Lafayette College

Environmental Poster Presentation
Fall 2013

"Think Globally, Act Locally" or
"Think Locally, Act Globally"
Which is it?"

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Event Summary

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 help 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
12. Organic Pest Management Practices at Lafayette
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
25. Not In My Backyard: The Future of Wind Energy in the US
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 CO_2 Removal
35. Organic Farming Practices

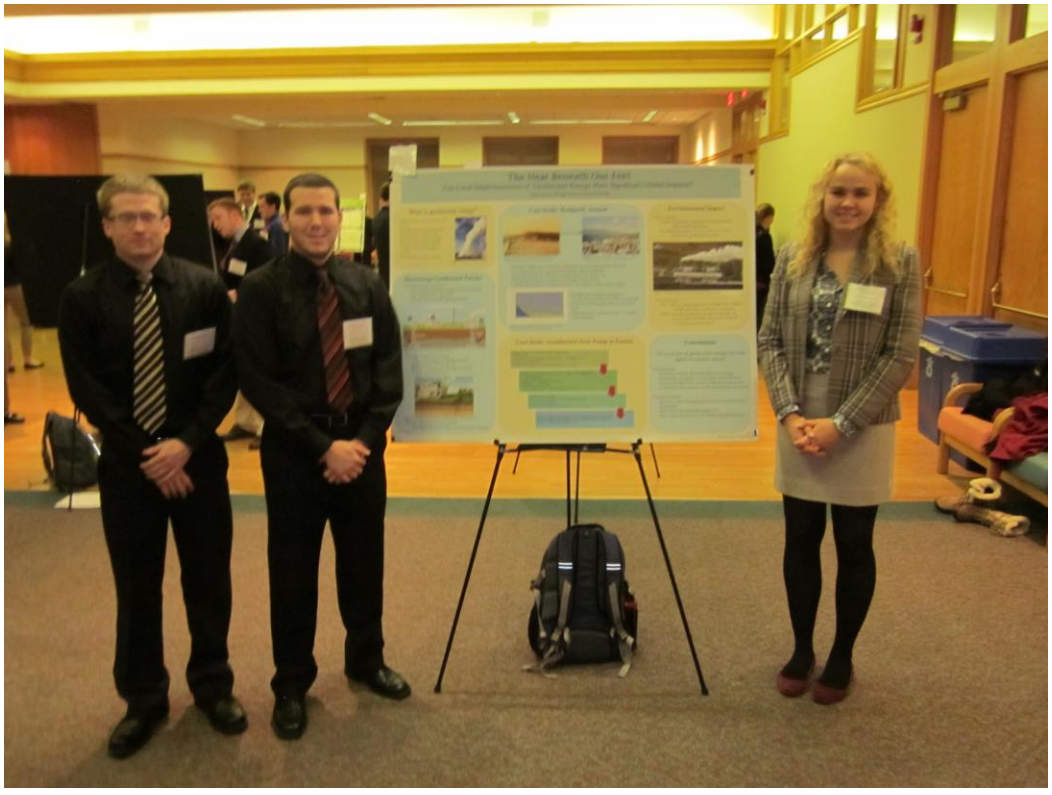
Poster #1

The Heat Beneath Our Feet

Matt Jouny, David Woods, and Bridgit Reeve

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 Jouny, Bridgit Reeve, David Woods

What is geothermal energy?

- Heat energy generated by the Earth
- Originates from radioactive decay in the Earth's core
- 50,000 times more energy than all fossil fuels within 10,000 meters of Earth's surface
- Renewable energy source

Figure 1: A geothermal hot spring

Harnessing Geothermal Energy

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

Figure 2: Diagram of Geothermal Power Plant

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

Figure 3: Animated schematic of a geothermal heat pump for a home

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

Case Study: Reykjavik, Iceland

Figure 4: Image of Reykjavik from 1932 when all buildings were heated by imported fossil fuels

Figure 5: Image of Reykjavic today where ~95% of the buildings are heated with geothermal water

- Up until 1960s, fossil fuels were primary source of electricity and heat
- Gradual transition to geothermal energy and hydropower
- Implementation of a district heating system for entire city
- Five geothermal power plants were built within 30 km
- Today, Reykjavik is considered one of the cleanest cities in the world

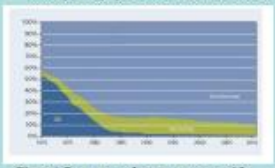


Figure 6: Percentages of energy sources used for space heating in Iceland over 40 years

- Geothermal energy accounts for 26.5% of electricity, over 90% of heating
- Only 0.1% of energy comes from fossil fuels
- Estimated CO^2 reductions of 3.5 million tons annually

Case Study: Geothermal Heat Pump in Easton

- Central Air (3.5kw @ 4months/year, 12 hours/day) = 5,000kWh/year
- Heating (8kw @ 5months/year, 12 hours/day) = 15,000kWh/year
- Capacity must exceed 8kw
- Get Bosch-Geo 6000 series rated at 38,200btu/hr (11.2kW)

- Coefficient of Performance COP = 4.5 = Q/W (4.5=20,000/W)
- W=4,600kWh/year
- 20,000-4,600=15,400kWh/year saved
- $.080/kWh in Easton, PA
- ~$1,230 saved per year; ~$18,450 saved per 15 years

- Estimated Price $15,000
- 30% Tax Credit (Energy Star) = $10,500 for system
- 15 year estimated lifetime
- $18450 saved - $10,500 spent = $7,950 saved over 15 years

Therefore, under these conditions, the amount of money the consumer saves in the long term negates the cost 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 US due to geothermal energy

Figure 7: Bagnore 4 geothermal power plant in Tuscany, Italy

- Air Emissions
  - Very little air emissions due to closed-loop system
    - Small amounts of mercury emissions
  - Sulfur dioxide emissions are approximately 30 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, so supply is more likely meet demand
  - Scarcity 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
  - Emits little environmental pollution
  - Safe to harness and use; no dangers in maintenance

*References as Requested

Poster #2

Wind Power at Metzgar Fields

Brendan Harney, Grace Waters, and Chris Castello

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.

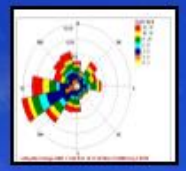
Our specific plan of action is to investigate what it would take for successful small-scale wind power development at Metzgar fields. In order to do so, we looked at how Lafayette invests into its current wind turbine and its performance. We analyzed the data from the current wind turbine and drew conclusions 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 has 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 globally Horizontal Axis Wind Turbines are much more popular, Vertical Axis turbines are better for Metzgar fields because of their height and higher efficiency with multi-directional wind
- Easton, PA is classified as low class 2-3 wind zone with average speeds of 4-5.5 m/s – these are the ideal speeds for a Windspire Standard Wind Unit with a 1.2 kW power rating
- Theoretical wind power is calculated using the density of air, rotor area, wind velocity, and performance coefficient of a turbine

$$P = \frac{1}{2} C_p \rho A v^3$$

- 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

# Turbines	kWh Produced (kWh/year)	Cost of Installation ($)	Saved Carbon Dioxide Emission (lbs)
1	2,000.00	2,000.00	2100
17	34,000.00	578,000.00	35700
53	106,000.00	5,618,000.00	111300
70	140,000.00	9,800,000.00	147000
11,850	23,700,000.00	280,845,000,000.00	24885000

Policies

Global

- Countries Commitment 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
  - -Earn 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 of investment, the best choice would be to power the maintenance building division of Metzgar fields.
  - -This would cost $795,000.00, save 111,300 pounds of CO_2 per year, and take 44 years to pay back the investment

Economics

Windspire Standard Wind Unit 1.2 kW installed at Metzgar Fields produces 2MWh per year – 2MWh saves around $220

This table represents the consumption, price rates, and expenditures of the college from July 1st, 2012 to June 30th, 2013

	Energy Consumption (kWh)	Price per kWh ($/kWh)	2012-2013 Expenditures ($)
Maintenance Building	105,984	0.167-0.17	17,680.60
Kamine Varsity House	32,800	0.11-0.113	3,694.31
College Hill Campus	23,614,765.52	0.09	2,158,095.19

This table shows how many turbines it would take to power different sections of Metzgar and the time to recoup the cost

# Turbines	Cost per Turbine ($)	Cost of Installation ($)	kWh Produced (kWh/year)	Theoretical Payback Period (Years)
1	15,000.00	15,000.00	2,000.00	68
17	15,000.00	255,000.00	34,000.00	68
53	15,000.00	795,000.00	106,000.00	44
70	15,000.00	1,050,000.00	140,000.00	49
11,850	15,000.00	177,750,000.00	23,700,000.00	83

The final table represents savings for Lafayette based on current prices from four different divisions of power

# Turbines	Savings (Maint. Bldg) ($/year)	Savings (Varsity) ($/year)	Savings (Campus) ($/year)
1	340	220	180
17	5780	3740	3060
53	18020	11660	9540
70	23800	15400	12600
11,850	4029000	2607000	2133000

References

Reference sheet is available upon request

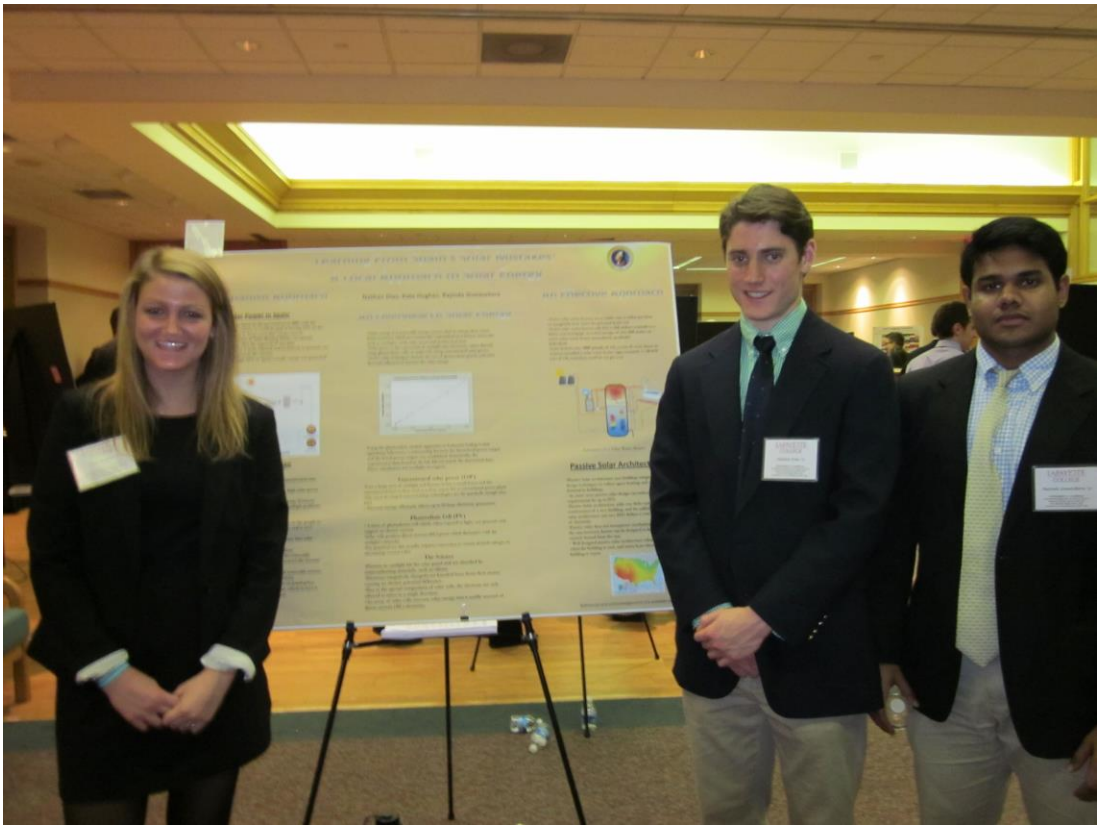
Poster #3

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.



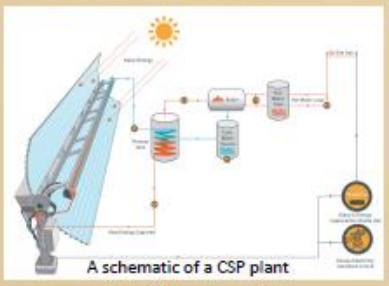
Learning From Spain's Solar Mistakes; A Local Approach to Solar Energy

Nathan Diaz, Kate Hughes, Rajinda Gunasekera

The Spanish Approach

Solar Power in Spain

•This plan was passed in Spain by the government in 2005 with the objective of leading the country to reach its goal of having 12% of the total energy consumed to be from renewable energy sources
  ○The presence 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, a all-time high 54% of Spain's totally energy was generated by renewable sources



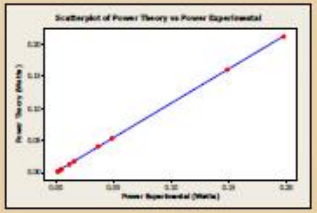
A schematic of a CSP plant

Renewable Energy Plan

•Spain is the country with the highest amount of concentrated solar power plants
•The majority of areas in Spain contain a relatively high solar power potential (5.0 kWh/m^2)
  •Encourages the utilization of solar energy (Gomez)
•The installation of miles of solar panels generated multiple problems
  ○Environmental problems
  ○Economical issues
•Spain is persistently putting pressure and regulations on the people to add and maintain solar panels to their personal homes and is over-generating solar power by roughly 60%
•The government is putting more money than necessary into solar power
  •Resulting in high debt, about $34 billion
•The country is planning to make civilians pay for the renewable energy they personally generate but attempting to restrict the amount of generates
  ○The cost to generate energy through renewable sources is higher than to use traditional electricity
•The PV market is complicated, whose success rests on panel prices which are dictated from the technology department, which in turn is effected by the consumer demand and PV purchases

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 is 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.



Using the photovoltaic module apparatus in Lafayette College's unit operations laboratory a relationship between the theoretical power output and the found power output was established. Statistically, the experimental data found in the lab did not match the theoretical data. These calculations are available on request.

Concentrated solar power (CSP)

•Uses a large area of sunlight and focuses it into a small beam and the concentrated heat is then used as 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.

Photovoltaic Cell (PV)

• A form of photoelectric cell which, when exposed to light, can generate and support 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 voltages or alternating current (AC)

The Science

•Photons in sunlight hit the solar panel and are absorbed by semiconducting materials, such as silicon.
•Electrons (negatively charged) are knocked loose from their atoms, causing an electric potential difference.
•Due to the special composition of solar cells, the electrons are only allowed to move in a single direction.
•An array of solar cells converts solar energy into a usable amount of direct current (DC) electricity.

An Effective Approach

•Active solar water heaters are a viable way to either pre-heat or completely heat water for personal home use
•Active solar water heaters add $13 to $20 dollars a month to a thirty year mortgage, so a fuel savings of over $20 makes an active solar water heater immediately profitable
Individual
•Solar heaters save 4000 pounds of CO_2 a year. If every home in Arizona installed a solar water heater approximately 5,728,670 tons of CO_2 emissions could be cut per year

Schematic of a Solar Water Heater

Passive Solar Architecture

•Passive Solar architecture uses building components and design techniques to reduce space heating and cooling demand in buildings.
• In some cases passive solar design can reduce heating requirements by up to 25%
•Passive Solar architecture adds very little costs to the construction of a new building, and the addition of passive solar architecture can save $511 dollars 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 releases heat when the building is cool, and stores heat when the building is warm

References and acknowledgements are available on request

Poster #4

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.

LAFAYETTE

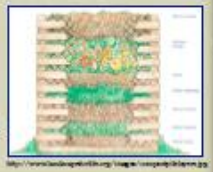
Composting: Application Beyond the Backyard Garden

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

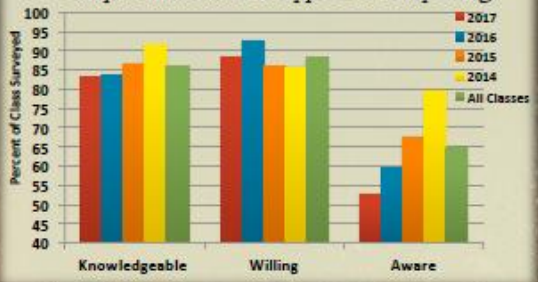
Current Food Loop at Lafayette

Dining halls → Food Waste → Pulpers in Marquis & Farinon → "Earth Tubs" at Hummel Lumber Yard → LaFarm → Dining halls

Students' Perceptions of Composting

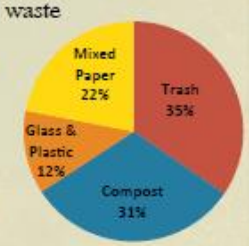
- Survey of 476 out of 2,478 students
- Questions:
  1. How much do you know about composting?
  2. Did you know that Lafayette composts?
  3. At which dining locations does Lafayette compost?
  4. Would you be willing to personally separate your food scraps from your trash?

Campus Awareness & Support of Composting



Waste Audit

- Took one day's worth of waste from Lower Farinon
- 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 windrows at LaFarm
- Composting in all retail dining facilities
  - Start with Lower Farinon
  - 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 longest 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.

Thank you to Prof. Kney, Prof. Brummel, Prof. Tavakoli, Prof. Waters, Plant Operations, Rodale Institute, LOSt, LEAP

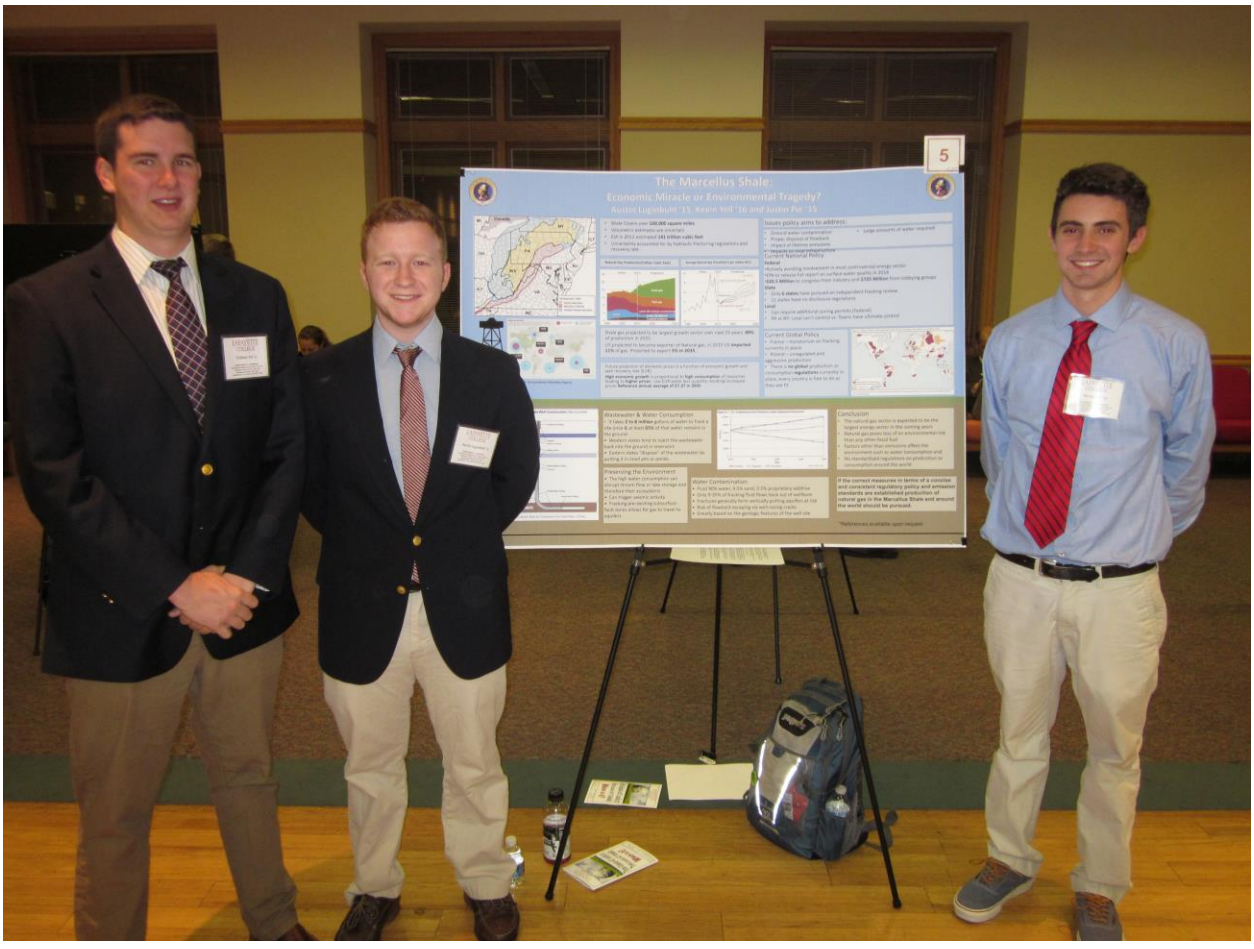
Poster #5

Marcellus Shale

Austin Luginbuhl, William Pie, and Kevin Yell

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.

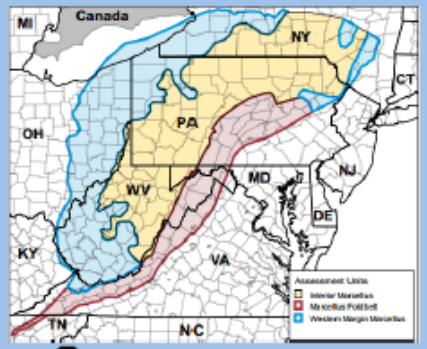
The Marcellus Shale is projected to be one of the largest growth sectors in the energy field. With an estimated 141 trillion cubic feet available for extraction, the next 25 years Shale gas is projected to grow to be 49% of the natural gas production in the United States. This gas can only be extracted by hydraulic fracturing. Fracking is an environmental hazard for a variety of reasons, which are explored in our poster.

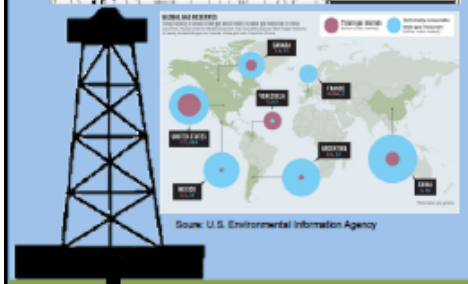


The Marcellus Shale:

Economic Miracle or Environmental Tragedy?

Austin Luginbuhl '15, Kevin Yell '16 and Justin Pié '15

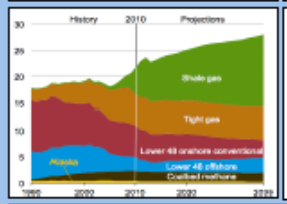




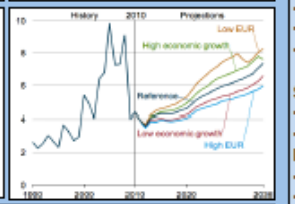
Source: U.S. Environmental Information Agency

- 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 rate

Natural Gas Production(Trillion Cubic Feet)



Average Natural Gas Price(2010 $ per million BTU)



Shale gas projected to be largest growth sector over next 25 years. **49%** of production in 2035.

US projected to become exporter of Natural gas, in 2010 US **imported 11%** of gas. Projected to export **5% 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 $7.37 in 2035**

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

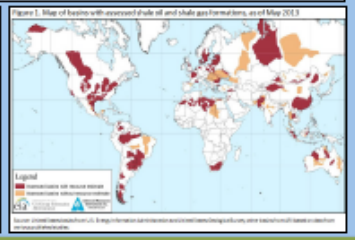
Federal
- Actively avoiding involvement in most controversial energy sector
- EPA to release full report on surface water quality in 2014
- **$20.5 Million** to congress from industry and **$725 Million** from lobbying groups

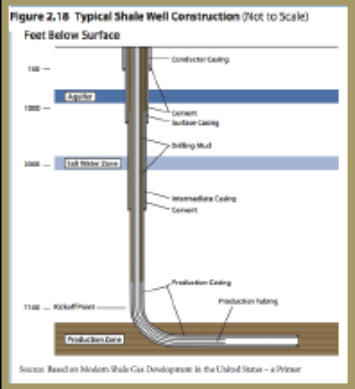
State
- Only **6 states** have pursued an independent fracking review
- 11 states have no disclosure regulations

Local
- Can require additional zoning permits (Federal)
- PA vs NY: Local can't 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

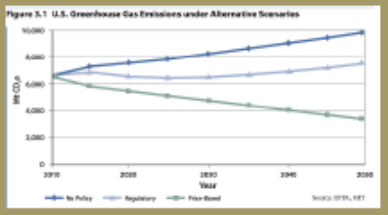




Source: Based on Modern Shale Gas Development in the United States – a Primer

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 for gas to travel to aquifers

Water Contamination

- Fluid 90% water, 9.5% sand, 0.5% proprietary additive
- Only 9-35% of fracking fluid flows back out of wellbore
- Fractures generally form vertically putting aquifers at risk
- Risk of flowback escaping via well-casing cracks
- Greatly based on the geologic features of the well site

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 production of natural gas in the Marcellus Shale and around the world should be pursued.

*References available upon request

Poster #6

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 ăt 3
- Mow often
- Leave grass clippings on lawn

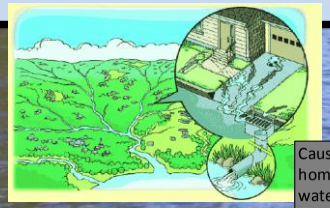
Yard waste
- Compost yard waste
- Never burn
- Never sweep into street or leave in storm drain

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



Causes of homeowner watershed pollution

Research:

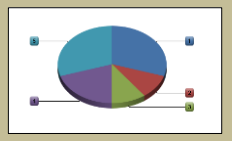
- Experimental survey
  - Control - Knowledge
  - Economic benefit - Limits?

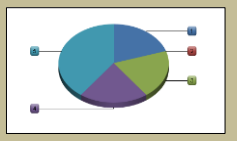
Results:

(Scale 1-5, 5 being most likely)

- Likeliness of purchasing and using organic mulch or organic pesticides on lawn

Knowledge –mean 3.10 *Control—mean 3.60*





- Likeliness to compost and mulch yard waste

Knowledge—mean 3.80 *Control—mean 4.20*

- Likeliness 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

References available upon request

Poster #7

Could the Deepwater Horizon Oil Spill Lead to a New Era of Environmentalism?

Colin Cavanagh, Zachary Heidrick, and Jeremy Cooley

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?

By:
Colin Cavanagh CE321, Zachary Heidrick EVST 100, Jeremy Cooley EVST 100

Problem Statement

Oil has become the lifeblood of modern day civilization and has sparked countless environmental concerns across the globe. Nested deep below the surface of the Earth, oil presents a daunting retrieval task and on April 20th, 2010 the BP oilrig in the Gulf of Mexico erupted spewing millions of barrels of oil into the ocean. This has sparked concerns for off shore drilling regulation, but is it enough to usher in a new "Golden Era" of environmental policy?

The Environmental Impact

- Within the Gulf Coast there are 14 marine species that are protected under US.
- The International Union for Conservation of Nature lists an additional 39 species that are at risk.
- The Gulf houses in total 15,419 species of living organisms, and is regarded as a breeding ground for many of these species.
- Sea grasses is regarded as the bottom of the food chain and if they begin to disappear so too will the species that live off of them.
- 32 national wildlife refuges affected
- Sargassum, a common brown algae, was devistated from the gulf oil spill

Road to Recovery

- The Oil Pollution Act of 1990 is the leading piece of legislature that is being cited in the case of the Deepwater Horizon Oil Spill.
- The National Resource Damage Assessment leads the restoration efforts.
- $4 Billion Dollar Criminal Settlement Reached between US and BP
- MMS disbanded and reorganized by Secretary of the Interior.
- Experts from various fields of study have been called upon in response to The Deepwater Horizon Oil Spill

Preventing Another Disaster

- Bringing together the science community, the regulatory agencies and the general public is more essential than ever before.
- Politics and Policy should remain separate from scientific study.
- New regulatory agencies must not allow the same violations to persist.
- Owners must be put on regulatory agencies to enforce regulations

New Innovations

- Nano Technology for cleaning spills used for the first time.
- Experimentation with Corexit 9500
- New spill Cleaning technologies developed during cleanup.
- Several oil cleaning contest to test new oil cleaning technologies.

Background

- The growing dependence on oil has resulted in a "drill first, ask questions later" mentality.
- The development of very elaborate blow out preventers has greatly increased the presence of offshore drilling .
- Fail safe measures required for the blow out preventer to work adequately were not in place on the rig.
- MMS Lack of power to sufficiently manage and regulate oil rigs.

Conclusions

- The BP oil spill was the greatest environmental disaster in American history.
- Several advancements in both policy and technology followed the spill.
- Science and research should dictate a political call to action
- Nothing is full proof and that due diligence is invaluable

References

- Full list of references available upon request.

Poster #8

Benefits of the Green Roof Initiative

Kerry Teemsma, Dwight Norrgard, and Dane Bolash

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.

Benefits of the Green Roof Initiative

Made By: Kerry Teemsma (CE321), Dwight Norrgard (CE321), and Dane Bolash (EVST100)

Environmental Changes

- Increased polluted runoff
- Depletion of water quality
- Loss of ecosystems
- Loss of organism diversity
- "Heat Island" Effect
- Reduction of O_2 emission
- Lessened Air Quality

Green Roof Benefits

Environmental:

- Manage Storm Water
- Filter Pollutants
- Increase Wildlife Habitat
- Save Energy
- Improve Air Quality
- Buffer Noise
- Reduce Urban Heat-Island Effect

Economic:

- Increase Lifespan of Roof
- Reduce Storm Water Development Charges
- Reduce Storm Water Detention Costs
- Lower Heating and Cooling Costs
- LEED Credits

Social:

- Improve Community Livability
- Create Green Spaces
- Provide Educational Opportunities
- Connect Community with Environment

Problem Statement

The removal of green spaces due to urban development has led to many detrimental changes to the environment.

Case Study

Whatcom Lightcatcher Museum, Bellingham, WA

Purpose: To test the significance of green roofs in the reduction of water run-off and system loads for wastewater treatment facilities.

Year Installed: 2009

Roof Type: Extensive, Flat

Area: 2,700 ft^2

Soil Depth: 4" on layout, 6" at HVAC and other rooftop infrastructure

Plants: Modular Flats of Pre-cultured Sedums

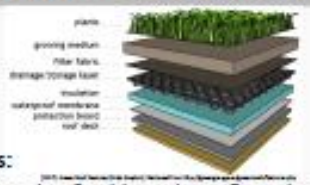
Cost: $35,000 or $16/ft^2

Conclusion and Future Research

The **Green Roof Initiative** is not only environmentally beneficial, but also provides various economic and social benefits that makes it a viable practice.

The **future plan** is to build a small-scale model green roof and run various comparison tests between the implemented green roof model and a standard roof model.

Green Roof Components



Types:

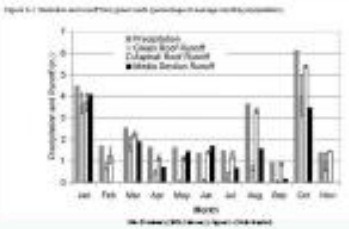
- Intensive, Semi-Intensive or Extensive
- Built-In-Place (BIP) or Modular

Implementation Outcome

According to Case Study, by the City of Bellingham and Sustainable Connections

- Reduced Outflows by 40-65%
- Lifespan of 40 years or greater
- Reduced Energy Demand by 5-15%
- Roofing Upgrades: $15-$25/ft^2
- Newly built: $10-$15/ft^2

Green vs. Asphalt Roof



Poster #9

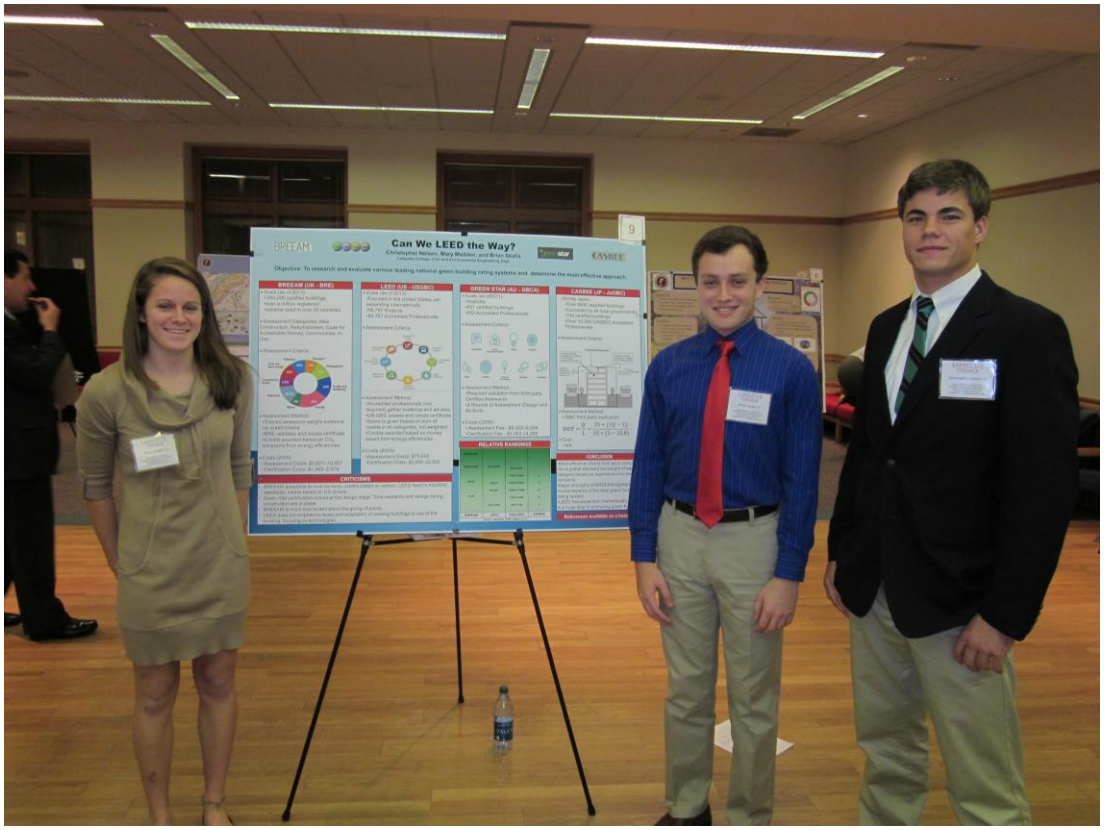
Green Building: LEED

Chris Nelson, Marry Maden, and Brian Skalla

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 systems 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.



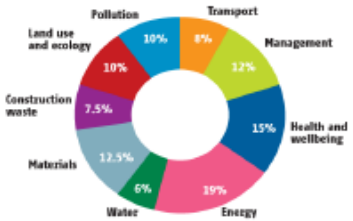
Can We LEED the Way?

Christopher Nelsen, 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:



- Assessment Method:
  - Trained assessors weighs evidence vs. credit criteria
  - BRE validates and issues certificate
  - Credits awarded based on CO_2 emissions from energy efficiencies
- Costs (2009)
  - Assessment Costs: $3,971–19,857
  - Certification Costs: $1,469–2,979

LEED (US - USGBC)

- Scale (as of 2013):
  - Focused in the United States, yet expanding internationally
  - 56,797 Projects
  - 88,767 Accredited Professionals
- Assessment Criteria:

- Assessment Method:
  - Accredited professionals (not required) gather evidence and advises
  - US-GBC assess and issues certificate
  - Score is given based on sum of credits in all categories, not weighted.
  - Credits awarded based on money saved from energy efficiencies
- Costs (2009):
  - Assessment Costs: $75,000
  - Certification Costs: $2,250–22,500

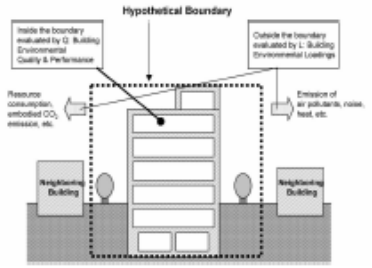
GREEN STAR (AU - GBCA)

- Scale (as of2011):
  - Australia
  - 631 certified buildings
  - 952 Accredited Professionals
- Assessment Criteria:

- Assessment Method:
  - Required validation from third party Certified Assessors
  - 2 Rounds of Assessment (Design and As Built)
- Costs (2009):
  - Assessment Fee - $4,002–8,004
  - Certification Fee - $5,063-14,268

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:



- Assessment Method:
  - JSBC third party evaluation

$$BEE = \frac{Q}{L} = \frac{25 * (SQ - 1)}{25 * (5 - SLR)}$$

- Cost:
  - NA

RELATIVE RANKINGS

BREEAM	LEED	Green Star	CASBEE
EXCELLENT			
VERY GOOD	PLATINUM	SIX STARS	
		FIVE STARS	S
GOOD	GOLD	FOUR STARS	A
	SILVER	THREE STARS	B+
PASS		TWO STARS	B-
	CERTIFIED	ONE STAR	C

Source: Saunders, 2008, Table 3, p.41

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 lenient about the giving of points.
- LEED does not emphasize reuse and adaptation of existing buildings or use of the building, focusing on technologies.

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

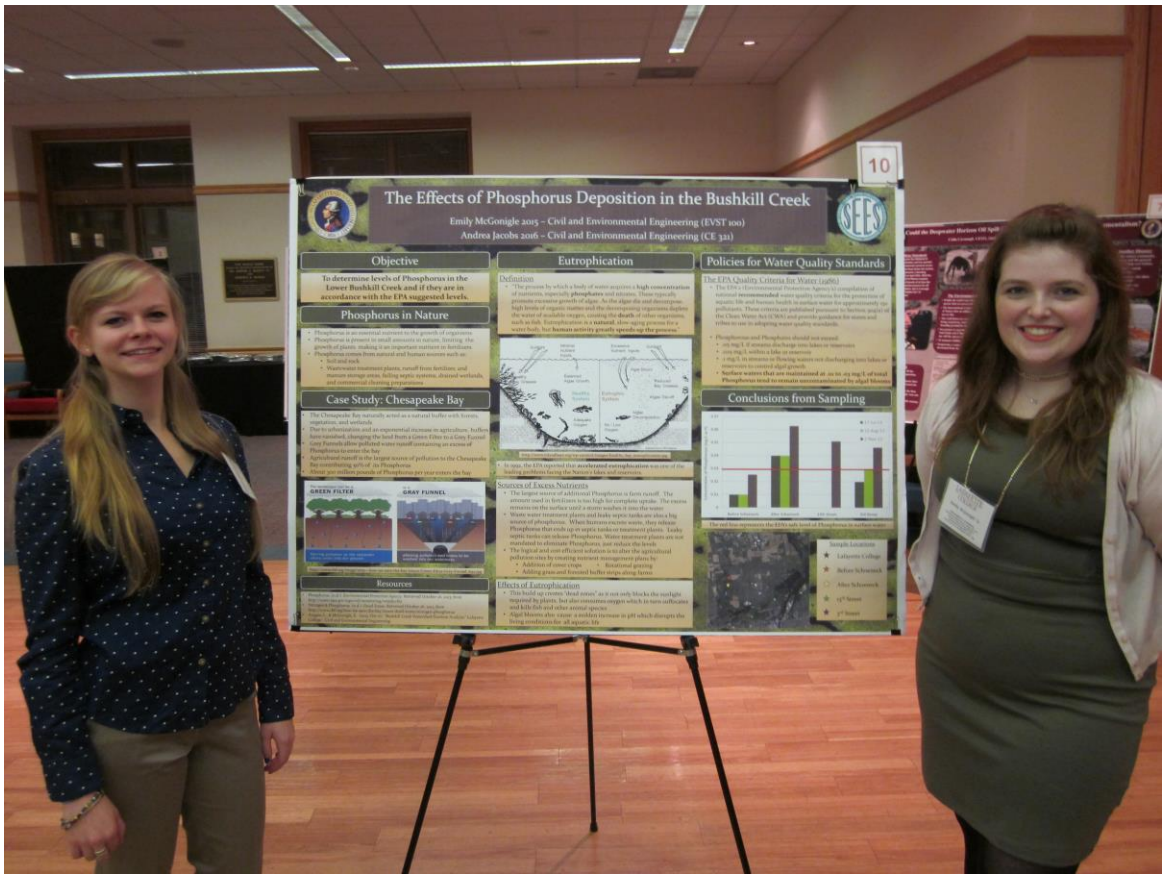
References available as a handout

Poster #10

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, runoff from fertilizer, and manure storage areas, failing septic systems, drained wetlands, and commercial cleaning preparations

Case Study: Chesapeake Bay

- The Chesapeake Bay naturally acted 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 Grey Funnel
- Grey Funnels allow polluted water runoff containing an excess of Phosphorus to enter the bay
- Agricultural runoff is the largest source of pollution to the Chesapeake Bay contributing 50% of its Phosphorus
- About 300 million pounds of Phosphorus per year enters the bay

http://www.cbf.org/image/area---how-we-save-the-bay/issues/Green-Filter-Grey-Funnel_695.jpg

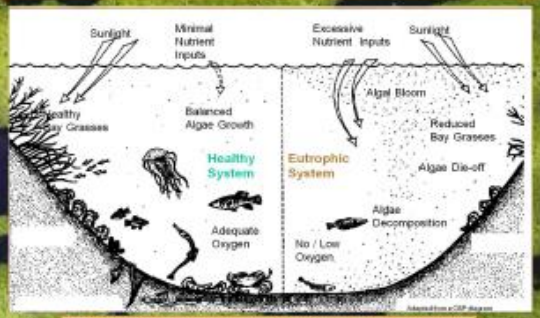
Resources

- Phosphorus. (n.d.). *Environmental Protection Agency*. Retrieved October 26, 2015, from http://water.epa.gov/type/rl/monitoring/vms56.cfm
- Nitrogen & Phosphorus. (n.d.). Dead Zones. Retrieved October 26, 2015, from http://www.cbf.org/how-we-save-the-bay/issues/dead-zones/nitrogen-phosphorus
- Amgaw, L., & McGonigle, E. (2015, Oct 17). "Bushkill Creek Watershed Nutrient Analysis." Lafayette College - Civil and Environmental Engineering

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.**'



http://www.inlandbays.org/wp-content/images/healthy_bay_eutrophication.jpg

- In 1992, 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 a storm washes it into the water
- Waste water treatment plants and leaky septic tanks are also a big source of phosphorus. When humans excrete waste, they release Phosphorus that ends up in septic tanks or treatment plants. Leaky septic tanks can release Phosphorus. Water treatment plants are not mandated to eliminate Phosphorus, just reduce the levels
- The logical and cost efficient 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 zones" as it not only blocks the sunlight required by plants, but also consumes oxygen which in turn suffocates and kills fish and other animal 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 Quality Criteria for Water (1986)

- The EPA's (Environmental Protection Agency's) compilation of national **recommended** water quality criteria for the protection of aquatic life and human health in surface water for approximately 150 pollutants. These criteria are published pursuant to Section 304(a) of the Clean Water Act (CWA) and provide guidance for states and tribes to use in adopting water quality standards.

- Phosphorous and Phosphates should not exceed:
  - .05 mg/L if streams discharge into lakes or reservoirs
  - .025 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 .01 to .03 mg/L of total Phosphorus tend to remain uncontaminated by algal blooms**

Conclusions from Sampling

The red line represents the EPA's safe level of Phosphorus in surface water

Sample Locations

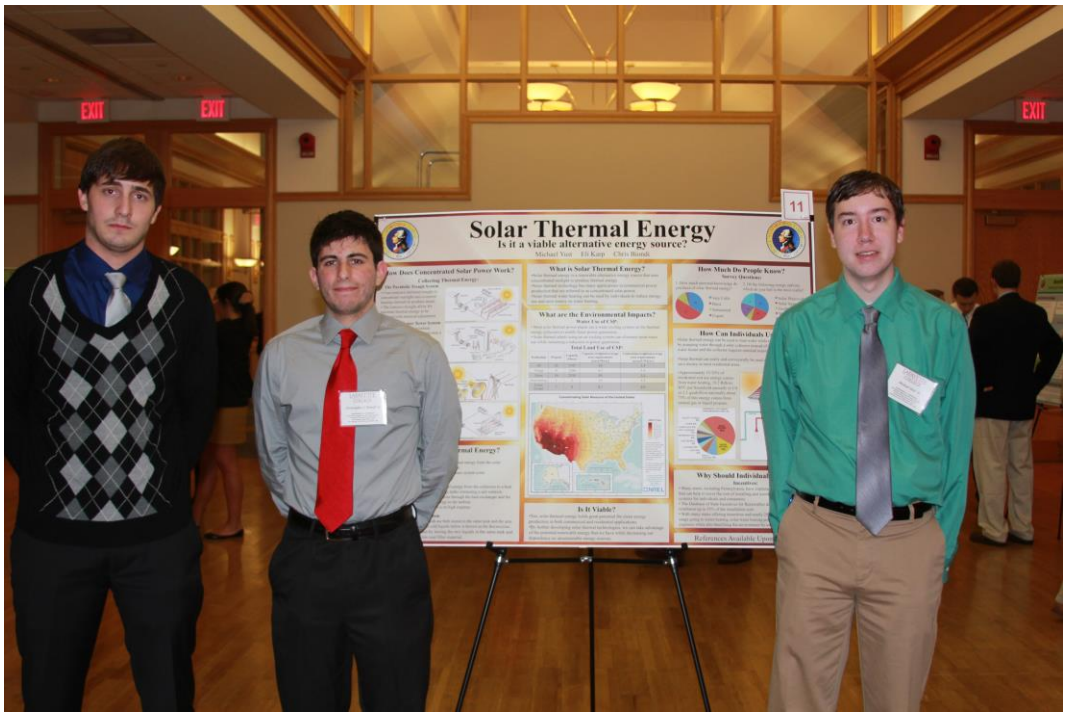
- Lafayette College
- Before Schoeneck
- After Schoeneck
- 13th Street
- 3rd Street

Poster #11

Solar Thermal Energy

Eli Karp, Chris Bondi, and Michael Yust

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 by 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.



Solar Thermal Energy

Is it a viable alternative energy source?

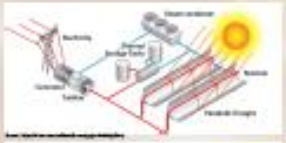
Michael Yust Eli Karp Chris Biondi

How Does Concentrated Solar Power Work?

Collecting Thermal Energy:

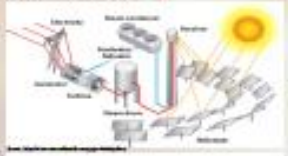
1. The Parabolic Trough System

- Uses concave mirrored troughs to concentrate sunlight onto a central heating element to produce steam.
- The concave troughs allow for maximal thermal energy to be gathered with minimal adjustment.



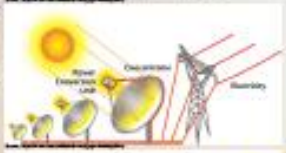
2. The Solar Power Tower System

- Uses heliostats to concentrate sunlight onto a heating element atop a large tower to produce steam.
- The swiveling heliostats allow for maximal thermal energy to be gathered throughout the day.



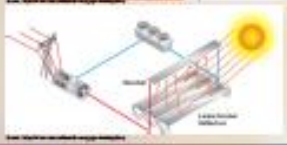
3. The Stirling Engine Dish System

- Uses a large concave mirrored dish to concentrate sunlight into a Stirling engine conversion unit.
- The use of a Stirling engine negates the need for power conversion facilities allowing more versatile use.



4. The Linear Fresnel System

- Uses multiple long flat mirrors to concentrate sunlight onto a central overhead heating element.
- The angles of the mirrors can be adjusted to maximize thermal energy collection throughout the day.



How Do You Store Thermal Energy?

1. Two-Tank Direct System

- Uses heat transfer fluid to transfer and store thermal energy from the solar collectors which can be used later to produce steam.
- Requires pressurized tanks that can greatly increase system costs.

2. Two-Tank Indirect System

- Heat transfer fluid is used to transfer thermal energy from the collectors to a heat exchanger where it is transferred into storage tanks containing a salt solution.
- To create steam, the process is run in reverse through the heat exchanger and the heat transfer fluid carries the thermal energy to the turbine.
- The main disadvantage of this system is its high expense.

3. Single-Tank Thermocline System

- The hot and cold heat transfer fluids are both stored in the same tank and the area between hot liquids at the top and cold liquids below is known as the thermocline.
- This method can reduce costs by storing the two liquids in the same tank and replacing much of it with a low cost filler material.

What is Solar Thermal Energy?

- Solar thermal energy is a renewable alternative energy source that uses concentrated sunlight to produce thermal energy.
- Solar thermal technology has many applications in commercial power production that are referred to as concentrated solar power.
- Solar thermal water heating can be used by individuals to reduce energy use and save money on water heating.

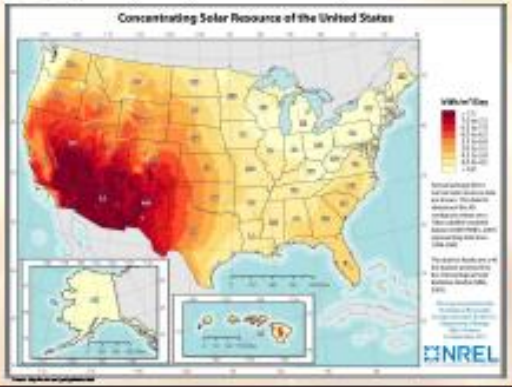
What are the Environmental Impacts?

Water Use of CSP:

- Most solar thermal power plants use a water cooling system on the thermal energy collectors to enable faster power generation.
- Solar thermal plants using an air cooling system can eliminate most water use while sustaining a reduction in power generation.

Total Land Use of CSP:

Technology	Projects	Capacity (Mwac)	Capacity weighted average area requirements (acres/Mwac)	Generation weighted average area requirements (acres/GWh/yr)
All	25	2747	10	5.5
Trough	8	1380	9.5	3.9
Tower	14	2358	10	5.2
Dish Stirling	1	5	10	5.3
Linear Fresnel	1	8	4.7	6.0



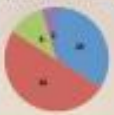
Is It Viable?

- Yes, solar thermal energy holds great potential for clean energy production in both commercial and residential applications.
- By further developing solar thermal technologies, we can take advantage of the potential renewable energy that we have while decreasing our dependence on unsustainable energy sources.

How Much Do People Know?

Survey Questions:

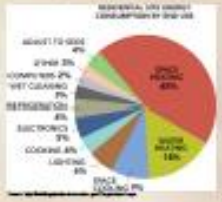
1. How much personal knowledge do you have of solar thermal energy?

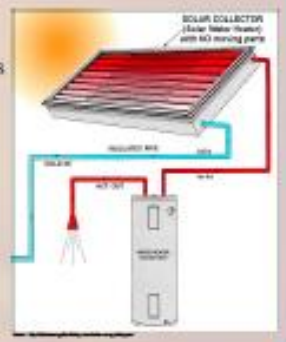


2. Of the following energy options, which do you feel is the most viable?

How Can Individuals Use It?

- Solar thermal energy can be used to heat water while reducing electrical costs by pumping water through a solar collector instead of using a fuel powered water heater and the collector requires minimal maintenance after installation.
- Solar thermal can easily and conveniently be used to conserve energy and save money in most residential areas.
- Approximately 15-20% of residential end use energy comes from water heating, 19.2 Billion BTU per household annually in US or 2.1 quadrillion nationally about 75% of this energy comes from natural gas or liquid propane.





Why Should Individuals Use It?

Incentives:

- Many states, including Pennsylvania, have implemented incentive programs that can help to cover the cost of installing and maintaining solar thermal systems for individuals and companies.
- The Database of State Incentives for Renewables & Efficiency (DSIRE) will reimburse up to 35% of the installation cost.
- With many states offering incentives and nearly 20% of residential power usage going to water heating, solar water heating provides a way to reduce expenses while also benefiting the environment by using less energy.

References Available Upon Request

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 Kaitlin Geraghty, Connor Lenox, and Yinan Xiong
What is "Organic" Gardening?
•Integration of cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity (USDA)
•Standards for certification, production, handling and labeling are set by the USDA
•Organic farmland comprises only .9% (as of 2011) of the world's total available farmland
Origins and Significance of Organic Pest Management
Rachael Carson's Silent Spring changed the way we look at chemicals and the environment
Described the dangers of unregulated pesticide use
Proposed society had to work with the environment, not against it
Sustainable method to control pest populations
Why Garden Organically?
Pros
Cons
Environmental
Avoids pollution of harmful chemicals
Targets specific species
Does not induce pest resurgence
Promotes biodiversity
Sustainable
Social
Prevents health effects from human consumption of toxic chemicals
Economic
Costly to remedy problems
Practical
Labor intensive
No well established or long-term effective techniques
Not as reliable as conventional methods
Economic
Lower quantity and quality of production
10-20% increase in cost
Techniques: Present and Future
Present
Crop Rotation
Maintenance of Soil Health
Pre-Growth of Healthy Plants
Row Covers
Hand removal
Trap/Cover Crop
Beneficial Insects
Predator Birds/Insects
Organic Sprays (Surround)
Future
•Focus on Healthy Soil
•Daily Scouting
•Crop Rotation
•Crop Residue clean up
•Weed Control
•Early Organic Treatment
"I am hoping to get LaFarm to be a culturally balanced, biologically diverse ecosystem."
-Sarah Edmonds, LaFarm Manager
(S. Edmonds, pers. comm.)
Case Study: LaFarm
Experiment: Pest Control Methodologies in the Lafayette Organic Garden
(Performed by Julia Seidenstein in Summer 2011)
Problem: Control of squash bugs, cucumber beetles and squash vine borers
Question: Which organic pest management techniques are most effective at LaFarm?
Labor Intensive
If sprayed directly on pest
Plants sprayed grew better
Keeps pest numbers from getting out of hand
Other plants may be more effective
Keeps plant alive for a little while but does not save it
What do Lafayette Students Think about Organic Products?
Given the 10-20% added cost of organic products, would you choose conventionally grown products over organic products?
Very Likely
Somewhat Likely
Not Likely
The Rodale Institute
Natural Agriculture
•Encourages nature to create its own sustainable balance
•Growth of food without fertilizers, chemicals, or additives
•Relationship between the soil, crops and environment
Natural Agriculture and Pest Management
•Beneficial Pests
•Pests signal an imbalance of soil nutrients
•Grow more of a pest prone crop and/or harvest earlier
Current Project: Organic Management of Brown Marmorated Stink Bug through Behavior-based Habitat Manipulation
•Goal to develop BMSB management techniques based around behavior of BMSB and the application of core organic pest management principles
Conclusions
•Organic Farming is growing produce while conserving resources and promoting cultural balance and biodiversity
•Pros of organic pest management outweigh cons
•Many organic pest management techniques (depends on plant and pest)
•LaFarm hopes to use its organic techniques to become a 'culturally balanced, biologically diverse ecosystem'
•Lafayette students are currently not likely to pay more for organic products
•The Rodale Institute focused on the importance of healthy soil in organic pest management
Resources
Bianchi, F., Booij, C., and Tscharntke, T. (2006). Sustainable Pest Regulation in Agricultural Landscapes: A Review on Landscape Composition, Biodiversity and Natural Pest Control. London: The Royal Society
Bell, J. (n.d.). Organic Pest Control Research at Lafayette College by Julia Seidenstein. LaFarm The Lafayette College Community Garden Working Farm. Retrieved November 11, 2013, from https://sites.lafayette.edu/lafarmblog/2012/03/22/organic-pest-control-research-at-lafayette-college-by-julia-seidenstein/
Shumei Natural Agriculture | Rodale Institute. (n.d.). Rodale Institute. Retrieved November 11, 2013, from http://rodaleinstitute.org/our-work/shumei-natural-agriculture/
Additional resources available upon request

Poster #13

The Ecological Consequences of the American Lawn

Elizabeth Osborn and Steve Allaico

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 Allaico and Elizabeth Osborn, Lafayette College

Introduction

Modern gardening and lawn keeping 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 163,800 km² (±35,850 km²) and is expanding rapidly due to urbanization (Cheng, Z. et al. 2008). The cultural obsession with a perfect, suburban lawn is largely responsible for the growth of turfgrass lawns and the overuse 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 the study was to examine the soil quality at various locations under different management practices and to explore the connections between biological need 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 trend of high chemical inputs on turfgrass lawns.

http://earthobservatory.nasa.gov/Features/Lawn/lawn2.php

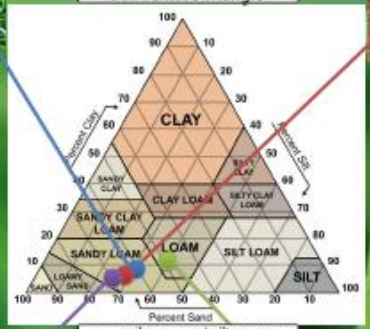
Methods

Soil Texture Analysis and Soil Moisture Density tests as described in Soil Lab Manual by Dr. Nancy Waters (2012). % Bulk density has an inverse relationship with % moisture density.

Soil collection at Elizabeth's House, Arlington, VA
This soil had the lowest % bulk density, indicating that it has the least amount of soil compaction. This is likely due to the fact that the soil is on a private lawn, not subject to frequent use, located on a slope or near a road.

The perfect lawn is one that is weed free, trim, uniformly thick, vibrantly green, and aesthetically pleasing.
- Joseph Dorsey (2010)

Soil Texture Triangle



www.soilsensor.com/soiltypes.aspx

Soil collection behind Farber Hall
This soil had the highest % sand, indicating that it is more porous, allowing greater aeration.

Soil collection along Bushkill Creek
This soil had the lowest % clay, indicating that it may be the least drought-resistant of the sampled soils.

Soil collection at the Organic Garden
This soil had the highest % clay, which suggests that it could be more drought-resistant. Due to their fine particles, clay soils have the small pore spaces and high surface area (NCDA&CS Agronomic Division). These properties allow clay soils to retain water more effectively than larger sand or silt particles.

Results

Figure #1: Soil Texture Analysis

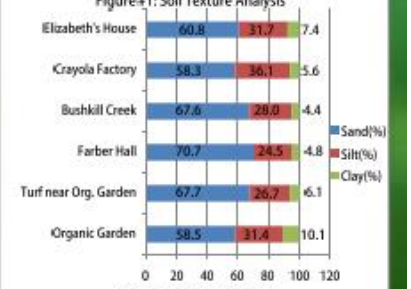


Table #1: % Bulk Density

	Elizabeth's House	Crayola Factory	Bushkill Creek	Farber Hall	Turf near Org. Garden	Organic Garden
Bulk Density (%)	78.4	79.8	82.9	83.4	82.3	83.1

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 of healthy types (loam and sand loam), good for growing turf grass (Penn State Extension).

In 2001, Americans spent $700 million on pesticides and $5.2 billion on fossil fuel-based fertilizers (Simmons 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 $48 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

Poster #14

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.

Can the Quad be a Learning Environment?

by Bonnie Malhotra, Nico Alarcon, and Andrew Haff

Think Globally

Reduce emissions and increase green space

- Modern Lifestyles disconnect people from nature and may have adverse effects on peoples well being and environmental sustainability. Experiment found people underestimate level of happiness when walking outdoors, overestimated level of happiness when walking indoors.
- Conflicting Stakeholder interests halt green space production.
- Individuals who live closer to green spaces have higher life satisfaction and lower mental distress controlling for variables such as income, marital status and employment.
- Statistically significant correlations were found between green users and responses to overall quality of life questions. Results suggest campus green spaces and their availability have a contributing factor to retention rate.

Increase of green space

Do we have happy students?

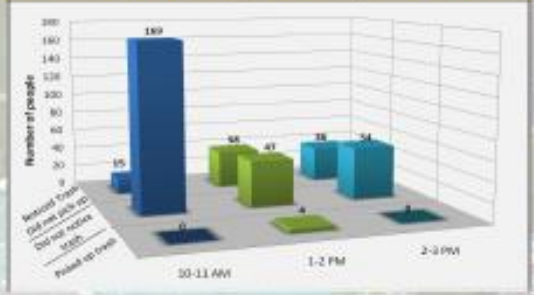
The increase of green space has led to higher sustainability, but can we assume higher sustainability leads to better well-being of students?

Act Locally

Quad Project 2009

- Anderson Courtyard, Pardee Drive – removed, encouraging less vehicular traffic and more pedestrian traffic
- Pedestrian friendly walkways; paths were mapped out based on studies which analyzed most trodden paths
- Promote the use of the Quad – more safe access
- Addition of over 40,000 trees, shrubs and plants

Results of Trash Observation on Quad



Students' Opinion on Quad's Image

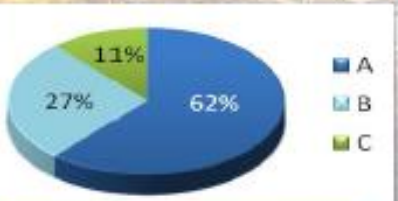


Figure 3. The results of survey conducted. A: It's a place for social interaction for students on campus. B: The numerous trees, plants and pathways add to the beauty of the campus. C: It supports sustainable behaviors with its locations if trash cans/recycling bins, increased walkways to reduce emissions and overall green space to encourage preservation of our environment.

Quad's Effect on Campus Life

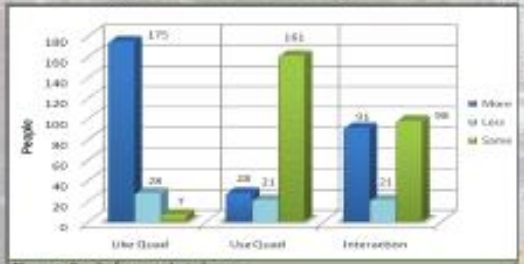


Figure 2. Results from conducted survey

Quad's Sustainability

- Reduced emissions by reducing amount of roadways present; this led to a decrease of vehicular traffic.
- Water usage has been more carefully regulated
- New irrigation system has increased rainwater efficiency.
- 37% of the people have changed their method of transportation. 60% of the people were not affected.

*References Available upon request

Poster #15

Recycling Promotion

Andrew Halloran, Tory Bingaman, and Faris Chugthau

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 – 30,000lbs 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 abstain 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:

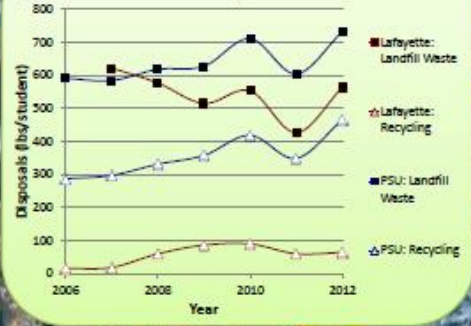
-Incorporate the block program through the RHC to promote recycling on campus

-Experimenting with the placement and convenience of recycling receptacles on and around campus

Figure 1 (Ramer Hall)

Figure 2 (Ruef Hall)

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

Acknowledements & References:

George Xiques (personal correspondence, Oct 2013)

Anthony Post (personal correspondence, Oct 2013)

LEAP

Background image courtesy of GLSANY

References available upon request

Poster #16

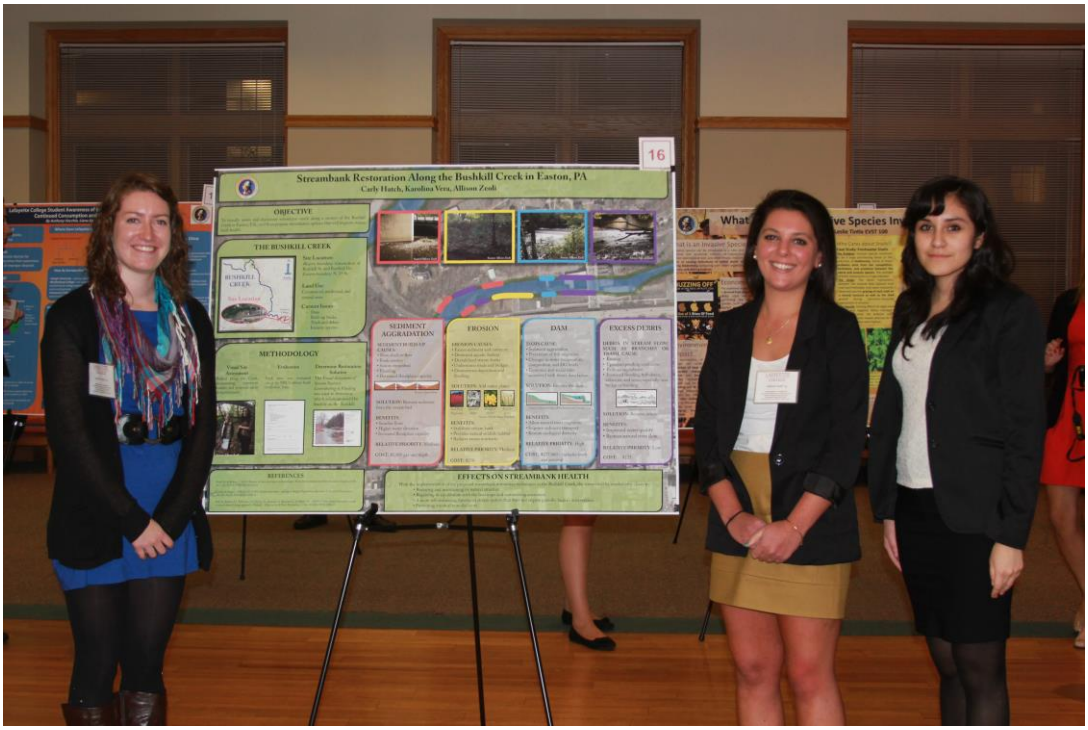
Stream Bank Restoration Along the Bushkill Creek in Easton, PA

Carly Hatch, Allison Zeoli, and Karolina Vera

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 stream bank health.

THE BUSHKILL CREEK

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

Land Use:
Commercial, residential, and natural areas

Current Issues:
- Dam
- Built-up banks
- Trash and debris
- Invasive species

METHODOLOGY

Visual Site Assessment
Walked along the Creek, documenting important features and potential areas of improvement.

Evaluation
Each area was evaluated using an NRCS stream bank evaluation form.

Determine Restoration Solution
The *Visual Assessment of Stream Features Contributing to Flooding* was used to determine which solutions would be feasible on the Bushkill.

SEDIMENT AGGRADATION

SEDIMENT BUILD-UP CAUSES:
- Slow, shallow flow
- Bank erosion
- Scours streambed
- Flooding
- Decreased floodplain capacity

Source: Open Notes

SOLUTION: Remove sediment from the stream bed

BENEFITS:
- Steadier flows
- Higher water elevation
- Increased floodplain capacity

RELATIVE PRIORITY: Medium

COST: $5,000 per unit depth

EROSION

EROSION CAUSES:
- Excess sediment and nutrients
- Destroyed aquatic habitat
- Destabilized stream banks
- Undermines roads and bridges
- Downstream deposition and flooding

SOLUTION: Add native plants

Source: USDA Plants Database

BENEFITS:
- Stabilizes stream bank
- Provides natural wildlife habitat
- Reduces excess nutrients

RELATIVE PRIORITY: Medium

COST: $250

DAM

DAMS CAUSE:
- Sediment aggradation
- Prevention of fish migration
- Changes in water temperature, composition, and DO levels
- Economic and social risks associated with future dam failure

SOLUTION: Remove the dam

Source: Vermont Dept. of Environmental Conservation

BENEFITS:
- Allow natural trout migration
- Improve sediment transport
- Restore ecological diversity

RELATIVE PRIORITY: High

COST: $227,000 – includes study and removal

EXCESS DEBRIS

DEBRIS IN STREAM FLOW, SUCH AS BRANCHES OR TRASH, CAUSE:
- Erosion
- Upstream ponding conditions
- Bedload aggradation
- Increased flooding, turbulence, velocities, and scour, especially near bridge or building

Source: [illegible]

SOLUTION: Remove debris

BENEFITS:
- Improved water quality
- Restore natural river flow

RELATIVE PRIORITY: Low

COST: $125

REFERENCES

Baird, D., & Klarup, C. (2012). Review of river restoration methodologies. *World Environmental and Water Resource Congress*, 2658-2671. doi: 10.1061/9780784412312.268

Cassells, J., Rapp, J., & Burns, M. (1998). Stream restoration - getting to design. *Engineering Approaches to Ecosystem Restoration*, 102-107. doi: 10.1061/40282(1998)16

Dahl, B., Jenkins, J. J., Patterson, J., Coleman, N., Jennings, G., Buckner, C., & Mayes, D. (2001). Urban stream restoration using a natural channel design approach. *Wetlands Engineering & River Restoration* 1-7. doi: 10.1061/40581(2001)2

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 its natural structure
- Regaining its equilibrium with the landscape and surrounding ecosystem
- A more self-sustaining, functional stream system that does not require periodic human intervention
- Preventing eventual remedial costs

Poster #17

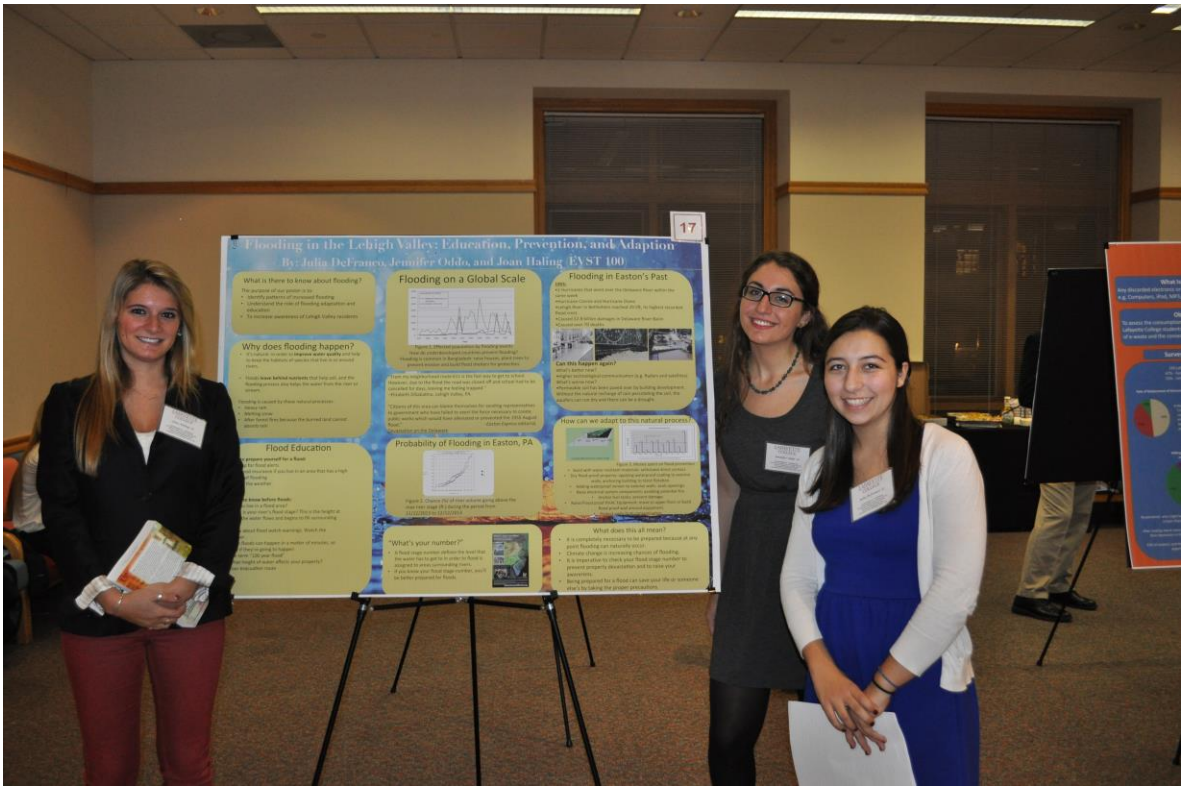
Flooding in the Lehigh Valley

Jen Oddo, Joanie Haling, and Julia DeFranco

We researched flooding in the Lehigh Valley for our poster project. As residents of this area, it is extremely important that we have an understanding of our surroundings and how they can affect our life. Not only is the topic of flooding interesting, but 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?

The purpose of our poster is to:

- 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

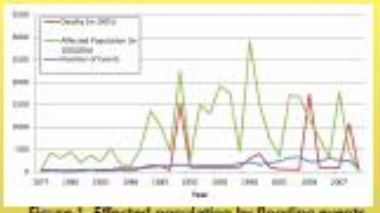


Figure 1. Effected population by flooding events

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 DiSabatino, 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

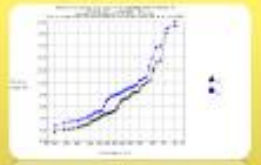


Figure 2. Chance (%) of river volume going above the max river stage (ft.) during the period from 11/12/2013 to 12/12/2013

"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 29.5ft, 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 flood-proof property: applying waterproof coating to exterior walls, anchoring building to resist flotation.
- Adding waterproof veneer to exterior walls: seals openings.
- Raise electrical system components: avoiding potential fire.
- Anchor fuel tanks: prevent damage.
- Raise/Flood proof HVAC Equipment: move to upper floor or build flood proof wall around equipment.
- Protect wells from contamination

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.

Poster #18

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 Agrios, and Clyde Gross

What Is E-Waste?

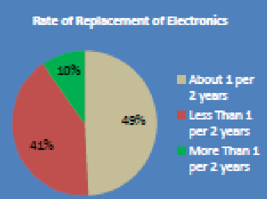
Any discarded electronic or electrical device.
e.g. Computers, iPod, MP3, Cell Phone

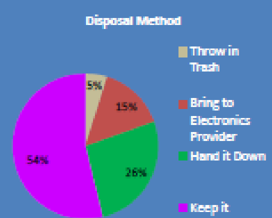
Objectives

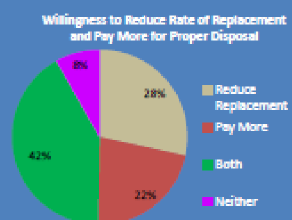
To assess the consumption of electronic devices by Lafayette College students. To determine their awareness of e-waste and the consequences of improper disposal.

Survey Findings

193 Lafayette students
67% - Familiar with e-waste
33% - Unfamiliar with e-waste







Respondents who might be willing to pay more for their electronics in order to ensure proper disposal would pay an additional $19 on average.

After reading about some negative effects of e-waste, 78% of the students that throw their electronics in the trash would pay more, reduce consumption, or both.

92% of students said they are willing to reduce their purchase rate and if given the opportunity, would pay more for proper disposal.

Where Does Lafayette College's E-Waste Go?

College-Owned Electronics → Schools, Non-Profits; Jontech
Personal Electronics → Raritan Valley Disposal → Liberty Recycling
Jontech, Liberty Recycling: 3.5 tons of electronics

How do Surrounding Colleges Handle E-waste?

- Lehigh University – spring collection event
- Muhlenberg College – no student disposal program; recycle/reuse college-owned equipment with 85-90% going to community groups
- Centenary College – Earth Day sponsored by 5R Processors event to pick up/recycle e-waste

Who Produces E-waste?

- 20-50 million tonnes/year
- United States – 3 million tonnes/year
- China – 2.3 million tonnes/year

Where does it go?

- China
- India

Figure 2. E-waste in China. Adapted from E-waste, Federal Department of Economic Affairs, 2009, Retrieved from http://ewasteguide.info/china-6. 2009 by EMPA. Adapted with permission.

Case Study: Guiyu, China

Environmental Effects

- **Groundwater Pollution**
  - Samples of dust, 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
  - Burning e-waste releases carcinogens/neurotoxins into the air
- **Water Pollution**
  - About 50% of the e-waste is disposed of, resulting in lead levels in the river that are 190 times higher than acceptable levels (according to WHO)

Social and Health Effects

- Shantou University Medical College conducted research that tested 165 children for concentrations of lead in their blood; 82% of the children had blood/lead levels of more than 100mcg
- Villagers along the river report stomach and breathing problems
- Levels of human exposure to dioxins are 10-15 times higher than the WTO recommended maximum intake
- Approximately 60,000 laborers do e-waste recycling
- Computer wires are sorted during the day and then burned at night, leaving the village covered in a residue from the ash

Economic Effects

- Processing 1.5 million tons of e-waste per year (as much as 80 percent from overseas), generating $75 million in revenue
- An average computer is worth only $1.50 to $2.00 in materials
- Officials are reluctant to regulate e-waste businesses because they provide Guiyu with 90 percent of its commercial and industrial taxes

Conclusions

Most Lafayette College students do not buy more than one electronic device every 2 years and responsibly dispose of their e-waste. This results 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

Poster #19

What makes an Invasive Species Invasive?

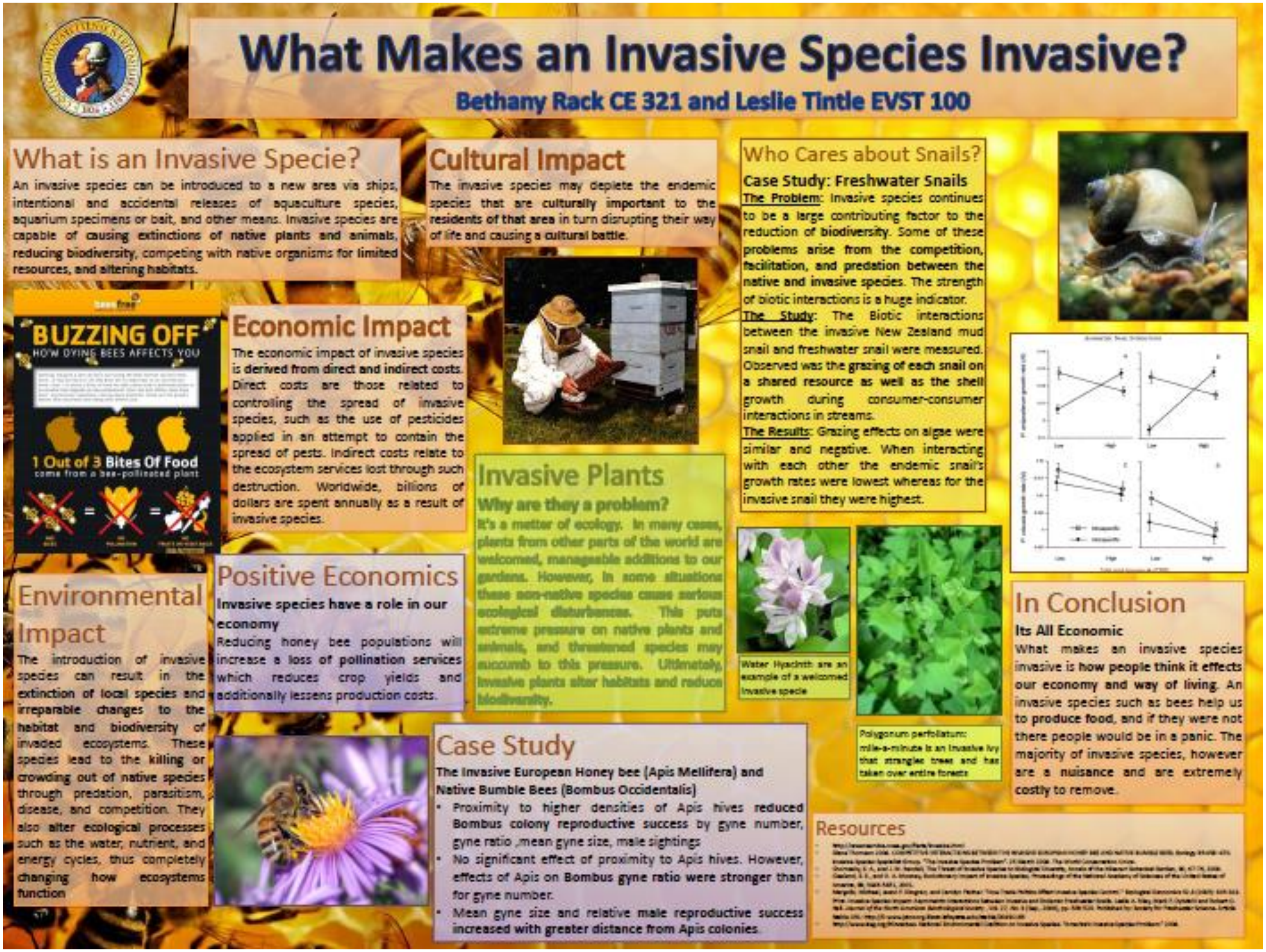
Bethany Rack and Leslie Tintle

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 Tintle 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.
Who Cares about Snails?
Case Study: Freshwater Snails
The Problem: Invasive species continues 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 of each snail on 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.
BUZZING OFF
HOW DYING BEES AFFECTS YOU
1 Out of 3 Bites Of Food
come from a bee-pollinated plant
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.
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.
Water Hyacinth are an example of a welcomed invasive specie
Polygonum perfoliatum: mile-a-minute is an invasive ivy that strangles trees and has taken over entire forests
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.
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
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 gyne number, gyne ratio ,mean gyne size, male sightings
No significant effect of proximity to Apis hives. However, effects of Apis on Bombus gyne ratio were stronger than for gyne number.
Mean gyne size and relative male reproductive success increased with greater distance from Apis colonies.
In Conclusion
Its 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

Poster #20

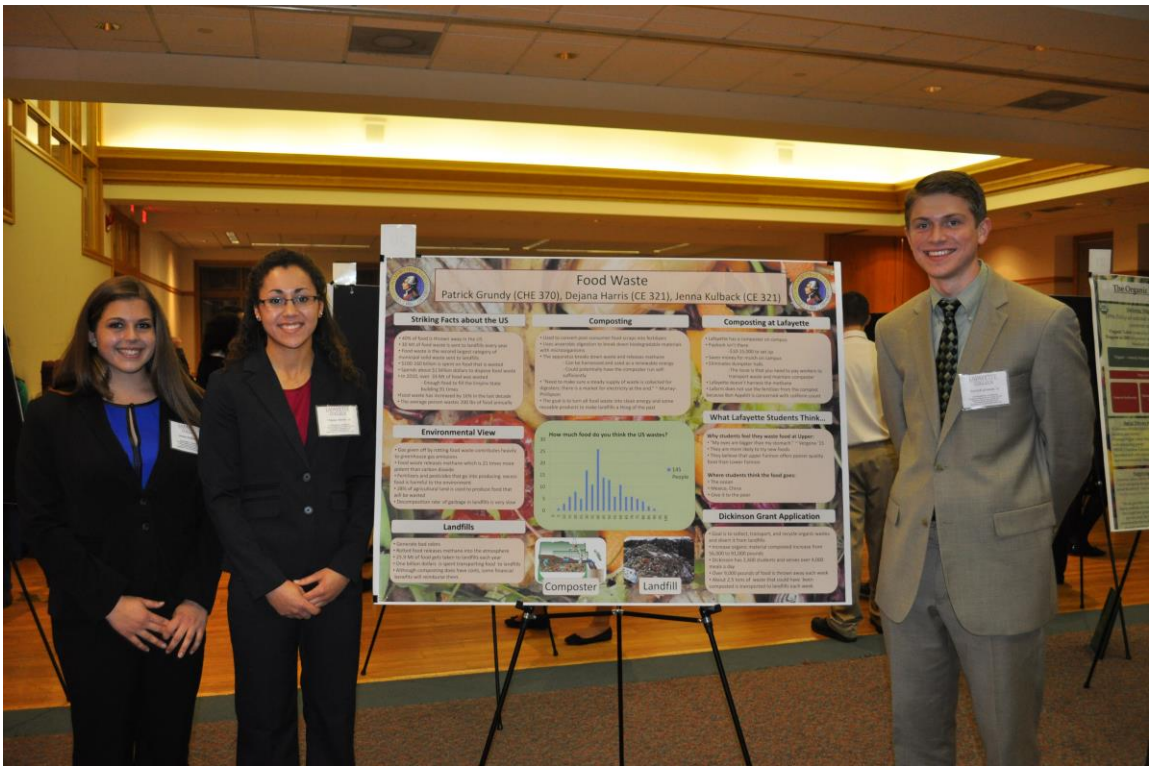
The Cost and Benefits of Reducing Waste in Food Production/Distribution

Patrick Grundy, Dejana Harris, and Jenna Kulback

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 compositing 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

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 composter 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-Phillipson
- The goal is to turn all food waste into clean energy and some reusable products to make landfills a thing of the past

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 hails
  - The issue is that you need to pay workers to transport waste and maintain composter
- Lafayette doesn't harness the methane
- Lafarm does not use the fertilizer from the compost because Bon Appétit is concerned with coliform count

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

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

Landfills

- Generate bad odors
- Rotted food releases methane into the atmosphere
- 25.9 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.

Composter

Landfill

Dickinson Grant Application

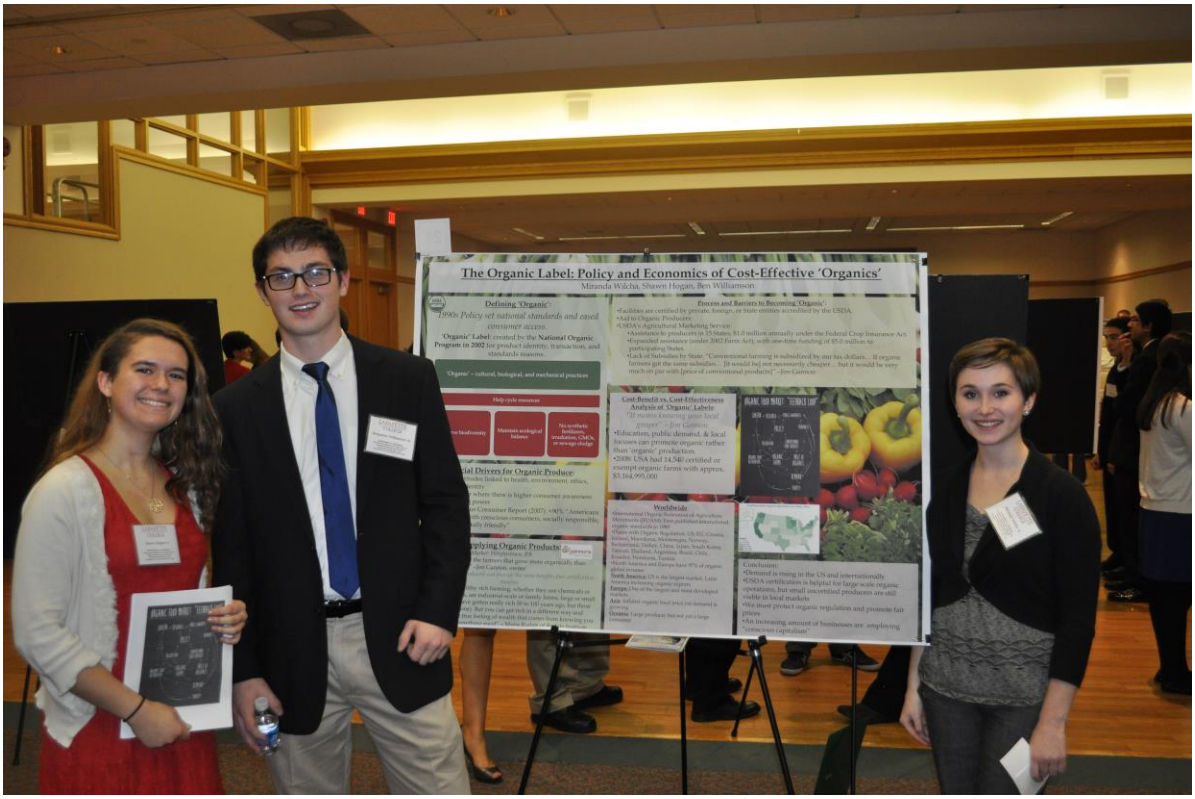
- Goal is to collect, transport, and recycle organic wastes and divert it from landfills
- Increase organic material composted increase from 56,000 to 91,000 pounds
- Dickinson has 2,400 students and serves over 4,000 meals a day
- Over 9,000 pounds of food is thrown away each week
- About 2.5 tons of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

Poster #21

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.



The Organic Label: Policy and Economics of Cost-Effective 'Organics'

Miranda Wilcha, Shawn Hogan, Ben Williamson

Defining 'Organic':

1990s Policy set national standards and eased consumer access.

'Organic' Label: created by the **National Organic Program in 2002** for product identity, transaction, and standards reasons.

'Organic' – cultural, biological, and mechanical practices

Help cycle resources

- **Conserve biodiversity**
- **Maintain ecological balance**
- **No synthetic fertilizers, irradiation, GMOs, or sewage sludge**

Social Drivers for Organic Produce:

- Consumer attitudes linked to health, environment, ethics, location, and identity
- Demand higher where there is higher consumer awareness with purchasing power
- BBMG Conscious Consumer Report (2007): <90% "Americans identified well with conscious consumers, socially responsible, and environmentally friendly"

Supplying Organic Products:

Organnons Natural Market: Wrightstown, PA

"Lot of red tape for the farmers that grow more organically than would be certified" –Jim Gannon, owner

Locally organic producers can provide the same benefits that certification ensures.

"No one gets filthy rich farming, whether they use chemicals or organic methods, are industrial-scale or family farms, large or small (they might have gotten really rich 50 to 100 years ago, but those days are gone). But you can get rich in a different way-and experience the true feeling of wealth that comes from knowing you are doing something good" – Maria Rodale of Rodale Institute

Process and Barriers to Becoming 'Organic':

- Facilities are certified by private, foreign, or State entities accredited by the USDA.
- Aid to Organic Producers:
- USDA's Agricultural Marketing Service:
  - Assistance to producers in 15 States, $1.0 million annually under the Federal Crop Insurance Act.
  - Expanded assistance (under 2002 Farm Act), with one-time funding of $5.0 million to participating States.
  - Lack of Subsidies by State: "Conventional farming is subsidized by our tax dollars… If organic farmers got the same subsidies… [it would be] not necessarily cheaper… but it would be very much on par with [price of conventional products]" –Jim Gannon

Cost-Benefit vs. Cost-Effectiveness Analysis of 'Organic' Labels:

"It means knowing your local grower" – Jim Gannon

- Education, public demand, & local focuses can promote organic rather than 'organic' production.
- 2008: USA had 14,540 certified or exempt organic farms with approx. $3,164,995,000

Worldwide

- International Organic Federation of Agriculture Movements (IFOAM): First published international organic standards in 1980
- Places with Organic Regulation: US, EU, Croatia, Iceland, Macedonia, Montenegro, Norway, Switzerland, Turkey, China, Japan, South Korea, Taiwan, Thailand, Argentina, Brazil, Chile, Ecuador, Honduras, Tunisia
- North America and Europe have 97% of organic global revenue

North America: US is the largest market, Latin America increasing organic exports

Europe: One of the largest and most developed markets

Asia: Inflated organic food price yet demand is growing

Oceania: Large producer but not yet a large consumer

Conclusion:

- Demand is rising in the US and internationally
- USDA certification is helpful for large scale organic operations, but small uncertified producers are still viable in local markets
- We must protect organic regulation and promote fair prices
- An increasing amount of businesses are employing "conscious capitalism"

Poster #22

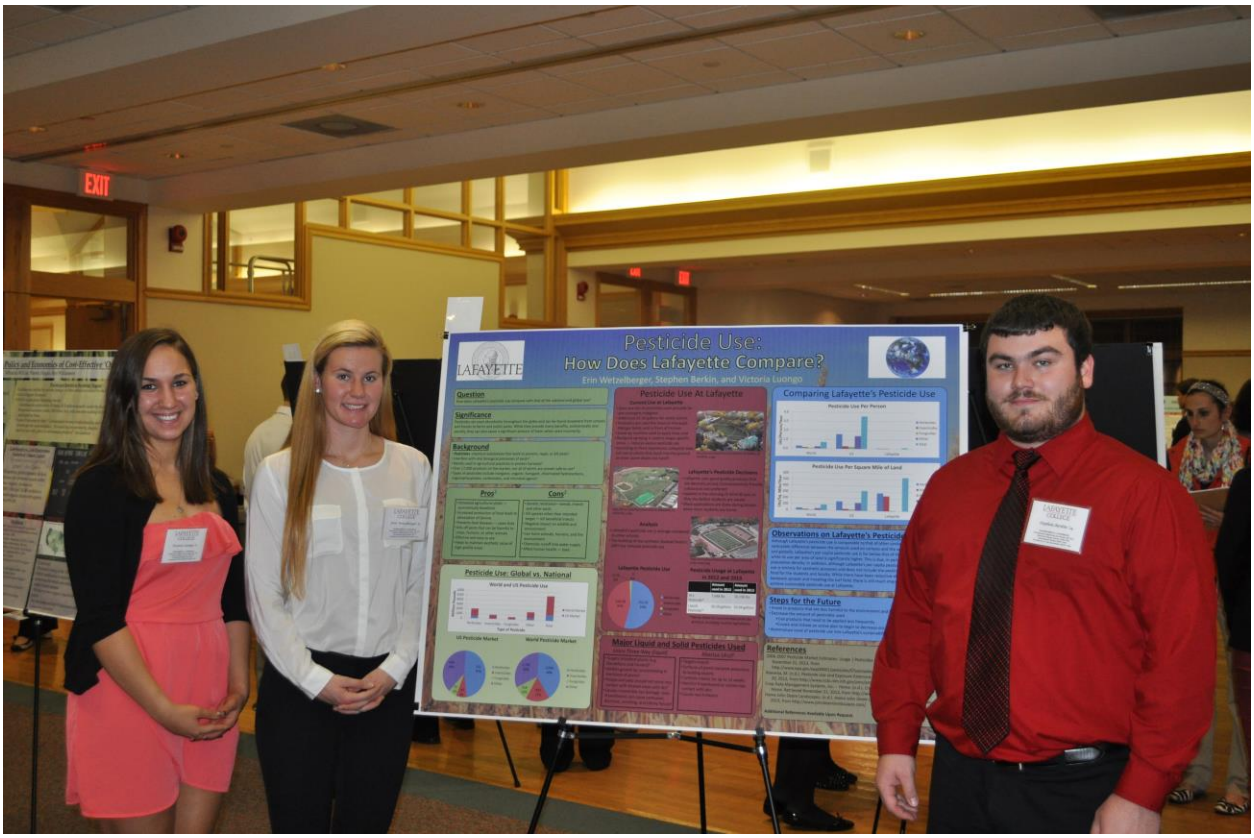
Pesticide Use: How Does Lafayette Compare?

Stephen Berkin, Victoria Luongo, and Erin Wetzelberger

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 Wetzelberger, Stephen Berkin, and Victoria Luongo

Question

How 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 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.

Background

- Pesticides -chemical substances that work to prevent, repel, or kill pests[1]
- Interfere with vital biological processes of pests[2]
- Mostly used in agricultural practices to protect harvests[2]
- Over 17,000 products on the market, not all of which are proven safe to use[2]
- Types of pesticides include inorganic, organic, fumigant, chlorinated hydrocarbons, organophosphates, carbamates, and microbial agents[1]

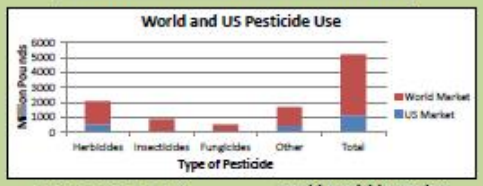
Pros[2]

- Increased agricultural yields — economically beneficial
- Increased production of food leads to elimination of famine
- Prevents fatal diseases — saves lives
- Kills off pests that can be harmful to crops, humans, or other animals
- Effective and easy to use
- Helps to maintain aesthetic value of high-profile areas

Cons[2]

- Genetic resistance—weeds, insects and other pests
- Kill species other than intended target — kill beneficial insects
- Negative impact on wildlife and environment
- Can harm animals, humans, and the environment
- Chemicals runoff into water supply
- Affect human health — toxic

Pesticide Use: Global vs. National



US Pesticide Market

World Pesticide Market

Pesticide Use At Lafayette

Current Use at Lafayette

- Over one ton of pesticides used annually for pre-emergent crabgrass
- Additional 25-30 gallons for weed control
- Pesticides are used the most on the quad, Metzgar fields, and in front of Farinon
- Stand up machine used to apply base coat
- Backpack spraying is used to target specific areas — reduces excess pesticide use
- According to Plant Operations, Lafayette does not use products that leach into the ground or enter storm drains via runoff

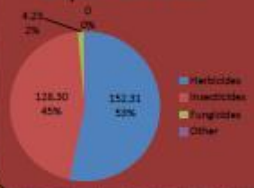
Lafayette's Pesticide Decisions

- Lafayette uses good quality products that are decently priced. Environmentally friendly substances are preferred
- Applied in the morning (3:30-6:00 am) so they dry before students are awake
- Mass applications are done during breaks when most students are home

Analysis

- Lafayette's pesticide use is average compared to other schools
- The building of the synthetic football field in 2007 has reduced pesticide use

Lafayette Pesticide Use



Pesticide Usage at Lafayette in 2012 and 2013

	Amount used in 2012	Amount used in 2013
Dry Pesticide*	7,648 lbs	10,190 lbs
Liquid Pesticide*	33.29 gallons	25.04 gallons

*Values listed for concentrated pesticide product, including inactive ingredients

Major Liquid and Solid Pesticides Used

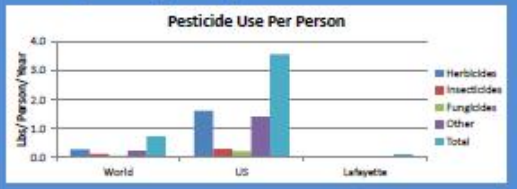
Lesco Three-Way (liquid)

- Targets broadleaf plants (e.g. Dandelions and Clovers)[4]
- Inhibits growth by concentrating in meristem of plants[5]
- People and pets should not come into contact with treated areas until dry[6]
- Causes irreversible eye damage, toxic if swallowed, can cause confusion, dizziness, vomiting, and kidney failure[7]

Allectus (dry)[8]

- Targets insects
- Surfaces of plants become poisonous to landing insects
- Controls insects for up to 12 weeks
- Harmful if swallowed or comes into contact with skin
- Causes eye irritation

Comparing Lafayette's Pesticide Use



Observations on Lafayette's Pesticide Use

Although Lafayette's pesticide use is comparable to that of other similar colleges, there is a noticeable difference between the amount used on campus and the amounts used nationally and globally. Lafayette's per capita pesticide use is far below that of the US and the world, while its use per area of land is significantly higher. This is due, in part, to Lafayette's high population density. In addition, although Lafayette's per capita pesticide use seems low, this use is entirely for aesthetic purposes and does not include the pesticides used in growing food for the students and faculty. While there have been reductive efforts, such as using the backpack sprayer and installing the turf field, there is still much improvement needed to achieve sustainable pesticide use at Lafayette.

Steps for the Future

- Invest 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 initiate an active plan to begin to decrease our pesticide usage
- Reintroduce issue of pesticide use into Lafayette's sustainability committee

References

2006-2007 Pesticide Market Estimates: Usage | Pesticides | US EPA. (n.d.). *EPA*. Retrieved November 21, 2013, from http://www.epa.gov/opp00001/pestsales/07pestsales/usage2007.htm

Alavanja, M. (n.d.). Pesticide Use and Exposure Extensive Worldwide. *NCBI*. Retrieved October 20, 2013, from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2946087/

Crop Data Management Systems, Inc. - Home. (n.d.). *Crop Data Management Systems, Inc. - Home*. Retrieved November 21, 2013, from http://www.cdms.net

Home John Deere Landscapes. (n.d.). *Home John Deere Landscapes*. Retrieved November 21, 2013, from http://www.johndeerelandscapes.com/

Additional References Available Upon Request.

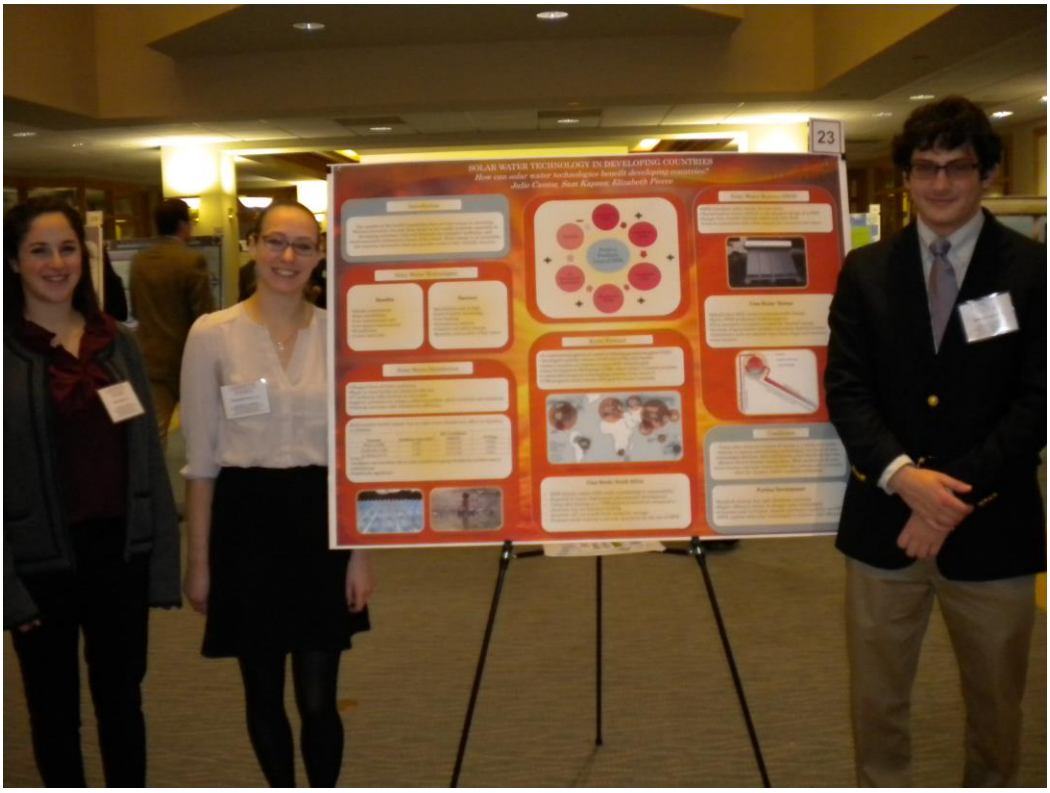
Poster #23

Solar Water Technology in Developing Countries

Julie Cantor, Elizabeth Pierce, and Sam Kapner

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.



SOLAR WATER TECHNOLOGY IN DEVELOPING COUNTRIES

How can solar water technologies benefit developing countries?

Julie Cantor, Sam Kapner, Elizabeth Pierce

LAFAYETTE LAFAYETTE

Introduction

One quarter of the world's population does not have access to electricity. Without electricity, hot and clean water is not readily available especially in developing countries. Coal and firewood are a limited, inefficient, and environmentally destructive source of hot water. Solar energy is an accessible, low emission alternative that can provide access to this valuable resource.

Solar Water Technologies

Benefits

- Simple construction
- Easy installation
- Low maintenance cost
- Less space requirements
- No pollution
- Create local jobs

Barriers

- Installation cost is high
- Lack of public knowledge
- Low funding
- Government policies
- Climate and safety factors
- Quantity and quality of hot water

Solar Water Disinfection

- Cheapest form of water sanitation
- Water in clear bottles are placed in the sun
- UV radiation kills bacteria in the water
- Improve sanitation by using a reflective surface, photo catalysts and chemicals
- Filtering increases solar disinfection efficiency

Multi-country health impact test on solar water disinfection effect on diarrhea in children[1]

Country	Incidence rate ratio*	95% Confidence Interval	P-Value
Kenya [120]	0.56*	0.41-0.76	<0.001
Cambodia [120]	0.43*	0.20-0.96	0.036
S. Africa [127]	0.36*	0.17-0.76	0.011

*Incidence rate=Incident rate in solar disinfection group divided by incident rate in control group

*Statistically significant

Kyoto Protocol

- An international agreement aimed at reducing greenhouse gases (GHG)
- Developed countries (Annex i) hold most of the GHG burden
- Annex I countries are required to meet GHG reduction goal
- Clean Development Mechanism (CDM): allows Annex I countries to invest in sustainable programs in developing countries (Non-Annex I)
- CDM programs count towards GHG goal for Annex I countries

Case Study: South Africa

- SWH directly reduce GHG while contributing to sustainability
- Expected to create employment and economic development
- Using solar heating as a CDM project is beneficial compared to electrical, but not kerosene heating
- Investors will not benefit from emissions savings
- Proposes credit sharing to provide incentives for the use of SWH

Solar Water Heaters (SWH)

- SWH transform solar energy into hot water
- Thermosyphon water collector is the simplest design of a SWH
- Simple heat transfer between water and solar fluid
- Used in conjunction with other sources for consistent hot water

Case Study: Taiwan

- Islands have little access to nonrenewable energy
- Entire SWH production without imports
- Close proximity to equator is ideal for thermal energy
- Increase of government subsidies increases implementation
- Installation costs are greater than those of gas and electrical water heaters

Conclusion

Using solar water as a source of energy is a cheap and viable solution to replace conventional technologies. As prices of solar technologies decrease, they will become more beneficial and cost effective for low income communities. More production of solar water heaters and solar water disinfection systems will eventually allow for cheaper, widely available technology.

Further Development

- Stanford creating thin light absorbent materials
- Higher efficiency results in cheaper solar technologies
- Countries such as Cyprus, Austria, and Israel currently use SWH
- SWH combine with solar technologies to enhance solar efficiency

Poster #24

Engineering Education K-12: Gender Roles

Scarlett Jimenez, Emma Kent, and Alex Huntowski

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 work force. 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.

Engineering Education K-12: Gender Roles

Analyzing, Understanding, and Overcoming Gender Disparities in Engineering Education

Alexander Huntowski, Scarlett Jimenez, Emma Kent

Research Question

Why are women underrepresented within the engineering fields?

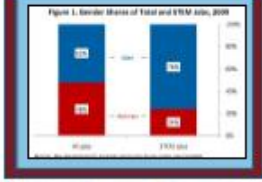
Objective of Research

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

Interest: As engineers ourselves, 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 directly working on projects without any prior planning, while females tend to work together, communicate, and plan before executing projects.
- Women are deterred from math and science fields because they feel as a gender, they are not supposed to participate in those 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.



The figures above represent gender gaps in both collegiate engineering fields and STEM jobs. The figures show females are drastically underrepresented in both. We believe these disparities stem from societal influence and a poor/absent engineering curriculum at the K-12 level.

STEM Fields: International Standings

As shown above, the U.S. is severely lacking in both math and science performance compared to other countries around the world. One of the purposes of our research was to come up with a potential solution (i.e. change the curriculum at the K-12 level) that would boost the representation and retention rates of women in engineering. We feel that this boost to the number of engineers in the U.S. will help the country's performance in both math and science fields relative to the rest of the world. The Organization for Economic Cooperation and Development (OECD) report compared 15-year-olds' test scores on an international level. For the US, the gaps between female and males scores were among the largest of all countries tested. On average there was no measurable gender gap in science, with girls outscoring boys in many countries including Finland, Greece, Poland, Slovenia, and Turkey.

Current Initiatives

Engineering is Elementary
- A program developed by the Museum of Science in Boston, MA. Serves as a introductory program to get children more interested in STEM fields and, improve instructors ability to teach engineering.

Future Worlds
- An interactive cyber learning system that introduces students to the concepts of sustainability.

GoldieBlox
- With the goal of introducing girls to the field of engineering and moving away from traditional gender specific toys, GoldieBlox is a construction toy that gives girls an alternative way to play and learn.

Women In Science and Engineering (WISE)
- A program that provides high school females t 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-8) may not provide them with equal opportunities.

Through science curriculum reformation we believe that young female adolescents may see the long lasting benefits and opportunities offered within the engineering field, translating into a greater female participation within engineering.

These curriculum changes would include:

Introducing 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 monotony and confinement of the classroom tends to dissuade both men and women from math, science, and engineering courses. We feel that having the children interacting with the environment and seeing their work have a real impact will greatly increase the students' interest in not only engineering, but the environment as well.

More group projects
Girls are often discouraged from engineering fields not because they are ill-equipped to work in the field, but because they lack confidence. We feel that if there were more group projects undertaken at the K-12 level, especially ones 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 closer observe how dynamics, psychology, and social aspects may lead to early age discouragement in females.

Through the development of a environmental education class module we would like to see the affects of single-sex classes.

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

References

Dingel, M. J. (2006). *Removing barriers: Women in academic science, technology, engineering and mathematics*. (pp. 160-176).Indianapolis: Indiana University Press.

Martin, E. (1991). The egg and the sperm: How science has constructed a romance based on stereotypical male-female roles. *Signs, 16*(2), 485-501.

Hughes, R. M., Nzekwe, B., & Molyneaux, K. J. (2013). The single sex debate for girls in science: A comparison between two informal science programs on middle school students' stem identity formation. 1-34.

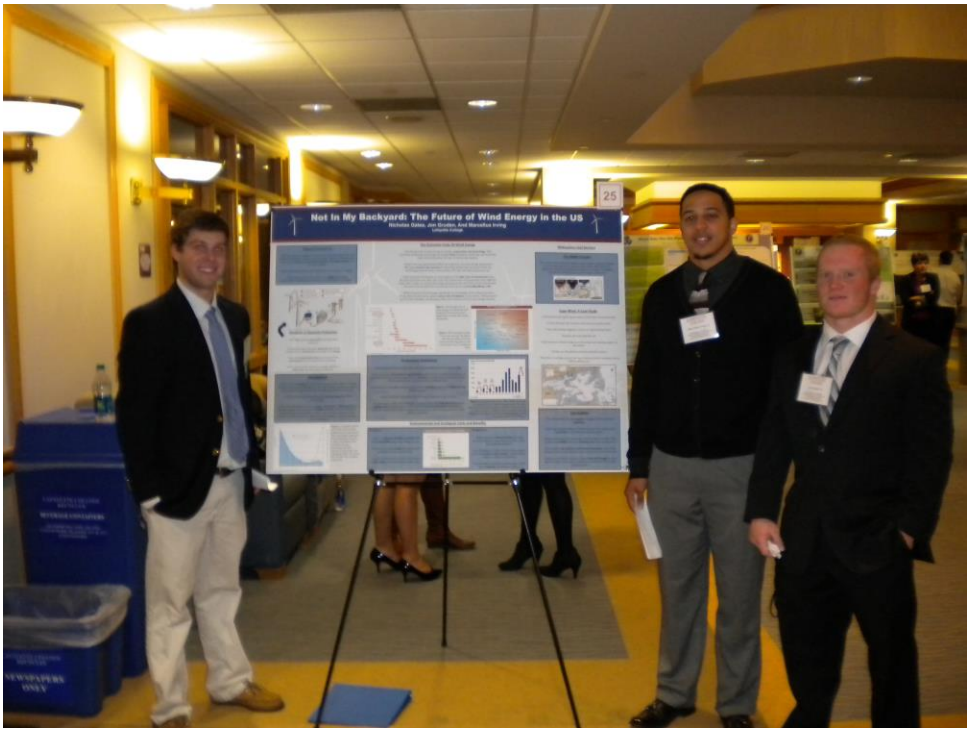
Poster #25

Not In My Backyard: The Future of Wind Energy in the US

Nick Gates and Duece Gruden

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 then 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.



Not In My Backyard: The Future of Wind Energy in the US

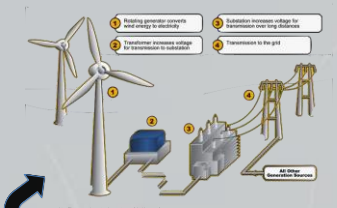
Nicholas Gates, Jon Gruden, And Marcellus Irving
Lafayette College

Research Questions

• With the pressure of global warming, does the United States have the ability to increase its reliance on wind energy? When considering wind, what are the **financial, social and ecological costs OR benefits** to the American people?

• What motivates or discourages Americans from using wind energy?

• Where does wind energy stand in the **future** of US energy consumption? And what are the issues surrounding this technology?



Simplicity of Electricity Production:

• The **rotor** spins the **main shaft** which generates electricity.

• The electricity goes through a **generator** and is then transferable to a **transformer** which alters the **voltage**.

• From here, **transmission lines** that are part of the **national grid** carry the electricity to customers.

• Space requirements in terms of acreage needed for **utility scale** wind farms can be extensive.

Introduction

• The industry is **growing**. In 2012, wind overtook natural gas for having the most potential energy capacity. The cost of producing wind energy is decreasing while the output from the average turbine is increasing.

• In 2012, wind farm installations had a 90% **increase** over 2011 production.

• While the data behind wind expansion is optimistic, public support for the technology is held back by the **NIMBY** principle. But, with the lack of consumer buy in, the industry is reliant on economic and government benefits to entice customers. We examine the effects of these incentives on the industry.

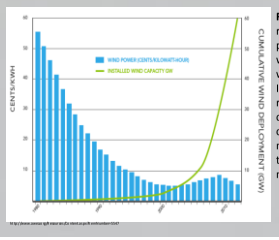


Figure 1. The graph depicts record low costs of wind powered electricity paired with record high capacity of wind availability in the US. In 2012, distributed wind reached a 10-year cumulative installed capacity of more than 812 megawatts (MW) with more then 69,000 units installed nationwide.

The Economic Costs Of Wind Energy

• The driving costs of wind energy are project **construction and technology**. With constantly developing technology and proper **siting** of projects increasing, cost to benefit ratios and driving down the buy in costs to the industry.

• Power Purchase Agreements (PPA's) are long term, low price energy agreements offering **a constant rate incentive** 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 are often very rural, the construction of transmission lines might be large scale in order to connect the energy produced by the wind farm to the national grid. The cost of construction for transmission lines can be up **to $1,000,000 per mile**.

• While the price of wind energy, specifically the technology of the turbine has been 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 energy industry.

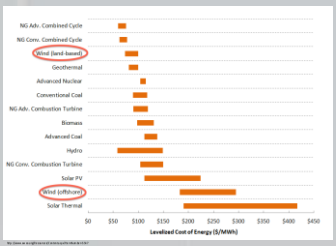


Figure 2. The average cost of wind energy is competitive with traditional fuel sources and is significantly cheaper then other renewables.

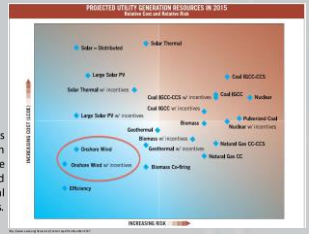


Figure 3. Wind energy provides a low cost and low risk option with the possibility of future environmental regulations and increasing prices of traditional fuels.

Government Involvement

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

• Many states have **Renewable Energy Standards** (RES), which mandate certain levels of renewable electricity production over time. **29 States** currently have an established RES. These standards don't currently exist on a federal level.

• Investments in wind **rely** heavily on government **incentives** such as the **Production Tax Credit** inventive.

• These incentives often determine the status of growth in the industry.

• The government also produces **barriers** for the industry. The **Cape Wind Project** was **delayed** while the government conducted an **environmental impact statement** to assess any potentially harmful impacts that could occur from the construction of the offshore wind farm.

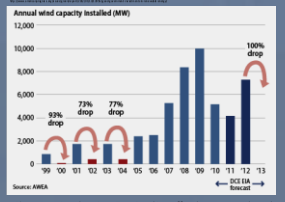


Figure 4. Production Tax Credits offer buyers tax breaks per kilowatt hour of electricity generated. The graph demonstrates that with lapses in the PTC incentive, come a serious decline in national wind investments. But, tax payments that stem from PTC generated projects exceed the government's PTC allocation.

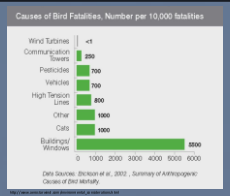
Environmental and Ecological Costs and Benefits

Positives:

• Wind is a **natural, reliable, abundant** and easily **accessible** alternative energy source.

• Wind Farms produce **clean** energy that isn't detrimental to the environment.

• In terms of altered land, wind farms require far **less space** then a traditional power plant.



Negatives:

• Wind farms are a **threat to birds**, but they don't kill nearly as many birds as do other forms of human infrastructure.

• The installation of wind farms and transmission lines can **disrupt animal habitats**, specifically fish habitats in offshore wind farms

• The consistency of wind on certain sites is often very **unreliable**. Rendering it useless.

Motivations And Barriers

The NIMBY Principle

This is the concept that while people usually support renewable energy, they are often opposed to projects that directly affect their lives. Opponents sometimes dislike the aesthetics of a project. The NIMBY principle is a driving factor in wind energy's opposition.

Cape Wind: A Case Study

• 130 turbines covering 25 square miles on the Outer Continental Shelf.

• 5 miles off Cape Cod, location of the worst air quality in MA.

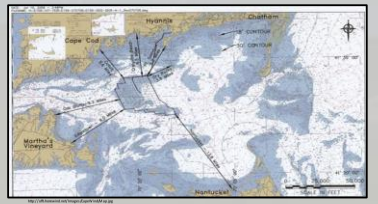
• Will reduced New England's reliance on imported fossil fuels.

•Turbines will reach 440 feet tall.

• Great amounts of local resistance to the project are slowing progress of the project.

• People are disturbed by potential aesthetic impacts.

• Wind farm could take a toll on the local economy which is centered around fishing and tourism.



Conclusions

• The United States has the **capacity** to support wide scale wind **expansion**.

• Technology advancements and dropping costs are making wind a **competitor** in the alternative energy market.

• People understand that investing in clean energy is the right thing to do but the **NIMBY** principle is **limiting** large scale investments.

• The market is **too reliant on government incentives**, rural siting and heavy initial investments to make it a realistic choice in the US.

• Despite an attractive resume on paper, **wind will struggle** to get a foot in the door of the very competitive and fossil fuel dominated energy market.

Poster #26

Where Does Your Old IPhone Go?

Sidney Palmer, Brianna Braswell, and Xiomara Rojas-Asqui

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

Brianna Braswell (EVST 100) Sidney Palmer (EVST 100) Xiomara Rojas-Aquí (CE 321)

Objective

In the absence of a universal definition, electronic waste or E-waste has become an increasing global issue with several environmental, economic and health implications. As a large contributor to E-waste, we selected the iPhone as a case study to examine the effects of E-waste due to its prevalence on Lafayette's campus.

What is E-waste?

- The Organization for Economic Co-operation and Development (OECD) states that e-waste is "any appliance using an electric power supply that has reached its end-of-life" (Introduction, 11)
- However, there is no set definition of E-waste. The disparities create confusion, which contributes to this global issue.

What are the issues with E-waste?

- **Lack of Regulation:** Many nations lack adequate regulations or effective enforcement
- **The Flow of E-waste:** E-Waste flows to disadvantaged areas. The EPA reports that it is 10 times cheaper to export E-waste to Asia rather than to the United States.
- **Risks to health:** Substances such as cyanide, dioxins and mercury can threaten human and environmental health when improperly managed
- **Toxic design:** E-waste is classified as hazardous waste due to many of the metals that are used to create the products. This results in adverse health and environmental implications.

How much E-waste do we generate?

Products	Total Disposed	Treated	Recycled	Recycling Rate
	tons	tons	tons	%
Computers	423,000	255,000	168,000	40%
Monitors	595,000	401,000	194,000	33%
Hard Copy Devices	290,000	193,000	97,000	33%
Keyboards and Mice	67,800	61,400	6,460	10%
Televisions	1,040	864,000	181,000	17%
Mobile Devices	19,500	17,200	2,240	11%
Total (in tons)	2,440,000	1,790,000	649,000	27%

(E-Waste Facts and Figures, 2)

Materials in Mobile Phones and Methods of Disposal

	Hazardous	Sustainable
Materials	• Mercury • Lead • Cadmium • polychlorinated biphenyls	• Gold • Palladium • Copper • Plastic
Methods of Disposal	• Landfill • Incineration	• Recycling • Collection Programs • "Take Back" systems • Materials Recovery Facilities (MRF)

Mobile Phone Waste From a Local to Global Scale

Lafayette College

Easton

United States

International

- Laws in place but not strictly enforced
- Single- stream recycling

- Mobile phones are not nationally recognized in E-waste legislation
- Industries pay for recycling and disposing mobile phones, but it as the discretion of the consumer

- Manufacturers decide where to export E-waste.
- Less expensive to export out of the US
- The location of dumping sites correlates with health issues.

Survey of Lafayette Students

Percentage of students that have an iPhone

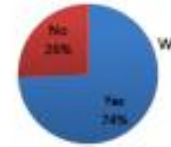


Figure 1. Shows the prevalence of iPhones on Lafayette College's campus

Where is/are your old iPhone(s) now?

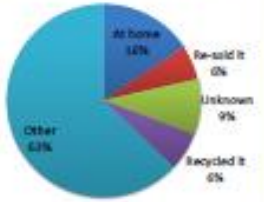


Figure 2. Shows what peers have done with their previous iPhones

Conclusion

- **Lafayette:** Students at Lafayette only recycle or resell 12% of iPhones
- **Environmental Impact:** With improper disposal, hazardous toxins are released into the atmosphere
- **Economic Impact:** A lack of regulation and cheaper prices gives manufacturers the agency to export E-waste to developing and underdeveloped nations
- **Health Impact:** Disposal methods such as incineration and combustion expose people to toxic metals and carcinogens that are detrimental to health
- **Our Recommendation:** A set definition of E-waste needs to be established on an international level in order for proper legislation to be created and regulated. Legislation should include mobile phone waste so that manufacturers and consumers have a greater responsibility when disposing mobile devices.

Future Study

•Within the next decade we hope that there will be more information and studies on the effects of E-waste, locally and globally.

•We would like to further research the effects of waste exports and how individual nations are dealing with the problem

References:

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Poster #27

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 Ratsimbazafy (EVST 100), Alexandria Sousa (EVST 100)

The Dichotomy Between Local Organic and Industrial Farms

- Agriculture is thriving due to the large increase in population caused by the Industrial Revolution
  - Increased demand has incentivized global, national, and regional markets to increase supply

Local Organic Farming

- Pros:
  - Increased 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
  - Proximity to local communities
  - Distributional limits

Industrial Farming

- Pros:
  - Increased efficiency in food production
  - Reduction in famine
  - Affordable crops
  - Enables large-scale exports, increasing GDP
- Cons:
  - Environmental Risk
    - Farm as a factory with "inputs" and "outputs"
      - Decrease in jobs
      - Intensive plowing
    - Normalized system of monocrop agriculture
    - Over-application of fertilizers and pesticides
    - Wasteful water usage
    - Nutrient loss
  - Public Health Risk

Objectives:

- Understand the differing impacts of local organic farming and industrial farming techniques on soil quality
- Test soil to determine how the quality of the soil reflects farming practices
  - Interpret how different practices may be chosen based on political and economic incentives
- Explain how political and economic incentives can be manipulated to decide the future of farming

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

Soil Tests

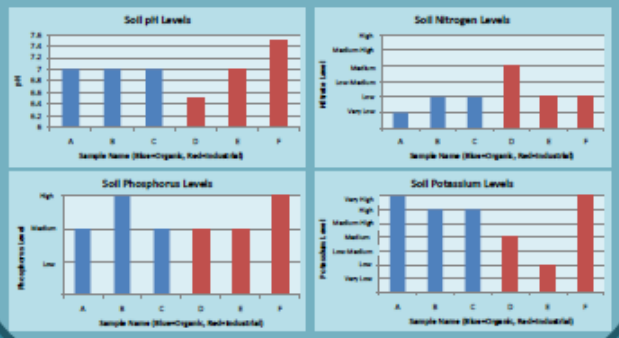
- **pH** - The measure of acidity or alkalinity in a solution.
  - Measured on a scale from 0 to 14
  - Pure water is "neutral" at pH=7
  - Ideal pH for garden soil : 5.5 to 7
- **Phosphorus** – Commonly a limiting nutrient required for plant growth
  - Excess phosphorus in soil can severely damage plants and contaminate water supplies

- **Nitrogen** – A nutrient often in combination with ammonia which optimizes plant root growth
  - Excess nitrogen does some damage to plants and can contaminate water supplies
- **Potassium** - An essential nutrient required for plant life
  - Sandy soils often lack potassium and are less likely to support vegetation

Research Methods

- Collected soil from three local, organic farms and three industrial farms in the Lehigh Valley area
  - To respect the privacy of the farms, samples were labeled A, B, C, D, E or F
- Tested soil to determine differences in chemical composition based on pH, nitrogen, phosphorus, and potassium levels
- Criteria for Organic Farming:
  - USDA standard: *"Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony."*
- Criteria for Industrial Farming:
  - USDA standard for conventional farming: *"Rapid technological innovation; large capital investments in order to apply production and management technology; large-scale farms; single crops/row crops grown continuously over many seasons; uniform high-yield hybrid crops; extensive use of pesticides, fertilizers, and external energy inputs; high labor efficiency; and dependency on agribusiness."*
  - USDA standard for local farming: *less than 400 miles from its origin, or within the State in which it is produced*
  - Industrial farming uses conventional farming practices and has a longer supply chain than local farms

Results



Analysis of Soil Test Results

- Predicted Results
  - Local Organic Farms
    - "good" pH level between 5.5 and 7
    - "medium" nutrient levels
  - Industrial Farms
    - pH levels below 4 or above 8
    - "high" nutrient levels due to over-fertilization
- Actual Results
  - Actual results did not reflect what was predicted
  - In all sampled farms, the pH showed a healthy soil range
  - All six samples displayed low to medium levels of Nitrogen
  - Phosphorus levels were in the middle range with one organic farm and one industrial farm showing higher concentrations
  - Potassium levels showed the greatest range with organic farms containing more on average than the industrial farms
- Interpretation and Possible Error
  - The soils from local organic farms and industrial farms had similar chemical compositions
  - This is likely due to careful soil monitoring by all farms and financial incentive not to over-fertilize with expensive chemicals
  - Taking samples at the start of the growing season as opposed to at the end could show drastically different results
  - Better testing equipment could decrease human error

Broader Policy Influences

- Government regulation
  - Pennsylvania's Right to Know Law of 2009
    - Accountability
  - Production practices
    - Enforceability
  - Distribution
- Economic Support
  - Subsidies
    - Encourage overproduction and monocultures
  - Grants
    - Encourage sustainable agriculture
- Organization Certifications
  - USDA organic

Implications for the Future

- What is the future of farming in the US?
  - Local Organic vs. Industrial
  - Quality vs. Quantity
- Organic Food Movement
  - Can smaller scale social movements advocating for organic farms outweigh governmental support for industrial farms?
- What needs to happen with each farm type?
  - Industrial Farms
    - Stricter quality regulations
    - Sustainable practices
  - Local Organic Farms
    - More economic support
    - More effective distribution

See attached paper for references

Poster #28

The Effectiveness of Rain Gardens in Pollutant and Runoff Management

Victoria Moscato, Erica Gennaro, and Nirupa Basnet

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

LAFAYETTE COLLEGE

Nirupa Basnet, Erica Gennaro, Victoria Moscato

BIOL 234: Environmental Biology

Introduction

❖ A man-made depression in the ground used for bioretention as stormwater runoff filters through layers of soil and biota
❖ Seeks to improve water quality and replace expensive installations of sewer drains, stormwater ponds, etc.
❖ First appeared in 1990's → Somerset, Maryland experimented with alternative stormwater management practices

Runoff Management

Figure 1. Diagram of a rain garden. Obtained from Google Images.

Successes
❖Runoff Volume Reduction
❖Peak Flow Reduction
❖Peak Flow Delay

Importance of Runoff Reduction
Higher volumes of stormwater runoff increase flooding, stream bank erosion, and sedimentation, which physically alters aquatic habitats.

Limitations
❖Less significant effect on larger rainfall events

Figure 2. Photograph of a rain garden. Obtained from Google Images.

Pollutant Management

Successes
❖ Total Suspended Solids Reduction
❖ Heavy Metal Reductions

Table 1. Field performance of a standard rain garden design on the University of Maryland campus (Davis).

Pollutant	Total Pollutant Mass Removal	Inflow Exceedance Probability*	Outflow Exceedance Probability*
TSS	54%	75%	28%
Copper	77%	32%	4%
Lead	84%	41%	<7%
Zinc	69%	35%	<5%

*Exceedance probabilities based on the following target values: 20 mg/L TSS, 13 µg/L acute Cu, 65 µg/L acute Pb, 120 µg/L Zn

Importance of Pollutant Reduction
❖Suspended solids increase water turbidity, inhibit light penetration, affect water balance in aquatic organisms, and facilitate the spread of toxins.
❖The bioaccumulation of heavy metals can inhibit plant growth and have serious health effects, including neurological, liver, and kidney damage, on aquatic life and humans.

Limitations
No significant reductions; occasional <u>increases</u> in:
❖Nutrient Levels
-Total Phosphorus
-Nitrogen Species
❖Pathogen Indicators
-*E. coli*
-Fecal Coliform

Mechanisms of Pollutant and Runoff Management

Deep-rooted native plants
❖Increase water absorption
❖Enhance soil permeability and porosity
❖Prevent soil erosion
❖Remove pollutants via uptake and degradation

Mulch, gravel, and soil layers
❖Increase temporary water storage
❖Increase infiltration into groundwater
❖Filter pollutants
❖Provide a habitat for microorganisms that degrade pollutants

Future Application: Bushkill Drive

Figure 3. Map of potential location of rain garden. Obtained from Google Earth.

❖Topography: Flat
❖Soil Type: High runoff potential
❖Soil Drainage: Less than 0.01 inch/hour
❖Average Annual Rainfall: 42.37 in
❖Average Annual Runoff: 32.01 in
❖~76% of rainfall becomes runoff and is not retained
❖Sources of Runoff: Parking lot and street (both significant sources of heavy metals)

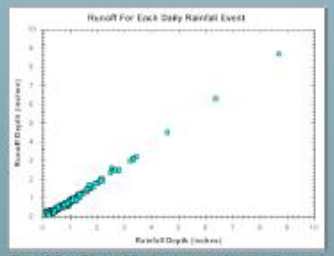


Figure 4. Runoff for rainfall events in potential location. Generated with the EPA National Stormwater Calculator.

We conclude that a rain garden would effectively reduce the high volume of stormwater runoff in the chosen location and prevent certain pollutants, likely the most predominant ones, from entering the nearby Bushkill Creek.

References

Davis, A. P. (2008). Field Performance of Bioretention: Hydrology Impacts. *Journal Of Hydrologic Engineering*, *13*(2), 90-95. doi:10.1061/(ASCE)1084-0699(2008)13:2(90)

Hsieh, C., & Davis, A. P. (2005). Water Quality Improvement through Reductions of Pollutant Loads Using Bioretention. *Journal Of Environmental Engineering*, *131*(8), 1156-1165. doi:10.1061/(ASCE)0733-9372(2005)131:8(1156)

Davis, A. P. (2007). Field Performance of Bioretention: Water Quality. *Environmental Engineering Science*, *24*(8), 1048-1064. doi:10.1089/ees.2006.0190

Additional references available upon request.

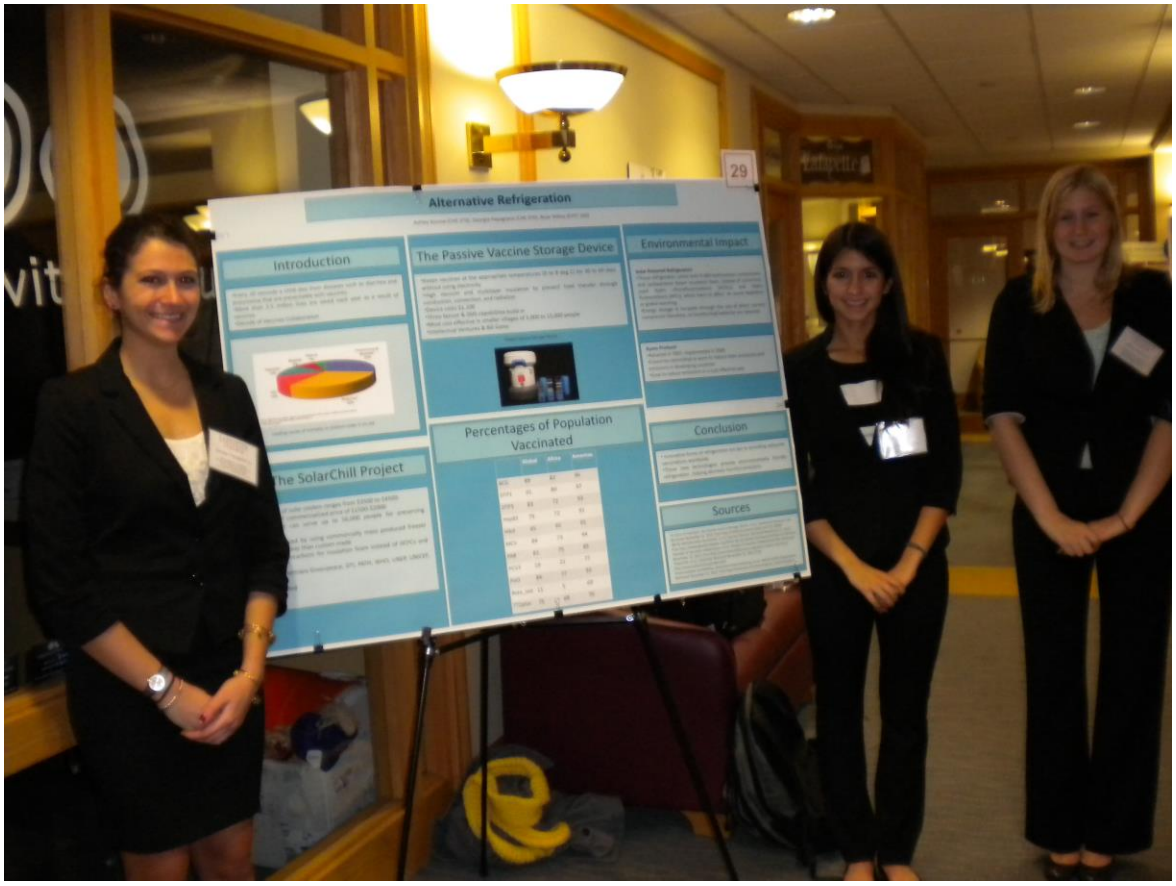
Poster #29

Alternative Refrigeration

Rose Willey, Georgia Papagianis, and Ashley Kunow

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.

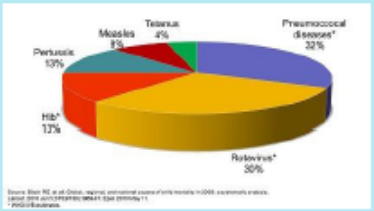


Alternative Refrigeration

Ashley Kunow (CHE 370), Georgia Papagianis (CHE 370), Rose Willey (EVST 100)

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 SolarChill Project

- The cost of solar coolers ranges from $3500 to $4500.
- SolarChill commercialized price of $1500-$2000
- 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, DTI, PATH, WHO, UNEP, UNICEF, etc
- Field tested

The Passive Vaccine Storage Device

- Keeps vaccines at the appropriate temperatures (0 to 8 deg C) for 30 to 60 days without using electricity
- High vacuum and multilayer insulation to prevent heat transfer through conduction, convection, and radiation
- Device costs $1,100
- Three Sensor & SMS capabilities build in
- Most cost effective in smaller villages of 5,000 to 15,000 people
- Intellectual Ventures & Bill Gates

Percentages of Population Vaccinated

	Global	Africa	Americas
BCG	89	82	96
DTP1	91	80	97
DTP3	83	72	93
HepB3	79	72	91
Hib3	45	65	91
MCV	84	73	94
PAB	81	75	85
PCV3	19	21	77
Pol3	84	77	93
Rota_last	11	5	69
TT2plus	75	68	70

Environmental Impact

Solar Powered Refrigerators

- These refrigerators utilize both R-600 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.

Kyoto Protocol

- Adopted in 1997, implemented in 2005
- Countries committed to work to reduce their emissions and emissions in developing countries
- Goal to reduce emissions in a cost-effective way

Conclusion

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

Sources

- "A Story of Invention: the Passive Vaccine Storage Device. (n.d.). Intellectual Ventures Lab. Retrieved November 22, 2013, from http://intellectualventureslab.com/?p=10095
- Bill & Melinda Gates foundation. (n.d.). Vaccine Delivery. Retrieved November 22, 2013, from http://www.gatesfoundation.org/What-We-Do/Global-Development/Vaccine-Delivery
- Decade of Vaccines Collaboration. (n.d.). Decade of Vaccines Collaboration RSS. Retrieved November 22, 2013, from http://www.decadeofvaccines.org/about-us/our-structure/
- SolarChill. (n.d.). SolarChill. Retrieved November 22, 2013, from http://www.solarchill.org/index.html
- Immunization surveillance, assessment and monitoring. (n.d.). World Health Organization. Retrieved November 22, 2013, from http://www.who.int/immunization_monitoring/en/

Poster #30

Off the Grid: Biogas Use at Easton's WWTP and Landfill

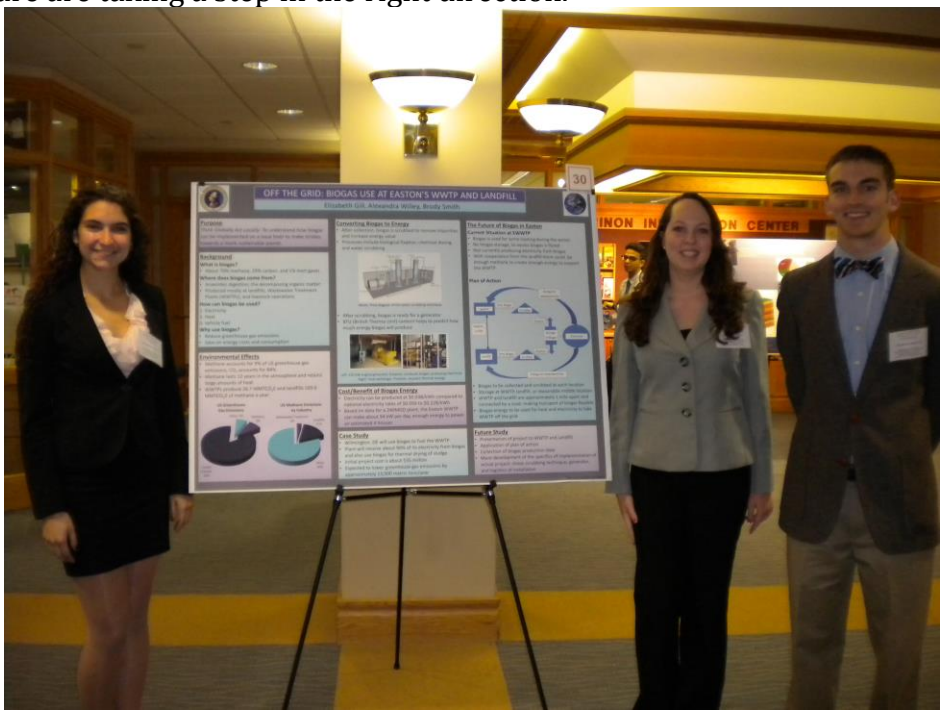
Brody Smith, Elizabeth Gill, and Alexandra Willey

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.



OFF THE GRID: BIOGAS USE AT EASTON'S WWTP AND LANDFILL

Elizabeth Gill, Alexandra Willey, Brody Smith

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?

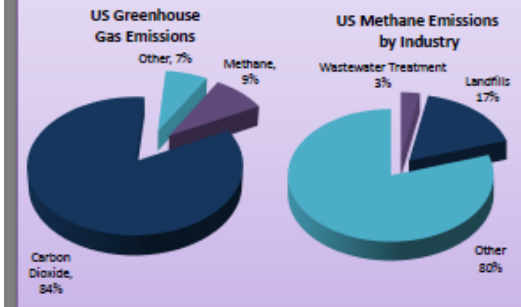
1. Electricity
2. Heat
3. Vehicle fuel

Why use biogas?

- Reduce greenhouse gas emissions
- Save on energy costs and consumption

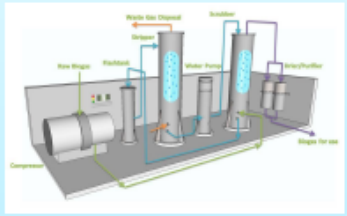
Environmental Effects

- Methane accounts for 9% of US greenhouse gas emissions; CO_2 accounts for 84%
- Methane lasts 12 years in the atmosphere and retains large amounts of heat
- WWTPs produce 26.7 $MMTCO_2E$ and landfills 169.0 $MMTCO_2E$ 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: combusts 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 240MGD plant, the Easton WWTP can make about 94 kW per day, enough energy to power an estimated 4 houses

Case Study

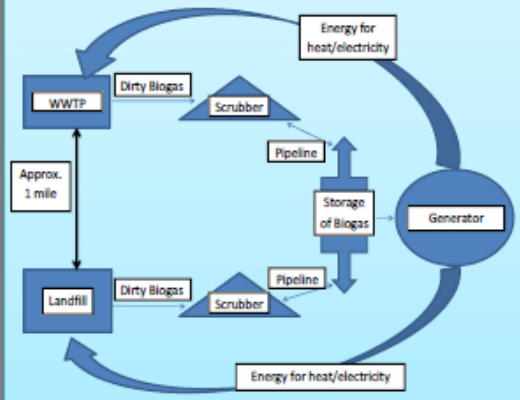
- Wilmington, DE will use biogas to fuel the WWTP
- Plant will receive about 90% of its electricity from biogas and also use biogas for thermal drying of sludge
- Initial project cost is about $35 million
- Expected to lower greenhouse gas emissions by approximately 13,000 metric tons/year

The Future of Biogas in Easton

Current Situation at EWWTP

- 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: chose scrubbing technique, generator, and logistics of installation

*References available upon request

Poster #31

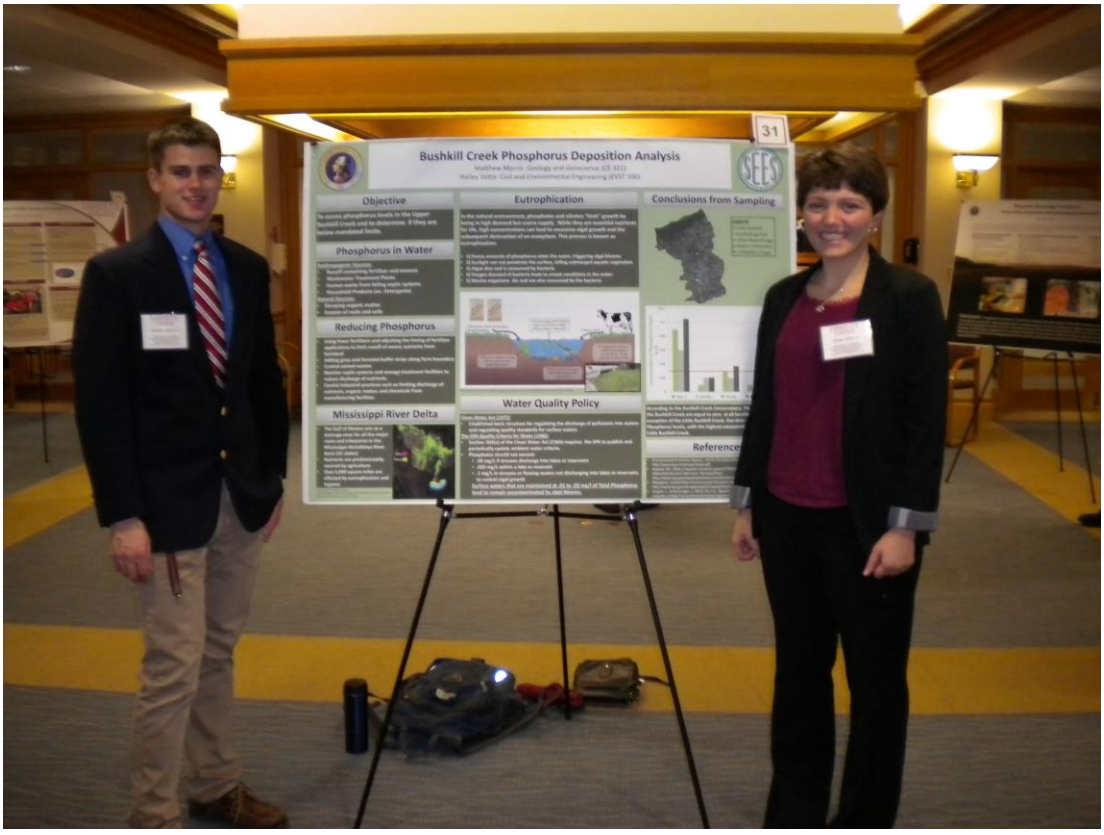
Bushkill Creek Phosphorus Deposition Analysis

Hailey Votta and Matthew Morris

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 phosphorous 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.



Bushkill Creek Phosphorus Deposition Analysis

Matthew Morris- Geology and Geoscience (CE 321)
Hailey Votta- Civil and Environmental Engineering (EVST 100)

Objective

To assess 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 (ex. Detergents)

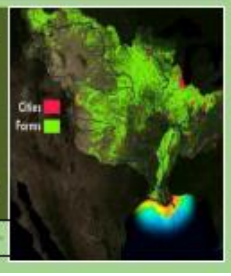
Natural Sources:
- Decaying organic matter
- Erosion of rocks and soils

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
- Careful industrial practices such as limiting discharge of nutrients, organic matter, and chemicals from manufacturing facilities

Mississippi River Delta

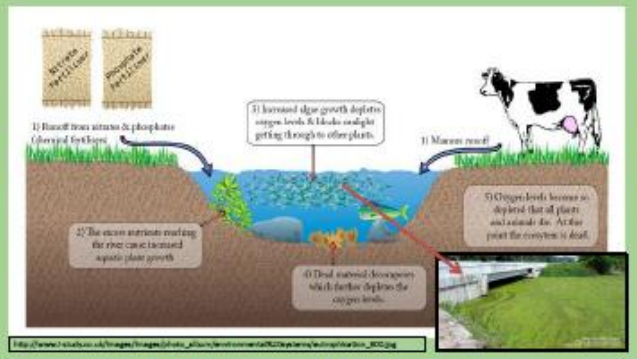
- The Gulf of Mexico acts as a drainage zone for all the major rivers and tributaries in the Mississippi-Atchafalaya River Basin (31 states)
- Nutrients are predominately sourced by agriculture
- Over 6,000 square miles are effected by eutrophication and hypoxia



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 not 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



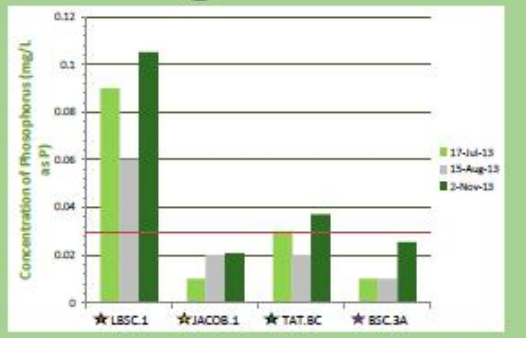
Water Quality Policy

Clean Water Act (1972)
- Established basic structure for regulating the discharge of pollutants into waters and regulating quality standards for surface waters

The EPA Quality Criteria for Water (1986)
- Section 304(a) of the Clean Water Act (CWA) requires the EPA to publish and periodically update ambient water criteria.
- Phosphates should not exceed:
  - .05 mg/L if streams discharge into lakes or reservoirs
  - .025 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 .01 to .03 mg/l of Total Phosphorus tend to remain uncontaminated by algal blooms.

Conclusions from Sampling



According to the Bushkill Creek Conservatory, *Phosphate* levels in the Bushkill Creek are equal to zero at all locations, with the exception of the Little Bushkill Creek. Our data reflects *Total Phosphorus* levels, with the highest concentration occurring in the Little Bushkill Creek.

References

- Environmental Protection Agency . (1972). *The Clean Water Act.* Retrieved from http://www.epw.senate.gov/water.pdf
- Hypoxia 101- What is hypoxia and what causes it? *Mississippi River Gulf of Mexico Watershed Nutrient Task Force.* Retrieved from http://water.epa.gov/type/watersheds/named/msbasin/hypoxia101.cfm
- Phosporus. *United States Environmental Protection Agency.* Retrieved from http://www.epa.gov/oecaagct/ag101/impactphosphorus.html
- Aragaw, L., & McGonigle, E. (2013, Oct 17). "Bushkill Creek Watershed Nutrient Analysis." Lafayette College Civil and Environmental Engineering

Poster #32

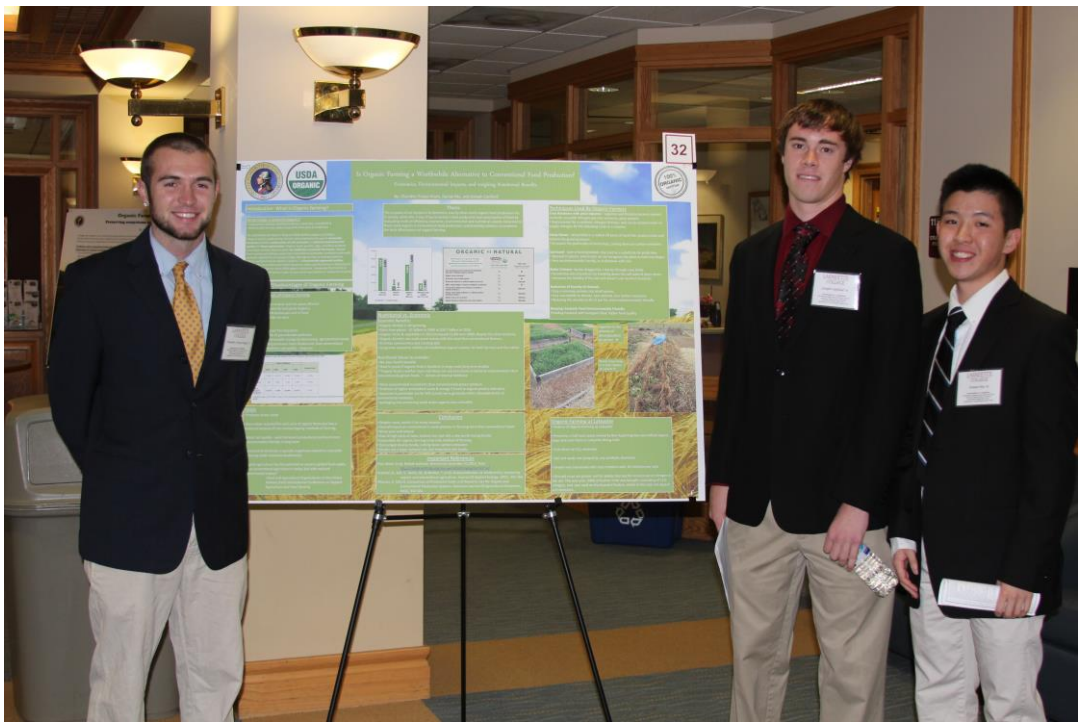
Is Organic Farming a Worthwhile Alternative?

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.



Is Organic Farming a Worthwhile Alternative to Conventional Food Production?

Economics, Environmental Impacts, and weighing Nutritional Benefits

By: Chandler Fraser-Pauls, Daniel Ma, and Joseph Canfield

Introduction- What is Organic farming?

What makes a product organic?

- Grown without synthetic fertilizers, pesticides, and GMO's
- Animals that are not subject to growth hormones or antibiotics

The USDA National Organic Program (NOP) defines organic as follows:

"Organic food is produced by farmers who emphasize the use of renewable resources and the conservation of soil and water to enhance environmental quality for future generations. Organic meat, poultry, eggs, and dairy products come from animals that are given no antibiotics or growth hormones. Organic food is produced without using most conventional pesticides, fertilizers made with synthetic ingredients or sewage sludge, bioengineering, or ionizing radiation. Before a product can be labeled "organic," a government-approved certifier inspects the farm where the food is grown to make sure the farmer is following all the rules necessary to meet USDA organic standards. Companies that handle or process organic food before it gets to your local supermarket or restaurant must be certified, too."

Advantages/Disadvantages of Organic Farming

Environmental Impacts of Organic Farming

Disadvantages:

- Less production output and not space efficient
- High costs to care for and grow Organics
- More carbon emissions per unit of food
- Organic pesticides do exist

Advantages:

- Sustainability over the long term
- Reduces the risk of groundwater pollution
- Reduces non-renewable energy by decreasing agrochemical needs
- Organic farming produces more biodiversity than conventional
- Better and healthier soil quality – long run

Yields

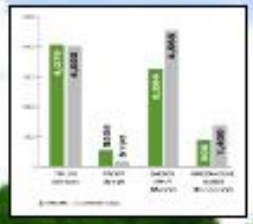
- Produces fewer yields
- More labor required for each acre of organic farms but less is produced because of non-monocropping methods of farming.
- Better soil quality - yield increased productivity/yield and more environmentally friendly in long term
- Farmland biodiversity is typically negatively related to crop yield (Reducing yields increases biodiversity).

"Organic agriculture has the potential to secure a global food supply, just as conventional agriculture is today, but with reduced environmental impact."

-Food and Agricultural Organizations of the United Nations (FAO) International Conference on Organic Agriculture and Food Security.

Thesis

The purpose of our project is to determine exactly what worth organic food production has in society, what role, if any, it has in society's total production and consumption of food by evaluating levels of efficiency, economic, environmental and nutritional aspects compared to those same aspects in conventional food production, and providing solutions to maximize the total effectiveness of organic farming.



Nutritional vs. Economic

Economic Benefits:

- Organic Market is still growing.
- Sales have grown – $1 billion in 1990 to $26.7 billion in 2010.
- Organic fruits & vegetables in 2010 increased 11.8% over 2009, despite the slow economy.
- Organic farmers can make more money with less land than conventional farmers.
- Enriches communities and creating jobs
- Long-term economic viability of established organic systems for both farmers and the nation

Nutritional Values to consider:

- No clear health benefits
- Hard to prove if organic food is healthier in large scale/long term studies
- "Organic food is neither more nutritious nor any less prone to bacterial contamination than conventionally grown foods. " - Annals of Internal Medicine
- More concentrated in nutrients than conventionally grown produce.
- Evidence of higher antioxidant levels & omega-3 levels in organic poultry and dairy.
- Exposure to pesticides cut by 30% (Levels were generally within allowable limits of conventional methods).
- packaging and processing could make organics less unhealthy

Conclusion

- Despite costs, worth it for many reasons
- Overall impact on environment is more positive in the long term than conventional foods
- More pure and natural
- Due to high costs of labor, limited role, but still a role worth having locally
- Impossible for organic farming to be only method of farming
- Encourages buying locally, cutting down carbon emissions
- Maybe not a large national role, but important role locally

Important References

- Our Work. (n.d). Rodale Institute. Retrieved November 12,2013, from http://rodaleinstitute.org/our-work/#more-pathway-links
- Gabriel, D., Gall, S., Kunin, W., & Benton, T. (n.d). Food production vs. biodiversity: comparing organic and conventional agriculture. *Journal Of Applied Ecology, 50*(2), 355-364.
- Klonsky, K. (2011). Comparison of Production Costs and Resource Use for Organic and Conventional Production Systems. *American Journal Of Agricultural Economics, 94*(3), 314-321.

Techniques Used By Organic Farmers

Crop Rotations with grain legumes - Legumes and Rhizobia bacteria convert normally unusable Nitrogen gas into ammonia, plant protein.

- Replacement for a synthetic nitrogen fertilizer, and can be plowed under to supply nitrogen for the following crops in a rotation.

Hoop House - raised beds in a walled off piece of land that: protect crops and extend the growing season.

- Increases the practicality of local crops, cutting down on carbon emissions

Surround - type of biodegradable clay used as a substitute for pesticides.

- Sprayed on plants, and insects do not recognize the plant as food any longer.
- Very environmentally friendly, as it dissolves with rain.

Roller Crimper- device dragged by a tractor through crop fields

- Accelerates decomposition by breaking down the cell walls of plant stems
- Increases the fertility of the soil and doesn't use harmful chemicals

Reduction of Density of Animals

- Stop crammming animals into small spaces.
- Less susceptible to disease. Less animals, less carbon emissions
- Reducing the density to 50 LU per ha, more environmentally friendly

Keeping Livestock Feed Environmentally Friendly

- Feeding livestock with inorganic feed, higher food quality

Legumes in the process of decomposition at Lafarm ->

Winter Cover Crop in a crop rotation at Lafarm ->

Organic Farming at Lafayette

- History of Organic Farming at Lafayette
- Presently, a half-acre space owned by Bon Appetit grown uncertified organic crops and uses them in Lafayette dining halls
- Cuts down on CO_2 emissions
- Soil and seeds not sprayed by any synthetic chemicals
- Grown very intensively with crop rotations with 10 rotations per year
- Unused crops are grown, not for production but for an increase of nitrogen in the soil. This past year, $400 of feather meal was brought, consisting of 11% nitrogen, and was used on the heaviest feeders, which in this case are squash and tomatoes.

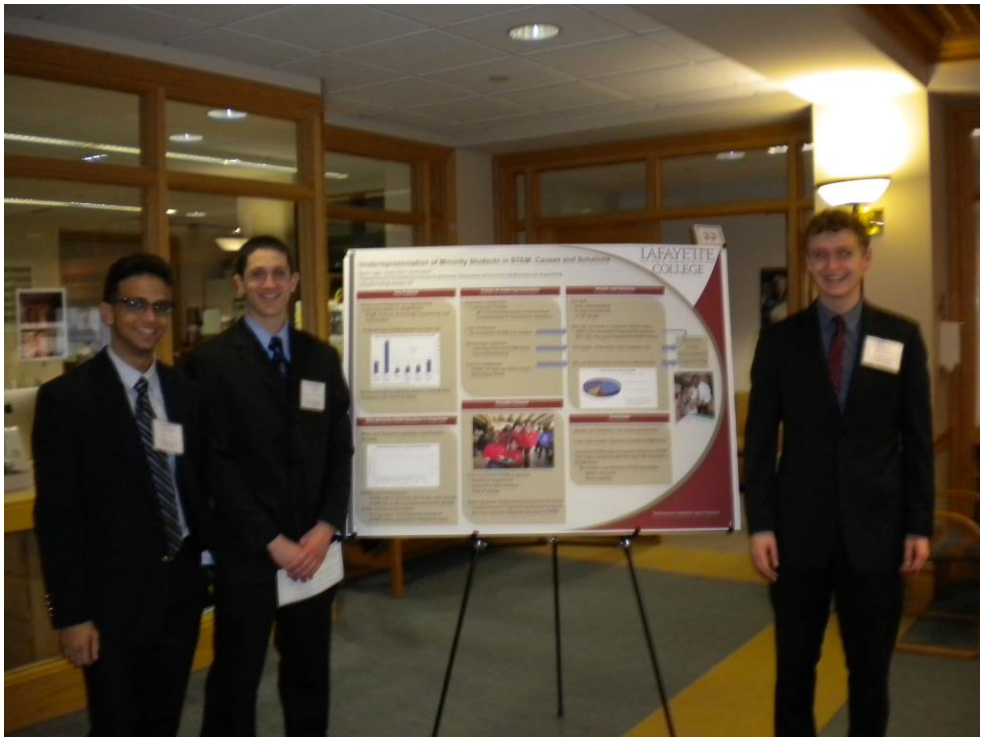
Poster #33

Engineering Education (K-12)

Keven Lugo, Justin Horn, and Chris Verni

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.



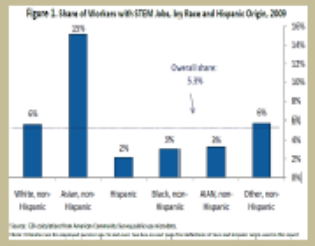
Underrepresentation of Minority Students in STEM: Causes and Solutions

Keven Lugo[1], Justin Horn[2], Chris Verni[2]
[1]Department of Civil and Environmental Engineering, [2]Department of Chemical and Biomolecular Engineering
Lafayette College, Easton, PA

LAFAYETTE COLLEGE

The Problem

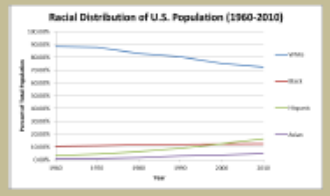
- Blacks and Hispanics are significantly underrepresented in STEM fields
  - STEM: Science, technology, engineering, and mathematics
- Graduate with STEM degrees at lower rate



- Blacks are half as likely to work in a STEM field
- Hispanics are a third as likely

Why Minority STEM Education is Important

- Black and Hispanic population significantly growing:



- STEM and the Economy:
  - STEM jobs to grow by 20% in the next decade
  - STEM key in driving future economic growth
- STEM and the Environment:
  - Facing major environmental problems
  - STEM literate population needed to solve

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 experience
  - 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

81% are more interested in engineering

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

Poster #34

Geoengineering and CO_2 Removal

Jesse Chazen

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

What is the issue?

1) Carbon Dioxide levels are at an all-time high due to overuse of fossil fuels

2) Concentration of Carbon Dioxide is at 393ppm and 350ppm is the ideal level

3) The overuse of fossil fuels is creating instability in the world due to the climate change

4) We are facing extreme weather conditions and trends indicate food availability will diminish

5) Global Average temperature is accelerating constantly and we have taken no decisive actions to lower it

6) Daily human practices that continue, like deforestation, are continuing to harm the planet

Figure 1

Carbon Capture and Sequestration (CCS)

Carbon Capture and Sequestration (CCS) is a three-step process that can greatly reduce CO_2 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.

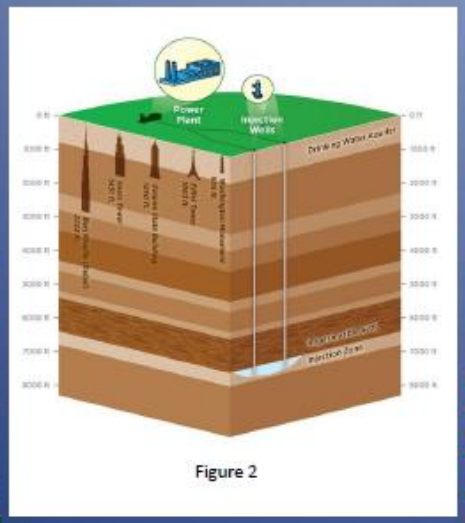


Figure 2

What Benefits Does CCS Provide?

1) It is a key tool in ameliorating climate change
2) It provides energy security for the world
3) Creates economic prosperity by creating a plethora of new jobs in an unprecedented sector

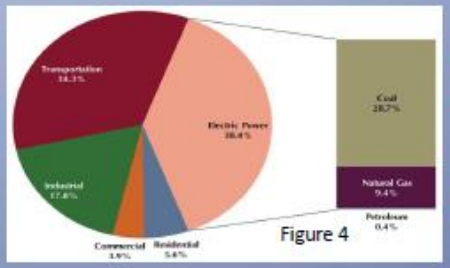


Figure 4

Figure 3

3 Different CDR Practices

Bio-Energy with Carbon Capture and Sequestration - Growing biomass, burning it to create energy and capturing and sequestering the carbon dioxide created in the process.

Ocean Fertilization - Adding nutrients to the ocean in select locations to increase primary production which draws carbon dioxide from the atmosphere.

Ocean Alkalinity Enhancement - Grinding up, dispersing, and dissolving rocks such as limestone, silicates, and calcium hydroxide in the ocean to increase its ability to store carbon and directly ameliorate ocean acidification.

Objectives of CDR

1) Assist natural processes to remove and absorb CO2 from the atmosphere
2) Address not only industrial CO2 sources but also transportation services
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 lies 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 it allows people and industry to maintain emissions and consumption rates
5) Transportation accounts for 34% of emissions but 68% of the energy used comes from petroleum based liquids and natural gas

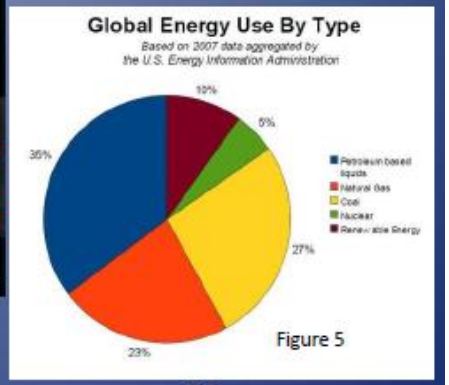


Figure 5

References

"Capture." — *The Carbon CCS & Storage Association (CCSA)*. CCSA, 5 Jan. 2013. Web. 22 Nov. 2013.

Le Quéré, Corinne. "CO2 Now." *Global Carbon Emissions*. GCE, 17 Nov. 2009. Web. 21 Nov. 2013.

"U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." *U.S. Energy Information Administration (EIA)*. USIA, 25 July 2013. Web. 21 Nov. 2013.

Thomas, Goreau. "Balancing Atmospheric Carbon Dioxide." *Balancing Atmospheric Carbon Dioxide*. Management of Coral Reefs Around the World, n.d. Web. 22 Nov. 2013.

Poster #35

Organic Farming Practices

Peter Todaro

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?

- Annually 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 instensive 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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