

# 2011 Student Sustainability Symposium Abstracts

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## **Climate Tracking: Applications of a Novel Technique To Sustainability, Richard Barnes**

Ecology, Evolution, and Behavior

Climate change has profound implications for the sustainability of society and the environment, yet estimates of climate change cover times scales which make results difficult to verify, are often computationally expensive to make, and have uncertainties which are not easily communicated, especially outside the area of computational meteorology and mathematics. We present a method of quantifying climate change over the past century and into the near-future which bypasses many of these problems. Using historical weather data and a surface-fitting algorithm, we are able to extract "climate velocities", representing the surface speed and direction of the climate for any location. Projections from these velocities can be used to extract possible future locations and direction-of-movement of biomes, biofuel hotspots, and agricultural productivity, with implications for conservation parkways, preemptive revegetation, agricultural policy.

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## **Bird-Building Collisions, Stephanie Beard**

Fisheries, Wildlife, and Conservation Biology

Hundreds of millions of birds die each year in the United States as a result of human-built structures. It is estimated to be the largest antropogenic source of avian mortality. As the human population continues to grow by an expected 3 billion individuals, many more structures will be created. Additionally, modern structures are frequently designed with large expanses of glass, often for energy efficiency, which greatly increases their danger to birds. Birds provide a number of ecosystem services: they control insects saving farmers large amounts of money in crop losses, and reduce the need for pest control via toxic chemicals. Birds are also vital to seed dispersal and plant pollination. They strengthen the resiliency of natural communities. They are a vital part of our culture; a source of pleasure, inspiration and beauty. My research examines bird-building collisions in the Twin Cities region with the help of Minnesota Audubon volunteers, and on the St. Paul and Minneapolis campuses with student and staff volunteers. With the help of these dedicated individuals, plus the support of many in the campus community, we have identified the the St. paul

campus structures that have the highest mortality rates. At some of those sites, we placed physical deterrents to test their efficacy in limiting bird mortality. Preliminary observations indicate the flight diverters may be effective. Direct protection for our campus wildlife is only one aspect of this work; by raising awareness in others, I hope that they will become inspired and take action on this issue, then this research will really "take flight"!

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### **CYCLES: Combining Indigenous knowledge and Sustainability to Promote Climate Change Education, Devarati Bhattacharya**

Science Education, Curriculum and Instruction

" The CYCLES project aims to integrate the relevant aspects of indigenous knowledge and approaches into education and help "sustain" local culture, wisdom and ethics to create an enhanced awareness about global climate change among the native and non-native population. This project is committed to train teachers to incorporate native arrays of information, understanding and interpretations that have guided the Native American societies in their interactions with the natural world.

FOCUS: Understanding of climate change, local to global perspective, inquiry and culturally responsive classroom"

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### **Art, Story and Infrastructure: A Model for Experiential Interconnection in Environmental Education, Jonee Kulman Brigham**

Liberal Studies

How can we make sustainability concepts and concerns personally relevant and meaningful? The focus on cultural sustainability in the 2010 edition of State of the World and the Institute on the Environment's cross disciplinary efforts such as "River Life", and "Dialogue Earth," among many other trends, underscore the importance of integrating the tools of cultural development such as art and storytelling with scientific development toward effective sustainable outcomes and effective outreach of environmental information to broad audiences. The conveniences of infrastructure have allowed individual actions, such as water use choices, to be experientially disconnected from impacts to natural systems. However, by paying attention to infrastructure and integrating it into our concepts of the world, we can counter its invisibility and better appreciate its contributions while better understanding the implications of its over-use. This project is gathering an interdisciplinary team of University faculty and outside partners around the

topic of how to use place-based interaction with infrastructure, interpreted through art, story, and science to create an experiential and informed sense of interconnection of our daily use of resources with the engineering and natural systems in which they interact. The project lays the essential groundwork needed to develop a replicable curriculum model based on a concurrent research process and demonstration project. The work of the project will be available for use and further development by the environmental education community, schools, and other researchers.

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### **Spatializing the Diet Gap: Quantifying agricultural land use efficiency in terms of calories delivered to humans, Emily Cassidy**

Institute on the Environment

Much attention is paid to the growing global population, yet affluence is a major driver of the resource demands made on the earth system. Increasing affluence is associated with greater demand for animal products. Since animal protein requires more land resources for the same number of calories, this represents a land use inefficiency. We map the calories produced by crops as well as those that are delivered to the food system. The difference between the two represents the calories that are effectively lost to human consumption due to inefficiencies of livestock production as well as the diversion of crops for non-food uses. As food preferences change, the increasing diet gap may further exacerbate challenges to food security.

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### **Do greener companies have better organizational and financial performance? An empirical investigation, Susan D'Mello**

Psychology

Today, many organizations are striving to go green with the hopes that they will gain a competitive edge. By thoroughly examining the corporate websites of the 2009 Newsweek top 500 green companies, as well as those on the Fortune 500 list, we documented over six thousand pro-environmental organizational behaviors reported by these organizations. All behaviors were classified in to Ones and colleagues' (2009, 2010) behavioral taxonomic clusters of avoiding harm, sustainable work, conserving, influencing, and taking initiative. Relationships between the number and types of environmental efforts, organizational performance, and green reputation, as well as between environmental behaviors and revenue were investigated.

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## **Three Ring Gardens: Growing Parks, People, Pride, Students for Design Activism**

Landscape Architecture

"Promoting Sustainability through Education, Green Space, and Community Development

Since March 2011, Students for Design Activism (SDA) has partnered in an exciting project with the largest alternative high school in the Twin Cities, Gordon Parks High School (GPHS). Located along the Central Corridor in St. Paul, GPHS and its at-risk students are neighbors to Skyline Towers (Section 8 housing project of 800 low-income, immigrant residents), a major interstate, an arterial road, office buildings, and parking lots. Public green space offering opportunities for flexible recreation, urban agriculture, gathering spaces, or activities promoting health lifestyles is virtually nonexistent in the neighborhood. Yet, with over 90% of the student body at GPHS from a low-income background and dependent on public transportation, educational green space is fundamental to their exposure to sustainable systems thinking. Responding to the needs of GPHS administration, community stakeholders, and the student body, SDA has developed a site plan and schematic design for "Three Ring Gardens." Fostering an education in food production, ecological education, storm water management, and alternative energy, Three Ring Gardens will offer unprecedented everyday experiences in community and ecological issues vital to thriving in the 21st century careers. Improved pedestrian and bike access promote neighborhood connectivity and will allow ease of access to future light rail stations. For the larger community, this will become a place for public art, pick-up games, outdoor performances, and a catalyst for local development. By focusing on food systems, transportation, and open space, Three Ring Gardens will offer a unique opportunity to improve equity, sustainability, and community development along. "

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## **Maximizing the yield potential of *Camelina sativa* for a sustainable biodiesel feedstock, Kevin Dorn**

Plant Biology

"*Camelina sativa* is an oilseed crop with great potential as a biofuel feedstock. The viability of using *Camelina* for producing biodiesel has been shown, and its agronomic characteristics are promising. *Camelina* can be grown on marginal soil with little nutritional inputs, and is drought and frost tolerant. In northern US climates, yields of 2400 lbs/acre have been observed. *Camelina* seed is nearly 50% oil by weight, and this oil has

exceptionally high fatty acid composition, useful for biodiesel production and as an animal feed supplement. Despite these positive characteristics of Camelina as a sustainable feedstock for next-generation biodiesel, there has been little breeding or biotechnology focused on enhancing this species defenses, nutrient efficiency, and yield. Since Camelina is a close relative to the model plant *Arabidopsis thaliana*, we are positioned to translate our understanding of *Arabidopsis* biology to this important next-generation biofuel feedstock. Utilizing our extensive knowledge of *Arabidopsis* growth, development, and disease and pest resistance, we are examining if these same pathways can be regulated in Camelina to produce a more sustainable, highly productive biodiesel crop. "

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## **Nitrogen dynamics in the tropical dry forests of Costa Rica, Maga Gei and Jennifer S. Powers**

Ecology, Evolution, and Behavior

The global nitrogen (N) cycle is undergoing severe alterations due to human activities including increased inputs through fossil fuel combustion, fertilizer manufacture, and the cultivation of legume crops. Yet it is not well known how the changing N cycle is affecting the biogeochemistry of tropical forests. In order to understand how much the N cycle has been artificially perturbed through human activities, it is necessary to have a robust estimate of the rates of biological nitrogen fixation and nitrogen cycling in natural ecosystems to serve as a benchmark for comparison. This research addresses key aspects of the N cycle in seasonally dry tropical forests, which are regions vulnerable to increasing N inputs. Legumes (Fabaceae, Leguminosae) are the most diverse and widespread group of plants with the capacity to form symbiotic associations with N-fixing bacteria, which convert unavailable atmospheric N into inorganic forms available to plants. In the dry forests of Área de Conservación Guanacaste in northwestern Costa Rica, legume trees are abundant and stand out as a different plant functional group with a suite of traits beyond high foliar N that differ significantly from other plants in the community. Here we show preliminary results of an ongoing project where we quantify the major N inputs to tropical dry forest ecosystems of Costa Rica, as well as the major controls on these processes. Our main hypothesis is that biological fixation by legume trees is the largest nitrogen source of N input to these ecosystems, and that the main controls on this process are soil nutrient status, soil moisture, and light availability. We describe our ongoing studies of symbiotic N fixation that include: a survey of root nodulation in five legume tree species in monoculture plantations, quantification of N-fixation in naturally regenerating forest along several

environmental gradients (the gradients include: crown exposure to light, seasonal water availability, and a soil phosphorous gradient), and shade house studies. We will compare the magnitude of symbiotic nitrogen fixation with other natural nitrogen inputs such as asymbiotic fixation, atmospheric deposition, or internal recycling through litterfall and decomposition. Considering that tropical dry forests are now the most endangered tropical biome, it is crucial to determine the role of legume trees in their biogeochemical cycles as these forests regenerate when they are abandoned from other land uses. Better understanding of the nitrogen cycle in unmanaged tropical ecosystems contributes to sustainability science through: i) providing benchmark data to better constrain pool and flux estimates in the global nitrogen cycle, ii) quantifying the potential for legume trees to act as alternative N sources or green manures in agroforestry systems, and iii) helps contribute to local capacity building through interactions with the Biological Education Program of the Área de Conservación Guanacaste. "

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### **Health impacts of the built environment: Within-urban variability in physical inactivity, air pollution, and risk of ischemic heart disease, Steve Hankey**

Civil Engineering

"Background: Physical inactivity and exposure to air pollution are important risks for death and disease globally. The built environment may influence exposures to these risk factors in different ways and thus differentially impact the health of urban populations. Urban areas are increasingly the focus of sustainable development efforts due to their large population growth rates.

Objective: To investigate the built environment's association with air pollution and physical inactivity, and estimate attributable health risks.

Methods: We use a regional travel survey to estimate within-urban variability in physical inactivity and home-based air pollution exposure (PM<sub>2.5</sub>, NO<sub>x</sub>, O<sub>3</sub>) for ~30,000 individuals in southern California. We then estimate the resulting risk for ischemic heart disease (IHD) using literature-derived dose-response values for the general public and for a sensitive subpopulation. Using a cross sectional approach we compare estimated IHD mortality risks among neighborhoods based on "walkability" scores.

Results: The proportion of physically active individuals is ~2× larger in high- vs. low-walkability neighborhoods (24.9% vs. 12.5%); however, since a small share of the total population is physically active, between-neighborhood variability in estimated IHD

mortality attributable to physical inactivity is modest (7 fewer IHD deaths per 100,000 per year in high- vs. low-walkability neighborhoods). Between-neighborhood differences in risks from air pollution were similar in magnitude (9 more [3 fewer] IHD deaths per 100,000 per year for PM2.5 [O3] in high- vs. low-walkability neighborhoods), suggesting that population health benefits from increased physical activity in high-walkability neighborhoods may be offset by risks from air pollution exposure.

Policy implications: Accounting for physical activity and exposure to air pollution are critical aspects of planning for cleaner, sustainable, health-promoting cities. "

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### **Investigation: the Copolymerization of Lignin and Poly (Lactic Acid), Stephanie Harris**

Bioproducts and Biosystem Engineering

"Currently, there is a strong push to develop renewable, biodegradable plastic resources to replace the plastics we now overwhelmingly derive from petroleum. Not only would these resources allow us to control our continued depletion of landfill space and the problems associated with waste incineration, such as air pollution, but they would allow us to leave a smaller carbon footprint as renewable sources of starting materials can be utilized in their production. These pursuits have led to research and development of biodegradable polymers to substitute for non or partially-renewable petroleum-based polymers. As we move away from dependence on fossil fuels, petroleum derivatives are also becoming less desirable in manufacturing and in the marketplace. Biodegradable plastics derived from biomass sources are becoming increasingly popular as the technology required to produce them is becoming better understood and more commonly utilized to create them. Poly (lactic acid) in particular has proven an important product as it is relatively inexpensive to produce, is derived from biomass sources, is completely biodegradable and has been approved by the United States Food and Drug Administration for food and medical uses. Considering lignin as a biomass source to copolymerize with poly (lactic acid) and improve upon its moisture barrier properties is a novel approach to utilizing an already readily available, renewable byproduct of industry in furthering research into biodegradable plastics. The structure and properties of lignin and poly (lactic acid) are presented. Lignin is presented in terms of its occurrence and composition of lignin in different biomass sources. Various extraction methods are compared for deriving lignin for copolymerization."

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## **Mapping the UMD Food System, Lee Haugen**

Anthropology, University of Minnesota Duluth

University of Minnesota Duluth (UMD) Food Services currently runs an efficient food system that produces 1,300 lunch meals for the campus community daily. As the only University of Minnesota campus with a self-managed system, UMD offers a unique opportunity to take steps to incorporate local foods in its system. Such steps would contribute substantively to current sustainability efforts on the UMD campus. In order for such changes to happen, it is first necessary to understand how UMD's system operates. A team of four anthropology student researchers conducted interviews with UMD food service staff and managers to develop a detailed understanding of the current food system on campus. The concluding interactive map of the system is a guide by which UMD students, staff and faculty can understand where locally grown foods and sustainable practices may serve as options. The research supported piloting efforts in the summer of 2011 to grow food to be used at UMD at the newly established Sustainable Agriculture Project at UMD, which successfully supplied to food services several types of vegetables and several hundred pounds of produce from within UMD's own resources. This project established the baseline of a system in which a sustainable and local food system could emerge and continue to develop over time.

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## **Winter Rye Best Management Practices to Reduce Loads of Sediment and Nutrients to Minnesota Surface Waters, Adam Herges**

Agronomy and Plant Genetics

"Surface runoff from agricultural fields is potentially harmful to our environment because of excessive loads of sediment and nutrients. Industrialized agriculture has provided food for the world, but has also created unintended water quality problems. Excessive nutrient contamination in the Gulf of Mexico has created a zone of hypoxia where dissolved oxygen levels are too low to support aquatic life. The Upper Midwest agriculture is mostly comprised of corn and soybeans and a large amount of the nitrogen (52%) reaching the Gulf of Mexico is a result of this cropping rotation (Alexander, 2008). In addition, up to 50% of applied synthetic fertilizer on Midwestern soils is lost every year due to rainfall and surface runoff (Tonitto, 2006). However, adding cover crops to an agricultural rotation provides soil cover and retention of nutrients. Various studies have shown that a winter rye cover crop can reduce nitrate leaching by 70% (Tonitto, 2006; Ball Coelho, 2005; Staver and Brinsfield, 1998). However, the use of cover crops in the United States Corn Belt is not

widely accepted nor implemented. A survey where 3,500 farmers were asked to provide information on cover crop use showed that only 11% of farmers in the Upper Midwest have used cover crops in the last five years (Singer, 2007). This study will develop viable Best Management Practices for beef and dairy producers that can utilize the cover crops as an economic incentive. Winter rye offers great potential for environmental benefits on land where corn silage or stover is removed to feed livestock. If the winter rye is established early enough, it can be grazed or harvested as forage in the spring before cash crop is planted. Two locations in southern Minnesota have been selected for monitoring surface runoff and developing viable cover cropping BMPs. Each location consists of a paired watershed design where one watershed is the control (conventional practice) and the other is the treatment (winter rye following corn harvest). The first location will have winter rye aerially seeded into standing corn grain with spring grazing of the winter rye. The second location will have drilling of winter rye following corn silage harvest with winter rye harvested as forage in the spring prior to soybean planting. This study will encompass two full growing seasons from 2009 to 2011. Additional small plot experiments with the use of a rainfall simulator to evaluate surface runoff differences between conventional practices and cover crop BMPs."

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### **Resources Availability and Supplementary Methods of Income Generation in Southern Udaipur District, Rajasthan, India, Ali Johnson**

#### Global Studies

In India a large percentage of the population lives in a rural setting. In these settings most people live a subsistence lifestyle and earn any supplementary income through agricultural methods. In recent decades reoccurring drought has hit various regions of India, affecting the livelihoods of many of these rural dwellers. To gain insight into the significance of the role natural resources play in their lives villagers in three different villages in Udaipur District, Rajasthan, India were surveyed on their agricultural endeavors as well as the output in the past few years. It was found that the "kals" (droughts) that had plagued this area for years without interruption have forced many people to turn away from buffalo rearing and vegetable production to the less input dependent raising of goats. The larger implications of this trend being the reduced standards of living on a population forced to reduce to produce below their capacity due to ecological circumstances.

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### **Perennial Sunflower for Wildlife and Food Uses, Michael Kantar**

## Agronomy and Plant Genetics

Global population is projected to reach nine billion people by 2050, and the human population will need an adequate food supply and methods for sustainable production (Baulcombe et al., 2009). Over the past century, agriculture has greatly increased crop yields and productivity. However, this increase in productivity has often come at the expense of long term environmental sustainability through overuse of fossil fuel-based fertilizers, and the depletion of fresh water and arable land (Tilman et al., 2002).

Addressing environmental damage is essential for the production of adequate food. Future cropping systems will need an increased emphasis on ecosystem services (Costanza et al., 1997). Ecosystem services can be incorporated into the landscape by increasing nutrient and water efficiency in major crops, adjusting agronomic practices (timing and duration of irrigation and nutrient applications), and by using perennial crops to help maintain healthy nutrient levels, control erosion and pests, and to keep water clean (DeHann et al., 2005; Baulcombe et al., 2009; Jackson and Berry, 2009; Glover et al., 2010). The objective of this research is to use current genetics and plant breeding techniques to introgress genes for perennial habit from *Helianthus tuberosus* L. ( $2n=6x=102$ ) into domesticated sunflower (*Helianthus annuus* L.,  $2n=2x=34$ ). *H. tuberosus* is part of the secondary gene pool of sunflower and has been used as a donor of many disease resistance traits making it an excellent donor for perennial habit. Because of previous success in gene transfer from *H. tuberosus*, we believe we will be successful in transferring perennial habit into annual sunflower.

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## **Rethinking Water Quality as an Ecosystem Service: A Framework for Integrated Biophysical Assessment and Economic Valuation, Bonnie Keeler**

Biosystems and Agricultural Engineering

"Progress in sustainability science relies on the development of integrated approaches to assess the social, ecological, and environmental tradeoffs associated with future actions or decisions. Ecosystem service assessment and valuation addresses this need by highlighting the dependency of human well-being on natural systems and the economic value of the goods and services they provide. While the concept of ecosystem services has been embraced by the sustainability community, there are still significant gaps in our understanding of how to link ecosystem processes with impacts on humans and integrate ecological and economic models for service assessment and valuation.

Here I present a framework for assessing and valuing the multiple ecosystem services

impacted by changes in water quality. Degraded water quality is a global problem threatening human health and well-being through impacts on drinking water, recreation, aesthetic value, and commercial activity. Despite the importance of water quality in decision-making, we lack a clear and consistent framework for valuing water quality due to changes in nutrient, sediment, or other pollutants. My research addresses this need by identifying key barriers to the economic valuation of water quality, presenting a template for water quality valuation based on linked economic and biophysical models for individual services, and providing clear guidance on how to integrate water quality assessment and valuation into decision-making."

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### **Gender Differences in Employee Sustainability across Cultural Regions: A Meta-Analysis, Rachael Klein**

Industrial/Organizational Psychology

Awareness of gender differences in pro-environmental workplace behaviors is important in understanding and supporting employee contributions to organizations' sustainability efforts. The authors sought to determine the degree and direction of these gender differences in sustainable behavior by meta-analyzing data collected from multi-national organizations in 21 countries. The authors computed the average extent of these gender differences based on their findings from 43 samples and 30,169 employees. Across cultures, female employees were more likely to perform pro-environmental behaviors than men, but only to a small extent. The size of this effect was stronger in the Anglo and Confucian Asian cultural regions. In Latin America, Latin Europe, Eastern Europe, and Germanic Europe, men were found to engage in more sustainable behaviors at work than women, but only with small effects.

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### **Electricity Generation and Biodiversity Impacts: A Framework for Comparing Biodiversity Risks of Electric Energy Sources, Kate Knuth**

Conservation Biology

Global biodiversity is in decline, partially due to climate change. Reducing the threat of climate change will require many solutions including a switch to less carbon-intensive electricity sources. While the transition away from carbon-intensive electric energy will benefit biodiversity by reducing the threat of climate change, other biodiversity impacts of this switch are unclear. To clarify risks, we propose the first framework for

comprehensively assessing and comparing biodiversity risks across electric energy sources. Categories of risk in the framework are terrestrial, aquatic, direct mortality, and greenhouse gas emissions. Using these categories, we review the biodiversity risks of six electric energy sources: coal, natural gas, nuclear, hydroelectric, wind, and solar. Applying the framework to these power sources offers insight into the trade-offs in choosing among electric energy sources. The need for further work to create and improve tools for comparing the biodiversity risks of energy sources as well as the need for better information regarding specific sources are discussed. This framework is a tool to include biodiversity risks in energy choices in an effort to improve decision-making in the context of climate change and biodiversity declines. In light of worldwide biodiversity declines, biodiversity should be a factor in making decisions about future electricity production.

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### **Energy Giants: The US, China, and Renewable Energy Production, Jenna Lewein**

Asian Languages and Literatures/Environmental Sciences, Policy, and Management

The research I would like to present at the sustainability studies symposium would focus on the relationship between the United States and China in regards to renewable energy production. Specifically, I would like to explore how the two countries are connected by these issues and what the potential effects of this could be. Currently, China is the world's largest producer of photovoltaic cells and wind turbines; the majority of it is imported by the West, including the United States. China also holds vast resources of rare earth minerals that are used in manufacturing components of several renewable energy technologies, which allows them to control a large section of the world's renewable energy market. However, sustainable energy practices in China are still largely in their infancy. China's huge economic growth has spurred an unceasing demand for energy; in 2009 China surpassed the United States in energy use for the first time in history. This increased demand for energy has prompted China to build hundreds of new coal-powered electrical plants, causing the country to surge ahead of the United States in yearly carbon emissions. I want to explore how China and the United States are negotiating the demand for more renewable energy, not only within their respective countries, but with each other.

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### **Perceptions of Density in the Residential Built Environment, Erin Lilli**

School of Architecture

Density is widely used in urban planning, yet this complex topic deserves further focus

given its current definition limitations coupled with the sharp increase in global urbanization. Moving forward, it will be crucial to merge quantitative and qualitative properties into the discussion of density. Residential suburban communities, in the United States, are often predicated on the notion of low dwelling unit densities with the inhabitants preferring an antidote to the perceived congestion and crowd of the urban core environment. Primarily consisting of single family homes on individual plots of land with private yards and wide streets; these developments are becoming more ubiquitous despite both the automobile's and land conversion's roles as major contributors to the high concentrations of carbon dioxide in the atmosphere. The question this study asks is; what are the relationships of influence with regard to residential built environment spatial characteristics, and the perception of low density? In other words, can we design an environment which is perceived as low density, while utilizing less land area than its actual low density counterparts? To investigate this question three housing typologies (single family homes, row houses, and stacked row houses) and three spatial characteristics (street width, set back distance, and tree coverage) were systematically altered and combined in graphically represented images of a residential street scene. These images were part of a survey sent to 400 randomly selected inhabitants of Beaverton, Oregon who were asked to choose the scene they felt was the most spacious and most preferred, from sets of stimuli, using discrete choice modeling.

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### **Virtually Bringing People Closer Together, Michelle Linhoff**

Institute on the Environment

"Increasing numbers of people are managing their social networks on mobile information and communication technology (ICT) platforms. This study materializes these social relationships by leveraging spatial and networked information for sharing excess capacity to reduce the environmental impacts associated with "last-mile" package delivery systems from online purchases. Three systems are compared using simulations to estimate the total last-mile delivery distance and greenhouse gas (GHG) emissions: a current door-to-door delivery system (CDS), a designated package pickup location system (PLS), and a socially networked package location system (SPLS). Results indicate that a PLS, such as a delivery kiosk on a public transit platform, in a grocery store, or at a gas station, can slightly reduce package travel miles and GHG emissions in an urban setting, as compared to the current door-to-door delivery system. However, in a suburban setting, reductions in package travel miles associated with local delivery are overwhelmed by the remainder of package travel

miles being carried out by multiple less-efficient personal vehicles. Once a social network is employed (SPLS), significant reductions in the last-mile delivery distance and carbon emissions are observed across both urban and suburban settings. Findings provide implications for both logistics management's decades-long focus on improving efficiencies of dedicated distribution systems through specialization, as well as for public policy targeting carbon emissions of the transport sector. "

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## **Fish, Forests and Futures, Emily Lowery**

### Landscape Architecture

"The health, economic and cultural well-being of the world's most vulnerable communities are dependent on the quality and quantity of their surrounding natural resources. The skill sets of landscape architects are applicable across bio-regions, cultures and economies and stand to benefit the lives of those who depend so heavily upon surrounding natural resources. This is the foundation of my capstone project.

What's the BIG IDEA? Over the next 9 months I will be working to develop and design a proposal to address deforestation on the island of Mfangano, Kenya. I will be partnering with The Organic Health Response (OHR), an established, committed organization, seeking to activate social solidarity, information technology, and environmental sustainability on Mfangano Island in Western Kenya to turn the tide against the devastating impact of HIV/AIDS across Lake Victoria.<sup>1</sup>

Why the BIG DEAL? In 1954, two dozen Nile Perch were placed in the water of Lake Victoria. By the 1980's the "Nile Perch Boom" began, annihilating the native fish species of the lake and the habitat in which they live. Within this time, the convergence of thousands of migrant fishermen, a cash explosion within impoverished and dis-empowered communities, vulnerable women and customary trade practices such as jaboya or "fish-for-sex," increasing food insecurity, ecological destruction, and a near total lack of health infrastructure has culminated in a perfect storm of HIV. The Suba people in Nyanza Province (the location of Mfangano) are suffering from the one of the most critical concentrations of HIV/AIDS in the world.<sup>1</sup>

Who's the partner ORGANIZATION? The Organic Health Response is unique in its holistic approach to countering the impact of HIV/AIDS as it recognizes that proper health interventions must address the biological, social, and ecological relationships. OHR, a

partnership of Kenyan and American partners, embraces a philosophy that champions social justice and environmentalism not merely as political ideals but as the key components of a comprehensive strategy to improve and sustain human health.<sup>1</sup> Last year, OHR received a \$100,000 Google Grant to pursue its mission and has received \$10,000 through UC Berkeley's "Big Ideas" Competition under the category of Global Poverty Alleviation. My friends in OHR will be moving back to Mfangano for one year in order to progress and implement the organization's planned projects and programs. This committed, passionate has allowed me to jump on board and use my capstone as a way to help develop a number of programs within the organization.

What will I DO? My intention is to create a proposal that would address incentives and/or alternatives to deforestation on varying scales. This proposal will be used by OHR to be implemented as a system or used as a guide. Deforestation on the island has resulted in erosion, landslides, soil degradation and respiratory problems caused by inhalation of burning charcoal from timber. The interdependence between the community and the local ecology is undeniable and illustrates that the promise of sustainability as a challenging, non-linear, web of interdependent systems. While the focus of my capstone will address deforestation on Mfangano, clearly this problem is one symptom of the larger issues of social/ecological (in)justice. By looking at the alternatives and incentives to deforestation, we are supporting Mfangano to better sustain the community living off of its resources with lasting sustainability.

I am incredibly excited and honored to be able to work with this passionate, committed group of people and I intend to be involved with this organization beyond the capstone lifespan. I see the field of Landscape Architecture as having a more visible role on the global stage as the world becomes smaller and our natural resources diminish. As landscape architects, we know enough to know we can help.

1 <http://www.organichealthresponse.org> "

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## **The Cost of Social Pressure on Sustainability Marketing Initiatives, Paola Mallucci**

### Marketing

"We examine the role of social pressure on the demand for sustainable goods. Sustainable goods are unique because they often confront the customer with trading off private benefits against social benefits. Consumers buy sustainable products, not only because they want to contribute to the greater good of society, but also because they feel obligated to

match the standard of behavior set by a firm that is a producer or marketer of a product or service of interest to this customer. Firms leverage this mechanism by increasing the social pressure on the individual through various policies and tactics such as greater social visibility accompanying the purchase. While it is widely accepted that increasing social pressure is an effective way to increase a firm's market share; the cost of social pressure to consumers is not as well understood. For instance, there is a current trend towards adopting opt-out rather than opt-in policies that capitalize on consumers' status quo tendencies to increase adoption of energy conservation behaviors. Are there limits to the effectiveness of opt-out appeals given the cost of social pressure? In a series of experiments, we show that using social pressure to encourage consumers to buy sustainable products decreases consumers' willingness to pay and share of purchase, all else equal. We argue social pressure is a form of coercion that generates a negative feeling and reduces consumers' utility. Further studies are being designed to unpack the ramifications of the cost of social pressure that accompanies the use of social pressure to market sustainable goods and services."

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### **Effects of Vegetation Cover on Nutrient, Tamara Marcus**

Ecology, Evolution, and Behavior

Motivation: As the population within cities continues to grow in the coming years, it becomes increasingly important to develop better ways to manage the city's vegetation. This experiment is designed to demonstrate the influence of different land coverage and management decisions in urban areas on water quality. Field and lab studies will be used to show how different species of trees influence nutrient flow in the Capitol Region Watershed District in St. Paul, Minnesota.

Method: Four streets in St. Paul, Minnesota were selected. Six gutters on each street were sampled, three on each side. The gutters were labeled with identification numbers in numerical sequence. Random numbers were generated via Microsoft Excel to determine which gutters would be sampled. Samples were collected from the randomly generated gutter through a sweeping process. Small dustpans were used to sweep up the debris in the gutter. The samples included leaves, rocks, and trash. The samples were then analyzed in lab to determine the amount of Nitrogen, Phosphorus, and Sulfur within the sample.

Results: Although the research has yet to be finished, it is hoped that the research will show the relationship between tree coverage and nutrient loading in urban waters. Conclusions: Although the research has yet to be finished it is hoped that one

application of the data will be for it to be used to facilitate future sustainable management practices of urban vegetation. This will reduce nutrient loading and improve the health of the Mississippi. "

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**Characterization of biologically active native Minnesota plant extracts, using a bioassay-linked metabolomics method, for incorporation into multi-functional landscapes , Amanda Martin**

Horticultural Science

Native Minnesota plant extracts have the potential to be made into useful products including drugs against resistant pathogens, "organic" agricultural pesticides, and natural preservatives for pharmaceutical, food, and cosmetic products. Critical in developing a useful product is the detection of extract bioactive constituents. Metabolomics techniques provide a way to investigate the global population of plant extract metabolites. Using these methods it is possible to classify different populations and plant parts based on their metabolic "fingerprint" and to detect potentially novel molecules with bioactivity. Serving as a model system for metabolomics method development, crude extract from the Minnesota native plant *Rhus typhina* (Staghorn sumac) was used since it has been demonstrated to have antioxidant and antimicrobial activity. Specifically, a bioassay-linked-metabolomics method was used as a way to probe un-fractionated plant extracts from several populations of extracts made from the plant. Extract metabolic fingerprints were obtained by reversed-phase liquid chromatography-electrospray ionization- time-of-flight mass spectrometry and antioxidant activity was assessed in a free-radical scavenging assay. Metabolic fingerprints were subsequently analyzed using multivariate statistical techniques to identify the metabolic features driving sample clustering due to differences in location, tissue type, or bioactivity level. Structural elucidation of these identified features will provide leads for specific bioactivity tests and product development. By developing value-added goods from native plants it will be possible to enhance conservation efforts to preserve plant communities and indigenous knowledge of medicinal botany, while filling the need for new drugs and products. Finally, by providing incentive to explore the diversity of secondary metabolites produced in native ecosystems, rather than the monoculture of conventional agricultural landscapes, it may be possible to create multi-functional landscapes that provide economic benefits as well as ecosystem services.

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## **Sinking MASS: Sustainable Water Use Practices for a City Plagued by Sinkholes, Laurie McGinley**

School of Architecture

"San Salvador, a city of 1.6 million inhabitants, is the capital of El Salvador. Rapid growth, volcanic soil conditions, natural and human made hydrological systems, seismic activity and aging infrastructure contribute to an endemic sinkhole problem that is consuming the city. Pre-settlement geological and hydrological conditions allowed storm water to flow in braided rivers that changed course throughout the rainy and dry seasons. Human development in San Salvador increased impermeable surfaces, decreased flexibility in surface water ways and created human-made, underground water systems. These systems are the pipes that carry water to and remove water from buildings. The current social practice of using water in buildings is causing the city to sink. Redesigning and rebuilding San Salvador's water use network is not enough to prevent the city from sinking. Individuals, businesses and families will need to change how they use water in order to make a systematic change that will save the city. Rainwater harvesting and waste composting are systems that can slow the damage. The largest question is, How will the cultural revolution gain momentum to convince people to change their way of life?

My Master of Science in Architecture, Sustainable Design thesis topic will investigate strategies to mitigate the sinkhole disaster in San Salvador using existing technologies to capture, treat and distribute water at the building level. San Salvador is a city that is faced with the very real danger of sinkholes and they are well poised adopt more sustainable practices in terms of water and energy in their buildings. What can we learn from Salvadorans that can apply to cities that are not in eminent danger in order to encourage mass adoption of more sustainable practices? "

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## **Evaluating Sustainability of Food Service Building Operations, Joe Messier**

School of Architecture

"While sustainability can be measured and discussed through a variety of metrics, greenhouse gas (GHG)emissions inventories are a popular tool for building designers and operators to evaluate the impact of building operations on the environment. Existing inventory guidelines, including those from the World Resources Institute, the US Environmental Protection Agency, and the UK Department for Environment Food and Rural Affairs, have become internationally recognized and utilized by many organizations

to conduct GHG inventories. However, these tools have been designed with the commercial office building sector in mind and are narrowly focused on the operational processes that are considered by the inventory. Food service building operations are unique amongst commercial building types in that they rely on processes that consume a variety of resources that are beyond the scope of typical GHG inventories. Directly, food service buildings consume vast quantities of electricity, natural gas, and water on-site in the preparation of food. Indirectly, food service buildings encompass operations in the agriculture sector in the production of food ingredients; the transportation sector in fuel consumption by vendors, employees, and customers; and even waste management. This research proposes a comprehensive GHG inventory protocol that assesses emissions generated by critical processes along the entire supply chain of food service building operations. This proposed inventory serves as a holistic evaluation of the operational impact on climate change. "

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### **Green Village GrowBarrels: Cultivating Food and Community in Minneapolis", Jennifer Nicklay**

#### Biology

"The Southeast Como neighborhood in Minneapolis, Minnesota is bordered by industry, railroads, freeways and the University of Minnesota; as a result, it's home to very diverse residents. One thing these residents share is a limited access to healthy and affordable foods – a situation recognized in the City of Minneapolis Urban Agriculture Policy Plan, in which Southeast Como was designated as a 'key area' for food access improvement. To address limited food access, the Southeast Como Improvement Association sought to design food production programs which fit the neighborhoods' needs. The Green Village GrowBarrel program, in particular, was designed to focus on the renting population – the majority of which is students – as it represents nearly 80% of the neighborhood's residents. The main considerations for this demographic, in addition to access and affordability, are portability, space, and ease-of-use. GrowBarrels, therefore, were designed to be self-watering container gardens constructed from nearly 100% recycled materials. They are perfect for short-term residents who are likely to move frequently because the GrowBarrel can be taken with them, ideal for those with little to no yard space for a traditional garden, and easy-to-use for beginners. This past summer, residents constructed their own GrowBarrel for free at building workshops, possible through a grant from the McKnight Foundation. In addition to disseminating a new food production system, the workshops

also promoted community development and introduced residents to sustainable urban agriculture and the local foods movement."

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### **Plant a tree, save a...lake?, Daniel Nidzgorski**

Ecology, Evolution, and Behavior

Ever wondered if planting a tree might help protect your local lake? It's certainly not the first thing that comes to mind when people think about the benefits and ecosystem services of urban trees. Many urban lakes are suffering from algae blooms caused by excess nitrogen and phosphorus in the water -- and trees affect how these nutrients move from land to water. In 2011, I began a multi-year study comparing fourteen common species of trees, as well as open turfgrass areas, in Saint Paul city parks. I am comparing the amount of nitrogen and phosphorus moving down through the soil to groundwater, which is a significant pathway of nutrient pollution to local lakes and streams. City planners and homeowners are continually making long-lasting decisions about urban tree planting and replacement; my research will help incorporate water-quality effects into these decisions.

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### **Lowertown Yards: Public Space from Renewed Infrastructure, Colleen O'Dell**

Landscape Architecture & Urban and Regional Planning

"The Lowertown area of downtown Saint Paul is both historically and culturally rich- the birthplace of the Dakota people and the city of Saint Paul, and the historic head of continental Mississippi navigation for the Northwest. For the last 150 years however, we have given this socially and environmentally vital riparian area over to machines and infrastructure: to railroads, automobiles, sewer systems, electrical grids, and surface parking. Like many prior industrial areas throughout the U.S., we have erased the original history and ecological functionality of the land, first by replacing it with hardscape engineered infrastructure lacking in cultural identity, and second by allowing that infrastructure to decay, obsolesce, and contaminate surrounding soil and water.

This dual landscape architecture and urban planning project repurposes and reconnects the disconnected pieces of Lowertown by daylighting and reusing stormwater to create public space, sustain urban agriculture, and create new water-cleansing wetlands. Additional design and planning approaches include the phytoremediation of rail yard contamination, reduction of impervious surfaces, establishment of creative pedestrian, bicycle, and light rail connections, and an active celebration of the creative local arts and

food culture. The resulting design transforms this concrete and asphalt brownfield into a green and thriving community that has reestablished its historic, cultural, and living bond with the Mississippi River."

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### **Procuring Sustainable Products, Rylie Olson**

Natural Resources and Science Management

"As the Environmental Revolution further takes hold and the awakening of Businesses and the Masses to the need for sustainable consumption takes place, procurement decision makers from all industries and sectors are turning to eco-labels to meet environmental sustainability objectives. Major stakeholders, like Walmart and U.S. Federal Government (GSA), are specifically driving the demand for 'green' products. There is minimal information, however, on the quality and validity of these eco-label claims, called indicators. How do decision makers know that the indicators actually result in a product with less environmental impact? For example, does a product that touts its recyclability have less of an impact than that same product that is biodegradable? One way to measure the various indicator impacts on the sustainability performance of the product is through life cycle analysis.

The goal of the study is to identify which indicators actually drive product life cycle performance by showing a positive, quantitative reduction in impact over the product's life cycle. This study utilizes both the economic-input output LCA model to identify hotspots related to key product categories in the Food, Beverage and Agriculture sector, as well as commercial life cycle databases to compare the individual indicators to a baseline impact model for each product category. We have tested these methods on packaged milk and plan to apply them to other products, such as wheat cereal, strawberry yogurt and orange juice. The ultimate goal is to determine where efficiencies can be gained (and costs kept down), while still maintain a level of accuracy to aid and assure procurers of reaching their sustainability goals. If companies have to spend fewer resources on deciding on the environmentally preferable option, they will be more likely to engage in procuring 'green' products/services.

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### **Emerging Green Patent Programs and Innovation Policy, Rebecca Pickens**

Science, Technology, and Environmental Policy

Green patent programs have emerged over the last few years as a new area of policy

experimentation. Government and NGO programs have focused primarily on defining green patents and facilitating green patent administration and licensing with accelerated processing and reduced fees. At the same time, non-profit and industry-based green patent pools have started to offer green patents to the public through rule-based patent pools. The Eco-Patent Commons and GreenXchange have had some success with attracting both participants and patents, but the progress has been relatively slow. This project has assessed the legal, economic, and policy issues around patents in general and green patents specifically. Drawing on this research, a set of evaluation criteria has been developed. The pilot programs are assessed against these criteria, along with some new policy proposals and some taken from literature.

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### **Thermochemical seasonal energy storage: A breakthrough technology to displace fossil fuel consumption, Josh Quinnell**

Mechanical Engineering

Residential space heating comprises 45% of the energy used in the average U.S. home and a staggering 10% of all energy consumed in the U.S. These energy needs are primarily met using natural gas, coal-fired electricity, and heating oil, resulting in 545 million metric tons of CO<sub>2</sub> emissions annually. Highly efficient distributed solar thermal systems for heating applications are a proven technology with the capacity to displace fossil-fuel consumption and reduce CO<sub>2</sub> emissions in all climates. The major challenge of adopting solar thermal systems to meet winter heating loads is the poor solar resource during winter months when the most energy for space heating is needed. The solution is seasonal storage; solar energy from the summer must be stored for use in the winter. Seasonal storage enables homes in cold climates (e.g. Minnesota) to meet all heating, cooling, and hot water loads with solar energy. Today, heated water is the primary storage method for these systems, but water is a poor seasonal storage medium due to large losses and prohibitively large storage volumes. We are developing a novel thermochemical storage device for the compact, long-term storage of solar thermal energy. This device stores up to 10 times more energy than heated water for the same storage volume and has very low losses because the energy is stored in a chemical reaction. System modeling has shown that compact, long-term storage using an inexpensive calcium chloride (road salt!) solution can reduce storage sizes by 75%. Computational fluid dynamic results and initial experiments have shown that losses can be reduced up to three times compared to heated water storage.

Thermochemical storage is the critical aspect to enable low-cost solar thermal systems for

space heating and few other technologies share its potential to reduce fossil fuel consumption and greenhouse gas emissions.

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### **Institutional Entrepreneurship in Emerging Industries: Lessons from the Carbon Offset Industry, Hans Rawhouser**

Strategic Management and Organization

In addition to competing in the marketplace, entrepreneurs in a new industry can play an important role as institutional entrepreneurs by helping to develop the rules governing the new industry. I argue that involvement in rulemaking, a type of institutional entrepreneurship, provides a reputation signal that benefits some firms and may hurt other firms under conditions of strategic uncertainty in new industries. Using a rich data set exclusively developed for the dissertation, I test the performance effects of this type of institutional entrepreneurship for 1,600 carbon offset firms developing 8,140 projects between 2003 and 2011.

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### **A Meta-analytic Review of Interventions Aimed at Greening Our Workforce, Sarah Semmel**

Psychology

Environmental sustainability is an increasingly important topic in our society. It is clear that for our planet to thrive we must reduce our environmental impact.

Industrial/Organizational psychologists can make important contributions to the sustainability goals of organizations and society. Quantitative synthesis approaches were used to assess the usefulness of green interventions aimed at changing employee behavior in work settings. A small number of studies provide initial support for the effectiveness of workplace interventions in greening efforts, with effect sizes generally in the moderate range. There appears to be a drastic shortage of research in this area. Scientists and practitioners are encouraged to apply scientific principles to help organizations achieve environmental sustainability goals.

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### **New method to convert heat directly into electricity, Yintao Song**

Aerospace Engineering and Mechanics

We demonstrate a new method for the direct conversion of heat to electricity using the

recently discovered multiferroic alloy, Ni<sub>45</sub>Co<sub>5</sub>Mn<sub>40</sub>Sn<sub>10</sub>. This alloy undergoes a martensitic (solid-solid) phase transformation from a nonmagnetic martensite phase to a strongly ferromagnetic austenite phase upon heating. When biased by a permanent magnet, this phase transformation causes a sudden increase of the magnetic moment to a large value and generates electricity in a surrounding circuit, as a consequence of Faraday's law of induction. Because of the low hysteresis of such a phase transition, a promising area of application of this concept appears to be energy conversion at small change in temperature, suggesting a possible route to the conversion of the vast amounts of energy stored on earth at small temperature difference. Our method can also be a promising candidate to generate green electricity from the many commercial and technological sources of waste heat.

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### **A new Paradigm for Sustainable Agriculture, Alex Strachota**

Agronomy and Plant Genetics

Agricultural production in the US is primarily based on monocultures of annual plants. While highly productive, this agricultural model is increasingly seen as a main contributor to environmental degradation, especially in agriculture's impact on topsoil, water, biodiversity, and climate. While much work is being done to address these concerns through plant breeding, nutrient management, reducing tillage, and buffering riparian areas, I argue that a genuinely sustainable agriculture demands a new paradigm, one that addresses the systemic design limitations of annual monocultures. Designing US agricultural systems based on perennial plants--species living for three or more years--and polycultures--groupings of multiple species of plants in space and time on the landscape--has the potential to address the root causes of much of modern agriculture's systemic failures. In order to establish perennial polyculture-based systems widely on the agricultural landscape, however, it will be necessary to overcome impediments and challenges in technical (agronomic), social-cultural, and policy arenas.

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### **Air quality and public health impacts of biofuel production and use in the United States, Christopher Tessum**

Civil Engineering

"The current US Renewable Fuel Standard (RFS2) requires increasing amounts of biofuel production up to 36 billion gallons in 2022. We use life cycle assessment, air dispersion

modeling, and health risk assessment to compare the air pollution-related health damage costs of an additional 7.5 billion gallons of corn grain ethanol and 5 billion gallons of cellulosic ethanol from corn stover to an equivalent amount of gasoline. This represents the entire RFS2 mandated increase in corn ethanol over 2008 volumes and the EPA projected fraction of cellulosic biofuels derived from corn stover, which is forecast as the lowest cost cellulosic feedstock.

Process-specific emissions for the life cycle of fuel production and use are extracted from the GREET life cycle model and allocated to a 12km grid over the continental US, in one hour time steps, during a 1-year model simulation. The life cycle assessment includes emissions from feedstock production (petroleum extraction and agricultural activities), conversion to fuel, distribution, and combustion in vehicles, plus the necessary inputs, such as fossil fuels, electricity, and fertilizer, for each step. A mechanistic photochemical air dispersion model (CAMx) predicts the fate and transport of emissions, estimating marginal pollution changes attributable to RFS2. We focus here on PM2.5 and ozone, two of the pollutants most responsible for air pollution-related health impacts.

Preliminary results suggest that the production and combustion of 7.5 billion gallons of corn grain ethanol and 5 billion gallons of cellulosic ethanol from corn stover will annually yield 260 more deaths due to PM2.5 and ozone compared to an energy equivalent amount of gasoline. This is equivalent to a value of statistical life (VSL) based increase in public health burden of 0.30 USD per gasoline equivalent gallon of fuel produced and combusted (0.08 USD/liter) for the ethanol scenario compared to gasoline. However, the cellulosic corn stover ethanol component by itself would yield a decrease of 70 deaths per year compared to gasoline.

Preliminary results suggest that initial implementation of RFS2 will worsen air-quality and related mortality in the US and increase health-related damage costs. "

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## **Sustainable Design, Construction, and Maintenance of Educational Environments as Learning Opportunity, Elizabeth Turner**

School of Architecture

There is a growing trend toward building "green schools" which promote the environmental, but also economic and social, sustainability of the communities they support through design strategies such as green roofs and geothermal heating, but also programmatic components like urban farming and student-run cafes. In many cases, the

educational goals of the academic institution drive innovative and sustainable construction practices which serve as a “living laboratory” for students. This research begins with case studies of sustainable learning environments, from pre-K facilities to Universities, with particular attention paid to sustainable design strategies and student engagement in the design process. The project then analyzes the specific priorities of Great River Montessori Junior/Senior High in St. Paul and proposes a “sustainable” design based on the school’s interpretation of Maria Montessori’s educational philosophy and input from students, faculty and staff. The next step is an evidence-based research project, utilizing Great River as a case study, which will examine the possibilities for schools to maximize potential for students to learn about sustainable systems through the design, construction, and maintenance of learning environments.

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### **The Relationship Between Individual Age and Sustainability: A Meta-Analysis, Brenton Wiernik**

Psychology

The purpose of this study was to quantitatively summarize research on the the relationship between age and a variety of environmental sustainability-related psychological variables using a technique known as meta-analysis. Relations between age and environmental concern, values, attitudes, awareness, knowledge, motives, intentions, and behaviors were examined. Overall, age was negatively related to environmental concern, attitudes, and knowledge, but it was positively related to social norm motives and to environmental behavior. However, magnitudes of the relationships were generally small. In general, it appears that younger individuals are somewhat more knowledgeable and concerned about environmental problems and more committed to improving the environment, but this concern does not lead to more sustainable behavior. The mismatch between younger individuals’ concern and their actions may be due to lack of opportunity or other societal constraints.

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### **A report of ongoing research on environmental endocrine disruptors in prairie voles, Shelby Williams**

Ecology, Evolution, and Behavior

"Sustainable biofuel production from diverse native prairie promotes wildlife conservation (1), may contribute to the country's energy needs, and reduces green house gases (2). The

potential for marginal croplands in Minnesota and elsewhere to be applied toward non-food bioenergy production suggests fertilization with sewage biosludge may be an alternative to traditional fertilizer application and waste treatment (3), as an annually harvested perennial prairie has shown to help purify groundwater of land-applied chemicals (4, 5). An important link in this broad chain is the effect on wildlife of the substances remaining in biosludge upon application. Specifically, this project addresses the effects of endocrine disrupting compounds (EDC) on the socially monogamous prairie vole (*Microtus ochrogaster*).

Since prairie voles occupy a critical central role in the ecological food web, their status is important to the sustainability of grassland ecosystems. Prairie voles form social bonds, exhibit biparental care, and have emerged as a suitable human model as well (6). EDCs are known to disrupt the social monogamy of a related species, the pine vole (7). In addition, studies of native fish in Canada show impacts on male gonadal development when exposed to EDCs in water, which consequently drove the experimental population near extinction (8).

In this study, voles in one treatment group experienced four EDCs at low to average concentrations, based on published literature. A second group experienced controlled pristine conditions with no EDCs, and a third group experienced elevated amounts. Partner preference tests tracked vole behavior toward their chosen partner given the option of interacting with a stranger vole, and alloparental behavior tests measured adult/pup interactions. Histological testing is planned which will aid in understanding the effects of EDCs on small mammal reproductive tissue. Behavioral tests are complete, scoring is underway, and subsequent analysis is being planned.

This study is designed to shed light on what reproductive and parental behavioral effects EDCs have on voles and their subsequent population dynamics. Because behavior in many vertebrate species, including humans, is influenced by endocrine brain hormones that are conserved across species boundaries, results may have significance beyond prairie voles. This information is applicable in evaluating health in manipulated environments, and is relevant for city planners, farmers, agronomists, and all who have a stake in developing the use of waste as a resource. REFERENCES: 1. Fargione J, Cooper T, Flaspohler D, Hill J, Lehman C, McCoy T, McLeod S, Nelson E, Oberhauser K, Tilman D. 2009. Bioenergy and wildlife: threats and opportunities for grassland conservation. *BioScience*. 59:767-777  
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## **Six Nations, One River, Soriya Yin**

### Forestry Resources

Collaboration is one of the most frequently recommended strategies to address global issues including sustainable tourism. Despite its frequent mention, little empirical research has been done to explain the relationship between collaborative efforts and the success of sustainable tourism initiatives (Mowforth & Munt, 1998; Selin, 1999; Hall, 1999). Even less work has been conducted in developing countries (Tosun, 2001), particularly in the Association of Southeast Asian Nations where research and information are limited (Wong, Mistilis & Dwyer, 2010). The proposed research tests models of intergovernmental collaboration as they relate sustainable tourism in the six Greater Mekong Sub-region (GMS) countries (China, Myanmar, Laos, Thailand, Cambodia and Vietnam). Eight key factors: 1) resources, 2) administration, 3) regional issues, 4) regional attachment, 5) Mutual benefits, 6) trust, 7) governance and 8) leadership will be assessed how they influence collaborative activities which in turn would influence sustainable tourism outcomes. A structural equation modeling (SEM) will be employed for data analysis. Data from a survey of four hundred and twenty random government officers from the six

countries will examine the constructs of interest: inter-governmental collaboration and sustainable tourism implementation. The study advances conceptual understanding of collaboration in sustainable tourism and adds to limited empirical literature about the GMS.

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### **Envisioning our Food System, Alice Yonke**

School of Architecture

"As our population and food demands increase, how we interact with our food systems needs to change as well. The University of Minnesota and the surrounding metro area have many resources allowing students to make choices that can improve our relationship with environmental, economic, and social impacts of our choices.

By conducting a survey of University of Minnesota Students through a UROP grant, I was able to gather information about where students get their food, their satisfaction with different realms of the the food systems, how they value these realms, how they would ideally change their food systems, and finally what actions, if any, they could do to help these changes happen.

The goal of my research is to identify specific concerns with in the University of Minnesota community food system and and encourage people to envision what we as a community would like our food system to look like. A student food guide was created as a result of the survey, to inform students about existing possibilities that address many of the concerns identified in the survey."