

Tufts University
Research Days 2010 – 2011
Sustainability
Poster Presentations



Tuesday, May 3, 2011

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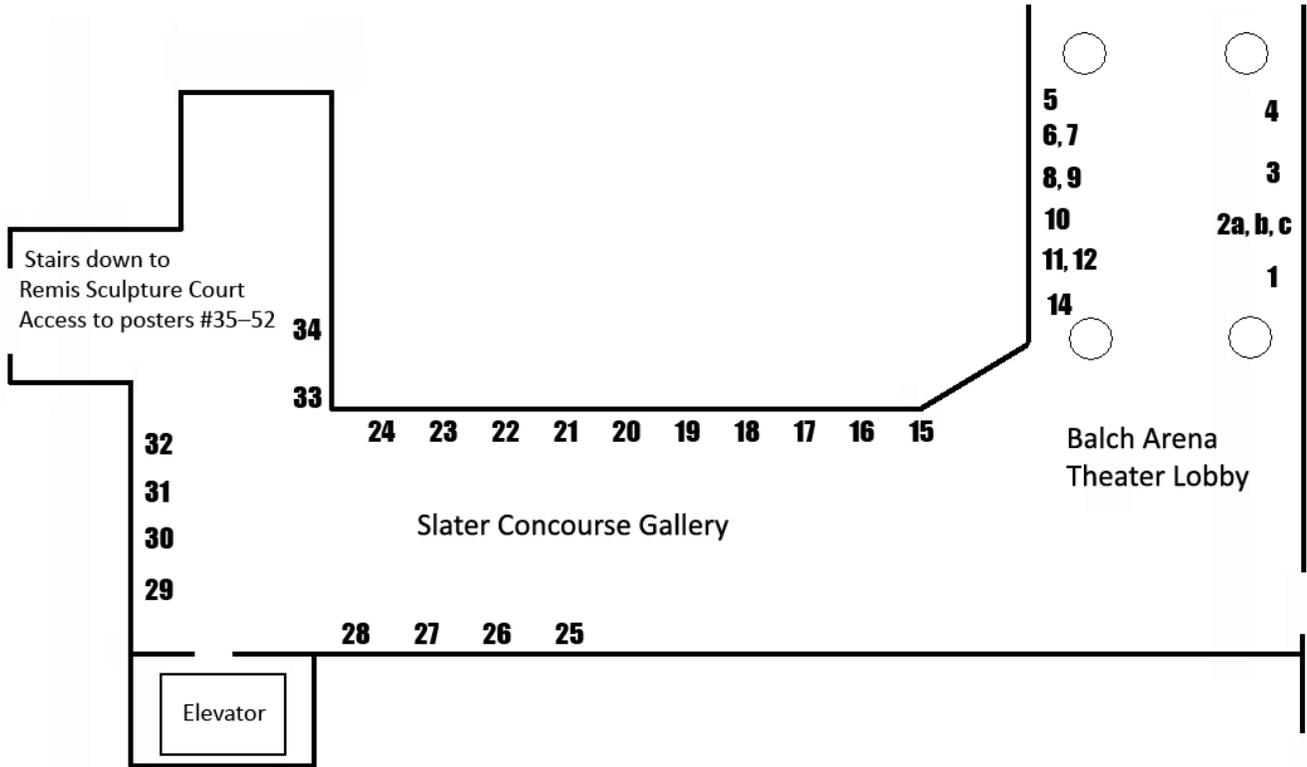
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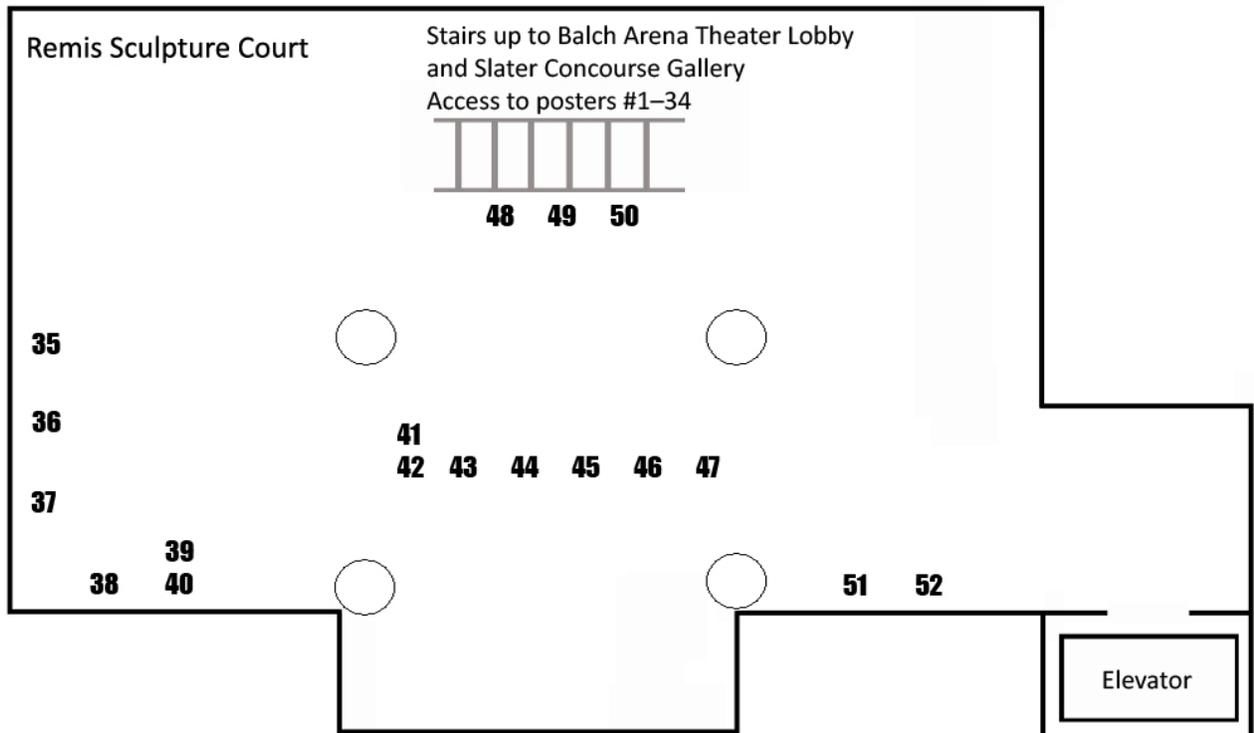
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Title:

Sustainability Research of the Center for International Environment and Resource Policy, The Fletcher School

Authors:

William Moomaw, Kelly Sims Gallagher, Mieke van der Wansem

Presented by:

Kelly Sims Gallagher

Department:

Center for International Environment and Resource Policy, The Fletcher School

Abstract:

At the Center for International Environment and Resource Policy (CIERP) we develop innovative strategies for shifting global development onto a path that is environmentally, socially, and economically sustainable. We analyze how economic and social activities impact the environment, and design strategies for meeting human needs without straining the planet's resources. CIERP turns theory into practice, educates the international community, and prepares students for careers as global citizens.

CIERP analyzes critical global environmental problems through an interdisciplinary approach. We identify underlying scientific, economic and technological dimensions of these issues, and then use principles of international law, diplomacy, and mutual gains negotiations to find effective, sustainable solutions. CIERP also studies the evolution of international negotiations and agreements on environment and resource issues.

Our work includes:

- Scholarly research for the international academic community
- Policy research that evaluates current programs or proposes new approaches
- Applied policy development for government agencies, the private sector, and international NGOs

CIERP focuses its research in four main programmatic areas:

- Energy, Climate, and Innovation
- Agriculture, Forests, and Biodiversity
- Water and Oceans
- Sustainable Development Diplomacy and Governance

Title:

Technology and Policy Approaches to Clean Energy Conversions: The Case of Brazilian Biofuels

Author:

Kathleen Araujo

Presented by:

Kathleen Araujo

Department:

Center for International Environment and Natural Resources - Energy, Climate and Innovation Program,
The Fletcher School

Abstract:

Worldwide, national policymakers and industry decision-makers face inter-related challenges of meeting sustainable energy needs in economically viable ways against a backdrop of competing societal exigencies. Confronted by resource limitations, environmental impacts and political uncertainties, the current energy system requires adaptation to provide a more sustainable supply. If managed properly, optimization of renewable energy—such as with certain biofuels, wind, solar energy or geothermal power—may provide a more lasting and environmentally benign supply of energy, while satisfying societal need and enhancing a country's economic competitiveness.

To understand what drives and sustains national clean energy conversions, this study examines how biofuels have been adopted at scale in Brazil by focusing on technology and policy. Specific aspects include regulatory co-evolution and industry engagement for the period 1975 to the present.

Title:

Developing a Carbon Capture and Storage Roadmap for China

Authors:

Hengwei Liu and Kelly Sims Gallagher

Presented by:

Hengwei Liu

Department:

Center for International Environmental Resource Policy, The Fletcher School

Abstract:

China now faces the three hard truths of thirsting for more oil, relying heavily on coal, and ranking first in global carbon dioxide (CO₂) emissions. Given these truths, two key questions must be addressed to develop a low-carbon economy: how to use coal in a carbon-constrained future, and how to increase domestic oil supply to enhance energy security? Carbon Capture and Storage (CCS) may be a technological solution that can deal with today's energy and environmental needs while enabling China to move closer to a low-carbon energy future. This study has been developed to propose a possible CCS roadmap for China. To develop the roadmap, we first explore major carbon capture opportunities in China and then identify critical CCS-enabling technologies, as well as analyze their current status and future prospects. We find that coal gasification or polygeneration in combination with CCS could be a nearly unbeatable combination for China's low-carbon future. Even without CCS, gasification offers many benefits: once coal is gasified into syngas, it can be used for many different purposes including for alternative fuels production, thereby increasing the domestic oil supply and the flexibility of the energy system.

Title:

Identifying Key Factors in the CleanTech Innovation: An Empirical Study on EV/HEV Innovation by Japan and the U.S. in 1990s

Author:

Xingshu Zhao

Presented by:

Xingshu Zhao

Department:

Center for International Environmental and Resource Policy, The Fletcher School

Abstract:

This paper attempts to identify key factors in the CleanTech Innovation in the United States. For this purpose this paper, based on the existing studies, firstly identifies four factors: Price, Regulation, Incentive, and Competition, and then examines their effects on EV/HEV Innovation by Japan and the US with data from 1970 to 2004, through three comparative analysis: (1) comparing EV/HEV Innovation in Japan before and after 1990; (2) comparing EV/HEV Innovation in the U.S. before and after 1990; (3) comparing EV/HEV Innovation in Japan and the U.S. in 1990s. The results indicate that (1) Regulation and Competition are the key factors in inducing technology innovation in Japan; (2) Radical policy like ZEV has the critical role in Japan's innovation, especially the HEV commercialization; (3) For the U.S., Incentive is conducive to R&D, but has a limited role in Deployment or Commercialization; (4) Regulation and Incentive have the smaller role than Price and Competition in the U.S. technological innovation.

Title:

A Thirst for Power: A Global Perspective on the Water Requirements of Energy Systems

Author:

Edward Spang

Presented by:

Edward Spang

Department:

Center for International Environment and Resource Policy, The Fletcher School

Abstract:

Discussion of the environmental implications of worldwide energy demand is currently dominated by the effects of CO₂ emissions on our global climate. However, at the regional scale, the water resource requirements associated with energy systems are a growing concern. While much of the research in this area has focused on estimating the water consumption of discrete energy technologies, my research synthesizes and expands the existing work in the field to explore the comprehensive water consumption of national level energy portfolios. To provide a new perspective on the topic, I calculated the energy sector water consumption for 160 countries and digitally mapped the results to create the first global representation of the geographic distribution of water-intensive energy systems. I then applied an econometric analysis to identify country characteristics that are closely linked to water intensive energy portfolios.

Title:

Social Values Towards Time and Their Influence on Sustainable Development Performance

Author:

Nancy Gleason

Presented by:

Nancy Gleason

Department:

Center for International Environment and Resource Policy, The Fletcher School

Abstract:

Sustainable development is needed to prevent further environmental degradation in our world. Social values, understood as the criteria for desirability, help us understand why people act the way they do. People's values are fundamental to successful sustainable development because societal standards need to have appropriate valuation and appreciation of nature to ensure the vitality and resiliency of the environment. This research theorizes that social values towards time may influence sustainable development efforts, and seeks to test the theoretical promise of future directed social values for successful forest policy implementation. A future directed society tends to exhibit more pro-environmental behavior as it takes into account future consequences of its actions. This research tests the hypothesis that the more forward looking a society is the better sustainable forest management practices that society will demonstrate. Case study research is being conducted in Suriname, Guyana and Papua New Guinea.

Title:

Global Warming's Smoking Gun

Author:

Eric J. Chaisson

Presented by:

Eric J. Chaisson

Department:

Wright Center for Science Education, Tufts University School of Arts and Sciences

Abstract:

Energy is central to the sustainability of any civilization. Yet, with energy use comes waste heat, an inevitable byproduct of the laws of thermodynamics. Such heat results not merely from the inefficiencies with which our technological gadgets obey thermodynamics' 2nd ("entropy") law; its 1st law demands that ALL energy utilized—efficiently or not—must be re-emitted back into the environment. This is the "heat island" effect viewed globally, which heretofore has been overlooked by organizations such as the Intergovernmental Panel on Climate Change (IPCC).

Over the past few years, I have modeled how global energy usage and its associated waste heat will rise as per capita energy usage likely continues increasing with the advance of cultural evolution. Although currently imperceptible, this heat pollution is slowly gaining and could reach a "tipping point" of 2 degrees Celcius within 2–3 centuries. Even if we sequester greenhouse gases and/or switch to nuclear power, society might soon encounter another heating problem—simply because of the ways that we go about our daily business.

I originally published this interdisciplinary research in peer-reviewed journals (e.g., Chaisson, *Eos/Amer Geophys Un*, v89, p253, 2008). This work has been widely examined in the US (*Sunday Globe*, Boston, 25 Jan 2009), the UK (*New Scientist*, London, v202, p24, 2009), and the UN (*Energy Challenges for the 21st century*, UNESCO, Paris, 2008). And my model projections have been largely confirmed in supercomputer simulations done at the National Center for Atmospheric Research, NCAR (Flanner, *Geophys Res Lett*, v36, pL02801, 2009). Evidently, our Earthly environment will eventually heat up regardless of what kind of energy we use or how we use it—with one exception.

The biosphere will not heat additionally if civilization adopts the use of ground-based solar energy—the kind that naturally lands on Earth every day (but not directed solar energy beamed from orbit), indeed the kind that the plants have managed to use for billions of years. Sunlight’s heating effects are already accounted for in the thermal balance of our atmosphere, thus will not additionally heat our air. Since solar energy also drives wind, water, and waves on our planet, these renewable derivatives, too, are potent energy sources minus any heating.

Some colleagues maintain that my heating concern pertains to a time too far in the future to worry about now. Others worry much the opposite—that it’s a likely recipe for the impending collapse of human civilization. I simply regard it as the single strongest scientific justification for using solar energy to sustain our society going forward.

Principal references for this interdisciplinary research can be found at:

http://www.tufts.edu/as/wright_center/eric/reprints/Eos_AGU_Chaisson08.pdf

http://www.tufts.edu/as/wright_center/eric/reprints/newscientist_galley1.pdf

Title:

Tackling Maritime Bunker Fuel Emissions: The Evolution of Global Climate Change Policy at the International Maritime Organization

Author:

Aaron L. Strong

Presented by:

Aaron L. Strong

Department:

Center for International Environment and Resource Policy, The Fletcher School

Abstract:

Few industries are as global in nature as the maritime shipping industry and few environmental problems are as global in scope as anthropogenic climate change. Given the international nature of the maritime industry in which goods owned by a company based in one country may be transported between two more countries by a ship flagged to a fourth country, carbon dioxide emissions from shipping have not been easily assigned to individual countries and have instead been classified as “international emissions” and excluded from any emissions inventories. This problem of attribution has also confounded international environmental institutions’ attempts to develop regulations for reducing emissions from international transport. By exploring the responses to this complex problem by both the Global Climate Change Regime and the International Maritime Organization, a UN specialized agency based in London which develops guidelines, protocols, and regulations for the maritime industry, as well as the interactions between these institutions, this paper sheds light on the mechanisms that underlie the failure of international agreements to tackle global climate change.

Title:

Sustainable Engineering via Service Learning: Preparing Students for Future Challenges

Author:

Mary McCormick

Presented by:

Mary McCormick

Department:

Department of Civil and Environmental Engineering, Tufts University School of Engineering

Abstract:

The evolving engineering education paradigm is centered on the belief that solutions to current and future problems must consider a human dimension. Inherent to this challenge is the necessary expansion of technological solutions to encompass the social, political, environmental, and economic dynamics of systems on a global scale. Correspondingly, the theme underlying all aspects of educational reform is adequate preparation for engineers to address global problems in sustainable ways. Educators must work towards shifting engineering pedagogies to help students learn a more all-encompassing, human-centered, problem-solving approach.

Across the country, institutions of higher education have undertaken the challenge of incorporating sustainability into curricula through various forms of pedagogy. However, there is little supporting evidence regarding the quality of these learning experiences, leaving the engineering education community with no robust or established way of measuring and/or comparing the efficacy of different pedagogies. With recognition of the need to assess sustainable engineering programs, a deeper question is exhumed: What are the appropriate assessment measures for a human centered learning experience? We contend that as teaching methods shift towards a more holistic approach, assessment must evolve in parallel.

Our research involves developing assessment instruments to measure the efficacy of sustainable engineering courses or programs. Using two complementary instruments, we will explore whether service learning has influenced students' knowledge of and motivation to practice sustainable engineering. Our rationale for this exploration rests in the experiential aspects of learning through service; rather than learning about sustainable engineering in a classroom, students are instilled with the humanistic nature of sustainable engineering through community involvement. Our poster illustrates the instrument development and validation processes, and provides preliminary results.

Title:

Sustainability in Theatre

Author:

Shai Troy Bedik

Presented by:

Shai Troy Bedik

Department:

Department of Drama and Dance, Tufts University School of Arts and Sciences

Abstract:

Sustainability is increasingly becoming relevant to all areas of human activity, not only industry and home, but the arts as well. Theatre is inherently a wasteful event. Large sets and costumes are built specifically for a production, only to be thrown out when the show is over. The aim of this thesis is to explore the different options that theatre has to reduce its carbon footprint, its waste, and to promote the process of recycling in the production process.

The first chapter discusses the evolution of the American environmental movement, bookmarked by two large-scale media works, Rachel Carson's landmark book *Silent Spring*, published in 1962 and Al Gore's *An Inconvenient Truth*, produced in 2006. Both these works caused a major shift in environmental awareness. Exploring the policies and attitudes over this strain of time will give the reader a sense of where the theatre fits into the larger environmental movement that has occurred over the past 50 years. It will then move to demonstrate where theatre fits into the environmental movement. Theatre is a large industry with the heart of an individual. It is a constantly growing and changing art form and has the power to change in a sustainable direction.

The second chapter is an amalgamation of green theatre practices, from a variety of sources. This chapter includes ideas for going green in set design and construction, costume design and construction, lighting, and theatrical venues. It also contains a detailed look at the Tufts drama department through interviews with the design and technical faculty. This establishes exactly what the department is doing in their specialties, with recommendations on how to improve sustainability in both the short-term and the long-term. The most important changes for each department are: a welding room in the scene shop to work with steel and other metals; special attention paid to dry cleaning for the costume shop; an understanding of how we are using energy for the light shop; and an overall increase in storage for the drama department.

The third chapter traces the efforts of New York and London to promote sustainability on Broadway and in the West End. It includes an interview with the Broadway Green Alliance (BGA), a subset of The Broadway League, an extended look at the Green Theatre Programme in London, and the Arcola Theatre's efforts to build a new, sustainable theatre space. This chapter compares and contrasts two different strategies to change theatre. The first is the grassroots approach of the BGA and the second is the government approach of London. The conclusion is that the BGA, with its grassroots organization, is a more effective method than that of London's. Both these cities serve as a model for other theatres and due to the large trickle-down effect of theatre, the efforts made in major metropolises will then be seen in smaller regional theatres in the future.

Title:

Green Keynesianism: What Are the Prospects?

Author:

Jonathan M. Harris

Presented by:

Jonathan M. Harris

Department:

Global Development and Environment Institute, Tufts University School of Arts and Sciences

Abstract:

In the wake of the global financial crisis, Keynesianism—activist government economic policy—has had something of a revival. In practice, governments have turned to Keynesian policy measures to avert economic collapse. This theoretical and practical shift is taking place at the same time that environmental issues, in particular global climate change, are compelling attention to alternative development paths. Significant potential now exists for “Green Keynesianism,” combining Keynesian fiscal policies with environmental goals. This offers the basis for an economic theory suitable for the transition to a stable-population, low-carbon, resource-conserving global economy. A “Green Keynesian” perspective emphasizes new macroeconomic categories including: human-capital-intensive services, investment in energy-conserving capital, investment in natural and human capital.

Title:

The Diffusion of Off-Grid Solar Photovoltaic Technology in Rural Bangladesh

Author:

J.R. Siegel

Presented by:

J.R. Siegel

Department:

Center for International Environment and Resource Policy, The Fletcher School

Abstract:

This paper analyzes how and why more than 650,000 off-grid households in rural Bangladesh have decided to purchase a solar home system (SHS) since 1996. My hypothesis is that positive word of mouth is the primary driver of these sales. The paper begins with a broad history of the genesis and growth of the off-grid SHS sector in Bangladesh from 1996 to the present. Next, it provides a review of the pertinent scholarly literature on energy technology diffusion. Third, it tests the hypothesis through an examination of 100 households in Panchua Village, including 60 with a SHS and 40 without a system. The data suggest that the hypothesis was correct, although it cannot be used to explain which system owner characteristics cause an owner to influence others to purchase a system. Fourth, the paper tests the alternative hypothesis that the subsidies under the World Bank-financed Rural Electrification and Renewable Energy Development Program were the key driver of sales. Drawing on the same data from Panchua Village, I conclude that the current subsidies to encourage sales are not large enough to encourage non-owners in the village to purchase a system. The paper concludes with suggestions for further research.

Title:

From a Culture of Disaster Response to a Culture of Adaptation: Climate Change and Flooding in Honduras

Author:

Laura Kuhl

Presented by:

Laura Kuhl

Department:

Center for International Environmental and Resource Policy, The Fletcher School

Abstract:

Honduras is highly vulnerable to natural disasters, particularly hurricanes, and this vulnerability is likely to increase with climate change. La Ceiba, the third largest city in the country, is highly vulnerable to floods due to its unique location at the foot of a steep mountain range, proximity to the coast, and rapid urban development. This research explores how La Ceiba can transition from a culture of disaster response to a culture of adaptation that incorporates a broad range of risks, including climate change. The research is based on fieldwork conducted on the northern coast of Honduras between May and July 2010. Over 100 interviews were conducted with stakeholders at the municipal and regional level, as well as with NGOs, community leaders and residents. In order to encourage a transition from a culture of disaster response to a culture of adaptation, I suggest that a disaster risk reduction framework may be helpful. Using this lens, I have identified seven potential building blocks for adaptation in La Ceiba, which include: local coping strategies, knowledge of climate change, the current disaster management strategy, national climate policies, national policies on disaster risk reduction, donors and international NGOs, and the international climate negotiations. After evaluating the current status in each potential building block, I conclude that all of these building blocks are necessary for a comprehensive approach to adaptation and can contribute in significant ways. The analysis also demonstrates, however, that this transition will not be easy, and will require dedicated effort on the part of all stakeholders. By viewing adaptation in the broader context of disaster risk reduction, adaptation measures are more likely to address the needs and priorities of residents and policymakers and contribute to integrated solutions to flooding and natural disasters in La Ceiba.

Title:

Rare Earth Oxysulfides as Sulfur Tolerant High-Temperature Catalysts for the Water-Gas Shift Reaction

Authors:

Ioannis Valsamakis and Maria Flytzani-Stephanopoulos

Presented by:

Ioannis Valsamakis

Department:

Department of Chemical and Biological Engineering, Tufts University School of Engineering

Abstract:

Lanthanide oxides, especially ceria, are used not only as sorbent materials for high-temperature removal of H_2S , but also as the primary support for Pt, Pd, Cu, Ni, and Au for low- and high- temperature redox reactions, such as the water-gas shift reaction (WGS). We report here on the activity and stability of lanthanide oxysulfides as catalysts for the high-temperature WGS. The key element for the catalytic activity of these materials is their enhanced oxygen storage capacity and thus reducibility based on the sulfur anion. This oxygen shuttling mechanism involves the entire bulk of these materials and occurs at temperatures higher than $600^\circ C$ which makes them perfect candidates for the high-temperature WGS. The reaction lights off at around $450^\circ C$ and at high temperatures, CO_2 conversions close to equilibrium are achieved. Nevertheless, the most important feature of these materials is their tolerance to sulfur compounds as confirmed by spiking the feed gas with different ppm amounts of H_2S . Thus these materials open new possibilities for combination and integration of fuel processing units in power generation.

Title:

Reactivation of Supported Gold Catalysts

Authors:

Joseph Lessard, Earl St. Sauver, Ioannis Valsamakis, Yanping Zhai, Matthew Boucher,
Maria Flytzani-Stephanopoulos

Presented by:

Joseph Lessard

Department:

Department of Chemical and Biological Engineering, Tufts University School of Engineering

Abstract:

The sintering of gold nanoparticles on metal oxide support catalysts can render them inactive. Recent studies have shown methods to regenerate sintered catalytic systems using various gas phase (e.g. oxygen or carbon dioxide) treatments. This work looks to investigate the impact various gas phase treatments have on different gold/metal oxide supports. Gold supported on zinc oxide (Au/ZnO) and gold supported on lanthana and lanthanum oxysulfate (Au/La₂O₃ and Au/La₂O₂SO₄) were prepared using a colloidal deposition technique to produce large, uniformly distributed gold nanoparticles (3–5 nm). Au/La₂O₃ was also prepared using a deposition-precipitation (DP) technique to generate atomically dispersed gold particles on the metal oxide surface. Proven gas phase treatments of oxygen (O₂) and sulfur dioxide–oxygen (SO₂–O₂) were tested over the colloidal samples. Additionally, a carbon dioxide (CO₂) and an O₂ treatment were tested over the DP samples. Samples were characterized using XRD, UV-vis, TEM and activity testing. O₂ treatments over the colloidal Au/La₂O₃ sample indicate gold redispersion with UV-vis results, though none of the other characterization techniques seem to indicate this. Additionally, activity test results over the DP samples show positive effects from the treatments. Further characterization is underway, as well as time-resolved experiments to better understand, and eventually model, the gold particle redispersion on various oxide supports.

Title:

Dispersed Gold Clusters: Novel Catalysts for Sustainable Hydrogen Production

Authors:

Nan Yi, Matthew Boucher, Simone Goergen, Howard Saltsburg, Maria Flytzani-Stephanopoulos

Presented by:

Nan Yi

Department:

Department of Chemical and Biological Engineering, Tufts University School of Engineering

Abstract:

Novel catalysts for the efficient conversion of fuels to hydrogen for fuel cell applications are under development. Among them a prominent place is held by new catalysts that are both active and stable for the low-temperature water-gas shift reaction to upgrade hydrogen. Another need is highly active and selective catalysts for the reforming of methanol, the easiest alcohol to reform at low temperatures. Achieving either of these two goals would be a breakthrough in the efforts to generate energy cleanly and with high efficiency. Here we demonstrated that a small amount of fully dispersed gold clusters on shape-controlled metal oxide (ceria, zinc oxide and iron oxide) exhibit good catalytic activity for low-temperature steam reforming of methanol (SRM) and the water-gas shift (WGS) reactions. Metal oxide nanoshapes, prepared by controlled hydrolysis and thermolysis methods, expose different crystal surfaces, and consequently disperse and stabilize gold differently. Although the reaction rates vary among the gold-ceria, gold-zinc oxide, and gold-iron oxide shapes, the apparent activation energies are similar. It indicated that the reaction lightoff coincides with the activation of Au–O–M species on the surface of all three oxide supports. Different shapes contain a different number of binding sites for the gold, imparting different overall activity.

Title:

Low-Cost Alkali Ion-Stabilized Atomic Pt Catalysts for Hydrogen Generation

Authors:

Yanping Zhai, Yuan Wang, Nan Yi, Howard Saltsburg, Maria Flytzani-Stephanopoulos

Presented by:

Yanping Zhai

Department:

Department of Chemical and Biological Engineering, Tufts University School of Engineering

Abstract:

We show that alkali ions (Na,K) added in small amounts activate platinum adsorbed on alumina or silica for the low-temperature water-gas shift (WGS) reaction ($\text{H}_2\text{O} + \text{CO} \rightarrow \text{H}_2 + \text{CO}_2$) used for producing hydrogen for fuel cell and other applications. The alkali ion-associated surface OH groups are activated by CO adsorbed at the nearby Pt ion at low temperatures (~ 100 °C). Both experimental evidence and density functional theory (DFT) calculations suggest that a partially oxidized (Na,K)-Ox-Pt(OH) species is the active site for the low-temperature Pt-catalyzed WGS reaction. These findings are useful for the design of highly active and stable WGS catalysts that contain only trace amounts of a precious metal, without the need for a reducible oxide support, such as ceria. Extension to other reactions is currently under investigation and will be shown for formic acid decomposition.

Title:

Development and Application of New Technologies to Detect Pollutants in the Subsurface and Forensic Analysis of Coal Tar and Crude Oil in the Environment

Authors:

Christian Zeigler, Patrick Antle, Albert Robbat, Jr.

Presented by:

Christian Zeigler and Patrick Antle

Department:

Department of Chemistry, Tufts University School of Arts and Sciences

Abstract:

Our research group has focused on building new analytical instruments and developing methods for *in situ* pollutant detection, environmental forensics, and remediation. Coal tar and petroleum-based pollutants consist of thousands of organic compounds, and how they disperse (weather) in the environment is a function of how individual components evaporate, dissolve, adsorb, degrade, and partition between various aqueous and solid phases. Polycyclic aromatic hydrocarbons (PAH), sulfur PAH (PASH), and their alkylated homologs serve as indicators of attenuation in the environment. Toward this end, 2-dimensional gas chromatography/mass spectrometry (GC-GC/MS and GCxGC/MS) instruments have been assembled in our lab to obtain the library of information (retention time and mass spectrometry patterns) of compounds that are unavailable in the literature or commercial databases so that we can detect them *in situ* (without bringing soil or water to the surface) and to provide compound-specific maps to discern differences between clean and weathered matrixes. This information will provide the means to determine whether coal tar or petroleum has weathered sufficiently so that no additional pollutants are being released into the environment. For example, recent studies have shown that when harbor sediment is dredged, new pollutants are released and spread 25-times more than originally found.

To obtain pollutant profile maps, a new probe has been designed and tested that can detect pollutants in real-time as the probe is advanced into the subsurface. GC/MS analysis of the contaminants provides compound identity and concentration. These 3-dimensional maps of the subsurface provide information related to the rate and transport properties of the pollutants. In addition, the probe allows for the first time, real-time remediation monitoring, since the destruction of pollutants can be detected *in situ*. The technology offers the opportunity to optimize the remedial technology, e.g., by monitoring pH, reagent concentrations, and degradation products. It is our hope that the tools we develop will provide the means to remediate polluted properties and return them to productive uses.

Title:

Mechanistic Studies & Green Catalysis Using Biomimetic Iron Complexes for Hydrocarbon Oxidations

Authors:

Taryn Palluccio, Olga Makhlynets, Elena Rybak-Akimova

Presented by:

Taryn Palluccio

Department:

Department of Chemistry, Tufts University School of Arts and Sciences

Abstract:

An ongoing theme in our group's research involves the study of redox active iron centers supported by non-heme/macrocyclic ligands and their ability to activate small molecules, namely oxygen and hydrogen peroxide, for "green" oxidative coupling with organic molecules. The biological significance of iron in oxygen activating enzymatic systems makes it a prime target for biomimetic studies; from our knowledge of these natural systems, we can potentially design novel synthetic complexes that exhibit enhanced reactivity, efficiency and substrate specificity. Utilizing the principles of metalloenzymes allows for manipulation of their catalytic activities in the laboratory to achieve selective catalytic transformations of organic molecules with the benefit of producing nonhazardous by-products. Discovering and understanding such biomimetic systems would not only further scientific knowledge, but also broaden the scope of cheap, efficient, selective, and environmentally friendly oxygenation catalysts that are available.

Title:

Towards Understanding the Fischer-Tropsch Reaction on Model Cobalt Nanoparticles

Authors:

Emily A. Lewis, April D. Jewell, Erin V. Iski, E. Charles H. Sykes

Presented by:

Emily A. Lewis

Department:

Department of Chemistry, Tufts University School of Arts and Sciences

Abstract:

Fischer-Tropsch synthesis (FTS), the reaction of hydrogen and carbon monoxide (syngas) to form hydrocarbons, is a large-scale industrial process that accounts for the production of 200,000 bbl/day of synthetic, non-petroleum-based oil. FTS is a heterogeneous process that is greatly affected by the adsorption of reactants, as well as catalyst shape and size. Previously, there has been very little fundamental research on cobalt, a well-known FTS catalyst, because of difficulties in preparing an atomically clean surface. We have developed model cobalt catalysts by depositing cobalt onto copper single crystals (an inert metal for FTS), yielding well-defined cobalt nanoparticles. Using ultra high vacuum, low-temperature scanning tunneling microscopy (UHV LT-STM), we have studied these model nanoparticles and the interaction of syngas with their surfaces on the molecular scale. With STM, we observe the known unit cells for both adsorbates: a (2×2) phase for atomic hydrogen and a $(\sqrt{3} \times \sqrt{3})R30^\circ$ phase for molecularly adsorbed carbon monoxide. It is shown that the two adsorbates segregate on the cobalt surfaces at 80 K, and we propose that atomic hydrogen blocks carbon monoxide adsorption, preventing complete overlayer formation and causing the build-up of carbon monoxide at the cobalt nanoparticle step edges. Additionally, with increasing carbon monoxide coverage, we demonstrate the 2D phase compression of hydrogen by carbon monoxide, providing the first visual demonstration of this well-known phenomenon in a catalytically relevant system. These effects are indicative of a spillover mechanism in which the carbon monoxide physisorbed to the copper migrates to the cobalt nanoparticles. Finally, since the carbon monoxide/hydrogen interface is exclusively at the nanoparticle step edges, this data gives evidence to the carbon monoxide hydrogenation reaction site.

Title:

Ion Gels for Printable Electrochemical Capacitors

Authors:

Adam Visentin and Matthew J. Panzer

Presented by:

Adam Visentin

Departments:

Department of Chemistry, Tufts University School of Arts and Sciences; Department of Chemical and Biological Engineering, Tufts University School of Engineering

Abstract:

The miniaturization of electronic devices is a developing trend; this requires device materials and components that are lightweight and possibly even flexible. Towards that end, electrochemical capacitors (ECs) are energy storage devices that have a higher energy density than typical capacitors. The simplest ECs comprise of two electrodes and an ionic conductor, such as a salt solution, between them. Manufacturing such a device can potentially be done using ink-jet printing to fabricate thin ECs on a flexible substrate at low cost. One material class being investigated as an ionic conductor is ion gels, which can be made into a self-standing film. An ion gel is an ionic liquid that has a 3-D network, possibly from a polymer, that increases its rigidity. Examining the properties of these gels from the inclusion of different polymers is one milestone in that direction.

Title:

Sustainable Post-Processing of Ion Gel Electrolytes for Energy Applications

Authors:

Ariel Horowitz and Matthew J. Panzer

Presented by:

Ariel Horowitz

Department:

Department of Chemical and Biological Engineering, Tufts University School of Engineering

Abstract:

“Green” systems require new technologies for successful implementation. Changeover from a conventional system to one that prioritizes sustainability offers unique opportunities to incorporate new design paradigms. I will apply principles of sustainable design to create an ionic liquid gel-based supercapacitor for energy applications. Recently, double-layer capacitors or “supercapacitors” have attracted strong research interest due to their potential for use in novel, green applications such as electric cars. Supercapacitors demonstrate capacitances that can be orders of magnitude higher than those attainable by conventional capacitors. Current devices rely on solvent-based electrolytes. An alternative approach employs ambient-temperature molten salts known as ionic liquids (ILs). ILs are non-volatile, non-reactive, and have a wide voltage window of stability. When combined with polymers or other gelation agents, ILs can form gel electrolytes suitable for applications demanding flexibility or lightness. Theoretically, ILs can be recovered from the gel post-service and re-used. I plan to investigate ways to easily separate the IL from other gel components, dispose of these other components sustainably, and purify the IL for further use. This investigation will help close the materials loop to make the IL gel supercapacitor a truly sustainable device.

Title:

Fabrication of Cu₂O and CuO Thin Films on Transparent Conducting Substrates via Solution-Based Electrodeposition for Highly Efficient Photovoltaic (PV) Cells

Authors:

Changqiong Zhu and Matthew J. Panzer

Presented by:

Changqiong Zhu

Department:

Department of Chemical and Biological Engineering, Tufts University School of Engineering

Abstract:

With their optical band gaps (1.3eV (CuO) and 2.0eV (Cu₂O)) suitable for solar energy absorption, air stability, and low photodegradation rates, the abundant and non-toxic copper oxides are promising materials for photovoltaic (PV) cells. The theoretical power conversion efficiency of a Cu₂O absorber is ~18% (~22% for CuO), however the largest efficiency value reported to date for a copper oxide PV cell is only 2% due to poor film morphologies, low conductivities or interfacial instabilities. We seek to address two of the major challenges relevant to the development of thin film photovoltaics using copper oxides: (1) controlled growth of dense, uniform, single phase films of both Cu₂O and CuO via solution-based electrodeposition on transparent conducting substrates from aqueous solutions using readily available precursors at conditions near ambient temperature and pressure and driven by direct current voltages (<1V); (2) reduced resistivity in the same films through incorporation of dopant species during electrodeposition so that they can be effective as PV active layers. We expect to gain a better understanding of the connection between the chemistry of the electrodeposition bath and the resulting composition, morphology, and optoelectronic behavior of copper oxide thin films and successfully demonstrate low resistivity, uniform films. This will fill an important knowledge gap and provide a means toward the realization of low-cost, large-area copper oxide PVs with efficiencies approaching their theoretical limit of ~20%.

Title:

Optimizing the Efficiency of Organic Bulk Heterojunction Photovoltaics Using the Design of Dynamic Experiments Methodology

Authors:

Athina E. Pantelidou, Matthew J. Panzer, Christos Georgakis

Presented by:

Athina E. Pantelidou

Department:

Department of Chemical and Biological Engineering, Tufts University School of Engineering

Abstract:

Organic Bulk Heterojunction (BHJ) photovoltaics have recently been demonstrated as a potential platform for sustainable electricity generation. Currently, organic BHJ solar cells require a high (constant)-temperature annealing step in order to obtain a more favorable nanostructure in the photocurrent-generating active layer. This project involves a new strategy using a time-varying annealing temperature profile. The optimal annealing profile can then be determined using a data driven methodology recently postulated and successfully used to improve chemical batch processes called the Design of Dynamic Experiments (DoDE). This methodology allows us to explore how time varying temperature profiles can be used to improve BHJ performance parameters such as short circuit current density, open circuit voltage and fill factor as well as to determine the optimal annealing profile of temperature as a function of time, in order to maximize photovoltaic power conversion efficiency. Validation of the optimized annealing profile is confirmed by fabricating organic BHJ cells using this profile and measuring power conversion efficiencies under simulated solar illumination.

Title:

Carbon-Supported Platinum Catalysts for Bio-Propane Production

Authors:

Branko Zugic and Maria Flytzani-Stephanopoulos

Presented by:

Branko Zugic

Department:

Department of Chemical and Biological Engineering, Tufts University School of Engineering

Abstract:

A novel approach to bio-fuels production was considered in this work; namely, the production of liquefied petroleum gas (LPG) from biomass-derived feed stocks. This approach involves a hybrid process combining fermentation of cellulosic biomass to butyrate and a catalytic step whereby the butyrate solution is converted to a propane and butane mixture. In this presentation, the catalytic decarboxylation of butyric acid over supported metal catalysts will be presented. Platinum-group metals and gold prepared in highly dispersed form on various oxide and carbon supports were evaluated in terms of their activity, selectivity to propane, and stability at moderate temperatures (200-350 °C) and pressures (1-6 bar). Various characterization techniques were used to follow structural changes of the catalyst and to correlate them with the remarkable stability observed for some of the examined catalyst formulations.

Title:

Ecology and Physiology of Green Roof Plant Communities

Authors:

Colleen Butler and Colin Mark Orians

Presented by:

Colleen Butler

Department:

Department of Biology, Tufts University School of Arts and Sciences

Abstract:

Green roofs mitigate many negative environmental effects of urbanization, especially stormwater runoff and the urban heat island effect. There is also the potential for green roofs to function as islands of biodiversity within urban and suburban environments. Historically, most roofs have been planted with Sedum, a stress-tolerant plant, but many people are promoting the planting of a more diverse set of plants, especially native plants. I began by analyzing rationales for preferring native plants on green roofs. Scientific arguments were commonly used, but rarely tested experimentally. I then conducted a rooftop experiment to assess suitability of 19 native and non-native plant species. Summer drought resulted in high mortality of nearly all non-Sedum species. To determine if Sedum's high performance was due to photosynthetic plasticity, I grew Sedum under wet and dry conditions in a greenhouse. There was variation in photosynthetic pathway and several species exhibited rapid switching in photosynthetic pathway in response to short-term changes in water availability. Finally, I tested the hypothesis that Sedum species would reduce peak soil temperature and increase performance of neighboring plants on a green roof during summer drought. Sedum reduced neighbor growth during wet periods, but cooled soil and increased neighbor performance during drought.

Title:

Changing Population Projections

Author:

Neva Goodwin

Presented by:

Neva Goodwin

Department:

Global Development and Environment Institute, Tufts University School of Arts and Sciences

Abstract:

The demographic transition that was identified in the 1960s is continuing in ways that were not predicted even 20 years ago. New UN projections show the global human population ceasing to grow by mid-century, at a level that may be significantly below what forecasters predicted in the 1990s. After 2050 the best guess is for decline in the world's population, based on a projected global fertility rate of 1.85—significantly below what is accepted as the replacement rate (2.1). While in many ways this is encouraging in terms of the possibility of supporting the human population with basic needs met and some level of comfort by the end of the present century, it also raises a number of important economic and social issues that are likely to emerge as major challenges around the world.

Title:

Turning Black Gold Into Green Gold: Prospects and Challenges for Reforming the Alternative and Renewable Energy Sector in Azerbaijan

Author:

Blake L. Ratcliff

Presented by:

Blake L. Ratcliff

Department:

International Development, The Fletcher School

Abstract:

In the promotion of a nascent industry, regulation can play an important supporting role. Azerbaijan's fledgling alternative and renewable energy sector is poised for fast, short-term growth, if the government is able to draft, pass, and enforce proper regulations that will promote, support, incentivize, and raise public awareness of the abundant wind, solar, geothermal, biogas, and small-scale hydroelectric energy potential. Fossil fuels stand squarely at the heart of Azerbaijan's economy and political hierarchy, but Azerbaijan can be seen as a model for other net hydrocarbon exporters as its rising clean energy sector can best be viewed as an alternative that is emerging as a byproduct of, rather than in opposition to, the oil and gas industry. This research will look at the challenges to proper alternative energy regulatory reform and offer policy prescriptions for the Azerbaijani government.

Research made possible by a Title VIII Embassy Policy Specialist (EPS) Fellowship to Azerbaijan in September/October 2010 coordinated by IREX.

Title:

Rail and Property Development in Boston

Author:

Jay Monty

Presented by:

Jay Monty

Department:

Department of Urban and Environmental Policy and Planning, Tufts University School of Arts and Sciences

Abstract:

The goal of this research is to ask whether legacy transit agencies in the United States can successfully use their vast land holdings to further long-term goals of sustainable financing, higher transit ridership and compact pedestrian-friendly development. Historical and contemporary examples exist of a practice termed 'Rail and Property Development' (R&P), a business model wherein a transit company develops real estate as a means of complementing adjacent transit facilities. The real estate development industry not only provides additional transit riders, but serves as a source of income that can be reinvested in transit operations or infrastructure. This research looks at the application of this model in Boston, Massachusetts using two case studies of recent developments on land owned by the Massachusetts Bay Transportation Authority (MBTA): Woodland Station in Newton, and Ashmont Station in Dorchester. Both of these developments were completed within the last 5 years and were constructed on land leased from the MBTA. These research and case studies are framed around the research question: "How is the Rail and Property Development model being pursued by the MBTA influencing long-term goals of advancing sustainability and financing public transit? What are the benefits and costs of this model to the transit agency and municipalities involved?"

Title:

The Distillery Program at Tufts Cummings School of Veterinary Medicine

Authors:

Joseph Popowski and Jack Hawkes

Presented by:

Joseph Popowski

Departments:

Division of Teaching and Research Resources and Department of Biomedical Sciences,
Cummings School of Veterinary Medicine

Abstract:

Plastination is a technique for preserving anatomical specimens patented by Dr. Gunther Van Hagens in 1978 and popularized by his "Body Worlds" exhibitions. In 2007, the veterinary school set up a plastination facility to improve anatomy instruction. The process uses substantial quantities of acetone. To help reduce the amount of acetone needed, a solvent recycler was installed. It reduced the amount of acetone required and had the additional benefit of allowing us to recycle solvents from the hospital. Waste solvents from the histopathology section are collected and sold back to the hospital for half what it would cost to purchase new solvents. This saves money, brings income to our program, saves the University the cost of disposal of hazardous materials, reduces our consumption of petroleum-based solvents, and conserves the fuel that would be used in transporting solvents to and from the school. The distillation program is an important component of the plastination program and a boon to the hospital in helping to reduce waste solvents.

Title:

Development of a Predictive Model of Ultrafine Particle Levels in an Urban Neighborhood Near a Highway

Authors:

Allison St. Vincent, Luz Padro, Wig Zamore, Doug Brugge, John Durant

Presented by:

Allison St. Vincent

Departments:

Department of Civil and Environmental Engineering, Tufts University School of Engineering;

Department of Public Health and Community Medicine, Tufts University School of Medicine;

Somerville Transportation Equity Partnership

Abstract:

Exposure to vehicle-generated ultrafine particles (<100 nm; UFP) has been linked to cardiovascular and pulmonary diseases in people living near highways. Due to the high degree of temporal and spatial variation of UFP near highways, models are needed to help predict UFP exposures in near-highway neighborhoods. The goals of this work are to explore data from near Interstate-93 in Somerville, MA and evaluate different types of models for predicting pollutant concentrations. On-road pollutant concentrations that were measured with a mobile air pollution monitoring laboratory include UFP, carbon monoxide, and nitrous oxides. We are evaluating regression modeling and dispersion modeling to gain insight into the characteristics of traffic-related air pollution in the study area. These results will help inform the development of a predictive UFP model that will be used as part of a cardiovascular health study being conducted in several neighborhoods near I-93 in Somerville.

Title:

Analysis of the Coastal Protection Experience in Three Towns on Cape Cod, Massachusetts

Author:

Peter Kelly-Joseph

Presented by:

Peter Kelly-Joseph

Department:

Department of Urban and Environmental Policy and Planning, Tufts University School of Arts and Sciences

Abstract:

Coastal protection data from 780 Notice of Intent submissions is presented from three towns on Cape Cod, Massachusetts to analyze the coastal protection experience since the creation of the Massachusetts Wetlands Protection Act in 1978. Notice of Intent records serve as a measure of demand for coastal protection and indicate that demand is rising in the study area and there appears to be a trend towards soft protection alternatives. A number of potential anthropogenic and natural variables are discussed that could influence demand for coastal protection but no clear trends are identified.

Title:

The Potential to Reduce Global Poverty and Mitigate Climate Change Through an Earth Atmospheric Trust

Author:

Brian Roach

Presented by:

Brian Roach

Department:

Global Development and Environment Institute, Tufts University School of Arts and Sciences

Abstract:

In 2008 Barnes, et al. (Science, 8 February 2008), proposed the creation of an "Earth Atmospheric Trust" to mitigate global greenhouse gas emissions. The proposal is based on the fact that the atmosphere is a global public good to which all humans have an equal right. It would create a global cap-and-trade system for all greenhouse gas emissions, with the auctioning of all permits. A significant portion of the revenues would be distributed to all people on earth in the form of an annual per-capita payment as a means of compensation for the damage inflicted on each person's ownership share of the atmosphere. The remainder of the revenues would be used to address the damages from climate change and fund innovation.

This analysis demonstrates that under reasonable assumptions an Earth Atmospheric Trust could significantly reduce global poverty as defined by the World Bank's thresholds of \$1.25 and \$2.00 per day. The implicit cost of the Trust is calculated for citizens of different countries and at different income levels. In richer countries, this cost exceeds the dividend payment for nearly all citizens. But in poorer countries, the dividend exceeds the implicit cost for the majority of citizens and, in particular, for the world's poorest. In fact, global poverty at the \$1.25 per day threshold would be nearly eliminated. The importance of policies that jointly address both climate change and global poverty is widely recognized, and this analysis finds that the Earth Atmospheric Trust can simultaneously achieve both goals.

Title:

Geological Carbon Sequestration in Europe and the U.S.

Author:

Antje Danielson

Presented by:

Antje Danielson

Department:

Tufts Institute of the Environment

Abstract:

Climate change is one of the pressing issues of our time. Anthropogenic emissions of CO₂ contribute to climate change in a significant way. CO₂ is produced when burning fossil fuels for heating and transportation, and in power plants for electricity production. There are alternatives to fossil fuel burning – chiefly renewable energy, nuclear energy, and conservation, but due to various issues related to those methods, coal as a fuel source is being discussed again, even though coal is currently the worst emitter of CO₂. If coal is considered a viable fuel source we also have to consider carbon capture and sequestration because it is generally agreed that in order to avoid catastrophic climatic changes we will have to reduce emissions of greenhouse gases drastically.

Carbon capture and sequestration (CCS) — catching the CO₂ at a point source and putting it into a sequestering medium such as suitable geological formations — is seen as one way of slowing the rate of CO₂ accumulation in the atmosphere and lessening global climate change. There is a limited number of geological formations suitable for carbon sequestration and therefore the local acceptance for this type of emissions mitigation is crucial. A number of demonstration projects have been carried out in the US and Europe and there are a number of full-scale projects planned. The 2009 European Union Directive on the geological storage of CO₂ suggests that CCS could account for 15% of the greenhouse gas reductions in the European Union in 2030. This poster will show the measures that have been enacted or drafted so far, to ensure a legal framework for carbon sequestration on both sides of the Atlantic and discuss potential barriers to the method.

Title:

Sustainability Research at Tufts University

Authors:

Antje Danielson, Kent Portney, Gretchen Kaufman

Presented by:

Antje Danielson

Departments:

Tufts Institute of the Environment; Department of Political Science, Tufts University School of Arts and Sciences; Department of Environmental and Population Health, Cummings School of Veterinary Medicine

Abstract:

The topic of sustainability in research and teaching was discussed by a group of Tufts faculty, meeting once per month during the academic year 2010/11. Collectively these faculty members defined what sustainability means to them as follows:

The idea of sustainability, as we understand it, was developed to describe human practices that actively protect and do not negatively affect the earth's natural ecosystem's ability to support healthy biological systems and human well-being now and in the future. Human practices have environmental, economic, and social dimensions that need to be considered in the context of sustainability.

At the Tufts Institute of the Environment we have used the above definition to analyze and critically look at the research performed in the University and benchmark the existing initiatives against drivers, concepts, and outcomes in agreement with the above definition. The results of this research are presented in the poster.

Title:

The Tufts Community Agriculture Project

Authors:

Jeff Hake and Marisol Pierce-Quionez

Presented by:

Jeff Hake and Marisol Pierce-Quionez

Departments:

Center on Agriculture, Food and Environment, Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy; Department of Urban and Environmental Policy and Planning, Tufts University School of Arts and Sciences

Abstract:

The good food and farming movement is an integral part of any concept of sustainability. Tufts currently lags behind other institutions of higher education in this field, as many Universities across the country already have or are currently constructing farms on or near their campuses. These farms operate as an educational hub for classes and research about sustainable food systems, a model of small-scale farming, and a source of fresh food for the community at large. Through investigations into campus farm case studies from across the country, the physical characteristics of our site, and the regulatory limitations associated with a farm in the city, we have been able to assess the feasibility of the construction of a 3.5 acre farm on the Tufts Medford Campus. Graphic visualizations and a farm business plan will help to illuminate our research and demonstrate that it is indeed feasible to operate a farm on campus. Practical application of our research is limited by the approval process of administrative and community networks, but in the meantime our research can be useful to other schools or organizations considering implementing similar projects.

Title:

The Impact of Future Climate Change on Wine Grape Revenues in the Pacific Northwest United States

Author:

Ellen Fitzgerald

Presented by:

Ellen Fitzgerald

Department:

Department of Economics, Tufts Graduate School of Arts and Sciences

Abstract:

The Pacific Northwest United States is one of the best wine producing regions in the world. Unfortunately, its current climate is marginally suitable for viticulture. As such, future climate change in this region subjects the wine grape industry to considerable risk. In this paper, I measure the impact of climate change on wine grape revenues in the Pacific Northwest United States by looking at the historical effects of random fluctuations in weather on annual wine revenues in California and Oregon using fine-scale (2.5 mi x 2.5 mi grid cells) daily data on minimum temperature, maximum temperature, and precipitation from 1995 – 2005.

The impact of future climate change on wine grape revenues is then estimated using county-level climate projections from the Hadley Global Climate model applied to my statistical estimates of the impact of climate on revenues. Results show that by 2030, wine growing regions in Southern California and Oregon will experience rising wine grape revenues while the premier growing regions in Northern California (i.e., Napa and Sonoma) will face declining wine grape revenues. By 2050 and 2100, wine grape revenues in all growing regions are expected to fall, with many regions experiencing losses that exceed 20% of historical wine grape values.

An innovation in my research is to focus on the impacts of extreme weather (measured by the number of hot days during the growing season, cold days in the spring, and cold days in the fall) on a specific crop in a specific region rather than on mean temperature change. Extreme weather is demonstrated in the statistical analysis to have a larger impact on grape production than mean weather changes.

Title:

Strengthening Agroforestry Projects & Impact Assessment in Guatemala

Author:

Sarah Coleman

Presented by:

Sarah Coleman

Department:

Center on Agriculture, Food and Environment, Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy

Abstract:

Agroforestry is the integration of trees in agricultural landscapes. Although it has been around for centuries, agroforestry is receiving increased attention as a strategy to conserve soil and water resources in vulnerable areas.

The impact of agroforestry depends on a variety of environmental, social and agricultural factors that are site-specific. EcoLogic Development Fund has established agroforestry in multiple communities in Guatemala and Honduras, but is striving to be more evidence-based through participatory inquiry and observation in order to amplify and inform project impacts. The proposed study entails field visits to communities in Guatemala to conduct focus group discussions, key informant interviews and participant observation to learn about traditional agricultural practices, livelihood conditions, and relevant natural resource concerns. In addition, focus groups will discuss experience with agroforestry thus far, and expected benefits from agroforestry in the future in order to identify community indicators of project impact. This fieldwork will enable improved understanding of existing conditions, and the development of a participatory monitoring and evaluation system. The study will serve as an example approach for other existing and future EcoLogic projects.

Keywords (2-3) Agroforestry, Conservation, Development

Title:

Water Quality and Sustainability Gains in Small Drinking Water Supply Systems: Assessing the Impacts of a Post-Construction Support Model in El Salvador

Authors:

Georgia Kayser, Jeffrey Griffiths, William Moomaw, Julie Schaffner, Beatrice Lorge Rogers

Presented by:

Georgia Kayser

Departments:

Center for International Environment and Resource Policy and the Institute for Human Security, The Fletcher School; Department of Food & Nutrition Policy, Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy; Department of Public Health and Community Medicine, Tufts University School of Medicine

Abstract:

The sustained provision of sufficient, safe, and reliable drinking water challenges community-run rural water systems. Post-construction support (PCS) may address these obstacles. Using a case-control design, qualitative and quantitative methods, and matched pair analysis, we measured the impact of the Circuit Rider (CR) model of PCS in El Salvador. The CR model provides technical, financial, and operational assistance to rural drinking water systems. CR communities had significantly better microbiological water quality, enhanced financial management and transparency, and greater investment in water treatment and system maintenance than control communities. CR PCS is associated with improved system performance and sustainability and is a low-cost (<\$1 per household per year) drinking water intervention.

Title:

The Battir Spring — the Road to a Safe Water Resource

Author:

Simcha Levental

Presented by:

Simcha Levental

Department:

Department of Urban and Environmental Policy and Planning, Tufts University School of Arts and Sciences

Abstract:

Battir is an ancient Palestinian village of 6,000 residents in Bethlehem Governorate located 6.5 km northwest of Bethlehem City and about 7 km southwest of Jerusalem. Battir has historically relied on a spring for irrigation and drinking water. The 1970s brought an influx of development that exposed the spring to increasing levels of raw sewage from boreholes. The pollution of the spring's waters has resulted in countless cases of waterborne disease amongst the vulnerable. A known protection area around the Battir spring might serve local and international NGOs to provide a local solution that will result in clean water for agriculture, reducing vulnerability to waterborne diseases. In the following poster we will show results of an analysis that aimed to define a strategy to protect the spring's waters.

The poster will include:

1. Introduction and background
2. Hydrological budget
3. TMDL assessment
4. Conclusion: Policy alternatives

Title:

Epidemiology of Water-Related Disease in the Context of Massive and Rapid Urban Displacements

Author:

Claudio Deola

Presented by:

Claudio Deola

Department:

Feinstein International Center, Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy

Abstract:

Water-related diseases represent a serious concern during emergencies, especially in less developed countries. Urban centers in these countries are likely to be the theaters of future disease control crises for a number of reasons. Political conflict and degradation of the rural environment exacerbate the phenomenon of Rapid and Massive Urban Displacement (RMUD), which has a significant impact on human health in urban settings. Considering the potential contributors to RMUD, we assumed that it compounds epidemiological features of the three following contexts: the slum dimension, the forced human migration, and the emergency/disaster context. There have been few epidemiological studies of morbidity due to water-related diseases that occur under the combination of these three dynamics. To address this, we conceived a specific RMUD framework to answer the following question: do water-related diseases exert the highest impact when at least 1,000 people are forced to occupy a certain area of a city in less than one week? The research presented here could not confirm this trend, partially due to lack of specific urban databases, but also because water-related diseases are driven by various risk factors which may not always be present or may be prevented. The following four risk factors, listed in order of increasing influence, are the main drivers of water-related disease in the aftermath of RUMDs: cause of displacement, health status of the displaced, the host living environment, and the quality of the humanitarian response.

Title:

Student Preference in Water

Author:

Tufts Against Plastic

Presented by:

Katy Kidwell, Lauren Deaderick, Robby Perkins-High

Department:

Tufts Against Plastic (Undergraduate Student Group), Tufts University

Abstract:

We are a group of students raising awareness for the environmental harm of bottled water. We advocate for the use of reusable bottles, and we pressure the administration to limit water bottle sales, especially in Hodgdon Good-To-Go. Here, students can use meal points to get bottled water, removing any sort of costs associated with it. In preliminary surveys, we found that the majority of students have reusable bottles, but opt for getting bottled water because it is "free" and more convenient.

Our club has worked with Facilities to get Hydration Stations (filtered water fountains) installed in Hodgdon, Houston, and the Campus Center to make filling reusable bottles easier. Our research is designed to show Dining Services that students do not prefer the taste of bottled water, but buy it simply because it is there. Because of the environmental impact of bottling water, there should be a cost associated with it on campus. We think that the elimination of bottled water in Hodgdon and the installation of Hydration Stations would reduce the use of bottled water on campus and increase the convenience of reusable bottles.

We tested this by having students taste bottled, filtered, and tap water in the dining hall. Our results show that students cannot tell any definitive difference in the water, so taste cannot be a factor in students' decisions.

Title:

Evaluating Trayless Dining at Tufts Dining Halls

Authors:

Callie Kolbe, Alex Freedman, Alice Pang, Frances Wilburn, Alex Shapiro, Dallase Scott, Negin R. Toosi, Tina Woolston, Patti Klos, Robyn Gittleman

Presented by:

Frances Wilburn

Departments:

Dining Services and Office of Sustainability, Tufts University; Tufts Experimental College, Tufts University School of Arts and Sciences

Abstract:

In 1990, Tufts University President Jean Mayer held a conference for 22 universities in Talloires, France and created a declaration that institutions of higher learning would be world leaders in developing, creating, supporting, and maintaining sustainability efforts. In recognition of this world renowned commitment, we explored how we could promote undergraduate individual behavior to reduce Tufts' environmental footprint. It was found that trayless dining was one such campus-wide policy that had greatly reduced food, water, and energy waste at many universities, as well as increased awareness of environmental issues. It was hypothesized that at Tufts, not only would trayless dining result in an overall decrease in the use of natural resources, but it would also affect student perception of their personal environmental responsibility. A sample of students entering the Carmichael dining hall the week before the trays were removed was surveyed about their perceptions of trayless dining or environmental social responsibility. The same method was used again to survey students during the trayless pilot program. This poster details the pilot study and presents updated data from the current academic year to evaluate the effect of trayless dining after 1 year.

Title:

Food Assistance Programs: Sustaining Impacts After Program Exit

Authors:

Beatrice Lorge Rogers, Jennifer Coates, Katie Houk, Elizabeth Kegode, Leslie Sanchez

Presented by:

Beatrice Lorge Rogers

Departments:

Departments of Nutrition Science and of Food & Nutrition Policy, Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy

Abstract:

One of the persistent challenges to food assistance programs is to ensure that the positive impacts achieved by the programs are sustained after the programs themselves shut down. The present study reviews the experiences of three countries whose food aid programs were supported by USAID under PL 480 Title II (donated food), in the two years after the food was withdrawn and the programs shut down: Bolivia, Kenya, and Honduras. The study is based on qualitative data collected at the time of program exit, and follow up data collected one year later. Key factors predicting sustainable impacts include: the program produced visible positive change in the beneficiary communities; the activities started under the program have an assured source of resources, whether from own profits (agricultural producer and processor associations), user fees (potable water systems), or, in specific cases, from government budgets (decentralized health systems in Bolivia and Honduras), but this depends on the government having both resources and capacity. Both visible benefit and assured resources were necessary to produce sustainable change. Programs were more sustainable if the participants were trained in both technical aspects (e.g., improved agricultural production; repair and maintenance of piped water systems) and managerial aspects of their activities. It appears that in cases where the implementing agencies informed communities early of their departure, and reduced their participation gradually, were more likely to produce sustainable effects than programs whose departure was more abrupt. The use of food as an incentive for participation in program activities risks creating unsustainable expectations among beneficiaries. The study will conclude with a third round of qualitative and quantitative data collection in the summer of 2011 and will provide guidance to aid agencies on actions to support sustainable change.

Title:

Building Sustainable Infectious Disease Surveillance and Response Systems Using a One Health Approach

Authors:

Robyn Alders, Aluma Araba, Brigitte Bagnol, Stan Fenwick, Ben Hickler, Joann Lindenmayer, Felicia Nutter, Diafuka Saila-Ngita, Jeffrey Griffiths, Siobhan Mor, Dawn Terkla, Linda Javin, Susan Albright, Andy Catley

Presented by:

Siobhan Mor

Departments:

Department of Environmental and Population Health, Cummings School of Veterinary Medicine; Department of Public Health and Community Medicine, Tufts University School of Medicine; Office of Institutional Research and Evaluation, Tufts University; Center for Excellence in Learning and Teaching, Tufts University; Technology for Learning in the Health Sciences, Tufts University

Abstract:

The RESPOND project within the USAID Emerging Pandemic Threats Program is building capacity and facilitating the development of sustainable disease surveillance and response systems in the Congo Basin and SE Asia. RESPOND is a consortium involving Development Alternatives Inc, Tufts University, University of Minnesota (UMN), Training Resources Group and Ecology and Environment.

In most countries, surveillance and response systems are usually best developed within the human health services with Integrated Disease Surveillance and Response (IDSR; a strategy developed by the World Health Organization Regional Office for Africa in 1998) being one notable example. In response to recent concerns about emerging infections at the human-animal-environmental interface, RESPOND is working with national authorities and the private sector to build cross-sectoral linkages between veterinary and public health extension services at the community level. RESPOND's "One Health" approach to capacity building works to strengthen these linkages and integrate veterinary health services as well as wildlife authorities into a broader functioning of frameworks such as IDSR. RESPOND's capacity building activities reach pre-service and in-service professionals, community-level first-responders, and national, provincial, and district-level staff in ministries of health, agriculture, and wildlife. Participatory learning processes are a crucial part of community-level capacity building as well as impact assessment for the monitoring and evaluation of RESPOND activities.

RESPOND's overall capacity-building efforts reinforce existing public health systems and work across all sectors to integrate issues of environmental, animal and human health. Training programs bring together Tufts and

UMN schools of public health, veterinary medicine, nursing, and wildlife management in regional networks with counterpart schools and institutions. RESPOND is working with faculty from these institutions to co-develop training curricula addressing emerging and reemerging zoonotic infections, participatory surveillance, epidemiology, and outbreak response in each country. Professional training programs emphasize applied, experiential approaches to provide practical, field-appropriate expertise for building on existing systems in a more efficient, integrated and sustainable way.

Title:

One Health for Sustainability

Authors:

Gretchen Kaufman, Robyn Alders, Joann Lindenmayer, Jeffrey Griffiths, Siobhan Mor, Susan Albright, Colin Mark Orians, Michael Reed, Elena Naumova, Antje Danielson

Presented by:

Gretchen Kaufman

Departments:

Department of Environmental and Population Health, Tufts Cummings School of Veterinary Medicine; Department of Public Health and Community Medicine, Tufts School of Medicine; Technology for Learning in the Health Sciences, Tufts School of Medicine; Department of Biology, Tufts School of Arts and Sciences; Department of Civil and Environmental Engineering, Tufts School of Engineering; Tufts Institute for the Environment

Abstract:

In the past decade, the world has witnessed increasing numbers of complex health challenges that have revealed the need for a broader more integrated understanding of the critical relationships between humans, animals, and their environment. Examples of these include emerging infectious diseases, climate change, biodiversity loss, and natural and manmade disasters and emergencies. Investigation of these complex issues has led advocates for human, animal and environmental health to coalesce around “One Health”, a concept that recognizes explicitly the interdependence of the three “healths.” We believe that acknowledging and accounting for the interconnectedness of humans, animals and the health of the environment will lead to more sustainable comprehensive solutions with long term impact.

Tufts University has shown itself to be a pioneer in One Health education and research through the development of methods and tools that support interdisciplinary inquiry and scholarship in a university environment, in the field and at the community level. The university’s history with One Medicine, the precursor to One Health, extends back to 1978 when Tufts’ president Jean Mayer used the concept to justify the establishment of the School of Veterinary Medicine among Tufts’ sister schools of medicine and dental medicine. This early engagement with the concepts of One Health, combined with a strong commitment to interdisciplinary education, helps to explain why One Health assets and initiatives abound throughout the university.

Educational initiatives such as the One Health University Seminar, new Masters in Conservation Medicine program, our combined degree programs in Public Health, the Biology of Water and Health course, the WSSS certificate program, and budding collaborations between community health and environmental studies, provide Tufts students with opportunities for scholarship in One Health. These interdisciplinary educational initiatives actively seek to involve faculty and curricular resources from across the university. Further, unique educational tools, such as the TUSK and OpenCourseWare platforms, the VUE concept mapping tool, and the international Curriculum Co-Development project facilitate new programs that aim to bridge traditional disciplinary silos at home and abroad. These resources and approaches are now being adapted to the field and community levels as part of Tufts contribution to the USAID | RESPOND project.

With the support of the Tufts Institute for the Environment, we are currently seeking to institutionalize the One Health vision at Tufts by establishing a university-wide One Health Center. The proposed center will provide a venue for teaching, regional and international community engagement and research collaboration among advocates of human, animal and environmental health across all campuses at Tufts University.

Title:

Adiponectin and the Suppression of Osteosarcoma Cell Metastasis

Authors:

Eileen Saunders, Qisheng Tu, Jake Chen

Presented by:

Eileen Saunders

Department:

Division of Oral Biology, Tufts University School of Dental Medicine

Abstract:

Objectives: Adiponectin, an adipose tissue-derived hormone, has important functions in the regulation of cancer and bone formation. Past studies have shown that this hormone can inhibit the proliferation of osteoclasts through the AKT pathway, which involves a complex series of proteins. Osteoclasts have an integral role in the metastasis of cancer to bone, and it can be hypothesized that adiponectin may be able to inhibit or reduce the metastasis of osteosarcoma cells through its interactions with proteins in the metastasis pathway. This project investigated the effect of adiponectin on the expression of certain proteins, such as transcription factors, matrix proteins, and cytokines that enhance or inhibit metastasis of osteosarcoma cells.

Methods: P53, NFKB, bone sialoprotein (BSP), GM-CSF, and MMP9 were the targeted genes. GAPDH was the control. Adiponectin was isolated and 5ug/ml and 10ug/ml were used to stimulate human osteosarcoma cells, which were then incubated for 3 and 5 days. The cells were harvested, and the RNA was isolated. Through reverse transcription, the RNAs were converted into cDNAs, which were then used for real-time PCR with primers for the genes of interest.

Results: Expression of MMP9 and BSP was suppressed by the 5ug/ml and 10ug/ml concentrations of adiponectin. The hormone increased the expression of GM-CSF and p53 at the 10ug/ml concentration of adiponectin only. NFKB showed insignificant results.

Conclusion: BSP is important for bone development and has been shown to enhance bone metastasis, and MMP9 is a marker of cancer invasion. P53 is a tumor suppressor gene, and GM-CSF has been clinically used to suppress breast cancer growth and metastasis. Thus, the ability of adiponectin to inhibit BSP and MMP9, but also enhance the expression of two genes that suppress cancer growth and metastasis supports the hypothesis that the hormone can suppress osteosarcoma cell metastasis.

Title:

Buccal and Palatal Bone Remodeling Following Single and Contiguous Teeth Extractions: A Study in Dogs

Authors:

Mansour Al-Askar, Terrence Griffin, Rory O'Neill, Paul C. Stark, Khalid Al-Hezaimi

Presented by:

Mansour Al-Askar

Department:

Department of Periodontology, Tufts University School of Dental Medicine

Abstract:

Purpose: The aim was to compare the effects of single versus contiguous teeth extractions on the alveolar interdental blood supply and ridge remodeling.

Material and Methods: Four beagle dogs were randomly divided to three groups: 1) bilateral single tooth extraction in the anterior and posterior sites in the upper and lower jaw; 2) bilateral extraction of two teeth in four anterior and posterior sites in the upper and lower jaw; 3) extraction of three teeth in four anterior sites and four posterior sites in the upper and lower jaw. The dogs were scarified after four months. Each extraction site was sectioned in sagittal plane and analyzed via micro-computed tomography scan in the bucco-lingual and apico-coronal direction.

Results: In all groups, bucco-lingual or palatal bone loss was observed four months after extraction. The mean bone loss in the alveolar width was significantly less in group one as compared to groups two and three ($P<0.05$). Bone loss in the alveolar bone loss was significantly high in group three in comparison to group two ($P<0.05$). The third group in the upper and lower arches showed more obvious resorption on the palatal/lingual side especially the lower group posterior to group two. A significance difference in the buccolingual/ or palatal ridge width between the three groups ($P<0.05$).

Conclusion: Width of the alveolar bone is compromised to a lesser extent when a single tooth is extracted compared to situations where more than one of the contiguous teeth are removed.

Title:

Stormwater Management Under Climate Change Uncertainty: Site-Specific and Robust Strategies for Three Case Studies

Authors:

Lauren Caputo, Ana Rosner, Thomas Renaud

Presented by:

Lauren Caputo and Ana Rosner

Departments:

Department of Civil and Environmental Engineering, Tufts University School of Engineering;

Department of Civil and Environmental Engineering, Worcester Polytechnic Institute

Abstract:

Planning long-term infrastructure under the deep uncertainty presented by climate change is a challenge for municipalities and regional authorities. Climate models provide a range of plausible changes in storm size, but with such a large degree of uncertainty as to provide little direct guidance to planners. To prepare for the future climate, it is imperative to develop adaptation strategies that are robust so that they perform well under a variety of climates and that are adaptive and flexible so they can be implemented and modified over time as more is known about the future climate. This research examines the stormwater systems of three case studies, all modeled in EPA SWMM software: Somerville, MA; Worcester, MA; and Aurora, CO. We evaluate the system performance under a range of possible future scenarios, informed by climate model predictions. We then propose and evaluate adaptation strategies that will perform well under a number of these plausible future conditions. Strategies for highly urbanized Somerville, MA, with over 70% impervious surfaces will focus on BMPs to decrease Combined Sewer Overflow (CSO) releases. Strategies for Worcester, MA, which has a newer and more flexible CSO system, will focus on operations/rules for improving the system. Strategies for Aurora, CO, an area that is currently rural but anticipating tremendous development, will focus on sizing and timing the building of regional detention ponds to decrease peak flows.

Title:

Shifting Sands: The Commercialization of Camels in Ethiopia and Beyond

Author:

Yacob Aklilu

Presented by:

Peter Walker

Department:

Feinstein International Center, Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy

Abstract:

Camel production and marketing is an under-researched aspect of livestock development in Ethiopia. This study examines the changing attitudes, ownership and use of camels in Ethiopia, and tracks camel trade routes across regional states and into Sudan. The study was conducted over five weeks by following camel movements and trade routes over 8,000 km from Mieso to Humera. Seventeen out of 24 markets serving this route were accessed during the study. Interviews were conducted with 104 informants including pastoralists, farmers, itinerant traders, value adders, middlemen, drovers and exporters and relevant agricultural, finance and customs staff.

Our findings indicate that camels are becoming the pack animals of choice instead of donkeys and mules for mid-altitude farmers between Minjar and Shiraro and Humera for various reasons. Camels are drought tolerant, do not compete with grazing animals and thrive well on available browses such as cacti and *Euphorbia tirucalli* in mid-altitude areas. Ownership motives include augmenting income from camel rental services in the interim (about US \$45–90/month/camel) and to finally sell them for profit after value adding. Camels are used for ploughing in Shiraro and Humera, and for cultivation and harrowing in Kobo and Alamata. Camel prices have increased over 100% in 2010, due to the export demand in Sudan and between July 2009 and June 2010 some 15,020 camels were exported through Humera, worth over US \$6 million. Up to 200,000 camels may exist in the mid-altitude regions at any given time. Few farmers are also engaged in camel breeding.

In conclusion, the economic significance of camels in general, and in the mid-altitude regions in particular, seems to be largely unrecognized by policy makers which needs to be re-addressed to provide appropriate support services. As a cross-border trade, the export process is carried out without any certification and this arrangement should continue in as long as this is acceptable by the importing side.

Title:

Contraception as a Tool for Humane Sustainable Management of Suburban Deer

Author:

Allen Rutberg

Presented by:

Allen Rutberg

Department:

Center for Animals and Public Policy, Cummings School of Veterinary Medicine

Abstract:

Among the most conspicuous beneficiaries of suburban development has been the white-tailed deer (*Odocoileus virginianus*), which has achieved very high densities in suburbs in the Northeast, mid-Atlantic, and Midwestern U.S. In these areas where dense human and deer populations coincide, serious conflicts ensue, including deer-vehicle collisions, damage to ornamental plantings, serious ecological impacts on parks, preserves, and other natural areas, and associations with tick-borne diseases. Because policy mechanisms to address these problems are weak, and traditional wildlife management tools (such as public hunting) are severely constrained or publicly unacceptable in these environments, political conflicts over how to manage suburban deer and their impacts are ubiquitous at the local level. One potential approach to suburban deer management which appears to have high public acceptability is contraception. Beginning in 2005, a research team from TCSVM and the Humane Society of the United States (HSUS) tested a set of single-administration, multiple-year preparations of the PZP (porcine zona pellucida) immunocontraceptive vaccine on Fripp Island, SC. Between 2005 and 2010, fawn: doe ratios on Fripp Island declined by approximately 84%, and population density declined by approximately 44%; both were stable in a neighboring control site. Two years into the project, the Fripp Island Property Association dissolved its deer committee, and complaints about deer virtually halted. Thus, in at least some environments, contraception has significant potential to manage suburban deer populations and the associated social and political conflicts.

Title:

Egypt, Sudan, and Ethiopia: The Nile River Disputes Case Study

Authors:

Yuan Wang and Shafiqul Islam

Presented by:

Yuan Wang

Departments:

Department of Urban and Environmental Policy and Planning, Tufts University School of Arts and Sciences;
Department of Civil and Environmental Engineering, Tufts University School of Engineering

Abstract:

In this study, Natural Societal Domain (NSD) framework will be applied to analyze the water conflicts among Egypt, Sudan, and Ethiopia over the Nile. NSD framework argues that the origin of many water problems can be characterized by six variables: three from the natural domain – Water Quantity (Q), Water Quality (P), and Ecosystem (E); and the other three from the societal domain – Governance (G), Economy (C), and Social Values & Norms (V). The dynamic interaction of these variables leads to conflicts while, on the other hand, creates solutions.

Egypt, Sudan, and Ethiopia have been in conflict over Nile water allocation since the colonial period. The 1929 and 1959 water treaties secured most of Nile water (Q) for Egypt and Sudan, with Egypt getting the lion's share. Although a regional collaborative organization, the Nile Basin Initiative (G) has been in operation since 1999, and the movements toward a new Cooperative Framework Agreement is slow, preventing riparian countries to fully utilize their water resources for agricultural and hydropower development (C). Here we find that the real outstanding issue posing a formidable challenge to any breakthrough in Nile riparian cooperation is the status quo insisted by Egypt and Sudan via the predominant colonial-era treaty regime. To arrive at a regional consensus on a Cooperative Framework Agreement, the legitimacy of this status quo should be challenged. In addition, the current positional bargain over water quantity should be switched to principle-based negotiation. The added economic value (C) through basin-wide full cooperation can probably drive this change.

Title:

Barriers to Use and Sustainability of Water and Sanitation Facilities in Ethiopian Primary Schools

Author:

Gogi Grewal

Presented by:

Gogi Grewal

Department:

Department of Food & Nutrition Policy, Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy

Abstract:

Despite recent efforts, access to safe and sufficient water and sanitation remains a significant problem in Ethiopia. The importance of adequate water and sanitation in the prevention of morbidity and mortality from infectious diseases caused by water-borne parasites, bacteria, viruses and protozoa is widely acknowledged. Schools present a desirable space for interventions that have the potential to impact health, and subsequently attendance and overall performance in education. This study investigated barriers to sustainability of use and maintenance of water and sanitation facilities and identified best practices; namely, those revolving around drinking water, hand-washing, and latrines.

Both primary and secondary data was collected, including fieldwork carried out in six regions of Ethiopia.

In-depth questionnaires and observations were conducted at 46 Community School Partnership Program (CSPP) schools in order to understand and assess the experiences, challenges, and best practices regarding drinking, hand-washing, and latrine facilities. Qualitative analysis was based on structured and semi-structured interviews, focus group discussions, and extensive observations. School directors (SDs), Parent-Teacher Association members, teachers, students and woreda officials were interviewed. Key barriers to maintenance were found to be insufficient funds, lack of spare parts, lack of accountability due to absence of designated responsibilities, and lack of support from local government. The main barriers to use were cultural reasons, lack of child-friendly design, and not enough taps or pits to meet demand. Lessons learned from this study have implications for improving water and sanitation programming in schools.