



**UNITED STATES SOCIETY**  
for ecological economics

**9TH BIENNIAL CONFERENCE JUNE 25-28 2017**

**Ecological Economics: From Theory to Practice**  
**Macalaster College, Saint Paul, MN**



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Welcome to the 9<sup>th</sup> Biennial conference of the U.S. Society for Ecological Economics, with a focus on **Ecological Economics: From Theory to Practice!** As a transdisciplinary field, Ecological Economics (EE) seeks to develop solutions to complex and interrelated economic, social, and environmental problems. “Theory to Practice” embraces many types of presentations including, but not limited to:

- Research that extends the state of the science of ecological economics
- Research that informs policy decisions
- Case studies of why policies and projects were successful or unsuccessful
- Discussions of how to bridge the gap between research and implementation, theory and practice.
- Identification of research and data needs in supporting policies and projects
- Identification of barriers to research and practice
- Identification of agendas to implement sustainability at the household, firm, local, state, regional, national and global level.

Following our 2015 conference, many of you reached out to us through our post-conference survey and indicated a need (and desire!) for more discussion and exchange of ideas related to EE methodologies and finding pathways for change, action and practice. The USSEE is currently reorganizing with the intention of bringing educators, researchers, decision makers and practitioners together to exchange ideas, methods, and stories of our work in an effort to expand our influence in an era where the urgency of EE-related problems challenges our ability to solve them.

Sincerely,

Conference Organizing Team

Time	Sunday June 25	Monday June 26	Tuesday June 27	Wednesday June 28
7:30-8:30				Women in Ecological Economics breakfast
8:30-10:00		Morning Plenary: Steve Polasky	Morning Plenary: Elizabeth King	Morning Plenary: Leehi Yona, Divest Dartmouth
10:00-10:15		<b>Coffee Break</b>		
10:15-11:45		Parallel Sessions 1-4	Parallel Sessions 14-18	Parallel Sessions 27-30
12:00-1:15		Lunch Plenary: Sigrid Stagl	Lunch Plenary: Alexandre Rivas	Lunch In Memoriam: Paul Baer USSEE Presidents' Address
1:30-3:00		Parallel Sessions 5-9	Parallel Sessions 19-22	
3:15-3:30		<b>Coffee Break</b>		
3:30-5:00		Parallel Sessions 10-13	Parallel Sessions 23-26	
5:00-6:00	USSEE Board meeting	Poster session	USSEE membership meeting	
6 p.m.	Evening reception, welcome address (Anne Hunt, Sustainability Director for City of Saint Paul)	Grad student networking event	Awards banquet	
8 p.m.		Movie screening: Waking the Sleeping Giant		

# PARALLEL SESSIONS AGENDA

Title of Session	Time	Author	Room
<b>Ecosystem services in land management</b>	Monday 10:15-11:45		Loch Hall, Dayton Campus Center
Developing robust and socially optimal nitrogen management strategies		Jesse Gourevitch	
Social norms, conservation, and the long-term effects of short-term financial incentives		John Kerr	
The Value of Sand Fixation Service of Desert Ecosystem in China		Leilei Cheng	
Ecosystem Services and Ecological Drought in the Upper Missouri Headwaters, MT		Nejem Raheem	
<b>Energy and bio-physical economics</b>	Monday 10:15-11:45		Board Room, Weyerhaeuser Hall
Superorganomics		Nathan John Hagens	
Induced innovation in the waste management sector		Sahar Milani	
Energy Policy and Job Creation at the State Level		Heidi Garrett-Peltier	
<b>Coastal and marine ecosystem services</b>	Monday 10:15-11:45		Davis Court, Markim Hall
The spillover effect of natural protected areas on tourism revenues		José A. Lara-Pulido	

Management options for balancing coral reef ecosystem service supply and demand		Kirsten Oleson	
Choice Modeling and Its Application to Sundarbans Mangrove Forest Preservation		Md. Hafiz Iqbal	
Economic Valuation of Marine Ecosystem Services: The Easter Medditerenean case		Shiri Zemah Shamir	
<b>An Introduction to Ecological Economics</b>	Monday 10:15-11:45	Josh Farley	Davis Hall, Dayton Campus Center
<b>Livelihoods and development I</b>	Monday 1:30-3:00		Loch Hall
A perfect storm: The collapse of quality of life in remote areas of Amazonas		James R. Kahn	
Case Study: Volta, Senegal & IncoMaputo River Basin Organizations in Africa		Ms Lucia Motaung	
Mismatches in spatial scale of supply and demand and their consequences for local Welfare in Scottish Aquaculture		Marcello Graziano	
Income inequality and public conservation land in Michigan's Upper Peninsula		Kathryn Frens	
<b>Advances in Ecological Economics I</b>	Monday 1:30-3:00		Davis Hall, Dayton Campus Center
Ecosystem service valuation for national accounting – current methodological debates		Nils Droste	

A Sketch of Statistical Economics on Energetics		Ram Poudel	
Needs, Norms and Consumption: The Consumer in a Sustainable Economy		Eric Kemp-Benedict	
Ecofeminism and Money		Joseph Ament	
<b>Agroecology and the global environmental crisis: Theory, application, and lessons from Santa Catarina, Brazil</b>	Monday 1:30-3:00	Ben Dube	Davis Court, Markim Hall
<b>Energy policy</b>	Monday 1:30-3:00		Board Room, Weyerhaeuser Hall
A Policymaker's View On Improving Key Economic Models Used for Climate Policy		Alex Barron	
Pipeline Policy Versus Renewables: Why Social Cost Matters		Spencer Phillips	
A Distributional Analysis of a Carbon Tax in the United States		Mark Paul	
Iberian power: the path toward a more competitive and sustainable electricity market		Agustin Garcia	
<b>Ecological Economics and Development</b>	Monday 3:30-5:00		Davis Hall, Dayton Campus Center
Dematerialization, Decoupling, and Productivity Change		Eric Kemp-Benedict	
Use of Bayesian Belief Networks in predicting contamination of drinking		David C. Hall	

water with E. coli in rural Vietnam			
Shrinking cities examined from a shrinking scale – the impact of household and neighborhood heterogeneity on changes in material and energy consumption, ecosystem services and environmental impact		Stephen B. Balogh	
The Panda’s Pawprint: The environmental impact of China-led re-primarization in Latin America and the Caribbean		Rebecca Ray	
<b>Food systems and agricultural ecosystems</b>	Monday 3:30-5:00		Davis Court, Markim Hall
CEA Lettuce Production: Methods, Environmental Sustainability and Economic Viability		Michael T. Mageau	
Financial Deregulation, Speculation, and Food Security: Case Studies from Brazil, Indonesia, and Thailand		Sean Morris	
Practicing Food Justice: A Comparative Evaluation of Recent Developments in Chicago & Philadelphia		Peter Kamps & John A. Sorrentino	
The Dynamics of Pest Resistance Build Up in the Context of Market Power		Brian J. Gross	
<b>Panel – Towards Just and Pluralistic Ecosystem Service Valuation: Challenges and Opportunities</b>	Monday 3:30-5:00	Moderators: Georgia Mavromatti & Bonnie Keeler	Board Room, Weyerhauser Hall



<b>Energy and ecological economics</b>	Tuesday 10:15-11:45		Board Room, Weyerhaeuser Hall
Modelling and forecasting EU allowance prices applying artificial neural networks		Agustin Garcia	
Modeling the Energy Future		James Case	
Mitigating climate change through alternative ecological refrigeration systems		Josiah Taylor	
A combined data envelopment and panel data analysis of the impact of mitigation technologies on environmental and economic productivity growth in OECD and BRICS countries		Fatih Karanfil	
<b>Ecosystem Services</b>	Tuesday 10:15-11:45		Davis Hall, Campus Center
An economic and ecological approach for ecosystem services production and income generation in the Amazon		Alexandre A. F. Rivas	
Combining Economics and Ecology for Migratory Species Conservation		Darius Semmens	
Co-investment in Agroecology for Ecosystem Services in Santa Rosa de Lima, Brazil		Joshua Farley	
The Use of Hedonic Analysis Within An Ecosystem Services Assessment To Inform Post-Hurricane Sandy Recovery And Resiliency Planning In Long Island, NY		Nadia Seeteram	

<b>Ecotourism and Outdoor Recreation</b>	Tuesday 10:15-11:45		Loch Hall, Campus Center
Sport fishing management for environmental protection and sustainable development: An Application to the middle Rio Negro		James R. Kahn	
Building Community Among Resorts in Protecting Ecosystem Services from the Threat of Aquatic Invasive Species		Patrick G. Welle	
The Economics of Outdoor Recreation in Washington State		Tania Briceno	
<b>New Perspectives On Teaching Ecological Economics</b>	Tuesday 10:15-11:45		Davis Court, Markim Hall
New Developments in Energy and Climate Change: The Potential for a New Energy Economy		Jonathan M. Harris	
Teaching about Population: Social, Economic, and Ecological Analyses		Anne-Marie Codur	
Ecological Economics, Music and Immersion in Nature: Integration through Experiential Learning		Nancy Bertaux, Kaleel Skeirik	
<b>Sustainable Agricultural Interventions</b>	Tuesday 1:30-3:00		Board Room, Weyerhauser Hall

Addressing Farm Program Drivers of Tropical Forest Destruction and Fertilizer Pollution		Clay Ogg	
Redefining efficiency in agriculture: A case study in Brazil's Atlantic Forest		Joshua Farley	
Sustainable intensification of agriculture: the location of land contraction and expansion matters		Nathaniel P. Springer	
Risk analysis of on-farm industrial oil production from winter oilseed crops		Prabodh Illukpitiya	
<b>Sustainable Land Use and Restoration</b>	Tuesday 1:30-3:00		Davis Hall, Campus Center
Land Use in Buffers of Two Costa-Rican National Parks		Robert Gottfried	
A new index for prioritization in landscape ecological restoration		Tanh Nguyen	
Socio-economic Analysis within an Ecosystem Service Framework: Assessing Delta Restoration		Tania Briceno	
The Role of the Value-Transfer Methodology in Scaling Human-Use Restoration Projects Under the Oil Pollution Act		Heath Byrd	
<b>Sustainable Water Management</b>	Tuesday 1:30-3:00		Loch Hall, Campus Center

The impact of water quality policy on farmer autonomy in agricultural watersheds		Courtney Hammond Wagner	
Water as a Fictitious Commodity: A Critique of Market-Based Environmental Policies		Hannah Lawson	
Upstream solutions to coral reef conservation: The payoffs of smart and cooperative decision-making		Kirsten Oleson	
<b>Sustainability Issues in Asia</b>	Tuesday 1:30-3:00		Davis Court, Markim Hall
Amenity demand versus species conservation in Indian zoos		David Martin	
A framework for understanding the livelihood impact of forest plantations in developing countries, with evidence from the Indian Himalaya		Forrest Fleischman	
Community-Managed Forests and Household Welfare: Empirical Evidence from Nepal		Jayash Paudel	
Environmental impacts of shifting to healthy diet: Case of China		Pan HE	
<b>Sustainability Issues in Sub-Saharan Africa</b>	Tuesday 3:30-5:00		Davis Court, Markim Hall
REACTING to a rebound? An econometric analysis of fuelwood		Kelsey Hample	

demand responses to a randomized controlled experiment with improved cookstoves in northern Ghana			
Using Binomial Probit Models to isolate factors that influenced community and household placement into Ghana's Modified Taungya System		Doe Adovor	
Decentralized forest and wildlife management in Tanzania: Does the theory match with practises?		Innocent H. Babili	
<b>Natural Capital and Governance</b>	Tuesday 3:30-5:00		Board Room, Weyerhauser Hall
The institution of science in natural resource management		Adrienne Strubb	
Characterizing Ecosystem Services of Coastal Dunes to Support Environmental Management Partnerships		Robert B. Richardson	
Conserving and regenerating forests and soils to mitigate climate change		Jonathan M. Harris & Anne-Marie Codur	
<b>Education for Sustainability</b>	Tuesday 3:30-5:00		Loch Hall, Campus Center
The entrepreneurial university and sustainable development in Kuwait: Research agenda on food, water, and energy		Ali Aljamal	

The role of economic literacy in fostering sustainability		Madhavi Venkatesan	
Explicit economics: Addressing conscious consumption for sustainability		Madhavi Venkatesan	
Ecological Economics Tools for Design Thinking		Sayeh Dastgheib-Beheshti	
<b>Advances in Ecological Economics II</b>	Tuesday 3:30-5:00		Davis Hall, Campus Center
The Economics of Equity: Insights from the BDY Model		Garvin H. Boyle	
Kiss nature goodbye. The dangerous illusions of post-environmentalism		Sam Bliss	
Multilevel Research: Exploring new avenues for sustainability between ecological and economic systems		Nikhil Joshi	
Meeting Planetary Boundaries: Economy-Wide Assessment of Global Policies towards Strong Sustainability		Maksym Chepeliev	
<b>Sustainability Indicators and Practices</b>	Wednesday 10:15-11:45		Loch Hall, Campus Center
Pricing Water under the Public Trust Doctrine: Designing a Process for Policy Makers in Hawaii		Regina Ostergaard-Klem	
Women Parliamentarians and Deforestation Around The World		Nurmukhammad Yusupov	

Moving Beyond GDP: The Impacts of State-Level Initiatives in Measuring “Genuine Progress”		Anders Hayden	
Genuine Progress Indicator 2.0: Pilot Accounts for the U.S., Maryland, and City of Baltimore 2012-2014		Michael Weisdorf	
<b>Sustainability-Based Policy</b>	Wednesday 10:15-11:45		Davis Hall, Campus Center
Ten Successes: Ecological Economics Applied		David Batker	
A new ecological economics model for Amazonas		Alexandre Rivas	
The Role of Ecological Fiscal Transfers for Solid Waste Management in the Overall Policy Mix		Felipe Luiz Lima de Paulo	
Ecological Fiscal Transfers in Europe – evidence-based design options of a transnational scheme		Nils Droste	
<b>Advances in Ecological Economics III</b>	Wednesday 10:15-11:45		Davis Court, Markim Hall
Integrated Systems Dynamic Model of the Macroeconomy: People, Nature, and Money		Carey King	
Developing and Applying Ecosystem Accounting to Coastal Long Island Bays		Anthony Dvarskas	
Modeling Intergenerational Sustainability		Garvin H Boyle	

<b>Improving Our Pedagogy, Expanding Our Reach: Infusing Ecological Economics Across Disciplines and Grade Levels</b>	Wednesday 10:15-11:45	Susan Santone	Board Room, Weyerhauser Hall
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# PLENARY SPEAKERS

## Evening of June 25



Since January 2006, **Anne Hunt** has served in a new position, created by Saint Paul Mayor Chris Coleman, as Sustainability Director. Anne has more than 25 years of experience in public and non-profit management and community organizing. Her work for the city has focused on policies and programs that: encourage energy-efficiency and conservation; development of clean and renewable energy technologies; and alternative transportation options to reduce carbon dioxide emissions; promote resource conservation through recycling and waste reduction; improve water quality; and strengthen habitat for wildlife in a built environment. For 13 years, Anne was the executive director of a non-profit coalition of community-based organizations providing innovative environmental programs and services for Saint Paul area residents. Prior to joining Mayor Chris Coleman's staff, Anne coordinated public policy initiatives for the Minnesota Environmental Partnership, a coalition of 90 environmental and conservation organizations. Anne recently received ICLEI's 2010 Sustainability Leadership Award for Local Government Staff.

## Morning of June 26



**Stephen Polasky** is a Regents Professor and the Fesler-Lampert Professor of Ecological/Environmental Economics at the University of Minnesota where he has a joint appointment in the Department of Applied Economics and the Department of Ecology, Evolution & Behavior. He is also a fellow of the University's Institute on the Environment. His research interests focus on issues at the intersection of ecology and economics and include the impacts of land use and land management on the provision and value of ecosystem services and natural capital, biodiversity conservation, sustainability, environmental regulation, renewable energy, and common property resources. He is a co-founder of the Natural Capital Project, a partnership between Minnesota, Stanford, The Nature Conservancy, and World Wildlife Fund. He served as Senior Staff Economist for environment and resources for the President's Council of Economic Advisers 1998-1999. He currently serves on the Board of Directors and the Science Council for The Nature Conservancy, the Sustainability External Advisory Committee for Dow Chemical, and the Science Advisory Board of NOAA. He was elected into the National Academy of Sciences in 2010. He is a fellow of the Association of Environmental and Resource Economists, the American Academy of Arts and Sciences, and the American Association for the Advancement of Science. He received a Ph.D. in economics from the University of Michigan in 1986.

## Lunch Session, June 26



**Sigrid Stagl** was the first graduate from the Ecological Economics program at RPI, New York (May 1999), making her the first PhD in Ecological Economics worldwide. Sigrid's thesis was on "Global food production and its alternatives – a socio-ecological economic perspective" (advisor: Sabine O'Hara). After her studies Sigrid worked at universities in Vienna (Austria), Leeds (UK) and Sussex (UK). She is now Full Professor of Environmental Economics and Policy at WU – Vienna University of Economics and Business. Sigrid's main research interests lie in (1) understanding institutional and behavioural change, (2) improving sustainability appraisal methods and (3) developing ecological macroeconomic models. Besides journal articles, her publications include "Ecological Economics – An Introduction", Cambridge University Press, 2005 (with M Common), which is used in graduate courses worldwide. From 2003 to 2012 Sigrid served as Vice-President and then President of European Society for Ecological Economics. She is

now Director of the MSc Program "Socio-Ecological Economics and Policy", which started in October 2012 at WU.

## Morning of June 27



**Elizabeth King** is an Assistant Professor at the University of Georgia, in the Odum School of Ecology and the Warnell School of Forestry & Natural Resources. Dr. King's fields of expertise are restoration ecology, social-ecological systems, resilience, and sustainability science. In her research, she embraces both interdisciplinary (connecting academic disciplines) and transdisciplinary approaches (connecting research, practice, and stakeholders). Her primary research focus has been in pastoralist systems in East Africa, where she has worked for over 20 years studying both ecological and social dimensions of land degradation and livelihood transitions. More recently, she has investigated multiple ecosystem service tradeoffs in rural agricultural systems, with particular attention to the constraints and capacities of households and communities to adapt and transform their livelihood strategies.

## Lunch Session, June 27



**Alexandre Rivas** received his doctoral degree in Environmental Economics and Public Finance from The University of Tennessee System (1998), Masters in Public Finance – The University of Tennessee System (1997) and bachelor in Fisheries Engineering from the Federal University of Ceará, Brazil (1988). He is full professor in the Economics Department from Federal University of Amazonas. President of Piatam Institute, Collaborating Professor in the Environmental Studies Program at Washington and Lee University (USA), Emeritus economist conferred by the Economics Council of the Amazonas State, Brazil. He is a Science and Technology Adjunct director from the Amazonas State Federation of

Industries (FIEAM). His current research interest focus mainly in the area of Environmental Economics and Natural Resources, with emphasis on the Economics of environmental services and economic valuation of the environment and environmental impact analysis of major projects in the Amazon. Dr. Rivas also actively participates in projects in the private sector.

## Morning of June 28



**Leehi Yona** is a Master of Environmental Science candidate at the Yale School of Forestry and Environmental Studies. Her research focuses on integrating climate change science and policy, with a previous focus in the Arctic. Currently, she is investigating ways to strengthen both the development and implementation of the Intergovernmental Panel on Climate Change's Greenhouse Gas Accounting Guidelines, focusing on soil ecology and regional political discourse. She holds a degree with high honours from Dartmouth and has been to nearly a dozen United Nations climate conferences. As a scholar activist, Leehi founded the Divest Dartmouth fossil fuel disinvestment campaign and is currently working with the Union of Concerned Scientists on a project to aggregate faculty engagement with divestment. Leehi is a recipient of the Lieutenant-Governor of Quebec's Youth Medal, was a Rhodes finalist this year, and was named Canada's Top Environmentalist Under 25.

### USSEE President's Address, Lunch Session, June 28



**Jim Kahn, USSEE President-Elect** is an environmental and ecological economist, and a founding member of USSEE. He received his PhD in environmental economics from the University of Maryland in 1981, studying under one of the leaders of the original ecological economics movement, John Cumberland. He is a past Secretary/Treasurer of USSEE. Jim Kahn is the John Hendon Professor of Economics at Washington and Lee University, and the Director of the Environmental Studies Program there. He has been a faculty member at the Center for Environmental Science and the Graduate Program in Tropical Fishery Science at the Federal University of Amazonas (Brazil) since 1992. Past positions include SUNY-Binghamton (now Binghamton University) from 1980-1991 and a joint appointment at the University of Tennessee/Oak Ridge National Laboratory from 1991-2000. He has over 150 publications (including 9 in Ecological Economics). Kahn has co-authors from diverse fields including ecology, chemistry, engineering, political science, hydrology, and fishery science. He held a Fulbright Scholarship in Brazil in 2001. Kahn has received numerous teaching awards including a SUNY-system-wide award for teaching excellence, and an Outstanding Faculty award from the Virginia State Council of Higher Education. Research interests focus on global climate change policy, sustainable development in remote regions, Amazonian issues, fishery management, causes of deforestation, economic incentives for preservation, and environmental valuation. Kahn has received research funding from NOAA, USEPA, US Department of Education, NYDEC, Mellon Foundation, CNPq (the Brazilian National Science Foundation) and the State of Amazonas, among other agencies.

# ABSTRACTS

## Alphabetical by Corresponding Author's Last Name

### **Using Binomial Probit Models to isolate factors that influenced community and household placement into Ghana's Modified Taungya System**

Doe Adovor (PhD) Michigan State University Department of Forestry); John Kerr (PhD) (Professor and Associate Chair Michigan State University Department of Community Sustainability); Runsheng Yin (PhD) (Professor Michigan State University Department of Forestry); Ernest Foli (PhD) Principal Research Scientist, Forestry Research Institute of Ghana)

This research used Binomial Probit Models (BPM) to isolate factors that influenced placement of Ghana's Modified Taungya System (MTS) into communities and households as a first step to investigating livelihood changes since launching the national reforestation program in 2002. In 2009 878 household surveys were conducted in 19 forest communities in Yaya, Nsemre and Sawsaw forest reserves in Ghana's Brong Ahafo Region. Included in the Yaya survey were 406 MTS participant and 240 non-participants. Included also are 232 households in Nsemre and Sawsaw where the MTS did not exist. The BPM results suggest that four factors (assistance from religious organization, access to transportation, rural-urban migration, and type of roof) increased significantly the predicted probability of MTS community placement while two (size of land and annual household income) decreased significantly the predicted probability of community placement. Extension support from public and civil society groups, and commercial crop production increased significantly the predicted probability of program placement within households following community selection. Also an increase in the number of individuals in a household with at least a junior secondary education and those receiving help from relatives outside of the village significantly decreased the probability of program placement within the household.

### **The entrepreneurial university and sustainable development in Kuwait: Research agenda on food, water, and energy**

Ali Aljamal \*, Mark Speece, Mohsen A. Bagnied (College of Business and Economics American University of Kuwait)

The entrepreneurial university is about engagement with critical social and economic issues facing modern societies. Kuwait's 2035 Initiative outlines a sustainable economy less dependent of oil revenues, focusing on food, water, and energy. The goals make sense, but there is little idea about how to achieve them. The problem is not purely technical, but about gaining acceptance for sustainable technologies and more sustainable behaviors. This paper discusses a research agenda focused on food, water, and energy in Kuwait. Partly, the agenda includes de-marketing, to reduce considerable waste of these resources. Partly, it investigates gaining acceptance for household use of sustainable technologies. A key element is involvement of students, who gain experience on real-world class projects, learn to interact with outside organizations in a consulting role, and become advocates for goals of the 2035 Initiative. One set of projects examines household adoption of hydroponics for vegetable production, which could substantially reduce dependence on imported food. Another set looks at adoption of small-scale reverse osmosis desalination technology, to reduce demand for government water produced through more expensive and more environmentally harmful thermal

desalination. A third set of projects examines how to market household solar systems to reduce dependence on government.

### **Ecofeminism and Money**

Joseph Ament, Gund Institute for Ecological Economics, The University of Vermont

The manner in which private banks create money in modern economies presents a problem for socioecological management. Ninety-seven percent of all money in circulation is the result of administering interest-bearing loans to the private sector. Accordingly, money is systematically channeled to investments that tend strongly to destroy social and environmental systems. The spending and investment needed for the consequent restoration is often characterized by long-term, no-return projects. The result is a global juggernaut structurally at odds with sustainability. Ecofeminism provides a lens through which to analyze the metaphysical underpinnings of the destructive global money system. This paper uses ecofeminist theory to consider how a society framed in the feminine might create and allocate money. First, it considers the early Western philosophy that created a dualist hierarchy that placed humans above nature, and men above women. Next, it translates that philosophy into the foundational assumptions of classical economics. Finally, it considers how neoclassical economics, and the money systems it uses, rests upon those dualisms. Public systems of money creation have the advantage of allocating money to projects based upon need, rather than profit. An economy reframed through a feminine lens offers the opportunity to leverage public money for global sustainability.

### **Decentralized forest and wildlife management in Tanzania: Does the theory match with practises?**

Innocent H. Babili, Sayuni B. Mariki and George.C.Kajembe (1. Institute of Continuing Education, Sokoine University of Agriculture, (SUA) Morogoro, Tanzania; 2. Department of Tourism, SUA, Morogoro, Tanzania; 3. Department of Resources Assessment and Management, SUA, Morogoro, Tanzania)

Over the past three decades, there has been a shift from top-down approach of natural resources management to more decentralized approach aimed at achieving positive ecological, rural livelihood and governance outcomes. However, through recentralization process, lower level actors in natural resources management are receiving from the government insufficient powers intended for decentralization. This paper draws from literature review and information collected through participant observation at stakeholders' workshop of forest and wildlife sectors held in Dar es Salaam, Tanzania in 2015. Using the two sectors as case studies, the paper applies decentralization, political ecology and multiple institutional logics of action (MILA) theories to demonstrate that although policies and legislation on natural resources management seem to favor decentralization, discourses and actual practices have undermined the decentralization policy and in some cases recentralized. This recentralization process is more pronounced in wildlife sector than forest sector. This calls for adoption of discourses and practices in forest and wildlife resources management that favor meaningful devolution of power to lower level actors, particularly local communities. Keywords: Decentralization, multiple institutional logics of action (MILA), political ecology, forest, wildlife, Tanzania

### **Shrinking cities examined from a shrinking scale – the impact of household and neighborhood heterogeneity on changes in material and energy consumption, ecosystem services and environmental impact**

Stephen B. Balogh, US Environmental Protection Agency, Office of Research and Development, Atlantic Ecology Division; Elvia Melendez-Ackerman, University of Puerto Rico at Rio Piedras; Cecilio Ortiz, University of Puerto Rico Mayaguez; Tischa Munoz-Erickson, US Forest Service, International Institute for Tropical Forestry; Ariel Lugo, US Forest Service, International Institute for Tropical Forestry; Susan



Yee, US Environmental Protection Agency, Office of Research and Development, Gulf Ecology Division; Gustavo Garcia-Lopez, University of Puerto Rico at Rio Piedras; Marla Perez Lugo, University of Puerto Rico Mayaguez

Urban populations continue to increase globally and cities have become the dominant human habitat. However, the growth of cities is not universal. Shrinking cities face decreased income, reduced property values, and decreased tax revenue. Fewer people per unit area creates inefficiencies and higher costs for infrastructure maintenance and the provision of public amenities. However, population losses and economic distress are not equal in all neighborhoods, and in fact are quite heterogeneously distributed across the landscape. Broader statements about the trajectory of a shrinking city may mask underlying differences in economic, cultural, and environmental impacts as well as the ability of some neighborhoods to be resilient and adaptive to economic changes in addition to climate change and other environmental stressors. This paper examines the recent impact of population loss in neighborhoods in the Río Piedras watershed in San Juan, Puerto Rico, on the provision of ecosystem services, material and energy flows, and ecological impacts, using public data and data collected previously in two household surveys. Using scenarios, we estimate future population changes and their potential positive and negative impacts on the environment and human well-being in these neighborhoods.

### **A Policymaker's View On Improving Key Economic Models Used for Climate Policy**

Alex Barron, Smith College

In a post-Paris world, increased ambition at the national level is critical to further progress on climate. This ambition is often calibrated with the projected costs of a policy – as estimated by “national” scale economic models (e.g. NEMS, IGEM, ADAGE) run by U.S. government agencies. However, these models have historically performed poorly in many of the areas where they need to be strongest: renewable energy deployment, energy efficiency, and emissions reductions in a wide range of sectors. At the same time, past modeling of U.S. climate legislation provided limited context on benefits and uncertainty that are critical to effective policy making. Neither academics nor government modelers have ignored these issues. However, while significant resources are appropriately devoted to improving climate models and integrated assessment models, the literature examining the national-scale models that are used for policy analysis is thin relative to the outside importance of these models in framing policy discourse and design. Because improvements to these models take time, this is a critical window for investments to refine these models so that the next wave of climate policies can benefit. Priority areas for action will be discussed based on direct experience with both the Congressional and Federal policy-making processes.

### **Ten Successes: Ecological Economics Applied**

David Batker, Earth Economics

Ecological Economics works. Projects and policies based upon Ecological Economics can be implemented across the US in red and blue states. This presentation will provide 10 quick examples including \$2 billion in Mississippi River Delta restoration projects, the spot prawn fishery AK to CA, levee setbacks, greening federal buildings, mining, national park expansion, court cases and more with valuable lessons learned from applying ecological economics in over 30 US states and internationally.

### **Kiss nature goodbye. The dangerous illusions of post-environmentalism**

Sam Bliss, Rubenstein School of Environment and Natural Resources, University of Vermont; Giorgos Kallis, Institute of Environmental Science and Technology, Universitat Autònoma de Barcelona

Post-environmentalists foresee salvation in technology. They call for concentrating human activity in dense cities and factory farms to leave more room for wildlife. They advocate deploying nuclear energy, genetic modification, synthetic materials, and more new technologies that “decouple” humans from nature. Only by breaking free from biological resources and natural cycles, they argue, can humanity shrink its total environmental impact and achieve economic development for all. In a forthcoming book, we critically review the scientific literature surrounding the foundational claims that underlie the post-environmentalist vision, as described in *An Ecomodernist Manifesto*. We find that urbanization, agricultural intensification, energy revolutions, and economic growth coincide with increasing, not decreasing, environmental damage. Modernization has not merely left some people behind, but has created material wealth at the direct expense of impoverished and exploited populations. People who “decouple” from nature care less about protecting it. Little evidence suggests that these trends will reverse. Collective action, not technology as such, improves social and ecological conditions. Post-environmentalism has the makings of a self-fulfilling prophecy – one that, if realized, will be a disaster.

### **The Economics of Equity: Insights from the BDY Model**

Garvin H Boyle, Orrery Software

In 1988 Benatti described a simple agent-based computer model demonstrating simple capital exchanges between economic actors. In a subsequent paper, Drăgulescu and Yakovenko elaborated the model and explored its behaviour. Now referred to as the BDY model, it is proving to be highly pertinent to the issue of income inequity, both within national economies and between nations. In this presentation I briefly review the history of the BDY model, its simple construction, and its easily demonstrated behaviour. I show how the ubiquitous and widespread problem of extreme economic inequality is largely a direct result of fundamental mathematical and “natural” processes unrelated to skill, talent or greed. Supporting empirical studies from the Econophysics literature and elsewhere will be referenced. I argue that the theoretical foundations of Ecological Economics must encompass this phenomenon if it is to maintain its stance as a science-based discipline. I address the philosophical question of whether such “natural” processes can be viewed as bad or good, and should or should not be resisted. Finally, I briefly outline the long-term local and global policy implications that must be addressed perpetually if the goal of a sustainable steady-state economy is to be achieved and maintained.

### **Modeling Intergenerational Sustainability**

Garvin H Boyle, Orrery Software

Modern agent-based evolutionary computer models are able to demonstrate extremely complex and important dynamics that cannot easily be expressed in mathematical equations. Our global economy is neither self-supporting nor independent of the health of the biosphere within which it arose. If we do not understand this instability, we cannot formulate policies to fix it. However, there are currently no hybrid biophysical/economic models that include both sub-systems coupled and co-evolving together. I argue that a deep understanding of the dynamics of inter-generational sustainability is necessary, but only possible through the careful study of such evolving hybrid agent-based models. I present ModEco, an evolutionary agent-based model economy, along with six hypotheses, and a challenge to modelers. In the biophysical sub-system the laws of conservation of mass and energy are observed and prices reflect the true cost of consumption. In addition, the cycles of life are modeled from birth to



death, from generation to generation. The inter-generational dynamics of this truly sustainable biophysical/economic society are presented. Interim results from ModEco seem to indicate that economic sustainability is an elusive quality with very unpleasant implications. I challenge other economic modelers to produce a hybrid model economy that is both sustainable, and socially just.

### **Socio-economic Analysis within an Ecosystem Service Framework: Assessing Delta Restoration**

Tania Briceno, Earth Economics

The 9,600 square-mile Mississippi River Delta is one of the world's largest and most productive deltas, whether measured by trade, fisheries, or navigation. As the Delta region deteriorates, with the dramatic land losses experienced over the last century, there is an urgent need to understand the link between socio-economic systems and the complex biophysical landscapes that provide ecosystem services to these systems in order to set up appropriate delta management plans. Landscape changes are having an effect on storm protection, fish habitat, water supply, recreational opportunities, among others. In this context, a socio-economic analysis framework is proposed for assessing the potential impacts of coastal restoration projects in this region. Under the directive of the Coastal Protection and Restoration Authority (CPRA) of Louisiana, this framework is developed to evaluate river sediment diversion projects designed for land building within the 2017 Coastal Master Plan. This framework links the output produced by hydrological and fisheries models (Delft3D, EwE, and CASM) to ecosystem goods and services in order to predict and assess socio-economic changes expected in different scenarios. Various quantitative measures and indicators are reviewed for their ability to reflect the interdependency of local economies and the biophysical characteristics of the Delta.

### **The Economics of Outdoor Recreation in Washington State**

Tania Briceno, Earth Economics

Approximately \$20 billion are spent every year in outdoor recreation in Washington State. These expenditures support about 200,000 jobs and fuel local economies. More importantly, the outdoor recreation economy provides many co-benefits in the form of environmental benefits and quality of life improvements. This study gives an overview of some of the major findings of recent studies conducted by Earth Economics for the Washington Recreation and Conservation Office and for Washington State Parks. There are more than sixteen different land managers in the state, promoting different types of outdoor recreation opportunities and conserving diverse landscapes that perform important ecological functions. Forests, wetlands, rivers, and urban green spaces all provide different benefits to surrounding communities. The ability to be physically active also improves the mental and physical health of Washingtonians, measured by various metrics. We value key benefits and identify critical factors that act as drivers to increase visitation to outdoor recreation sites. A set of tools are proposed for land managers to enhance outdoor recreation opportunities while moving towards a more sustainable economy.

### **Modeling the Energy Future**

James Case

Among its many shortcomings, the free market has shown itself to be a remarkably inefficient steward of the planet's limited supply of fossil fuels. There is, moreover, ample reason to believe that careless development of the remaining resource could mean "game over" for the atmosphere. An energy-driven — rather than dollar-driven — model for assessing alternatives will be proposed.

### **The Value of Sand Fixation Service of Desert Ecosystem in China**

Leilei Cheng, Yingshuang Bao, Qi Lu, Pak Sum Low, Hao Guo, Bo Wu Cheng L., Bao Y., Lu Q., Guo H., and Wu B. are from the Institute of Desertification Studies, Chinese Academy of Forestry, China. Pak S.L. is from Bond University, Australia.

Various ecosystem services have been valued, but no data on desert ecosystem services have been provided. Desert ecosystem provides a number of unique ecological functions and services that produce significant local, regional and global benefits. The most unique and important service is sand fixation by desert vegetation. Based on the data of the National Desertification and Sandification Monitoring, we have estimated the value of sand fixation service of desert ecosystem in China. The amount of sand fixed by desert vegetation was approximately 37.8 billion tonnes, and the value of sand fixation service was 1223.2 billion Chinese yuan in 2009. The methodology used in this research may be replicated in evaluating the sand fixation service elsewhere in the world, although the uniqueness of the desert ecosystems in various countries must be taken into consideration.

### **Meeting Planetary Boundaries: Economy-Wide Assessment of Global Policies towards Strong Sustainability**

Maksym Chepeliev, Center for Global Trade Analysis, Purdue University

In this study we apply recent developments in planetary boundaries estimates to quantify the sustainability limits of critical natural capital, which stock has to be preserved in terms of Strong Sustainability (SS) concept. Based on different scenarios of population change, economic growth and technological change by countries we develop baseline economic development paths till 2100 and identify patterns of energy and material use, as well as global environmental change. Using available planetary boundaries estimates and developed long term economic scenarios we identify natural capital stocks and associated material flows that transgress the planetary boundaries and violate the SS concept. We further apply a multi-region Computable General Equilibrium model GTAP, which was developed by the Center for Global Trade Analysis at Purdue University and covers 140 regions and 57 commodities, to study policy options that can ensure global economic development within sustainability boundaries. Policies under consideration include energy subsidies reform, emission taxation, shift of taxation base from labor and capital to natural resources and pollution, etc. In addition to conventional economic indicators assessment approach also includes environmental welfare gains, which are estimated within the framework of Weak Sustainability.

### **Ecological Economics Tools for Design Thinking**

Sayeh Dastgheib-Beheshti, York University, Toronto, Canada

Design thinking, an abductive problem-solution methodology based on the mindset of product designers, has been recognized as one of the few methods suitable for tackling complex problems with high levels of uncertainty. While the idea of design thinking itself has been developed into toolkits for application in diverse fields, product designers continue to grapple with the moral dilemmas they face from the lack of attention afforded by their profession to questions such as sustainability, ecological and social impact, as well as equitable distribution of costs and benefits. It can be argued that the simplistic economic perceptions of the value of design only as public goods, as well as the great separation in time and location between actions and consequences, have been the two main factors utilized by capitalist and market economies to pacify product designers into complacency. This paper highlights the ecological economics elements that can be formulated into tools to assist product designers to think systematically, improve the design thinking process, and envision new socio-economic relationships.

## **The Role of Ecological Fiscal Transfers for Solid Waste Management in the Overall Policy Mix**

Felipe Luiz Lima de Paulo, PhD Student in Administrative Sciences at University of Minho in Braga, Portugal; Pedro Jorge Sobral Camões University of Minho, Portugal; Irene Ring Technische Universität Dresden, Germany

Local governments have yet to overcome several challenges with regard to solid waste management. For example, while waste incineration is expensive, landfills require land availability. Although waste disposal is understood as a typical public service based on fees paid by citizens, fundamental institutional, financial, social, and environmental problems still exist (Bhada-Tata & Hoorweg, 2012). In this sense, it is crucial to explore the role of new policy instruments and initiatives to integrate a solid waste management plan. The Ecological Fiscal Transfers - EFT are an intergovernmental fiscal transfer aiming to enhance the environment. So far, there are three countries that adopted an EFT scheme by integrating additional protected area-related indicators to distribute public revenues to local governments: Brazil (Ring, 2008), Portugal (Santos, et al 2012) and, in small scale, France (Schröter-Schlaack et al., 2014). Although biodiversity conservation is the major policy objective related to the introduction of EFT schemes in these countries, some Brazilian states also consider municipal solid waste management in their EFT scheme. This paper intends to theoretically explore the role of the EFT on solid waste management in the overall policy mix. The expectation is to advance the literature on policy analysis in general, and the EFT literature.

## **Ecological Fiscal Transfers in Europe – evidence-based design options of a transnational scheme**

Nils Droste (UFZ - Helmholtz Centre for Environmental Research, Martin-Luther University Halle-Wittenberg, FLACSO - Facultad Latinoamericana de Ciencias Sociales Ecuador); Irene Ring (Dresden University of Technology, UFZ – Helmholtz Centre for Environmental Research); Rui Santos (Cense – Centre for environmental and sustainability research, Universidade Nova de Lisboa); Marianne Kettunen (Institute for European Environmental Policy (IEEP))

Ecological Fiscal Transfers (EFT) have recently gained attention as a promising instrument to provide incentives for nature conservation addressing public authorities. In this paper we develop a proposal for an EFT design within the supranational context of the EU and assess its potential effects with evidence-based estimates. To provide such a knowledge base for a potential supranational EU-EFT implementation, we i) provide a theoretical underpinning, and an analytical synthesis of the current experiences both with the uptake of EFT and the implementation of EU's nature conservation legislation (i.e. the Habitats and Bird Directives), ii) propose a model for an EFT implementation within the existing EU funding framework for N2k financing which is built upon both quantitative and qualitative conservation indicators, iii) compute fiscal effects of our suggested model and analyze how the resulting payments would be (spatially) distributed among European regions, and iv) discuss the model outcomes in terms of ecological effectiveness, distributive effects, and cost-effectiveness.

## **Ecosystem service valuation for national accounting - current methodological debates**

Nils Droste (UFZ - Helmholtz Centre for Environmental Research, Martin-Luther University Halle-Wittenberg, FLACSO - Facultad Americana de Ciencias Sociales Ecuador); Bartosz Bartkowski ((UFZ - Helmholtz Centre for Environmental Research)

While recent experimental frameworks for national ecosystem service accounting have shown substantial progress some crucial methodological issues remain. In response to Obst et al. (2016), we provide arguments with regard to the suitability of particular valuation approaches. Respective valuation methods need to be consistent with national accounting standards but we disagree with their

conclusions regarding specific valuation techniques. Firstly, that methods used for estimating shadow prices can also be used to derive consumer surplus does not justify their general exclusion for national accounting valuation of ecosystem services, especially for public ecosystem services. Secondly, that preference-based methods can also be used to assess welfare changes does not imply that cost-based methods are generally better suited for ecosystem accounting. Instead, we see an essential need for societal preference information in accounting contexts. Thirdly, assessing ecosystem degradation values through replacement costs instead of restoration costs implicitly assumes substitutability of ecosystems with alternative man-made supply - which does not supply sustainable management information.

### **Agroecology and the global environmental crisis: Theory, application, and lessons from Santa Catarina, Brazil**

Josh Farley (University of Vermont); Gina Clithero; Abdon L. Schmitt (Federal University of Santa Catarina); Sam Bliss; Ben Dube; Michael Middleman (University of Vermont and Vermont Agency of Agriculture)

The conflict between farms and forestland is perhaps the biggest threat to biodiversity and the stable climate. This global problem is playing out in Brazil's Atlantic Forest: encroaching agricultural systems push ecosystems toward catastrophic thresholds, while sacrificing farmlands to reforestation would plunge many small farmers into extreme poverty—a catastrophic economic threshold. Agroecology addresses this tradeoff with knowledge- and labor-intensive systems that empower small farmers while restoring and protecting biodiversity and ecosystem services. The Redesigning Agroecosystem Research Group, a project of the Federal University of Santa Catarina and more recently the University of Vermont, has been working for two decades to meet the conflicting demands of farmer livelihoods and ecosystem restoration in Brazil's Atlantic Forest through developing, researching, and disseminating systems based on Voisin rotational grazing and agroforestry. In this session, we present papers on: (1) The theoretical basis for agroecology as a solution for the conflict between agriculture and the environment. (2) Redefining efficiency in agriculture (3) Co-investment in agroecology for Ecosystem Services in Brazil's Atlantic Forest (4) Lessons from successes and challenges for applying this framework in other parts of the world, including in the United States.

### **Developing and Applying Ecosystem Accounting to Coastal Long Island Bays**

Anthony Dvarskas, Stony Brook University

Recent efforts internationally and within the United States have focused on developing accounting systems for ecosystem services. The United Nations System of Environmental-Economic Accounting Experimental Ecosystem Accounting (SEEA-EEA) provides a draft framework for assessing ecosystem services over space and time. The focus of the initial framework, however, is largely on terrestrial rather than aquatic systems. Given the importance of coastal ecosystem assets to the livelihood of many communities within the United States and beyond, this research applied the principles from the SEEA-EEA to three selected pilot watersheds on Long Island. Using a combination of GIS, systems modeling, and review of existing data we have developed a framework for applying the SEEA-EEA to coastal and aquatic ecosystem assets. We specifically explore indicators useful to pending decisions related to nitrogen loading reductions to the pilot bays. The study demonstrates the complexity of the connections between the supply and demand for ecosystem services derived from coastal ecosystem assets as well as the challenges in designing data collection for indicators. Future steps should include development of ecological production function models that can predict the relationship between the extent and condition of recommended coastal habitat classes and the provision of final ecosystem services.

### **Redefining efficiency in agriculture: A case study in Brazil's Atlantic Forest**

Joshua Farley, Department of Community Development and Applied Economics, University of Vermont, Morrill Hall, Burlington, VT, USA; Abdon Schmitt-Filho Departamento de Zootecnia e Desenvolvimento Rural, Centro de Ciências Agrárias, Universidade Federal de Santa Catarina, Florianópolis, SC, Brazil

Brazil's Atlantic Forest is at 15% forest cover. Ecologists believe there will a potentially catastrophic collapse in biodiversity unless forest cover reaches 30%. At the same time, the restoration of farmland to forest threatens the viability of small family farms. Some scientists claim more intensive industrial agriculture is the most efficient technological solution, while others favor agroecology. Some claim the free markets is the most efficient institutional solution, while others favor non-market approaches. We use a case study of agriculture in Brazil's Atlantic Forest to compare these options using an alternative definition of food system efficiency: minimizing the ecological cost of providing food security for all. We break the efficiency down into an identity. Economic efficiency provides food security with the least amount of food production, technical efficiency produces adequate food with the least throughput, and ecological efficiency minimizes ecological costs for a given quantity of throughput. We use the identity to suggest leverage points for achieving sustainable food security. We conclude that industrial agriculture is generally less efficient than agroecology. Free markets are particularly inefficient for research and development of agricultural technologies, and for rationing food when income distribution is highly unequal.

### **Co-investment in Agroecology for Ecosystem Services in Santa Rosa de Lima, Brazil.**

Abdon Schmitt-Filho Departamento de Zootecnia e Desenvolvimento Rural, Centro de Ciências Agrárias, Universidade Federal de Santa Catarina, Florianópolis, SC, Brazil; Joshua Farley Department of Community Development and Applied Economics, University of Vermont, Morrill Hall, Burlington, VT, USA

The world must produce enough food for a growing population while restoring global ecosystems, but with conventional agriculture, food production is among the greatest threats to global ecosystems. In Brazil's Atlantic Forest, the challenge is to restore forest cover and ecosystem services without driving farmers into poverty. In Santa Rosa de Lima, we are working with farmers to implement high biodiversity silvopastoral systems and multi-function riparian zones that can improve farmer livelihoods, restore ecosystem services, and comply with Brazil's forest code. Scaling the project up will require public sector support, justified by the public good benefits provided. Current policies—Brazil's forest code that mandates restoration and payments ecosystem services—fail to simultaneously improve farmer livelihoods and promote restoration at the necessary scale. Using participatory action research, we develop a proposal for an alternative approach to PES in which the public sector co-invests with farmers in the transition to agroecological systems that can achieve these goals. Farmers are willing to donate 10% of their sales to a rotating fund that will finance adoption by additional farmers, assuring continuity even if public sector support falters. Also, sufficiently profitable agroecological practices could go viral even without government support.

### **An Introduction to Ecological Economics**

Joshua Farley, Community Development and Applied Economics; Fellow, Gund Institute for Ecological Economics

USSEE conferences attract many attendees who are interested in the field but have not studied it extensively and would like to learn more. I propose a symposia that will present core ideas in the field by skilled communicators and experts consisting of three 90 minute sessions with four to five

presentations each: 1) biophysical foundations, 2) the human sub-system, and 3) debates and controversies. Presentations will stand on their own, but in their entirety will clearly (albeit briefly) describe the fields' central paradigms and controversies. I will recruit presenters from conference attendees over the next month, but also solicit pre-recorded videos from leaders in the field who will not be attending the conference, such as Herman Daly. The conference presentations will be recorded. All videos will be posted on the USSEE and other web-sites, incorporated into an MOOC currently under development at UVM, and made freely available for viewing or download, hopefully exposing an ever-broader audience to the field. We will build on the library of presentations in future conferences, beginning with the 2017 CANSEE presentation in Montreal.

### **A framework for understanding the livelihood impact of forest plantations in developing countries, with evidence from the Indian Himalaya**

Forrest Fleischman, Department of Forest Resources, University of Minnesota

National and international policies are increasingly encouraging tree plantations as a tool for economic development, poverty alleviation, ecosystem restoration, and carbon sequestration. In this paper I use institutional political economy to conduct a theoretical examination of the potential impacts of tree plantations on rural livelihoods, drawing on evidence from the scattered literature evaluating plantation programs. I argue that the effect of plantations varies based on the ability of those living near the forest to participate in the design of the plantation, as well as the relative power of the forest users and those funding and implementing the plantation. I then show, using preliminary data from a larger project examining plantation projects in the Indian Himalaya, that the postulated theoretical relationships are valid, but they interact with broader economic changes occurring in rural India.

### **Income inequality and public conservation land in Michigan's Upper Peninsula**

Kathryn Frens and William Porter--- Michigan State University Department of Fisheries and Wildlife

Dialogue around public conservation land is often framed as a debate over the opposing values of economic growth and environmental conservation, despite research showing that public land has no effect on either employment growth or on wages. However, as the natural resources extraction industries decline in the northern US, research suggests that the increased importance of tourism spending to local economies might lead to a "hollowing out" of the income distribution and thus to increased income inequality. Inequality is known to have a negative effect on human wellbeing, including health and social cohesion, and thus possible increases in inequality are of concern to the public. Here we examine the relationships among income inequality, employment sector, and public land in northern Michigan using a Bayesian hierarchical modeling framework. Inequality is higher in metropolitan areas and areas where the economy is highly dependent on tourism services. No difference in inequality was found between areas with differing amounts of public conservation land.

### **Modelling and forecasting EU allowance prices applying artificial neural networks**

Miguel Angel Jaramillo (University of Extremadura); Blanca Moreno (University of Oviedo); Agustin Garcia (Global Development And Environment Institute - GDAE, and University of Extremadura); Alvaro Lopez (University of Extremadura)

The European Union has introduced the European Trading System, which states a market for carbon emissions or European Union allowances (EUA). Under this system, companies producing carbon emissions must manage associated cash flows by buying or selling carbon allowances. Moreover, future carbon prices could affect companies' decision about decarbonization technology investments, so there

is a need to forecast CO2 emission allowances prices. This paper provides artificial neuronal networks based models to provide accurate and timely forecasts for EUA prices. Models are based on daily carbon price observations. We also try to include external variables that can affect those prices as production of emissions changes (more production can produce an increase of carbon emissions so EUA demand will increase and thus its price). In that sense, one of the most important activities affecting EUA prices is electricity generation. Fuel prices may also affect EUA prices, as the wholesale electricity market and the EUA emission allowances market are linked, since polluting power production technologies incorporate their emission allowance costs into the short-term marginal kWh cost of electricity. Thus, the models used to forecast EUA prices considers the daily stock price of EU emitters sectors (as a proxy for daily production) and fuel spot prices.

### **Iberian power: the path toward a more competitive and sustainable electricity market**

Agustin Garcia (Global Development And Environment Institute - GDAE, and University of Extremadura); Maria Teresa Garcia-Alvarez, (University of A Coruna); Blanca Moreno (University of Oviedo); Mihaela Caraus (University of Extremadura); Tania Iglesias (University of Extremadura)

Over the past several years, important policy developments affecting the electricity market have taken place. European Union policy is aimed at promoting a deep reform toward a more liberalized, competitive and environmentally-friendly electricity market, which will affect the cost of energy supply and substantially modify countries' energy mix. The Spanish and Portuguese cases are two interesting attempts to transition towards a cleaner economy. At the end of the last century, Iberian countries started the electricity market liberalization process and the promotion of renewable energies in the electricity generation mix. The challenge was to lead the process, changing the role played in previous energy transitions. Moreover, the goals went beyond the power sector. The point was to seek advantage from a "greener energy", new employment opportunities or reduced dependence on imported fuels, among other factors, to expand the effect toward a more sustainable economy. The results have been contradictory. Economic disturbances resulting from the EU financial crisis have added doubts to the process during the last few years. Our paper describes the evolution of the electricity sector and market, trying to identify the main features conditioning the changes (socio-economic background, EU environmental and single-market policy, domestic policies,...), and the key points going forward.

### **Energy Policy and Job Creation at the State Level**

Heidi Garrett-Peltier, Assistant Research Professor, Political Economy Research Institute, University of Massachusetts Amherst

The U.S. federal government is increasingly becoming populated by individuals who are climate skeptics or climate deniers, as well as many who oppose an expansion of clean energy in favor of bolstering fossil fuels. Federal support for clean energy and climate change mitigation is therefore likely to be systematically cut over the next four or more years. It therefore becomes increasingly important to focus on state-level energy policy and the economic benefits of such policies. New York and Washington are two states among others that are trying to create a greener economy by becoming more energy efficient, expanding renewable energy, and reducing the use of fossil fuels. Analyses conducted by the Political Economy Research Institute show that such clean energy policies are engines of job growth in a number of different sectors, and that the number of jobs lost through fossil fuel retrenchment is small in comparison to the number of jobs created by clean energy. We will present this state-level analysis, including the costs of implementing a 10-year emission reduction state policy and the methodology and estimates of employment impacts from these state-level clean energy policies.

### **Land Use in Buffers of Two Costa-Rican National Parks**

Robert Gottfried, Professor Emeritus of Economics, The University of the South, Sewanee, TN; Charles Brockett, Professor Emeritus of Political Science, The University of the South, Sewanee, TN; and Christopher Van De Ven

Privately owned lands adjacent or close to publically protected lands of great ecological value are widely recognized as playing a crucial role in either protecting or degrading those lands. This buffer role is especially important for the Reserva Forestal Golfo Dulce (RFGD) on Costa Rica's Osa Peninsula, which connects at its northeastern end to one national park (Piedras Blancas) and further to the southwest wraps around three sides of a second park, Corcovado, which is often referred to as the "crown jewel" of the country's park system. We have obtained the results of a recent land use survey of parcel owners along with related geocoded data for all parcels in the northern half of the RFGD and many in the southern half. This paper reports our preliminary findings, first, on variations in parcel land use (as well as several related variables) according to distance from the two national parks. Second, although this is cross-sectional data, it does include information on date of parcel purchase in what had been a frontier region, allowing for well-grounded inferences about land use changes and their relationship to central features such as rivers and new roads.

### **Developing robust and socially optimal nitrogen management strategies**

Jesse Gourevitch, Gund Institute for Ecological Economics, University of Vermont

Improving nitrogen (N) fertilizer management is central to sustaining agricultural productivity, improving water and air quality, and mitigating climate change. Despite recent advances in quantifying the social costs and benefits of N, inadequate characterization of methodological uncertainty and biases threatens to undermine effective N management strategies. We evaluate how the assumptions and parametric relationships underlying N valuation functions affect socially optimal N fertilizer application rates for corn in Minnesota. Our results suggest that the privately optimal N fertilizer application rate is 163 kg ha<sup>-1</sup>, while the socially optimal rate is between 124 and 161 kg ha<sup>-1</sup>, depending on the location of application. Based on loss in yields under the socially optimal application rates, farmers ought to be compensated between \$0.1 and \$13 ha<sup>-1</sup>. We found that parameters related to the relative risk of disease for exposure to N and the value of damages to health drive uncertainty in the social costs of N. Also, alternative methods for estimating the cost of health impacts significantly shift the spatial configuration and magnitude of the social costs of N. By illuminating the value of improved N fertilizer management to society, decision-makers can more effectively prioritize and implement actionable strategies.

### **The Role of the Value-Transfer Methodology in Scaling Human-Use Restoration Projects Under the Oil Pollution Act**

Richard W. Dunford - Environmental Economics Services; Heath Byrd – Cardno

There are three approaches for determining the appropriate size (i.e., scale) of ecological and human-use restoration projects under the Oil Pollution Act: value to cost, service to service, and value to value. In general, there are tradeoffs among these three approaches for scaling human-use restoration projects with respect to the units of measure, the need for monetary estimates of human-use activities, the need to quantify human-use gains from the restoration projects, and assessment costs. Instead of conducting a costly, original valuation study, economists often transfer values from previous studies when estimating human-use losses from an oil spill. In our paper we evaluate the role of the value-



transfer methodology in scaling human-use restoration projects. Our paper includes an example from a recent oil spill of the use of the value-transfer methodology for human-use restoration scaling.

### **The Dynamics of Pest Resistance Build Up in the Context of Market Power**

Brian J. Gross, Economics, Whittier College; Jennifer Alix-Garcia, Agricultural and Applied Economics, University of Wisconsin-Madison; David Zilberman, Agricultural and Resource Economics, University of California-Berkeley.

Given its importance to farmers and the environment, it is not surprising that pesticide resistance has inspired a large economic literature. Although much has been written regarding the role of farmers and regulators in managing resistance, the literature maintains some conceptual holes. Research has largely focused on resistance as a common pool resource problem and/or one facing myopic behavior, leading to the overuse of pesticides. However, the existing literature's emphasis on the resource framework has ignored other features essential to understanding the dynamics of resistance in a more complex reality. In this paper we observe that patent-holding chemical producers effectively have monopoly power, which implies that a monopoly is a reasonably accurate depiction of the pesticide market. This modification leads to substantial changes in the policy prescription for dealing with resistance. Previous papers have considered this characteristic (for example, Alix and Zilberman (2003) and Noonan (2003)) and contrasted the optimality conditions of social optimum, monopoly and myopic cases, identifying the possibility of slower buildup of resistance under monopolistic behavior. We build a formal, continuous time optimal-control framework for verifying the intuition of the discrete and static situations, demonstrating the stability of steady-states, and comparing outcomes.

### **Superorganomics**

Nathan John Hagens, University of Minnesota EarthTrust

Humans are an ultrasocial species. Combining this with the contribution of ancient primary productivity to current solar flows, our economy has functioned akin to a superorganism seeking low entropy inputs to provide 'evolutionarily derived feelings' to larger numbers of people. Energy underpins the entire endeavor. Each \$1000 of 2005 GDP requires 7 watts of energy input – and this constant has held most of the last 50 years. While the energy spigot maintains its size relative to the economy, how the superorganism accesses this energy changes through time as the best first (and cheapest) fossil deposits are exhausted. Complexity, credit, government rule changes and technology all combine to keep the spigot widening, and environmental impact grows apace. Modern economic theory parses explanations of the human ecosystem into 'macro' and 'micro' components to advise policy and describe the actions of self-interested rational 'actors'. Heterodox economic critiques suggest the changing of taxes, incentives and including externalities into prices as ways of become more sustainable and solving metabolic issues like climate change. Viewed from the perspective of a Superorganism however, an explanation of the human ecosystem would have major departures from economic theory and suggest novel, if low probability, responses towards better futures.

### **Use of Bayesian Belief Networks in predicting contamination of drinking water with E. coli in rural Vietnam**

David C. Hall, University of Calgary, Alberta, Canada

A Bayesian Belief Network (BBN) was designed to describe association between various deterministic and probabilistic variables gathered from 600 small scale integrated (SSI) farmers in Vietnam. The

variables relate to E. coli content of their drinking water, sourced on-farm from wells and rain water. Sensitivity analysis of the model revealed that choice variables were particularly likely to influence endpoint values, reflecting the highly variable and impactful nature of preferences, attitudes, and beliefs relating to mitigation strategies. This BBN model of SSI farming in Vietnam is helpful to understanding the complexity of small scale agriculture as well as for identifying and estimating impact of policy options, particularly where combined with other analytical and policy tools. With appropriate knowledge translation, the model results will be particularly useful for helping SSI farmers understand their options for engaging in water public health mitigation strategies that do not disrupt their chosen livelihoods.

### **REACTING to a rebound? An econometric analysis of fuelwood demand responses to a randomized controlled experiment with improved cookstoves in northern Ghana**

Kelsey Hample, NCSU

The motivation to produce and distribute improved cookstoves (ICS) is threefold: to reduce negative health effects caused by indoor emissions, to reduce contribution to climate change, and to reduce pressure on local forests for fuel. Using data from the REACTING (Research on Emissions, Air quality, Climate, and Cooking Technologies in Northern Ghana) randomized controlled trial in northern Ghana, we study the effects the introduction of two ICS may have on household demand for fuelwood and charcoal. The few existing analyses of fuel demand response to ICS have noted the possibility of a ‘rebound effect,’ a phenomenon in which ICS yield smaller-than-expected savings in energy consumption, due to reductions in the relative effective price of energy. In recent RCT studies, results are mixed: an ICS intervention in Senegal, for example, was found to cause a significant reduction in fuelwood consumption while the evaluation of a similar intervention in India found no significant effect. Results: Neither the Gyapa-only treatment (locally produced ICS) nor the Philips-only treatment (imported, charcoal-using ICS) had statistically measurable effects on fuelwood expenditure or use. The Gyapa+Philips treatment roughly halved fuelwood expenditure (t-statistic = 4.45 from a DiD regression). As for charcoal expenditure, both treatments that included the Philips stove increased charcoal expenditure by on average 30%.

### **Conserving and regenerating forests and soils to mitigate climate change**

Anne-Marie Codur, Tufts University Global Development and Environment Institute; William Moomaw, Tufts University Global Development and Environment Institute; Seth Itzkan, Soil4Climate, [soil4climate.org](http://soil4climate.org); Jonathan M. Harris, Tufts University Global Development and Environment Institute

In formulating climate policy, the window of opportunity for action is limited. It will not be possible to achieve the goals of the Paris Agreement – staying below 2°C with a more ambitious goal of goal of remaining below 1.5°C – without working on both sides of the greenhouse gas accumulation equation: emissions and absorption. In particular, even with successful reduction of greenhouse gas emissions, significantly increased sequestration of carbon in natural ecosystems, including forests, soils, and wetlands, will be essential. In theory it would be possible to sequester 1.4 gigatons of carbon per year in agricultural soils; 1.3 gigatons of carbon per year in forest and agroforest soils and agroforestry soils, and between 0.5 and 1.4 gigatons of carbon in currently degraded lands. This is the basis for the French Ministry of Agriculture’s “4 per 1000 initiative for food security and climate”, launched during the Paris Agreement meeting on climate change (COP-21). Full implementation of the 4 per1000 initiative has been estimated to involve a cost of about \$500 billion per year, about the level of current global agricultural subsidies, and less than 1% of global GDP. We explore the possibilities for implementation of this ambitious program.

### **New Perspectives on Teaching Ecological Economics**

Jonathan M. Harris, Tufts University Global Development and Environment Institute; Anne-Marie Codur, Tufts University Global Development and Environment Institute

This complete session is organized by the Tufts University Global Development and Environment Institute. The Institute has just completed the fourth edition of a text that combines environmental and ecological economics perspectives, *Environmental and Natural Resource Economics: A Contemporary Perspective*, and also offers a series of teaching modules that seek to introduce ecological economics perspectives into economics curricula. The text and modules have achieved wide usage, and the modules are made available for free at the website <http://ase.tufts.edu/gdae/> In this session, we will present material from the most recent versions of text chapters and modules. We would welcome the addition of other papers discussing aspects of the promotion and expansion of ecological economics education, and could expand the session into two or more sessions. We will offer two presentations: 1. *New Developments in Energy and Climate Change: The Potential for a New Energy Economy* Presenter: Jonathan M. Harris, Tufts University Global Development and Environment Institute 2. *Teaching about Population: Social, Economic, and Ecological Analyses* Presenter: Anne-Marie Codur, Tufts University Global Development and Environment Institute

### **Moving Beyond GDP: The Impacts of State-Level Initiatives in Measuring “Genuine Progress”**

Anders Hayden, Department of Political Science, Dalhousie University; Jeffrey Wilson, School for Resource and Environmental Studies, Dalhousie University

In recent years, GDP’s limitations as a wellbeing or prosperity indicator have increasingly been recognized in the political and academic mainstream, and “beyond-GDP” measurement initiatives have proliferated around the world. Among the main alternatives is the Genuine Progress Indicator, which the states of Maryland and Vermont now calculate. What effect are these initiatives having in practice? Is there any evidence to date that alternative indicators have shaped policy and public priorities in ways that live up to their supporters’ expectations—whether the goal is a transformative shift toward prioritizing ecological sustainability and social equality or a more limited reformist vision of better policymaking? What obstacles exist to fulfilling those expectations? Other beyond-GDP and sustainable-development indicator initiatives have suffered from a naïve “rational-positivist” view—i.e., a belief that simply producing new measurements will positively affect policy choices. To what extent have Vermont and Maryland been able to link new prosperity measurements to the policymaking process and avoid the disappointment over limited impacts evident elsewhere? This paper draws on semi-structured interviews with elite respondents—researchers, NGO leaders, public-sector officials, and politicians—involved in producing, advocating, and using the Genuine Progress Indicator.

### **Environmental impacts of shifting to healthy diet: Case of China**

Pan He, Department of Geographical Science, University of Maryland, College Park, MD 20742, USA; Giovanni Baoicchi Department of Geographical Science, University of Maryland, College Park, MD 20742, USA; Klaus Hubacek, Department of Geographical Science, University of Maryland, College Park, MD 20742, USA; Kuishuang Feng, Department of Geographical Science, University of Maryland, College Park, MD 20742, USA; Yang Yu Civil and Environmental Engineering, Stanford University, Stanford, CA 94305, USA

Diets in China is not only correlated with malnutrition issues but also leading to significant environmental consequences on greenhouse gas (GHG) emissions, water consumption and land use. To

identify potential win-win opportunities as well as trade-offs in improving public health and reducing environmental impact simultaneously, knowledge is required on whether a healthy diet would result in less environmental impact. Existing studies fall short in including socio-economic heterogeneity of individual dietary choices, and their performance of multiple types of environmental impacts. In this paper, we evaluate nutritional quality of Chinese diets using an individual-level dataset, China Health and Nutrition Survey (CHNS). With the identified malnutrition issues, we estimate the change of GHG emissions, water consumption and land appropriation of shifting to healthy diet. Our findings enrich understandings on the food-nutrition-environment nexus, and provide policy implications on food-related environmental regulations.

### **Risk analysis of on-farm industrial oil production from winter oilseed crops**

Prabodh Illukpitiya, Firuz Yuldashev, Jason P deKoff, Department of Agricultural and Environmental Sciences Tennessee State University 3500 John A Merritt Blvd Nashville TN 37209

One of the ways small farms may enhance their income is by diversifying their operations and adopting alternative enterprises. Growing winter oilseed crops during winter fallow period not only can provide additional income source for farmers, but also provide energy security for them. Small farmers who are struggling and declining rapidly can take advantage of this briskly growing, high value sub-sector of the energy industry. Production of oilseed crops is rare in most of midsouth and southeastern region, however, small-scale oilseed and on-farm industrial oil production remain largely unproven concepts. The objective of the study is to explore the economic viability of producing on-farm industrial oil from selected winter oilseed crops. The analysis was performed in two stages namely net return to producers from oilseed production and profitability of investment of small-scale processing unit for processing into industrial oil. Monte Carlo simulation was performed to analyze range of net return given uncertainty factors. According to the study findings, industrial rapeseed, carinata and crambe can generate positive net benefits for farmers under subsidy program for industrial oil production.

### **Choice Modeling and Its Application to Sundarbans Mangrove Forest Preservation**

Md. Hafiz Iqbal, Department of Economics, Government Edward College Pabna

Sundarbans mangrove forest plays an important role in the reclamation of land, protection of coastal habitat from cyclones and tidal surges and uplifts the socio-economic conditions of the coastal people. It is the breeding ground for several globally threatened species, including the endangered the Ganges river dolphin, the masked fine foot, the water bird, the Bengal tiger and reptiles. Now it is affected by insects, disease and climatic and human induced factors for commercial and trading purposes. Depletion of this forest is responsible for creating imbalance ecosystem. This study carried out through questionnaire survey in the adjacent villages and major tourist spots of Sundarbans mangrove forest. To fulfill the research objectives, this study attempts to apply choice experiment approach to assess tourists and villagers perceptions or attitudes i.e. the preference and willingness-to-pay for provisions of different attributes like donation, cutting Golpatta (*Nipa fruticans*), visiting option and location option. Multinomial Logit and Random Parameter Logit models are used to quantify the respondents' perceptions on the proposed attributes of this study. All of the attributes are found statistically significant and positive. The estimate of WTP on visiting option is higher than the WTP on other attributes in the study area.

### **Sport fishing management for environmental protection and sustainable development: An Application to the middle Rio Negro**

James R. Kahn (1,2), Carlos E.C. Freitas (1,2), Sandro Bitar (2), Alexandre Rivas (1,2) and Larry Hurd (1) (1. Washington and Lee University (USA) 2. Universidade Federal do Amazonas (Brazil))

The county of Barcelos in Amazonas, Brazil contains one of the best freshwater fisheries in the world (peacock bass). Currently, fishing services are provided by firms from outside the region, at rates of up to US\$5000 for 6 days of fishing. Unfortunately, very little of this money winds up in the communities. This paper develops the theoretical foundation for a larger effort to bring community based sport fishing to the region. The paper begins with an optimal control model that includes the demand for fishing days and the supply of sport fishing boats as a function of price and the size of the stock. Equations are introduced to account for sport fishing catch and release mortality, commercial fishing mortality and subsistence fishing mortality. The optimal control model is solved and then used to evaluate an innovative program of ITQs for sport fishing days (SFD-ITQs). The evaluation takes place with regard to the impacts on stocks and the potential to implement a sustainable development program of community-based sport fishing and ecotourism. Recommendations are made for the most efficient and just ways to distribute the SFD-ITQs.

#### **A perfect storm: The collapse of quality of life in remote areas of Amazonas**

James R. Kahn—Washington and Lee U. (WLU) and Federal University of Amazonas (UFAM); Fabiana Calacina da Cunha—UFAM; Ingrid Rafaela de Almeida Lopes-UFAM; Giulia Lopes—UFAM; Katelyn Degnan WLU; Brianna Rakouska-WLU

Since the post-World War II collapse of the rubber trade, remote areas in the middle Rio Negro areas in the state of Amazonas (Brazil) have experienced poverty in terms of cash income, but have not experienced hunger. Since the return of democracy in 1984, public services have improved, with elementary education available in almost all communities, and improved access to medical services such as antibiotics and a trained health agent to administer the antibiotics. In the last few years, quality of life has dramatically declined due to synergistic impacts from competition for commercial fishers, the collapse of markets for other extractive products, global climate change and the political and economic crises in Brazil. This paper details the impacts on these communities, which are not widely discussed in the current economic and political environment in Brazil. Suggestions are made for policies to improve the quality of life, such as zoning of fishery areas and the development of community-based ecotourism.

#### **A combined data envelopment and panel data analysis of the impact of mitigation technologies on environmental and economic productivity growth in OECD and BRICS countries**

Marc Baudry, EconomiX-CNRS, Paris Nanterre University; Fatih Karanfil, EconomiX-CNRS, Paris Nanterre University

This paper examines the evolution of technical progress with respect to CO<sub>2</sub> emissions and GDP of both OECD and BRICS countries. We first use directional distance functions in the framework of data envelopment analysis to obtain Malmquist productivity indexes. Within this framework it is assumed that capital, labor and energy are used to produce two outputs, one good (GDP) and one bad (CO<sub>2</sub>). While doing so, we disaggregate energy use into fossil and non-fossil fuel sources, and also account for the share of industrial value added in GDP for each country to control for structural differences between countries. In the second stage of the analysis, we investigate to what extent research and development activities have contributed to both environmental and economic productivity growth. For this purpose, we perform a panel data analysis, and use patent data from the European Patent Office's PATSTAT database to explain the evolution of technical progress estimated in the first stage. While using these

data, we disaggregate patents by type (low-carbon patents and other patents) based on the technological classes in section Y of the cooperative patent classification.

### **Dematerialization, Decoupling, and Productivity Change**

Eric Kemp-Benedict, Stockholm Environment Institute

The prospects for long-term sustainability depend on whether, and how much, we can absolutely decouple economic output from total energy and material throughput. While relative decoupling has occurred – that is, resource use has grown less quickly than the economy – absolute decoupling has not, raising the question whether it is possible. This paper proposes an explanation for why decoupling has not happened historically. Drawing on theories of biased productivity change, it proposes: 1) resources, but not goods or labor, are priced in competitive markets, and prices rise in the short run when demand increases relative to capacity; 2) innovation that saves on inputs to the production of goods and services is biased toward inputs with a higher cost share. These assumptions set up two halves of a supply-demand dynamic, which we explore from a post-Keynesian perspective. In this dynamic, resource costs as a share of GDP move towards a stable level, at which the growth rate of resource productivity is typically less than the growth rate of GDP. The presentation then discusses conditions under which absolute decoupling might occur.

### **Needs, Norms and Consumption: The Consumer in a Sustainable Economy**

Eric Kemp-Benedict, Stockholm Environment Institute

Consumers develop rules for their day-to-day consumption activities, which they modify gradually through experience. Their consumption helps them to satisfy a hierarchy of needs, from biological needs such as food and shelter, to physical and financial security, to “higher” needs such as esteem and play. Starting from this theoretical orientation, we identify a category of consumption goods, which we call “super-satisfiers”, that are particularly costly but with long-lasting benefits, including education, transport, and housing. Because of their cost and time demands, we argue that consumers try to meet multiple needs with each super-satisfier, so their consumption choices do not line up neatly with the hierarchy of their needs. Housing is among the most important super-satisfier, and we discuss how the housing choice drives and constrains other consumption choices. Drawing on the literature on the US housing market, we note that sustainability initiatives that limit the expansion of housing, such as zoning for ecosystem or cultural preservation, can potentially make housing costlier for low-income households, while other sustainability initiatives can reduce the cost.

### **Social norms, conservation, and the long-term effects of short-term financial incentives**

John Kerr, Michigan State University; Tsering Bum, Emory University; Maria Lapinski, Michigan State University; Rain Wuyu Liu, Michigan State University; Jinhua Zhao, Michigan State University

What happens to protection of ecosystem services once a payment for ecosystems (PES) service program ends? This is a critically important question because most PES programs are funded by donors and governments and are subject to changing budgets and programmatic priorities. We present a model that integrates perspectives from economics and communication sciences to address the question of how financial incentives and social norms can interact after financial incentives have ended in a PES program. We discuss the effects that financial incentives can have on social norms and the effects that norms can have on subsequent behavior after financial incentives have ended. This is important because the dominant literature on behavioral payment programs lacks a sophisticated understanding of social norms and fails to address what will happen to behavior once payments

end. That literature addresses the potential problem that payments can crowd out other sources of motivation for pro-social behavior, but it lacks the sophisticated understanding of social norms that has the potential to help explain and address this phenomenon. We present evidence on these issues from three social experiments and discuss the implications for PES programs.

### **Integrated Systems Dynamic Model of the Macroeconomy: People, Nature, and Money**

Carey W. King, University of Texas at Austin; Harshit Jayaswal, University of Texas at Austin; Prathaj Haputhanthri, University of Texas at Austin

As we attempt to transition to a low-carbon energy supply, largely again based again on renewable energy flows, it is paramount to have internally consistent macro-scale models that track flows and interdependencies among money, debt, employment and biophysical quantities (e.g., natural resources and population). The World3 model of The Limits to Growth accounted for finite resources and population, but neglected money and debt. Most neoclassical economic models neglect money, debt and natural resource constraints. This presentation presents a macro-scale modeling framework that is consistent with both biophysical and economic principles. This improved framework can contribute to more robust policy-making ability under changing circumstances characterized by high debt, low interest rates, aging infrastructure and populations, and a low-carbon transition. Specifically, the modeling approach integrates macro-scale system dynamics models of money, debt, and employment (specifically the Goodwin and Minsky models of Steve Keen (Keen, 1995) with system dynamics models of biophysical quantities (specifically population and natural resources such as in the Human and Nature Dynamics Model (“HANDY” of Motesharrei et al., 2014). In other words, these models exist separately, but they have not been combined to fundamentally link the biophysical world to monetary frameworks.

### **The spillover effect of natural protected areas on tourism revenues**

José A. Lara-Pulido, (Department of Business Studies - Universidad Iberoamericana) Guevara-Sanginés, Alejandro (Department of Economics - Universidad Iberoamericana)

In this paper we investigate the effect of proximity to natural protected areas on the number of persons visiting touristic destinations in Mexico. We find that being nearer than 30 kilometers from a natural protected area increases tourist occupation by 1%. In economic terms this effect is equivalent to 590 million USD annually. We estimate this effect by using OLS, specifying the natural log of occupied rooms as the dependent variable and a dummy that indicates if a destination is near to a natural protected area as an independent variable; also, we control other characteristics as independent variables. In terms of policy this finding is relevant, since expenditure on natural protected areas is commonly seen as non-profitable disbursement; yet, as we show, a portion of tourism revenues depend on the preservation of natural areas.

### **Water as a Fictitious Commodity: A Critique of Market-Based Environmental Policies**

Hannah Lawson, Sarah Lawrence College

Drawing on Polanyian-Ecological framework, this paper argues that the commodification of water has led to ineffective market-based policy. This paper will first discuss the major economic tools and theories that are used in environmental economics in an attempt to improve policy, and how they all assume that water is a normal commodity. Second, it will explore how the assumption and treatment of water as a commodity has led to market-based solutions. Understanding how water is priced in the market through the valuation of ecosystem services and contingent valuation is important for analyzing how the market system exploits the supply of water. Negative externalities on the environment are

rarely reflected in the value and price of water. Because of these issues, a variety of policies such as payments for ecological/ environmental services (PES) and a new market for water has been proposed. Analyzing these policies and their effectiveness, this paper argues that it is the intellectual framework that limits the imagination of different solutions, rather than the policies themselves that is the real problem. Finally, this paper will conclude by considering alternatives to market-based policies and the ongoing commodification of water.

### **CEA Lettuce Production: Methods, Environmental Sustainability and Economic Viability**

Michael T. Mageau, Assistant Professor of Environment and Sustainability; Director, Environment and Sustainability Program; Director, Center For Sustainable Community Development

Controlled Environmental Agriculture (CEA) has the potential to generate large quantities of locally produced, healthy organic produce. These methods also hold the promise of reducing the environmental impacts of agricultural production and distribution while generating significant sustainable local economic development potential. We examine the environmental impacts (land, water, energy, soil, chemical and nutrient requirements) and economic viability (operational costs versus revenues) of several common CEA production methods using nearly five years of data from a 10,000 ft<sup>2</sup> University of MN, Duluth CEA research facility in Silver Bay, MN and a relatively new 2,000 ft<sup>2</sup> CEA business venture in Duluth, MN. We also compare the environmental impacts of these CEA lettuce production methods with more conventional field-based CA lettuce production. We conclude that these CEA production methods have far less environmental impacts than more conventional field-based production approaches and that these CEA approaches have tremendous local economic development potential.

### **Amenity demand versus species conservation in Indian zoos**

David W. Martin and Cassidy A. Shell

We explore whether the amenity demand for zoos affects the diversity of the species in its collection. Given India's urbanization, the increased amenity demand could encourage Indian zoos to focus on attractive species. However, India's National Zoo Policy encourages zoos to prioritize local endangered species in their collection. A priori increasing amenity demand could encourage zoos to narrow or to diversify their collections. The between zoos collection diversity could increase as zoos match their localities or if visitors expect species from all ecosystems in their one zoo visit the between zoo collection diversity might narrow. The within zoo collection might be broad to educate visitors about local ecological balance or the demand for viewing attractive local species might narrow the within zoo collection diversity. We empirically explore the role of amenity demand on the between-zoo and within-zoo diversity of zoos' collections. We use the Central Zoo Authority of India's database for 2011 to calculate the alpha (within zoo) diversity and the beta (between zoo) diversity for the 30 listed zoos. For independent variables we use the cities' population and wealth (vehicles per household) from the 2011 census. We use SUR estimation because each zoo's alpha and beta diversities are related.

### **Towards Just and Pluralistic Ecosystem Service Valuation Methods: Challenges and Opportunities**

Georgia Mavrommati, Assistant Professor, University of Massachusetts Boston; Bonnie Keeler, University of Minnesota; Shannon Rogers, Assistant Professor, Plymouth State University; Richard B. Howarth, Professor, Dartmouth College



Even though the increased recognition of the multidimensional properties of ecosystem services and the development of advanced methods to incorporate ecosystem services into decision making in recent years, there remain challenges related to valuation. Conventional economic approaches have been criticized, amongst others, for their inability to capture the collective nature of ecosystem services, for their emphasis on monetary metrics, and the difficulty of addressing spatio-temporal considerations. Responding to these challenges, scientists have introduced alternative methods to assess ecosystem service values (e.g. multi-criteria assessment, discourse based methods). The main objectives of this session are to discuss in depth: (i) the challenges of the conventional valuation methods; (ii) the opportunities of the alternative valuation methods to assess ecosystems service values and; (iii) the remaining methodological and practical challenges that need to be further investigated. We will utilize our experience from four deliberative multicriteria evaluation workshops with eleven panels of residents of the upper Merrimack River watershed in New Hampshire to lead the discussion on this topic.

### **Induced innovation in the waste management sector**

Sahar Milani, St. Lawrence University

Each year, households and businesses generate approximately 1.3 billion tons of municipal solid waste (MSW) throughout the world. Despite the existence of recycling programs, most of the world's waste is still transferred to landfills. However, this waste can serve as a source of energy via incineration or landfill gas capture. In this paper, I study the determinants of three categories of waste management innovation: landfill, incineration, and recycling. I utilize patent applications from the OECD Regional Patent database from 1979-2010 to empirically investigate the impact of energy prices on waste management innovation across 41 countries. The results suggest that higher coal prices may encourage the development of landfill gas technologies as a substitutable energy source. On the other hand, I find that energy may serve as an important input for waste disposal as higher fuel prices have a positive impact on recycling and incineration patent applications. Both internal and external knowledge stocks prove to be important determinants of all three types of waste management technologies.

### **Financial Deregulation, Speculation, and Food Security: Case Studies from Brazil, Indonesia, and Thailand**

Sean Morris - M.S. Candidate - Department of Community Development and Applied Economics - University of Vermont; Joshua Farley - Professor - Department of Community Development and Applied Economics - University of Vermont

Climate change and natural resource constraints pose a significant threat to the world agricultural productivity. Concern about the effects of these issues on commodity agricultural products (wheat, soy, cocoa, rice, oats, corn) is especially merited in countries of the global south, where food expenditures represent a larger portion of expenditures and demand is less inelastic. While the issue of commodity food price volatility has traditionally been analyzed through equilibrium-based models, this presentation will discuss the role played by the increasingly consolidated international financial system in contributing to these market distortions. This presentation offers three case studies from 1990's-era exchange rate crises in Brazil, Indonesia, and Thailand to examine the relationship between international capital flows, currency speculation, and food insecurity. Primary sources include exchange rate data from the International Comparison Project (ICP) of the World Bank and data on international food security from the Food and Agricultural Organization of the United Nations. Implications for domestic and international agricultural and monetary policies are discussed.

### **Case Study: Volta, Senegal & IncoMaputo River Basin Organizations in Africa**

Ms. Lucia Motaung, Ministry of Environment, South Africa

Africa is a land of transboundary waters, with international river basins covering fully 62 percent of the continent's land mass. Africa is also a continent with a long history of transboundary water management and a voluminous body of transboundary water law, which at least partially regulates the use of many of its basins (Lautze and Giordano, in submission, 2005). The findings indicate that a range of factors have driven transboundary water law in Africa in the post-colonial period. Internally, these factors include joint management, water development, and water sharing and division. Externally, they have included a range of factors emanating largely outside the African continent including geopolitics, the concept of hydraulic mission, cultural ties, international environment agendas, and global concern with water conflicts. The results show an evolutionary change in the way these external factors have influenced African transboundary water law. More importantly, analysis of the way internal and external drivers interact suggests that both must be considered by basin states and the outside actors if either is to achieve their objectives (Lautze and Giordano & Borghese, 2005).

### **A new index for prioritization in landscape ecological restoration**

Tanh T. N. Nguyen, Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University 2. Daniel G. Scognamillo, Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University 3. Christopher E. Comer, Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University 4. Caitlin M. Glymph, Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University 5. Dave A. Holdermann, Texas Parks and Wildlife Department

Decisions for ecological restoration need both economic and ecological information. We developed an integrated landscape index (ILI) combining economic and ecological attributes in a geospatial framework. We demonstrated the application of ILI using the case study of black bear restoration (BBR) in East Texas where economic-ecological issues are considered for decision-making. This study used data mining to obtain and process census, parcel, and habitat suitability data (food availability, tree den availability, cover, distance to road, and human impact). We used R programming language to develop a model to create ILI with interactive ecological and economic indications. The outcome ILI incorporated habitat suitability, conservation cost references, and human impacts. The ILI spatially indicated suitable habitats for black bear colonization, current and future (short-term, long-term, and uncertain) human impacts, and potential restoration expenses. Integration of these components allows for more informed and realistic decision-making for black bear conservation. With a portable structure, the ILI allows the add-in of new components as well as modification of individual components so that the overall decision structure can evolve to meet changing decision-making priorities.

### **Addressing Farm Program Drivers of Tropical Forest Destruction and Fertilizer Pollution**

Clay Ogg

To better support crop prices and protect the environment, Europe and the U.S. worked for decades to create farm policies and agricultural trade policies that avoid encouraging land use and chemical use. Economic research played an important role in this trade reform/environmental cooperation. Since the biofuel boom, tropical countries that experience the most rapid forest and savanna loss now support agriculture, often on a scale with Europe and the U.S. Their Farm subsidies greatly increase deforestation and increase pollution from fertilizer. Preventing forest loss could increase farm income by several billion dollars in the U.S., alone. It is useful to identify where farm subsidies are the most damaging as well as potential remedies to the forest destruction and fertilizer pollution caused by farm

subsidies in tropical countries. Remedies may include changing payment schemes for farmers so that payments do not encourage farm input use. This "decoupling" of payments increases economic efficiency of the trade system as well as benefiting farmers and the environment. Conservation compliance programs, such as those used in Brazil and in the U.S., benefit the world's farmers and provide even larger environmental leverage. Potential gains from these trade reforms are large as farm program drivers of deforestation dwarf past incentive programs for saving forests.

#### **Management options for balancing coral reef ecosystem service supply and demand**

Kirsten L.L. Oleson (UH Manoa); Mary Donovan (UH Manoa); Joey Lecky (UH Manoa, NOAA); Alan Friedlander (UH Manoa, National Geographic); Susan Yee (US EPA)

To operationalize ecosystem goods and services and make the concept relevant for decision-making, the process that leads from ecosystem structure and functioning to human wellbeing needs to be unpacked. Delineating ecosystem service capacity, pressures affecting capacity, demand for services, and actual flow could improve evaluation of sustainability and help guide management. Coral reefs are a model system to demonstrate the use of this conceptual process framework. We map the theoretical ecological capacity of coral reefs across the Main Hawaiian Islands for producing goods and services (coral reef health, fisheries, cultural resources, and recreation), using advanced statistical models and ecological production functions from the literature. We qualitatively analyze the link to land-based pollution and to fishing. To understand the relationship between capacity and actual flow, we overlay maps of actual human use with predicted capacity. We find some areas with low potential capacity have high demand, and vice versa. To assess the expected negative relationship between pressures and capacity, and highlight anomalies where both pressure and capacity are high or both are low, we overlay maps of land-based source pollution with ecosystem service capacity. These results highlight certain areas that may be less sustainable than others, and suggest spatially-specific management

#### **Upstream solutions to coral reef conservation: The payoffs of smart and cooperative decision-making**

Kirsten L.L. Oleson (U Hawaii); Kim Falinski (U Hawaii); Joey Lecky (U Hawaii); Clara Rowe (Yale U); Carrie V. Kappel (NCEAS); Kimberly A. Selkoe (NCEAS); Crow White (Cal Poly)

Land-based source pollutants threaten coral reef ecosystems. To achieve the greatest conservation outcome at the lowest cost, managers could benefit from tools that evaluate the benefits (in terms of LBSP reduction) and costs of implementing alternative land management strategies. Here we use a spatially explicit predictive model that quantifies change in sediment reaching the coast for evaluating the costs and benefits of alternative threat-abatement scenarios. We examine trade-offs among possible agricultural road repair management actions across the landscape in West Maui, Hawaii, USA. We investigated changes in sediment delivery to coasts and costs incurred from management decision-making that is (1) cooperative or independent among landowners, and focused on (2) minimizing costs, reducing sediment, or both. The results illuminate which management scenarios most effectively minimize sediment while also minimizing the cost of mitigation efforts. We find targeting specific "hotspots" within all individual parcels is more cost-effective than targeting all road segments. The best outcomes are achieved when landowners cooperate and target cost-effective road repairs, however, a cooperative strategy can be counter-productive in some instances when cost-effectiveness is ignored. Simple models, such as the one developed here, have the potential to help managers make better choices

#### **Pricing Water under the Public Trust Doctrine: Designing a Process for Policy Makers in Hawaii**

Regina Ostergaard-Klem, Associate Professor of Environmental Science; Hawaii Pacific University

Under Article XI, Section 1 of the Hawaii Constitution, water is recognized as a public good under the Public Trust Doctrine. Furthermore, under the 1987 Water Code, the state must protect and conserve water resources for the benefit of its people. Although access to water is a constitutional right, Hawaii does not have a private market for water, and the allocation of water resources can be convoluted. This year marked the end of 150 years of Hawaii's sugar industry, prompting both a reevaluation of water leases and redesign of the allocation and pricing of state water. At the request of state policy makers, this study collates and evaluates relevant research on ecosystems services and economic valuation and provides recommendations for a structured, facilitated decision-making process. The study investigates the questions: "what price should the state of Hawaii charge state lessees for surface water under the Public Trust Doctrine and current water code?" and furthermore, "what process best reflects the responsibility of policy makers to the public trust?" The end goal is to offset the cost of watershed management, respect Native Hawaiian rights, and allow for the most efficient use of water for current lessees and future generations.

### **Community-Managed Forests and Household Welfare: Empirical Evidence from Nepal**

Jayash Paudel, PhD Candidate in the Department of Resource Economics at the University of Massachusetts Amherst

This paper evaluates the role of use of community-managed forests as a means of improving economic well-being of rural Nepalese households. It utilizes a nationwide survey consisting of detailed questionnaires related to household welfare and employs instrumental variable (IV) approach to investigate the linkage between community-managed forests and food consumption. Results show that households that use community-managed forests for firewood spend significantly more on food consumption than those dependent on government-managed forests. The study further finds that community-managed forest users appear to be more participatory and are more likely to find their food consumption adequate. Together, these results provide compelling evidence that community-managed forests can be an effective means of addressing food insecurity among rural households typically thought as possessing lower levels of social capital.

### **A Distributional Analysis of a Carbon Tax in the United States**

Mark Paul, Cook Center for Social Equity, Duke University; Anders Fremstad, Department of Economics, Colorado State University

Although the vast majority of economists support a carbon tax as an efficient mechanism to reduce greenhouse gas emissions, the policy does not enjoy widespread public support. One reason for this is that economists have failed to adequately address the policy's effect on household budgets. This paper models the distributional impacts of a price on carbon on households in the United States. We combine carbon emissions data from the Energy Information Agency and the Input-Output tables from the Bureau of Economic Analysis to calculate the carbon intensity of each industry and commodity. We then analyze data from the Consumer Expenditure Survey to calculate how households would be affected by placing a price on carbon. In addition, we explore the distribution impacts of a carbon tax by race/ethnicity, age, and region. While the cost of placing a price on carbon falls disproportionately on low-income households, we show that the policy can be made progressive by rebating all or part of the revenue to households as lump-sum transfer. We also model other revenue recycling schemes such as cuts in labor or capital taxes and discuss the implicit trade off between equity and efficiency.

### **A Sketch of Statistical Economics on Energetics**

Ram C. Poudel (1, 2) and Jon G. McGowan (1) (1Department of Mechanical and Industrial Engineering, University of Massachusetts, Amherst, USA; 2Department of Mechanical Engineering, Central Campus Pulchowk, Institute of Engineering, Tribhuvan University, Nepal)

In the tradition of Frederick Soddy, scholars are making efforts to extend energetics concept into economic theory. We undertake to do that in a quantitative way utilizing the Social Field Theory. We equate capabilities of an individual with social potential energy. An economy facilitates the transformation of capabilities into capital to characterize economic development. Physicists Lee Smolin suggested Statistical Economics can provide a pathway between microscopic and macroscopic properties of an economy. We start with the Hamiltonian of an individual and develop a physics-like “micro-equation of an individual”. A first-order statistical model of economy aggregates the micro-equations in the style of non-equilibrium thermodynamics, taking multi-body dynamics into account. The resulting stochastic model for an ensemble of economic agents bases on Hamiltonian of a society, a function of social energy, which can be viewed as a proxy of total wealth in an economy. We will demonstrate a basic statistical model of the economy with pedagogical examples taken from the Survey of Consumer Finances. This model aims to provide insight into the origins and dynamics of wealth in society taking social energetics into account.

#### **Ecosystem Services and Ecological Drought in the Upper Missouri Headwaters, MT**

Nejem Raheem, Emerson College Department of Marketing Communication; Steve Colt, Alaska Pacific Univ

Ecological drought is a drought which changes the quantity of ecologically available water to the extent that it drives changes in ecosystem structure and function. As climate models predict greater frequency of severe, multidecadal drought, land managers need to adopt an ecosystem services approach to drought planning. A SNAPP working group comprised of researchers from universities, federal agencies, and NGOs is working to provide a template for land managers in the upper Missouri Headwaters in Southwestern Montana to catalog salient ecosystem services that might be affected by ecological drought, and adapt their planning accordingly.

#### **Trends in international trade and development finance and their environmental implications**

Rohini Kamal, University of Massachusetts-Amherst and Boston University; Alfredo Rosete, Mount Holyoke College; Rebecca Ray, University of Massachusetts-Amherst and Boston University; Brandon Taylor, University of Massachusetts-Amherst and Boston University

The last decade has brought major shifts in international trade and development finance. China has skyrocketed as a major market and source of finance for developing countries. Development banks have adopted, and reformed, their environmental and social safeguards. Nations have begun to use local content rules to spur green energy development, only to be challenged at the WTO. This panel will explore these trends and their significant impacts on the prospects for sustainable development around the world. **Moderator:** Rebecca Ray, University of Massachusetts – Amherst and Boston University **Panelists:** (1) Rohini Kamal, UMass Amherst and Boston University: Chinese development finance and its impact recipient countries’ green energy prospects; Discussant: Alfredo Rosete (2) Alfredo Rosete, Mt. Holyoke College: Can environmental and social safeguards help development banks mitigate risk?; Discussant: Rohini Kamal (3) Rebecca Ray, UMass Amherst and Boston University: Chinese demand for commodities and its environmental impact in Latin America; Discussant: Brandon Taylor (4) Brandon Taylor, UMass Amherst and Boston University: Climate, Jobs, and Health Benefits of Local Content Contingent Renewable Energy Programs; Discussant: Rebecca Ray

## **Characterizing Ecosystem Services of Coastal Dunes to Support Environmental Management Partnerships**

Robert B. Richardson, Department of Community Sustainability, Michigan State University

Coastal sand dunes are of critical ecological importance, but little is known about the socioeconomic values of these dynamic ecosystems. The shorelines of the Great Lakes in Michigan are characterized by more than 275,000 acres of sand dune formations, which represent the largest area of freshwater coastal dunes in the world. These ecosystems contain a diversity of wildlife, vegetation, habitats, zones, topographical relief, and climatic conditions—environmental features that are unique to Michigan. Approximately 40 percent of the State’s coastal dunes are in public land management by federal, state, and local units of government. Coastal area management often involves confronting tradeoffs between conservation and development. Construction of roads and homes contributes to wind erosion, fragmentation of habitats, and biodiversity loss. These fragile ecosystems are threatened further by invasive species, and erosion from recreation uses. The objectives of this project are to characterize the social and economic values of coastal dunes in Michigan using mobile technology, and to catalyze a network of stakeholders to advocate for conservation of coastal dunes and to promote awareness of their ecological importance. The project involves an innovative partnership between researchers and conservation practitioners to advance understanding and sustainability of coastal dunes.

## **An economic and ecological approach for ecosystem services production and income generation in the Amazon**

Alexandre A. F. Rivas, Federal University of Amazonas

With 81.4% of its area still preserved, the Amazon biome has seen in the past few years an increasing pressure for deforestation. Command and control policies have been the main approach to tackle the problem but their results are proving to be ineffective. The heart of the problem remains untouched: the incentive to deforest. In the Brazilian Amazon, there are about seventy-six million hectares of deforested/altered land. Implementation of policies and/or practical attitudes grounded on economic incentives may contribute to significantly address the problem. Thus, the objective of this paper is to present an alternative approach to stimulate ecosystem services and forest recovery based on the idea that degraded areas can both be recovered and generate income to families taking care of these new forests.

## **A new ecological economics model for Amazonas**

Thomaz A. Q. Nogueira, Amazonas State Government, Brazil; Ronney C. C. Peixoto, Amazonas State Government, Brazil; Alexandre A. F. Rivas, Federal University of Amazonas and Washington and Lee University

Amazonas is comprised of 1.5 million km<sup>2</sup> (2 ½ times the size of Texas) and still has 98% of its original forest cover, has greatly increased the state’s GDP through economic incentives for clean manufacturing in the state capital of Manaus. Although the economic transformation of Manaus has been remarkable, the same progress has not been seen in smaller cities and rural areas, as the economic activity in the Industrial pole of Manaus has not filtered outward to other locations. The State of Amazonas has developed a new plan for sustainable economic development that will improve the quality of life in more remote areas, while continuing the growth of clean manufacturing in Manaus. The plan is based on three pillars, sustainable economic growth, social justice and environmental protection. This paper outlines the conceptual plan for sustainable economic development in Amazonas, discusses the most

promising activities that have been identified, and looks at some of the preliminary implementation plans to take the state on the desired trajectory of green and just sustainable development.

### **Improving Our Pedagogy, Expanding Our Reach: Infusing Ecological Economics Across Disciplines and Grade Levels**

Susan Santone, Executive Director, Creative Change Educational Solutions, Adjunct Instructor, Eastern Michigan University College of Education

The future depends on a shift to ecological economics (EE), but this won't happen unless schools prepare citizens who understand it and advocate for change. The right curriculum can make all the difference, but EE is marginalized in the economics field and invisible in other disciplines. This problem permeates both K-12 and higher education. But it doesn't have to be this way. Educators would love EE if they only discovered it because the field provides everything they want: interdisciplinary content, meaningful inquiry, and community applications. With exposure and resources, educators could easily reframe conventional economics course and/or integrate EE concepts into science and social science courses. EE is an opportunity waiting to happen. This session will introduce teaching strategies and lessons to integrate ecological economics into science and social sciences courses from kindergarten through college. Participants will take part in hands-on activities on life cycle analysis, entropy, indicators, and ecosystem services. The activities demonstrate age-appropriate ways to challenge neoliberal/'conventional' economic assumptions and how to scaffold this learning across grades. The session is a call to action. Together, we will define why we need to expose and reframe problematic curriculum. We will then identify interest in/opportunities for collaborating.

### **Combining Economics and Ecology for Migratory Species Conservation**

Darius Semmens, USGS Geosciences & Environmental Change Science Center, Denver, CO; Ken Bagstad, USGS Geosciences & Environmental Change Science Center, Denver, CO; John Loomis, Colorado State University, Dept of Agricultural and Resource Economics, Fort Collins, CO; Josh Goldstein, The Nature Conservancy, Office of the Chief Scientist, Fort Collins, CO; Jay Diffendorfer, USGS Geosciences & Environmental Change Science Center, Denver, CO; Ruscena Wiederholt, The Everglades Foundation, Palmetto Bay, FL; Laura López-Hoffman, University of Arizona, School of Natural Resources and Environment, Tucson, AZ

Migratory species deliver goods and services to people throughout their annual cycles of movement. Source areas for these services are the habitats upon which migratory species depend for survival and reproduction. The concept of spatial subsidies provides a means of quantitatively linking source and delivery areas through the integration of ecological and economic information. We present three case studies through which we have quantified the net flow of ecosystem services provided by migratory species between source and delivery areas in North America. The three species were selected to provide a range of different services with both market and non-market values. They include Mexican free-tailed bats (*Tadarida brasiliensis mexicana*; regulating and cultural services), monarch butterflies (*Danaus plexippus*; cultural services), and northern pintail ducks (*Anas acuta*; provisioning and cultural services). We discuss lessons learned from these case studies, as well as how spatial subsidy information can inform the establishment of equitable harvest agreements and payments for ecosystem services (PES) programs for trans-border management and conservation of migratory species.

### **Economic Valuation of Marine Ecosystem Services: The Eastern Mediterranean case**

Dr. Shiri Zemah Shamir, School of sustainability, IDC Herzliya and NRERC, University of Haifa; Prof. Mordechai Shechter, NRERC, University of Haifa; Mr. Yoav Peled, NRERC, University of Haifa

While many current and potential uses of the Eastern Mediterranean have clearly defined economic value and apparent benefits to various stakeholders (e.g. energy and raw materials extraction), the marine ecosystem's benefits are severely underexplored and are not manifested in economic terms. Coupled with increasingly changing environmental conditions (e.g. climate change, biological invasion), the need for performing both monetary valuations cum spatial analyses of the benefits derived from this ecosystem, is clearly evident. The initial phase of the study performed an evaluation of marine and coastal ecosystem services in order to quantify and map their contributions to society. By employing various economic valuation methods, the benefits of the assessed ecosystem services were monetized. In addition, the study performed spatial analyses of marine ecosystem services in order to map the spatial distribution of benefits, identify critical areas of ecosystem services' supply, and provide predicative supply trends given expected marine resource management scenarios. Our main tool for applying the spatial analysis was the ARTificial Intelligence for Ecosystem Services (ARIES) model. The analyses carried out during the initial phase provided foundational estimation of the wider array of ecosystem services of the East (especially Israeli) Mediterranean area, including deep-water ES.

### **Practicing Food Justice: A Comparative Evaluation of Recent Developments in Chicago & Philadelphia**

John A. Sorrentino Department of Economics, Temple University and Peter Kamps Chicago Department of Family & Support Services

Food justice is defined as “Access to culturally acceptable, nutritionally adequate food through local, non-emergency sources for all people at all times.” (Cadieux & Slocum, 2015) Besides the federal programs to alleviate food insecurity, there are several public and private institutions in Chicago and Philadelphia that are committed to promoting food justice. The work for this presentation will involve investigating and reporting the demographic characteristics of the relevant populations and estimating the effectiveness of the actual Chicago and Philadelphia food-related programs in terms of biophysical and socioeconomic indicators. Among the former are the spatial locations of healthy food sites, measures of accessibility to these sites, measures of reduced food-insecurity, and health effects of changes in the diets of the affected populations. Among the latter are measures of whether the food-related activities increase community engagement, increase local human capital, and multiplier effects of keeping food production local within the parameters of the respective growing seasons. An overall valuation incorporating both sets of indicators will be attempted for each city. A comparison will judge the relative merits of the programs in the two cities. This information can inform policy, as food programs compete with other programs for limited public and private funds.

### **Sustainable intensification of agriculture: the location of land contraction and expansion matters**

Nathaniel P. Springer, University of Minnesota

Increasing agricultural crop yields through improved technologies and management has – and continues to be – a central strategy for increasing global food production while simultaneously sparing land use. Critics have argued that such intensification may instead stimulate the expansion of agriculture, for if farmers can produce crops more productively, they have a greater incentive to expand operations onto nearby lands. Recent work has shown that these two drivers are not mutually exclusive: productivity growth can stimulate local land expansion while at the same time sparing land use globally. Yet this dynamic may be particularly troubling if land contraction happens in degraded or marginal agricultural areas while expansions happen on highly productive forestlands. This study presents a global input-output approach – the World Trade Model with Rectangular Choice-of-Technology – that captures both the global technological and economic forces and the local spatially explicit impacts. Scenario results confirm this troubling outcome: reducing the agricultural yield gap in



Latin America and Africa spares agricultural land use globally, but also increases deforestation due to land expansion in these relatively productive areas. Investment in agricultural technology should be coupled with strong land protection polices and funding to prevent such outcomes.

### **The institution of science in natural resource management**

Adrienne Strubb, University of Minnesota; Forrest Fleischman, PhD, University of Minnesota; David Briske, PhD, Texas A&M University

The cascading effects of climate change challenge decision-makers to keep apprised of the latest research in sustainable natural resource management. This is not entirely a question of sufficient science, but rather of governance and access. In seeking information, decision-makers use readily available, accessible tools. Information seeking behavior is influenced by many factors, including everyday life patterns, educational levels, media selection, agency, and community. Our paper illuminates the network of knowledge that public agencies are tasked with in disseminating sustainable natural resource management information to landowners. To gauge the institutional and individual indicators driving the transfer of science, we surveyed three natural resource agencies, with over 200 participants in Texas, during summer 2016. We reveal a network incorporating influential individuals, organizations, and online resources. Preliminary results show that decision-makers are limited by science availability and agency directives. Although, we encourage the use of transdisciplinary research approaches in science creation, we need to be cognizant that science is again funneled in application. We argue that it is important to understand the information seeking network of decision-makers and their institutional boundaries because the embedment of information silos that reinforce one science over another.

### **Refrigeration alternatives, climate change, energy, & Jevons' Paradox**

Josiah Taylor, University of Vermont, Faculty of Food Systems

Alternative ecological refrigeration systems offer viable means to significantly reduce energy demands and greenhouse gases. Where refrigeration exists, energy intensive cooling technologies produce significant GHGs. In regions where refrigeration is not widespread there is development of more complex food systems – energy demands and climate change consequences of refrigeration systems globally are rapidly growing. Ecological stability is at serious risk as humans transgress multiple planetary boundaries, and immediate tools are needed to reduce these threats. Refrigeration systems can be a significant leverage point for climate change mitigation. Historically there have been diverse efficient and ecological means of food refrigeration. Conventional refrigeration displaced many of these ecological practices. Rising cold storage alternatives like hybrid ecological-electric systems using outside air intakes incorporating cold winter air are promising developments. These and other systems represent additional wedges toward reducing GHGs and mitigating climate change. This paper explores contemporary uses and benefits of refrigeration alternatives, challenges, and future possibilities. Jevons' Paradox also provides an important perspective, because while efficiency increases, so too is overall energy consumption and corresponding GHGs. This also discusses potential strategies related to implementing ecological refrigeration alternatives integrated with changes in consumer habits to drive efficiency and net declines in energy usage.

### **The role of economic literacy in fostering sustainability**

Madhavi Venkatesan, Bridgewater State University

Does demand drive supply or does supply drive demand? Or is it a mixture of both? Do consumption decisions implicitly include our values or are decisions made with the assumption that what we are consuming has already factored in the long-term best interest of human health and environmental well being? These basic questions are often unaddressed in the introductory economics. Instead assumptions related to consumption and production and demand and supply are embedded as representative of consumer and producer behavioral norms, typically with minimal discussion. Could implicit assumptions prompt observable behavior rather than be indicative of it? If so, could increasing awareness of the role of embedded values in demand and supply influence behaviors of consumers and producers and thereby promote sustainable outcomes? These questions provided the foundation for a survey of undergraduate students. The intent of the evaluation was to specifically assess the understanding and prevalence conscious consumption. The results revealed that there was a limited understanding of economics, that students consumed on reflex, and that conscious consumption was difficult to attain because of the assumption that price equaled cost of consumption. The outcome of the survey results promotes the perspective that economic literacy can be a catalyst to achieving sustainability.

### **Explicit economics: Addressing conscious consumption for sustainability**

Madhavi Venkatesan, Bridgewater State University

Sustainability is typically discussed in a siloed fashion in the United States. Cradle-to-cradle production and regulation are proffered as salves for evidenced degradation but little attention is directed to how a society can enable sustainability as a cultural norm. Further and related, the role of the individual economic agent as consumer, investor, and government participant is seemingly not addressed. To a large extent, the population majority delegates the powers conferred in the three roles to a minority leaving outcomes impacting society as a whole dependent on the incentives of a few, who may or may not be aligned with the public welfare. Therefore, given the evidence of marketed demand fostered by a consumerism based economy, perhaps the most significant, powerful, and traction-inducing vehicle for instituting sustainability may be found in enabling conscious consumption at the individual level. Arguably, the conduit for conscious consumption would then be education not limited to defining sustainability but inclusive of the rationale for sustainability, the patience requisite for implementation, and the acceptance of sustainability as a societal norm of behavior. Conscious consumption in turn would then be the foundation for cultural traction of sustainable growth and development.

### **The impact of water quality policy on farmer autonomy in agricultural watersheds**

Courtney Hammond Wagner, University of Vermont

Diffuse runoff of nitrogen and phosphorous in agricultural lands is a growing challenge to water quality across the globe. Governance bodies in nutrient impaired watersheds are increasingly tasked with managing agricultural land use for water quality. The design of water quality policies determines whether the policy is successful at motivating farm management change. In particular, the ability for farmers to maintain autonomy in the future of their farm system is of importance for the policy reception. I examine the impact of choice rules, or what farmers must, must not or may do under a policy regime, on farmer autonomy and behavior amongst farmers in New Zealand and Vermont, USA policy regimes. These regimes represent two variations of water quality policy choice rules: practice-based rules, which require farmers to adopt specific practices, and performance-based rules, which require farmers to choose a set of practices to meet a measured performance standard. Using social psychological theory and structural equation modeling, I find the variation in choice rules influence farmer's perceived control in nutrient management and their intention to adopt nutrient management

behaviors. This research contributes an improved understanding of how water quality policy gives landowners flexibility of choice in running their farm system.

### **Genuine Progress Indicator 2.0: Pilot Accounts for the U.S., Maryland, and City of Baltimore 2012-2014**

John Talberth, Center for Sustainable Economy and Michael Weisdorf, CSE, PSU

For over thirty years sustainable development practitioners have used the Genuine Progress Indicator (GPI) as a way to evaluate economic performance, quantify the benefits and costs of growth, and predict the effects of policy changes on economic wellbeing. The popularity and use of the metric is increasing partially in response to new global demands for metrics that go beyond Gross Domestic Product (GDP) by taking social, economic, and environmental costs associated with economic activity into account and by incorporating the nonmarket dimensions of wellbeing. However, because the basic GPI accounting protocols have yet to be consistently updated to respond to critiques, theoretical advances, new valuation methods, and new data sources a proliferation of studies at the global, national and sub-national level contain widely divergent methodologies. For example, some GPI studies add imputed values for leisure time while others deduct the costs of lost leisure time and still other fail to consider leisure time at all. Because of increasing methodological divergence, GPI practitioners have called for a new, consistent framework to guide future GPI studies – GPI 2.0. Since 2013 an international group of GPI practitioners participated in an online forum, workshops and demonstration projects aimed at refining the GPI 2.0 framework. This paper is an attempt to operationalize this emerging framework in the context of GPI accounts for the U.S., the State of Maryland, and the City of Baltimore. The goal is to demonstrate the feasibility of consistent, multi-scale GPI accounts rooted in social welfare theory that make use of new data sets and methodologies that improve the accuracy and rigor of many of the GPI's standard components.

### **Building Community Among Resorts in Protecting Ecosystem Services from the Threat of Aquatic Invasive Species**

Patrick G. Welle, Emeritus Professor of Economics and Environmental Studies, Bemidji State University, Bemidji, MN

The spread of aquatic invasive species (AIS) threatens ecosystem services provided by freshwater lakes, particularly in northern Minnesota, where water-based recreation and tourism comprise a major component of the regional economy. Governmental and non-governmental entities have partnered in programs to educate boaters and inspect watercraft at public accesses to prevent the transport of AIS, while recognizing that boat launching at private accesses is another potential pathway for AIS introduction. The main purpose of this study is to identify and enhance the ecological economic motives among resort owners to collaborate in AIS prevention efforts. In addition to assessing resort owners' perceptions of the threat to ecosystem services from AIS, the study elicited participants' ideas on the best ways to insure that guests employ adequate preventive measures with boats and other equipment. All 56 resorts operating on the eleven lakes in the study area participated in the study. Respondents place the greatest importance on preventing potential damages from zebra mussels and Eurasian milfoil. Over a third disagree that customers know what precautions to take, particularly concerning non-residents. Dissemination of the findings and community meetings identified mutual interests and provided opportunities for partnerships, e.g. cost-sharing on decontamination equipment.

### **Women Parliamentarians and Deforestation Around The World**

Nurmukhammad Yusupov, Solbridge Int'l School of Business; Oybek Yuldashev, Central Asia Research Group; Raufhon Salahodjaev, Central Asia Research Group

Deforestation has now taken the center stage in the climate change debate which has become a heavily politicized process, especially after the recent meeting in Paris. However, unfortunately, climate change debate often finds itself in the midst of political confrontations, in which the outcome is largely dependent on the personal characteristics of the political decision makers and their preferences. We are motivated by the literature which documents positive impact of the high level involvement of women in the political process. Specifically, we argue that involvement of women in that process can be instrumental in reducing deforestation, arguably one of the best ways to curb anthropogenic global warming. We find significant and robust evidence for this hypothesis in a cross-section of 163 countries covering 1990–2010. Our results are robust to various specifications and estimation methods. Our results have important policy implications and call for wider involvement of women in the climate change debates and policy making. Especially because women are globally underrepresented in parliaments around the world with less than 20 percent of seats occupied by female politicians.

# POSTERS

## **Using Difference-in-Difference methodology to isolate direct and spillover effects of Ghana's Modified Taungya Policy on program participants and non-participants in project communities.**

Doe Adovor (PhD, Michigan State University Department of Forestry); John Kerr (Professor and Associate Chair Michigan State University Department of Community Sustainability); Runsheng Yin (Professor Michigan State University Department of Forestry); Ernest Foli (Principal Research Scientist, Forestry Research Institute of Ghana)

In 2009 we surveyed 878 households to track changes in five livelihood assets (financial, human, natural, social and physical capital) among participants and non-participants of Ghana's Modified Taungya System (MTS). The study compared changes in assets when the reforestation program was first launched (1999) to assets in 2009. Data for the analysis was drawn from surveys conducted in 19 communities fringing Yaya, Nsemre and Sawsaw forest reserves in the Brong Ahafo Region. With an interest in attributing change in livelihood outcomes, the omitted variable problem was anticipated. Hence we used a Difference-in-Difference (DID) method to compute how much of the observed changes in each livelihood asset may be attributed to the MTS policy. The DID estimates suggests that on average 5.25% of the observed changes in livelihood assets among MTS participants may be attributed directly to the MTS policy while 4.28% among non-MTS participants in project communities may be attributed to spillover effects from the project. The DID also suggests that the MTS policy slowed down the rate of decline in Natural Capital Index by 5.7% and by 4% respectively among MTS project participants and Non-participants in project communities.

## **Comparison of Gmelina arborea's Carbon Stock at Different Group Ages in Cibugel Village's Community Timber Plantation, Sumedang Regency, Bandung**

I Dewa Agung Panji Dwipayana (School of Life Science and Technology, Bandung Institute of Technology, Indonesia). Muhammad Aslam Fadritama (School of Life Science and Technology, Bandung Institute of Technology, Indonesia). Fitriana Puspitasari (School of Life Science and Technology, Bandung Institute of Technology, Indonesia). Enden Dea Nataya (School of Life Science and Technology, Bandung Institute of Technology, Indonesia). Rizky Nur Endah Sari (School of Life Science and Technology, Bandung Institute of Technology, Indonesia). Muti'ah Nurul Jihadah (School of Life Science and Technology, Bandung Institute of Technology, Indonesia). Wahyudi Nelvianto (School of Life Science and Technology, Bandung Institute of Technology, Indonesia).

In 2014, Indonesia ranked as the thirteenth country with the highest levels of carbon dioxide emissions in the world. To involve the people, Indonesian government choose to build Community Timber Plantations. One is located in Cibugel village of Sumedang regency, West Java. Gmelina arborea was selected by the people as the major crops there because of its economical value without considering about how this species contribute in carbon sequestration determined by its age-related carbon stock. This study conducted to determine Gmelina arborea's carbon stock distribution in those plantation areas with different group ages which are 2, 4, and 15 years old. The biomass measurement method used for Gmelina arborea plantation was non-destructive, destructive for understory and Walkley & Black Method for soil carbon content. The result shown the highest total carbon stock was found in the area with 15 years old Gmelina arborea plantation. The highest contributor was the plantation itself followed by soil carbon content and understory. The total carbon stock of area with Gmelina arborea

plantation age 2, 4, and 15 years were 19,96 ton/ha, 34,33 ton/ha, and 122, 22 ton/ha respectively. The result is a proof that Community Timber Plantation is having both economical and ecological value.

### **Measuring Sustainability Literacy**

Mary Ellen Mallia, Ph.D., University at Albany; Elizabet Genis, University at Albany

An international tool called the Sustainability Literacy Test was developed in 2014 with the goal of providing an instrument for academics to assess student knowledge and skills on current social, economic and environmental challenges. This assessment was administered to sustainability-themed freshman seminars and Environmental Economics courses at the University at Albany over a two year period. The intention was to determine if sustainability literacy improved as a result of the course and if there were differences in growth between the economic and freshman seminar courses. It was assumed that the Sustainability Literacy test served as a valid measurement of sustainability literacy and provided a means to compare results across campuses. The poster will highlight the implementation of the test and results garnered from the courses. On average, the Environmental Economics scores improved at a greater rate than those of the Freshman Seminar course, in line with our hypothesis.

### **Development and testing a diagnostic capacity tool for improving socio-ecological system governance**

Patricia McKay, MSU

The capacity to sustainably govern complex socio-ecological systems (SES) has been identified as a necessary but daunting task by SES scholars, resource stewards and stakeholders. This research sought to inform the question: What are determinant capacities and functional linkages that can be incorporated into diagnostic tools for analysts seeking to improve sustainable socio-economic system SES governance? Literature was used to identify and translate determinant capacities and functional linkages into a quantifiable metric of governance quality. The tool was developed from ecological, business, governance and decision science literature. This tool recognizes the dynamic and systemic linkages between the resources and the social systems that use and govern them for improving systems thinking and SES outcomes. The tool was tested to determine its ability to capture perceived characteristics of governance quality and problem management using Michigan's cleanup and redevelopment program. The results of this research indicated that the exploratory tool was reliable and valid. This research contributes to the evolving body of SES frameworks, specifically the study of individual and organizational capacities for improved SES outcomes. The implications of this research suggest participatory network-based governance with higher levels of resource exchange, in the form of interdependency, trust, diplomacy and reciprocity, align with practitioners' perceptions of improved program performance. Further, while some capacities and related findings of this research may be context specific, concepts associated with the development and testing of this diagnostic tool, such as the use of systems thinking, participatory network-based governance, and related competencies may have more universal application.

### **The Effect of Political Instability on the Level of Damage Incurred from Natural Disasters in South Asia**

Kathryn Pettit, Environmental Studies Program, Washington and Lee University

Natural disasters are usually defined as natural events (cyclones, earthquakes, floods) that cause extreme damage, resulting in serious economic loss and casualties. However, the severity of a natural disaster often depends in part on human-related factors. Much research has been done on the extent that extreme weather events invoke instability and conflict. My research seeks to identify if this

relationship also operates in the other direction. First, this paper explores the role that political instability (measured by corruption, regime strength, and conflict level) plays in intensifying or mitigating the damages from a natural disaster. I utilize time-series and cross-country analyses amongst South Asian countries to measure how much variation in damages incurred (due to a natural disaster) is attributable to government-related factors. Second, I investigate potential mechanisms that this relationship works through, such as investment into disaster preparedness and regulation enforcement. A further understanding of the role that government stability plays in vulnerability to extreme weather events is essential in the face of climate change.

### **Modeling the Impact of Sustainable Intensification on Landscapes and Livelihoods**

Robert B. Richardson, Michigan State University; Laura Schmitt Olabisi, Michigan State University; Kurt B. Waldman, Michigan State University; Naomi Sakana, Center for International Forestry Research; Philip Grabowski, Michigan State University

Agriculture faces tremendous pressure to supply a growing and wealthier population with more food, fiber and fuel, while recognizing the limits of agricultural ecosystems. Globally, it remains unclear whether it is possible to increase agricultural output without increasing deforestation and associated greenhouse gas emissions. The objective of this study was to advance the understanding of landscape-level implications of sustainable intensification of agriculture on forest conservation in Zambia. Participatory system dynamics modeling was used to examine evidence for linkages between sustainable intensification and landscape-scale drivers of deforestation in Zambia. We found limited evidence of linkages between sustainable intensification practices and agricultural encroachment into forested ecosystems. The clearing of forested land for agriculture was found to be largely driven by population growth, urbanization, and the rising demand for wood fuels for cooking and heating. The findings have implications for the development of integrated approaches to address the challenges of food and energy insecurity, as well as for policies aimed at climate change mitigation and reducing greenhouse gas emissions. The study demonstrates that participatory system dynamics modeling can be a useful tool for identifying the primary drivers of change in complex agro-ecological systems.

### **Cognitive Dissonance with Economic Activity**

Jeffrey Weih, Portland State University

If all economic production involves joint production (as ecologic pollution) (after Baumgärtner, et.al., 2008), and if all economic consumption involves joint consumption (as ecologic depletion), then all economic function involves joint ecologic dysfunction. A nation's economic activity is instantaneously mediated by its common virtual currency subunits, each sharing that nation's evolving pattern of earning and spending and each exchangeable with any other nation's currency. How (and how much) I earn and spend represents my contribution to (and participation in) the evolving national pattern of depletion and pollution. Primarily because all economic/ecologic sectors are interdependent, the amount of my earning and spending indicates the degree of my responsibility for ecological depletion and pollution in general. The way I earn and spend is more determinative of the effect I have in the present; the amount I earn and spend is more determinative of the effect I project into the future. The more I earn and spend, the more I experience a cognitive dissonance, which is only partially relieved by earning and spending in less directly damaging ways. As I perform an economic action, I contradict (imply a denial of) an ecologic value.

## **Foundations of value production in ecological economics**

Michael Weisdorf, Portland State University

Ecological economics is situated in the context of human ecological behavior as such. Production concepts from ecology can and should be translated to applications in ecological economics at multiple levels. Economic concepts like 'agricultural production' can be disambiguated based on trophic level; the macro-ecological economics of pastoral activity differs substantially from that of intensive horticulture, even if the processing and distribution of their respective products is superficially or economically similar on a micro-level. In addition to conventional ecological trophic structure, a novel, ecological-economic 'socio-trophic structure' can be described along similar lines by tracing economic value from its primary commodification in the labor process through several socio-trophic layers of consumption, including wage consumption by laborers, business profits consumed by their employers, and various sorts of economic rent consumed by an increasingly hypertrophic financial structure of dubious complexity. This perspective allows for the grounding of socioeconomic analysis in the natural science of ecological production, on the basis of measureable physical quantities. Adequate descriptions of ecological economic value require consideration of the underlying material phenomena as well as the price-system and other social relations from which any pecuniary calculations might be derived. Establishing the nature of the relation between the price-system and human ecological behavior as such is fundamental for a sufficient theory of ecological-economic value.



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