RCN Conference on Pan American Biofuels & Bioenergy Sustainability

Golden Tulip Recife Palace, Recife, Brazil
July 22-25, 2014

Technical Program
Wednesday, July 23, 2014: 8:30 AM-11:30 AM

Wednesday, July 23, 2014: 08:30 AM - 11:30 AM, Boa Viagem Room
Socioeconomic Sustainability Dimensions of Biofuels in the Americas
Chair: Samuel Sweitz, Michigan Technological University

Session Overview
Although many Pan American governments continue to incentivize the growth of the biofuels industry, one of the key challenges for biofuels sustainability has been concern about its social impacts and implications. This session focuses on the Pan American region and invites research abstracts on the social implications of future biofuel and bioenergy expansion. Examples of relevant topics include food security, land and resources rights, and related topics. Case study presentations are also welcomed

Wednesday, July 23, 2014: Socioeconomic Sustainability Dimensions of Biofuels in the Americas 08:30 AM - 11:30 AM (Boa Viagem Room)	
Chair:	Sam Sweitz, Michigan Technological University, Michigan, USA
8:30 AM	Interrogating Social Sustainability in the Biofuels Sector in Latin America: Global Standards and Local Experiences in Mexico, Brazil and Colombia . **T. Selfa**, C. Bain, R. Moreno, A. Eastmond, S. Sweitz, C. Bailey, T. Martins, G. S. Pereira, and R. Medeiros
8:50 AM	Global and Local Perspectives on the Jatropha Plantations for Biodiesel in Sucopo, Yucatan, Mexico . **A. Eastmond** and S. Sweitz
9:10 AM	Agro-Fuels and Income of Rural Households in Yucatan, Mexico . **J. Becerril**, A. Eastmond, and S. Sweitz
9:30 AM	Bioenergy, Land Use Change and Ecosystem Services in Tabasco, Mexico . **C. J. Vazquez-Navarrete**
9:50 AM	Effects of Use of Biofuels for Increasing Production and Productivity in Rural Communities in Northeast Brazil . **J. Ferreira Irmao** and J. Ribemboim
10:10 AM	Energy Crops, Food Security, and Rural Development: The Role of Oilseed Production Around Brazil . **R. Bailis**
10:30 AM	Roundtable Discussion of Key Research Issues and Challenges

8:30 AM Interrogating Social Sustainability in the Biofuels Sector in Latin America: Global Standards and Local Experiences in Mexico, Brazil and Colombia

Theresa Selfa, SUNY – ESF, Syracuse, NY, Carmen Bain, Department of Sociology, Iowa State University, Renata Moreno, Syracuse University, Amarella Eastmond, CIR, UADY, Merida, Mexico, Sam Sweitz, Social Sciences, Michigan Technological University, Houghton, MI, Conner Bailey, College of Agriculture, Auburn University, Tatiana Martins, Sustainable Development Practices Graduate Program, UFRRJ/ International Center of Studies in Sustainable Development, CIEDES, Rio de Janeiro, Brazil, Gustavo Simas Pereira, IFRJ/RJ and UFRRJ/IF/DCA, IFRJ and UFRRJ, Rio de Janeiro, Brazil and Rodrigo Medeiros, Department of Environmental Sciences, Federal Rural University of Rio de Janeiro / Conservation International, Americas Center for Sustainability

Abstract:
Across the Americas, biofuels production systems are diverse due to geographic conditions, historical patterns of land tenure, different land use patterns, government policy frameworks, and relations between the national state and civil society, all of which shape the role that biofuels plays in individual nations. Although many national governments throughout the Americas continue to incentivize the growth of the biofuels industry, one of the key challenges for biofuels sustainability has been concern about its social impacts and implications. In this article, we discuss some of the key social tensions, issues and implications of the recent expansion of biofuels production in Mexico, Colombia, and Brazil. We consider the ability of governments and non-state actors in multi-stakeholder initiatives (MSI) to address social and environmental concerns that affect rural livelihoods. We find that each of our cases suggests that both government and MSIs are falling short in their efforts to integrate and address a broader range of livelihood impacts.

8:50 AM Global and Local Perspectives on the Jatropha Plantations for Biodiesel in Sucopo, Yucatan, Mexico

Amarella Eastmond, Unidad de Ciencias Sociales, Universidad Autonoma de Yucatan, Merida Yucatan, Mexico and Samuel Sweitz, Michigan Technological University

Abstract:
Based on preliminary fieldwork data from Sucopo (municipality of Tizimin, Yucatan, Mexico), we analyze the local socioeconomic impacts from the establishment -and later abandonment - of 3,000 ha of jatropha plantations by Global Clean Energy Holdings. The information was obtained from interviews with Sucopo inhabitants and secondary sources. It is argued that the current global demand for "sustainable biofuels" has built on historical systems of resource extraction in the region (such as the henequen industry) which linked consumer demand in the global north to land, labor and natural resources in the global south. These linkages have fostered a growing dependence between local households, on the one hand, and global market forces, on the other, putting long-term food security and social and cultural capital at risk. By examining the jatropha plantations in the context of biofuel policies, operational practices on the ground and local socioeconomic impacts on the land and labor markets, wages, food security, and traditional village life, we describe and analyze distinct visions of sustainability held by the different stakeholders. We conclude that as long as global notions of sustainable biofuels fail to consider local ones, future biofuel projects in the area are likely to be short lived.

9:10 AM Agro-Fuels and Income of Rural Households in Yucatan, Mexico
Javier Becerril, Facultad de Economia, UADY, Merida, Mexico, Amarella Eastmond, CIR, UADY, Merida, Mexico and Sam Sweitz, Social Sciences, Michigan Technological University, Houghton, MI

Abstract:
This study examines the effects of Agro-Fuels Industry (AFI) on wide annual income of rural households in Yucatan, Mexico. This uses the "Propensity Score Matching" approach and cross-sectional data of 907 inhabitants from 192 households in three municipalities: Santa Elena, Muna and Tizimín. The findings reveal a robust positive and significant impact on the total annual income of the people who work for the AFI established in the eastern region of Yucatán. Specifically there is a positive difference of $ 14,123.0 pesos (US$1,100) annually among people who work as employees for the AFI and working in any other gainful employment within or outside the study area.

9:30 AM Bioenergy, Land Use Change and Ecosystem Services in Tabasco, Mexico
Cesar J. Vazquez-Navarrete, Ciencia de los alimentos e ingeniería, Colegio de Postgraduados, Tabasco, Mexico

Abstract:
Tabasco was an extended, rich, flooded lowland. The expansion of agriculture and oil industry and the growth of human population have transformed it to a highly fragmented, drained and complex flat surface in the last 75 years. All these changes influence over wealth and prosperity of tabasquean people. However, the knowledge of the impact in the ecosystems and their services is incipient yet. Recent studies explore economic approaches to evaluate ecosystem services. These approaches have twofold goals; first, it examines the link between human wealth and ecosystem health and second, it permits researchers and decision makers to develop compatible solutions with ecosystem functions; specially, when government introduces and fosters new economic activities. For instance, palm oil is cultivated to food purposes in Mexico, however, this crop has a potential to become one of the main biofuel in tropical regions. This study employed the ecosystem approach to examine the development of bioenergy industry in the form of oil palm. One of the main objectives of this study is to explore implications of the conversion of ecosystems and agroecosystems to oil palm. Methodology consisted on the construction of different scenarios by considering two factors: (i) the agronomical potential growth of oil palm in Tabasco at different levels of expansion and (ii) the land use change regarding to some levels of expansion. The study area was the Chontalpa Region in Tabasco, Mexico. Results show the changes in land use mainly in ecosystems, the gain or losses of economic values owing to the conversion of ecosystems and agroecosystems to oil palm, and the new economic balance for farming economy. In brief, oil palm would play a new incentive of agricultural and economic growth. This study recommends further research to develop a better understanding of social and ecological implications of future biofuel and bioenergy expansion.

9:50 AM Effects of Use of Biofuels for Increasing Production and Productivity in Rural Communities in Northeast Brazil
Jose Ferreira Irmao, Economics, UFRPE, Recife, Brazil and Jacques Ribemboim, Economics, UFRPE

Abstract:
The paper contains results of a research undertaken for the ANEEL (National Agency for Electric Energy) on the sources of sustainable energy for production in small agriculture in Northeast Brazil. The aim was to identify forms of uses of electric energy in family farming agriculture for stimulating local development in rural communities. Methods of research included field work and application of questionnaires in rural communities and settlements of landless workers. Research covered seven of the nine Northeastern states in a sample of small landholdings. Results shown a very good potential for increasing production and productivity through the use of electric energy, in special, by means of irrigated agriculture when communities dispose of biofuel energy. Attention was also posed in the use of alternative sources of energy, those made available by sun and wind energy. Additional results also indicated that the use of energy in agro-industrial activities such as fruit processing and livestock production increase productivity, income and employment in rural communities mainly those outside main roads and means of transportation. But one further and less effective result was that the successful means for increasing production, productivity and income of small landholdings depend strongly on programs of education, promotion of rural non-agricultural activities and policies aiming reduction of urban-rural inbalances.

10:10 AM Energy Crops, Food Security, and Rural Development: The Role of Oilseed Production Around Brazil

Robert Bailis, School of Forestry and Environmental Studies, Yale University, New Haven, CT

Abstract:
Biodiesel in Brazil is relatively new in comparison to ethanol and is currently used in a five percent blend (B5) nationwide. The biodiesel program is based on three “fundamental pillars”: social inclusion, environmental sustainability, and economic viability. The majority of the nation’s biodiesel is derived from soy, which raises problems for both social inclusion and environmental sustainability. Soy has been implicated in destruction of Amazon and Cerrado biomes. However, as the world’s second largest soybean producer, Brazil’s soy complex serves multiple domestic and international markets. The tremendous expansion of soy largely predated the introduction of biodiesel. The cultivated area grew much more rapidly in the five years prior to the policy than in the five years after its implementation, possibly driven more by demand for soymeal than for oil used to make biodiesel. Thus, attribution of environmental impacts is unclear. Further, while the policy of social inclusion requires that a portion of feedstock be sourced from small farmers, the industry’s dependence on soy makes this questionable. Soy tends to be planted in large, heavily mechanized, monoculture plantations, not amenable to smallholder inclusion. Efforts to introduce alternative crops deemed more environmentally or socially sustainable like Jatropha curcas, castor, oil palm and some native palms have not gained much momentum and they have seen little utilization as biodiesel feedstocks. This paper and the associated presentation examine the implications of dependence on soy for the sustainability of Brazil’s biodiesel industry and discuss the prospects for larger volumes of alternative feedstocks to be introduced.

Wednesday, July 23, 2014: 08:30 AM - 11:30 AM, Candeias Room
Pan American Bioenergy Development and Integrated Water Resources Management
Chair: David Watkins, Civil and Environmental Engineering, Michigan Technological University
Co-Chair: Márcia M.G.A. Moraes, UFPE – Pernambuco, Brazil

Session Overview
Large-scale bioenergy production will affect the hydrologic cycle in multiple ways, including changes in canopy interception, evapotranspiration, infiltration, and the quantity and quality of surface runoff and ground recharge. This session focuses Pan American biofuel and bioenergy development and invites research abstracts on water footprint analyses, water quality, integrated water-energy analyses, watershed scale studies linked to biofuel and bioenergy development, and other related topics, including case studies.

Wednesday, July 23, 2014: Bioenergy Development and Integrated Water Resources Management 08:30 AM - 11:30 AM (Candeias Room)	
Chairs:	David Watkins, Michigan Technological University, Michigan, USA Márcia M.G.A. Moraes, UFPE – Pernambuco, Brazil
8:30 AM	Bioenergy Development and Integrated Water-Energy Management in Pan America . **D. Watkins**, M. M. G. A. Moraes, H. Asbjornsen, A. Mayer, J. Licata, J. Gutierrez Lopez, T. Pypker, V. Gamez Molina, G. F. Marques, A. C. G. Carneiro, H. M. Nuñez, H. Önal, and B. D. N. Germano
8:50 AM	Implications of Woody Bioenergy Feedstock Production for Water Supply and Hydrologic Regulation Services . **J. Gutierrez-Lopez**, J. Licata, T. Pypker, and H. Asbjornsen
9:10 AM	Impacts of Sugarcane Expansion on Water Resources in Areas of São Paulo State . **M. M. Guarenghi** and A. Walter
9:30 AM	Energy-Water Nexus: An Input-Output Dynamical MODEL . **G. A. D. Oliveira** and **F. M. C. D. Souza**
9:50 AM	Hydro Economic Modeling and Water Scarcity Cost in a Watershed with Irrigated Bio Fuel Crops Production . **G. Fernandes Marques**
10:10 AM	An Economic Analysis of Land Use Changes and Sugarcane Production in Brazil: The Role of Irrigation Water . **A. C. G. Carneiro**, H. M. Nuñez, **H. Önal**, and M. M. G. A. Moraes
10:30 AM	Roundtable Discussion of Key Research Issues and Challenges

8:30 AM Bioenergy Development and Integrated Water-Energy Management in Pan America
David Watkins[1], Márcia M.G.A. Moraes[2], Heidi Asbjornsen[3], Alex Mayer[4], Julian Licata[5], Jose Gutierrez Lopez[6], Tom Pypker[7], Vivianna Gamez Molina[8], Guilherme Fernandes Marques[9], Ana Cristina G Carneiro[2], Hector M. Nuñez[10], Hayri Önal[11] and Bruna da Nobrega Germano[2], (1)Civil and Environmental Engineering, Michigan Technological University, Houghton, MI, (2)Department of Economics, Universidade Federal de Pernambuco, Recife, Brazil, (3)Department of Natural Resources and Environment, University of New Hampshire, (4)Civil and Environmental Engineering, Michigan Tech Univ., Houghton, MI, (5)National Institute of Agricultural Technology, Concordia, Argentina, (6)Department of Natural Resources and Environment, University of New Hampshire, Durham, NH, (7)Department of Natural Resources, Thompson Rivers University, Kamloops, BC, Canada, (8)Civil and Environmental Engineering, Northern Arizona University, Flagstaff, AZ, (9)Civil Engineering, Centro Federal de Educação Tecnológica de Minas Gerais, Belo Horizonte, Brazil, (10)Department of Economics, Centro de Investigación y Docencia Económicas, Aguascalientes, Mexico, (11)Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, IL

Abstract:
Large-scale bioenergy production will affect the hydrologic cycle in multiple ways, including changes in canopy interception, evapotranspiration, infiltration, and the quantity and quality of surface runoff and groundwater recharge. As such, the water footprints of bioenergy sources vary significantly by type of feedstock, soil characteristics, cultivation practices, and hydro-climatic regime. Furthermore, water management implications of bioenergy production depend on existing land use, relative water availability, and competing water uses at a watershed scale. This paper reviews previous research on the water resource impacts of bioenergy production--from plot scale hydrologic and nutrient cycling impacts to watershed and regional scale hydro-economic systems relationships. Primary gaps in knowledge that hinder policy development for integrated management of water-bioenergy systems are highlighted. A number of case studies in Pan America are analyzed to illustrate relevant spatial and temporal scales for impact assessment, along with unique aspects of biofuel production compared to other agroforestry systems, such as energy-related conflicts and tradeoffs. Based on the case studies, the potential benefits of integrated resource management are assessed, as is the need for further case-specific research.

8:50 AM Implications of Woody Bioenergy Feedstock Production for Water Supply and Hydrologic Regulation Services
Jose Gutierrez-Lopez, Department of Natural Resources and the Environment, University of New Hampshire, Durham, NH, Julian Licata, National Institute of Agricultural Technology, Concordia, Argentina, Tom Pypker, Department of Natural Resources, Thompson Rivers University, Kamloops, BC, Canada and Heidi Asbjornsen, Department of Natural Resources and Environment, University of New Hampshire

Abstract:
Woody bioenergy plantations are generally managed to maximize biomass production. This can be accomplished through various management approaches, such as species selection, short rotation lengths, genetic breeding programs, planting density, species combinations, and chemical and fertilizer application. One of the consequences of maximizing productivity in bioenergy plantations is a trade-off between increased carbon uptake by rapidly growing trees (positive for carbon sequestration and climate change amelioration) and increased water use by plantations relative to the original native

vegetation or pre-existing vegetation the original vegetation (negative for downstream water supply). Moreover, the particular management regime employed for bioenergy production can also affect soil hydraulic properties that determine partitioning of throughfall between soil and groundwater recharge versus runoff, thereby influencing peak and dry season flows. However, few studies have examined the impacts of establishing bioenergy plantations on these hydrologic services, and the trade-offs compared to alternative management practices. In this presentation, we show initial results from research in Wisconsin, USA that quantifies water use in two aspen plantations (ages 10 and 24) and a mature aspen-dominated forest stand (age 33) to understand potential consequences of increased bioenergy production in the region on water supply. Findings indicated that average stand transpiration in the 10 and 24 year old stands was 25K L d^{-1} and 16K L d^{-1} ha^{-1}, respectively, compared to 62K L d^{-1} ha^{-1} for the mature stand. These differences in stand water use reflect both the higher estimated sapwood area for the 10 year old stand (25.7 m^2 ha^{-1}) compared to the 24 year old and mature forest stand (12.0 and 10.2 m^2 ha^{-1}, respectively), combined with the much higher mean sap velocity for the mature forest stand (44.1 cm h^{-1}) compared to the 10 and 24 year old stands (9.0 and 15.0 cm h^{-1}, respectively). These results highlight the importance of considering potential carbon-water tradeoffs when designing and managing tree plantations for bioenergy production, and underscore the need to balance both biomass accumulation and water use. We discuss our findings within the larger context of understanding the potential implications of stand water use in bioenergy plantations across different stand ages, species, and management regimes for downstream water supply and hydrologic regulation services.

9:10 AM Impacts of Sugarcane Expansion on Water Resources in Areas of São Paulo State

Marjorie M. Guarenghi[1,2] and Arnaldo Walter[1], (1)University of Campinas-Unicamp, Campinas, Brazil, (2)Laboratório Nacional de Ciência e Tecnologia do Bioetanol – CTBE/CNPEM, Campinas, Brazil

Abstract:
The expansion of sugarcane cropping for bioethanol production can impact both the quantity and the quality of water resources in the region where it occurs. Land use changes and different management practices can modify the runoff processes in the watersheds and the river flows (TUCCI and CLARKE, 1997). The consumption of water resources associated to sugarcane and ethanol production has decreased during the last years. This has been possible due to the use of fertirrigation and due to the reduction of water withdraws for the industrial phase through the optimization of some processes and water reuse (ELIA NETO et al., 2010). However, the vinasse and the use of agrochemicals can contribute to the pollution of water bodies (GOLDEMBERG et al., 2008).
This abstract is based on the master's thesis of the first author which evaluated whether it is possible to observe impacts of sugarcane expansion both on the quantity and the quality of water bodies. For this research, data of water monitoring in the state of São Paulo were used; these database is publically available and this was a premise for defining the research: what can be understood from the data publically available?
Data used were those from the monitoring stations regarding precipitation, discharge and quality parameters; they are provided by the Brazilian Water Agency (ANA), Department of Water and Energy (DAEE) and Brazilian Commission for the Environment (CONAMA).
The selection of studied areas was made considering the monitoring stations with the longest historical series (above 15 years), with less than 10% of failures, and located in areas with significant expansion of sugarcane over the years. Stations located near hydroelectric plants were avoided and small scale rivers

basins were prioritized. To evaluate the water quality impacts, an additional criterion used was the availability of parameters related to agrochemical inputs and vinasse.
The selection of studying sites was limited by the unavailability of long time series of discharge and variables of water quality in areas with growing sugarcane cultivation. Besides the unavailability of long time series, many data of gauging stations have several failures, mainly in small scale catchments.
In Brazil, the implementation of a water monitoring network was motivated by the importance of hydroelectric plants. This explains the shortage of gauging stations in basins with less than 500 km2 (PAIVA and PAIVA, 2003). The methodology for evaluating the effects of land use change in river flow is more conclusive in small-scale basins (COSTA, 2003). However, the hydrological monitoring network in small-scale basins has constrains, and data is available for just few years or the series have several failures.
The selection of areas to assess the potential impacts on water quality was also constrained by the shortage of time series during long periods for many parameters related to agrochemical inputs and stillage, as potassium and nitrogen series. Among the 80 water quality monitoring stations preselected, approximately 25 stations have data for nitrogen concentration along six years, and less than 10 have registered parameters for potassium. The stations with registers of potassium correspond to information for three large rivers, and the monitoring of this parameter started only in 2001.
Based on the procedure described above, three studying sites in São Paulo State were chosen: the regions of Jaú, Pontal and Ribeirão Preto.
The Jaú River basin, located at the central part of São Paulo State, has an area of 417 km2. In this area, it was only possible to evaluate the discharge between 1982 and 1999. During these eighteen years, the area planted with sugarcane increased 20% (regarding the total area) followed by a reduction of pasture area. In the 1990s, sugarcane cropping area represented more than 50% of the total area of the region. The ethanol and sugarcane production is very important to the economy of the cities in the region of Jaú. Three mills of sugar/ethanol are placed close to the Jaú River.
In the regions of Pontal e Ribeirão Preto, with drainage watershed of 12.445 km2 and 10.679 km2, respectively, both the river discharge and the water quality parameters of the Pardo River were analyzed. In those areas, the area planted with sugarcane grew 40% during the period of evaluation of the streamflow (between 1974 and 2011). In 2010, more than 60% of the total area of the Pontal region and around 50% of Ribeirão Preto region were occupied by sugarcane cropping. Seven sugar/ethanol mills are located near the discharge and water quality stations analyzed.
The historical time series provided by the monitoring stations were analyzed using nonparametric procedures. The Mann-Kendall's test was applied to detect trends, as well as Pettitt's test to determine abrupt changes. Discharge data were correlated with the sugarcane planted area in each studied region over the years. The main water quality variables analyzed were potassium, total phosphorus, nitrate, nitrite, and ammonium. The concentrations of these parameters were correlated to sugarcane planted area and to the population growth.
According to the test, no trend and no changing point were detected in total annual discharge of the rivers analyzed. In fact, all these time series present better correlation to precipitation series. No significant correlation was observed between sugarcane growth and the river flows.
The quality parameters series in Pardo River showed significant increasing trends, except the potassium concentration for which no trend was observed. However, the parameters evaluated are not only influenced by the agrochemical inputs and vinasse containing nitrogen, as well as phosphorus and potassium due to sugarcane production. The increase on concentrations can be associated to the fertilizers leaching, as well as to the discharge of sewage and industrial effluents without appropriated treatment from urban areas.

Despite the use of appropriate procedures for the analysis of hydrological data, the research results are inconclusive. Among the biggest sugarcane producers, São Paulo State is supposed to be the one with the largest water monitoring network. But even in this case, time series are poor for analyzing the relationship between land use changes and its effects on water resources.
The stations with the largest time series correspond to meso- or large-scale basins. In these areas, several anthropogenic, climatic and geographical factors impact on water resources. So, it is difficult – and in some cases impossible – to isolate the effects of sugarcane expansion on catchment hydrology. Impact assessments on water quality were also constrained by the shortage of important monitoring parameters related to agriculture practices and to residues from urban areas and from industrial activities. The bulk of quality monitoring stations are in large rivers, and several time series have failures that constrain the assessment along the time. Therefore, based on the database available to São Paulo State it was not possible to determine the impacts of sugarcane expansion on the water resources.
For the proper evaluation of impacts on water resources caused by the expansion of sugarcane activity, using statistical procedures, it would be necessary to monitor specific areas in small-scale watersheds. This would allow proper data gathering in regions where the influence of other factors could be reduced. To make this possible, investments are required for the installation of new gauging stations to expand the network of water controlling stations.

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9:30 AM Energy-Water Nexus: An Input-Output Dynamical Model
Geraldo A. de Oliveira, DASE, IFPE - INSTITUTO DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DE PERNAMBUCO, RECIFE, Brazil and **Fernando M. Campello de Souza**, PPGEE, UFPE - UNIVERSIDADE FEDERAL DE PERNAMBUCO, RECIFE, Brazil

Abstract:
Energy and water are of utmost importance for any country's economy and way of life. Understanding the intricate relationship between energy and water and developing technologies to keep that relationship appropriate is an important key to a sustainable and secure future for any country.

There are trade-offs between energy and water. Large scale power plants — nuclear, coal, biomass and of course, hydroelectric — use lots of water. Conversely, making drinkable, potable water, and piping it into big cities, involving typically large distances, certainly requires plenty of energy.

Water and energy are strongly tied and certainly dependent on each other, with each affecting the other's availability. Water is necessary for energy development and generation, and energy is needed to supply, use, and treat drinking water and waste water. Both, energy and water, are essential to our health, quality of life, and economic growth, and demand for both these resources continues to rise.

Water and energy are the two most fundamental resources of modern civilization. People die, and one cannot grow food, if water is not available. Without energy, one cannot run computers, or power homes, schools, offices, farms, and industrial plants. As the world's population grows in number and affluence, the demands for both resources are increasing faster than ever.

The earth holds about eight million cubic miles of freshwater — tens of thousands of times more than humans' annual consumption. Only about 2.5% of the world's water is freshwater. Unfortunately, less than 1% is accessible via surface sources and aquifers, and the rest is imprisoned in underground reservoirs and in permanent ice and snow cover. Also, the available water is often not clean or not located close to population centers.

The reality that each of these precious resources, energy and water, might soon cripple the use of the other has been under-appreciated. To generate energy, massive quantities of water are consumed, and to deliver clean water, massive quantities of energy are consumed. Desalination, a process that removes salt from water, is the most energy-intensive and expensive option for treating water and is used where alternatives are very limited. Other energy needs associated with water occur at the point of end-use, often in households, primarily for water heating, water cooling, clothes washing, and pumping water. Many people are concerned about the perils of peak oil — running out of cheap oil. A few are voicing concerns about peak water. But almost no one is addressing the conflict between the two: water restrictions are hampering solutions for generating more energy, and energy problems, particularly rising prices, are curtailing efforts to supply more clean water.

Physical constraints on the availability of water for energy sector use encompasses both quantity and quality issues: there may not be enough of it or that which is available may be of insufficient quality. These restrictions may be natural or may arise from regulation of water use. One cannot build more power plants without taking into account that they impinge on the freshwater supplies. And one cannot build more water delivery and cleaning facilities without increasing energy demand. Solving the dilemma requires new global policies that integrate energy and water solutions and innovative technologies that help to boost one resource without draining the other. One need an analytical tool, a mathematical tool, to treat this problem. One mathematical dynamical model is proposed here.

Water and energy are fundamentally linked. Policy reforms in both industries, however, do not appear to acknowledge the links nor consider their wider implications. This is clearly unhelpful, particularly as policy makers attempt to develop effective responses to water and energy issues, underpinned by prevailing drought conditions and impending climate change, and an ever increasing demand for both resources.

Energy production requires a reliable, abundant, and predictable source of water, a resource that is already in short supply throughout much of the world.

The time has come to consider both issues as one. Instead of water planners assuming they will have all the energy they need and energy planners assuming they will have all the water they need, one must get them in the same room to make decisions. A restructuring of the institutional arrangements is in order. And one will need an analytical tool. This is the underlying idea of this proposed analytical model.

One analyzes here the links between water and electricity — termed water-energy nexus, or energy-water nexus — in the general context. For that matter a dynamic input-output Leontief model is proposed.

The Supply Chain Model

The supply chain management is a central tool in business administration.

The input-output matrix summarizes the matching of supply and demand amongst the various sectors of the economy; the gross purchase or sales of physical products among the various sectors of economy. It also describes the technology of production.

Two important economic variables are supply, ***s***, and demand, ***d***. It is assumed that if demand grows, then supply will grow, or should grow, to match it. And vice-versa. In other words, supply keeps tracking demand. There exists thus a feedback phenomenon.

Since demand is always varying, there will be always a dynamic equilibrium. The system is, in general, always moving. It is the dynamics of this movement that one wants to study and control. It is the essence of a supply chain management. In the case of the energy-water interplay this is crucial, since these two variables are closely intertwined.

The variable which provokes the increasing or decreasing of production is the difference between demand and supply. As the population grows, the demand for water (which has no substitute) and energy will grow, and not always in a balanced fashion. There will be a “demand surplus” or a “supply surplus”.

Earth and the communities that live upon it are part of a system. By approaching these massive problems from an integrated standpoint, one begins to solve problems in a more systematic way.

The energy-water nexus is attracting the attention of diverse stakeholders around the world and it is becoming more and more clear that one cannot plan for the planet’s future if one does not consider energy and water as a whole.

Water and energy policy, planning and management must be integrated to encourage conservation, motivate innovation and ensure sustainable use of water and energy. It takes a significant amount of water to create energy, and a significant amount of energy to move and treat water.

One may not realize it, but when one uses energy, one is also using water indirectly — lots of it!

The model proposed here includes the dynamical aspects of the interplay between water and energy, due to the necessity of having stocks, and allows a thoroughly comprehension and control of this interaction. It was implemented in a spread sheet. Several possibilities concerning the links between these two resources, as well as the control of the system (policies) are analyzed.

9:50 AM Hydro Economic Modeling and Water Scarcity Cost in a Watershed with Irrigated Bio Fuel Crops Production

Guilherme Fernandes Marques, Instituto de Pesquisas Hidráulicas, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

Abstract:
Bio fuels production, such as ethanol, fills an important role in meeting a common objective to increase renewable energy use in several countries. Recently, irrigation has demonstrated potential to significantly improve sugar cane productivity in Brazil, contributing to further increase production without expanding the crop area. Water resources are a critical element in planning biofuel production in this context; given potential demands for irrigation, waste assimilation and use of shared infrastructure, like multipurpose reservoirs also used for hydropower generation and urban water supply. To avoid transferring impacts to the producer watersheds (water conflicts, waste production and other externalities) biofuels should planned considering the regional hydrology and water availability, existing infrastructure and competing water demands, including economic ones. Such integrated approach should allow investigation of infrastructure expansion, water transfers and conjunctive use opportunities with groundwater management, for example. This research involves a framework to investigate water management, policy and operational decisions, based on the economic value of the water in the watershed. The framework uses a network based, hydro economic optimization model, with an objective function that minimizes the water's scarcity cost to users, subject to physical and legal constraints in the system. The information produced should be useful to (a) support the water allocation among economic demands, especially the ones related to bio fuel crops production, (b) support the development and adaptation of water planning and management in watersheds where the production of bio fuels is expected to increase, (c) understand the impact of bio fuel production in the water's availability and economic value and (d) evaluate economic costs of meeting environmental demands in a scenario with high water consumption for bio fuel production.

10:10 AM An Economic Analysis of Land Use Changes and Sugarcane Production in Brazil: The Role of Irrigation Water

Ana Cristina G Carneiro[1], Hector M. Nuñez[2], **Hayri Önal**[3] and Márcia M.G.A. Moraes[1], (1)Department of Economics, Universidade Federal de Pernambuco, Recife, Brazil, (2)Department of Economics, Centro de Investigación y Docencia Económicas, Aguascalientes, Mexico, (3)Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, IL

Abstract:
Brazil is the second largest producer and consumer of ethanol in the world. Nearly half of the liquid fuels consumed by light duty vehicles in the country is comprised by ethanol derived from sugarcane. Being the largest exporter, Brazil also plays an important role in the growing global biofuel markets. It is often argued that with a more efficient utilization of the pastures and by converting a small fraction of the vast amount of pasture lands to cropland, Brazil could increase its sugarcane and ethanol production

further to meet the domestic and global ethanol demand. Sugarcane is a water intensive crop; therefore, significant amounts of irrigation water would be needed if sugarcane acreage expands beyond the traditional production areas. While the potential for expanding sugarcane area through livestock intensification and pasture land conversion has been investigated in a few previous studies, less attention has been given to the availability of water resources needed for such expansion. This paper presents a comprehensive approach and investigates the prospects for increasing sugarcane production in Brazil considering the competition between sugarcane and other crops for available land and water resources. A spatially explicit price endogenous mathematical programming model is developed for this purpose where the agricultural and transportation fuel sectors are simulated and equilibrium in commodity and fuel markets is determined in a simultaneous framework. The productivity in agriculture, the demands for major food/feed crops, domestic and export demands for ethanol, and irrigation water availability are projected for 2030 to carry out a prospective economic analysis. The model results show that without the consideration of irrigation water, livestock intensification can allow expanding the sugarcane production by nearly 150 percent compared to the base case (2007). However, when the water resources availability is incorporated along with the cropland limitation the potential for sugarcane expansion is reduced to merely 5 percent. These results demonstrate the important role of water resources and irrigation infrastructure development if Brazil targets a serious expansion in its ethanol industry.

Wednesday, July 23, 2014: 08:30 AM - 11:30 AM, Piedade Room
Bioenergy and Biodiversity: Key Lessons and Research Priorities in the Pan America
Chair: Audrey Mayer, Michigan Technological University

Session Overview:
Understanding how large-scale bioenergy production can affect biodiversity is important if society is to meet current and future sustainable development goals. This session invites abstracts of research on biodiversity and ecosystem impacts of biofuel and bioenergy production systems in the Pan America region.

Wednesday, July 23, 2014: Bioenergy and Biodiversity: Key Lessons and Research Priorities 08:30 AM - 11:30 AM (Piedade Room)	
Chair:	Audrey Mayer, Michigan Technological University
8:30 AM	Bioenergy and Biodiversity: Key Lessons from the Pan American Region . **K. Kline**, F. Martinelli, A. L. Mayer, R. Medeiros, C. O. F. D. Oliveira, G. Sparovek, A. Walter, and L. Venier
8:55 AM	Land Sparing Versus Land Sharing: How Might Biodiversity and Bioenergy Coexist? . **A. L. Mayer**
9:20 AM	Integrating Biodiversity Metrics in Life-Cycle Analysis of Intensive Biomass Production in North American Forests: Challenges and Considerations . **J. Verschuyl**, T. B. Wigley, C. Gaudreault, M. Margni, D. Miller, S. Riffell, B. Titus, and K. Vice
9:45 AM	The Sustainability of Forest Residue for Bioenergy in Canada: What Can Biodiversity Tell Us? . **L. Venier**, I. Aubin, K. Webster, R. Fleming, P. Hazlett, B. Titus, and H. Chen
10:10 AM	Assessing the Impacts of Pan American Bioenergy Development on Birds and Insect Pollinators . **J. Knowlton**
10:35 AM	Roundtable Discussion of Key Research Issues and Challenges

8:30 AM Bioenergy and Biodiversity: Key Lessons from the Pan American Region
Keith Kline, Environmental Science Division, Climate Change Science Institute and Center for Bioenergy Sustainability, Oak Ridge National Laboratory, Oak Ridge, TN, Fernanda Martinelli, Sustainable Development Practices Graduate Program, UFRRJ/ Conservation International Brasil, Rio de Janeiro, Brazil, Audrey L. Mayer, School of Forest Resources and Environmental Science, Michigan Technological University, Houghton, MI, Rodrigo Medeiros, Department of Environmental Sciences, Federal Rural University of Rio de Janeiro / Conservation International, Americas Center for Sustainability, Camila Ortolan F. de Oliveira, UNICAMP/University of Campinas, Campinas, Brazil, Gerd Sparovek, University of Campinas (UniCamp), Campinas, Brazil, Arnaldo Walter, University of Campinas-Unicamp, Campinas, Brazil and Lisa Venier, Canadian Forest Service, Natural Resources Canada, Sault Ste. Marie, ON, Canada

Abstract:
Understanding how large-scale bioenergy production can affect biodiversity and ecosystems is important if society is to meet current and future sustainable development goals. A variety of bioenergy production systems have been established within different contexts throughout the Pan American region, with wide-ranging results in terms of documented and projected effects on biodiversity and ecosystems. The Pan American region is home to the majority of commercial bioenergy production and therefore the region offers a broad set of experiences and insights on both conflicts and opportunities for biodiversity and bioenergy. This paper synthesizes lessons learned from experiences in Canada, the United States, and Brazil regarding the land use conflicts that can arise between bioenergy production and ecological conservation and benefits that can be derived when bioenergy policies promote planning and more sustainable land management systems. We propose a research agenda to address priority information gaps that are relevant to biodiversity concerns and related policy challenges in the Pan American region

8:55 AM Land Sparing Versus Land Sharing: How Might Biodiversity and Bioenergy Coexist?
Audrey L. Mayer, School of Forest Resources and Environmental Science, Michigan Technological University, Houghton, MI

Abstract:
Biodiversity has been threatened at a global scale by the increasing spatial extent of human land use, particularly agricultural production. Approaches to mitigate the impact of land use on biodiversity generally represent one of two opposing approaches: land sparing versus land sharing. In the land sparing approach, human land use is intensified so that the least amount of area is impacted. In the case of agriculture, including the production of biomass for bioenergy, heavy applications of fertilizers, pesticides, and the use of technologies such as genetically modified organisms can generate very high yields in very small but highly modified areas. In the land sparing approach, land management techniques that mimic natural systems are used to allow for productive areas that support high amounts of biodiversity. These methods include permaculture, agroforestry, shifting agriculture, and interspersion of crop areas with natural habitat features. I will review the experiences thus far with these two approaches in agriculture, and suggest lessons learned for biomass-based bioenergy systems that may be compatible with high biodiversity systems.

9:20 AM Integrating Biodiversity Metrics in Life-Cycle Analysis of Intensive Biomass Production in North American Forests: Challenges and Considerations

Jake Verschuyl, Western Wildlife Program, National Council for Air and Stream Improvement, Anacortes, WA, T. Bently Wigley, Forestry, National Council for Air and Stream Improvement, Clemson, SC, Caroline Gaudreault, Canadian Operations National Council for Air and Stream Improvement, Montreal, QC, Canada, Manuele Margni, Polytechnique Montreal, Montreal, Canada, Darren Miller, Southern Environmental Research, Weyerhaeuser NR Company, Columbus, MS, Sam Riffell, Department of Wildlife, Fisheries, and Aquaculture, Mississippi State University, Mississippi State, MS, Brian Titus, Pacific Forestry Centre, Natural Resources Canada, Victoria, BC, Canada and Kirsten Vice, Canadian Operations, National Council for Air and Stream Improvement, Montreal, QC, Canada

Abstract:
Energy policy in the United States and Canada has increasingly promoted developing plant-based biofuels to complement, and potentially provide alternatives to, fossil fuels. This has resulted in more interest in intensive biomass production to meet anticipated growth in demand. Native grasses, woody species, and forestry residues currently show promise as a local energy source for wood products facilities and for producing marketable biofuels. Large scale adoption of intensive biomass production in forests, however, has potential to alter management, species composition, physical structure, and landscape configuration of forests in some regions of North America. Because forest lands support a large proportion of biodiversity in many regions, it is important to understand how biodiversity may respond to practices associated with biomass production systems and what additional information is needed by forest managers and policymakers. Additionally, it has been argued by many that it is necessary to examine the full life cycle of biomass-derived fuels to understand implications of their production and use using a comprehensive set of environmental indicators, including land use and biodiversity. Existing Life Cycle Analysis (LCA) studies, however, often focus only on greenhouse gasses and energy.

We use results of a review of documented relationships between intensive production of forest biomass and forest biodiversity in North America to highlight challenges and applications of biodiversity as an indicator for biomass harvesting systems within Life Cycle Impact Assessment (LCIA), one of the phases of LCA. We searched the literature for papers that characterized biodiversity responses to at least one of four treatments related to biomass harvesting: removal of forest harvest residues (coarse woody debris [CWD] manipulations), thinning, intercropping and short-rotation woody crops. Three levels of biodiversity (ecosystem, species, and genetic diversity) have been considered in LCIA approaches, but only information on species diversity offers enough depth or rigor to provide inference. Biodiversity responses from reviewed literature included species richness, diversity, abundance of taxa or groups of species (guilds) and abundance of individual species for birds, mammals, reptiles, amphibians, and invertebrates. We used meta-analyses to summarize biodiversity response to the four biomass harvest treatments.

We found a wealth of literature reporting effect on birds, small mammals and invertebrates. Few studies were found investigating response of amphibians and reptiles to biomass removal. We found that removal of snags and CWD may have more significance for birds than for other taxa. A decrease in abundance of invertebrates in CWD or snag removal plots is a possible mechanistic explanation for the reported lower bird abundance and diversity. Forest thinning treatments had generally positive effects on diversity and abundance across all taxa. We found biodiversity response to biomass harvest at least somewhat dependent on harvest intensity. More research is needed to determine effects of short

rotation woody crops, intercropping, fine woody debris removal and geographic variability. Our review highlights the need for manipulative experiments designed to test biomass removal hypotheses.

Existing literature confirms that biodiversity response to biomass production is complex, influenced by site-specific factors temporal and spatial scale of analyses, taxa being considered, and other factors. Challenges for biodiversity assessment within the LCA framework for biomass harvesting include those inherent to the multi-dimensional complexity of biodiversity itself and several complications related to the non-linear responses of biodiversity to biomass harvesting. Thus, generic LCAs that do not account for complexities such as these likely offer limited insight into actual implication of biomass production for biodiversity.

9:45 AM The Sustainability of Forest Residue for Bioenergy in Canada: What Can Biodiversity Tell Us?
Lisa Venier[1], Isabelle Aubin[1], Kara Webster[1], Rob Fleming[1], Paul Hazlett[1], Brian Titus[2] and Han Chen[3], (1)Canadian Forest Service, Natural Resources Canada, Sault Ste. Marie, ON, Canada, (2)Pacific Forestry Centre, Natural Resources Canada, Victoria, BC, Canada, (3)Faculty of Natural Resources Management, Lakehead University, Thunder Bay, ON, Canada

Abstract:
The federal and provincial governments in Canada are becoming increasingly interested in biomass harvesting, in part because of recently declining markets for traditional products and associated job losses, as well as heightened public and policy debate over climate change and the need to reduce Canada's growing greenhouse gas emissions. In a recent national scan of regulations relevant to biomass harvesting by the World Wildlife Fund and the Forest Products Association of Canada (2010), every province surveyed had made some sort of overarching policy commitment to a greater reliance on renewable fuels; the scan also found that forest biomass harvesting and related concerns about resulting environmental impacts are becoming increasingly discussed and debated across all provinces. All provinces assessed have also indicated that biomass harvesting must be conducted within existing forest management policies and guidelines. Concerns have been raised about the scientific credibility and social acceptance of the developing bioenergy sector. The report entitled "Fuelling the BioMess" by Greenpeace Canada (2011) and an internal Environment Canada report on eNGO (environmental non-government organization) and conservation group views on forest biomass harvesting in Canada (Dagg et al. 2011) highlight concerns about ecological impacts of biomass harvest including impacts on biodiversity and wildlife habitat as well as soil fertility and forest productivity. It was the opinion of many organizations that forest residue is not an acceptable biomass resource because of its importance to biodiversity and productivity (Dagg et al. 2011). There is, however, very little scientific evidence, particularly within North American forest ecosystems, to either support or deny this statement. In this paper we will review the research in Canada related to the impacts of biomass removal for bioenergy on biodiversity and describe current projects designed to address the question of how much biomass can be removed while maintaining forest ecosystem integrity as measured by biodiversity. In particular, we will describe a recent study in Chapleau, Ontario that is attempting to integrate data from a variety of taxonomic groups using a multi-trophic, ecosystem approach.

10:10 AM Assessing the Impacts of Pan American Bioenergy Development on Birds and Insect Pollinators

Jessie Knowlton, School of Forest Resources and Environmental Science, Michigan Technological University, Houghton, MI

Abstract:
Bioenergy has the potential to help meet worldwide energy demands while reducing dependence on fossil fuels and mitigating climate change. As a result, global energy use from biomass is expected to increase two to six fold by 2050. In the U.S. and Argentina, biomass power plants require dedicated woody crops, and aspen and eucalyptus are possible fuel sources for each country, respectively. Brazil and Mexico are considering meeting increased bioenergy production goals through biodiesel made from palm oil. However, few studies have addressed the ecological impacts of the expansion and harvesting of these feedstocks. The biodiversity subteam of the National Science Foundation Partnerships for International Research and Education "Sustainability, Ecosystem Services, and Bioenergy Development across the Americas" grant will examine some of the impacts of the expansion bioenergy feedstocks on birds and insect pollinators in these four countries (Brazil, Mexico, Argentina and the US). One of the most challenging questions for conservation is how species move in human-modified landscapes (HMLs) and select habitats, since species unwilling or unable to move through HMLs risk population decline and extinction. Many models attempting to predict the long-term persistence of species in HMLs rely on accurate estimates of the permeability of different landscape elements. The permeability of different agroforestry plantations is still poorly understood, even for well-studied species such as birds and insects. We will use radio-telemetry, point counts and pan traps to study bird and insect pollinator movements and habitat preferences within bioenergy plantations and surrounding lands in all four countries. In each country we will compare species' richness, abundances, movement behaviors and habitat choice in the relevant possible feedstock plantation type (i.e., aspen, eucalyptus or oil palm) and two most likely alternative land-uses (e.g., cattle pasture and cropland), as well as native forest or grassland as a control. Both birds and insects deliver essential ecosystem services to native vegetation and agricultural crops, including pest control, pollination and seed dispersal. Further, birds and insects are commonly used as bio-indicators and proxies of overall biodiversity. This research is a vital part of the larger team's effort to determine the socio-ecological impacts of Pan American bioenergy development that will serve as a foundation for sustainability modeling of complex systems.

Wednesday, July 23, 2014: 08:30 AM - 11:30 AM, Imperial Room
Policies for the Sustainable Development of Biofuels in Pan America
Chair: Barry Solomon, Department of Social Sciences, Michigan Technological University
Co-Chair: Alberto Acevedo, Natural Resources Research Center, National Agricultural Technology Institute (INTA)

Session Overview:
Rapid growth of biofuel production in the United States and Brazil over the past decade has increased interest in replicating this development in other nations of the Pan American region. A key biofuel policy research question is "are national biofuel policies achieving their goals?" This session welcomes abstracts covering analyses of biofuel and bioenergy policies in different Pan American countries. Abstracts addressing alternative international governance regimes for biofuel sustainability are also welcomed.

Wednesday, July 23, 2014: Policies for the Sustainable Development of Biofuels in Pan America **08:30 AM - 11:30 AM** (Imperial Room)	
Chairs:	Barry Solomon, Michigan Technological University, Michigan, USA Alberto Acevedo, National Agricultural Technology Institute (INTA), Buenos Aires Argentina
8:30 AM	Policies for the Sustainable Development of Biofuels in Pan America: A Review and Synthesis of Five Countries . **B. Solomon**, A. Banerjee, A. Acevedo, K. Halvorsen, and A. Eastmond
8:50 AM	Climate Change, Decarbonisation, and Bioenergy Production: Integrating Policy Science into a Broader Context . **K. E. Halvorsen**
9:10 AM	A Blueprint for Sustainability Certification Implementation in the U.S. and Brazil . **J. Endres** and **R. Aguiar**
9:30 AM	Indirect Effects of Bioenergy: International Standards and Science . **M. Davis**, K. Kline, F. Ghatala, and D. Goldin
9:50 AM	Biofuel Sustainability in Latin America and the Caribbean: A Review of Recent Experiences and Future Prospects . **R. Bailis**, **B. Solomon**, C. Moser, and T. Hildebrandt
10:10 AM	Trajectory of Wood Energy Policies in the United States: Sustainability and Governance in Global Markets . **D. Becker**
10:30 AM	Roundtable Discussion of Key Research Issues and Challenges

8:30 AM Policies for the Sustainable Development of Biofuels in Pan America: A Review and Synthesis of Five Countries

Barry Solomon, Department of Social Sciences, Michigan Technological University, Houghton, MI, Aparajita Banerjee, Michigan Technological University, Houghton, Alberto Acevedo, Natural Resources Research Center, National Agricultural Technology Institute (INTA), Buenos Aires, Argentina, Kathleen Halvorsen, School of Forest Resourses and Environmental Science and Department of Social Sciences, Michigan Technological University, Houghton, MI and Amarella Eastmond, CIR, UADY, Merida, Mexico

Abstract:
Rapid growth of biofuel production in the United States and Brazil over the past decade has increased interest in replicating this success in other nations of the Pan American region. However, the continuing production of food-based feedstock is widely seen as unsustainable and is in some cases linked to deforestation and increased greenhouse gas emissions, raising further doubts about long-term sustainability. As a result, many nations are exploring the production and use of cellulosic feedstock, though progress has been extremely slow. In this paper we will review the North-South axis of biofuel production in Pan America and its linkage with the agricultural sectors in five countries in Pan American. The key research question is "are national biofuel policies achieving their goals?" Policy goals and results will be highlighted for the main biofuel policies that have been enacted at the national level. The geographic focus will be given to the two largest producers - the United States and Brazil; two smaller emerging producers – Argentina and Canada; and one stalled program - Mexico. However, several additional countries in the region are either producing or planning to produce biofuels. We will also review alternative international governance regimes for biofuel sustainability that have been recently developed, and whether the biofuel programs are being managed to achieve improved environmental quality and sustainable development.

8:50 AM Climate Change, Decarbonisation, and Bioenergy Production: Integrating Policy Science into a Broader Context

Kathleen E Halvorsen, Michigan Technological University, Houghton, MI

Abstract:
The primary value of bioenergy production is as a potential tool to mitigate climate change. This brings us into a larger policy science context of energy production and consumption, decarbonisation, and climate change policies. Understanding how these arenas will move forward and help us to transform societies in order to mitigate climate change requires new, integrated policy science research that integrates across these areas. This presentation focuses on describing an interdisciplinary, international social science research agenda that can meet these goals.

9:10 AM A Blueprint for Sustainability Certification Implementation in the U.S. and Brazil

Jody Endres, Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign, Champaign, IL and **Rayane Aguiar**, Energy Biosciences Institute, University of Illinois at Urbana Champaign, Champaign, IL

9:30 AM Indirect Effects of Bioenergy: International Standards and Science

Maggie Davis[1], Keith Kline[1], Fred Ghatala[2] and Diego Goldin[3], (1)Environmental Science Division, Climate Change Science Institute and Center for Bioenergy Sustainability, Oak Ridge National Laboratory, Oak Ridge, TN, (2)Waterfall Group, Canada, Vancouver, BC, Canada, (3)The Argentine Standards Institute (IRAM), Buenos Aires, Argentina

Abstract:
In 2009 the International Organization for Standardization (ISO) created a project committee to develop an international standard to provide guidance on Sustainability Criteria for Bioenergy. Four working groups were assigned specific tasks. This paper summarizes the results of the working group created to critically assess and present results on "indirect effects," beginning with the topic of food security impacts from bioenergy production. From May 2011 to July 2013, this group reviewed and critically assessed over 160 publications on indirect effects (e.g., approaches to model indirect land use change) published between 2004 and 2013. The working group delivered a total of four reports, which were presented to the larger project committee to guide the development of the standard based on consensus. The report submitted in February 2012 contained a consensus statement by the working group members on the current state of science of indirect effects, which guided discussions within the project committee. The report highlighted that the science on indirect effects is "nascent and rapidly evolving" and summarized the conclusions and recommendations, based on the literature reviewed and the expertise of the work group, as follows:
"(T)he state of science, in terms of evidence based research, is inconclusive or contradictory regarding indirect effects of bioenergy. … An economic operator should not be held responsible for indirect effects and variables that are outside the operator's control." "Recent modeling (of indirect effects) has highlighted potential impacts as well as the high variability in results though much of the modeling thus far has relied on assumptions that may not be supported by empirical evidence. To date, there has been limited causal analysis to support assumptions underlying indirect effects modeling." "There needs to be equitable treatment of direct and indirect effects for any energy options being analyzed including baseline fuel(s) that would be replaced by proposed bioenergy sources."
This paper is authored by the co-convenor and secretariat of this working group and for the first time presents its findings outside of an ISO context. In this paper the authors discuss the process to reach the above conclusions and the use of ILUC in other standards, provide a literature review based on contributions by experts participating in the working group, and offer some conclusions about indirect effects as they relate to bioenergy production.

Financial Support: IRAM, ORNL, U.S. Department of Energy, Waterfall Group

9:50 AM Trajectory of Wood Energy Policies in the United States: Sustainability and Governance in Global Markets

Dennis Becker, Forest Resources, University of Minnesota, Saint Paul, MN

Abstract:
Expanded wood energy production in the United States would accomplish many societal and economic objectives. It could also contribute significantly to efforts to restore forests and reduce the risk of catastrophic wildfire. But not all biomass is created equal. Concerns exist domestically and globally about the procurement of woody biomass and market-driven impacts on forest ecology, water quality, air emissions, and global greenhouse gas concentrations. A policy analysis framework is presented that couples sustainability concerns with multi-jurisdictional governance mechanisms intended to neutralize

negative impacts. Policy gaps are highlighted along the supply chain to illustrate areas for improved coordination and policy development.

10:10 AM Biofuel Sustainability in Latin America and the Caribbean: A Review of Recent Experiences and Future Prospects

Robert Bailis[1], Barry Solomon[2], Christine Moser[3] and Tina Hildebrandt[3], (1)School of Forestry and Environmental Studies, Yale University, New Haven, CT, (2)Department of Social Sciences, Michigan Technological University, Houghton, MI, (3)Leuphana Universitat, Luneburg, Germany

Abstract:
The Latin American and Caribbean (LAC) region is a leader in global biofuel production, accounting for 27% of supply. This is driven by a proliferation of mandates and targets calling for increased use of biofuels around the world. While biofuels are theoretically renewable, unsustainable production can alter landscapes and stress social-ecological systems. To mitigate impacts, different types of governance mechanisms have been introduced including national regulations, voluntary certification schemes, sustainability standards, meta-standards, and codes of conduct. Voluntary certification has gained prominence in the region, with nearly 200 producers and processors in 13 LAC countries obtaining certification . However, given the potential social and environmental impacts evident in the region, voluntary certification may be insufficient and stronger sustainability mechanisms may be justified.