Special Issue on Pan American Biofuel and Bioenergy Sustainability

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This editorial will introduce a set of seven articles appearing in this Special Issue on Pan American biofuel and bioenergy sustainability. We will discuss the importance of sustainability in biofuel and bioenergy development and rationale for a focus on the Pan American region. These articles are one outcome of a US National Science Foundation-funded project, and we will list the project goal, objectives, and activities. We will also provide short overviews of the articles.

The implications of large-scale biofuels and bioenergy production on environmental systems and social conditions are largely unknown. Yet despite this lack of fundamental sustainability knowledge, there is sustained interest in development of biofuels and bioenergy production systems that will concomitantly lead to changes in extant human and natural systems. These changes may be beneficial or detrimental, and may involve: land ownership and management, creation of new employment opportunities, occupational safety, unforeseen transportation and logistical challenges, impacts on water availability and quality, potential competition with food production, among others.

The Pan American region is of interest to study for biofuel and bioenergy sustainability because of its dominance in global biofuel production, its large biofuel production capacity because of abundant land area and

favorable soils and climate, its possession of a significant fraction of the world's biodiversity, large agricultural sectors, and rich policy experience. The articles in this Special Issue are organized into two main categories: natural and social sciences; and systems analyses.

Natural and Social Sciences

Biogeochemical Science

Gollany et al. (2015) review the current state of knowledge and highlight gaps in research on biogeochemical processes related to biomass production. The article discusses biomass production from both agricultural and forest sites, including short rotation woody crops. It analyzes overarching biogeochemical cycling issues as well as on-site and off-site impacts. Research gaps in field experiments and modeling domains are thoroughly examined and the article concludes that researchers should engage across interdisciplinary, inter-agency, and international lines to better ensure the long-term soil productivity across a range of scales, from site to landscape.

Hydrological Science

Watkins et al. (2015) argue that large-scale bioenergy production will affect the hydrologic cycle in multiple ways from plot scale to watershed and regional scale. The article identifies key factors affecting water yield from the landscape and the potential influences that bioenergy crops could have on streams flow, water quality, and water availability for other uses. Four Pan American case studies explore energy-related water conflicts and tradeoffs. The article ends with a call for further case specific research.

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Biodiversity Science

Kline et al. (2015) identify the Pan American region as containing among the most diverse ecosystems on Earth, for example supporting over a third of the species in most taxonomic groups in Central and South America. Challenges and opportunities for biodiversity are analyzed through three case studies, in Canada, the US and Brazil. The importance of biodiversity and ecosystem protection in international bioenergy certification programs is highlighted and priorities for future research are provided.

Policy and Sustainability

Solomon et al. (2014) survey the biofuel policies in the five countries from the perspective of sustainability, as well as accomplishments of past policies. In all cases, the policies and production patterns are tied to the preexisting agricultural sectors. The most common policy instruments have been production mandates and tax breaks. Brazilian policies have accomplished the most, Mexican policies the least, with mixed results elsewhere. However, no national biofuel policies fully incorporate sustainability concerns, thus all countries have room for improvement.

Social Sustainability

Selfa et al. (2015) discuss three case studies, in Mexico, Colombia, and Brazil, which highlight some of the social issues and tensions accompanying expansion of the production of biofuels. These include income and food security loss, land concentration, and loss of access to land and natural resources. These problems especially affect peasant farmers, and poor and indigenous communities. The commonalities observed were adverse effects of land-use changes on sustainable livelihoods, which should be addressed by more robust policy and governance tools, including multi-stakeholder initiatives.

Systems Analysis for Sustainability

Biomass Supply Chains

Lautala et al. (2015) address the design and analysis of biomass supply chains for biofuel and bioenergy production and identify key challenges specific to them. The concept of integrated biomass supply chains is introduced with the goal to provide uniform feedstocks to conversion facilities from multiple biomass sources. Factors affecting system performance are highlighted, and models to

evaluate and optimize these systems are introduced. Gaps and challenges in supply chain research are uncovered with recommendations to guide future research.

Environmental Life Cycle Assessment (LCA)

Shonnard et al. (2015) review the recent literature on LCA of biofuels in the Pan American region. The analysis of this literature provides both qualitative and quantitative results to better understand the scope of environmental impacts studied, similarities and differences in study methods, as well as the expected magnitude that these differences make. A case study of renewable jet fuel production from jatropha grown in Mexico illustrates the critical importance that policy-driven LCA methodology has on biofuel LCA results. Recommendations for future LCA research are also provided.

A Research Coordination Network (RCN) on Pan American Biofuels and Bioenergy Sustainability has been established with lead funded by the National Science Foundation (award No. CBET-1140152). This project began in 2011, and includes investment of additional resources from Argentina, Brazil, Canada, Mexico, Panama, US, and Uruguay. The goal of this RCN project is to create a community of biofuels/bioenergy researchers and industry/government/NGO practitioners concerned with sustainable biofuels and bioenergy development across the Americas. The objectives are to establish and sustain an international RCN with a focus on biofuels/bioenergy sustainability in the Pan American region; to develop coordinated research programs; and to create new knowledge on social, environmental, and economic sustainability implications of large-scale biofuels/bioenergy production from biomass grown in this region. To accomplish these objectives, three workshops were held: in Merida, Mexico (May 29–31, 2012); in Buenos Aires, Argentina (May 28–30, 2013); and in Houghton, Michigan (June 3–5, 2015), and a larger conference in Recife, Brazil (July 22–25, 2014). A 3-credit graduate course was offered in late 2014, with students and faculty from several universities across the Pan American region using internet-based live video-conference technology. A Research Roadmap Report has been developed, summarizing the state of knowledge, gaps in knowledge, and recommendations for future research.

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