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Editorial

Scaling up biofuels? A critical look at expectations, performance and governance

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ABSTRACT

This editorial is the introduction to a Special Issue of Scaling Up Biofuels? A Critical Look at Expectations, Performance and Governance which assesses biofuels contribution to sustainability governance and upscaling. The issue aims to contribute to a more informed, evidence-based policy debate on the role of bioenergy for sustainable development. It comprises six review papers that share a solutions-oriented and policy-focused approach towards the assessment of sustainability. Bioenergy production and consumption is not evaluated as an isolated industry or additionality. Instead, it is assessed as an inherent component of the broader social-ecological system and history of which it forms a part. Synthesizing available empirical evidence on performance, and contextualizing the evidence in view of expectations and bioenergy governance in and over time, the papers address the role of biofuels for climate mitigation; their ability to deliver on socio-economic policy expectations; the actual performance in view of risk anticipation and mitigation; the role of state policy considering sector development and sustainability; and the ability of certification schemes to deliver on market conversion, and quality. The synthesis paper draws on the empirical findings to develop a set of sustainability conditions (*sine qua nons*) that have to be considered in processes of policy making and upscaling.

1. Introduction

Bioenergy is a vital part of the sustainable development strategies of nation states and international institutions, from national bioeconomy programs to IPCC climate mitigation, or the 2030 Agenda (Edenhofer et al., 2011; Intergovernmental Panel on Climate Change (IPCC), 2015; UN General Assembly, 2015; IEA and OECD, 2013; Gota et al., 2015). As a result, the modern energy mix increasingly depends on the combustion of biomass-derived agrofuels, such as biogas, bioethanol, and biodiesel. In addition, the use of traditional biomass-derived energy sources (wood and charcoal) has undergone re-labelling as modern energy sources in those countries where technology permits for greater efficiency in its consumption (e.g., pellets heating systems). According to the International Renewable Energy Agency (IRENA) appraisal, "modern bioenergy has the potential to become the most important source of growth in renewable energy use by 2030" (IRENA, 2016). Compared to the alternatives, such as wind and solar energy, bioenergy is the only renewable energy that is proficient at providing scheduled baseload power, explaining the attention and upscaling ambitions given to it by policy makers and energy providers (Bracmort, 2011; Australian Business Council for Sustainable Energy, 2007).

Upscaling the use of modern bioenergy in the form of liquid biofuels – the focus of this Special Issue – is promoted under the assumption that it can support several transformative yet unresolved policy goals, such as transitioning towards a more secure and climate-friendly energy system, realizing "green growth" objectives of rural development and employment, and/or allowing countries to comply with international commitments, such as the Sustainable Development Goals (particularly Goal 2) which request the doubling of the share of renewables in the energy sector by 2030 (IRENA, 2016). A 2015 synthesis report of Intended Nationally Determined Contributions to the Paris Agreement shows that already, the largest global share of mitigation measures in the transport sector – a sector that accounts for approximately 23% of today's energy-related CO2 emissions - focuses on "decarbonizing fuel" through the use of biofuels (Gota et al., 2015). While countries like Brazil continue to push for "explor[ing] the full potential of biofuels as a mitigation tool" in the context of the United Nations Framework Convention on Climate Change (UNFCC, 2013); about seventy-six states, provinces, or countries had adopted biofuel mandates as of 2012, and global subsidies for liquid biofuels were valued to exceed US$20 billion in that year alone (Worldwatch Institute, 2014).

In practice, however, these policy aspirations with their assumption of biofuels' sustainability and scalability need to be critically re-visited. These anticipations often conflict with actual trends of bioenergy production and consumption, and an emergent scholarship documenting a range of environmental and social harms of (1st and 2nd and, increasingly, 3rd generation) biofuels or biogas (Hunsberger et al., this issue; Mohr and Raman, 2013; Haberl et al., 2010; Mwirigi et al., 2009; Boulamanti et al., 2013; MacKay, 2009; Lam and Teong Lee, 2012).

A growing literature puts into question many of the expectations that are frequently "bundled" with cleaner energy – such as job creation, rural development and decentralized energy production (e.g., Hunsberger et al., this issue; Li, 2011). Emerging empirical research also highlights the significance of land-related problems confronting bioenergy production in the form of land grabbing, environmental degradation, deteriorating public health, or competition with food production (Borras et al., 2010; Fairhead et al., 2012; NDRC, 2015; Fargione et al., 2010; Goetz et al., this issue; Hahn, 2008). The major share of these socio-economic and ecological harms and sustainability problems of bioenergy production are

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(expected to be) borne by societies and ecosystems of tropical and non-industrial countries (Buchholz and Volk, 2012); while research documents the use of unsustainably produced bioenergy in major importer countries (e.g., Europe), pointing to (global) governance challenges as well as environmental and social justice issues linked with bioenergy (Godar et al., 2016; NRDC, 2015). Even the mitigation potential of biofuels has been contested – both regarding the ability to reduce CO2 emissions (compared to fossil fuels), but also concerning sufficiently large-scale supply availability (Searchinger et al., this issue; Searchinger et al., 2008; Searchinger et al., 2015; Plevin et al., 2010; Njakou Djomo and Ceulemans, 2012; Jefferson, 2013a, 2013b; MacKay, 2009; Childs and Bradley, 2008). Meanwhile, a substantial number of companies are struggling with the economic viability of bioenergy projects (Ottinger, 2009; Goetz et al., this issue), and production output has been unstable over time (Worldwatch Institute, 2014; EIA, 2013). Together, these observations call into question biofuels' utility for solving any of the multiple energy sustainability issues today.

The highly confident policy aspirations also reflect the necessity to scrutinize those bioenergy scenarios and simulation models that put forward the promise of sustainable bioenergy futures. Analyses of modelled (future) realities seem to be important points of reference for policy makers, supporting as well as influencing perspectives of future bioenergy demand and production feasibility. A brief Scopus or Google Scholar search using the terms "biofuels and sustainability" reveals the major share of research on biofuels continues to consist of scenarios and simulation models evaluating the *potential* environmental and/or socio-economic repercussions and/or physical limits to upscaling of bioenergy production – rather than empirical case studies.

A major problem then is that the assumptions upon which such projections are based – such as the idea of relevant and timely technological progress and/or the existence of and orientation towards economic equilibrium – work as built in "technological fixes." So does a model's focus on one variable (e.g., CO2) and/or single-factor causality, which yields policy recommendations that focus, for example, on carbon storage without acknowledging the complexity of interdependencies and/or conflicts with other variables (e.g. biodiversity, land rights, food availability and price). This allows researchers and policy makers to perceive the empirical evidence on the multiple biophysical or socio-economic challenges of bioenergy production and upscaling as transient or negligible phenomena (Haberl, 2016; Msangi and Evans, 2013; Negash and Swinnen, 2013; Naylor et al., 2007; Jefferson, 2014). In other words, such modelled analyses of bioenergy sustainability tend to be biased towards projecting how things *could* work out in the future, *if* the models' assumptions hold true (Searchinger et al., this issue). The tendency is to generate an optimism that generates a focus on what could be, at the expense of addressing contemporary sustainability challenges and particular environmental or social justice issues linked with bioenergy and the (increasingly large-scale) agricultural production that accompanies it (see Hunsberger et al. (this issue), Goetz et al. (this issue), Oliveira et al. (this issue)); while disregarding historical knowledge about energy transitions (Jefferson, 2014).

Regardless of the particular method used, the empirical knowledge base for judging the full sustainability implications of bioenergy remains weak (Haberl, 2016; Erb et al., 2016; Souza et al., 2015; Sovacool, 2014); and scenarios generally suffer from enormous uncertainties, due to unidentified feedbacks and future trends as well as the decontextualization of diets, agricultural technology, land use patterns, business models, climate change impacts, or energy crop yields (Haberl, 2016; also Searchinger, this issue) – all of which are key aspects for effective insights on sustainability and scalability. Haberl (2016), for example, concluded that the diverging estimations of future bioenergy availability and its contribution to GHG emission reductions make it impossible to ascertain reliable numbers regarding sustainable bioenergy potentials at this stage.

The Special Issue *Scaling up Biofuels? A Critical Look at Expectations, Performance and Governance* analyses under what circumstances bioenergy does and can deliver on the different policy goals often attached to it, while drawing on the literatures on change management and scalability to distill lessons on whether and how to upscale bioenergy. The focus is on biofuels, both bioethanol and biodiesel. Clearly, the sustainability challenges of the first generation of biofuels has shaped prominent questions in the current policy debate with its focus on how to facilitate growth of bioenergy production and consumption (e.g., Mohr and Raman, 2013; The Royal Society, 2008; Union of Concerned Scientists, 2008; Gustafson, 2015; Grunwald, 2008). In this context, the debate on biofuels' sustainability and scalability remains largely focused on predictions and options regarding related land take, land governance, land competition, and land use change (e.g. German, 2015; Borras et al., 2010; Ottinger, 2009; Grain, 2013; Alves Finco and Doppler, 2010). The main questions being asked revolve around issues of technology and land availability: Is it possible to increase the biomass produced without compromising other land uses and values? Are there land reserves to expand cultivation? How can we ensure ecological sustainability? Particular emphasis is on implications for food security, biodiversity, and land grabbing. Mounting evidence on forced evictions of customary land users for biofuels plantation development; the destruction of tropical forests and natural habitats in the process of upscaling of palm oil production; and/or the 2007/2008 and 2011/2012 food price crises have drawn international attention to the many troubles that are linked (though not unique) to biofuels production (Childs and Bradley, 2008; NRDC, 2015; von Braun and Tadesse, 2012; Yule, 2010).

With this Special Issue we aim to raise awareness of the fact that these questions (and related answers) are necessary yet insufficient inputs into the holistic assessment and meaningful understanding of biofuels' sustainability, even more so in view of the widely pursued policies that aim at dramatic and fast-track upscaling (Colchester and Chao, 2011; Worldwatch Institute, 2014; Buchholz and Volk, 2012). In order to understand the sustainability of biofuels in view of their social, economic and ecological dimensions in and over time and in consideration of the sustainability of upscaling, we need to account for issues of national and global environmental and social justice; the distribution of benefits (and costs); take a more critical perspective regarding the assumptions of modelled futures; re-evaluate the prospects of states and enterprises to govern for sustainability (De Man and German, this issue; Oliveira et al., this issue); and consider short-term as well as long-term opportunity costs of the decision to maintain and/or expand bioenergy production and consumption and the related dangers of creating new energy infrastructures that lock in a different set of unsustainable energy production and consumption patterns; without necessarily delivering on associated policy goals, such as improving energy security.

2. About the special issue

The issue aims to contribute to a more informed, evidence-based policy debate on the role of bioenergy for sustainable development. It comprises six review papers that share a solutions-oriented and policy-focused approach towards the assessment of sustainability. Bioenergy production and consumption is not evaluated as an isolated industry or additionality. Instead, it is assessed as an inherent component of the broader social-ecological system and history of which it forms a part. Hence, synthesizing available empirical evidence on performance, and contextualizing the evidence in view of expectations and bioenergy governance in and over time, is relevant for policymakers, market participants, and civil society. These insights can inform forecasting, risk management, policy development and monitoring in view of sustainability generally, and upscaling in particular.