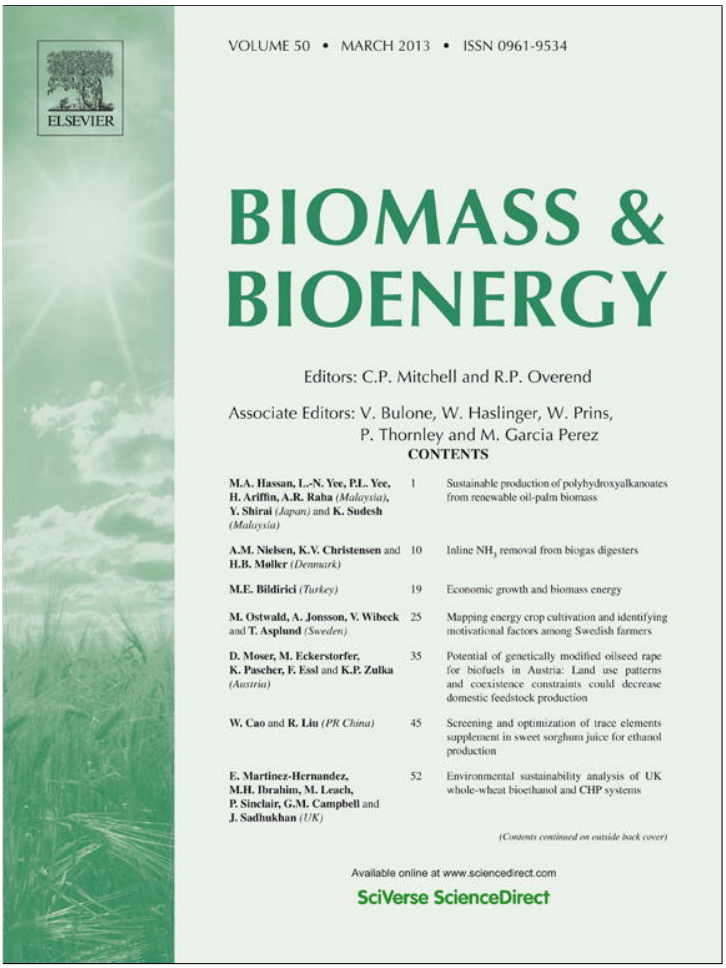

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Short communication

Do we need a unified appraisal framework to synthesize biofuel impacts?

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ABSTRACT

In the past decade a significant evidence base has been built about biofuels' environmental and socioeconomic impacts. What is still missing is a discussion about whether it is desirable, or even feasible, to synthesize this evidence in a clear, coherent and policy-relevant manner, and if so, how exactly such a synthesis should be conducted. This Short Communication presents arguments for and against the adoption of a unified framework for synthesizing biofuel impacts, and seeks common ground between the two perspectives.

1. Background

Biofuels are a class of liquid fuels (e.g. bioethanol, biodiesel) mainly derived from sugar, starch and oil-bearing crops, animal fats and lignocellulosic material through diverse chemical and biological processes [1]. Biofuel production and consumption have expanded rapidly in several parts of the world due to interconnected policy concerns such as energy security, rural development and climate change [2]. Biofuel production and the biofuel-related literature have followed very similar trends (Fig. 1). According to Scopus more than 4000 biofuel-related academic papers were published in 2011 alone, compared to just under one hundred ten years earlier (Fig. 1).

Fig. 1 shows that the biofuel literature has expanded significantly since 2005 and particularly during periods when major biofuel policies were decided, such as the EU Renewable Energy Directive (EU-RED) in 2009 and the US Energy Independence Act in 2007. It seems that the biofuel controversy that erupted during the preparation of these policies catalyzed biofuel research across the world. As a result, rather than

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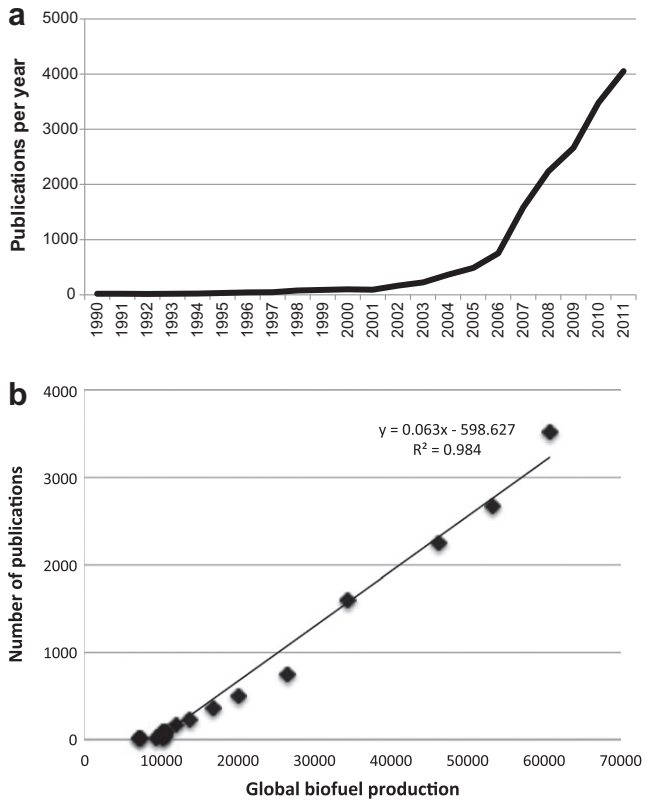

Fig. 1 – Number of peer-reviewed biofuel publications in Scopus per year (1a) and correlation between global biofuel production and number of publications in Scopus (1990–2010) (1b).

being curiosity-driven, this research has been overwhelmingly driven by a demand from policymakers, civil society and the private sector for better evidence about biofuels' profitability and sustainability.

Discussions about biofuel sustainability usually focus on a relatively small number of impacts, notably food security, economic profitability, and greenhouse gas (GHG) emissions. Recent biofuel research has brought attention to numerous other important impacts such as biodiversity loss, water consumption/pollution, soil erosion, and social conflicts, which are nevertheless often overlooked in the wider biofuel debate. Additionally, research initiatives such as the Scope International Biofuel Project have identified and discussed these different biofuel impacts but have not attempted to provide comprehensive and coherent conceptual frameworks that can put these diverse impacts and trade-offs into perspective and help to structure the biofuel debate [3]. This has been identified as a major gap in biofuel research and practice [4–6].

This lack of efforts toward the development and use of frameworks that can synthesize in a comprehensive and consistent manner the multitude of biofuel impacts raises a dilemma that has rarely been addressed by biofuel experts. Should we synthesize the existing evidence of biofuels' diverse environmental and socioeconomic impacts through a single, coherent and unified framework, or should we instead illustrate the various, often mutually incompatible perspectives embraced by the different biofuel appraisal approaches in a disaggregated manner?

In this Short Communication, we present arguments for both viewpoints ('thesis' and 'antithesis'), and conclude by seeking common ground between the two. While broadly agreeing on the problem definition, the authors of this article hold different views on the desirability of a unified synthesis framework. The "thesis", presented in the next section, is defended by AS and PS, whereas ML puts forward the "antithesis" in Section 3.

2. Thesis: synthesizing the biofuel literature with a unified framework can improve biofuel policymaking (AS and PS)

Concerns over biofuel sustainability have become more prevalent in the past few years, as numerous policy instruments that aim to promote biofuel sustainability have been put in place [7]. For example, policies such as the EU-RED have specified some sustainability criteria (e.g. GHG emissions, biodiversity loss, impact on food security) that a biofuel practice needs to fulfill before it can be widely adopted within the EU. Voluntary certification schemes have articulated several additional social and environmental sustainability criteria for biofuels and biofuel feedstocks [8,9].

An array of powerful appraisal techniques ranging from life cycle assessment (LCA)-based techniques to remote sensing, econometric models and complex land use change models, to name just a few, has been employed to assess the broad range of sustainability impacts associated with biofuel production and use. Yet, we are still missing a way to synthesize this body of evidence in a clear, cohesive and policy-relevant manner. Considering the demand for sustainable biofuels, the research community has to at least assess the feasibility and the benefits that such syntheses can offer.

We argue that synthesizing biofuels' trade-offs through a consistent conceptual framework is as important as ensuring a robust assessment of individual sustainability impacts. In our opinion, the lack of such unified syntheses contributes to a piecemeal understanding of biofuel sustainability and may have already compromised the effectiveness of policies concerned with biofuel sustainability such as the ones mentioned above.

We suggest that two very promising unifying frameworks are sustainability science and the ecosystem services (ES) approach. Sustainability science is an emerging field of research that deals with the interactions between natural and social systems, in particular with the ways in which these interactions can meet the needs of current and future generations [10]. The ES approach, in turn, aims to identify and assess the multiple benefits that humans derive from ecosystems (directly and indirectly) as well as the mechanisms through which ecosystem degradation can compromise human wellbeing [11,12]. There are at least four interrelated reasons why we believe that the synthesis of the available biofuel evidence with these two frameworks can contribute positively to the current biofuel debate.

First, both frameworks employ a systems-perspective. They explicitly seek to link environmental impacts and human wellbeing, two key elements of the biofuel debate

evoked by supporters and critics of biofuels alike [6]. In fact, both frameworks have been extensively used to study coupled social-ecological systems such as those in which biofuel production and use take place, and can capture all major drivers and impacts associated with such activities [2]. As a result they can help stakeholders to obtain a better understanding of the full range of biofuel trade-offs across different spatial and temporal scales. Synthesizing and communicating the complex dynamics and trade-offs of biofuel production and use in a robust yet understandable way is something that other biofuel sustainability assessment frameworks in their current format miss [6].

Second, transdisciplinarity is a key element of both frameworks, thanks to their ability to integrate insights from different knowledge sources, including the natural and the social sciences, as well as experiential and local knowledge. Furthermore, they can accommodate empirical findings from diverse economic, biophysical and indicator-based valuation tools that represent radically different value perspectives [12,13]. The methodological pluralism embraced by both frameworks is particularly desirable when dealing with complex and politically charged issues, such as biofuels, as it can offer useful information to a wide spectrum of actors that usually hold very different perspectives regarding biofuel impacts [14,15].

Third, both frameworks approach research questions in a use-oriented, rather than a curiosity-driven manner, linking thus practical knowledge with action [10,12]. This means that they are ideal for tackling practical problems associated with human activity and its environmental and socioeconomic impact. Thanks to this use-orientation both frameworks are sensitive to stakeholder needs and requirements and can provide practical advice that can be integrated in biofuel policies.

Fourth, sustainability science and the ES approach are widely accepted internationally by academics, practitioners and policymakers. Methodologically both frameworks have evolved and matured over the past decades through the efforts of hundreds of scholars and practitioners around the world. Even though sustainability research was initially pursued in a rather disjointed manner by different academic disciplines, there is strong evidence to suggest that the sustainability science field has coalesced and reached greater unity during the last decade [16]. On the other hand, the ES community has held a relatively shared understanding of the main ES concepts and tools. Large-scale research initiatives such as the Millennium Ecosystem Assessment (MA) and the Economics of Ecosystems and Biodiversity (TEEB) were instrumental in building this shared conceptual basis. The term "sustainability" often appears in national legislation, international policy instruments (e.g. UN Convention on Sustainable Development, UNCSD) and numerous academic and educational initiatives [10]. The ES approach has been adopted by the UN Convention on Biological Diversity (CBD), is increasingly operationalized in national and international policies through multiple efforts [17] and is a major theme of the forthcoming Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES).

However, despite these attractive features, to our best knowledge, the two frameworks have rarely, if ever, been applied to synthesize the evidence about biofuel impacts and thereby to frame, explain, assess and convey the direct and indirect impacts of biofuel production and use.

We strongly believe that such syntheses will be a great leap forward. They can potentially complement and improve the quality of existing policies that aim to enhance biofuel sustainability, not least by providing an integrated knowledge of biofuel impacts. Such knowledge can allow for the better understanding of the trade-offs associated with biofuel production and use and can pave the way for a broader social mandate that is a pre-requisite for effective biofuel governance [15].

3. Antithesis: unified synthesis as a pipe dream and a distraction (ML)

While improving the evidence base directly usable for biofuel decision-making is a worthy objective in itself, a single framework for capturing and synthesizing the entire richness and breadth of issues at stake in a biofuel appraisal is bound to remain not only incomplete, but possibly also counterproductive to the broader pursuit of biofuel sustainability.

The starting point of my discontent with the "thesis" presented above is the emphasis on biofuel appraisal as essentially a technocratic and formalized assessment procedure, in which 'objective appraisal' leads straightforwardly to 'better' decisions via instrumental forms of learning [18,19]. However, appraisal entails more than just a set of procedures and involves a range of activities through which different types of knowledge, "*understandings, and evaluations are constructed and rendered salient to inform*" commitments to given courses of action [[20]: p. 265]. Therefore appraisals can be perceived as "value articulating institution" considering that they contain "*rules concerning a) who should participate and in which capacity, b) what is considered data and which form data should take, and c) […] how a conclusion is reached*" [[21]: 2207]. In this wider definition, the term 'appraisal' covers not only formalized assessment routines, but also wider sociopolitical discourse. In biofuel policies, social appraisal can include parliamentary inquiries, government reviews, advisory body reports, reviews conducted by international organizations, and academic or commercial assessments. Wider discursive aspects of biofuel appraisal include media interventions and nongovernmental organization initiatives.

More often than not, biofuel policymaking is characterized by unclear objectives, pervasive uncertainties, and many actors pursuing multiple goals. Direct and smooth transfer of appraisal knowledge to such policymaking contexts is therefore a rare exception, as opposed to the much more common indirect, uncertain, and unpredictable "seepage" of information [22]. From this perspective, four specific reasons undermine and partly invalidate the case for a synthesis framework.

First, not all disputes on knowledge can be resolved simply by providing more and better information. Often the opposite is the case, particularly when better knowledge merely provides an additional layer on the top of existing political battles, and enables policy advocates to better argue their positions [23]. This has often been the case in biofuel contexts [e.g. [24]]. The main objective of appraisal should therefore

be to help elucidate the different, equally legitimate, perspectives related to biofuel production and use, rather than merely seeking to provide "better information".

Second, knowledge can have a significant political role, as an instrument of power and legitimization in political arenas. Aiming to "structure the biofuel debate" essentially entails an attempt to frame the issues at stake. It also suggests that a single biofuel "debate" exists, whereas in reality biofuel decision-making encompasses various (often mutually incompatible) "debates" that are strongly influenced by the diverse values, preferences and expectations of the involved parties. In an appraisal context, framing involves a number of activities, frequently seen to lie outside of the scope of appraisal, including the choice of policy questions, setting of research priorities, choice of relevant and legitimate disciplines, formation of hypotheses and interpretation of uncertainties [20]. Often the main controversy in appraisals concerns precisely this process of framing the debate, which essentially determines the priorities between rival perspectives, worldviews, and belief systems. Different biofuel stakeholders often hold radically different perceptions about the impact of biofuel production and use, largely because of the differences in the ways in which they frame biofuel sustainability [14,15]. Imposing a mutually accepted (indeed, accepted by whom?) synthesis will be unlikely to bring these different perceptions and framings closer together, let alone eliminate the controversies and frame conflicts. A biofuel expert should certainly seek to reduce ambiguity by providing clarity and better evidence for policymakers and stakeholders. However, an exclusive focus on such an instrumental role of expertise in policymaking, whereby decision-makers are assumed to simply pick up the knowledge and policy recommendations emanating from research, would tend to obscure other, more indirect roles of expertise [25]. Knowledge uptake is shaped by a variety of factors, while it frequently has a 'conceptual' role of gradually shaping the participants' perceptions, ways of thinking, beliefs and worldviews; challenging received wisdoms; and clarifying points of convergence and disagreement by rendering them more explicit.

Third, the search for a unifying conceptual framework, in the name of ensuring an integrated synthesis of biofuel trade-offs and avoiding ambiguity, adheres to an ideal of holism. Yet, such an ideal obscures the irreducible conflicts between competing paradigms and worldviews, as well as the complexity of the real world. Any overarching synthesis framework embodies an implicit or explicit, non-neutral belief system, and imposing such a framework risks downplaying real and significant differences between diverging normative, interest-based and epistemic perspectives. For instance, the ES approach has been criticized for overlooking ecological, economic, and political complexities [26]. In addition to unduly reducing the multiplicity of perspectives, "unified" frameworks may also ignore important concrete needs and interests of communities, which have been poorly or not at all represented in the construction of the synthesis framework [27]. Hence, the claim that the ES approach and sustainability science, or any "synthesis framework" for that matter, "can capture all major drivers and impacts associated with [biofuel] activities" begs the question: "major" as defined by whom? By choosing a particular synthesis framework, an analyst at the same time chooses the worldview underpinning this framework, and imposes this worldview upon the policy actors as the sole, or at least primary, acceptable prism through which to approach biofuel issues. In doing so, the analyst removes from discussion, inadvertently or on purpose, fundamental issues of framing that belong to the decision-making sphere – the sphere of policy commitments [20] – rather than appraisal [e.g. [28,29]]. In practice, the analyst hence runs the risk of privileging already dominant perspectives, including the very definition of sustainability, and serving the powerful voices and actors that frequently seek to drive the debate toward a premature closure around their preferred solutions.

Finally, the different epistemic perspectives should be at the heart of any useful public policy appraisal, rather than being reduced to a "unified synthesis". Appraisals based exclusively on a unified framework risk to favor 'stealth issue advocacy' whereby competing interests use "*science as a proxy for political battle over these interests*" [[30]: 47]. Assuming a consensus on underlying values and worldviews among the parties involved, as well as on the degree of certainty on the relevant scientific facts and their interpretation (whereas disagreement and uncertainty are a rule rather than an exception) leads to the domination of one cognitive and normative framework over the others, the suppression of uncertainty, and an unjustified narrowing down of the range of choices available to policy makers.

Summing up, even though biofuel debates must, at given decision moments, be closed down in order to arrive at an agreement on a course to be taken at a given point in time, currently the balance is skewed in favor of prematurely "closing down" debates even in situations that would precisely require the opposite. Often, what is needed is 'opening up' the biofuel debates to a variety of equally legitimate perspectives and framings [20], and broadening the range of options available to the decision-maker [31]. Attempts to synthesize biofuel evidence with a single unified framework would further consolidate the dominance of appraisal approaches that seek to prematurely "close down" biofuel debates.

4. Unified synthesis of biofuel impacts or not?

Despite our divergent opinions on whether or not biofuel impacts and trade-offs should be synthesized through a unified framework, all authors of this article agree that any such decision bears significant implications for decision-making. Crucially, any choice between the two significantly conditions the policy process by framing the problem, shaping the type and form of available evidence, and influencing judgments on what type of information and actors are seen as legitimate. As a result, both approaches can offer significant advantages and facilitate biofuel policymaking in certain contexts, while being obstacles to well-informed policy processes in other contexts (Table 1).

At frequent intervals, decisions and commitments to a given biofuel technology pathway or a biofuel policy option need to be made and debates have to be 'closed down'. In such situations, and against the background of a general lack of understanding of the multiple and intricate trade-offs

Table 1 – Strengths, weaknesses and appropriate domains for synthesizing biofuel impacts with a unified sustainability science or ES framework.

Strengths	Weaknesses	Appropriate domains	Inappropriate domains
Adopt a systems-perspective. Transdiciplinary focus. Use-relevant rather than curiosity-driven research approaches. Sustainability science and the ES approach enjoy a broad acceptance among academics, practitioners and policymakers internationally.	Might merely help stakeholders to better argue their entrenched positions. Imposes a single framing of biofuel sustainability, suppressing thus the differences between (often mutually incompatible) stakeholder values, perceptions, expectations, and framings. Obscures ecological, economic, and political complexities and overlooks the needs and interests of communities that have been poorly (or not at all) represented during the construction of the synthesis frameworks. Risks promoting 'stealth issue advocacy', downplaying uncertainty and narrowing down the available range of policy alternatives.	Maize ethanol in the US Rapeseed biodiesel in the EU Sugarcane ethanol in Brazil	Palm oil biodiesel Jatropha biodiesel Soybean biodiesel Sugarcane ethanol outside Brazil (e.g. in Sub-Saharan Africa) Next-generation biofuels

involved in biofuel decisions, a framework that can synthesize the existing evidence base seems useful. Unified synthesis frameworks can be appropriate in "structured" policy situations [9], when facts are relatively certain and policy priorities consensual. In our opinion biofuel domains that can benefit from such a unified synthesis need to combine the following characteristics:

- a consensus among policy actors about the definition and framing of the key problems;
- a substantial body of literature about the impacts of the specific biofuel/feedstock;
- a scientific consensus about the type and magnitude of impacts;
- relatively low uncertainties for each impact;
- a shared understanding among policy actors about the meaning and significance of these impacts;
- a relative consensus among the key stakeholders about the policy goals and appropriate instruments;
- institutions that can benefit from an integrated exposition of the sustainability impacts of the biofuel in question.

Cases in which these criteria may be fulfilled are likely to be found in some decision-making situations concerning maize ethanol (in the US), rapeseed biodiesel (in Europe) and sugarcane ethanol (in Brazil). In such cases a common synthesis framework can greatly facilitate policy formulation, decision-making and help move toward a legitimate closure of the debate.

Nevertheless, biofuel decision-making frequently involves situations in which there are not only considerable scientific uncertainties, but also significant disagreements on values, policy goals and policy instruments, as well as on the interpretation of facts. Such cases are frequent in decision-making on palm oil biodiesel, jatropha biodiesel, soybean biodiesel, sugarcane bioethanol (outside Brazil) and next-generation biofuels. In these cases, a unified synthesis framework could prove counterproductive, as it would tend to prematurely suppress debate and conceal key topics of disagreement. However, we also acknowledge that some decisions concerning US and Brazilian ethanol or EU rapeseed biodiesel entail conflicts and uncertainties that would warrant a disaggregative approach. Conversely, a synthesis framework may also be appropriate in some situations in biofuel domains that in general do not exhibit the characteristics we have suggested.

To conclude, we strongly believe that any decision on whether to adopt a common synthesis framework should be informed by the needs and expectations of the decision-makers and parties involved, as well as by a detailed understanding of the changing policy context. Whichever the choice between a unified synthesis and a disaggregative approach, this choice should ideally be made in collaboration between the analyst and the relevant policy actors. In any case, the reasons for the choice should be provided and made available to the relevant parties, rather than being a priori "imposed" by the analyst. In other words, analysts should not advocate the adoption of a unified synthesis framework (or the rejection of one, for that matter) as a standard recipe in all situations. The challenge for biofuel experts is to remain open and reflexive about the policy implications of their own methodological choices, as well as to be sensitive to the context, the demands from (and the power relations between) the policy actors. Whether through the adoption of a unified framework or a disaggregative approach, the ultimate aim of biofuel appraisals must be to provide a basis for an informed and balanced democratic debate on the one hand, and transparent decision-making on the other.

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