Sustainability indicators: planning ethanol by Strategic Environmental Assessment

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Abstract

Sugarcane ethanol has becoming a promise for partial replacing fossil fuel around the world. In Brazil it is already reality. By planting sugarcane for obtaining ethanol creates global concern over the extent to which the indirect effects of large scale land use change are being evaluated. Despite the benefits from applying environmental tools in the sugarcane ethanol sector, there is a common lack of using a strategic tool for evaluating the planning of this expansion provided in the energetic national plan for more than 4 million hectares for the next decade. Considering the potential contributions of impact assessment to this context, this paper proposes a SEA guideline to conduct the expansion of the industry based on SEA Directive European 2004, as presented by Partidário (2007). This proposition focuses on the watershed boundaries. In order to test the guideline, it was applied to a watershed which is threatened by scarcity of water and pressure over biodiversity and where sugarcane expansion is expected. Nine strategic issues were identified and five strategic decision conditions were linked with them. For each with them we correlate relevant sustainability aspects that resulting in 44 sustainability indicators in total. For the 44 selected indicators, 31 (79%) have available data, easily accessible. These indicators can dynamically evaluate environmental sustainability aspects of the expansion of sugarcane crops for ethanol production, and thus they can show the feasibility of SEA of plans and other strategic decisions related to this issue. For the remaining 13 indicators which data were not obtained, there are two possible paths: supplying the data by the responsible agencies or replacing these indicators in order to establish adequate others with available data. The proposed SEA guideline can be applied for planning expansion of sugarcane crop for ethanol production, thus validating the initial hypothesis in ensuring the sustainability of this sector. The case study indicates a high potential for a complete application of this guideline using existing data, which can support more sustainable decision for taking decision in cropping sugarcane for ethanol.

1. Introduction

Sugarcane ethanol is largely used in Brazil in order to provide fuel for the light vehicle demand. However there are national and international drivers, such as high oil prices and energy security, to increase output. In the state of São Paulo, the main producer, sugarcane crop represents almost 60% of the total cropped area.

In Brazil´s Decennial Plan for Expansion of Energy (PDE) 2020 there are forecasts that the number of cars will almost double from 2009 to 2020 and those vehicles will mainly run with ethanol. According to this plan, the required area of sugarcane to meet this demand will increase from 8 million hectares from 12.6 million hectares, which is an increase of 57.5%.

The concerns related to the indirect consequences of large land use change driven by planting of sugar cane for ethanol is widely emphasized in the literature (Gallardo; Bond, 2011a,b; Goldemberg, 2008; Duarte et al. 2012). In the state of São Paulo there are some environmental tools applied to the sugarcane sector such as Environmental Impact Assessment, Agri-environmental Zoning and socio-environmental certifications. Nevertheless the basis for decision-making is focused on the project level, with a clear lack of impact assessment tools in the strategic level. To assess the expansion of sugarcane crops, addressing environmental, social and economic aspects, it is necessary to apply a strategic-level assessment process with a

sustainability focus (Cashmore et al. 2004; Cashmore et al. 2008; Bond et al. 2012; Bond et al. 2011). Considering this, the framework provided by Strategic Environmental Assessment (SEA) theory has important contributions to the Brazilian ethanol context. In Brazil SEA isn´t a requirement under legislation.

The objective of this paper is to develop a guideline for applying SEA in the context of planning sugarcane expansion based on the approach proposed by Partidário (2007). In particular, the following research questions are addressed:

(i) What are the main relevant strategic issues in undertaking a SEA study in this context?
(ii) What are the main sustainability indicators related to the sugarcane sector for producing ethanol?
(iii) Can be find data for the proposed sustainability indicators?

2. Methods

With the purpose of developing guidelines for SEA in order to facilitate and encourage the application of this tool for planning the expansion of the sugarcane sector in Brazil, several methodologies were identified and studied (Thérivel, 2004; Dalal-Clayton and Sadler, 2005; João, 2005). Despite there being no worldwide scheme to applying SEA, the majority of these have some similar steps. We selected a methodology based on the SEA Directive European 2004 presented by Partidário (2007).

This methodology is composed of three main phases: 1 – critical decision factors and the context for SEA; 2 – Analysis and Evaluation and 3 – Follow up. In this proposition, as it is a recommendation for policy-making, we will focus on the first two phases. For the third phase, we only emphasized its importance and highlighted that indicators have to be used in order to verify the sustainability and to promote appropriate governance to the SEA process. In this paper we only address the first phase.

For testing this approach we have selected a watershed where sugarcane expansion has been increasing in recent years, which is threatened by scarcity of freshwater and pressure on biodiversity. This watershed, called Turvo/Grande, is the fourth largest watershed in the state of São Paulo, covering 15.975 km^2 and 64 cities.

3. Results and discussion

In order to define the strategic issues and Critical Decision Factors (CDF), an extensive bibliographic review was conducted in order to find the most important impacts of sugarcane ethanol production. Nine strategic issues were identified and from those, five CDF were identified. Table 1 presents the strategic issues, the CDF and the main features of CDF which summarize the main issues targeted to sustainability to guide the expansion of sugarcane for ethanol.

Once CDFs were defined, the most important features of the reference scenario and also for the future scenarios are defined, and the next step is related to find appropriate indicators to measure this dimension.

One of the main difficulties in developing this research was finding the appropriate sustainability indicators to better represent the CDF. Whereas the main bottleneck of the SEA technical components are related to scoping or defining strategic questions and to determining the sustainability indicators, the main objectives are: identify the more appropriate relevant issues with this specific focus and identify properly sustainability indicators to represent faithfully these relevant issues.

The sustainability indicators are one of the most relevant technical aspects from the SEA methodology for phases 2 and 3, useful both for building technical studies and for following up the results of planning. For this reason we focused this discussion mainly in the aspects of the indicators.

Table 1 – Strategic issues and CDFs for the watershed-based sugarcane expansion SEA

Strategic issues	CDF	Description
Promotion of sustainable territorial expansion	**Land use change and food security**	It aims to understand the ongoing land use change. It also establishes the relationship between the expansion of sugarcane crops, other agricultural areas, cattle areas and areas devoted to environmental protection. The purpose is to identify whether and how the expected trends of sugarcane expansion occur. Food security is also an issue associated with this context.
Promoting the sustainable management of natural resources	**Environmental services**	From the perspective of environmental services, this topic is related to natural resources, which should be used based on the assumptions of sustainable development. Surface and groundwater, biodiversity and soil are considered whilst natural resources affected. Waste and inputs are added in this balance in order to reduce the consumption of natural resources.
Guarantee of social rights of industrial workers in agricultural and industrial phases	**Socioenvironmental benefits**	Understanding how the expansion of sugarcane areas can affect the socioeconomic and environmental dynamics. The implications in employment generation, wages and income distribution are considered. It also includes issues related to working conditions in sugarcane crops such as slave labor cases among others. Issues related to access of infrastructure and sanitation are related.
Contribution to enhancement of local socioenvironmental benefits		
Maintenance of small and medium farmers in the local/regional economy	**Land ownership and instruments of control**	The evaluation of issues related to land ownership of sugarcane producing areas is included in this topic. The main relevant tools applied to guide the sugarcane expansion is considered that means Agrienvironmental Zoning and Agriecological Zoning and also other planning instruments which have interference with areas for sugarcane expansion such as management plans, watershed plans, local master plans.
Good governance and inter-relationship with the planning sector and other related as well as other existed instruments of control		
Mitigation of indirect, cumulative and synergic impacts associated with the production chain and the supply chain for ethanol		
Meeting the goals of renewable energy production under national energy planning	**Air quality and greenhouse gases**	Aspects related to air quality and health mainly connected to the practices of sugarcane burning are considered. Energy efficiency by cogeneration and emissions reduction of GHG are also related in this matter.
Positive energetic balance and reduction of GHG emissions		

Table 2a and Table 2b correlates the 5 CDFs to 44 selected sustainability indicators. These tables also highlight those indicators which do not have available data by the application of this approach to the watershed studied.

Table 2a – Description of the sustainability indicators and their availability of data

CDF	Environmental indicators	Current availability of data
Land use change and food security	1. Relation between crop area and total area	•
	2. Relation between sugarcane crop area and total area	•
	3. Relation between area with vegetation and total area	•
	4. Relation between silviculture area and total area	•
	5. Relation between cattle area and total area	•
	6. Relation between urbanized area and total area	•
	7. Areas occupied by permanent and temporary crops (by crop types)	•
	8. Amount of production of permanent and temporary crops (by crop types)	•
	9. Number of head of cattle per pasture area	•
Land ownership ...	10. Relation between areas considered with high and medium ability for sugarcane cropping in the agrienvironmental zoning and total area	○
	11. Relation between area considered available for cropping sugarcane and total area	○
	12. Relation between own area and area cropped by sugarcane	○
	13. Number of properties registered in the same location of another property	○
Environmental services	14. Number of monitored points with Trophic State Index, classified as mesotrophic, oligotrophic and ultraoligotroophic, regarding the total amount of monitored points	•
	15. Number of monitored points with the Water Quality Index classified as Good and Optimum in respect of the total amount of points monitored	•
	16. Number of monitored wells which water is classified as potable water relative to the total quantity of wells monitored	•
	17. Total volume of granted water	•
	18. Relation between volume of granted water for irrigation and the total volume of granted water	•
	19. Conflicts due to the extraction or use of surface water and groundwater, per type	○
	20. Annual amount of lost of soil by erosion	•
	21. Annual amount of used agrochemicals	○
	22. Amount of agribusiness waste (vinasse and filter cake) used	○
	23. Relation between area occupied by forest fragments and total area	•
	24. Relation between area occupied by the Conservation Units of integral protection and total area	•
	25. Relation between area occupied by the Conservation Units of sustainable use and total area	•
	26. Relation between Permanent Preservation Areas with vegetation cover and total Permanent Preservation Areas	•
	27. Relation between endorsed Legal Reserve Area and total area	○
	28. Amount of penalties for violations of environmental regulations relating to flora and fauna	○

Legend: without data – ○

with data – •

Table 2b – Description of the sustainability indicators and their availability of data.

CDF	Environmental indicators	Current availability of data
Socioenvironmental benefits	29. Geometric rate of annual growth	•
	30. Urbanization rate	•
	31. Number of formal employment relationships of men and women, according to educational level (agriculture, livestock, industry, civil construction, trade and services in total)	•
	32. Relation between number of jobs in agricultural activity and total employment	•
	33. Relation between the average wage paid to employees in the sugarcane crop and the minimum wage	○
	34. Annual number of people in slave labor	•
	35. Relation between amount of households connected to the sewage system and total households	•
	36. Quantity of treated sewage in relation to total sewage collected	•
	37. Relation between number of households provided with solid waste collection and total households	•
	38. Quality index of landfill of the landfills	•
	39. Annual number of records of accidents associated with sugarcane farming	○
	40. Annual number of records of deaths resulting from work associated with sugarcane farming	○
Air quality	41. Rate of hospitalization for acute respiratory infection in children under 5 years old	•
	42. Relation between number of days and total days in the year, where the air quality standard is exceeded for the parameters: total suspended particulates, inhalable particulate matter (PM10) and Nitrogen Dioxide	•
	43. Number of days per year which sugarcane burning occurred	○
	44. Relation between number of establishments which comply with the goals of phasing out of sugarcane burning and total establishments which still operate with sugarcane burning	•

Legend: without data – ○

with data – •

According to Table 2a and Table 2)b, for the 44 sustainability indicators, 31 (79%) have easily accessible data. The main constraint of this application is related to the *land ownership and instruments of control* CDF, which does not have readily available data for the selected indicators.

Despite this shortcoming, the analysis of these indicators applied to the selected watershed provides important results for the other CDFs:

- land use change and food security: the expansion of cultivated area for cane sugar may occur in areas where coffee, soybeans, beans and rice are grown, because between 2003 and 2010 these crops were reduced both in cultivated area and in quantity produced;
- environmental services: there is already not significant native vegetation, including within protected areas, legal reserves and areas of conservation; the protection area of biota does not reach 5% of the total area of the watershed; and the water quality is in general evaluated as good;
- socioenvironmental benefits: a noteworthy reduction of geometric annual rate of populationgrowth; increasing urbanization rate; the public sewer of the cities does not reach 100%; the occurrence of slave labor in the recent past; and the lack of available data on labor incomes and accidents and deaths in sugarcane crops;
- air quality and GHG: there is only a few monitoring points to represent the meaning of this CDF to the SEA application.

4. Conclusion and recommendations

The case study indicates a high potential for a complete application of this guideline using existing data, which can support more sustainable decision for taking decision in cropping sugarcane for ethanol. The main relevant strategic issues and the related CDFs are presented and they are appropriated for evaluating the planning of the sugarcane expansion for producing

ethanol. The approach by using a watershed as an unit of area of analysis can be useful mainly for obtaining sustainability indicators data.

The 44 sustainability indicators can dynamically evaluate social, economic and environmental sustainability aspects of the expansion of sugarcane crops for ethanol production, and thus they can show the feasibility of SEA of plans and other strategic decisions related to this issue. For the remaining 13 indicators for which data were not obtained, there are two possible paths: supplying the data by the responsible agencies or replacing these indicators with indicators for which data is available.

The good availability of data indicates a high potential for implementation of SEA process to support initiatives in the most important regions for sugarcane expansion. By analyzing the predicted expansion in Brazil, the relevance of such a study is magnified, since the information provided by this proposed SEA is not currently being addressed by any other instrument in Brazil. At least in the watersheds where expansion can be potentially harmful, a SEA could be developed in order to offer better information about social and environmental issues, and also to support the proposition of appropriate monitoring. The SEA results could also be an important support to the development of Environmental Impact Assessments, at the project level.

The proposed SEA guideline can be applied for planning expansion of sugarcane crop for ethanol production, thus validating the initial hypothesis in ensuring the sustainability of this sector. The case study indicates a high potential for a complete application of this guideline using existing data, which can support more sustainable decisions for sugarcane expansion.

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