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SOCIAL LCA IN PROGRESS

Addressing positive impacts in social LCA—discussing current and new approaches exemplified by the case of vehicle fuels

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Abstract
Purpose This paper seeks ways to address positive social impacts in social life cycle assessment (SLCA) and attempts to answer two questions: How can the SLCA methodology be improved in order to systematically identify all potential positive impacts in the supply chain? How can positive impacts be taken into consideration along with negative impacts in SLCA? In order for SLCA to be an attractive tool, it needs to provide users with the possibility to include positive impacts, not as variables stipulating lack of negative impacts but rather as fulfilment of positive potentials.
Methods By scrutinising the social impacts addressed in the SLCA UNEP/SETAC Guidelines today and reviewing approaches for positive impacts in other research fields, a developed approach to capture and aggregate positive social impacts in SLCA is proposed. To exemplify the application, the case of vehicle fuels is used to investigate the possibilities of addressing positive impacts in SLCA. This includes a literature review on potential positive social impacts linked to vehicle fuels.
Results and discussion The subcategories in the SLCA Guidelines are proposed to be divided into positive and negative impacts and complemented with some additional positive impacts. Related indicators are proposed. A draft approach for assessing positive impacts is developed where the proposed indicators are categorised in four different levels, from low to very high potential positive impact. The possibility to aggregate positive social impacts is discussed. Besides multi-criteria decision analysis (MCDA), few useful ideas for aggregating positive impacts in SLCA were found in the literature that mostly focused on surveys and monetarisation. Positive social impacts linked to vehicle fuels (fossil fuels and biofuels) are identified, and the proposed approach is schematically applied to vehicle fuels.
Conclusions The SLCA methodology may be refined in order to better identify and assess positive impacts, and approaches developed for capturing and aggregating such impacts are proposed. Challenges of aggregating positive and negative social impacts still remain. The knowledge on social impacts from vehicle fuels could be improved by applying the proposed approach. However, the approach needs more development to be practically applicable.

Keywords Aggregation · Life cycle assessment · Positive impact · Social assessment · Social impact · Social LCA

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1 Introduction

Life cycle assessment (LCA) is a powerful tool for assessing impacts along the whole value chain of products and has had a great influence on the way products and services are studied and considered today. The life cycle perspective is an integral part of laws and regulations (e.g., EU 2009) and of eco-labelling schemes (ISO 2000). LCA typically focuses on environmental impacts, but recently, the LCA methodology has been extended to include social and socio-economic impacts along the value chain.

This new methodology, social life cycle assessment (SLCA), shares the life cycle perspective with environmental LCA (ELCA), i.e., it considers the full life cycle of products: extraction and processing of raw material, manufacturing, distribution, use, reuse, maintenance, recycling and final disposal. However, SLCA addresses associated social impacts, i.e., effects on human beings and society. In 2009, guidelines on SLCA (Benoit and Mazijn 2009) were released (hereafter called 'the Guidelines'). These Guidelines are the result of a global, open process involving stakeholders from the public, academic and business sectors, and are currently the most established and well-used framework for conducting SLCA.

Although the starting point is the same, there are some distinct differences between ELCA and SLCA. One difference relates to the type of impacts studied. In ELCA, the impacts are normally seen in relation to a no-change scenario and the majority of impacts are negative as regards the Area of Protection (AoP). In some cases, positive environmental impacts are identified, such as accumulation of carbon as a result of biomass production, but in general, the impacts are negative. SLCA acknowledges to a greater extent that positive social impacts are important and are actually one reason why products are attractive to users. The SLCA methodology thus needs to have strategies for including both positive and negative impacts in assessments and ways to clearly present and communicate them.

However, it is not easy to determine what should be counted as a positive impact. A production facility with no child labour is a good feature in areas with a high risk of child labour, but in parts of the world where the risk of child labour is low or negligible, this is a non-issue, or at least not seen as a positive impact. Should the lack of child labour then be considered a general positive impact?

To induce clients and customers to buy their products, producers and retailers try to link these products to as many benefits as possible, in order to balance out any potential negative aspects. Thus, they have an interest in counter-balancing the potential negative social impacts in the product supply chain with positive social impacts. An SLCA includes aspects that producers promote as beneficial to local communities, people and other stakeholders. Fair trade and other labelling schemes allow companies to communicate to customers that a product fulfils certain criteria. The potential to cover and display both positive and negative impacts is a key strength of SLCA, but the lack of well-developed methodology for identifying and assessing the positive impacts is a key weakness.

This paper examines ways to better address positive social impacts in SLCA. More specifically, two issues are addressed: how to improve the SLCA methodology as presented in the Guidelines in order to systematically identify all potential positive impacts in the supply chain and how positive impacts can be taken into consideration along with negative impacts in SLCA. The objective is to take the SLCA methodology one step forward and present identified positive impacts more clearly. We argue that in order for SLCA to be an attractive tool for market actors, similar to ELCA, it needs to provide users with the possibility to include positive impacts, not as variables stipulating lack of negative impacts, but rather as fulfilment of positive potentials.

In order to exemplify and provide more concrete methodological improvements, the case of vehicle fuels is used to investigate the possibilities to address positive impacts in SLCA. The production and use of vehicle fuels can lead to environmental, economic and social impacts. The environmental and economic impacts are relatively well studied from a life cycle perspective, while there has been more limited appraisal of the social aspects with this approach. However, socio-economic impacts are included to some extent in current biofuel policies and certification frameworks (Ekener-Petersen et al. 2014). Looking at vehicle fuel production, positive impacts have been identified in bioenergy production chains, where local employment is often mentioned as a driving force for production but also potential contributions to development of societal services and to improved infrastructure in the area of production. The case study on positive social impacts of vehicle fuels is meant to complement an earlier case study conducted on vehicle fuels (Ekener-Petersen et al. 2014). In that study, a number of vehicle fuels were assessed with SLCA methodology, utilising the Social Hotspot Database (SHDB) (Benoit-Norris et al. 2012). SHDB is a tool for assessing potential social impacts but limited to negative impacts only.

2 Positive impacts in SLCA

In SLCA, the social impacts in SLCA are assessed in relation to an AoP, which in the Guidelines is suggested to be human well-being. According to the Guidelines, human well-being is a description of the state of an individual's life situation. In the Guidelines, human well-being is linked to five different groups of stakeholders: workers, the local community, society, consumers and value chain actors (Benoit and Mazijn 2009)

As outlined in the Guidelines, social impacts can be assessed on two levels, either for a generic product chain on a general level or by conducting a specific assessment of the actual product chain for a specific product. The generic assessments often aim to identify social hotspots, in order to highlight potential risks of substantial negative social impacts and risks to brand reputation, as well as revealing opportunities for social improvements (Benoit-Norris et al. 2012). When performing a generic SLCA study, data on national, regional and/or sector level are often used and the data sources are mainly global databases and reports from the UN, Amnesty International, International Labour Organisation (ILO), World Health Organisation (WHO) and the like.

When performing specific assessments, on-site data from published documents and interviews with stakeholders are the main source of information. The SHDB for may be used for sourcing data to perform a SLCA hotspot assessments. This database contains generic social data, taking a risk perspective (Benoit-Norris et al. 2012).

Positive impacts in SLCA are described in the Guidelines as impacts that go beyond compliance stipulated by laws, international agreements, certification standards, etc. This means that social benefits/social security and public commitment to sustainability issues are impact areas that are considered positive only under the assumption that they provide additional benefits to the stakeholders concerned, i.e., benefits above the level already provided in society. An example is health care not relating to work injuries but provided to workers by a supply chain actor, going beyond the general level of health care provided in the society or the community. Thus, the impacts defined as positive not only are non-harmful to human well-being or indifferent to it but also actually increase human well-being when they materialise.

The stakeholders in the Guidelines are associated with 31 subcategories, including for example child labour, fair salary, health and safety, local employment, cultural heritage and corruption. These subcategories can be seen as different impact areas, within which activities in the value chain may have an impact on the human well-being of the related stakeholder. Most of these subcategories involve a negative impact for stakeholders. However, among the 31 subcategories, a few can be regarded as representing potentially positive impacts, where their materialisation could add to human well-being. These subcategories are social benefits/social security, local employment, public commitment to sustainability issues, contribution to economic development and technological development.

With the heritage from ELCA, mainly focusing on negative impacts, most of the work done so far on SLCA has focused more on the negative impacts or, in generic hotspot assessments, on potential negative impacts. Consequently, methods for assessing the positive impacts together with the negative impacts in a clear way are not yet well developed. However, positive social impacts indicate opportunities for improvement of human well-being and should therefore receive more attention in order to provide a more complete picture of the total social impact from a product or service and enable increased improvements in human well-being.

A review on positive impacts in SLCA by Petti et al. (2014) shows that only a limited number of applications of SLCA have so far explicitly addressed the issue of positive impacts.

They noted that in 13 of the 35 case study papers on SLCA they reviewed, positive impacts were not mentioned at all. In the remaining 22 papers, the utility of goods was identified as a positive impact in two papers. In one paper, all benefits, i.e., wages, holidays etc., were considered positive impacts, even though these are already required by law in many cases (Traverso et al. 2012). One paper distinguished between positive and negative impacts by linking them to the three dimensions of sustainable development, with environmental and economic indicators considered negative and social indicators positive (Vinyes et al. 2013).

Addressing positive impacts can be done in different ways. In a paper by Ekener-Petersen and Finnveden (2013), positive data were handled by inverting the issue, i.e., measuring lack of, or low level of, positive aspects as negative impacts. For example, the social benefit/social security indicator, in itself a measure of positive impact, was measured by expenditure on this item, with low expenditure on a relative scale identified as negative. The underlying assumption is that there is a 'sufficient' or neutral level of expenditure, with lower levels seen as negative and higher levels as positive. This level of sufficiency is not well-established, however, and thus the approach has limited value for identifying positive impacts in general. Such an approach could be useful if the impacts are assessed in relation to performance reference points (Benoit and Mazijn 2009), where there is a set value for acceptable performance. In such cases, a 'sufficiency' level is set and negative and positive impacts can be determined in relation to that level. This is the approach adopted by Ramirez et al. (2014), but they do not explicitly distinguish between positive and negative impacts and do not address the implications of applying their method to positive and negative impacts.

Another approach is taken by Ciroth and Franze (2011), where the negative and positive impacts of different aspects are handled by assigning them values on a scale of positive integers (from 1 for positive to 6 for very negative impacts). Thus, an assessment that is slightly negative in one regard can be aggregated with an assessment that is slightly positive in another regard, without the presence of both negative and positive impacts resulting in zero. Furthermore, a median value can be found taking both types into account. The median, a figure between 1 and 6, then defines the total impact on the same scale. However, a very negative impact may be concealed if aggregated with several positive impacts.

An interesting difference between studies can be seen in the way impacts are considered positive. In the method described by Ciroth and Franze (2011), the absence of a negative issue, such as forced labour, is assessed as a positive impact. However, assessing the absence of a negative impact as positive instead of neutral is questionable. If the goods are not produced at all, the benefits of the positive aspects are lost. However, the negative aspects, such as bad working conditions, are irrelevant if production does not take place; if there is no work, working conditions cannot be either good or bad. It should be noted here that the impact of having a job is measured as positive elsewhere in the method, in the subcategory 'local employment', and not under the negative aspect bad working conditions. In our view, positive impacts are only

those relating to issues that may add value in themselves, such as job creation or capacity building. This view on how to define positive impacts in SLCA is supported by Petti et al. (2014), 'It must be emphasised however that a positive impact is not the absence of a negative one', and by Jørgensen et al. (2008), 'In relation to forced labour, for example, it would not be possible to obtain a "good score", but merely to vary from OK (no forced labour) to poorer'. It is also supported in the Guidelines, as a positive impact must go beyond compliance with laws, regulations, standards, etc.

One reason behind the differing views is the way the context is considered. If the present general behaviour in an area is taken as the starting point, for instance if forced labour is common practice, then the absence of forced labour in a production plant may count as a positive. This perspective is more relevant in a case-specific approach, where the specific context in the different phases of the supply chain is known. In contrast, for a generic approach with no defined specific supply chain, relating the impacts to a general framework such as the core conventions of the ILO Standards (ILO 2015), where the starting point is no forced labour, is more relevant. However, in the case of a specific assessment using this perspective, all other impacts should be considered in the same way. This could mean that in a developed country with strict regulations on e.g. social security, a production plant with a fair, but relatively less extensive, social security programme compared with the general level would be assessed as displaying a negative impact.

Another approach to address positive impacts is the concept of hand printing proposed by Norris (2013) and others (Biemer et al. 2013). The more well-known concept of foot printing (Rees and Wackernagel 1996) aims at assessing the total area of productive land and water required to uphold a specific consumption. This area might be considered a negative environmental impact, as it places a burden on ecosystem services. Hand printing then tries to measure positive impacts in terms of avoided negative environmental impact that would have contributed to the footprint. However, while the activities discussed in hand printing are of a social character, as they often involve interactions between individuals and groups, the impacts in question are still basically environmental.

3 Aggregation of positive and negative social impacts

Once positive impacts are explicitly addressed, the challenge arises on how to aggregate them with the negative impacts identified in the same assessment. To get some ideas on how to assess and aggregate positive (and/or negative) social impacts, a review of peer-reviewed literature including such methods in other areas was performed. First, we looked at familiar methodologies for social assessment, i.e., social impact assessment (SIA). We then searched the scientific database Scopus, using different combinations of search terms such as social, assessment, positive, negative, impact, and aggregation and supplemented by snowballing. A limited amount of approaches was found.

A well-known tool for assessing social impacts is the SIA methodology. Its aim is not to assess products and services, as in SLCA, but to assess the social impacts from implementation of planned programmes, projects and plans (Vanclay 2003). A SIA does not look at whole value chains, but a specific intervention. Typically, this methodology is used in the public sector for infrastructure investments in society but is also commonly applied in the private sector when new industrial activities are being considered.

SIA aims at capturing both negative and positive (beneficial) impacts, on the community or other affected parties, from the assessed object. However, in practice, it appears that the negative and positive impacts identified in a SIA are viewed more as features that should be mitigated or enhanced to make the assessed object as beneficial as possible for the affected parties. Aggregation of the impacts to a final outcome, in order to conclude whether the object is beneficial overall, seems to be less common. According to Esteves et al. (2012), 'SIAs often do not meet public expectations of being a deliberative process to determine the acceptability of a project. Rather, they are seen at best, as a process for incremental project improvement'. Furthermore, it has been concluded that the distributional perspective, identifying the spatial, temporal and stakeholder distribution of impacts and benefits, is sometimes lacking in SIA (Esteves et al. 2012).

To conclude, the SIA methodology does not offer useful approaches for aggregating positive and negative impacts in SLCA, although it offers methodological experiences on how to measure and identify social impacts on specific sites.

Positive impacts are included alongside negative in some assessments of specific products and services, such as analyses of large-scale sporting events, tourism affecting specific sites and social impacts associated with mobile phones. For example, Kim et al. (2015) developed an instrument comprising a multidimensional measurement scale to measure local residents' perceived social impacts from hosting large-scale sporting events in the case of a specific racing sports event, including positive and negative social impacts. Lindberg and Johnson (1997) used a cost-benefit framework based on contingent valuation for measuring social impacts of tourism, while Lindberg et al. (2001) used economic modelling in their assessment of social gains and losses of tourism. Wilhelm et al. (2015) aimed to assess both the negative and positive impacts associated with the lifecycle of mobile phones but focused mostly on possible improvements of the negative impacts.

In sum, many analyses including both positive and negative impacts tend to focus on mapping the perceived social impacts based on surveys and interviews, in most cases

translating them into economic values. The methods seem mainly to be based on cost-benefit analysis (CBA), where costs and benefits for a certain activity are identified, if necessary monetised and then aggregated. Using surveys and questionnaires in SLCA can be very challenging when aiming at assessing the full life cycle in all its complexity. Moreover, monetarisation of social impacts is not commonly proposed and supported in the realm of SLCA. Hence, the usefulness of CBA and other similar approaches for handling positive impacts in SLCA can be viewed as limited.

In addition, most of the positive social impacts assessed in existing approaches relate to the use phase of the product/service. However, the use phase is currently not generally addressed in SLCA studies, due to lack of proposed methodology for assessing this phase in the Guidelines and subsequent approaches. Since existing analyses mostly are tailored for a specific product category and thus are difficult to generalise, they do not appear to provide much input for the assessment approach we are seeking for SLCA.

One tool that is not specifically dedicated to positive social impacts, but which may be useful, is multi-criteria decision analysis (MCDA), a toolbox of different methods (Dodgson et al. 2009; Jeswani et al. 2010; Zhou et al. 2006). The benefit of MCDA is that it is designed to manage large amounts of complex data in different formats in a systematic way. This means that it can handle both positive and negative impacts simultaneously, even without monetising them. A potential drawback is that it requires a decision maker, or a group of decision makers, to express their values and preferences as input to the process. As no decision-makers, or any easy accessible stakeholders, are available in a generic SLCA process and there is no generic set of values available to enter into the process, an aggregation through MCDA may be challenging to apply.

4 Suggested approach to address positive impacts in SLCA

Taking the social benefits of an activity, in the case of SLCA, the production and consumption of a good or service, as a starting point, the negative impacts addressed in SLCA may be viewed as aspects that must be deducted from the initial benefit, i.e., they diminish the benefit from the activity. This represents a new perspective on social impacts that can be applied to the methodology outlined in the Guidelines.

Using the stakeholder approach in the Guidelines, the first step is to identify the potential benefits of the activity for the different stakeholders. Benefits related to all subcategories should be identified, and not just subcategories identified as having mainly positive impacts, to find out what benefits the negative impacts in fact are deducted from.

To start with, it is important to define the system analysed in relation to the impacts being assessed. In the present study, the starting point is that the supply chain under examination already exists and the social impacts to be assessed are limited to those related to this particular supply chain. The stakeholders are influenced either negatively or positively (or neutrally) by the supply chain activities. If the supply chain ceases to exist, the assumption is that all impacts, positive and negative, will disappear. This assumption may be criticised since, in reality, it is likely that resources in terms of financial capacity, available working hours and raw material freed from the terminated supply chain will be used elsewhere. This is discussed by e.g. Jørgensen et al. (2010), who argue that the non-implemented life cycle must be assessed alongside the implemented life cycle to fully capture all social impacts on the stakeholders. Also, Lagarde and Macombe (2013) discuss the impact on groups outside the conventional supply chain, through the mechanism of competition. However, in the present study, we opted to draw the system boundaries in such a way that alternative use of the resources in another supply chain lay outside the assessment.

As mentioned earlier, the Guidelines list a few subcategories with mainly positive impacts. Drawing on the approach referred to above, we conducted a systematic review of all negative subcategories in the Guidelines in order to identify additional impact areas that might be listed as positive. This was done by reflecting on the benefits implicitly considered to be harmed by the list of subcategories with negative impacts.

First, the subcategories in the Guidelines were amended by introducing an additional column for separately listing the subcategories displaying positive impacts (Table 1). Then, some subcategories currently mentioned as ‘positive’ were judged as only being used to identify negative impacts and were reformulated in a ‘negative’ way. For example, ‘health and safety’ for the stakeholder ‘Consumer’ was reformulated to ‘reduced health and safety’. Additionally, by considering the benefits that the existence of the supply chain could bring to the stakeholder Consumer, which in turn could be harmed by negative impacts, the additional benefit ‘user values’ was identified. Thus, the user value for Consumers could be harmed and diminished for instance by Reduced health and safety linked to consumers, i.e. negative impacts on health and safety from the actual good or service.

It should be noted that no connection is assumed between positive and negative impacts listed on the same row in Table 1. Further, the positive impacts, such as local employment and user values, are assumed to materialise under acceptable conditions, i.e. local employment is per se assumed to imply acceptable working conditions for the workers.

The different subcategories of social impacts, as presented in Table 1, need to be operationalised in more manageable indicators to enable an assessment. Some of the aspects will not be possible to quantify, and in these cases, semi-

Table 1 List of subcategories with positive or negative impacts related to different stakeholders

Stakeholder category	Subcategories with positive impacts	Subcategories with negative impacts
Worker	Local employment[a]	(*Restricted*) Freedom of Association and Collective Bargaining
	Social benefits/social security[b]	(Existence of) Child Labour
		(*Non-*) Fair Salary
		(Excessive or insufficient) Working Hours
		Forced Labour
		(*Non-*) Equal opportunities/discrimination
		(*Reduced*) Health and Safety
Consumer	*User values*	(*Reduced*) Health and Safety
		(*Restricted*) Feedback Mechanism
		(*Reduced*) Consumer Privacy
		(*Reduced*) Transparency
		(*Reduced*) End of Life Responsibility
Local community	*Economic development*	(*Restricted*) Access to Material Resources
	Capacity building	(*Restricted*) Access to Immaterial Resources
	Community engagement	Delocalisation and Migration
	Infrastructure development	(*Non-respect of*) Cultural Heritage
	Improved Safe & Healthy Living Conditions[c]	(*Reduced*) Safe & Healthy Living Conditions
		(*Non-*) Respect of Indigenous Rights
		(*Non-*) Secure Living Conditions
Society	Contribution to economic development	Contributing to Armed Conflicts
	Public commitments to sustainability issues	Corruption
	Technological development	*Tax Evasion*
	Prevention and mitigation of armed conflicts	
Value chain actors	Promoting social responsibility	(*Un-*) Fair Competition
		(*Unfair*) Supplier Relationships
		(*Non-*) Respect for Intellectual Property Rights

Adapted from SLCA Guidelines (Benoit and Mazijn 2009), with new additions shown in italics

[a] Local employment is here assumed to include fair employment conditions in alignment with international standards and conventions: fair salary, reasonable working hours, health and safety at work, etc.

[b] Social benefits/social security is here assumed to exceed what is regulated by law and/or already supplied for by the state or other external actors

[c] Safe and healthy living condition is here assumed to supply benefits that exceeds what is supplied for by the community, state or any other external actor

quantitative assessments needs to be used. In Table 2, a tentative set of indicators linked to the positive impacts are proposed.

This approach is developed in relation to the assessment approach in the SHDB, as our starting point is to complement an earlier study using the SHDB. Thus, the assessment method should be compatible with the SHDB approach. The characterisation in the SHDB is done in four levels of risks of negative social impact: low risk, medium risk, high risk and very high risk, mostly using relative scales for setting the risk level. The aim here is hence to categorise the results of the indicator on four levels of positive impact: (i) low potential positive impact, (ii) medium potential positive impact, (iii) high potential positive impact and (iv) very high potential positive impact. This can be done by linear scaling, where the scale is set based on minimum and maximum values for each indicator. This requires a dataset with a full range of potential values for each indicator, in this case for a large group of sectors/countries. The indicators may be compared with corresponding indicators for other comparable products or value chains. But, no general comparison of the levels of potential benefits for different countries/sectors can be made unless a systematic characterisation method and relevant scale for the indicator values, similar to that in the SHDB, are

Table 2 Positive aspects and tentative indicators to describe the potential benefit

Positive social aspect	Tentative indicator for describing the potential benefit
Local employment	Number of local jobs created in relation to final product energy unit (MJ)
Social benefits/social security	Share of additional benefits supplied in relation to a potential full packages of social benefits offered
User values	No proposal
Local economic development	Additional activities related to development of local economy as generated from or associated with the processes to produce the product in question could be quantitative (funds allocated to specific activities) or quantitative (presentation of initiatives).
Capacity building	Share of additional capacity building supplied in relation to a full packages, or share of employees benefit from capacity building activities
Community engagement	Low to very high level of commitment. Qualitative assessment turned into semi-quantitative.
Infrastructure development	Low to very high level of contribution. Qualitative assessment turned into semi-quantitative
Improved safe and healthy living conditions	Changes in DALY (or QALY) that can be linked to activities in the supply chain.
Contribution to economic development	Share of national GDP/changes overtime in national GDP for the specific sector.
Public commitments to sustainability issues	CSR reports, examples, storytelling. Qualitative assessment turned into semi-quantitative.
Technology development	Commerce reports. Qualitative assessment turned into semi-quantitative. Payments for uses of patents.
Prevention and mitigation of armed conflicts	Potential action linked to the supply chain actors that have had positive impact on conflicts. Qualitative assessment turned into semi-quantitative.
Promoting social responsibility	The extent of activities. Qualitative assessment turned into semi-quantitative.

defined. For most of the proposed indicators, no such datasets are available and the scales can thus not be set at present.

The expected results from this new imaginary database/assessment tool, mirroring the SHDB, would be different levels of benefits (low to very high) for different parts of the supply chain on a sector/country level. The results should be presented in form of a table showing each lifecycle phase and positive impact associated with the different aspects.

Next step would be to present the results together with the potential negative impacts (level of risk) from the SHDB. Methods for aggregation positive and negative results were examined and discussed in chapter 3, but this exercise did not identify any useful methods for aggregation in SLCA. Near at hand would be to present them in a common table with a correspondence between the four levels. However, negative and positive impacts are measured on different scale, and a medium risk does not necessarily correspond to a medium benefit regarding the impact on the AoP. Thus, displaying the results alongside each other in a table calls for clear explanations and a careful interpretation.

5 Addressing positive impacts—the case of vehicle fuels

In this section, vehicle fuels are used as an example to investigate the possibilities of addressing positive impacts in SLCA, based on the approach described in previous sections. Our intention is to complement potential negative social impacts identified in an existing SLCA study on vehicle fuels (Ekener-Petersen et al. 2014) with positive ones, to get a broader picture of the overall impact.

We identified types of potential positive social impacts linked to vehicle fuels, including fossil fuels and biofuels. In a first step, the literature reviewed in Ekener-Petersen et al. (2014) was revisited, looking for mentions of positive impacts instead of negative ones. Thereafter, a search for positive social impacts of biofuels was made in other peer-reviewed literature, based on combinations of search terms such as biofuels, fossil fuels, gasoline, petrol, diesel, oil, ethanol, biodiesel, social, impact, 'social impact', positive and benefit. This was supplemented by snowballing technique searches. Some grey literature was also included, as we looked for general indications of positive impacts (Table 3). We do not attempt to provide an exhaustive review of the literature on social impacts from vehicle fuels but rather to illustrate the types of potential positive social impacts associated to vehicle fuels. Table 3 provides only reference to potential positive aspects. There are a range of risks and problems associated with these supply chains that need to be considered in connection to the aspects included in Table 3.

As shown in Table 3, there are indications of positive social impacts for both renewable- and fossil fuel-based vehicle fuels for many of the social aspects in the literature. The fact that some social aspects (e.g., public commitment to sustainability issues) are not identified in the literature review should not be interpreted as no positive social impact is linked to these areas.

Some authors list increased food security (van der Hilst et al. 2013; van Eijck et al. 2014) and land rights (van der

Table 3 Types of positive social impacts associated with production of vehicle fuels, identified based on examples from literature

Stakeholder	Positive social aspect	Fossil fuels (oil)—different stages in the life cycle	Renewables (ethanol)—different stages in the life cycle
Worker	Social benefits/social security. Provision of social benefits and social security for workers to an extent above what is publicly supplied.[a]	Healthcare, occupational training, schools, etc. (Chevron 2014)	Health care, dental care, life insurance, etc. (Smeets et al. 2008). Training of workers lacking formal education (Halldórsson et al. 2010)
Local community	Local employment. The role of directly or indirectly affecting local employment.[a]	Job creation (linked to oil spills) (Cheong 2011; O'Rourke and Connolly 2003; Rogers et al. 2012)	Job creation (Buytaert et al. 2011; Smeets et al. 2008; Van der Hilst et al. 2013; van Eijck et al. 2014)
	Local economic development. Contribution to the local economy from activities in the supply chain	Economic activity (linked to oil spills) (Cheong 2011) Financing development projects, cultural heritage, projects on identity and local culture (Rogers et al. 2012)	Rural development (Buytaert et al. 2011; van Eijck et al. 2014). Profit-sharing programmes (Smeets et al. 2008). Poverty reduction for smallholders (van Eijck et al. 2014). Increased access to energy (van Eijck et al. 2014). Increased local prosperity (Van der Hilst et al. 2013). Increased income for farmers (OECD 2008). Empowerment of women, in small-scale production (Amigun et al. 2011)
	Capacity building. On-the-job training, skills development, education and learning.	New skills (linked to oil spills) (Cheong 2011)	Workers re-qualification programmes, self-sustaining smallholders (Coelho et al. 2006). On-the-job training for certain skills (van Eijck et al. 2014)
	Community engagement. Community stakeholders are included in relevant decision-making processes and are the organisation engages with the community in general.[a]	Community engagement and stakeholder involvement (De Vita et al. 2015)	Education and health for workers' children (Halldórsson et al. 2010)

[a] Description of social aspects based on the Methodological sheets (UNEP/SETAC 2013)

Hilst et al. 2013) as positive impacts from biofuel production. However, these are not included here, as our starting point is that general human and legal rights are respected. Thus in our view, experiencing food security and having land rights respected cannot be considered positive impacts. These are expected conditions in prevailing circumstances, and their absence would instead be considered a negative impact. This aligns with the argumentation made for forced labour earlier; it can only be neutral or negative, never positive.

The analysis is limited to considering potential positive social impacts in only three phases of the supply chain of vehicle fuels, production/cultivation, processing and transport, in order to align it with that by Ekener-Petersen et al. (2014). This means that the phase most expected to display positive social impacts, the use phase, is excluded from the assessment. The use of vehicle fuels is obviously connected with clear positive impacts, not captured here, for stakeholders who can access them to propel a vehicle and thereby transport goods or people from one place to another.

A few assessments of biofuels for transport that consider both positive and negative social impacts can be found in the literature. However, no such assessment was found for fossil fuels.

Based on interviews with different actors (e.g., industry and researchers), Ndzibah et al. (2010) list positive and negative environmental, social, cultural and economic impacts of different biofuels for transport in their lifecycle (indicated with + or −). However, they do not propose any specific methodology for comparing the different social impacts.

Also, Gasparatos et al. (2011) address the negative and positive impacts of biofuels for transport on society and, based on the concept of ecosystem services, develop a simplified conceptual framework to illustrate the trade-offs in biofuel production. The main impacts of biofuels on human well-being, identified based on a literature review, include rural energy security and access to energy, food security and access to food, health, land tenure, and gender issues (Gasparatos et al. 2011). Those authors concluded that significant future research must be conducted before operational frameworks based on the concept of ecosystem services are realistically able to assess biofuel sustainability.

Based on a literature review, Ribeiro (2013) describes the social constraints and strengths of ethanol with regard to its lifecycle stages and, to some extent, the actors involved. That study found little evidence in the peer-reviewed literature regarding positive and negative social impacts of first-

generation ethanol, as well as potential social impacts of cellulosic ethanol, and stresses the need for greater availability of data. No further methodology development for comparing different social impacts is made. Ribeiro (2013) concluded that evidence-based frameworks for impact assessment of projects that consider positive and negative social impacts over time and potential off-site impacts need to be developed.

In order to identify potential bottlenecks for sustainable, certified ethanol production, Smeets et al. (2008) formulate a set of practically applicable sustainability criteria (including environmental and socio-economic impacts) and apply these to production of ethanol from sugarcane in the state of Sao Paulo, Brazil. Seventeen areas of concern, including nine socio-economic areas (competition with food production, employment, income distribution, land tenure, working conditions and workers' rights, wages, child labour, social responsibility and benefits, and competitiveness/economic implications) are formulated and scored on four aspects to determine whether an area of concern is a minor, medium or major bottleneck. The four aspects are the following: (i) importance of the area of concern, (ii) availability of indicators and criteria, (iii) the need for improvement strategies and (iv) the impact of improvement strategies on the costs and potential of ethanol production.

van der Hilst et al. (2013) develop a methodological framework for ex-ante assessments of potential environmental and socio-economic impacts of large-scale production of transportation biofuels, using potential biofuel chains in Mozambique, Argentina and Ukraine as demonstration. The assessment includes quantitative, and sometimes qualitative, indicators to describe the positive, neutral or negative impacts of different socio-economic aspects: legality, land rights, economic viability, local prosperity, social well-being, labour conditions, food security and gender. The social impacts addressed align with the impacts considered in the Guidelines. However, land rights and food security are specified as separate impacts by van der Hilst et al. (2013), as they are focussed issues in biofuel production. In the Guidelines, these impacts are covered, but within more broadly defined impacts categories such as Access to Material Resources.

Some studies assess the socio-economic aspects specifically related to *Jatropha* cultivation for bioenergy. A review by van Eijck et al. (2014) covered the social aspects food security, local prosperity, labour working conditions, land rights and gender, and concluded that hardly any studies quantify related social impact comprehensively. However, van Eijck et al. (2014) do not provide any specific approach for analysing or comparing the social impacts identified.

In summary, existing assessments of biofuels for transport addressing both positive and negative social impacts only provide limited input for the assessment approach developed in this paper.

Due to limitation in the possibility to fully develop the proposed approach with a characterisation step, we will only schematically apply the developed approach on vehicle fuels. To illustrate the intended result, we have made assumptions on the potential outcome of an assessment for an imaginary vehicle fuel (see Table 4).

The aggregation of results for social impacts should be done with caution. The assessment of positive social impacts (as illustrated in Table 4) should be weighed towards an existing scale for that specific location. We argue that positive impacts could be brought forward together with the negative impacts, for instance from the SHDB, but a potential positive impact cannot take out a negative risk.

6 Discussion

Different stakeholders benefit from positive impacts in different ways. Assessment of positive impacts should thus examine which stakeholders/groups seem most likely to experience positive impacts, where these actors are located (developing/developed world), and whether there is a difference between renewable- and fossil fuel-based vehicle fuels. To exemplify, contribution to economic development may be beneficial to stakeholders on all levels, individual, community and society, but some levels may benefit more than others and, in the worst case, some level may not benefit at all (see e.g., Adeola (2000) that discuss oil extraction using the example of the Ogoni people in Nigeria). In addition, to consider the distribution of positive (and negative) impacts among stakeholders, there is a need to reflect also upon their distribution on a temporal scale, i.e. whether there is uneven distribution of impacts between present and future generations. It should be noted here that future generations are not among the stakeholders proposed in the Guidelines, although their potential as stakeholders in assessments is discussed and set out as a potential future development (Benoit and Mazijn 2009).

Social impacts are not very clear-cut to assess and may mean different things for people in different contexts. The impacts to be assessed in SLCA are clearly based on values. To the largest extent possible, the issues in the Guidelines are based on internationally agreed documents. Still, even such international agreed documents are seen by some as reflecting Western values (Mouffe 2005). Max-Neef (1992) claim that human needs are the same in all cultures, but the ways in which these needs are satisfied differ between cultures. Hence, even assuming universal agreement on the importance of human dignity, there may still be differing views on what this concept constitutes and how it can be achieved. The use of MCDA for aggregation may help in making the values behind a specific SLCA outcome visible, as it offers transparency of the values underpinning the systematic and controlled decision-making process in the tool.

The context is which the positive impacts materialise is important, as a positive social hotspot ought to be valued more highly when those in need get a considerable improvement. In the globalised world, production is typically located in developing countries, while consumption largely takes place in

Table 4 Made-up assessment of an imaginary vehicle fuel, for illustrative purposes only

Positive social aspect	Lifecycle phase		
	Production of feedstock (location 1)	Processing of feedstock (location 2)	Transport (location 3)
Local employment	LPI	MPI	LPI
Social benefits/social security	LPI	MPI	LPI
Local economic development	MPI	MPI	–
Capacity building	MPI	HPI	–
Community engagement	–	–	–
Infrastructure development	–	MPI	–
Improved safe and healthy living conditions	–	–	–
Contribution to economic development	LPI	VPI	LPI
Public commitment to sustainability issues	LPI	LPI	–
Technological development	MPI	MPI	–
Prevention and mitigation of armed conflicts	–	–	–

LPI low potential positive impact, *MPI* medium potential positive impact, *HPI* high potential positive impact, *VPI* very high potential positive impact, '–' indicates that no information is available to assess the aspect

developed countries. Thus, positive impacts linked to the use phase will typically largely materialise in the developed world, while the generally more negative impacts from production, environmental and social, are likely to materialise in the developing world. This should be considered when making an overall assessment. One way to do this might be to deploy 'equity weights'. Basically, it is about giving different weights to individuals depending on their per capita income when assessing benefits: above unity weight for those with below average income and below unity weight for those with above average income, with the magnitude of the weight depending on inequality aversion. Based on similar reflections, Daw et al. (2011) concluded that the same ecosystem services have different effects on the well-being of different beneficiaries due to context, reflecting local, social and personal factors. Those authors propose stakeholder analysis as a tool for handling these issues, and again, MCDA might offer possibilities to include such an analysis in the assessment. Another similar approach for considering context is discussed in Macombe et al. (2013), based on a proposal by Hunkeler (2006). The differing value of an additional work hour in different contexts could be calculated by its purchasing power for accessing resources for basic needs, such as housing and food. With that kind of calculation, the positive social impact from job creation would differ among regions and countries, typically forming a higher value for poor people.

We have proposed an approach for assessing positive impacts in a way that corresponds with the assessment of risks in the SHDB. To realise this would require a database parallel to the SHDB, with characterised assessment outcomes based on large data set. Data availability to form a database on these issues will be possible but will require step-by-step approach tackling the different positive social aspects in some order of priority.

We suggest using aspects with relatively good data availability as starting points for such a construction. Based on the literature review for vehicle fuels and the availability of data found there, national economic contributions and job creations are two possible aspects to start with. However, this does not mean that these aspects are the most important, i.e. correspond to the highest positive social impact. For vehicle fuels, data availability is relatively good for the economic dimension, especially on a national level, but would be more challenging for the local level. In terms of job creation, numbers of potential job creation are found for example for biodiesel in Indonesia (Cassman and Liska 2007) and for ethanol plants in USA (Parcell and Westhoff 2006). However, these are in most cases ex-ante estimations, and there is a risk that positive impacts are over-estimated, as there is less monitoring and follow-up of these aspects than of the negative aspects. The social aspects considered are often highly complex, and experience from the field illustrates these challenges. In the case of job creation, there might be immigrant workers rather than local people that get the job offered thus the potential benefit local job creation is reduced.

There may be strong arguments to find an aggregation method for positive and negative social impacts, even though this is a complex task needed to be addressed with caution. Weighting might be one method to take into account. It may be warranted to weight the impacts, positive and negative, in SLCA differently, to get a more relevant picture of their level of severity in relation to each other. One could easily reason, in general terms, that some impacts are more important than others. The result of an unweighted assessment may even be perceived as unethical if the different impacts differ in severity in an obvious way. In the SHDB, some rough weighting is actually done when calculating the Social Hotspot Index, by assigning a factor of 1.5 to issues that are considered most important, and a factor of 1 to other issues. However, the choice of issues considered more important than others is not described in the methodology.

As the Guidelines are a global tool intended to be used in many different settings and by people with different cultural backgrounds, it is not evident how to reach a commonly agreed weighting approach on a global scale. For example, a study by Kölsch (2009), cited in Feifel et al. (2010), showed that European values on social aspects differ partly from those in Brazil. Moreover, prioritisation could differ even in the same cultural setting when done within different levels of society (local, regional, national). Yet, weighting is commonly done in ELCA. Although social issues can be said to constitute more sensitive, disputable and political issues, there are also differing views in a global context on the weight of climate change in relation to other environmental issues. Thus, there are several weighting models available for ELCA, and the method best suited for the actual context can be selected. This could perhaps be a possibility for SLCA. In a recent publication on the application of SLCA, weighting was conducted based on the results of a stakeholder survey (Dong and Ng 2015). This approach is also in line with MCDA methodology. However, it will only be applicable where there is a possibility to interact with stakeholders and/or decision makers.

There is an ethical aspect to the aggregation of negative and positive impacts. If they are allowed to balance each other out, producing a neutral result, this might pose a problem, as the negative and positive impacts might not affect the same stakeholders. A report on social assessments of conservation initiative states that 'it is important to ensure that all indicators are of the same type (so that positive and negatives do not obscure each other or cancel each other out)' (Schreckenberg et al. 2010, p. 33). Even if the impacts affect the same stakeholders, it can still be a problem to have them simply outweigh each other, without considering the views of the affected stakeholder. For example, suffering from occupational health impacts can most likely not be outweighed by improved take-back practices. Again, using MCDA can be a way of handling this problem, as there is transparency on the way the weighting is done and where affected stakeholders' priorities could be taken into account in the process.

Finally, instead of using a quantitative method, an option could be to integrate the positive and negative social impacts qualitatively, in a discussion. In this way, reasoning can be developed that makes room for a more complex discourse on the topic than is permitted in more quantitative aggregation.

7 Conclusions

A systematic approach to capture positive social impacts, adding to the methodology proposed in the Guidelines, was developed and tested for the case of vehicle fuels. The starting point for the approach is to consider all benefits from the product system, from which the negative impacts are assumed to be deducted, to identify a full range of positive impacts.

The assessment approach was built on the SHDB, an assessment tool of potential negative social impacts, relating indicators to a scale when assessing risks along the value chain. We have tried to develop a similar approach for the positive impacts. From the limited trial of the approach on vehicle fuels, we conclude that there are indications of positive social impacts for both renewable- and fossil fuel-based vehicle fuels for many of the social aspects in the literature, which might change the overall picture of social impacts from vehicle fuels. Further, the trial indicates that it may be feasible to conduct impact assessments in the future based on this approach. However, further development is needed, and one of the main challenges is to establish the corresponding scales to which the indicators for positive impacts on different locations can be assessed. Also, including the use phase in SLCA assessments would improve the possibilities to better capture all relevant positive impacts.

The aggregation of positive and negative social impacts is challenging. The aggregation methods for positive and negative social impacts found in the literature are mainly surveys, questionnaires and monetarisation. As these tools are rather poorly matched to the preconditions for SLCA, their usefulness is limited. The most suitable approach identified is multi-criteria decision analysis (MCDA), which responds to several of the demands SLCA places on the aggregation method. Further, methodology development is needed on how positive impacts can be taken into consideration along with negative impacts in SLCA.

This paper highlights the importance of assessing positive impacts in the SLCA framework by defining them as positive at the outset of analysis. The assessment then includes an explicit positive side, and not only negative impacts or the absence of them. In this way, market operators, policy makers and others are given an option to assess both positive and negative impacts, enabling them to adjust production and value chains to maximise the positive aspects, minimise the negative aspects and manage risks.

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