

**Pre-proceeding**

**6<sup>th</sup> Social LCA  
Conference**

Pescara, Italy  
September 10-12, 2018

# **Social LCA**

*People and Places  
for Partnership*

6<sup>th</sup> SocSem



*Collection FruiTrop Thema*

# **Social LCA**

## *People and Places for Partnership*

**Pre-proceedings of the  
6<sup>th</sup> Social Life Cycle Assessment  
Conference**

*S-LCA 2018 – September 10-12, 2018 – Pescara (Italy)*



## **Collection FruiTrop Thema:**

Social LCAs — Socio-economic effects in value chains (2013)

Social LCA in progress — Pre-proceedings of the 4<sup>th</sup> International Seminar in social LCA (2014)

Social LCA — Researcher School Book  
Social evaluation of the life cycle, application to the agriculture and agri-food sectors

# Introduction

*Social Life Cycle Assessment (S-LCA) is officially recognised to be part of Life Cycle Thinking (LCT) and is rapidly emerging as an essential approach for both private and public sectors. Indeed, social life-cycle information is more and more crucial to guide policy decisions and business strategies. Policy makers have to promote sustainable consumption and production strategies to respond to national and international social challenges, by gathering baseline and future-oriented impact information for market-oriented policies and developing strategies for resource efficiency and eco-design. Private businesses have to improve efficiency to boost margins and competitiveness, while contributing to sustainability maximizing economic and social value.*

*The aim of the 6<sup>th</sup> International Conference on S-LCA "People&Places4Partnership" is to discuss about its key role as a decision-making tool in the definition of strategies for sustainability, thus supporting both public and private businesses in making more informed decisions. Benefits will be: better sustainable policies, more sustainable business strategies, sustainable product design and improved life quality driven choice.*

# Acknowledgements

*The Organisers appreciate all the valuable support provided by the Scientific Committee: Henrikke Baumann, Catherine Benoit, Andreas Ciroth, Elisabeth Ekener, Matthias Finkbeiner, Sara Russo Garrido, Jacquetta Lee, Catherine Macombe, Bernard Mazijn, Luigia Petti, Peter Saling, Marzia Traverso, Cassia Maria Lie Ugaya, Alessandra Zamagni. We would like to thank them for their commitment and support. A special thanks to Catherine Macombe, Catherine Sanchez and Denis Loeillet for having taken great care of the editing and printing of these Proceedings. We would also like to express our gratitude to Monica Serreli for always being there and for her technical support, to Ioannis Arzoumanidis for his great availability to listen and contribute to solving problems and to Manuela D'Eusanio for the logo and web-site design. Finally, we would like to thank the Sponsors who have helped to make this Conference happen: Apicoltura Luca Finocchio, Aptar, ArcelorMittal, Bureau Veritas, Cirad, Ecoinnovazione, Department of Economic Studies of the University "G. d'Annunzio", Marramiero Winery, PRé Sustainability, RWTH Aachen, Steelcase.*

*Luigia Petti, Marzia Traverso, Alessandra Zamagni*

## Sponsors

*in alphabetical order*

**Apicoltura Luca Finocchio** (Italy)  
**Aptar** (Italy)  
**ArcelorMittal**  
**Bureau Veritas**  
**CIRAD** (France)  
**Ecoinnovazione** (Italy)  
**G d'Annunzio University, Department of Economic Studies** (Italy)  
**Marramiero winery** (Italy)  
**PRé Sustainability**  
**RWTH Aachen** (Germany)  
**Steelcase**

## Scientific Committee

**Luigia Petti** ("G. D'Annunzio" University, Italy)  
**Marzia Traverso** (RWTH Aachen University, Germany)  
**Alessandra Zamagni** (Ecoinnovazione, Italy)  
**Henrikke Baumann** (Chalmers University of Technology, Sweden)  
**Catherine Benoit** (Harvard University/NewEarth, USA)  
**Andreas Ciroth** (Green Delta, Germany)  
**Elisabeth Ekener** (Royal Institute of Technology, Sweden)  
**Matthias Finkbeiner** (Technische Universität Berlin, Germany)  
**Sara Russo Garrido** (CIRAIG, Canada)  
**Uday Gupta** (Mahindra Sanyo Special Steel Pvt Ltd, India)  
**Jacquetta Lee** (University of Surrey, UK)  
**Catherine Macombe** (IRSTEA, France)  
**Bernard Mazijn** (Ghent University, Belgium)  
**Serenella Sala** (European Commission, Joint Research Centre, Italy)  
**Peter Saling** (BASF SE, Germany)  
**Cassia Maria Lie Ugaya** (Universidade Tecnológica Federal Do Paraná, Brazil)

## Organising Committee

**Ioannis Arzoumanidis** ("G. D'Annunzio" University, Italy)  
**Manuela D'Eusanio** ("G. D'Annunzio" University, Italy)  
**Silvia Di Cesare** ("G. D'Annunzio" University, Italy)  
**Luigia Petti** ("G. D'Annunzio" University, Italy)  
**Andrea Raggi** ("G. D'Annunzio" University, Italy)  
**Monica Serreli** (work and organisational psychologist, Italy)  
**Marzia Traverso** (RWTH Aachen University, Germany)  
**Alessandra Zamagni** (Ecoinnovazione, Italy)

## Part 1: Methodological developments and tool focus

- 1A Positive social impacts
- 1B Inventory database
- 1C Characterising social impacts
- 1D Type I and Type 2 in Social Life Cycle Impact Assessment (S-LCIA)
- 1E Sector-specific approaches
- 1F Future scenarios of countries and development of social indicators
- 1G Complementarity and overlapping between Environmental and Social LCA
- 1H Presentation and interpretation of results of Social LCA

## Part 2: Contextualising S-LCA scientifically

- 2C S-LCA in LCSA
- 2D Social Sciences studies on product life cycles

## Part 3: Fields of applications

- 3A Circular economy: innovations and other applications cases
- 3B Social Organisational LCA
- 3C Policy and Social LCA
- 3D Social LCA in procurement and design
- 3F Strategic priorities of industry in Social Impacts

# Table of contents

(only the first author is quoted)

## Part 1: Methodological developments and tool focus ..... 11

1A	<ul style="list-style-type: none"> <li>• Structure of a Net Positive analysis for supply chain social impacts (<i>C. Benoit Norris</i>)..... 12</li> <li>• To assess use phase impacts in S-LCA (<i>E. Ekener</i>)..... 13</li> </ul>
1B	<ul style="list-style-type: none"> <li>• Consistent Assessment of Positive Impacts (<i>Diana Indrane</i>) ..... 18</li> <li>• Preliminary evaluation of data collection methods for SLCA studies (<i>R. Trevisani Juchen</i>)..... 22</li> </ul>
1C	<ul style="list-style-type: none"> <li>• Influence diagrams and scoping for social LCA, an example from sustainable minings (<i>A. Ciroth</i>) ..... 28</li> <li>• Proposal of social indicators to assess the social performance of waste management systems in developing countries: a Brazilian case study (<i>V. Ibañez-Forés</i>) ..... 32</li> <li>• Social sustainability assessment of Calabrian olive growing (<i>N. Iofrida</i>)..... 33</li> <li>• Integrating active impacts in sustainability assessment in product (manufacturing) life cycle (<i>M. Kumar</i>) ..... 38</li> <li>• The Social Value of Products: What can it be and can it enrich Social life cycle assessment? (<i>S. Russo Garrido</i>) ..... 43</li> <li>• Social Analysis within the SEEBalance® for a detailed assessment of social impacts of products and processes (<i>P. Saling</i>)..... 47</li> <li>• Discussing Features of Social Measures Important in SLCA Impact Indicators' Selection (<i>Y. Soltanpour</i>)..... 52</li> <li>• Including governance and economic aspects to assess and explain social impacts: a methodological proposal for S-LCA (<i>S. Sureau</i>) ..... 57</li> <li>• Sustainable Guar Initiative (SGI) – social impact characterization of an integrated sustainable project (<i>M. Vuillat</i>) ..... 63</li> <li>• Towards a taxonomy for social impact pathway indicators (<i>B. P. Weidema</i>)..... 66</li> </ul>
1D	<ul style="list-style-type: none"> <li>• Development of S-LCIA models: a review of multivariate data analysis methods (<i>J. Bonacina de Araujo</i>) ..... 67</li> <li>• Using DALY for Assessing Human Health Impacts of Conflict Minerals (<i>A. Furberg</i>)..... 72</li> <li>• Perspectives in the application of social life cycle analysis to waste management (<i>J. Mery</i>)..... 76</li> </ul>
1E	<ul style="list-style-type: none"> <li>• Social LCA of sorting centres for WEEE reuse in Greece (<i>K. Abeliotis</i>)..... 81</li> <li>• Assessing the Social Sustainability of Frugal Products (<i>L. Simoes</i>) ..... 86</li> <li>• Social Life Cycle Assessment addressed to the valorisation of wine production waste and residues – A review with methodological clues (<i>O. Grech</i>) ..... 92</li> <li>• Small but Complex: Assessing Social Impacts on Smallholders in Agri-food Sector (<i>D. Indrane</i>) ..... 96</li> <li>• The challenge of quantification: Social Life Cycle Assessment for advanced biofuel from waste wood integrated in the steel industry (<i>I. Kaltenegger</i>)..... 102</li> </ul>

1E	• Social performance evaluation of an artisanal apparel brand in Peru using Social LCA ( <i>J. D. Villegas</i> ) ..... 105	105
	• Including social aspects in the sustainability management of organisations – Implications of the application of social life cycle assessment in the energy industry in Sweden ( <i>S. Welling</i> ) ..... 111	111
1F	• Specific indicators and challenges for the assessment of life cycle impacts on intangible cultural heritage in South America ( <i>F. Eisfeldt</i> )..... 115	115
1G	• Integration between the territory indicator of VIVA project and the social LCA analysis for the wine sector ( <i>A. Acampora</i> ) ..... 117	117
	• Functional unit definition criteria in LCA and Social LCA: a discussion ( <i>I. Arzoumanidis</i> ) ..... 121	121
	• Complementarity of social and environmental indicators and risks. An example of the mining industry ( <i>C. Di Noi</i> ) ..... 122	122
	• S-LCA in agricultural systems – U.S. corn production as a case study ( <i>M. Frank</i> ) ..... 128	128
	• Integrating odor management tools in Social Life Assessment in rural area: preliminary study ( <i>A. Trivino</i> ) ..... 130	130
1H	• A global effort: 2019 S-LCA Guidelines ( <i>C. Benoit Norris</i> ) ..... 134	134
	• Weighting and scoring in Social Life Cycle Assessment ( <i>B. Barros Telles do Carmo</i> )..... 140	140
	• Social Life Cycle Assessment for a Biorefinery Project ( <i>E. Cadena</i> ) ..... 141	141
	• S- LCA based social sustainability tool for companies ( <i>A. Reinikainen</i> ) ..... 147	147
	• Generation, calculation and interpretation of social impacts with the Social Analysis of SEEBalance® ( <i>P. Saling</i> ) ..... 149	149
	• Social life cycle assessment of rural cassava starch factories in Cauca-Colombia in the post-conflict ( <i>L. A. Taborda</i> )..... 150	150
	• Pathways to S-LCA Interpretation – where to start ( <i>J. Werker</i> )..... 155	155

## Part 2: Contextualising S-LCA scientifically .....161

2C	• Choice of social indicators within technology development – the case of mobile biorefineries in Europe ( <i>B. Brunklaus</i> )..... 162	162
	• Bioeconomy network mapping and assessment of sustainability performance ( <i>G. Medyna</i> ) ..... 167	167
	• Social life cycle assessment through the framework Multi-Level Social Life Cycle Assessment of the bioelectricity generation in Floreana Island ( <i>M. A. Muñoz Mayorga</i> )..... 171	171
2D	• Beyond a CSR context towards pluralism in SLCA: exploring alternative social theoretical perspectives ( <i>H. Baumann</i> ) ..... 177	177
	• How Product Social Impact Assessment differs from Product Social Value Assessment and why they complement each other ( <i>M. Caraty</i> )..... 178	178

## Part 3: Fields of applications.....185

3A	<ul style="list-style-type: none"> <li>• The Role Of Social Aspects Evaluation In The Industrial Symbiosis Models (<i>G. Arcese</i>) ..... 186</li> <li>• Transitioning towards bioeconomy: assessing the social dimension through the lenses of the stakeholders (<i>P. M. Falcone</i>) ..... 189</li> <li>• Social Life Cycle Assessment of Niobium Mining in Brazil in a Circular Economy context (<i>S. Neugebauer</i>) ..... 194</li> <li>• Using the social hotspots database to assess the social risks of prospective value chains: The case of D-Factory (<i>D. Peñalosa</i>) ..... 197</li> <li>• Assessing fair wages in social life cycle assessment of agricultural product: case of Thai sugarcane (<i>J. Prasara-A</i>) ..... 203</li> </ul>
3B	<ul style="list-style-type: none"> <li>• How experiences and existing data of companies can be used to define the Goal and Scope in a Social Organisational Life Cycle Assessment (<i>M. D'Eusanio</i>) ..... 208</li> <li>• How can Social organizational LCA benefit from existing and improve future sustainability reporting of companies? (<i>A. Lehmann</i>)..... 215</li> <li>• Setting the SOLCA concept framework to the artisanal and small-scale mining sector: a case study (<i>E. Zerazion</i>) ..... 216</li> </ul>
3C	<ul style="list-style-type: none"> <li>• Social risk in raw materials extraction: a macro-scale assessment (<i>U. Eynard</i>)..... 221</li> <li>• The experience of Urban Wellbeing Laboratories. A study of the social, energy and environmental costs of the food supply chain in Campania Region (<i>C. Vassillo</i>) ..... 226</li> </ul>
3D	<ul style="list-style-type: none"> <li>• The Product Social Metrics consensus developed by major companies (<i>M. Goedkoop</i>)..... 227</li> <li>• Challenges and opportunities of using Social LCA in the Norwegian construction and public procurement (<i>S. Mamo Fufa</i>) ..... 231</li> <li>• Integrating SLCA in Product Design at Nestlé (<i>U. Schenker</i>) ..... 236</li> <li>• Product Social Impact Assessment: a case study from the automotive sector (<i>L. Zanchi</i>) ..... 240</li> </ul>
3F	<ul style="list-style-type: none"> <li>• A new scheme to evaluate socio-economic impacts of products: a well-being indicator approach (<i>S. Di Cesare</i>) ..... 241</li> <li>• What social priorities for agro-business now if the future is realized as planned? (<i>C. Macombe</i>)..... 242</li> <li>• SLCA of events: application of an LCA-based method in the event impact analysis (<i>J. R. V. Tkatch</i>) ..... 246</li> <li>• The role of social sustainability in aviation biofuel supply chains (<i>Z. Wang</i>)..... 252</li> <li>• Towards a harmonized communication of products' social impacts (<i>M. Traverso</i>) ..... 255</li> </ul>



## *Part 1*

# *Methodological developments and tool focus*

# Structure of a Net Positive analysis for supply chain social impacts

**Catherine Benoit Norris<sup>1</sup>, Gregory A. Norris<sup>1</sup>, Lina Azuero<sup>2</sup>**

<sup>1</sup> Harvard School of Public Health, New Earth (USA)

<sup>2</sup> Dell

## **Abstract**

Net Positive is becoming one of the sustainability buzzwords of this decade. Beyond the noise, it has the potential to be a transformational movement, helping businesses to redefine their role in society, their social purpose. As an idea, its simplicity and candor makes it both extremely attractive and powerful. It poses a great question and sets a challenge: Can we give more to the environment and society than we take? To be Net Positive a company's handprint needs to be greater than its footprint.

The Net Positive Project and Harvard SHINE have worked to clarify the Principles and methodology that can make the Net Positive concept both actionable and valid. This includes defining handprints in a measurable way. In this paper, we advance and demonstrate methods that can be used to assess social Net Positive impacts. Reviewing and building on social life cycle assessment, we introduce a structure for Net Positive analysis of social impacts. This framework is meant to be practical, actionable and comprehensive. In order to focus on applicability, we also discuss methods, models and data collection.

## To assess use phase impacts in S-LCA

Elisabeth Ekener<sup>1</sup>, Elena Mokeeva-Hansson<sup>1</sup>, Catherine Macombe<sup>2</sup>

<sup>1</sup> KTH Royal Institute of technology, SEED dept., Stockholm (Sweden)

<sup>2</sup> Irstea – Centre de Montpellier (France)

### Introduction

In the ongoing work to further develop the S-LCA methodology, based on the S-LCA guidelines developed by the UNEP/SETAC (Benoît, Norris et al. 2010, UNEP/SETAC 2010), a number of S-LCA researchers have highlighted that the use phase of a product has not been sufficiently addressed (Jørgensen, Hauschild et al. 2009, Ekener-Petersen and Finnveden 2013, Chhipi-Shrestha, Hewage et al. 2015, Sureau, Mazijn et al. 2017). Only a few aspects – health and safety, feedback mechanism, consumer privacy, transparency and end of life responsibility – are considered, i. e. mostly addressing the relation between the consumer and the producer/retailer. The exclusion of core issues of the use phase impacts in S-LCA studies may be problematic. To give a full and comprehensive picture of the overall social impacts caused by the existence of a given product by S-LCA, all relevant life cycle phases, including the use phase, should be covered. The use phase in S-LCA has been recognized as profoundly different compared to other phases, demanding a special approach which has not been developed yet (Macombe, Lagarde et al. 2013). Preferably, such an approach should be a generally applicable method, and searching for useful approaches in other disciplines could be the first step (Ekener-Petersen 2013).

The aim of this paper is to examine ways for assessing the use phase in S-LCA and proposing a methodology for that purpose. This is done by defining a potential methodology and applying and testing it in a case study on a mobile phone.

### Methods

As social impacts on users are effecting human beings, thus on an individual level, the impacts of usage depend not only on the way of use, but also on the status of the user (e.g. health status, emotional vulnerability etc.) (Vanclay 2002). This is also underlined by Mathe (2014), who states that it is on the operational level the way an activity affects human well-being is determined. This idea is also supported by Macombe, Lagarde et al. (2013) and Wangeli (2016), who argues that S-LCA needs to be based on social sciences in order to conceptualize social impacts.

The main approach applied for developing use phase assessment methodology uses Grounded Theory (GT) (Strauss and Corbin 1967). GT is a methodology for developing theory that is grounded in data systematically gathered through

interviews. Theory developed through this method can state consequences and related to them conditions, therefore, the practitioner is able to assert predictability for it. The practitioner begins from individual cases or incidents and gradually builds abstract categories. These categories synthesize and interpret data, helping to identify patterned relationships within them. *Semi-structured interviews* are conducted to collect data, based on open ended questions with a flexible structure that are aimed to explore certain issues; however an interview is not limited to those.

We used GT approach for guiding both the data collection and data analysis from semi-structured interviews. The choice for respondents was determined to create a diverse sample, in terms of gender, age and nationality. However, all the respondents presently reside in a Western Europe country. This is a limit of this study, as an increased variety within the sample of prospects might bring a larger range of usages and improve the robustness of the findings, making them more generalizable to wider population (Thiéart 2014).

The interviewer asked the respondents opening questions: *What are your experiences from using the mobile phone? What benefits you have or what are things that you are not happy with? We are particularly interested in your personal feelings when using the phone. Please compare with an ordinary mobile phone, if you ever had one.* Recording the audio from the interview was vital for further analysis.

The analysis of interviews focused on the identification of services mentioned. A tree of services was built, showing the hierarchy of services, provided by the smartphone. Then, the social issues were allocated to the different groups of services, according to the verbatim, with an indication whether they are felt positive or negative by users. In fact, we used two different concepts to deal with social issues. In the verbatim, users explained general *social consequences* of using a mobile phones (for instance *"It is about getting antisocial, but not doing that on purpose"*). Meanwhile, users describe the consequences in terms of their own experience (for instance *"It is a personal satisfaction to be happy with having the answer at the moment I had the question"*). This is actual social impact of the use: the ones that tell us about a feeling or other phenomenon experienced which is caused by the phone use. We considered only the social consequences and social impacts which reflect the change from using this particular group of services compared to a reference scenario offering the same function/service.

Finally, in order to classify the identified social impacts and define impact categories, the impacts were linked to capabilities as they have been interpreted by (Grisez, Boyle et al., 1987, complemented by Reitinger, Dumke et al., 2011). Capabilities approach is a concept used for addressing the questions of what is important in a human life. Reitinger, Dumke et al. (2011) imply that in S-LCA both functioning and freedoms should constitute the informational base of evaluation, and they are both captured in the notion of capability, making it applicable for S-LCA. Capabilities approach has since been employed in S-LCA studies by Holger, Jan et al. (2017) and (Wangel 2016).

In the latter, the capabilities were linked to valuable functioning of a school lunch, where the functioning was based on literature and expert judgment by the author.

In our study we used the list of capabilities proposed by Grisez, Boyle et al. (1987), with an additional category *fairness* suggested by Reitinger, Dumke et al. (2011):

1. *Life itself*: its maintenance and transmission, health and safety
2. *Knowledge & aesthetic experience*: knowing reality, appreciating beauty and anything that engages us to know and feel
3. *Work and play*: transforming the natural world in order to express meanings and serve purposes
4. *Friendship*: various forms of harmony between and among individuals and groups of persons
5. *Self-integration*: inner peace opposed to inner conflicts between one's judgements and choices and among feelings
6. *Self-expression* (or practical reasonableness): harmony among one's judgments, choices and performances
7. *Transcendence*: harmony with some more-than-human source of meaning and value
8. *Fairness*: equal opportunity and fair processes.

Interpretations of their explanations are made by the authors of this paper

The data collection from interviews and analysis resulted in the identification of services from mobile phone. The services were grouped according to their main functions, which allows us distinguish four different devices:

- 1 – services for communication purposes (keeping in touch),
- 2 – services now available in mobility, "Internet on the go" (information & tasks),
- 3 – services for entertainment purposes and
- 4 – basic functionalities available in mobility

Social consequences and social impacts from using the services were extracted from analysis of the interviews transcriptions. Finally, the identified social impacts were linked to capabilities based on the verbatim and thus were allocated into impact categories.

## **Discussion and conclusion**

When it comes to the applicability of this method on a generic level in S-LCA, GT approach has some drawbacks. It requires substantial resources, time and knowledge and expertise for both data collecting and analysis, which might be considered not practically possible by a practitioner.

Another limitation of the study is the Western context of use covered by the answers of the respondents. For a broader coverage of potential social impacts, especially capturing the expected different but substantial social impacts in developing countries, the geographical scope of the study, and the variety and diversity of interviewees, would need to be expanded.

To be able to assess the use phase social impacts in conjunction with the assessment of the other phases in the life cycle, and to conclude on the collection of impacts from the full life cycle, a connection between our proposed approach and the current approaches in the Guidelines must be made. The capabilities affected by the use in this study could be added into the assessment framework in the Guidelines as new subcategories linked to the category Consumer. This would allow for a more full assessment of the use phase impacts than what was previously possible. Applying this framework will make the assessment result more comprehensive and relevant when trying to determine the social impacts from a product or service in a life cycle perspective. Thus, the GT approach has a potential to become a generic method for the use phase assessment in S-LCA. However, further research is needed to simplify the method and improve its applicability.

## References

- Benoît, C., G. A. Norris, S. Valdivia, A. Ciroth, A. Moberg, U. Bos, S. Prakash, C. Ugaya and T. Beck (2010). "The guidelines for social life cycle assessment of products: just in time!" *The international journal of life cycle assessment* 15(2): 156-163.
- Chhipi-Shrestha, G. K., K. Hewage and R. Sadiq (2015). "Socializing/sustainability: a critical review on current development status of social life cycle impact assessment method." *Clean Technologies and Environmental Policy* 17(3): 579-596.
- Ekener-Petersen, E. (2013). *Tracking down Social Impacts of Products with Social Life Cycle Assessment*. Doctoral, KTH Royal Institute of Technology.
- Ekener-Petersen, E. and G. Finnveden (2013). "Potential hotspots identified by social LCA—part 1: a case study of a laptop computer." *The International Journal of Life Cycle Assessment* 18(1): 127-143.
- Grisez, G., J. Boyle and J. Finnis (1987). "Practical principles, moral truth, and ultimate ends." *Am. J. Juris.* 32: 99.
- Holger, S., K. Jan, Z. Petra, S. Andrea and H. Jürgen-Friedrich (2017). "The Social Footprint of Hydrogen Production-A Social Life Cycle Assessment (S-LCA) of Alkaline Water Electrolysis." *Energy Procedia* 105: 3038-3044.
- Jørgensen, A., M. Z. Hauschild, M. S. Jørgensen and A. Wangel (2009). "Relevance and feasibility of social life cycle assessment from a company perspective." *The International Journal of Life Cycle Assessment* 14(3): 204.
- Macombe, C., V. Lagarde, A. Falque, P. Feschet, M. Garrabé, C. Gillet and D. Loeillet (2013). "Social LCAs: socio-economic effects in value chains." *FruiTrop, Montpellier, CIRAD*.
- Mathe, S. (2014). "Integrating participatory approaches into social life cycle assessment: the S-LCA participatory approach." *The International Journal of Life Cycle Assessment* 19(8): 1506-1514.

- Reitinger, C., M. Dumke, M. Barosevcic and R. Hillerbrand (2011). "A conceptual framework for impact assessment within S-LCA." *The International Journal of Life Cycle Assessment* 16(4): 380-388.
- Strauss, A. and J. Corbin (1967). "Discovery of grounded theory."
- Sureau, S., B. Mazijn, S. R. Garrido and W. M. Achten (2017). "Social life-cycle assessment frameworks: a review of criteria and indicators proposed to assess social and socioeconomic impacts." *The International Journal of Life Cycle Assessment*: 1-17.
- Thiétart, R.-A. (2014). "Méthodes de recherche en management." Paris, Dunod.
- UNEP/SETAC (2010). *Guidelines for social life cycle assessment of products*, UNEP/Earthprint.
- Vanclay, F. (2002). "Conceptualising social impacts." *Environmental Impact Assessment Review* 22(3): 183-211.
- Wangel, A. (2016). "Back to basics—the school lunch." *The International Journal of Life Cycle Assessment*: 1-7.

# Consistent Assessment of Positive Impacts

**Diana Indrane<sup>1</sup>, Mark Goedkoop<sup>2</sup>, Ilonka de Beer<sup>3</sup>**

<sup>1</sup> Valmiera (Latvia)

<sup>2</sup> PRé Sustainability

<sup>3</sup> Sandalfon Sustainability

## Introduction

Social Life Cycle Assessment (LCA) strives to consider both positive and negative impacts of the product life cycle. The UNEP/SETAC Guidelines describes positive impacts as performance beyond compliance with local laws, international agreements or certification schemes (UNEP/SETAC, 2009). It is understood that positive impacts should provide additional benefits to the addressed stakeholders and recognise not only achievement of minimum benchmark.

In the Handbook for Product Social Impact Assessments (PSIA), positive impacts are assessed alongside negative impacts. Data is interpreted, and scores are attributed to each social topic in relation to a five-point scale (Fontes, 2016). The proposed scales are described in generic levels: (i) -2 non-acceptable performance, (ii) -1 intermediate negative performance, (iii) 0 aligned with international standards, (iv) +1 intermediate positive performance and (v) +2 ideal performance (ibid.).

In the initial process of developing the PSIA method, no formal guiding principles were used to establish reference scales for qualitative assessment. Defining a positive impact as intermediate positive performance and ideal performance appears to be too vague and leaves each position open for interpretation. Moreover, the lack of specific guiding principles has led to some inconsistencies in the reference scales presented throughout the Handbook. For certain social topics, benchmarks representing positive impacts, capture compliance instead of the best practices e.g. the benchmark “Normal working week does not exceed legal limit or 48 hours for hourly workers. Overtime is voluntary and compensated at premium rate” is considered as the ideal performance for social topic “Working hours” (Fontes, 2016). This distinction appears to be odd as compensation of the overtime is regulated by appropriate laws and should be considered as compliance. Moreover, the reference scales presented in the PSIA method are contradicting with the description of positive impacts outlined in PSIA.

Thus, this paper explores ways how to systematically address positive impacts in the Handbook for Product Social Impact Assessment. The aim is to explore applicability of Theory of Change (ToC) and how the principles can be transferred to the Product Social Impact Assessment.

## Methods

The literature concerning positive impacts in SLCA have been reviewed to better define positive impacts in PSIA and create a clearer understanding of aspects that should be assessed at the upper levels of reference scales. ToC has been adopted as guiding principle for establishing consistent reference scales for each of the social topics presented in PSIA.

### Defining positive impacts

Review report on positive impacts in SLCA papers and case studies by Di Cesare et al. (2016) revealed that the concept of positive impacts is not clearly defined within SLCA methodology and no shared definition can be deducted. Authors define positive impacts in a number of different ways that mainly fall under two categories: “The net positive effect of an activity on a community and the well-being of individuals and families” and “An improvement related to the previous situation”. Interestingly, the method by Citroth and Franze (2011) considers the absence of negative issues as a positive impact. However, study carried out by Di Cesare et al. (2016) emphasise that absence of negative impacts should not be regarded as positive impacts but neutral, which also supported by statements made in the UNEP Guidelines.

In accordance to the definitions listed above, this paper views positive impacts as those relating to activities that add/provide value to stakeholders and looks beyond mere compliance. Considering this, assessment of positive impacts in PSIA would now focus on whether supply chain actors are promoting good practices, carrying out interventions to improve conditions and whether the undertaken interventions are creating positive value for stakeholders. The reference scales would aim to assess the effort and will of supply chain actors to manage given social issues (Are the supply chain actors able to make improvements and are they willing to?). Hence, to achieve an ideal performance or positive impact, value chain actors would need to actively contribute.

### Establishing consistent reference scales

To establish consistent reference scales for each social topic presented in PSIA, more detailed guiding principles are needed. As each intervention undertaken by the companies to promote good practices can be observed and measured at different points along an impact pathway, we decided to focus on certain points for each level on the reference scales. That is, interventions undertaken to improve working conditions were linked with the Theory of Change. In the literature, ToC is defined as “A causal flow that illustrates how a proposed set of interventions and inputs will result in specific outputs contributing to different outcomes leading to certain impacts” (Sustainable Food Lab, 2014).

We decided to assess the ideal performance as an output from conducted interventions, as it is harder to disentangle the specific effects from interventions on outcome

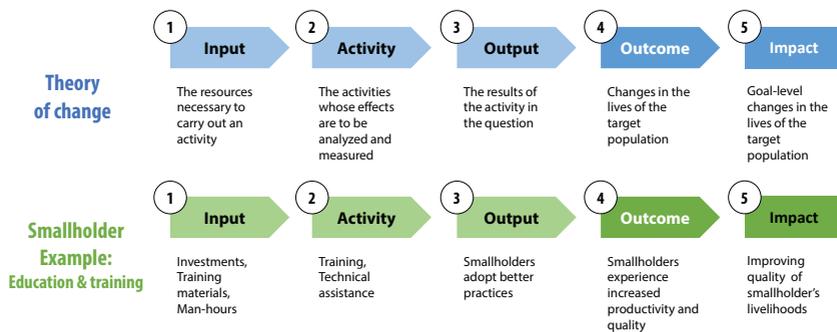


Figure 1: Illustration of Theory of change

or impact level. That is, while the link between the carried-out activities and their immediate effects are relatively easy to recognise, this link is harder to acknowledge if performance is measured further down the impact pathway. Moreover, outcomes and impacts can take many years to evolve and manifest. That said, if the Theory of Change for certain interventions is clear, then it is recommended to measure further along the impact pathway e.g. Outcomes or Impacts.

The inclusion of stakeholder experiences and satisfaction with the undertaken interventions and application of though practices served as a way to assess outputs. The approach aims to give voice to the affected stakeholder group. Moreover, the reference scales consider whether good practices are supplemented by continuous improvement and sharing/reporting of the best practices, whereas, the intermediate positive performance was determined on Input and Activity level. More detailed guiding principles for establishing reference scales are described in Table 1.

Additionally, the table outlines the general criteria that have to be met for each level on the references scales. For levels 0 and -1, multiple options have been described depending on whether interventions are undertaken or not. For example, the first situation when a score of 0 can be assigned is if the local conditions are satisfactory or for certain social topics, certifications can serve as sufficient proof of compliance. In the second situation, interventions are undertaken to improve local conditions (inputs or activities), however, no follow-up assessment is conducted to understand whether stakeholders are satisfied with provided interventions. That is, the usefulness of the activities is not clear.

## Conclusions

Scrutiny of literature sources revealed that the concept of positive impacts is not clearly defined within SLCA methodology and no shared definition can be deduced. For the purpose of the further development of the PSIA method, positive impacts are described as activities that provide value to stakeholders and looks beyond mere compliance.

Reference scales	Location on impact pathway	Guiding principles
+2	3	Useful (to the stakeholders) and tailored interventions that have resulted in positive outputs; resources are used, knowledge is applied.
+1	1-2	Stakeholders find the interventions useful, tailored to local conditions and needs.
0	1-2	Interventions are made, but no monitoring or assessment of impacts, satisfaction or relevance.
0	0	No interventions, but also no significant issues reported. OR Credible certifications for the topic are applicable.
-1	1-2	Risks are known, opportunities identified, and actions are taken. However, the situation is still not compliant.
-1	0	Risks are known, opportunities identified, but no interventions.
-2	0	No interventions; Silent and or beneficial complicity. Likely to be high risk, or no data.

Table 1: Guiding principles for establishing reference scales developed based on Theory of Change

Guiding principles for establishing consistent references scales were proposed based on the Theory of Change. Application of ToC in reference scale development enabled us to clearly define how positive impacts will be addressed in PSIA. Assessing intermediate positive performance and ideal performance at different points on the impact pathway, allowed us to create a separation between the upper levels of reference scales.

The next steps are to use these guidance principles to revise and streamline the reference scales presented in PSIA for each of the social topics. Furthermore, applicability of the revised reference scales should be tested on case studies prior to making the method made public. Additionally, the method should be subjected to external review process.

## References

- Di Cesare, S., Silveri, F., Sala, S., & Petti, L. (2016). Positive impacts in social life cycle assessment: state of the art and the way forward. *International Journal of Life Cycle Assessment*, <https://doi.org/10.1007/s11367-016-1169-7>
- Fontes, J. (2016). *Handbook-for-Product-Social-Impact-Assessment-3.0*, 1–146.
- Ciroth A, Franze J (2011) LCA of an ecolabeled notebook. Green Delta and Federal Public Planning Service Sustainable Development, Berlin
- Sustainable Food Lab. (2014). *Performance Measurement in Smallholder Supply Chains: A practitioners guide to developing a performance measurement approach*. Retrieved from <http://www.sustainablefoodlab.org/wp-content/uploads/2016/04/Performance-Measurement-Practitioners-Guide-SFL-2014.pdf>
- UNEP/SETAC. (2009). *Guidelines for Social Life Cycle Assessment of Products*. Management (Vol. 15). <https://doi.org/DTI/1164/PA>

# Preliminary evaluation of data collection methods for SLCA studies

**Rodrigo Trevisani Juchen<sup>1</sup>, Jaylton Bonacina de Araujo<sup>1</sup>,  
Arij Mohamad Radwan Omar Chabrawi<sup>2</sup>, Cássia Maria Lie Ugaya<sup>1</sup>**

<sup>1</sup> Federal University of Technology - Paraná, Curitiba (Brazil)

<sup>2</sup> University of Brasilia – Federal District, Brasília (Brazil)

## Introduction

For the evaluation of the social impact caused by products and organizations, UNEP and SETAC (BENOÎT et al., 2010) have created a series of guidelines for Social Life Cycle Assessment (SLCA) followed by the publication of Methodological sheets for subcategories of social LCA (BENOÎT-NORRIS et al., 2011) which presents suggestions of specific and generic indicators for each of the sub-categories of the stakeholders: Worker, Consumer, Local Community, Society and Actors in the Value Chain. The sheets contain the base definition of indicators and justify each subcategory in its relevance to sustainable development. The SLCA can use generic data, which is not specific to organizations, such as country or sector data, and has been used in studies with the use of SHDB database (BENOÎT-NORRIS et al., 2012). These data demonstrate a broad and widespread social scenario for a sector or region.

Although LCA studies traditionally use generic data (e.g. databases or literature), foreground data are usually data specific to the processes that are within the company's sphere of influence. This is also true in the case of SLCA, which uses specific data, which can for example be obtained primarily with focus groups of the organization's workers or with the local community surrounding the plant.

For the collection of SLCA data, UNEP and SETAC (BENOÎT et al., 2010) presented some suggestions, but there is no consensus on how to perform the acquisition of this information, especially in the case of qualitative and subjective data.

Given the importance of collecting data for the social inventory and in order to contribute constructively to the scientific community, the objective of the present study is to analyze the data collection methods used in SLCA case studies.

## Method

Initially, criteria for analyzing the case studies were drawn from the UNEP / SETAC (2009) guidelines and the social research conduct method (REA and PARKER, 2014), which are:

- i) *stakeholders and subcategories included*: Across the entire product lifecycle chain, social impacts can be seen in 5 stakeholders, who are Workers, Society, Consumer, Local Community and Value Chain Actors and 31 subcategories;
- ii) *collection instrument*: Once the study deemed necessary the specific information of the product or company and thus decided to perform the primary collection, this work observed the availability of the method of collection, for example, the questionnaires used;
- iii) *sampling*: The range of data collected is always evaluated in one study. The ideal number can be determined from a statistical concept or the availability of data. For this review, we note the transparency of the researchers' information regarding the definitions of samples;
- iv) *application of triangulation*: To check the veracity of information, a triangulated data discriminates coherence and cohesion in empirical research, comparing information from different sources, where it is possible to identify distortions or discrepancies. For this criterion, it was identified if there was triangulation;
- v) *data quality analysis*: This item can be defined based on quality criteria such as temporal correlation, scientific robustness or methodological transparency. The analysis of the studies consisted in verifying that the studies performed the data quality analysis.

Then, some case-studies of SLCA published in scientific journals were randomly selected to apply the criteria.

Finally, the methods were analyzed according to some principles of the global LCA database (UNEP, 2011) that were pertinent to data set: Accuracy, Relevance, Consistency, Materiality and Practicality.

## Preliminary results

We evaluated 11 studies, each with different scopes (products, organizations and in distinct regions), whose listing is presented in Table 1, with data from each study related to the evaluated criteria.

### Stakeholders and subcategories included

All studies follow the methodology published in the guidelines when addressing social stakeholders listed by UNEP and SETAC (2009), but only 4 (36%) studies work considering all of them (FRANZE and CIROTH, 2011) (CIROTH, A, FRANZE, J., 2011) (HOSSEINIJOU, MANSOUR, SHIRAZI, 2014) and (RAMIREZ et al., 2016).

The other studies include workers as the principal scope of the study (100%), being the second and third the most common stakeholders the Local Community (63%) and Society (54%), but there is rarely data collection from the Value Chain and Consumers.

Source	Stakeholders	Triangulation	Data Quality	Questionnaire availability	Data type
<b>Albrecht et al., 2013</b>	Workers	No	No	No	Generic
<b>Aparcana and Salhofer, 2013</b>	Workers	Yes	No	Yes	Specific
<b>Arcese et al., 2013</b>	Worker / Local Community	No	No	Yes	Specific
<b>CIROTH, A. and FRANZE, J., 2011</b>	All of them	Yes	Yes	No	Specific and Generic
<b>De Luca et al., 2015</b>	Workers / local Community / Society	No	No	No	Specific and Generic
<b>Foolmaun and Ramjeeawon, 2013</b>	Workers / Local Community / Society	No	No	Yes	Specific
<b>Franze and Ciroth, 2011</b>	All of them	No	No	No	Generic
<b>Chang et al., 2015</b>	Workers	No	No	No	Generic
<b>Hosseinijou et al., 2014</b>	All of them	No	No	No	Generic
<b>Souza et al., 2016</b>	Workers	No	No	No	Generic
<b>Ramirez et al., 2016</b>	All of them	Yes	Yes	No	Specific

Table 1: SLCA studies evaluated

As a result, for the subcategories, the indicators that make up the Workers' stakeholder are also the most used. This may be justified in view of the fact that the subcategories of this interested party generally present a more objective and easily available indicator in data libraries (e.g. worked hours).

Also, for the subcategories it is possible to note one more detail, the adaptation or inclusion of a subcategory not listed in the guidelines. For example, SOUZA et al. (2016) used the subcategory Education, however, in UNEP and SETAC (2009), education is only one of the points included in the subcategory of Immaterial Resources.

### Collection and sampling tool

According to Rea and Parker (2014), it is important to define the sampling and the form of data collection. Of all the articles evaluated, only 9% of the studies evaluated described the sampling in detail, by number and characteristics of the group of interest (FOOLMAUN and RAMJEEAWON, 2013).

Regarding the form of specific data collection, 36% of the studies opted for the use of questionnaires. However, APARCANA and SALHOFER, 2013, ARCESE, LUCCHETTI, MERLI, 2013, FOOLMAUN and RAMJEEAWON, 2013 and RAMIREZ et al., 2016 presented

how the subcategories were translated for the elaboration of the questionnaire, and only Ramirez et al. (2016) did the interviews on the site.

### Analysis of data quality

Regarding data quality analysis, UNEP and SETAC (2009) recommend it to be performed. However, few studies have implemented this practice. Ciroth and Franze (2011), who represent 9% of the studies evaluated, adapted quality criteria to be used in the study. However, the authors used generic data to complement the lack of primary data, and the differentiation of this practice in data quality analysis was not presented.

The option to investigate the effect of possible data variation (sensitivity analysis) was also considered as quality analysis, present in the studies of (HOSSEINIJOU, MANSOUR, SHIRAZI, 2014 and MORIIZUMI, MATSUI, HONDO, 2010).

### Triangulation application

UNEP and SETAC (2009) also suggest that triangulation is performed, which allows the construction of coherence and cohesion in empirical research, comparing information from different sources, in which it is possible to identify distortions or discrepancies. Among the analyzed studies, only (CIROTH, A., FRANZE, J., 2011) and (RAMIREZ et al., 2016) did the triangulation, and the first authors compared the data collected in the industries with the generic data obtained from various reports or surveys in the regional industries of the same sectors while the latter compared primary data obtained from different actors (e.g. checked data from managers, workers and union).

### Analysis of studies according to principles of Shonan Guidance

Even all authors are using the SLCA, the wide diversity of methods presented for collection of specific data for the inventory is evident. Differences already begin when one chooses to work with some of the stakeholders, thus eliminating several subcategories, resulting in a "bottleneck" in the research, which can lead to a limitation when comparing with the principles of *Materiality* and *Completeness*.

At the same time, data triangulation and data quality analysis are techniques that could corroborate with the *Accuracy* of the data.

In addition, the lack of clear procedures in the way of conducting data collection may result in a lack of *Consistency*. From the studies analyzed, it was noticed that the *Transparency* of the method of obtaining generic data is clearer than the studies that collected specific data.

Despite the advantage of using specific data, obtaining it usually takes more time, costs and stress for the research team than generic data. Thus, studies that opt for generic data value by *Practicality*, however, reduce the *Relevance* of the study.

## Conclusion

Watching the applied work of SLCA, are notable differences between the practices addressed in data acquisition. In general, the studies do not follow all UNEP / SETAC guidelines and there is a lack of information about collecting data method, as well as the definition of the sample and questionnaire used. Thus, it is necessary to define aspects necessary for the acquisition, in order to have greater transparency of studies and reliability of information for SLCA.

The concern with the application of triangulation and data quality is precarious in its majority. Such practices with a database reinforce the robustness of a study, but are still largely ignored by researchers.

Also notable, each researcher finds his own way of work, that best suits him. Doing that, he accomplishes one or two principles found in the Shonan guidance, which were all developed as a final factor for datasets. The database managers should provide users with a suitable quality and sufficiently documented for future independent research, because these principles have only one fundamental task of bringing all this large data to an effectively access and applicability in SLCA.

For the continuation of this work, it is suggested continuation of bibliographic review of data collecting. The complete understanding of state of art is crucial to identify the pros and cons of what has been used by the researchers, so far. And based on that, the elaboration of a proposal of methodology including triangulation and quality of data and fulfilling the principles listed by UNEP / SETAC is necessary, in order to clarify and improve, as far as possible, the steps of a data collection.

## Reference

- Albrecht, S., Brandstetter, P., Beck, T., Fullana-i-Palmer, P., Grönman, K., Baitz, M., Deimling, S., Sandilands, J., Fischer, M., 2013. An extended life cycle analysis of packaging systems for fruit and vegetable transport in Europe. *Int. J. Life Cycle Assess.* 18, 1549–1567. <https://doi.org/10.1007/s11367-013-0590-4>
- Aparcana, S., Salhofer, S., 2013. Application of a methodology for the social life cycle assessment of recycling systems in low income countries: three Peruvian case studies. *Int. J. Life Cycle Assess.* 18, 1116–1128. <https://doi.org/10.1007/s11367-013-0559-3>
- Arcese, G., Lucchetti, M., Merli, R., 2013. Social Life Cycle Assessment as a Management Tool: Methodology for Application in Tourism. *Sustainability* 5, 3275–3287. <https://doi.org/10.3390/su5083275>
- Chang, Y.-J., Sproesser, G., Neugebauer, S., Wolf, K., Scheumann, R., Pittner, A., Rethmeier, M., Finkbeiner, M., 2015. Environmental and social life cycle assessment of welding technologies. *Procedia CIRP* 26, 293–298.
- CIROTH, A., FRANZE, J., 2011. LCA of an Ecolabeled Notebook – Consideration of Social and Environmental Impacts along the entire Life Cycle.
- De Luca, A.I., Iofrida, N., Strano, A., Falcone, G., Gulisano, G., 2015. Social life cycle assessment and participatory approaches: a methodological proposal applied to citrus farming in Southern

Italy. *Integr. Environ. Assess. Manag.* 11, 383–396.

Foolmaun, R.K., Ramjeeawon, T., 2013. Comparative life cycle assessment and social life cycle assessment of used polyethylene terephthalate (PET) bottles in Mauritius. *Int. J. Life Cycle Assess.* 18, 155–171. <https://doi.org/10.1007/s11367-012-0447-2>

Franze, J., Citroth, A., 2011. A comparison of cut roses from Ecuador and the Netherlands. *Int. J. Life Cycle Assess.* 16, 366–379. <https://doi.org/10.1007/s11367-011-0266-x>

Hosseinijou, S.A., Mansour, S., Shirazi, M.A., 2014. Social life cycle assessment for material selection: a case study of building materials. *Int. J. Life Cycle Assess.* 19, 620–645. <https://doi.org/10.1007/s11367-013-0658-1>

Ramirez, P.K.S., Petti, L., Brones, F., Ugaya, C.M.L., 2016. Subcategory assessment method for social life cycle assessment. Part 2: application in Natura's cocoa soap. *Int. J. Life Cycle Assess.* 21, 106–117. <https://doi.org/10.1007/s11367-015-0964-x>

Souza, A., Watanabe, M.D.B., Cavalett, O., Ugaya, C.M.L., Bonomi, A., 2016. Social life cycle assessment of first and second-generation ethanol production technologies in Brazil. *Int. J. Life Cycle Assess.* 1–12. <https://doi.org/10.1007/s11367-016-1112-y>

# Influence diagrams and scoping for social LCA, an example from sustainable minings

**Andreas Ciroth**

*GreenDelta, Berlin (Germany)*

## Introduction

Social LCA is a technique typically intended to provide a holistic assessment of social impacts over the entire supply chain and life cycle. However, social LCA has limitations, for a variety of reasons:

- Social LCA typically does not deal with risk and chances<sup>1</sup>
- Social LCA typically does not model local situations in high resolution, and thus tends to overlook specific local conditions
- Social LCA is a rather technical approach with high data needs, which are especially difficult to satisfy in regions where social LCA is new and no background databases are available; as a consequence, immediate improvement in perilous situations might be better achieved with more “hands-on” tools
- Social LCA results have the issue to be difficult to understand, and alternative approaches such as CSR, labelling, or local social impact assessments, are at times applied instead

In this situation, it is interesting to investigate, for a given issue, the ideal portfolio of tools to be used, including social LCA, but not necessarily limited to it. Moreover, in every social LCA, it is as first step important to specify goal and scope for the further analysis, and it is worthwhile to be aware of aspects which have an influence on the overall social impacts of an investigated product. So far, goal and scope in social LCA is conducted typically without a diagram or visualization of relations between different aspects to be decided about in goal and scope. We introduce influence diagrams and advanced hot spot analysis as a means to both “tailor” the approaches to be applied for assessing the social sustainability of a given situation, and also to shape goal and scope of a social LCA, where social LCA is part of said portfolio.

## Approach

Causal loop and influence diagrams are a common tool in modelling and systems analysis and often described in literature [1-3]. They typically serve to better

---

<sup>1</sup> We are aware that some databases and studies are calling the indicators used “risk for ...”, to highlight that the indicators do not reflect a deterministic impact; however, we mean here an explicit, direct treatment of risks similar to risk assessments for example.

understand the system under study, and more specifically to identify elements in the system that have a stronger influence on system results and, ideally, also on system stability.

A typical use of causal loop diagrams is qualitative modelling. They help in structuring a topic, and thus can be used as first step of a more detailed analysis and system assessment. Despite these points, applications to Life Cycle and Sustainability Assessment are scarce to non-existent. For social analysis, however, several applications exist, reflecting also the wider scope of a typical social impact study, e.g. [4-5].

We develop and present a causal loop diagram for sustainability assessment of mining in general, and apply this to specific mine sites in Finland, Portugal, and South Africa, where this approach is currently applied, led by GreenDelta, in the European H2020 research project ITERAMS.

## Results and interpretation

For the diagram, we developed specific archetypes, i.e. elements with a specific function, which are adapted to the specific idea of modelling sustainability impacts. These archetypes are:

- *endpoints*: Endpoints are impacts on local community, workers, and so forth (Fig. 1)



Figure 1: Local community impacts as one of the endpoints in the diagram.

- *life cycle connection points*: The model primarily addresses the mine, which makes sense as the remaining life cycle model is linear; life cycle connection points are used to link “local” requirements of the foreground, mine system to the supply chain
- *arrows* are used to show relations, a positive relation between a and b means that with an increase of a, b increases; a negative relation means that with an increase of a, b decreases (Fig. 2)

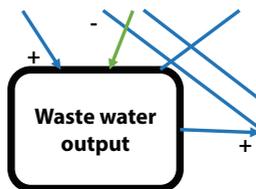


Figure 2: Arrows showing positive (blue) and negative (green) relations in the diagram.

- *further elements* in the diagram are input variables, conditions that cannot be changed but have impact on results potentially, stocks within the system (which include in-system variables with a certain value) and risks as a specific type of stocks.

An analysis of the diagram shows relations within the system, and hot spots and main drivers for impacts. Fig. 3 shows a simple example for contribution to impacts on workers, from a mine.

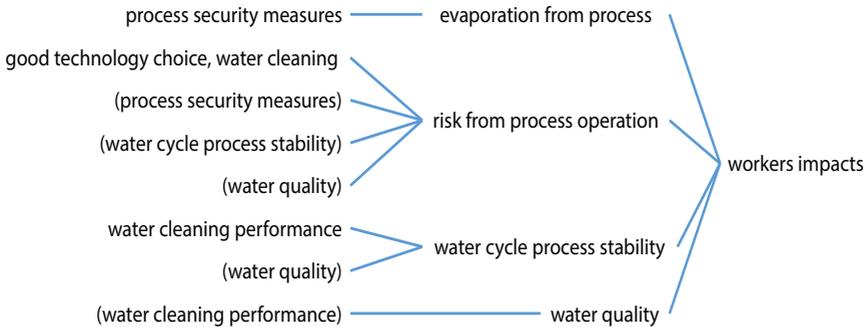


Figure 3: Causes for worker impacts of a generic mine.

The analysis also shows which tools are suitable for addressing the hot spots and main drivers which exist according to a defined broader goal and scope, considering a portfolio of social life cycle assessment to analysis of economic performance to risk assessment; also more regional approaches, such as Social Impact Assessment, can contribute important insights, which can be detected via the qualitative diagrams.

## Conclusions and future developments

In the presentation, the developed causal loop diagram and the approach for obtaining the diagram for the case will be explained, with results from the ITERAMS project. Results are quite promising and we believe that using causal loop diagrams in sustainability and life cycle assessments helps to clarify selection of the (combination of) appropriate tools for the assessment, and further, helps to structure the goal and scope setting in LCA.

We believe that influence diagrams, common in systems theory and general modelling, are an interesting idea to be brought into social LCA and Life Cycle Sustainability Assessment more in general, since they help to get a better understanding of the interrelations of the investigated system, beyond the quite simple linear life cycle assessment model, towards life cycle systems thinking, and towards a truly comprehensive and yet efficient modelling and assessment.

## References

- [1] Bala B.K., Arshad F.M., Noh K.M.: Causal Loop Diagrams. In: System Dynamics. Springer Texts in Business and Economics. Singapore, 2017, pp 37-51
- [2] Bossel, H.: Modellbildung und Simulation, Kassel 1994
- [3] Sterman, J.: Business Dynamics, Boston 2000.
- [4] Nkambule, N.P: Measuring The Social Costs Of Coal-Based Electricity Generation In South Africa, dissertation, 2015
- [5] Pollard, S., H. Biggs, and D. R. Du Toit. 2014. A systemic framework for context-based decision making in natural resource management: reflections on an integrative assessment of water and livelihood security outcomes following policy reform in south Africa. Ecology and society 19(2): 63. [Http://dx.doi.org/10.5751/es-06312-190263](http://dx.doi.org/10.5751/es-06312-190263)

# Proposal of social indicators to assess the social performance of waste management systems in developing countries: a Brazilian case study

Valeria Ibañez-Forés<sup>1</sup>, María D. Bovea<sup>1</sup>, Claudia Coutinho-Nóbrega<sup>2</sup>

<sup>1</sup> Dept. Mechanical Engineering and Construction, Universitat Jaume I, Castellón (Spain)

<sup>2</sup> Dept. of Civil and Environmental Engineering, Universidade Federal da Paraíba, João Pessoa (Brazil)

## Abstract

The Brazilian National Solid Waste Policy Law promotes sustainable integrated solid waste management nationally, and is committed to improve “informal” recyclable waste pickers’ socio-economic conditions. This has led municipalities to develop waste management strategies to incorporate “informal” waste pickers into the “formal” system. In order to measure the social improvement achieved by this action, it is necessary to define a set of indicators capable of quantifying the social performance of waste management systems that adapt specifically to developing countries.

In this study, a set of social impact categories, indicators and metrics capable of assessing the socio-economic and labour conditions of the different stakeholders involved in the life cycle of a municipal solid waste management (MSWM) system is proposed. Then they are applied to a case study in the city of João Pessoa, Paraíba (Brazil). João Pessoa is one of the pioneering Brazilian cities to incorporate a door-to-door selective waste collection system managed by the previous “informal” waste pickers, reorganised into associations or cooperatives of collectors of recyclable materials. Although this waste collection system has steadily expanded around the city until the present-day, it has never been analysed from a social perspective.

# Social sustainability assessment of Calabrian olive growing

**Iofrida N.<sup>1</sup>, Strano A.<sup>1</sup>, Gulisano G.<sup>1</sup>, Falcone G.<sup>1</sup>, Silveri F.<sup>2</sup>, Petti L.<sup>2</sup>, De Luca A.I.<sup>1</sup>**

<sup>1</sup> *Mediterranean University of Reggio Calabria, AGRARIA Department, Feo di Vito (Italy)*

<sup>2</sup> *"G. D'Annunzio" University, Department of Economic Studies, Pescara (Italy)*

## Introduction

Assessing sustainability became of utmost importance in many fields of study and companies are striving to add new "sustainability qualities" to their businesses and products. As well, consumers shifted their attention from environmental issues to social impacts concerns, such as working conditions, wage fairness, gender equity, and so on. Among these social concerns, the physical and psychosocial factors in the work environment are under the attention of the EU policies as well as at companies level, but there is a lack of tools to put them in practice, first of all validated and userfriendly assessment methodologies (EUOSHA, 2012; Tomaschek et al., 2018). According to Tomaschek et al. (2018), until now, most of job assessment tools for work-related risk factors have been based on self-reports more than analytical observations, but such instruments can possibly suffer from low reliability due to bias resulting from observers' individualities.

The aim of the present study is to apply a Social Life Cycle Assessment methodology to assess physical and psychological risk factors affecting workers in an objective and quantitative way, highlighting those conditions attributable to the functioning of the life cycle, having possible consequences on workers' health.

Social Life Cycle Assessment is the last tool developed within the framework of Life Cycle Thinking, and many methodologies have been proposed (Di Cesare et al., 2016; Petti et al., 2016), but most of them are epistemologically far from its environmental and economic peers. The methodology here proposed is the Psychosocial Risk Factor impact pathway (Gasnier, 2012; Silveri et al., 2014; De Luca et al., 2018), that enable to account the amount of hours of exposure to a possible health risk in terms of odds ratio (OR).

The case study is the oil olive production in the hilly areas of Calabria region (South Italy). In the Mediterranean basin, olive growing is the most important agricultural activity, fostering the survival of rural economies. In Calabria region, is the most diffused crop, with 184.596,37 hectares cultivated with oil and table olive orchards (ISTAT, 2012). Hilly areas are mainly devoted to the production of high quality products, and represents 66% of the regional olive groves surfaces. Small and medium-scale

farms have to deal not only with the market challenges balancing profitability, quality, but also with the new consumer's requirements oriented toward new sustainable qualities in terms of healthy and socially responsible production. "Musculoskeletal diseases" is the most frequently reported work-related health problem followed by stress and anxiety (Tomaschek et al., 2018). Occupational diseases and injuries are considered one of the principal cause for working absences and compensation expenses, representing therefore a real socio-economic issue for all actors involved (Chang et al., 2016).

In this study, the oil olive growing systems in Calabrian hilly areas have been assessed and compared, distinguishing three main typologies of soil management that also identify three typologies of farming systems.

## **Theoretical background**

Social Life Cycle Assessment (SLCA) is the last methodology among life cycle tools, and the most controversial. It did not reach a methodological consensus on many issues, such as the focus of the assessment, the source of impacts, the impact assessment method and the epistemological bases underpinning the methodological choices (Iofrida et al., 2016; De Luca et al., 2018).

The present study applies a Psychosocial Risk Factors (PRF) pathway (Gasnier, 2012; Silveri et al., 2014; De Luca et al., 2018), that allows to predict possible impacts on health on the workers directly involved in the life cycle of a product. PRFs can be described as "those aspects of work planning and management - and their relative social and environmental contexts - that can potentially lead to physical or psychological damages" (Cox and Griffiths, 1995:69). Decent work, especially in agriculture, is the principal goal of many international organizations and policies (such as ILO, the International Labour Organization). Especially in agriculture, particular working conditions occur and they can threaten workers' safety, in terms of ergonomics, exposure to hazardous products, diseases and accidents, and psychosocial risks.

## **Material and methods**

A field and desk territorial survey from previous studies about Calabrian olive growing (De Luca et al., 2018) provided the preliminary data about olive growing consistency and typology of farming systems applied. Interviews to sector operators were also conducted to define the typologies of agricultural operations and working tasks. Among these last, it emerged that one of the main issues, in hilly areas, regards weed control, directly linked to soil degradation, erosion, and, therefore, reduction of soil fertility. Mechanical weeding can probably worsen erosion in hilly areas due to the soil disturbance, but chemical weeding can have effects on human health and toxicity. In fact, epidemiological studies have found associations between the use of agricultural chemicals and mortal diseases such as cutaneous melanoma, non-Hodgkin's lymphoma, renal cell carcinoma, gastric cancer and Parkinson's disease, among others (Fritschi et al., 2005; Elbaz et al., 2009; Fortes et al., 2016).

The goal and scope of this study was to highlight the negative impacts on workers' health directly linked to the functioning of the agricultural phase of the olive growing's life cycle (50 years). Data were gathered from previous studies, i.e. from a sample of 30 farms located in hilly areas of Calabria that were considered representative of the area of study, with an average surface of cultivated area of 5 hectares. Data concerned oil olives production, inputs consumption, machinery use, typology of tasks, duration, and working conditions. Direct interviews were also conducted with farmers, to make the inventory the most adherent to regional realities. Once data were gathered, three scenarios have been defined according to the possible farming typologies, with specific reference to the weed management. The SLCA here presented has been developed through the following steps:

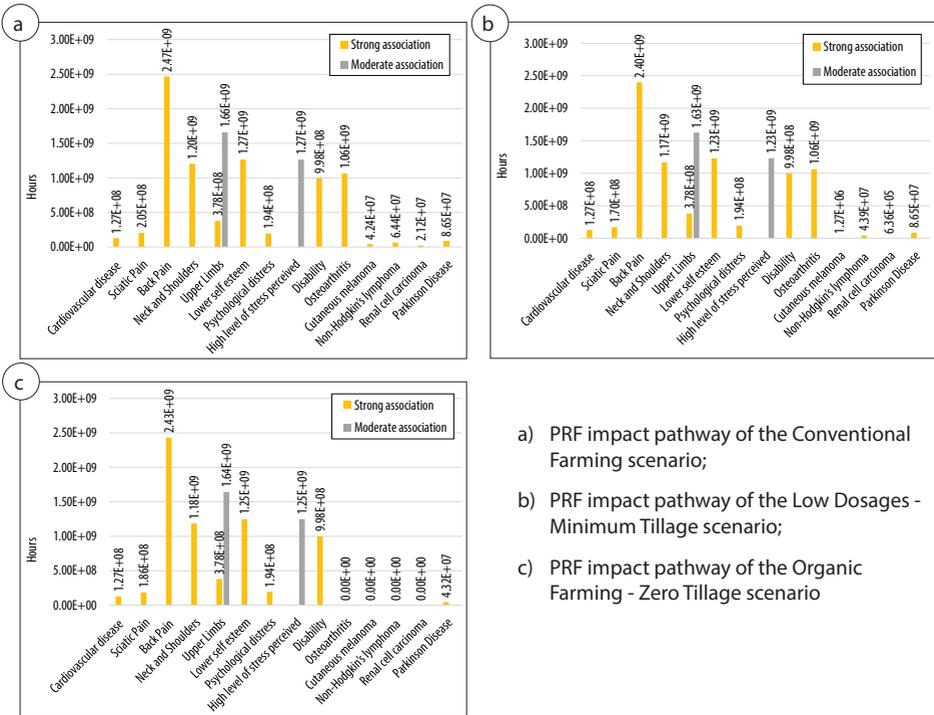
1. The inventory step consisted in the compilation of 18 sheets, one per each phase per each scenario; every operation was qualified and quantified in terms of working hours needs;
2. A literature review among medical and epidemiological studies, to find correlations and associations between particular working conditions and human diseases, by means of the OR, a statistical measure of the intensity of association (e.g. Siegrist, 1996; Fritschi et al., 2005; Elbaz et al., 2009; Fortes et al., 2016).
3. The ORs have been classified in classes of strength of association: weak, moderate and strong;
4. A Psychosocial Risk Factors Matrix was built, putting in relation each working condition with a health risk;
5. The quantification of possible social impacts in terms of working hours per each health disease.

## Results

During the impact assessment phase, 14 situations of risk have been identified, linked to 12 possible health disorders or diseases, with moderate and/or strong association.

Every working task (tillage, shredding, pruning, pesticide application, harvesting, etc.) has been linked to a psychosocial risk factor (noise, vibration, high physical demand, pesticide exposure, outdoor working environment, etc.), and the total amount of exposure hours were calculated distinguishing moderate association ( $1,3 < OR < 1,7$ ) and strong association ( $1,7 < OR < 8$ )

Considering the total amount of working hours, the LDMT (Low Dosage - Minimum Tillage) is the scenario that entails less exposure to possible PRF. The most affecting impact category in all scenarios is the back pain (musculoskeletal disorders): the CF (Conventional Farming) scenario shows the worst result, with 2.468 million hours of exposure during the whole life cycle, while LDMT is the best one.



- a) PRF impact pathway of the Conventional Farming scenario;
- b) PRF impact pathway of the Low Dosages - Minimum Tillage scenario;
- c) PRF impact pathway of the Organic Farming - Zero Tillage scenario

Figure 1: Evaluation and comparison of the three scenarios

However, taking into consideration possible mortal diseases such as the cutaneous melanoma, non-Hodgkin's lymphoma, renal cell carcinoma, and the Parkinson's disease, the OFZT (Organic Farming - Zero Tillage) scenario is absolutely the best one, due to the absence of organophosphate pesticides and glyphosate exposure.

## Conclusions and future developments

The PRF impact pathway here proposed allowed assessing those social impacts directly linked to the functioning of the olive growing life cycle, by quantifying the hours of possible exposure. Scenarios have been compared objectively, recurring to previous medical and epidemiological scientific studies. This methodology is epistemologically in line with other life cycle tools, such as LCA, because it allows to outline cause-effect relationships between working situations and workers' health. The main asset of the PRF impact pathway stays in the prediction of possible consequences of the products' life cycle. It is possible to extend this typology of assessment to other products or services, as well as including more typologies of stakeholders such as consumers, local residents and the like.

## References

- Chang, YJ, Nguyen, TD, Finkbeiner, M, Krüger, J 2016. Adapting Ergonomic Assessments to Social Life Cycle Assessment. *Procedia CIRP*, 40, 91-96.
- Cox, T, Griffiths, A 1995. The nature and measurement of work stress: theory and practice. In: Wilson, J, and Corlett, N (Eds) *The Evaluation of Human Work: A Practical Ergonomics Methodology*. London: Taylor & Francis.
- De Luca, AI, Falcone, G, Stillitano, T, Iofrida, N, Strano, A, Gulisano, G 2018. Evaluation of sustainable innovations in olive growing systems: A Life Cycle Sustainability Assessment case study in southern Italy. *J. Clean. Prod.*, 171: 1187-1202.
- Di Cesare, S, Silveri, F, Sala, S, Petti, L 2016. Positive impacts in social life cycle assessment: state of the art and the way forward. *Int. J. Life Cycle Assess.* doi:10.1007/s11367-016-1169-7
- Elbaz, A, Clavel, J, Rathouz, PJ, Moisan, F, Galanaud, JP, Delemotte, B, Tzourio, C 2009. Professional exposure to pesticides and Parkinson disease. *Annals of Neurology*, 66(4), 494-504.
- EU-OSHA 2012. Management of Psychosocial Risks at Work: An Analysis of the Findings of the European Survey of Enterprises on New and Emerging Risks. European Agency for Safety and Health at Work, Luxembourg.
- Fortes, C, Mastroeni, S, Segatto, MM, Hohmann, C, Miligi, L, Bakos, L, Bonamigo, R 2016. Occupational Exposure to Pesticides With Occupational Sun Exposure Increases the Risk for Cutaneous Melanoma. *J. Occup. Environ. Med.* 58(4). <http://doi.org/10.1097/JOM.0000000000000665>
- Fritschi, L, Benke, G, Hughes, A M, Krickler, A, Turner, J, Vajdic, CM, Fritschi, J. 2005. Occupational exposure to pesticides and risk of non-Hodgkin's lymphoma. *Amer. J. Epid.* 162(9), 849-857.
- Gasnier, C 2012. Etude de l'impact des conditions de travail sur la santé dans la perspective de développer des pathways en ACV sociale. Bilan de recherche de stage (March - October 2012). Altran and IRSTEA.
- Iofrida, N, De Luca, AI, Strano, A, Gulisano, G 2016. Can social research paradigms justify the diversity of approaches to social life cycle assessment? *Int. J. Life Cycle Assess.* 1-17. <http://doi.org/10.1007/s11367-016-1206-6>
- ISTAT 2012. 6th Italian agriculture census. <http://dati-censimentoagricoltura.istat.it/>
- Petti, L, Serreli, M, Di Cesare, S 2016. Systematic literature review in social life cycle assessment. *Int. J. Life Cycle Assess.* 1-10. doi:10.1007/s11367-016-1135-4.
- Siegrist, J 1996. Adverse health effects of high effort/low reward conditions. *J. Occup. Health Psy.* 1(1), 27-41.
- Silveri, F, Macombe, C, Gasnier, C, Grimhuler, S 2014. Anticipating the psychosocial factors effects in social LCA. Proceedings of SETAC Europe 24th Annual Meeting, May 11-15, Basel.
- Tomaschek, A, Lanfer, SSL, Melzer, M, Debitz, U, Buruck, G 2018. Measuring work-related psychosocial and physical risk factors using workplace observations: a validation study of the "Healthy Workplace Screening." *Saf. Sci.* 101, 197-208. doi:10.1016/j.ssci.2017.09.006

# Integrating active impacts in sustainability assessment in product (manufacturing) life cycle

**Manish Kumar<sup>1</sup>, Monto Mani<sup>2</sup>**

<sup>1</sup> Indian Institute of Science, Bangalore, Centre for Product Design and Manufacturing (India)

<sup>2</sup> Indian Institute of Science, Bangalore, Centre for Sustainable Technologies & Centre for Product Design and Manufacturing (India)

## Introduction

Sustainability assessment (SA) has received immense attention among manufacturing industries as it improves their environmental-performance, visibility, thereby providing a market competitive edge. This has led researchers to explore various dimensions of sustainability for impacts occurring in and beyond the purview of manufacturing. Recent developments in sustainability measures suggest a need for systems based (holistic) approach to integrate (and not substitute) the reductionist approach with existing SA practices (Sala, Farioli, and Zamagni 2013). Reductionist approach is efficiency based where impacts per product are reduced or minimized. A shift from reductionist approach towards holistic perspective and applicable tools, equal focus on theory and practice is evident from recent literature. The focus of assessment practices on effectiveness along with traditional efficiency measures is much needed (Hauschild 2015). Effectiveness measures aims to objectively assess the benefits, and impacts occurring due to a product, discerned during the use phase of a product. Social dimension of sustainability has received less attention as compared to economic and environmental dimensions in existing SA tools as (1) data for use phase of products is not available for any stakeholder, (2) product's characteristics are different, and (3) users and circumstances of product use varies (Saling, Kicherer, and Reuter 2004). The relationship between manufacturing and social impacts is not clear yet, as empirical data linking social impacts to manufacturing actions is lacking (Sutherland et al. 2016). Few studies have focused on the causal link between manufacturing activities and social impacts; social impacts are linked to company's conduct and not the individual industrial process (Dreyer, Hauschild, and Schierbeck 2006), whereas (Schmidt et al. 2004) hold circumstances of production and disposal responsible for social impacts. Existing social-life cycle assessment methods is limited to factory workers while impacts on various stakeholders in other life cycle stages (post-manufacturing) are not considered for assessment (Wu, Yang, and Chen 2014).

Impacts associated with a product during its life cycle can be classified as embodied and active impacts. Embodied impacts are caused during the realization of a product, while active impacts occur during the use and post-use phases of a product life cycle (Kumar and Mani 2017). Current sustainability assessment practices take in to account embodied impacts (impacts which have already happened) throughout the product

life cycle, whereas active impacts (that are ongoing and likely to happen in future) are not considered in many tools. For instance automobiles manufacturing have improved over years with the help of new manufacturing techniques and research in material science. This improvement has resulted in light weight, improved fuel economy and material efficiency. Environment in which automobiles operates, has also changed over years due to increased congestion, low travel speed ; resulting in increased use of air conditioning and hence more emissions. Such cases of active impacts are not looked upon in assessment measures.

Existing assessment practices are efficiency based which are not adequate for holistic sustainability assessment with increasing evidence of rebound effect. Rebound effect is net increase in energy consumption driven by increasingly affordable energy efficient appliances. Adequate information about active impacts associated with products is not available in literature which can be utilized for SA practices in the realization

Embodied Impacts			Active Impacts			
Process Related			Process Related		Product Related	
During Manufacturing Operations			Post Manufacturing Operations		Use Phase	
Environmental	Economic	Social	Acute	Chronic	Use Phase	EoL Phase
Energy consumption	Manufacturing cost Profit etc.	Employee health and safety	Workplace injuries/ Occupational Health and safety risks	Cases of cancer due to certain processes and material uses etc.	Exposure to material used in products	Chemical leaching into groundwater
Water consumption		Customer satisfaction	Health issues from certain materials etc.		Impacts caused due to product failure	Discarded materials from appliances affecting human health etc.
Raw material usage		Product responsibility			Reduced "use life" of products	
Natural land use		Customer health and safety etc.			Impacts caused due to behavioral change	
Solid waste generation					Impacts caused due to lack of safety and certification standards etc.	
Gaseous and liquid emissions etc.						
<b>Efficiency measures</b>			<b>Effectiveness measures</b>			

Table 1: Product life cycle impacts overview

(design and manufacturing) and use and disposal of a product. Table 1 presents the concept of embodied and active impacts with the help of few examples. Overlap in embodied and active impacts is noticeable e.g. employee and customer health and safety in embodied impacts are similar to acute post-manufacturing phase impacts and use phase impacts. Also, existing SA methods include categories of impacts listed in table 1 ; e.g. Life cycle costing (LCC) assesses all costs related to a product, Working environment LCA (WE-LCA) specifically focuses on working environment social impacts, sLCA aims to assess both positive and negative social and socio-economic impacts etc. The distinction between embodied and active impacts discussed here is important as active impacts are not ordinarily foreseen by current LCA practices. Also, the list of active impacts identified till now is not exhaustive. Current paper focuses on identification of active impacts for a product manufactured using 3D printing throughout its life cycle, with an aim to subsequently develop a framework to capture the same.

## **Main Text**

### **Active Impact in Product Life Cycle**

Active impacts as the name suggests, are related to activity associated with a product, and can also be called current or ongoing impacts. Active impacts in a product life cycle can be related to the product or the (manufacturing) process. Such impacts occur throughout the product life cycle. Product related active impacts are caused during the use and post use phases e.g. BPA exposure to humans is not a new concern, as plenty of studies have reported harmful impacts of BPA, where it has become a public health concern because of its widespread use and exposure (Huang et al. 2012) ; concentrations of lead metal in toys is yet another potential health concern for children ; Duncan (2006) presented detailed list of several such impacts caused due to use of daily household products. The study presented list of such impacts and verified using blood and urine tests ; traces of industrial chemicals (e.g. phthalates, dioxins, metals, PBDE's, PCB's) were found in human tissue. Impacts related to a manufacturing activity can be classified into acute and chronic depending on the intensity and duration of exposure.

### **Case Study : 3D printing manufactured product**

3D printing has evolved in last few years for building prototypes to large scale manufacturing. It is recognised as next industrial revolution with application in electronics, personal products, healthcare, automobiles, construction and aerospace/defence (Gao et al. 2015). Though it is going to make technology accessible to masses as common individuals will be able to access and use it at home as well as at workplaces, this might result in generation of huge amount of waste, if we look at behavioral aspects of users e.g. multiple trial for 3D printing etc. Also, as a rebound effect, it is most likely to increase raw material consumption. Assessment measures in 3D printing process are currently focused on embodied impacts. Detrimental effects

of exposure to operator during operation phase for a 3D printing process have been studied by (Stephens et al. 2013) (Deng et al. 2016) (Scungio et al. 2017) & (Zontek et al. 2017). At home this could inadvertently expose children and homemakers. Need for investigating chronic health impacts of 3D printing process is suggested (Huang et al. 2013), as such impacts would be more significant at home than for a factory environment. Table 2 presents embodied and active impacts occurring during a product life cycle in case of product manufactured using 3D printing.

Geography (G1, G2, G3, G4...)	Continent				
	Country				
	City				
	Industry	Raw Material Extraction	Manufacturing	Use	End of Life
Active Impact		Carcinogenic chemical solvents used on the processes	Due to material degradability	Toxicity due to material waste	
Embodied Impact	Energy, water, material, occupational health and safety		NA		
Stakeholders (First order)	Workers	Workers	Consumers, society	Society, workers	
Stakeholders (Second order)	Worker's family	Worker's family	Coming generations	Coming generations	

Table 2: Embodied and Active impacts for 3D printed product

### Conclusions and future developments

The issues related to occurrence of various kind of active impacts are raised in this paper. Preliminary work to include such impacts is to create a structured systems framework to perceive and assess active impacts. Linkages between active impacts and manufacturing activity are yet not very clear from literature, as very few case studies on assessment of social impacts of manufacturing processes are available (Sutherland et al. 2016). There are evidences that material and processing choices are responsible for such impacts. A framework to capture data requirements to calculate such impacts might help to include them into existing SA practices in product life cycle.

## References

- Deng, Yelin, Shi-Jie Cao, Ailu Chen, and Yansong Guo. 2016. "The Impact of Manufacturing Parameters on Submicron Particle Emissions from a Desktop 3D Printer in the Perspective of Emission Reduction." *Building and Environment* 104:311–19.
- Dreyer, Louise, Michael Hauschild, and Jens Schierbeck. 2006. "A Framework for Social Life Cycle Impact Assessment (10 Pp)." *The International Journal of Life Cycle Assessment* 11(2):88–97.
- Duncan, David Ewing. 2006. "The Pollution within." Retrieved March 12, 2018 (<http://ngm.nationalgeographic.com/2006/10/toxic-people/duncan-text>).
- Gao, Wei et al. 2015. "The Status, Challenges, and Future of Additive Manufacturing in Engineering." *Computer-Aided Design* 69:65–89.
- Hauschild, Michael Z. 2015. "Better—but Is It Good Enough? On the Need to Consider Both Eco-Efficiency and Eco-Effectiveness to Gauge Industrial Sustainability." *Procedia CIRP* 29:1–7.
- Huang, Samuel H., Peng Liu, Abhiram Mokasdar, and Liang Hou. 2013. "Additive Manufacturing and Its Societal Impact: A Literature Review." *The International Journal of Advanced Manufacturing Technology* 67(5–8):1191–1203. Retrieved September 20, 2017 (<http://link.springer.com/10.1007/s00170-012-4558-5>).
- Huang, Y. Q. et al. 2012. "Bisphenol A ( BPA ) in China : A Review of Sources , Environmental Levels , and Potential Human Health Impacts." *Environment International* 42:91–99. Retrieved (<http://dx.doi.org/10.1016/j.envint.2011.04.010>).
- Kumar, Manish and Monto Mani. 2017. "A Methodological Basis to Assess and Compare Manufacturing Processes for Design Decisions." Pp. 301–11 in *Research into Design for Communities, Volume 2: Proceedings of ICoRD 2017*, edited by A. Chakrabarti and D. Chakrabarti. Singapore: Springer Singapore. Retrieved ([http://dx.doi.org/10.1007/978-981-10-3521-0\\_26](http://dx.doi.org/10.1007/978-981-10-3521-0_26)).
- Sala, Serenella, Francesca Farioli, and Alessandra Zamagni. 2013. "Life Cycle Sustainability Assessment in the Context of Sustainability Science Progress (Part 2)." *The International Journal of Life Cycle Assessment* 18(9):1686–97.
- Saling, Peter, Andreas Kicherer, and Wolfgang Reuter. 2004. "SEEBalance<sup>®</sup> : Managing Sustainability of Products and Processes with the Socio-Eco- Efficiency Analysis by BASF." (March).
- Schmidt, Isabell et al. 2004. "Managing Sustainability of Products and Processes with the Socio-Eco-Efficiency Analysis by BASF." *Greener Management International* 45:79–94.
- Scungio, Mauro, Tania Vitanza, Luca Stabile, Giorgio Buonanno, and Lidia Morawska. 2017. "Characterization of Particle Emission from Laser Printers." *Science of the Total Environment* 586:623–30.
- Stephens, Brent, Parham Azimi, Zeineb El Orch, and Tiffanie Ramos. 2013. "Ultrafine Particle Emissions from Desktop 3D Printers." *Atmospheric Environment* 79:334–39.
- Sutherland, John W. et al. 2016. "CIRP Annals - Manufacturing Technology The Role of Manufacturing in Affecting the Social Dimension of Sustainability." 65:689–712.
- Wu, Ruqun, Dan Yang, and Jiquan Chen. 2014. "Social Life Cycle Assessment Revisited." *Sustainability* 6(7):4200–4226.
- Zontek, Tracy L., Burton R. Ogle, John T. Jankovic, and Scott M. Hollenbeck. 2017. "An Exposure Assessment of Desktop 3D Printing." *Journal of Chemical Health and Safety* 24(2):15–25.

# The Social Value of Products: What can it be and can it enrich Social life cycle assessment?

**Sara Russo Garrido<sup>1</sup>, Luce Beaulieu<sup>1</sup>, Breno Barros Telles do Carmo<sup>2</sup>**

<sup>1</sup> Université du Québec à Montréal and CIRAIG, Montréal (Canada)

<sup>2</sup> Federal University of Semiarid, Engineering Center, Rio Grande do Norte (Brazil)

## Introduction

Social life cycle assessment (SLCA) has traditionally been chiefly oriented towards identifying negative social performances/impacts across the life cycle of products and services. Moreover, SLCA studies often exclude the use phase, as well as the stakeholder category 'consumers', in large part because their associated indicators are very limited. In response to these shortcomings, a growing number of actors are exploring the concept of social value of materials and products (PSV) (SOVAMAT, 2017; Caraty, 2014). The underlying rationale is that, if indeed the production of materials and products generate some negative social impacts across supply chains, once they are in use, these materials and products must bear some social value for individuals and communities.

What is the social value of products? How to define it and to quantify it? How could companies draw on the concept of social value to better ascertain the SLCA of their products? These questions are extremely relevant to the field of Social Life Cycle Assessment (SLCA). Gaining a better understanding of product social value may help in developing new and relevant impact subcategories, in particular those associated with a product's use phase and the stakeholder category 'consumer'. Drawing on a project carried out by the CIRAIG for a group of 5 multi-national companies (Nestlé, Umicore, Solvay, Arcelor-Mittal, and Veolia), this presentation will focus on these questions.

The presentation will be divided in three parts. The first part of the presentation will provide a working definition for 'product social value' and identify its key constitutive components. Second, we will discuss some initial findings with regards to the question of how the social value of products could be measured. Here, a glimpse at the experimental pilot case studies undertaken in this project will be presented, together with our insights on the strengths and weaknesses in the experiment. Lastly, we will discuss whether and how the concept of product social value can help enrich SLCA's methodological framework. More specifically, we will discuss whether 'product social value' can help identify new impact subcategories pertaining to stakeholders during the use phase

## Defining product social value

Our work presents the outcome of an extensive literature review on the subject on ‘product social value’ and its related concepts, which spans a number of fields, such as sociology, anthropology, marketing, management, design, and psychology. There is no clearly defined literature or known theories specifically on ‘product social value’. Therefore we explored the possible meanings of this term, mostly by exploring the meaning of its constitutive terms (value, social, social value, product, etc.) and delving into the literature on customer value<sup>1</sup>. The definitions encountered show a propensity for authors in different disciplines to identify different – yet often overlapping – aspects as being associated with the concept of the social value of material and immaterial things.

One point of convergence is the fact that authors put forward the idea that social value is what concerned individuals, groups and societies perceive as being socially valuable. It is deeply rooted into “what matters to people”. Another point of convergence is the notion that what individuals/groups perceive as socially valuable in a product, is the product’s ability to enhance personal well-being and/or collective well-being. Taking these perspectives into account, a proposed working definition was developed, placing the concepts of personal well-being and collective well-being at its centre.

Subsequently, these central concepts were fleshed out (e.g., what are the key constitutive aspects of personal and collective well-being?), drawing on relevant social sciences theoretical frameworks, such as the work of Max-Neef (1991) on identifying human fundamental needs, Narayan’s (2000) work on the key components of well-being, Boztepe’s (2007) work on the user experience of a product, as well as the multiple capitals model (OECD, 2011; Garrabé, 2012). This allowed ultimately for the development of a preliminary framework identifying the key constitutive components of ‘product social value’.

## How to measure product social value

Beyond developing a working definition, our work also focused on understanding how product social value could be measured. This led us to explore how people (at the individual or group level) attribute product social value onto products. Results from our literature review suggested that individuals and groups are unlikely to come to the same conclusions on the social value of a given product, as their decision-making processes are different. While it would have been relevant to explore both individual and group attribution of social value, our work focused mostly on the individual component, as exploring groups’ decision making processes demanded a much greater time investment.

A glimpse at the experimental pilot case studies undertaken in this project will be presented, together with our insights on the strengths and weaknesses in the

---

1 Focus on the literature on customer value was deemed relevant, given the obvious link between customers and users of a product.

experiment. The pilots focused on testing the feasibility of applying our product social value preliminary framework onto three types of products: a bottled beverage, an automotive catalyzer, and a break-wall. The pilots aimed at illustrating the interplay of key constitutive components of the framework when applied by consumers, through an multicriteria decision-making assessment (MCDA)-based methodology.

## Social value and SLCA

Lastly, our work explored how a better understanding of PSV can inform the methodological approach in SLCA. The first question to address was whether product social value –as defined in the project – was a good port of entry to enrich SLCA thinking on social impacts. On the whole, we believe it was. Product social value and social impacts in SLCA both draw on the concepts of human well-being and development. However, the points of reference they call upon, are different.

While ongoing debates exist in the SLCA field on the nature of potential social impacts and the impact subcategories which should be considered, the UNEP-SETAC SLCA Guidelines provide a certain common ground through its definition of impact subcategories in accordance with approaches from the field of Corporate Social Responsibility and International Development – both aspiring to a certain degree of universalism. In contrast, ‘product social value’ – as defined in this project – is much more aligned with the well-being and user experience literature. Moreover, product social value is much more relative in its approach, as it is closely tied to “what people value” – which can change, depending on people’s underlying values, and is still very much up to debate.

This being said, the work on product social value brings a few immediate considerations to the fore, namely that thinking about product social value can help improve our thinking around stakeholder categories. SLCA practitioners usually consider only one stakeholder during the use phase: the consumer. However, the present project suggests that we should also consider impacts onto local community and society during the use phase. Indeed, our working definition and framework proposed, as well as our results from our pilots studies suggest that individuals are likely to reflect upon the social value of a product on collective well-being, during the use phase.

Our work on product social value also points to a path towards potentially developing more relevant impact subcategories for the ‘consumer’ stakeholder category. Can thinking about key components of well-being or user-experience factors help us better define relevant subcategories for this stakeholder? We believe on the whole that it might be.

## Conclusion

In short, the work presented explores the concept of PSV, some insights into how to measure it, and possible linkages with SLCA methodology. While the work presented identifies some aspects that might be key to assessing product social value, it also

highlights that more research is needed in order to identify which aspects are more important than others. Deductive reasoning will be necessary to tackle this type of work – our experience suggests that tools and approaches from the fields of marketing and anthropology might be well positioned to undertake this type of exercise.

## References

- BOZTEPE, S. (2007). User Value : Competing Theories and Models. *International Journal of Design* 1(2) p.55-63.
- Caraty, Mélodie, 2015. The social value of steel. Conference presentation at 4th SLCA Seminar, Montpellier, France.
- GARRABÉ, M. (2012). Modèle à capitaux multiples et analyse sociale du cycle de vie des capacités : méthodologie générale, 44 p. [en ligne]. Disponible: [http://www.michel-garrabe.com/pdf/modele\\_capitaux.pdf](http://www.michel-garrabe.com/pdf/modele_capitaux.pdf)
- Max-Neef (1991) on identifying human fundamental needs, Narayan's (2000) work on the key components of well-being,
- NARAYAN, D., CHAMBERS, R., SHAH, M.K. et PETESCH, P. (2000). *Voices of the poor: Crying out for change*. New York, Oxford University Press for the World Bank, p.
- OECD (2011). *Compendium of OECD well-being indicators*, p. [en ligne]. Disponible: <http://www.oecd.org/std/47917288.pdf>
- SOVAMAT, 2017. Accessed at: [www.sovamat.org](http://www.sovamat.org), on Jan.10, 2017.

# Social Analysis within the SEEBalance® for a detailed assessment of social impacts of products and processes

**Peter Saling, Ana Alba Perez, Peter Kölsch, Thomas Gruenenwald**

*BASF SE, CDS/S, Ludwigshafen (Germany)*

## Introduction

The SEEBalance® (the trademark was just given for the wording, the method can be applied in general, without restriction beyond the normal procedures of citation) methodology, evaluates the ecological and economic consequences of alternate products or processes while simultaneously integrating findings on their impact on society into the analysis. Social criteria and objectives – such as education, health or working conditions – are becoming increasingly important which is why these factors are also addressed by the SDGs (Sustainable Development Goals). For this reason, social aspects also have an increasing impact on marketing and management decision-making processes.

When BASF introduced its SEEBalance® methodology in 2005, the possibility to integrate all three dimensions of sustainability into one weighted result was an absolute novelty. Back then, all indicators were evaluated quantitatively, which was especially challenging in case of the social analysis.

The amount of data on relevant social indicators has often been insufficient, especially concerning data on social factors on a global scale. Interpreting the results has thus occasionally posed a challenge. The perception of social factors has changed enormously. Those factors have for instance gained prominence and become more tangible also because of the clear target definition set by the SDGs. Because of the new developments in the area of Social indicators assessment, e.g. in the Roundtable for Product Social Metrics or the “World Business Council for Sustainable Development” (WBCSD), the SEEBalance® method was revised and transferred to a new assessment system.

SEEBalance® still makes use of BASF’s Eco-Efficiency Analysis method to evaluate environmental factors and costs of a product. However, the social dimension will be evaluated through a so-called “social analysis” which is based on a two-stage procedure. In both stages, social conditions for workers, consumers and society are analyzed and evaluated.

The questions which needed to be answered in the development of the method were on one hand how to assess social impacts in a meaningful way by utilization of relevant information. Furthermore, how to identify relevant social topics for

companies, countries with a meaningful set of social indicators. Thirdly the question needed to be answered, how the different types of information can be combined in an overall result for the Social Analysis and how to link and integrate it with results from the environmental and costs assessment.

The aggregation and partially weighting steps needed to be developed as well. The harmonization of different data sets in a coherent assessment system that allows combinations of different information on social topics on different levels, was another challenge.

## Methods

A so-called „Social Life Cycle Assessment“ in which information from specific data bases and company information are evaluated and made transparent represents the first stage. In addition to that, the second stage consists of a so-called “Social Hot Spot Assessment“. In this stage, central social hotspots along the corresponding value chain are assessed and evaluated. Hotspots are for instance characterized by issues such as working conditions, health care, human rights, or aspects concerning the equality of men and women in a certain country or industry. Comparing specific products of the same kind which can be produced in manifold ways and, above all, in different locations can serve as an example: apart from environmental factors and costs, the social conditions in each particular location are integrated into the analysis. Among those are issues such as the fair pay of local workers, regulated working hours, a functioning health care system or similar matters. The results of the social analysis and the Eco-Efficiency Analysis together constitute the SEEBALANCE® methodology

SEEBalance® thus enables a direct comparison between different alternatives. Apart from obtaining precise statements on the alternative with the best results in each category, customers also receive information on the potential for optimization of each of the three dimensions which can be derived separately, with the goal of increasing sustainability along the value chain. Additionally, the methodology allows for a comparison of single criteria with the SDGs which, for instance, results in direct statements on how the SDGs are being addressed by a certain product.

## Social Life Cycle Assessment

In the Social Life Cycle Assessment, data along the supply chain in a LCA approach are collected and assessed. Different levels of the assessment are applied, beginning from specific company related data via regional data and regional average data. The results of the assessment are expressed in a specific 4 folded color code from “Red“ via “Orange“ and “Yellow“ to “Green“. In a system boundary sheet, the major impacts for different life cycle steps can be displayed, linked with further detailed information (Figure 1).

The impact categories that are assessed in the SLCA were derived from the Roundtable of Social Product out of the Metrics Handbook of Product Social Impact Assessment

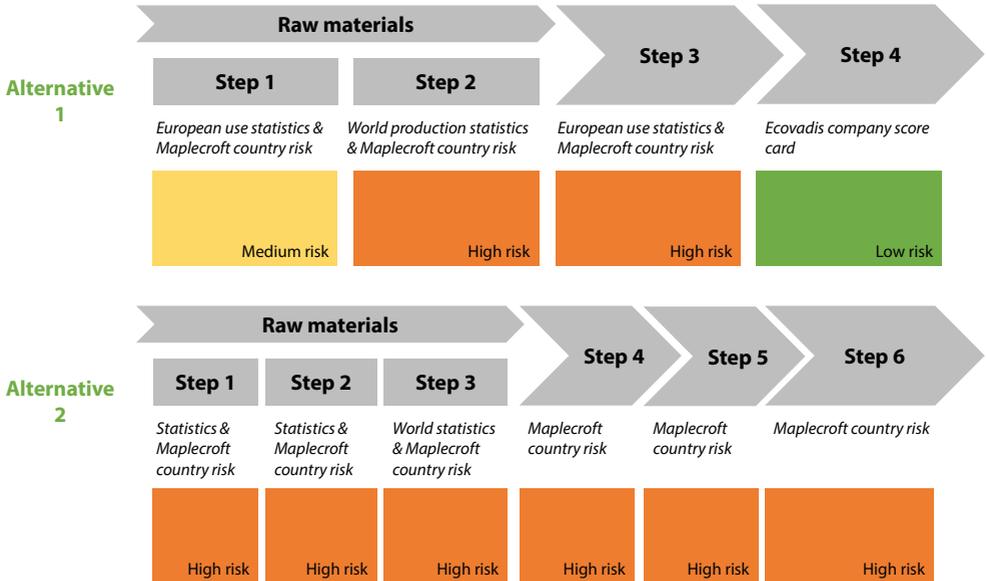


Figure 1: System boundaries with assessed life cycle steps

(PSIA) and the WBCSD publication “Social Life Cycle Metrics for Chemical Products - A guideline by the chemical sector to assess and report on the social impact of chemical products, based on a life cycle approach” (WBCSD 2016).

The assessment of the social topics based on these publications was developed in that way, that different available databases and data systems as in Ecovadis, Reprisk or Maplecroft are used. The indicators chosen from different data sources fit well together so that a coherent assessment on different data levels is possible. Three stakeholder groups as “workers” “communities” and consumers are covered. The focus is on the workers due to the fact, that most of the product related aspects can be dedicated to this stakeholder group.

## Social Hot Spot Assessment

In addition to the Social LCA, a social Hot Spot Assessment is performed to highlight specific life cycle steps with detailed information. It follows several steps to find relevant Hotspots for every alternative that is assessed in the study. Firstly, for a deep dive into social hotspot(s) of the value chain, the significant value chain steps need to be identified. After that decision, an expert evaluation of relevant topics considering the SDGs is performed. The definitions of the SDG help to find key aspects that should be considered. In the analysis, main social focus topics discussed by stakeholders, societies, NGO etc. will be selected and highlighted. If there is a negative effect found,

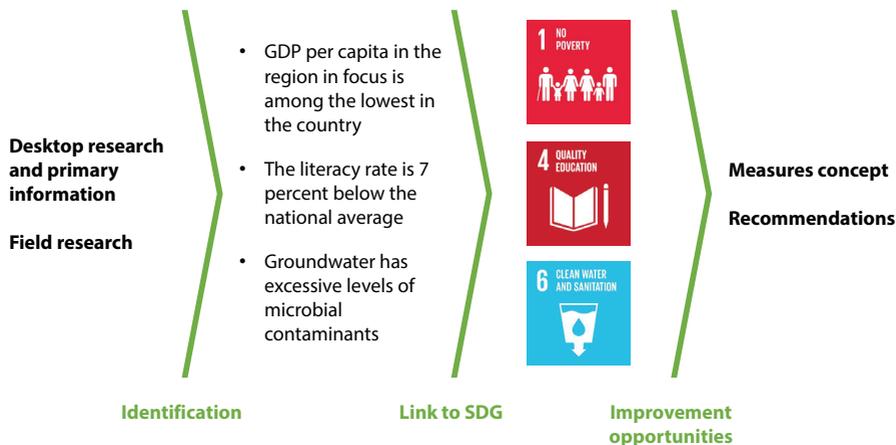


Figure 2: Results and measures concept from the Social Hot Spot Assessment

it will be linked to the most relevant SDG. That gives a good overview in a kind of a SDG mapping. In displaying the results, the most significant SDG effects will be summarized and linked to recommendations and measures for further improvement activities (Figure 2).

## Future developments

The new SEEBALANCE was developed for the assessment of social indicators within new frameworks and requirements in industry but as well from different stakeholders. Several examples were created to test the method and identify improvement potentials. Different data assessments were checked and it was found, that the new Social Analysis delivers quite meaningful results that help to improve products and processes along the supply chain concerning social impacts. In the future developments, the new Social Analysis will be integrated into the AgBalance for the Agrosector as well. Additionally, new opportunities for data gathering, data integration and interpretation will be checked and implemented.

## References

- Benoit, C. and Vickery-Niederman, G., Social sustainability assessment literature review, The Sustainability Consortium, (2010).
- Ekener-Petersen E., Finnveden G, Potential hotspots identified by social LCA –Part 1: a case study of a laptop computer, IntJ Life Cycle Assessment, 18(2013) 127-143.
- Fontes J., Bolhuis A., Bogaers K. Saling P., van Gelder R., Traverso M., Das Gupta J., Bosch H.,

Morris D., Woodyard D., Bell L., van der Merwe R., Laubscher M., Jacobs M., Challis D.; Handbook of Product Social Impact Assessment. <http://product-social-impact-assessment.com>. 2016. [Accessed Aug 10, 2016]

Hosseinijou S., Mansour S., Shirazi M., Social life cycle assessment for material selection: a case study of building materials, *Int J Life Cycle Assessment*, 19(2014) 620-645.

Kölsch, D., Saling P., Kicherer, A., Grosse-Sommer, A. How to Measure social Impacts? What is the SEEBalance® about? – Socio-Eco-Efficiency Analysis: The Method. In: *International Journal of Sustainable Development*. Int. J. Sustainable Development, Vol. 11, No. 1, 2008, 1-23.

Saling P, Kicherer, A.; Dittrich-Kraemer B, Wittlinger R, Zombik W, Schmidt I, Schrott W, Schmidt S, Eco-efficiency analysis by BASF – The method, *Int J. LCA* 7 (4), 2002, 203-218.

Schmidt I., Meurer M., Saling P, Kicherer A, Reuter W, Gensch, CO, SEEBalance - Managing Sustainability of Products and Processes with the Socio-Eco-Efficiency Analysis by BASF, Greener Management International, Greenleaf publishing Sheffield, S. Seuring (guest editor), Issue 45, Spring 2004, 79 - 94.

Saling P, Grosse-Sommer A, Alba-Perez A, Kalisch D, Using the Eco-Efficiency Analysis and SEEBalance in the Sustainability Assessment of Products and Processes. In: *Sustainable Neighbourhood, from Lisbon to Leipzig through Research*, 4th BMBF-Forum for Sustainability, Leipzig, Germany, May, 2007, pp 8-10.

Saling P, Pierobon M, Measuring the sustainability of products: The Eco-Efficiency and SEEBALANCE® analysis, LCM 2011, Berlin, <http://www.lcm2011.org/papers.html>, 21.11.2011

Guidelines for Social Life Cycle Assessment of products, United Nations Environment Programme (UNEP), 2009, ISBN: 978-92-807-3021-0

WBCSD: Alvarado C., Brown A., Hallberg K., Nieuwenhuizenn P., Saling P., Chan K., Das Gupta J., Morris D., Nicole G., Wientjes F., Dierckx A., Garcia W., Combs C., Kilgore A., Satterfield B., Haver S., Jostmann T., Vornholt G., Bergman U., Feesch J., Whitaker K., Kiyoshi M., Govoni G., Mehta R., Menon A., Sen S., Upadhyayula V., Bande M., Coërs P., Debecker D., Poesch J., Viot J.F.; *Social Life Cycle Metrics for Chemical Products - A guideline by the chemical sector to assess and report on the social impact of chemical products, based on a life cycle approach*, November 2016, [www.wbcsd.org/contentwbc/download/1918/24428](http://www.wbcsd.org/contentwbc/download/1918/24428), Accessed November 30, 2017, ISBN 978-2-940521-52-4

# Discussing Features of Social Measures Important in SLCA Impact Indicators' Selection

Yazdan Soltanpour<sup>1,2</sup>, Iuri PERI<sup>1</sup>, Leïla Temri<sup>2</sup>

<sup>1</sup> University of Catania, Department of Agriculture, Food and Environment (Italy)

<sup>2</sup> SupAgro, Montpellier (France)

## Introduction

There have been several attempts to formalize Social Life Cycle Assessment (SLCA) methodology and make it as robust as the environmental part of Life Cycle Assessment (LCA). "Guidelines for SLCA of products" (UNEP/SETAC, 2009) and progressively "The Methodological Sheets for Sub-categories in SLCA" (UNEP/SETAC, 2013) have provided recommendations on how to conduct the first two phases of SLCA (i.e., goal and scope definition and life cycle inventory). The research on the third phase (life-cycle impact assessment) was, at that time, not considered sufficiently mature to be included (Sureau et al. 2017). With S-LCA conceived by the same practitioners who created LCA, it is not surprising that they attempted to model social impacts in the same way it was done for environment alone (Iofrida et al. 2017). Most of the applications take into account values, stakeholders' perceptions, subjectivities, and participation in an interpretivist way, but often without clarifying the theoretical underpinnings (Iofrida et al. 2017). In the following we attempt to clarify the role of these features of societal measures in the selection of the end-point social impact indicators in SLCA.

## Subjectivity

The construction of the subcategories and the related characterization models will inevitably include value judgments and assumptions (UNEP, 2009). It should be stressed that the way in which an instrument is implemented will lead to different results in terms of social impact (Rey-Valette & Cunningham, 2003). The SLCA guidelines (UNEP, 2009) recommend to cover at least the subcategories mentioned to prevent using S-LCA results on a few limited topics for social marketing aims while not addressing core issues. Nonetheless, concerning UNEP/SETAC (2009, 2013) 31 sub categories of assessment, for general applicability, require large amounts of data which are not always available, and there is a large influence of the subjectivity of the individual researcher (Blom and Solmar 2009; van Haaster et al. 2017).

Environmental LCA uses quantitative and comparable indicators to provide a simple representation of the environmental impacts from the product life cycle. This poses a challenge to the social LCA framework because due to their complexity, many social impacts are difficult to capture in a meaningful way using traditional quantitative

single-criterion indicators (Dreyer et al. 2010). Consensus on a single end-point SLCA measure would not be finalized unless its goal is well defined. Researchers agree on the goal of SLCA on that to assess the social impacts of products along their life cycle. However, the variables that are to be considered as social is yet to be agreed upon.

## Diversity of Social Values

Contextual values are moral, personal, social, political and cultural values such as pleasure, justice and equality, conservation of the natural environment and diversity. In most views, the objectivity and authority of science is not threatened by epistemic, but only by contextual (non-cognitive) values (Reiss and Sprenger 2017). Social facets are more influenced by context than environmental or economic ones (Sierra et al. 2017). Social aspects can be highly diverse and are weighted very differently by different interest groups and in different countries and regions (Grießhammer et al. 2006). Therefore, the social (and socio-economic) impacts to be covered in an assessment and the way this should be done should be case and context specific (UNEP, 2009).

Ethical issues such as justice, equity and dignity are subject to the society where they are discussed, i.e. what is considered right in a certain society might not be the case in another. Therefore, claiming the rightfulness of a society's (working, living, institutional) conditions based on other societal values would be invalid. One might say that the international organizations' agreements are one good indication of social values that have to be respected by all the member countries. These values are however, normative ideals that are projected to become universal. Some societies might be far from the agreements signed by their countries' representatives. On the other hand, the absence of one quality should not be translated as a weakness since other qualities, not considered in the assessment (i.e. family ties, traditional mechanisms of social support, ...), may compensate them. The social indicators should have a universal character, no matter where it's used, they would have the same sense.

## Aggregation of data

It is mentioned in the guidelines (UNEP, 2009) that "the action of summing or bringing together information (e.g. data, indicator results, etc.) from smaller units into a larger unit (e.g., from inventory indicator to subcategory) in S-LCA may be done at the life cycle inventory or impact assessment phase of the study and should not be done in a way that leads to loss of information about the location of the unit processes". Modeling or aggregating the results of the subcategories in order to present one result in terms of well-being has been proposed by Dreyer (2005) and Weidema (2006). While thinking about aggregating indicators we have to consider the fundamental principle that objective and subjective dimensions are separate entities that normally bear little or no relationship to one another, and so must be separately measured (International Wellbeing Group, 2013). The SLCA subcategories, which have been mainly inspired by ISO 26000 (2010), are not of one single nature.

The change in the social indicators should neither be considered negative nor positive. The value of the change is relative to the future plans of the region, and whether the change complies with that plan or not makes it positive or negative. If we don't know the sense of the effect, adding the data together would give a result without any sense. Unlike the natural scientist, the social scientist is not interested in the common or average aspects of the facts under consideration; rather the social scientist is interested in their characteristic traits, their cultural significance, and their meaningful interrelationships as defined by the problem in hand (Hekman, 1983). Furthermore, the statistical feature of social indicators of sustainable development is to reflect the detail of distributions under different arrangements and not average or modal situations (Antoine, 1999 in Rey-Valette & Cunningham, 2003).

Analyzing each single indicator independently can be a solution to avoid the aggregation problem. Either a comparison of the indicator is carried out between two alternatives or the situation, the case study is studied before and after the change. Another solution can be simply limiting the assessment to a single end point indicator. Endpoint indicators have the advantage that they can reflect the potential damage or benefit to the Area of Protection, having the advantage, in theory, that no subjective weighting is needed (Jorgensen et al., 2008).

## **Rebound effect**

The social domain is complex due to the existence of strong interactions between factors leading to multiplier effects (Rey-Valette & Cunningham, 2003). Sierra et al. (2017) outlined that social sustainability assessment has two aspects: 1) the social contribution in terms of how interventions interacts with its context and 2) the potential benefit distribution effects on a long-term basis balanced with its short-term contributions. The impact of a single technology at the macro level is generally small, but could potentially be large (Hasster et al., 2017). Each change in the production cycle may have its particular effect on the society and each effect, in turn, may create its own consequences (e.g. change in socio-cultural relations). This stems from the fact that every product is accompanied by particular production-consumption culture. Therefore, apart from the main cycle of the product which is analyzed, their rebound effects have to be considered as well. Weidema (2008) defined rebound effects for production and consumption changes, as derived changes in production and consumption when the implementation of an improvement option liberates or binds a scarce production or consumption factor (money, time, space and technology).

The amplitude of a single change's rebound effects may vary in different time periods for the same society as they may become resistant to certain conditions, adopting strategies which allow them to receive the change more pacifically. Resilience, the ability to absorb the external changes, depends to the capacity of the society to undergo or adapt to change. Therefore, the results of assessment can be expected to be different according to the time of its realization. The assessment carried out after the adaptation process would result a more stable situation. End-point (or even

midpoint) indicators may be able to capture a great deal of the effects created by the change in the system.

## Conclusions and future developments:

The search for universal objective social impact indicators continues in SLCA. Diversity of societal norms in different countries and researchers' point of view (from different disciplines) have prolonged the consensus. The end-point social impact indicator should be able to capture the social effects created in long-term, covering the rebound effects and the range of affecting factors. In this process we should not forget the difference between the natural sciences and social sciences in the sense that social issues are influenced much more by the subjectivity of researchers and the social context of the impacted population.

## References

- Blom M, Solmar C, 2009. How to socially assess biofuels, a case study of the UNEP/SETAC code of practice for socio economical LCA, Master's thesis in cooperation with the Division of Quality and Environmental Management at Luleå University of Technology, commissioned by Enact Sustainable Strategies in Stockholm, Sweden
- Dreyer L, Hauschild M, Schierbeck J, 2006. A Framework for Social Life Cycle Impact Assessment (10 pp). *Int J Life Cycle Assess* 11:88–97. doi: 10.1065/lca2005.08.223
- Dreyer LC, Hauschild MZ, Schierbeck J, 2010. Characterisation of social impacts in LCA: Part 1: Development of indicators for labour rights. *The International Journal of Life Cycle Assessment* 15:247–259 . doi: 10.1007/s11367-009-0148-7
- Grießhammer R, Norris C, Dreyer L, et al, 2006. Feasibility Study: Integration of Social Aspects into LCA
- Hekman SJ, 1983. Weber, the Ideal Type, and Contemporary Social Theory. M. Robertson, the University of Michigan
- Iofrida, N, Strano, A, Gulisano, G, De Luca, AI, 2017. Why social life cycle assessment is struggling in development? *The International Journal of Life Cycle Assessment*. doi: 10.1007/s11367-017-1381-0
- International Wellbeing Group, 2013. Personal Wellbeing Index: 5th Edition. Melbourne: Australian Centre on Quality of Life, Deakin University (<http://www.deakin.edu.au/research/acqol/instruments/wellbeing-index/index.php>)
- ISO 26000, 2010, Guidance on social responsibility, <https://www.iso.org/obp/ui/#iso:std:iso:26000:ed-1:v1:en>
- Reiss J, Sprenger J, 2017. Scientific Objectivity. In: Zalta EN (ed) *The Stanford Encyclopedia of Philosophy*, Winter 2017. Metaphysics Research Lab, Stanford University
- Rey-Valette H, Cunningham S, 2003. Evaluation of the social impact of fishery management measures. In: *The Introduction of Right-based Management in Fisheries*. Bruxelles
- Sierra LA, Pellicer E, Yepes V, 2017. Method for estimating the social sustainability of infrastructure projects. *Environmental Impact Assessment Review* 65:41–53 . doi: 10.1016/j.eiar.2017.02.004

- Sureau S, Mazijn B, Garrido SR, Achten WMJ, 2017. Social life-cycle assessment frameworks: a review of criteria and indicators proposed to assess social and socioeconomic impacts. *The International Journal of Life Cycle Assessment*. doi: 10.1007/s11367-017-1336-5
- UNEP/SETAC, 2009. Guidelines for social life cycle assessment of products. <http://www.cdo.ugent.be/publicaties/280.guidelines-sLCA.pdf>
- UNEP/SETAC, 2013. The Methodological Sheets For Subcategories in Social Life Cycle Assessment (S-LCA). [http://www.lifecycleinitiative.org/wp-content/uploads/2013/11/S-LCA\\_methodological\\_sheets\\_11.11.13.pdf](http://www.lifecycleinitiative.org/wp-content/uploads/2013/11/S-LCA_methodological_sheets_11.11.13.pdf)
- van Haaster B, Ciroth A, Fontes J, et al. 2017. Development of a methodological framework for social life-cycle assessment of novel technologies. *The International Journal of Life Cycle Assessment* 22:423–440 . doi: 10.1007/s11367-016-1162-1
- Weidema B, Thrane M, 2007. Comments on the development of harmonized method for Sustainability Assessment of Technologies (SAT). *Sustainability Assessment of Technologies*
- Weidema BP, 2006. The Integration of Economic and Social Aspects in Life Cycle Impact Assessment. *The International Journal of Life Cycle Assessment* 11:89–96 . doi: 10.1065/lca2006.04.016
- Weidema BP, 2008. Rebound effects of sustainable production, Bridging the Gap; Responding to Environmental Change – From Words to Deeds”, Portorož, Slovenia, 2008.05.14-16

# Including governance and economic aspects to assess and explain social impacts: a methodological proposal for S-LCA

**Solène Sureau, Wouter M. J. Achten**

*Université libre de Bruxelles (ULB) (Belgium)*

## **Introduction**

Since the 2000's, S-LCA research goes in various directions and the streamlining of S-LCA is still ongoing, despite the publication of the Guidelines for S-LCA (Benoît and Mazijn 2009). Among the main issues are the issues of what is to be assessed and the inclusion of impact pathways in the impact assessment, as in E-LCA. In this paper, main conclusions of a state of the art of S-LCA research (Sureau et al. 2017; Sureau and Achten, upcoming) on those two issues are summarized, as a basis for our approach to conduct S-LCA including its underlying theoretical approach and methodological proposal.

## **Some conclusions on S-LCA developments and practice**

In most S-LCA frameworks and studies, including the Guidelines, it is mainly internal organizational aspects of value chain actors that are taken into account, while it seems that also economic aspects relating to the product and to the relations between value chain actors could be considered. This is especially true given the growing trend of outsourcing globally which implies that much happens outside the organizations and thus between value chain actors. Among the 14 S-LCA frameworks reviewed (Sureau et al. 2017), only two allude to fair prices in the criteria to be assessed, and the Guidelines are not one of them. Yet, the Guidelines recognize that socioeconomic processes, such as the pressure for low prices, are causes of social impacts, in addition to companies' behavior (Benoît and Mazijn 2009). In studies applying the Guidelines criteria relating to value chain actors are rarely included (Sureau and Achten, upcoming).

The non-integration of governance and economic processes in S-LCA might originate in the fact that currently S-LCA does not include stressors of commonly used social midpoint impacts (i.e. subcategories of the Guidelines) among its assessment criteria. Currently, S-LCA practice is mainly an assessment of midpoint impact (or subcategories) indicators (Type I performance assessment). Some type II studies quantify endpoint indicators (e.g. DALY, Arvidsson et al. 2016) or investigate causal relationships between endpoint indicators (e.g. health impacts) and potential stressors (income, Feschet et

al. 2012). But there is a lack of research work looking at what can potentially influence the midpoint impacts, and thus at relationships between those midpoint impact indicators and their potential stressors. Yet E-LCA characterization focuses on links between environmental problems (midpoint) and their stressors (materials used and emissions, i.e. inventory data) in addition to links between problems (midpoint) and damages (endpoint or AoP). As such E-LCA makes it possible to explain environmental phenomena and damages and to highlight problem sources (processes or use of certain materials). If stressors of midpoint impacts (i.e. what we call explanatory variables) were included in the S-LCA assessment, it could become a tool to assess, but also to manage and to improve impacts.

If we would go further and if we would look at links between these explanatory variables and midpoint impacts, this would enable a shift from an assessment that looks at impacts, sustainability dimensions and product chain actors separately to a holistic assessment tool that considers links between them. Particularly, economic aspects relating to the product and value chain governance aspects could link product chain actors, and might have the potential to capture potential transfers of impacts between them, if our theoretical approach is verified.

### **Proposed approach for S-LCA**

In addition to commonly included midpoint impacts (or subcategories), we propose to include in the assessment explanatory variables, i.e. variables that have potentially an influence on midpoint and hence endpoint impacts. Concretely, we propose a S-LCA that looks at practices of value chain actors regarding others stakeholders (e.g. workers), but also at what pushes companies to adopt such practices. In fact, we believe that by explaining practices, it becomes possible to improve practices, and hence impacts on stakeholders. As explanatory variables, we argue for variables reflecting chain governance and economic aspects, according to our specific theoretical approach.

### **Theoretical framework**

Our theoretical approach is based on the school of thoughts of value chain analysis which focuses on the way in which firms and countries are globally integrated and on the implications of power relations between value chain actors (Kaplinsky and Morris 2000). This approach was already referred to some years ago in the LCA field by Sim (2006), but received few attention since then. Yet, S-LCA could benefit from this approach that has the same scope, focusing on the whole product chain.

Figure 1 shows the general theoretical approach that underlies most of our methodological propositions. It illustrates the inter-connection between the classical three (or four) pillars of sustainability within the LCA approach. Focusing on the assessment of social impacts, impact pathways start from physical flows related to product life cycle(s), as well as from monetary flows. From physical flows, impacts on human health derived from environmental problems are assessed as part of E-LCA (1).

Other social impacts derived directly from physical flows should be assessed in S-LCA (e.g. health impacts of pesticide use) (2). However monetary flows are among the main stressors of social issues (positive and negative/problems) (3) and impacts (4) since these flows constrain the behaviors and practices of economic actors towards other actors in the value chain and other stakeholders e.g.: workers, consumers, local community, society, etc. These monetary flows, e.g. the payment of an income generating price and a fair distribution of added value among actors depend strongly on the type of chain governance in which economic actors are playing (5). Depending on the level of market consolidation at various stages of product chains (e.g. extraction/production of raw materials, assembling/processing, wholesale, and retail), the power between actors will be balanced differently, with strong implications on prices.

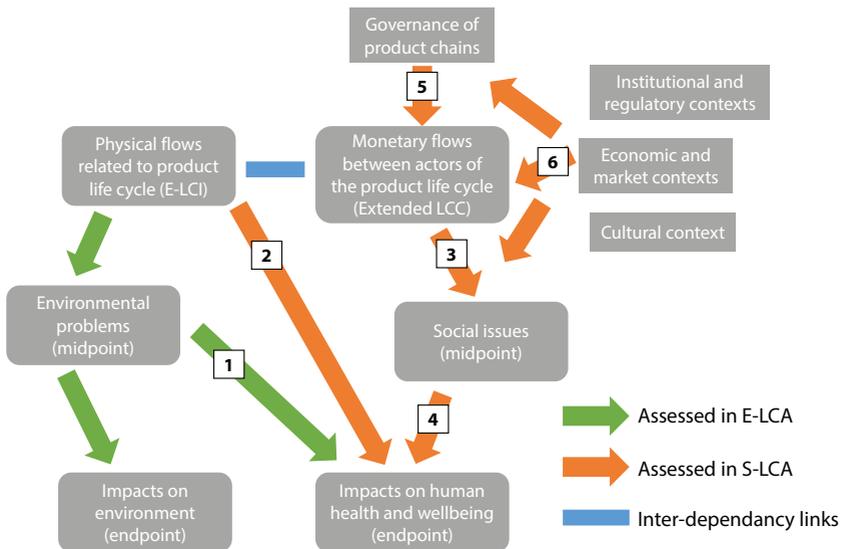


Figure 1: Sustainability approach and underlying theoretical approach for S-LCA

The level of competition and market consolidation are themselves influenced by the market context, e.g. the degree of market openness (6). Other contextual variables play a role for chain governance aspects as well, but also for monetary flows, and social issues (e.g. institutional, regulatory, economic and cultural context).

### Methodological proposal

Our approach proceeds as explained below (see figure 2). This description aims to identify the different ideas integrated in our approach, but will not detail all the ideas at the same level of detail.

First, assessment criteria are selected among all sustainability aspects (1) with stakeholders of assessed product chains (2).

Following, we propose – as a new LCIA step – the identification of impact pathways and the classification of selected assessment criteria as explanatory or impact variables (3) (Sureau et al. 2017). This can be done through a participatory approach or on theoretical basis. Impact variables are then characterized/referenced with a type I LCIA, with norms as reference point for normative data (Kruse et al. 2008) and other alternatives for other variables (4). Explanatory variables are processed together with impact variables with a Type II characterization that investigates identified impact pathways (5). We thus propose a LCIA combining Type I and Type II as suggested by Chhipi-Shrestha et al. (2014).

According to our theoretical approach, we look at how chain governance aspects (terms of trade between value chain actors) influence economic aspects (fairness of prices) and how this in turn influences working conditions among value chain actors.

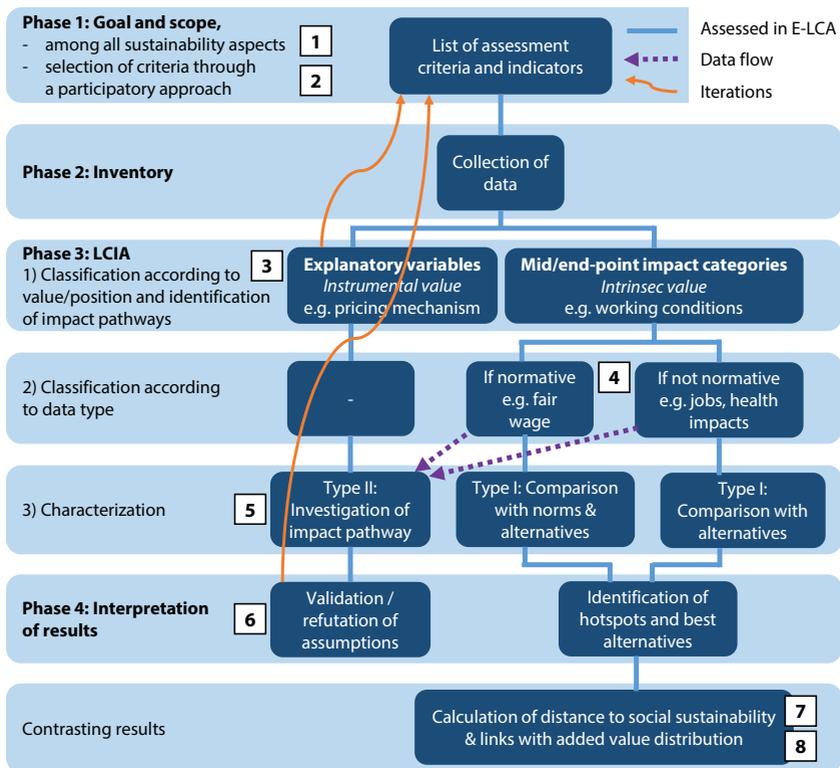


Figure 2: Our methodological proposals

Concretely, to do so, we compare different alternatives, that are products produced and traded under differing chain governance schemes (e.g. products from a globalized long product chain and products from a local short chain).

Regarding economic aspects, we check whether the selling price covers the prime costs including a decent income for workers. Data used are Life cycle costing data, in addition to income and price data. However, our indicator should not be interpreted the same way as LCC results, since it seeks to assess price fairness, while LCC seeks to assess cost efficiency.

Depending on whether these variables are found to influence social impacts, recommendations for inclusion/exclusion thereof in future assessment are provided **(6)**.

In the interpretation phase, in order to put the results in perspective, we propose to adapt and apply an existing approach which calculates the distance to sustainability, i.e. the “Eco-Social cost” (Croes and Vermeulen 2015) **(7)**. This approach monetarizes “impacts” with externalized preventative costs, i.e. costs that are necessary for negative impacts to be avoided. It implies the definition of thresholds that cannot be exceeded. Thus, while monetarization is considered as reflecting a weak sustainability approach that legitimates a substitution between capitals, the type of monetarization we propose to apply is close to the strong sustainability approach (Roman et al. 2016).

Behind the use of this approach is the assumption that prices do not cover all costs and that low prices result in negative social (and environmental) impacts. By putting in perspective the retail price of a product (or a price at another stage of the value chain) with externalized preventative social costs, the tool would contribute to raise awareness of consumers regarding the true costs of products, thus supporting economic actors in adjusting prices whenever necessary. Another benefit is to make economic actors reflect on improvement options that they can implement to reduce negative impacts and on factors that permit improvement, but are initially considered outside their sphere of influence. In order to verify our basic assumption, we will also test the relationship between the importance of externalized preventative social costs and the distribution of added value along the value chain (or the retail price) **(8)**.

## **Conclusions and future developments**

The presented methodological proposal is currently being tested on different products of alternative food systems. Preliminary results indicate that the integration of economic data does not simplify the running of S-LCA, but brings new insights on how LCA-based tools (E-LCA, LCC and S-LCA) could be better embedded within a (strong) sustainability approach.

## References

- Arvidsson, Rickard, Jutta Hildenbrand, Henrikke Baumann, K. M. Nazmul Islam, and Rasmus Parsmo. 2016. "A Method for Human Health Impact Assessment in Social LCA: Lessons from Three Case Studies." *The International Journal of Life Cycle Assessment*, April, 1–10. <https://doi.org/10.1007/s11367-016-1116-7>.
- Benoît, Catherine, and Bernard Mazijn. 2009. "Guidelines for Social Life Cycle Assessment of Products." Paris: UNEP/SETAC.
- Chhipi-Shrestha, Gyan Kumar, Kasun Hewage, and Rehan Sadiq. 2014. "Socializing Sustainability: A Critical Review on Current Development Status of Social Life Cycle Impact Assessment Method." *Clean Technologies and Environmental Policy* 17 (3): 579–96. <https://doi.org/10.1007/s10098-014-0841-5>.
- Croes, Pim R., and Walter J. V. Vermeulen. 2015. "Comprehensive Life Cycle Assessment by Transferring of Preventative Costs in the Supply Chain of Products. A First Draft of the Oiconomy System." *Journal of Cleaner Production* 102 (September): 177–87. <https://doi.org/10.1016/j.jclepro.2015.04.040>.
- Feschet, Pauline, Catherine Macombe, Michel Garrabé, Denis Loeillet, Adolfo Rolo Saez, and François Benhmad. 2012. "Social Impact Assessment in LCA Using the Preston Pathway." *The International Journal of Life Cycle Assessment* 18 (2): 490–503. <https://doi.org/10.1007/s11367-012-0490-z>.
- Kaplinsky, Raphael, and Mike Morris. 2000. "A Handbook for Value Chain Research." <http://www.value-chains.org/dyn/bds/docs/395/Handbook%20for%20Value%20Chain%20Analysis.pdf>.
- Kruse, Sarah A., Anna Flysjö, Nadja Kasperczyk, and Astrid J. Scholz. 2008. "Socioeconomic Indicators as a Complement to Life Cycle Assessment—an Application to Salmon Production Systems." *The International Journal of Life Cycle Assessment* 14 (1): 8–18. <https://doi.org/10.1007/s11367-008-0040-x>.
- Roman, Philippe, Géraldine Thiry, and Tom Bauler. 2016. "Comment mesurer la soutenabilité ?" *L'Économie politique*, no. 69 (February): 48–55.
- Sim, Sarah. 2006. "Sustainable Food Supply Chains." EngD Portfolio, University of Surrey.
- Sureau, Solène, Bernard Mazijn, Sara Russo Garrido, and Wouter M. J. Achten. 2017. "Social Life Cycle Assessment Frameworks: A Review of Criteria and Indicators Proposed to Assess Social and Socioeconomic Impacts." *The International Journal of Life Cycle Assessment*, June, 1–17. <https://doi.org/10.1007/s11367-017-1336-5>.

# Sustainable Guar Initiative (SGI) – social impact characterization of an integrated sustainable project

**Vuillat Marie<sup>1</sup>, Wathelet Alain<sup>2</sup>, Viot Jean-François<sup>3</sup>, Laurent Flore<sup>3</sup>, Martz Patricia<sup>4</sup>, Arzac Paul<sup>5</sup>, Zaaraoui Nisrine Carmen<sup>4</sup>, Causse Samuel<sup>6</sup>**

<sup>1</sup> Evea, Paris (France)

<sup>2</sup> Solvay, Brussels (Belgium)

<sup>3</sup> Solvay, Paris (France)

<sup>4</sup> L'Oréal R&I, Aulnay-sous-Bois (France)

<sup>5</sup> L'Oréal, Clichy (France)

<sup>6</sup> Evea, Lyon (France)

## Introduction

Sustainable Guar Initiative (SGI) is a three-year long integrated program aiming at developing sustainable guar production within the Bikaner district in Rajasthan, India. This desert district is one of the largest producers of guar and guar gum in India. SGI was set up by Solvay, L'Oréal, HiChem and the NGO TechnoServe, and is based on 4 themes:

- (1) Agronomy: enhancing sustainable practices for rain-fed guar production,
- (2) Environment: groundwater-neutral approaches and best practices in guar farming, along with tree plantation,
- (3) Social impact: gender approaches, nutrition, health & hygiene and
- (4) Market improvement: traceability, supply chain and market access.

Guar gum is extracted from guar seed and can be used as such, or functionalized. It is for example used as a bio-based thickening agent in personal care products.

To confirm and consolidate the relevance of the program and to identify potential improvement opportunities, an environmental and social Life Cycle Assessment (LCA) has been conducted, comparing the guar production before and after the Sustainable Guar Initiative.

The environmental LCA has been based on a wide survey involving more than 1500 farmers over a three-year period. This data collection shows the changes in cultivation practices with benefits on Guar production yield, leading to greater revenues for the farmers. This Guar productivity increase compensates the negative effects of new inputs to the field required by the application of cultivation best practices.

The social LCA has been conducted according to already available guidance, including UNEP-SETAC Guidelines for Social Life Cycle Assessment of Products and WBCSD

Social Life Cycle Metrics for Chemical Products. Diane Indrane's Master's thesis on "Integrating Smallholders within the Handbook for Product Social Impact Assessments" has been a milestone in order to better take into account the smallholders specific issues. Methodological developments have been undertaken in order to address the specificities and complexity of this project. At the goal and scope stage, we expanded the identification of relevant stakeholders and social aspects. At the inventory stage, we collected new information on a broader scope in order to integrate more social aspects, stakeholders or life cycle steps. During the performance assessment stage, we set up a common rating system enabling aggregation related to inventory from multiple sources.

Firstly, we experimented the value and limits of the functional unit in social LCA. We think it is especially important to wonder if the main group of people involved in the realization of the function (farmers producing guar) is the same group of people benefiting from actions and changes set up by the program. Are the beneficiaries larger or smaller than the producing group? Who is directly affected and who is indirectly affected? These aspects should be questioned when describing the functional unit.

We also discussed the criteria for stakeholder's selection and social topics selection, using a range of different information, from local interview to statistical data. Then, the main challenge was to deal with social topics potentially very relevant but for which very few data were available. For some topics, included in the program, monitoring and performance measurement is in place (for instance women empowerment) but for other topics it is not the case (occupational health and safety of workers). In order to solve this issue, we collected new data that we managed to organize and characterize thanks to the rating system described hereafter.

Finally, we developed a specific rating system enabling to deal with data heterogeneity among the social aspects, stakeholders or life cycle steps. We started with the work from Diana Indrane based on the theory of change:

- 1) inputs are the resources necessary to carry out an activity,
- 2) activities are then implemented and effects can be analyzed,
- 3) output of the activities can be measured,
- 4) outcomes are the changes in the lives of the targeted population,
- 5) impact is an experienced improvement in lives of the targeted population.

Focusing on the first three steps, we described them according to 2 criteria: implemented actions and fulfillment status (result).

- Actions can be the presence of monitoring, identification of opportunities, intervention, feedback monitoring.
- Fulfilment status can be legality or illegality, meeting the basic needs of a population fraction and positive feedback.

But no monitoring doesn't necessarily mean illegality or that basic needs are not met. These two criteria were not sufficient to describe all situations especially for some topics not included in the program thus, so not monitored. In order to be able to integrate unmonitored topics, we integrated risk assessment as another component of the rating system, enabling to fill the gap when no surveillance is implemented.

When using risk assessment, the question of the risk perimeter should be addressed. A sector and country risk does not necessarily mean a local risk. How is it possible to finely tune this generic data with local information such as an individual testimony? Describing more precisely the testimony sources is then very important to evaluate its relevance (How many people are testifying? What kind of person is it? Do they have an interest?).

We also experience the specific case of positive impacts. Positive impact can result directly or indirectly from an action. They rarely have a negative counterpart, but the question can still be addressed. It is therefore difficult to use risk assessment or theory of change for these aspects. The presence of positive or negative signals can be used. And so, the origin and type of signals can be used as rating criteria.

Our work is an attempt to structure social impact assessment method. Risk, actions and results could be three main components of an integrated social impact assessment method enabling to aggregate the complexity and diversity of human aspects and heterogeneity of data available.

This study is a methodology development based on specific example of the Guar culture in developing country and is considered as a guiding document for future development in the complex matter like social life cycle assessment.

## References

- Technoserve, 2015. Proposal for Hichem, Solvay and L'Oréal, "Sustainable Guar Program".
- UNEP/SETAC, 2009. Guidelines for Social Life Cycle Assessment of Products. Management (Vol. 15).
- WBCSD, 2016. Social Life Cycle Metrics for Chemical Products.
- Fontes, J., 2016. Handbook-for-Product-Social-Impact-Assessment-3.0, 1–146.
- Indrane, D., 2017. Small but Complex: Integrating Smallholders within the Handbook for Product Social Impact Assessments.

# Towards a taxonomy for social impact pathway indicators

**Bo P. Weidema**

*Aalborg University, Aalborg (Denmark)*

## **Abstract**

The purpose of taxonomy is to provide structure and conceptual clarity to a scientific domain through clear definitions of hierarchically organised concepts. By reducing confusion and supporting harmonisation of terminology, the ultimate purpose is to improve monitoring, knowledge-generation, and decision-making. For social impact pathway indicators an important aspect of this is to ensure consistency in modelling, so that similar impacts are treated in a similar way. Social impacts are here understood in the wider sense of welfare economics, as all impacts that affect human wellbeing, including ecosystem, health and socio-economic impacts. The taxonomy presented here extends previous contributions by suggesting a conceptually complete taxonomy at three levels of the impact pathway: Elementary flows, midpoint impacts, and endpoint impacts (Areas of Protection). The completeness is ensured conceptually by including unspecified residuals, but also and more importantly by the use of fully quantifiable indicators that can be traced from source to sink, so that completeness can be verified by input-output balances and against measured totals. Using the impact pathway of “Undernutrition”, an application example is provided.

# Development of S-LCIA models: a review of multivariate data analysis methods

**Jaylton Bonacina de Araujo, Cássia Maria Lie Ugaya**

*Federal University of Technology - Paraná, Curitiba (Brazil)*

## **Introduction**

Types II and III Social Life Cycle Impact Assessment (S-LCIA) models of Types II and III are supposed to be based on causal relationships between the inventory indicators with a given Area of Protection (AoP), through one or multiple impact pathways (Neugebauer et al., 2017). These routes can lead to the calculation of the potential social impact by the use of characterization models, allowing the elaboration of mid-point categories or directly to end-point categories. This type of approach is similar to that used in the methods of environmental LCIA (Neugebauer et al., 2017; UNEP/SETAC, 2009; WU et al. 2014). Most of the Type II are based on the impact pathways solely by means of theoretical structures representing relationships between variables that have already been described in the social sciences (Brent and Labuschagne, 2006; Neugebauer et al., 2014; Reitingner et al., 2011). However, the use of statistical methods has also been presented by several authors, such as Wu et al (2015), Feschet et al. (2013), Hutchins and Sutherland (2008) and Norris (2006).

The modeling of cause-and-effect chains in S-LCA presents a considerable degree of complexity, since the S-LCIA models take into account a large number of variables and many relationships are established between them. In addition, many pathways of impact have not yet been identified, explored, and even validated (WU et al., 2015).

In this sense, the use of methods that allow the analysis and understanding of several variables and their relationships can contribute to elaboration and validation of S-LCIA methods. The statistical techniques of multivariate data analysis can help in this purpose, since they contemplate several methods aimed at the simultaneous analysis of multiple variables, which makes it possible to establish cause-effect relationships, correlation and prediction between these variables (Hair, 2010).

Therefore, the aim of this study is to perform a literature review regarding the statistical methods of multivariate analysis, seeking to identify its applicability in the construction of S-LCIA models.

## **Methods**

According to Hair (2010), methods of multivariate analysis can be classified according to the relationship established between the variables, as dependent relationships,

where the dependent variable to be predicted or explained by other variables and interdependence relationships in which no single variable or group of variables is defined as being independent or dependent; the number of dependent and independent variables (or also called explained and explanatory variables); and how these are measured. This makes these techniques differentiated between them and with different objectives. Among this range of methods, the most established and ascending ones can be highlighted: Principal component analysis (PCA) and Exploratory factor analysis (EFA); Multiple regression; Multiple discriminant analysis and Logistic regression; Canonical correlation; Multivariate analysis of variance and Covariance; Conjoint Analysis; Cluster Analysis; Corresponding Analysis; Structural equation modeling (SEM) and Confirmatory factor analysis (CFA).

In order to identify the applicability of these methods for the construction of S-LCIA models, their characteristics were analyzed through a literature review. Table 1 shows the observed characteristics and their definitions.

Characteristics		Definition
1.	Type of relation	The method has a relationship of dependence or interdependence.
2.	Confirmatory/ Exploratory/ Predictive	The method provides an exploratory, confirmatory or predictive approach.
3.	Number of relations between dependent and independent variables	The method considers multiple relations between dependent and independent variables, has a dependent variable and several independent variables or has several dependent variables.
4.	Identification of latent variables	The method allows the identification of latent variables (also called factors)
5.	Applications on S-LCA	The method has already been applied in some S-LCA study.

Table 1: Analyzed characteristics of multivariable methods.

## Results

From the criteria presented in Table 1, five methods of multivariate data analysis were evaluated, the results of the analysis are presented in Table 2.

The Principal component analysis (PCA) and Exploratory factor analysis (EFA) are techniques that can be used to analyze interrelationships among a large number of variables and to explain these variables through so-called factors (or latent variables) (Costello and Osborne, 2005). In short, the aim of this methods is aggregate information contained in several variables into a smaller set of variates. PCA and EFA are not requiring a theoretical basis or hypothesis substantiated a priori, which configures its exploratory characteristic. These techniques are based on the establishment of correlations between a large number of variables (Hair, 2010). The identification of these factors can help in the construction of impact pathways, since it allows the discernment of intermediate effects, represented by the midpoint impact categories.

Method	Type of relation	Confirmatory/ Exploratory/ Predictive	Number of relations between dependent and independent variables	Identification of latent variables	Applications on S-LCA
Principal Component Analysis (PCA)	Interdependence	Exploratory	Multiple independent variables	Yes	No
Exploratory Factor Analysis (EFA)	Interdependence	Exploratory	Multiple independent variables	Yes	No
Confirmatory Factor Analysis (CFA)	Interdependence	Confirmatory	Multiple Dependency and Independence Relationships	Yes	No
Structural Equation Modeling (SEM)	Dependence	Confirmatory	Multiple Dependency and Independence Relationships	Yes	Wu et al., 2015
Simple and Multiple Regression	Dependence	Predictive	A single dependent variable and several independent variables	No	Norris, 2006 Feschet et al., 2013 Hutchins; Sutherland, 2008

Table 2: Analysis of the characteristics of multivariate analysis methods.

However, these techniques do not establish a cause-and-effect relationship between variables since it uses only correlation.

The Confirmatory factor analysis (CFA) and the Structural equation modelling (SEM) have very similar characteristics because both are confirmatory techniques (i.e., hypothesis-testing), which demands an established theoretical model and that will be put to the test. Both techniques establish relationships between the variables through factors, however, in CFA it is evaluated the correlation between variables, without establishment of cause effect. The CFA is very similar with the EFA, but the EFA is focused on the elaboration of factors and the CFA is related to confirmatory analysis of the factors. In SEM, it is possible to analyze several dependency relations simultaneously (Byrne, 2013, Hair, 2010). The Confirmation of the factors through these techniques allows the establishment and validation of impact pathways of previously based on theory in the social sciences (Feschet et al., 2013; Hutchins and Sutherland, 2008; Norris, 2006), as proposed by Wu et al. (2015), making an application of the SEM as a way of attesting the cause effect chain related to the Area of Protection "Human Health", identifying possible mid-point and end-point categories.

Simple and multiple Regression allows the determination of correlation between variables, being defined a dependent variable that is related to one or more independent variables. This method enables the prediction of the dependent variables, through the determination of coefficients. The regression methods compared to the models cited above do not allow the identification of factors (Wooldridge, 2015). The

regression techniques are very versatile, according to the type of variable and type of data being used, and there are models focused on categorical (scale that simply assigns a qualitative label to an observation) or metric variables (measure quantity or relative degree), time series, panel data, and cross-sectional data (Enders, 2008; Wooldridge, 2010). This method has been explored in some studies of Type III S-LCIA, such as Norris (2006) and Feschet et al. (2013), where the authors evaluated life expectancy as a function of countries' GDP. Hutchins and Sutherland (2008) in their study also used a regression technique, assessing infant mortality rate in relation to the GDP of the countries. From the characteristics of the regression methods, it can be used in the S-LCIA for the elaboration of characterization models since they allow the prediction of dependent variables.

## Conclusion

From the review of the multivariate analysis methods, it was possible to conclude in a preliminary way that the exploratory methods, such as Principal component analysis (PCA) and Exploratory factor analysis (EFA) can be applied to identify undiscovered impact pathways, mainly because they allow the factor's identification, which can later be confirmed by other methods, such as Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM).

The Structural equation modeling (SEM) can aid in the validation and confirmation of impact pathways already explored by S-LCA publications and relationships already researched in studies related to social sciences, as it evaluates the cause-effect relationships within the impact pathways and allows the establishment of factors that can be considered mid-point or end-point categories, as already demonstrated in previous applications in S-LCA.

Simple and multiple regression methods can be used for the elaboration of characterization models, depending on the possibility of estimation of the dependent variable. In addition, because of the diversity of techniques, regression methods can be very flexible in terms of the use of categorical or interval variables and types of data series.

As preliminary conclusions, it is possible to affirm that the multivariate analysis methods have a wide possibility of application in the construction of S-LCIA models, assisting in the identification, modeling and validation of impact pathways, as in obtaining characterization methods. As next steps it is necessary to evaluate the other methods of multivariate analysis.

## Acknowledgements

The authors appreciate Grupo O Boticário, CNPq, CAPES and Fundação Araucária for financing the project.

## References

- BRENT, A. and LABUSCHAGNE, C. Social Indicators for Sustainable Project and Technology Life Cycle Management in the Process Industry (13 pp + 4). *The International Journal of Life Cycle Assessment*, v. 11, n. 1, p. 3–15, 2006.
- BYRNE, B. M. *Structural equation modeling with EQS: Basic concepts, applications, and programming*. [s.l.] Routledge, 2013.
- COSTELLO A. B. and OSBORNE, J. W. Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical assessment, research & evaluation*, v. 10, n. 7, p. 1–9, 2005.
- ENDERS, W. *Applied econometric time series*. [s.l.] John Wiley & Sons, 2008.
- FESCHET, P. et al. Social impact assessment in LCA using the Preston pathway. *The International Journal of Life Cycle Assessment*, v. 18, n. 2, p. 490–503, 2013.
- HAIR, J. F. (ED.). *Multivariate data analysis*. 7th ed ed. Upper Saddle River, NJ: Prentice Hall, 2010.
- HUTCHINS, M. J. and SUTHERLAND, J. W. An exploration of measures of social sustainability and their application to supply chain decisions. *Journal of Cleaner Production, Sustainability and Supply Chain Management*. v. 16, n. 15, p. 1688–1698, 2008.
- NEUGEBAUER, S. et al. Impact Pathways to Address Social Well-Being and Social Justice in SLCA—Fair Wage and Level of Education. *Sustainability*, v. 6, n. 8, p. 4839–4857, 2014.
- NEUGEBAUER, S. et al. Calculation of Fair wage potentials along products' life cycle – Introduction of a new midpoint impact category for social life cycle assessment. *Journal of Cleaner Production*, v. 143, p. 1221–1232, 2017.
- NORRIS, G. A. Social Impacts in Product Life Cycles - Towards Life Cycle Attribute Assessment. *The International Journal of Life Cycle Assessment*, v. 11, n. 1, p. 97–104, 2006.
- REITINGER, C. et al. A conceptual framework for impact assessment within SLCA. *The International Journal of Life Cycle Assessment*, v. 16, n. 4, p. 380–388, 2011.
- UNEP/SETAC. *Guidelines for social life cycle assessment of products*. Paris: United Nations Environment Program SETAC Life Cycle Initiative United Nations Environment Programme, 2009.
- WOOLDRIDGE, J. M. *Econometric analysis of cross section and panel data*. [s.l.] MIT press, 2010.
- WOOLDRIDGE, J. M. *Introductory econometrics: A modern approach*. [s.l.] Nelson Education, 2015.
- WU, R., YANG, D., CHEN, J. Social Life Cycle Assessment Revisited. *Sustainability*, v. 6, n. 7, p. 4200–4226, 2014.
- WU, S. R. et al. Causality in social life cycle impact assessment (SLCIA). *The International Journal of Life Cycle Assessment*, v. 20, n. 9, p. 1312–1323, 2015.

# Using DALY for Assessing Human Health Impacts of Conflict Minerals

**Anna Furberg, Rickard Arvidsson, Sverker Molander**

*Environmental Systems Analysis, Chalmers University of Technology, Gothenburg (Sweden)*

## Introduction

The mining and trade of conflict minerals, including tin (Sn), tantalum (Ta), tungsten (W) and gold (Au) (together called 3TG), are financing civil wars and violent conflicts in the Democratic Republic of the Congo (DRC). The revenues from the illegal trade of 3TG minerals are in the order of hundreds of millions of US dollars per year (Young, 2015). Since 2010 in the United States (US), companies listed on the US stock exchanges are required to report any use of 3TGs in their products in accordance with the Dodd-Frank act (Young, 2015). Other minerals, including copper (Cu), cobalt (Co) and diamond are also being mined in the DRC and have been associated with the conflict (Parsmo, 2015). These seven minerals will therefore all be referred to as conflict minerals in this study. These minerals are found in many different products, such as electronics, cemented carbides, chemicals and jewelry. Thus, there is a need to consider human health impacts of conflict minerals in social life cycle assessment (SLCA). Several studies have developed and applied approaches for assessing human health impacts in SLCA, including impacts from economic inequality (Bocoum et al., 2014), income and tax revenues (Feschet et al., 2013), accidents and preventions thereof (Arvidsson et al., 2016), and chemical pollutants (Arvidsson et al., 2016). These approaches use either the disability-adjusted life years (DALY) indicator, life expectancy or infant mortality to quantify results. The DALY indicator was developed in the 1990s for the World Health Organization and the World Bank and is often used to quantify impacts on human health, e.g. in studies of the global burden of disease. So far, initial studies have calculated human health impacts related to conflict minerals in terms of DALY. An example is the study of a golden ring by Parsmo (2015), where it was concluded that the conflict mineral dominated the life cycle human health impact. The aim of this study is to conduct an improved calculation of human health impacts of conflict minerals, applying the DALY indicator.

## Method

DALY provides a measure of the number of years lost due to disability or premature death (Murray, 1994). Its intended use is to support prioritization of health care and research as well as to identify disadvantaged groups and provide a basis for health-related efforts in terms of intervention, evaluation and planning. A number of social preferences are incorporated in DALY through the application of a standard life

expectancy, disability weighting, as well as through the inclusion of age-weighting and discounting (Murray, 1994). The standard life expectancy provides a measure of the number of years that a person could have lived for the case of premature death. For the case of disability, the standard life expectancy provides a measure of the average time lived with a disability until the disability changes or leads to death. Disability weights are required in order to be able to compare years lost due to premature death and disability. These weights have a value between 0, implying perfect health, and 1, implying death. Age-weighting and discounting can be applied in the calculation of DALY in order to incorporate social preferences related to the time lived at different ages and at different times, respectively. Anand and Hanson (1997) criticize DALY, for example the application of disability weights. Their criticism is due to the inability of these weights to consider the varying capacity of different persons to cope with disability and the systematic bias against persons with a permanent disability. Thus, methodological choices in the application of DALY need to be carefully considered and transparently presented.

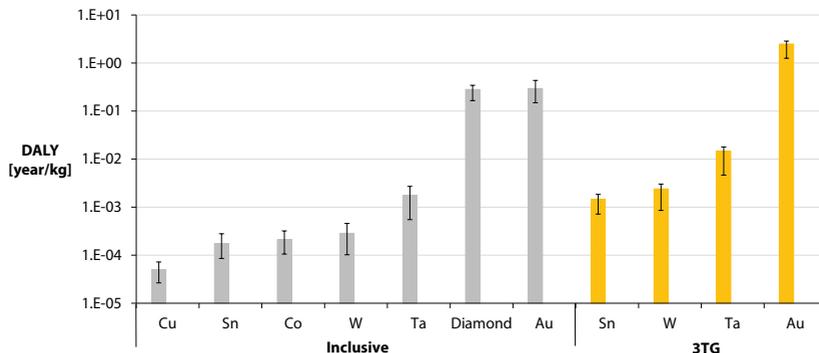
In this study, DALY for a conflict mineral  $i$  based on data from time period  $j$  ( $DALY_{ij}$ ) [years/kg] was calculated using the following equation, including only premature deaths and not cases of disability:

$$\text{Eq. 1} \quad DALY_{ij} = \frac{N_j \times (LEX_j - L_j) \times P_{ij}}{\sum_i P_{ij} \times m_{ij}}$$

where  $N$  is the number of premature direct deaths in the DRC due to the conflict [-],  $LEX$  is the national life expectancy [year],  $L$  is the average age at death [year],  $P$  is the average global market price [USD/kg] and  $m$  is the virgin production in DRC [kg]. Data for  $N$  was obtained from the Uppsala conflict data program (UCDP, 2018), data for  $P$  and  $m$  for all minerals were obtained from the United States Geological Survey with exception for diamond for which data was obtained from KP (2018),  $L$  is based on Parsmo (2015), and data for  $LEX$  was obtained from the World Bank. Two scenarios were constructed by considering different minerals as conflict minerals: i) an inclusive scenario with  $i = \{\text{Sn, Ta, W, Au, Cu, Co, diamond}\}$  following Parsmo (2015), and ii) a scenario considering only the 3TG minerals as conflict minerals, thus with  $i = \{\text{Sn, Ta, W, Au}\}$ , following the US Dodd-Frank Act (Young, 2015). The time period  $j$  was set to 2010-2014, representing the latest data for the region, thus providing a probable estimate of the continued situation in the near future. Parameter uncertainties were considered for  $N$ ,  $LEX$  and  $L$  by selecting the average, lowest and highest value for each parameter during the time period while uncertainties in  $m$  and  $P$  were considered in the same way but for each mineral, respectively. Age-weighting and discounting were not applied.

## Results and discussion

Resulting human health impacts of conflict minerals are presented per kg in Figure 1 for the two scenarios, with error bars to illustrate parameter uncertainties, and in more detail in Table 1. Minerals with a high economic value that are produced in



Source: Made by Anna Furberg, Rickard Arvidsson and Sverker Molander. Based on calculations described in the extended abstract.

Figure 1: DALY per conflict mineral for (i) an inclusive scenario following Parsmo (2015) and (ii) a 3TG scenario following the Dodd-Frank Act (Young, 2015). The minerals are copper (Cu), tin (Sn), cobalt (Co), tungsten (W), tantalum (Ta), diamond and gold (Au). Note the logarithmic scale.

Additional information required in order to calculate human health impacts from the use of conflict minerals for specific products is what share of the minerals in a specific product that is from the DRC. In this study, all premature deaths are allocated to the minerals, which results in an overestimation of the DALY from the conflict. However, the exclusion of disabilities, due to lack of data, provides an underestimation of the DALY from the conflict. In addition, the direct deaths may only constitute 5-20% of the total casualties of the conflict in the DRC (Checchi et al., 2017), which also includes e.g. increased mortality due to infrastructural damages. Additional human health impacts from the mining of conflict minerals, such as occupational accidents during artisanal mining and the use of mercury during mining of gold specifically (Parsmo 2015), may also be of high magnitude and should therefore also be considered in SLCA studies of products containing conflict minerals.

## Conclusions and future developments

Human health impacts related to conflict minerals mined in the DRC have been calculated in this study, showing comparatively high impacts for Au and diamond. Depending on methodological decisions, such as which minerals are considered conflict minerals, as well as uncertainties in input parameters, the magnitude of the human health impacts of specific conflict minerals vary. The results from this study can, if methodological choices are described in a transparent manner, be applied by SLCA practitioners in order to assess impacts on human health related to the use of conflict minerals in specific products.

Inclusive scenario			
Mineral	DALY [year/kg]		
	Base case	Low value	High value
Cu	5.0E-05	2.7E-05	7.2E-05
Sn	1.7E-04	8.5E-05	2.8E-04
Co	2.1E-04	1.1E-04	3.2E-04
W	2.8E-04	1.0E-04	4.6E-04
Ta	1.7E-03	5.5E-04	2.7E-03
Diamond	2.8E-01	1.7E-01	3.4E-01
Au	3.0E-01	1.5E-01	4.4E-01
3TG scenario			
Sn	1.5E-03	7.2E-04	1.8E-03
Ta	2.4E-03	8.6E-04	3.0E-03
W	1.5E-02	4.6E-03	1.8E-02
Au	2.5E+00	1.3E+00	2.9E+00

Table 1: DALY per conflict mineral for (i) an inclusive scenario following Parsmo (2015) and (ii) a 3TG scenario following the Dodd-Frank Act (Young, 2015). The minerals are copper (Cu), tin (Sn), cobalt (Co), tungsten (W), tantalum (Ta), diamond and gold (Au).

## References

- Anand, S, Hanson, K, 1997. Disability-adjusted life years: A critical review. *J. Health Econ.* 16: 685-702.
- Arvidsson, R, Hildenbrand, J, Baumann, H, Nazmul Islam, KM, Parsmo, R, 2016. A method for human health impact assessment in social LCA: lessons from three case studies. *Int. J. Life Cycle Assess.* In press.
- Bocoum, I, Macombe, C, Revéret, J-P, 2015. Anticipating impacts on health based on changes in income inequality caused by life cycles. *Int. J. Life Cycle Assess.* 20(3), 405-417
- Cecchi, F, Warsame, A, Treacy-Wong, V, Polonsky, J, van Ommeren, M, Prudhon, C, 2017. *Lancet.* 390(10109), 2297-2313
- Feschet, P, Macombe, C, Garrabé, M, Loeillet, D, Saez, A, Benhmad, F, 2013. Social impact assessment in LCA using the Preston pathway. *Int. J. Life Cycle Assess.* 18(2), 490-503
- KP. 2018. (Kimberley Process) Democratic Republic Congo. Accessed 10 January 2018, <<https://www.kimberleyprocess.com/en/democratic-republic-congo>>
- Murray, CJL 1994. Quantifying the burden of disease: The technical basis for disability-adjusted life years. *Bulletin of the World Health Organization* 72: 429-445.
- Parsmo, R 2015, The blood wedding ring - assessing the life cycle lives lost in jewelry production. Division of environmental systems analysis, Chalmers University of Technology, Gothenburg, Sweden.
- UCDP. 2018. (Uppsala Conflict Data Program) DR Congo (Zaire). Accessed 10 January 2018, <<http://ucdp.uu.se/#country/490>>.
- Young, SB 2015. Responsible sourcing of metals: certification approaches for conflict minerals and conflict-free metals. *Int. J. Life Cycle Assess.* 1-19.

# Perspectives in the application of social life cycle analysis to waste management

**Mery Jacques**

*Irstea, ELSA group (France)*

## **Introduction**

Economic activities, hence exchange of energy, matter and information induce waste, i.e. finally unwanted (and thermodynamically induced) stuff by its holder. Since this rejection property is not intentional by the holder, this can be defined from an economic viewpoint as one induced externality of any exchange. However, in some cases, other people or organisations are interested by gaining what is waste for its holder : waste for the ones sometimes become resource for the others. What becomes waste is then interesting for life cycle thinking and analyses of value chains, at the local scale (typically organic waste) as well as at more global scales (typically specific industrial waste). An ultimate waste may be described like any waste no more asked for by anyone inside the accessible area of the poorest individuals in a given society (what is waste in a society may often be a resource for another one if there are perfect information and no transport costs). Hence, ultimate waste does exist and needs to be treated, from open dumps in individual or collective back-yards to technical processes (incineration, methanisation, engineered landfills...).

In these latter cases, one can observe life-cycles inside the waste industries (since waste treatments sometimes generate hopefully valuable secondary materials or energy but also new unwanted waste, like fly ash from incinerators), which can be an analog to the small cycle of water (the technical treatments) compared to the great cycle of water (the industrial and domestic metabolisms). Environmental life cycle analysts early noticed this dual scale : one find environmental LCA of value-chain product where waste is an impact of the industrial or domestic metabolisms (often quantified through the emissions of the technical processes of waste treatment), and other more specific environmental LCA inside the waste sphere devoted to the flows and impacts of the technical process of waste treatment themselves (landfill leachate studied as waste from waste for instance). Since some materials are recycled in energy or matter, and other not, this creates open loops which makes crucial the definition of the system and the allocation procedures. Sometimes, the induced flows occur very late after the occurrence of commercial value chains or even after waste treatment (leachate leakage from landfills, radioactive particles from long life nuclear waste), which rises some temporal and even ethical questions (Mery, 2010).

All these methodological and even ethical problems have been analysed in the 1990s and 2000s and are now well known (while not fully solved) from the environmental

LCA community. What will be of interest here is the corresponding problems of waste life cycles from a social viewpoint. We will show the specificity of waste from this social viewpoint, then we will analyse the paradigms and compare the methodologies of social LCA applied to the specific value chain of waste.

## **A social definition of waste**

Since waste is what people or organisations don't want anymore, the definition of waste is fundamentally linked to human preferences. Waste is negatively defined, which induces, economically speaking, a negative price for its holder : there is a willingness to pay for throwing it, which creates a singular exchange property : the sense of payment is the same that the sense of the material flow. One consequence is that if some people or organisation are interested in (even without any payment), a flow can easily occur, possibly through intermediaries who know how to capture the potential "waste rent". Note that this flow has sometimes an illegal character due to national requirements of autonomy of waste treatments or limitation of environmental impacts, or else environmental justice considerations (see the Bale convention for industrial waste or the highly surveyed nuclear waste in OECD countries). This is why waste can be stolen (for instance from household recycling centres in developed countries and landfills in developing ones) and, above all for our purpose, why marginal people live through (waste a low value resource) and within waste, and finally can be seen as "human waste", naturalising socially what initially was economic conditions, as History and some NIMBY (Not In My Back-yard) cases showed in some circumstances.

## **Social impacts in waste management**

From an occidental viewpoint and living standard, there are obvious negative social effects of waste management in developing countries : Probo Koala affair in Abidjan, wire burning from electronic waste in Ghana, vehicles or computers which should be dismantled in Europe getting a second life or death in Africa or India, ship dismantling on Indian coasts, people living on landfills or from insecure waste picking in south America, surface water seeming more to be a waste than a resource, or even advocacy coalitions between Northern industries and southern mafias in Italy, etc. As for child labour, the question is to build an evaluation from a more or less consensual value judgement (possibly expressed by votes inside international institutions) or from impact evaluation, then using indicators coming from the social sciences (human and social capital, capabilities). In some cases, what may seem immoral by the ones may be seen efficient by the others, and conversely. What is common between type 1 and type 2 social LCA is the need to define the cycles of interest (small ones inside the waste sector, or large ones finishing at the end of life of products, which will be detailed hereafter) and the stakeholders.

### Actors of the value chain: waste producers

The producers of organic and non dangerous domestic waste : the agricultural sector recycle most of its wastes, the technical and human loops are quite closed and often quite short (waste employees can even be the same than the waste producers). Downstream sectors (restaurants, retail, consumers) use waste treatment services, from collection to final disposal in compost or methanisers (less and less in landfills in European countries). This lead to more or less formal local employment, and sometimes to NIMBY effects, through the local environmental and social impact of waste installations (odours, traffic). Forest and paper industries use sometimes larger loops (up to intercontinental business, like used paper from Europe to China, up to recently), giving employment at wider scales and countries.

The producers of industrial waste sometimes operate inside private markets not well known by public authorities and some sectors are prone to informal or illegal activities (construction and demolition waste, electronic waste, end of life vehicles, oil and gas). Some materials need heavy technologies for treatment (metals, dangerous waste) and justify international value chains on specific utilities while construction and demolition waste use more local and diffuse facilities. Social impacts of these value chains, especially collection and sorting, can then be geographically very diffuse as well as quite concentrated.

Producers have a general responsibility in the generation of waste, which is still a negative externality : despite the jobs created (see below), one sustainable way of production anywhere in the world is clearly to avoid waste upstream (eco-design, foodwaste preventing policies), and the social impacts of the modes of production should be evaluated. For instance the French electro-nuclear sector (and all electricity consumers downstream) are the cause of the distress or conflicts in the local community which will have to “welcome” forever the long live radioactive wastes.

### Actors of the value chain: collection and sorting

Environmental sustainability requires reducing final waste treatment like landfill and incineration without any energy capture, hence recycling. This needs more processes upstream, dedicated to collection schemes (different material flows). The sorting can be done upstream by the producer (who incurs social impacts in families and economic impacts in firms) or downstream in more and more automated sorting plants. This has social impacts too, since sorting was a typical employment source for marginalised people. About 150 years ago, the préfet Poubelle has already removed the resource of Parisian scavengers by preventing them to collect and sort manually the domestic waste, now encapsulated in “poubelles”. The same problems occur now in South America, where modern sorting plants threat the resource of scavengers.

### Local communities

One specificity of waste is that it is unwanted, for its holder by definition, and often for the neighbours of the waste. The image of waste, especially those of others, is

quite negative indeed, explaining the NIMBY syndrome. Procedural aspects (the way decision and location of plants are made by public or private authorities) can enhance the substantive negative aspects (odours, noise, traffic...). Until now, NIMBY conflicts seemed located to developed countries. But more and more conflicts may come from the middle class of developing countries. The participative turn of some democracies (especially South American ones) should increase the importance of local communities in the neighbourhood of waste treatment facilities

### **Workers and employment in waste management: from multinational firms to individual scavengers**

There is an astonishing variety of contracts for waste collection and treatment, from highly formal ones including ISO 9001/14001 certifications, linking big towns and multinational firms for decades, to informal day to day scavenging. Even in developed countries, some marginalised people informally collect some types of domestic non organic waste (especially metallic ones). More generally, people manually dealing with waste are not well socially ranked (to say the least) anywhere in the world, but some local actors (among them NGO) sometimes try to valorise as much as possible these yet dangerous jobs. The social impact of the end of life of products and the social impact of the life cycle of internal waste management value chains themselves, are of considerable interest concerning the working conditions and the balance of power between employers and employees or buyers and sellers in the waste sector.

### **Applying social LCA to waste management**

There is considerable room for applying type 1 social LCA in developing countries since marginalised people and difficult working conditions are at stake in the waste sector, from collecting to landfilling. Interesting social innovations occurred in South America due to the participative turn in some countries at the end of the 20th century. These should be evaluated. More generally, type 1 analysis and UNEP methodological sheets (2009, 2013) should be easily applied to some well known hotspots in developing countries, and some field studies have paved the way, from social impact assessment (Manhart et al, 2011) to explicit (Umair et al, 2015) or even scored social LCA applications (Apacarna and Salhofer, 2013). Sometimes, the health stakes are so high that even type 2 social LCA should be applicable (use of quantitative health exposure pathways or statistical regressions on unambiguous causalities). Even in some developed countries, environmental justice and LCC inside the value chain are sometimes at stake, like the relationship between Italian Northern industries and Southern mafias. Here, waste management can influence social structures, then causes or reinforces social impacts. In developed countries, the social hotspots are generally more downstream : the accursed share or flip side of the consumer society lies in the final sinks of industrial and domestic metabolism, hence incinerators and landfills. Spatially concentrated social impacts of these final sinks on local communities lead to NIMBY conflicts, beginning in the 1980s in North America and in the 1990s in Europe. They can be one Achille Heel of the consumer society (it is nowadays very difficult to settle any new big waste plant in Europe, despite continuous material flows still

requiring sinks for the ultimate waste) or of a sector, like nuclear energy in France and the USA (while Sweden and Finland have succeeded in the acceptance of local communities for settling the final sinks of their nuclear energy sector: finding pathways explaining these differences, probably linked to cultural inheritances beyond some obvious differences in procedural decision-making, may be an interesting task for type 2 social LCA).

## Conclusion and future developments

From a social definition of waste, we inferred that there are unavoidable social impacts in waste management. Social LCA can then be applied to the great cycle of matter (industrial and domestic metabolism) or inside the small cycle of waste (waste value chain only, upstream management of waste production excluded). In these two cases, different hotspots and social impacts can be identified along the value chain actors, especially local communities and workers. Some social impacts may even be quantified through pathway analysis if relevant data are available and sound methodologies are used (Parent et al, 2010; Macombe and Loeillet, 2017). There is room for the two type of social LCA to be developed, even in developed countries.

## References

- Apacarna, S, Salhofer, S, 2013. Application of a methodology for the social life cycle assessment of recycling systems in low income countries : three Peruvian case studies, *Int. J. Life Cycle Assess.* 18, 1116-1128
- Macombe, C, Loeillet, D, 2017. Instruments to assess the social impacts of value-chains, chapter 20 In: Biénabe, E, Rival, A, Loeillet, D (Eds) *Sustainable Development and Tropical Agri-chains*, Editions Quae, Versailles 257-265
- Manhart A, Osibanjo O, Aderinto A, Prakash S, 2011. Informal e-waste management in Lagos, Nigeria – socio-economic impacts and feasibility of inter-national recycling co-operations. Final report of component 3 of the UNEP SBC E-waste Africa Porject
- Mery, J, 2010. L'éthique environnementale dans les outils d'évaluation économique et environnementale : application à l'équité intergénérationnelle et à la gestion des déchets, *Vertigo - la revue électronique en sciences de l'environnement [En ligne]*, Volume 10 Numéro 1 | avril 2010, mis en ligne le 10 mai 2010, consulté le 12 janvier 2018. URL : <http://journals.openedition.org/vertigo/9620> ; DOI : 10.4000/vertigo.9620
- Parent, J, Cucuzzella, C, Revéret, JP. 2010, Impact assessment in SLCA: sorting the sLCIA methods according to their outcomes. *Int. J. Life Cycle Assess.* 15(2): 164-171.
- Umair S, Björklund A, Ekner Petersen E, 2015. Social impact assessment of informal recycling of electronic ICT waste in Pakistan using UNEP SETAC guidelines, *Recources Conservation and Recycling*, 95, 46-57
- UNEP, 2009. *Guidelines for the Life-Cycle Assessment of Products*
- UNEP, 2013. *The Methodological Sheets for Sub-categories in Social Life-Cycle Assessment (S-LCA)*

## Social LCA of sorting centres for WEEE reuse in Greece

**K. Abeliotis, C. Chroni, A. Tragaki, K. Lasaridi**

*Harokopio University, School of Environment, Geography and Applied Economics, Athens (Greece)*

### Introduction

Waste Electrical and Electronic Equipment (WEEE) or e-waste is one of the fastest growing waste streams worldwide. More than 40 million tonnes of e-waste are created globally each year. The management and disposal of these kind of waste is complex and sometimes related to illegal e-waste trade towards developing countries (European Commission, 2017).

Moreover, in the European context for WEEE management, the amended EU Waste Framework Directive introduced definitions for 'reuse' and 'preparing for reuse'. 'Reuse' means any operation by which products or components *that are not waste* are used again for the *same* purpose for which they are conceived. 'Preparing for reuse' means checking, cleaning or repairing recovery operations, by which products or components of products *that have become waste* are prepared so that they can be reused without any other pre-processing.



Figure 1: Focus of the LIFE+ ReWeee project.

However, despite the enhanced legislative framework, the actual quantities of WEEE collected and reported reused and prepared for reuse in 2012 in the EU correspond to 2% of the total WEEE collected. The UK, Germany and France lead the way (European Commission, 2017). Reused WEEE, and prepared for reuse WEEE in Greece is reported to be 0% for 2012 (European Commission, 2017). In order to enhance the public perception towards the reuse of electric appliances and the prevention of WEEE generation, an initiative has been undertaken by a group of partners, which is implemented via the LIFE+ ReWeee project (ReWEEE, 2017). The project aims to prevent the generation of WEEE. In order to achieve this objective, two WEEE sorting centers will operate for the first time in Greece, in the wider region of Attika in southern

Greece, and central Macedonia on northern Greece, respectively. The core activity of those centers is the collection, the storage and the sorting of WEEE depending on their condition and then their preparation for reuse or treatment (see Figure 1). Currently, the two centers are in the development stage, i.e. they are not operating.

The aim of this manuscript is the presentation of the key parameters that need to be taken into account in order to assess the social impact resulting from the operation of the two sorting centers for WEEE reuse in Greece via means of S-LCA.

## **The social impacts of electrical and electronic equipment**

As the full supply chain of an electrical or electronic product is very complex, it will be simplified into the following life cycle stages (Ekener-Petersen & Finnveden, 2013):

- Resource extraction
- Refining and processing of raw materials
- Manufacturing and assembly (including manufacturing of components, assembly of complex components and final assembly)
- Marketing and sales
- Use (i.e. customer relations)
- Recycling and disposal

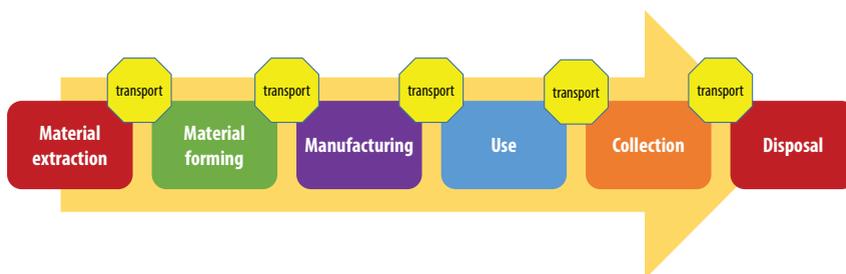


Figure 2: The life cycle of an EEE product.

The aforementioned life cycle of EEE extends across different regions of the World (see Figure 2). Raw materials are extracted from different quarries, manufacturing and assembly take place, typically in Asia, while the use phase takes place in Europe. The recycling of WEEE takes place within the geographical context of the use phase while the final disposal takes place, mostly, in different parts of the developing world. Note also that among the life cycle stages of EEE depicted in Figure 2, transportation of materials and equipment plays also a pivotal role.

Therefore, social impacts are generated throughout the supply chain of an EEE. The following lines outline the social impacts resulting from the operation of a WEEE collection and sorting centre in the entire supply chain of an electrical or electronic appliance:

- Collection of WEEE requires personnel. Therefore it has a positive social impact since it generates new jobs
- Sorting of WEEE for preparation for reuse requires the employment of personnel which has a positive impact at the local level for the creation of jobs.
- Repair of recovered appliances generates jobs at the local level, which is a positive social impact.
- Reuse of EEE extends the life span of appliances. Therefore the demand for new appliances is reduced in the geographical context where appliances are manufactured or assembled.
- Lower demand of appliances affects also negatively all the other stages in the supply chain of electrical and electronic equipment (transportation, use, collection).

### **Proposed parameters for the S-LCA of the WEEE sorting centres**

In the following paragraphs, the key parameters required for the social life cycle assessment of the two sorting centers will be outlined.

#### **Goal and scope definition**

The study does not include the social impact from electricity generation and other inputs of a supporting kind, nor did it include the social impacts related to transport. These activities also have social impacts, but are not covered within the framework of this study.

#### **Functional unit**

The functional unit in the study is the operation of a sorting and preparation for reuse EEE centre operating in Greece. The case study sought to include the product system from 'cradle to grave' and the impacts on all relevant stakeholders as suggested by the UNEP Guidelines (Benoit and Mazijn, 2009).

#### **Social life cycle impact assessment**

Social life cycle impact assessment is the process by which inventory data is aggregated within subcategories and categories to help understand the magnitude and the significance of the data collected in the Inventory phase using accepted level of minimum performance. Social impacts are consequences of positive or negative pressures on social endpoints (i.e., well-being of stakeholders). No particular impact assessment method is proposed in the UNEP Guidelines (Benoit and Mazijn, 2009).

In the methodology described in the Guidelines, the social impacts are assessed in relation to stakeholders and/or impact categories (Benoît and Mazijn, 2009). Each stage of a product's life cycle can be associated with geographic locations, where one or more of these processes are carried out (mines, factories, roads, rails, harbors, shops, offices, recycling firms, disposal sites). At each of these geographic locations, social and socio-economic impacts may be observed in the following five main stakeholders categories (Benoît and Mazijn, 2009): (i) Workers/employees, (ii) Local community, (iii) Society (national and global), (iv) Consumers (at every stage of the supply chain), and (v) Value chain actors.

The five main categories are divided into their respective subcategories. Subcategories are the basis of a S-LCA assessment because they are the items on which justification of inclusion or exclusion needs to be provided. The subcategories are socially significant themes or attributes (Benoît and Mazijn, 2009). Methodology sheets for each one of the impact subcategories for public consultation have been released (Benoît et al., 2011). The purpose of these sheets is to help in the implementation of the S-LCA with the suggestion of inventory indicators for each stakeholder and subcategory (Benoît et al., 2011). However, subcategories measurement and the definition of impact categories are still a challenge.

In our case, and since the sorting centres are not operating, in order to assess the social impact of the operation of the two sorting centers, the following key parameters (subcategories) are proposed for each one of the stakeholders:

- Workers: relevant parameters: health and safety; fair wages; no child labor; appropriate working hours; freedom of association; work-related health problems; number of accidents; gender pay gap;
- Local community: healthy and safe living conditions; security; land and property rights;
- Society: full time jobs; part time jobs; male and female employment; safe environment;
- Consumers: healthy and safe products;
- Value chain actors: corporate social responsibility actions; rate of appliances production; rate of appliances trade;

More specifically the operation of the two sorting centers in Greece is expected to:

- increase male and female employment rates, especially among low-skills workers;
- increase demand for part-time jobs and thus provide employment opportunities to specific age-groups (elder workers, young adults);
- enhance ICT use among less privileged social groups; this is of essential importance given the country's underperformance in ICT use and diffusion, as described in the Greek National Digital Strategy 2016-2021.

## Conclusions

Reuse of electrical and electronic equipment is among the top priorities in the EU waste hierarchy. In order to enhance the public perception towards the reuse of electric appliances and the prevention of WEEE generation in Greece, an initiative has been undertaken by a group of partners. In the framework of this initiative, two WEEE sorting centers will be established. In order to assess the social impact of the operation of the two sorting centers in Greece, the methodology of social LCA will be applied. The key parameters for the application of social LCA in the field of WEEE reuse have been presented.

## Acknowledgements

The LIFE –REWEEE project is implemented with the co-financing of the European Commission through the LIFE+ Funding programme.

## References

- Benoît C, Mazijn B (eds), 2009. Guidelines for social life cycle assessment of products, UNEP/ SETAC Life Cycle Initiative. Accessed 1 December 2017, <[http://www.unep.fr/shared/publications/pdf/DTIx1164xPA-guidelines\\_sLCA.pdf](http://www.unep.fr/shared/publications/pdf/DTIx1164xPA-guidelines_sLCA.pdf)>.
- Benoît Norris C, Vickery-Niederman G, Valdivia S, Franze J, Traverso M, Ciroti A, Mazijn B, 2011. Introducing the UNEP/SETAC methodological sheets for subcategories of social LCA. *Int J Life Cycle Assess* 16, 682–690.
- Dreyer, LC, Hauschild MZ & Schierbeck J, 2010. Characterisation of social impacts in LCA. Part 1: Development of indicators for labour rights. *Int J Life Cycle Assess* 15, 247–259.
- Ekener-Petersen E & Finnveden G, 2013. Potential hotspots identified by social LCA—part 1: a case study of a laptop computer. *Int J Life Cycle Assess* 18, 127–143.
- European Commission. Study on WEEE recovery targets, preparation for re-use targets and on the method for calculation of the recovery targets. Accessed 1 December 2017, <[ec.europa.eu/environment/waste/weee/pdf/16.%20Final%20report\\_approved.pdf](http://ec.europa.eu/environment/waste/weee/pdf/16.%20Final%20report_approved.pdf)>.
- ReWEEE 2017. Development and demonstration of Waste Electrical and Electronic Equipment (WEEE) prevention and reuse paradigms. Accessed 1 December 2017, <<http://www.reweee.gr/en>>.

# Assessing the Social Sustainability of Frugal Products

**Leonor Simoes<sup>1</sup>, Sara Russo Garrido<sup>2</sup>, Ana Carvalho<sup>1</sup>**

<sup>1</sup> CEG-IST, Instituto Superior Técnico, Universidade de Lisboa (Portugal)

<sup>2</sup> CIRAIQ, Université du Québec, Montréal (Canada)

## Introduction

In 2010, the expression “Frugal Innovation” was used by Adrian Wooldridge, to refer a brand new innovation encapsulating changes in all areas of the business model: product or service design, marketing and supplier’s selection to name a few (Basu et al., 2013; Radjou and Prabhu, 2015). Frugal Innovation has been defined by Rocca’s (2016) as:

*“Frugal innovations are products, services, processes and business models that target underserved customers of low-mid market segments with high-quality solutions at affordable prices. They are developed in a sustainable and cost-effective manner that minimise the use of [human] resources, materials and capital in the entire value chain, while enhancing social value.”*

In this sense, Frugal Innovation requires the integration of a set of constraints related to Social Sustainability, which plays a significant role in its implementation, as frugal solutions intend to deliver a maximized social value (Khan, 2016). Frugal Innovation requires a deep knowledge of the market, its opportunities and threats, which is only achieved with a narrow relationship with the stakeholders. On the one hand, Frugal Innovation implies a set of changes within the organizations, and there is still scepticism about it, especially when proposing a link with Social Sustainability (Khan, 2016). On the other hand, social aspects are generally seen as subjective, since they are difficult to identify, quantify, and measure. Therefore, an analysis of Frugal Innovation from a Social Sustainability point of view is needed. Key questions are still to be answered: (1) How both social impact and social value concepts can be integrated and applied to Frugal Innovation Social Sustainability assessment?; (2) What are the metrics to assess each of them?. This work intends to answer these questions, while suggesting an innovative framework (FISA) that integrates Social Sustainability into frugal innovations’ development and implementation.

## Methodology

In the development of the present work, the following methodologies were applied: an exhaustive and comprehensive Literature Review was first conducted, focusing

on Frugal Innovation and Social Sustainability; (2) as further and more complete analysis and conceptualizations were required to respond to the principal questions of the work, Grounded Theory was applied in defining Social Value, and analysing case studies and reports; (3) stakeholders characterisation was conducted through an adaptation of the “Five step approach to stakeholder engagement” proposed by Business Social Responsibility organization ([www.bsr.org](http://www.bsr.org)), which results into the Value-Expertise-Willingness method, described below; (4) lastly, semi-structured interviews were conducted to validate the framework FISA.

## Framework development

FISA provides a set of indicators that allow the social assessment of a frugal solution (product, or service). Its development required four types of results coming from literature review and grounded theory application: (1) Most relevant stakeholders for Frugal Innovation; (2) Most significant social assessment areas for Frugal Innovation; (3) Frugal characteristics; (4) Social Value and Social Impact concepts.

### Stakeholders

It was important to perform a stakeholder characterisation to understand the role of each one in frugal development and implementation, and also to identify those with higher relevance and significance for Frugal Innovation.

The method Value-Expertise-Willingness (V-E-W) was adapted from the “Five step approach to stakeholder engagement” proposed by Business Social Responsibility organization ([www.bsr.org](http://www.bsr.org)). It was applied to identify which stakeholders have more relevance for and in Frugal Innovation. This method required the analysis of all stakeholders in terms of their:

- **Value**, which is decomposed into the Influence a stakeholder has towards the frugal performance of the company or the frugality of a product, and then into his Necessity of Involvement into the Frugal Innovation process of implementation development, or improvement;
- **Expertise**, whose subcategories are Contribution and Legitimacy. Both intend to reflect the skills and knowledge a stakeholder has which serve as input to the company’s frugal performance or frugality of the product or service, and the meaning and legitimacy of a stakeholder’s claim to engage with the Frugal Innovation implementation, development, or improvement within the company; and
- **Willingness** (to engage) translates the predisposition a stakeholder has to participate with the Frugal Innovation implementation, development, or improvement.

The results of V-E-W method provide information on which stakeholders are the more relevant and significant for Frugal Innovation. Out of the map of stakeholders

(Figure 1) it is possible to verify that local community, consumers/users/customers, and neighbouring communities are the most relevant stakeholders, since they are the ones with higher value and expertise to the frugal innovation products and services. Therefore these are the stakeholders who are going to be included in the abstract.

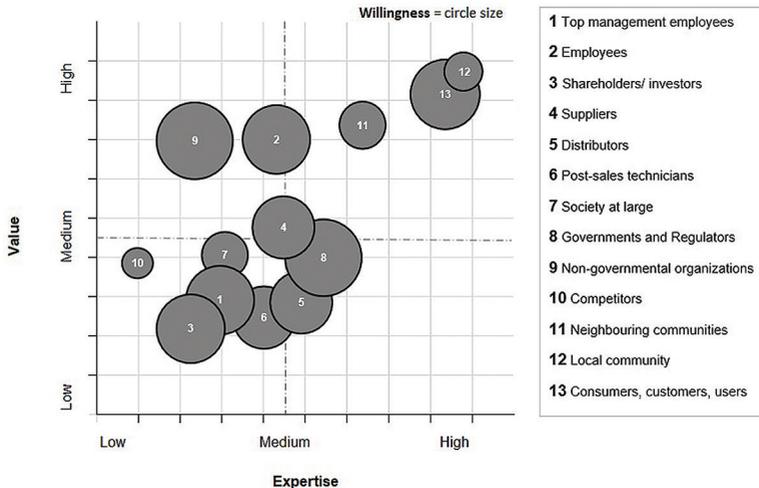


Figure 1: Stakeholder mapping (V-E-W method).

### Social assessment areas

As the research on Social Sustainability Assessment evolves, the literature offers insight of which social areas should be assessed. As this works intends to study what is different in Frugal Innovation and the novelty it brings to Social Assessment, the input of FISA is the result of the Grounded Theory conducted after collecting information from literature, companies and funding entities. This information was organized according to Social Midpoints (Simões, 2014) and the corresponding Endpoints used by Global Reporting Initiative (GRI): Product Responsibility, Labour practices and decent work, Society, and Human Rights.

The results of this application on Grounded Theory showed **Society** – whose midpoints are: Business Impacts, Community Involvement and Welfare; Community Funding and Support; Fair Business Operations; Corruption in Business; Stakeholder Participation; Innovation and Competitiveness -, and **Product Responsibility** – whose midpoints are: Consumer Health and Safety; Product Management and Consumer Satisfaction. Therefore these two social areas are included in the framework.

## Frugal characteristics

FISA's indicators intend to cover the characteristics of frugal innovation. Consequently each indicator is assigned to one or more frugal characteristics of the product or service being assessed. Within FISA, the characteristics are represented with symbols, as referred below. Scholars describe frugal innovations as those solutions which meet some specific characteristics. Tiwari and Herstatt (2012) use a list of frugal examples to enumerate their characteristics: low price, sophisticated technology, easy to use, portable, robust, simple, large-scale and economies of scale, low energy consumption and emissions, and adequate quality. In the same vein, Radjou et al. (2012) refer the frugality of Jugaad innovations by its mass production, low cost and price, low energy consumption, smart use of resources, simplicity and durability. In brief, Roland Berger (2015) publication presents these attributes organized into six according to the acronym FRUGAL (functional, robust, user-friendly, growing, affordable, local). Frugal innovations are **functional**-star (designed to be practical and useful). **Robust**- triangle (lasting materials and maintenance-friendly components); **User-friendliness**- square (easiness-to-use and fault-resistance); **Growing**- rectangle ( volume of people and the target mass markets); **Affordable** –circle (cheap price, and low costs of operation); **Local** –pentagon (local collaborations to better fit in a budget); **Sustainable**- cross (triple bottom line).

## Social Value and Social Impact concepts

Within the FISA, Social Value and Social Impact are the two aspects to be analysed for the social assessment of a certain frugal innovation. The presented indicators are assessing these two aspects which were defined in this work as:

- *Social Value is the perception that the concerned stakeholders have about the products influence in their individual and collective wellbeing.*
- Social Impact is how the company activities, or the product itself, change or influence each stakeholder in a period of time. (adapted from UNEP, 2009, p.43)

In FISA, each indicator corresponds to the assessment of Social Value – when it is blue, or to the Social Impact assessment – when it is orange, or to the assessment of both Social Value and Social Impact simultaneously – when it is green.

## FISA

Having the information and results described above, the formulation of indicators was the step then taken. Literature (Searcy et al., 2007; Vanchon and Mao, 2008; Hassini et al., 2012) contributed to the choice and definition of each indicator, even if sometimes in an indirect manner. The practical applicability of the set of indicators was the main objective of this formulation, so that those indicators easier to measure or calculate, and those whose data is easier to get, were privileged over the others. In Figure 2, the first level of assessment of FISA is presented.

Framework FISA – Frugal Innovations' Social Assessment – Level 1			
Stakeholders	Local community	Consumers, users, customers	Neighbouring communities
<b>Areas of Assessment</b> <b>Endpoint: Society</b> <b>Midpoints:</b> 1. business Impacts, Community Involvement and Welfare 2. Community Funding and Support 3. Fair Business Operations 4. Corruption in Business 5. Stakeholder Participation	<ul style="list-style-type: none"> <li>Market share (1) ★◀</li> <li>Price per average income (2 and 3) ●</li> <li>Site-specific studies (1 and 5) ◆</li> </ul>	<ul style="list-style-type: none"> <li>Product lifetime (1 and 3) +</li> <li>Direct impact on users (2) ★■◀+</li> <li>Feedback contacts (5) ★■◆</li> </ul>	<ul style="list-style-type: none"> <li>Contracts with neighbouring suppliers (1) ◀+</li> <li>Impact on the delocalisation of neighbouring people (1) ◀+</li> <li>Involvement of neighbouring people (5) ★◀+</li> </ul>
	<ul style="list-style-type: none"> <li>Value chain entities audited (4) +</li> <li>Opportunities to cooperate locally (1, 2 and 3) ●◀+</li> </ul>		
<b>Endpoint: Product Responsibility</b> <b>Midpoints:</b> 1. Consumer Health and Safety 2. Product Management and Consumer Satisfaction	<ul style="list-style-type: none"> <li>Covered needs ratio (1) ◆+</li> <li>Substitute products ratio (2) ★</li> <li>Price comparison (2) ●</li> <li>Initiatives to raise awareness (2) ◀</li> <li>Local maintenance technicians (2) ▲</li> <li>Purchasing alternatives (2) ●</li> </ul>	<ul style="list-style-type: none"> <li>Product lifetime (1 and 2) ▲</li> <li>Educational actions (1 and 2) ■</li> <li>Product adoption curve (2) ◀</li> <li>Distribution channels (2) ◀</li> <li>Users per product (2) ●</li> </ul>	
	<ul style="list-style-type: none"> <li>Environmental impact (1 and 2) +</li> </ul>		
Legend: Blue = Social Value Indicator; Orange = Social Impact Indicator; Green = Social Value and Social Impact Indicator Functional = ★, Robust = ▲, User-friendly = ■, Growing/Timely-to-Market = ◀, Affordable = ●, Local = ◆, Sustainable = +			

Figure 2: Framework FISA – Frugal Innovations' Social Assessment

FISA intends to provide a tool for decision makers in companies to choose between a product and another, or to have a deep insight on how good is the product's frugal performance in terms of its social sustainability. Using FISA, the decision-maker can assess the product or service stakeholder-by-stakeholder, in each social area. The indicators presented in the matrix assess the stakeholder presented in the columns, regarding a mid-points (rows) and evaluate the frugal characteristics which are identified by the symbols.

## Conclusions and future developments

Frugal Innovation and Social Sustainability are deeply related, since the former intends to promote the latter, and by this promotion aims to cover social needs and solve social problems, targeting a large amount of underserved customers. FISA supports Frugal Innovation developers in making decisions – assessing the Social Sustainability performance of the product or service which will contribute to enhancing its Social Value. Future developments could propose the second level of assessment of FISA, where the remaining stakeholders will be considered. In addition, future work could explore the practical applicability of FISA in companies already implementing Frugal Innovation.

## References

- Basu, R.R., Banerjee, P.M., Sweeny, E.G. (2013). Frugal Innovation: Core Competencies to address Global Sustainability. *Journal of Management Global Sustainability*, 1, 63–82.
- Engel, K., Sebaux, E. (2014). Capturing the Power of Frugal Innovation. *AT Kearney Insights*.
- Hassini, E., Surti, C., Searcy, C. (2012). A literature review and a case study of sustainable supply chains with a focus on metrics. *International Journal of Production Economics*, 140, 69–82.
- Khan, R. (2016). How Frugal Innovation Promotes Social Sustainability. *Sustainability*, 8, 1034.
- Searcy, C., McCartney, D., Karapetrovic, S. (2007). Sustainable Development Indicators for the Transmission System of an Electric Utility. *Corporate Social Responsibility and Environmental Management*, 14, 135-151.
- Vachon, S., Mao, Z. (2008). Linking supply chain strength to sustainable development: a country-level analysis. *Journal of Cleaner Production*, 16, 1552–1560.
- Radjou, N., Prabhu, J., Ahuja, S. (2012). *Jugaad Innovation: Think Frugal, Be Flexible, Generate Breakthrough Growth*. Jossey-Bass: San Francisco, CA, USA.
- Rocca, F. (2016). *Supply Chain Management for Frugal Innovation Product*, Master's Thesis, Instituto Superior Técnico (Technical University of Lisbon), Portugal.
- Radjou, N., Prabhu, J. (2015). Frugal Innovation: How to Do More with Less. *The Economist*, February.
- Roland Berger Strategy Consultants (2015). Frugal products. Think Act, June. Report.
- Simões, M. (2014). Social key performance indicators – Assessment in supply chains, Master's Thesis, Instituto Superior Técnico (Technical University of Lisbon), Portugal.
- Tiwari, R., Herstatt, C. (2012). Frugal Innovation: A Global Networks' Perspective. *Die Unternehmung*, 66(3), 245-274.
- UNEP. (2009). *Guidelines for Social Life Cycle Assessment of Products*. United Nations, Paris.

# Social Life Cycle Assessment addressed to the valorisation of wine production waste and residues – A review with methodological clues

**Orlanda Grech<sup>1</sup>, Luciano Vogli<sup>1</sup>, Serena Righi<sup>1</sup>, Manuela D'Eusanio<sup>2</sup>**

<sup>1</sup> CIRSA – Università di Bologna, Ravenna (Italy)

<sup>2</sup> Dipartimento di Economia – Università degli Studi "G. d'Annunzio", Pescara (Italy)

## Introduction

Italy is the leading country in terms of wine production, standing at 50.9 million hectolitres for the harvest in 2016. Emilia-Romagna represents the third largest Italian region, after Veneto and Puglia, reaching about 7 million hectolitres. Against the above background and the circular bioeconomy framework, VALSOVIT project, funded by Emilia-Romagna Region through ERDF programme 2014-2020, aims to look for a sustainable valorisation of wine production waste and residues. Within this project, and the "Climate-KIC Pioneers into Practice 2017" programme, a review of the scientific literature which refers to methodologies and case studies on social sustainability assessment of wine waste and residues exploitation has been conducted to gain an insight to what has been done so far on this topic on a global scale. Ultimately, a way forward is suggested through recommendations as to how to improve existing methodological frameworks for the Social Life Cycle Assessment (S-LCA) envisaged in VALSOVIT project.

## Review of methodology and case studies addressed to the valorisation of wine industry residues, to second generation biorefineries and to innovative technologies

In gathering background to this work, reference was first made to the methodology surrounding S-LCA, namely Guidelines for Social Life Cycle Assessment of Product (UNEP/SETAC, 2009) and Methodological Sheets for Subcategories in Social Life Cycle Assessment (UNEP/SETAC, 2013), and a Technical report on the Social Life Cycle Assessment by the Joint Research Centre at the European Commission (Sala et al., 2015). Then a bibliographic research was performed with a list of keywords dealing not only with specific winemaking residues valorisation, but also with second generation biorefineries and innovative technologies, in line with the scope of VALSOVIT project. In analysing the research undertaken, a framework was designed made up of 15 fields

---

1 Part of this research were done while the author was undertaking an international placement as part of the "Pioneers into Practice 2017" programme by Climate-KIC.

in order to be able to characterize each research paper, and to extract and collect the main elements. A relevance index was applied in order to classify the relevance of research papers according to their value-added element towards the VALSOVIT project and the further development of the existing S-LCA framework.

From the literature review carried out, no specific application was found in the sector of the valorisation of wine production waste and residues. Moreover, in all papers analyzed the approach was innovative and experimental, but not yet comprehensive. For these reasons, specific methodological indications of a social assessment to the sector of interest cannot be provided, only general recommendations are proposed.

Whilst the mix of literature analysed revolved around the discussion of the S-LCA methodology per se and applied case studies, the starting point for almost all research studies was the utilization of the UNEP/SETAC guidelines (UNEP/SETAC, 2009) and methodological sheets (UNEP/SETAC, 2013). In assessing the social sustainability of the system or process at hand, a quantitative, qualitative, and semi-quantitative stance was taken across a mix of subject areas in various countries. In deciding which stakeholder categories and subcategories to analyse in relation to the process under study, a number of authors elicited the participation of experts or stakeholder themselves in order to get a more direct picture of the issues at stake, even if in this way an element of subjectivity and possibly bias due to personal choices and interests can be introduced.

On the other hand, a number of authors relied on secondary data, such as input-output models and the Social Hotspot Database (SHDB), running the risk of not correctly assessing the social sustainability of the product system itself where sectoral and/or country level data is not available and proxies are utilised. Recommendations put forward in this latter case for further stakeholder participation to validate the results contrast recommendations put forward by other authors for reliance on local reports or studies that counterbalance the reliability of stakeholders' answers. In assessing the social impact itself, various approaches were undertaken, the most relevant ones being: Social Hotspot Index (SHI) based on a top-down and bottom-up approach (Benoît Norris, 2014); Subcategory Assessment Method (SAM) (Ramirez et al., 2014); score system based on fulfilment of social compliance criteria (Aparcana & Salhofer, 2013a); scoring system based on number of issues at stake (Blom & Solmar, 2009); score system based on weighting factors, or on weighting factors and stakeholder gaps (Russo Garrido et al., 2016); econometric/process model (Souza et al. 2016). A number of issues with the current methodology were highlighted, mainly linked to the fact that the general framework for S-LCA of products along their lifecycle is still at an early stage (Arcese et al., 2017). These issues include: the need for more fine tuning for S-LCA to be successful when comparing different products; the need for considering further aspects pertaining to local context or special situations like the social responsibility of a company; the need for large international consensus on a characterisation method for social impacts, and in the choice of social indicators – the choice of indicators as well as the social assessment method may thus be subjective; the need to better develop methods to evaluate subcategories.

## Conclusions and future developments

The key message following this bibliographic review is that a balance needs to be struck in relying on primary and secondary data to perform such social sustainability assessments within the framework of the S-LCA. Firstly, when making use of secondary data, reliance on existing data that guides social hotspot identification should be done with caution. With reference to the Social Hotspot Database, it was noted that there is need for more sectoral data to be featured and that such SHDBs are to be updated on a regular basis, including for sectors which are deemed innovative. Also, when making use of SHI for social sustainability assessment, as based on SHDB, this approach should be further expanded to include positive impacts (and not only negative impacts linked to social risks). Secondly, when going for secondary data and relying on experts' opinions, caution should also be applied in order to minimise bias due to subjective choices and sometimes to personal interests. This can partly be counterbalanced by removing the focus on social risks when undertaking a S-LCA, and start featuring an assessment on the positive impacts created by a product or process. In terms of the impact characterization model, it is imperative that weighting and normalisation is done in a consistent manner based on both experts' evaluation as well as globally-accepted social databases and input-output models. Moreover, other methods and/or frameworks should not be excluded in favour of solely utilising the S-LCA framework, but rather they should be combined to it, since the final aim is to evaluate the social externalities that result as a consequence of a product lifecycle, and this can be achieved by using different integrated methods. Finally, since the assessment of impacts is dependent on the conduct of the companies involved in the life cycle, more than the individual industrial processes, it would be recommended to include a weighting according to an index which reflects the company's sustainability practices. This would enable a more consistent comparability of processes across different companies. Alternatively, the use of a two-layer assessment, based on two layers of impact categories – both a predetermined, obligatory and an optional, self-determined set of categories, the latter expressing interests specific to the product manufacturer – as already utilised in literature is to be encouraged in undertaking of LCAs hereon, with caution towards subjectivity that can be introduced in adopting a bottom-up approach towards sustainability assessment.

## References

- Aparcana, S., Salhofer, S., 2013a. Development of a social impact assessment methodology for recycling systems in low-income countries. *The International Journal of Life Cycle Assessment*, 18(5), 1106-1115.
- Arcese, G., Lucchetti, M.C., Massa, I., 2017. Modelling Social Life Cycle Assessment framework for the Italian wine sector. *Journal of Cleaner Production*, 140, 1027-1036.
- Benoit Norris, C.B., 2014. Data for social LCA. *The International Journal of Life Cycle Assessment*, 19, 261-265.
- Blom, M., Solmar, C., 2009. How to socially assess biofuels: a case study of the UNEP/SETAC code of practice for social-economical LCA.

Ramirez, P.K.S., Petti, L., Haberland, N.T., Ugaya, C.M.L., 2014. Subcategory assessment method for social life cycle assessment. Part 1: methodological framework. *The International Journal of Life Cycle Assessment*, 19(8), 1515-1523.

Russo Garrido, S., Parent, J., Beaulieu, L., Revéretet, J.P., 2016. A literature review of type I SLCA – Making the logic underlying methodological choices explicit. *The International Journal of Life Cycle Assessment*, , 1-13.

Sala, S., Vasta, A., Mancini, L., Dewulf, J., Rosenbaum, E., 2015. *Social Life Cycle Assessment - State of the art and challenges for supporting product policies*. European Commission, Joint Research Centre, Institute for Environment and Sustainability, Publications Office of the European Union, Luxembourg.

Souza, A., Watanabe, M.D.B., Cavalett, O., Ugaya, C.M.L., Bonomi, A., 2016. Social life cycle assessment of first and second-generation ethanol production technologies in Brazil. *The International Journal of Life Cycle Assessment*, 1-12.

UNEP/SETAC, 2009. *Guidelines for social life cycle assessment of products*. United Nations Environment Programme, Paris.

UNEP/SETAC, 2013. *The methodological sheets for sub-categories in social life cycle assessment (SLCA)*. United Nations Environment Programme, Paris

# Small but Complex: Assessing Social Impacts on Smallholders in Agri-food Sector

**Diana Indrane<sup>1</sup>, Urs Schenker<sup>2</sup>, Thomas Andro<sup>3</sup>, Mark Goedkoop<sup>4</sup>, Ilonka de Beer<sup>5</sup>**

<sup>1</sup> *Independent, Valmiera (Latvia)*

<sup>2</sup> *Nestlé Research Center*

<sup>3</sup> *Solvay*

<sup>4</sup> *PRÉ Sustainability*

<sup>5</sup> *Sandalfon, Sustainability*

## Introduction

Social life cycle assessment (SLCA) stems from the concept of life cycle thinking and seek to capture social impacts of a product throughout the life cycle, from the extraction of raw materials to the end-of-life. The UNEP/SETAC guidelines define social impacts as “Consequences of positive or negative pressure on social endpoints (i.e. wellbeing of stakeholders)” (UNEP/SETAC, 2009). That is, the social aspects assessed may have a direct or indirect effect on diverse stakeholder groups that are involved in the life cycle of a product. Five main stakeholder groups are identified within SLCA: Workers, Local communities, Consumers, Value Chain Actors and Society (ibid). However, the agri-food sector in low income countries is often characterised by a predominance of smallholder<sup>1</sup> farmers. According to the Food and Agriculture Organisation (FAO), approximately 550 million farms worldwide are managed by smallholders and their families (FAO, 2014). It is estimated that smallholders make up to 85% of the world’s farmers (IFC, 2013), many of whom are linked to poverty and social vulnerability. Despite smallholders’ significant role in agriculture supply chains, SLCA frameworks and methods have a limited capacity to evaluate social impacts associated with family-owned businesses. Typically, the impact categories and performance indicators presented for workers are developed for organisations with management structure and employees (Fontes, 2016; Arcese et al., 2016). Whereas, smallholders are independent persons and most of the impact categories are not applicable to them.

Scrutiny of the available Type I<sup>2</sup> SLCA agriculture case studies (Table 1) revealed that practitioners, typically, apply the procedure described by the UNEP/SETAC Guidelines

1 In the literature, no universally accepted definition of smallholders exists, and typically several parameters are used to describe the group. Thus, in this paper term smallholders refer to “Independent persons who mainly rely on family labour to produce food and non-food products on a small scale with limited access to resources”. Smallholders can also refer to artisanal fishers, gardeners, hunters and gatherers, and other small-scale producers.

2 The Guidelines distinguishes two different characterisation models within SLCA: performance reference point methods and impact pathway methods, or Type I and Type II SLCA methods (UNEP/SETAC, 2009).

Author	Product system	Geographical specification	Purpose	Stakeholder groups	Comments regarding Smallholders, farmers and SMEs
Arcese et al., 2016	Wine production	Italy	To reproduce the Guidelines settings and integrating improvements tailored to Italian wine sector	Workers Local Communities Supply Chain Actors Society Consumers	Specialised indicators supplied also in the agriculture step: E.g. Distribution of responsibilities among family members
Petti et al., 2016	Tomatoes	Italy	To present implementation of subcategory assessment method (SAM)	Workers Local communities Consumers	It is noted that not all elements of regionalisation are considered by SAM, especially in small organisations
Franze & Ciroth, 2011	Agriculture: Cut roses	Ecuador & Netherlands	To “try out” the UNEP/SETAC Guidelines	Workers Local communities Supply chain actors Society Consumers	—
Revéret, Couture, & Parent, 2015	Milk	Canada	To assess the environmental and social impact	Workers, Local communities Value chain actors Society	Covers only farm workers that are not relatives of the producer. As business owners, the producer and his family members are not considered to be Workers, even if they work on the farms.
Agyekum et al., 2016	Wild bamboo bicycle frames	Ghana	To assess the environmental and social impact	Workers Local communities	Identified challenges when applying S-LCA to SMEs in the developing countries

Table 1: Characteristics of Type I SLCA studies and scientific articles incorporating agriculture supply chains, farming, SMEs, published between 2010 – 2017

or were set to test the application of the Guidelines. Even when an SLCA study is conducted at a farm level, farmers or their family members are not included in the assessment. The lack of recognition could be caused due to the geographical scope of the case studies – mainly the developed countries. Commercial farms do not face the same basic development challenges as smallholders do, and are often automated and run by workers.

To the authors' knowledge, a study on wine production in Italy by (Arcese et al., 2016) is the only paper focused on including indicators specifically tailored to address family

businesses in SLCA. Arcese et.al addressed all five stakeholder groups listed in the UNEP/SETAC guidelines, but included additional impact categories and performance indicators. However, if SLCA studies are to address social impacts on smallholders, there is a need to assess social aspects that are at the lower levels of the hierarchy of needs.

As the ultimate goal of social LCA is to systematically identify social conditions of a given product and promote improvement opportunities, it is crucial to address the most salient issues for all the involved stakeholders. Therefore, this paper aims to examine ways to better understand and address smallholders in SLCA. More specifically, it addresses how to improve the SLCA methodology as presented in the Handbook for Product Social Impact Assessments in order to systematically identify social impacts associated with smallholders.

## **Development process**

An SLCA method specifically designed to address smallholders was developed together with the Roundtable for Product Social Metrics and based on the overarching principles (Figure 1) presented in the Handbook for Product Social Impact Assessments (PSIA). Literature concerning smallholders' constraints and social issues was reviewed to determine social topics and performance indicators. Additional inputs were given by two roundtable member companies - Nestlé and Solvay – that have experience with smallholder assessments. A vast number of social issues were identified, and the most essential aspects were prioritised. Once the relevant social topics and performance indicators were determined, a company's ability to influence the issue or act upon the result were evaluated. Impact assessment approaches were established based on the Theory of Change<sup>3</sup> with an aim to assess if value chain actors are promoting good practices and creating positive value for Smallholders.

Applicability and feasibility of the proposed method for Smallholders were tested on two case studies. The products chosen for the case studies were coffee produced by Nestlé and Guar gum derivable produced by Solvay. Both case studies analysed real-world cases. As the proposed method is a first attempt at assessing social impacts on smallholders within the PSIA framework, learning about the method was the most crucial factor of success in both case studies.

## **Results**

Altogether nine social topics were determined for the stakeholder group Smallholders: (1) Meeting basic needs, (2) Access to services and inputs, (3) Women's empowerment, (4) Education and Training, (5) Child Labour, (6) Health & Safety, (7) Land titles, (8) Trading relationship and (9) Next generation smallholders. At least 2 quantitative and 2 qualitative performance indicators are determined for each social topic. The proposed

---

<sup>3</sup> Theory of Change is a causal flow that illustrates how a proposed set of interventions and inputs will result in specific outputs contributing to different outcomes leading to certain impacts (Sustainable Food Lab, 2014).

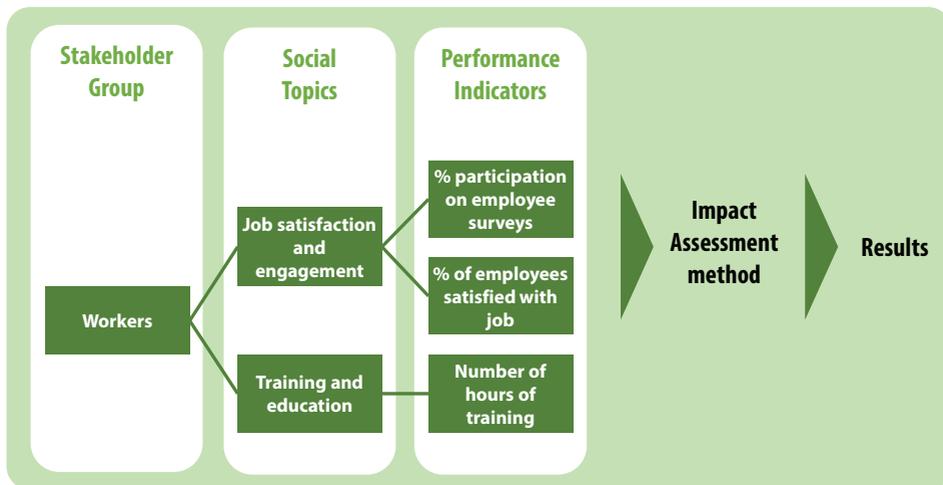


Figure 1: Key components of PSIA method (Fontes, 2016)

social topics addresses issues not only directly linked with production processes (Education and training i.e. agriculture practices) but also includes important social aspects at a household level that are linked with smallholders' ability to work (i.e. meeting basic needs). Moreover, the social topic 'Next generation smallholders' addresses the attractiveness of the profession.

As the aim was to develop a standardised method that is not designed for a specific geographic region, the list of social topics and performance indicators proposed for smallholders is limited, but if needed, can be expanded. The method provides a framework for assessing smallholders within PSIA, which can be adapted to specific case studies. However, the assessment should focus on material issues.

Results from the case studies indicated that this method makes it possible to assess Smallholders within the PSIA framework and supports evaluation of products derived from agriculture supply chains. The scale-based approach allowed to assess both negative and positive performance and helped to identify potential hotspots. However, during the process, numerous opportunities for improvement were identified. Additional guidance on how to manage potential overlaps among the social topics is needed, and there may be a need to reconsider the importance of the social topic Health and Safety. Moreover, the assessment process highlighted the performance indicators and social topics that may be challenging due to lack of data. For example, food security is a complex assessment and lacks generic data sources.

## Further development

Development of the PSIA method for smallholders relied mainly on literature review, discussions with the Roundtable members and internal experts in the companies working with smallholder assessments. Therefore, it may be desirable to review the method externality to identify further opportunities for improvement.

Due to the time constraints, only one stakeholder group was addressed in the case studies. In the future, it is suggested to apply the whole PSIA method along the whole product value chain. Starting from the raw materials and ending with the end of life of products. Assessment of more complex supply chains would provide insights on the compatibility of smallholder method with the current Handbook.

In the development process, the focus was placed on addressing smallholders in agriculture supply chains. Nevertheless, the proposed method could potentially be applied to wide range of industries with smallholder labour e.g. fishing, informal recycling, handicraft, building, etc. In the future, it would be interesting to test the applicability of the method across different sectors.

Development of the PSIA method for smallholders did not include the development of weighting factors. Thus, aggregation of social topic scores and the total stakeholder score were based on equal weighting. Weighting factors may be necessary when a distinction needs to be made on the importance of various social topics assessed e.g. in the decision-making process. Hence, there are opportunities to establish either case specific or generic weighting factors based on their perceived importance or relevance for the stakeholders. The development process could be based on smallholder or expert opinion. On indicator level, this could be very important for the social topic "Meeting basic needs" which is covering 3 separate social issues. Meanwhile, weighting factors could play a significant role when aggregating stakeholder scores.

## References

- Agyekum, E. O., Fortuin, K. P. J. (Karen), & van der Harst, E. (2016). Environmental and social life cycle assessment of bamboo bicycle frames made in Ghana. *Journal of Cleaner Production*, 143, 1069–1080. <https://doi.org/10.1016/j.jclepro.2016.12.012>
- Arcese, G., Lucchetti, M. C., & Massa, I. (2016). Modeling Social Life Cycle Assessment framework for the Italian wine sector. *Journal of Cleaner Production*, 140, 1027–1036. <https://doi.org/10.1016/j.jclepro.2016.06.137>
- FAO. (2014). The State of Food and Agriculture. *Canadian Journal of Comparative Medicine (Vol. 34)*. <https://doi.org/9789251073179>
- Fontes, J. (2016). Handbook-for-Product-Social-Impact-Assessment-3.0, 1–146.
- Franze, J., & Ciroth, A. (2011). A comparison of cut roses from Ecuador and the Netherlands. *International Journal of Life Cycle Assessment*, 16(4), 366–379. <https://doi.org/10.1007/s11367-011-0266-x>

- IFC. (2013). Working with Smallholders. IFC publication. Retrieved from AskSustainability@ifc.org
- Petti, L., Sanchez Ramirez, P. K., Traverso, M., & Ugaya, C. M. L. (2016). An Italian tomato “Cuore di Bue” case study: challenges and benefits using subcategory assessment method for social life cycle assessment. *The International Journal of Life Cycle Assessment*. <https://doi.org/10.1007/s11367-016-1175-9>
- Revéret, J.-P., Couture, J.-M., & Parent, J. (2015). Socioeconomic LCA of Milk Production in Canada Jean-Pierre. In *Sustainability* (Vol. 6, pp. 4200–4226). <https://doi.org/10.3390/su6074200>
- Sustainable Food Lab. (2014). Performance Measurement in Smallholder Supply Chains : A practitioners guide to developing a performance measurement approach. Retrieved from <http://www.sustainablefoodlab.org/wp-content/uploads/2016/04/Performance-Measurement-Practitioners-Guide-SFL-2014.pdf>
- UNEP/SETAC. (2009). Guidelines for Social Life Cycle Assessment of Products. Management (Vol. 15). <https://doi.org/DTI/1164/PA>
- Wu, R., Yang, D., & Chen, J. (2014). Social Life Cycle Assessment Revisited. *Sustainability*, 6(7), 4200–4226. <https://doi.org/10.3390/su6074200>

# The challenge of quantification: Social Life Cycle Assessment (s-LCA) for advanced biofuel from waste wood integrated in the steel industry

**Ingrid Kaltenegger, Stephan Schwarzinger**

*Joanneum Research Forschungsgesellschaft mbH, LIFE – Centre for Climate, Energy & Society, Graz (Austria)*

## **Purpose of work**

Steel is an essential raw material that directly or indirectly affects any sector of the economy. About half of the world's production of about 1,665 Mt in 2015 went into the construction sector while 16 % were used to produce mechanical machinery. Another 13% were used in the automotive sector, 11% were processed to metal products (Worldsteel, 2016). The world steel industry is also a big employer, according to Worldsteel (2015), about 8 million people were employed in 2014, the EU accounted for 328,000 jobs in 2015<sup>1</sup>.

Even though there is a substantial economic gain for local communities, large steel making facilities might hold great conflict potential for employees as well as society. Low compensation and bad health or safety measures on the one side and massive pollution of water, air and land on the other side can be sources of dispute, to name only a few.

The project TORERO demonstrates the first implementation of a technology concept for creating and using torrefied wood for the production of bioethanol, fully integrated in a large-scale, industrially functional steel mill. The outcomes will be relevant for both, the bioethanol end-users and for Europe as a whole through the reduced demand for fossil fuel molecules and thus significantly reduced GHG emissions.

Besides environmental and economic issues regarding this new process, a special focus will be laid on social issues (including health and safety) which will be considered in the whole life-cycle and assessed at a district and regional level at the demonstration plant location.

## **Approach, scientific innovation and relevance**

To assess impact along supply chains, Life Cycle based methodologies have been developed over the last years. Life Cycle Assessment (LCA) considers mainly environmental impacts along supply chains, from extraction of raw materials to end-

<sup>1</sup> [http://europa.eu/rapid/press-release\\_MEMO-16-805\\_en.htm](http://europa.eu/rapid/press-release_MEMO-16-805_en.htm)

of-life of products. In the steel industry LCA is a key tool: It is widely used and most of the larger corporations have developed their own method. Its application is not only crucial because of the massive material flows and pollutant emissions of steel production itself but increasingly used to illustrate steel's properties as a circular economy material and its CO<sub>2</sub> eq. savings in comparison to e.g. aluminium, cement or carbon fibre materials. Nevertheless, for a systematic understanding of sustainability, the societal dimension needs to be monitored accordingly.

Coupling the assessment of environmental and socio-economic issues may support more comprehensive sustainability assessment of impacts, benefits, and related trade-offs (JRC, 2015).

However, the practical relevance of sLCA is currently very small. If compared with LCA, the level of methodological development, application, and harmonisation of sLCA is still in a preliminary stage and experience with product assessments focusing on social aspects is still limited. Especially the fact that decisions in an economic context are mainly reasoned by quantitative parameters inhibits the widespread implication of sLCA. In TORERO, the sLCA (Social Life Cycle Assessment) methodology is adapted to the specific challenges and framework conditions of the project (e.g. key social parameters and aspects) and will be done to identify and describe the most relevant social effects (e.g. labour practices and working conditions, regional corporate citizenship, product responsibility). The social sustainability will be assessed during the project at a district and regional level in the demonstration plant location.

Within the project, social impacts will be analysed quantitatively and qualitatively according to a checklist for different stakeholder categories (e.g. workers, local communities, society), different subcategories (e.g. health and safety, working conditions, equal opportunities) and related relevant indicators. A matrix that has been already elaborated will be applied to identify social "hot spots" and the options for reducing the potential negative impacts and risks through different measures. Finally, the elements of the matrix are checked according to their relevance in the different production steps for an initial qualitative analysis.

As a first step, the product's life cycle has been identified and analysed, comparing the "traditional" production of steel to the new an innovative process where waste wood is used as a feedstock and ethanol is fermented out of CO from the use of bio-coal in the blast furnace.

As the steel company involved in this project has started a CSR program some years ago and has reported on their CSR activities on a regular basis since, the data from the last report is taken as a starting point for the development of a framework for sLCA: a meeting with the CSR department of the company which is involved in the project, has already taken place and data were provided.

For the assessment reference framework the scheme used in UNEP/SETAC (2009) was used and the stakeholder and impact categories were defined according to these scheme. At that very moment, the data from the CSR reports is being analysed and

gaps being identified. In a next meeting the identification of relevant stakeholders and social indicators will be discussed further.

### **Preliminary results and conclusions**

TORERO demonstrates for the first time a technology concept for creating and using torrefied wood for the production of bioethanol, fully integrated in a large-scale, industrially functional steel mill. The installation of the new process will probably not be completed within the next year but preliminary results on the set-up of the sLCA in this special context will be available at the time of the conference in September 2018.

### **Acknowledgement**

The work is part of the project "TORERO (TORefying wood with Ethanol as a Renewable Output) large-scale demonstration". The project receives funding from the European Union Horizon 2020 program. Torero relates to work programme topic LCE-19-2016-2017 "Demonstration of the most promising advanced biofuel pathways".

### **References**

- Joint Research Centre, Social Life Cycle Assessment. State of the Art and Challenges for supporting product policies, Joint Research Centre, Italy, 2015
- World Steel Association: Sustainable Steel. Policy and Indicators 2015, Belgium 2015
- World Steel Association: World Steel in Belgium Figures, 2016
- Benoit and Mazijn, 2009. UNEP/SETAC: Guidelines for Social Life Cycle Assessment of Products

# Social performance evaluation of an artisanal apparel brand in Peru using Social LCA

Juan David Villegas<sup>1</sup>, Franziska Eisfeldt<sup>2</sup>, Luis Alejandro Taborda<sup>3</sup>,  
Carolina Chanis<sup>4</sup>

<sup>1</sup> SIS Group, Manizales (Colombia)

<sup>2</sup> SIS Group, Berlin (Germany)

<sup>3</sup> Universidad Nacional de Colombia/ SIS Group Palmira (Colombia)

<sup>4</sup> SIS Group, Toronto (Canada)

## Introduction

Fast fashion is a worldwide phenomenon of low-cost apparel mass production and instant consumption that mimics current high-cost luxury fashion trends. This model poses significant sustainability risks, due to the waste management problem caused by short life cycles, and poor labour and environmental conditions across the product chains. These problems are of even more concern due to pervasive opaqueness and chain segmentation. Against this background, consumers, investors and policy makers need robust tools to better inform their decisions. *Life cycle thinking* can provide a suitable framework to improve apparel industry's overall sustainability and transparency. Life cycle assessment (LCA) has been used to measure environmental impacts of textiles and apparel (Muthu, 2015), and can be applied to internal improvement processes, sustainable procurement, eco-design, and science-based consumer awareness and marketing tools<sup>1</sup>. Environmental labels relevant for the textile industry can require LCA information and consider environmental effects across the product chain from production of raw materials to waste management. Among these: the EU eco-label and the Nordic environmental label (Muthu, 2015). Notwithstanding these developments, social aspects of apparel value chains are still underreported and understudied. To fill this gap, Social LCA is a method in development to assess products and services, in terms of their potential positive and negative impacts along their life cycle. S-LCA methodological framework has seen some important developments in the last decade such as the release in 2009 of the UNEP/SETAC Guidelines for Social Life Cycle Assessment of Products (Benoît et al., 2010). Up-to-now, S-LCA has been scarcely applied to specific cases in the apparel sector (e.g. Lenzo et al., 2017). This work attempts to carry out an entire S-LCA including foreground and background processes by using case-specific data for the foreground system and generic data provided by the PSILCA database (Eisfeldt and Ciroth 2017) for background processes. The methodology provided by the Guidelines for S-LCA will be followed. Therefore, the ongoing work will be described according to the typical steps of LCA practice.

---

1 Ecolabels and environmental product declarations

## Definition of goal and scope

The goal of this work is to use S-LCA to assess the social performance of apparel products from a Peru-based brand. We will investigate the applicability of the existing methodological framework (i.e. the S-LCA Guidelines and a commercial database) in the evaluation of products of small-scale handicraft operations. We will also discuss the use of the results for marketing and/or as information tool for consumers ('social'-labelling). One of the roadblocks in this regard, is the difficulty of data acquisition across the entire product chain. In face of this, practitioners can be tempted to limit their analysis to the process parts from which they can obtain primary data. Some authors (Dreyer et al., 2006) have previously contested the applicability of S-LCA at the unit process level, recommending instead a "company-based" approach based only on site-specific data, that is closer to corporate social responsibility (CSR) reporting than to life cycle thinking. In contrast, Weidema (2005) does not recommend exclusion exclusively on grounds of primary information absence (i.e. lack of influence to obtain reliable data). He suggests that this approach can lead to an oversimplified analysis and misrepresentation of the product's life cycle. Instead, he recommends using averages (e.g. obtained from generic databases) to fill data gaps whenever a company cannot prove that its process performs above average. The UNEP/SETAC Guidelines focus on the product and are in line with E-LCA ISO Standards (ISO 14044, 2006). According to them, process chains in existing E-LCA models provide a starting point for the system scope in S-LCA. The guidelines propose the definition of an ideal system from which the actual system to be modelled can be refined in relation to the goal. Finally, the guidelines' suggestion is to leave the decision to the practitioner of which processes to model with site-specific data and which ones with generic data.

In our case, the ideal system is the complete product chain: cultivation and production of cotton and alpaca fleece, production of fibers and fabrics, apparel manufacturing, marketing and sales, distribution, use, final disposal and all other material, energy and services inputs (Figure 1). Based on personal interviews (see next section), we selected three products among the brand's best-sellers: a cotton-based sweatshirt, sweatpants made from French Terry (fabric for athletic use) and a bag from an alpaca blend with recycled leather appliances. Then, we excluded waste management and use phases, as the goal of the study deals with decisions at the consumption point. We will compare our system to a reference: "Generic apparel production in Peru, with equivalent functionality" (price, size and materials as reference flows). The functional unit will be a piece of the product sold to an US customer (main market of the operation). Finally, we will use specific site data for the manufacturing stage and other parts of the chain where the organization has direct control. For the remaining (e.g. fabric production), we will use secondary data. In this study, we are also testing the applicability of the database PSILCA v2.1 (Eisfeldt and Ciroth, 2017) to establish the background system's inventory of small-scale apparel product chains. As activity variable, PSILCA uses worker-hours related to 1 USD of sector or process output. This choice, according to the developers, is more straightforward for stakeholder category Workers, even though it is for the moment applied to all indicators. For this reason, our focus will be on this category. However, we are also including other stakeholder categories such as

Local society (local employment, cultural heritage<sup>2</sup>) and Consumers (transparency), due to their relevance to the goal of the study and the size of the operation. Further boundary refinements can be made at a later phase.

## Life Cycle Inventory Analysis

We interviewed (face-to-face) 4 female artisans from Huaycán (Ate district, Lima)<sup>3</sup> and the artisan's program managers from the NGO Light and Leadership Initiative (LLI). We used semi-structured questionnaires to enquire about working conditions and socio-economic context. We then selected the products of three artisans working full-time in the program (with steady income derived from their work in 2017)<sup>4</sup>. These products were among the best-sellers and were representative of the brand's materials and workmanship. All artisans work from home, where they combine their handiwork with household duties. We interviewed one of the artisans at her home/ workplace in one of the more vulnerable sectors of Huaycán<sup>5</sup> and privately interviewed the remaining at the NGO's offices in Huaycán. Artisans are paid per hour of work involved in each piece, at a rate of S/.5 (slightly higher than the minimum hourly wage in Perú<sup>6</sup>). They are reimbursed for materials, which, according to them, is not the usual practice. Before the program, some of them were housewives, due to the impossibility of combining family life with work, denying their households of additional income. Others, previously worked as seamstress in Gamarra (large commute times, conflicts with family life) or sold their produce to workshops there, at rates as low as S/.1<sup>7</sup>.

Additionally, the artisans and their families benefited from the educational program provided by the NGO and received feedback from international volunteer fashion designers. One challenge addressed here, is how to capture those benefits in our study because, presently, there is no applicable indicator in PSILCA. Consultants of PRÉ (Fontes et al., 2014) suggest the training and education sub category. Hence, one way could be to address the training benefits only in the foreground system. Instead, we considered the 2017 NGO's investment in the educational program. We divided this sum among the 127 women attending the workshops. The corrected artisans' hourly rate is then S/.5.57; 16% larger than the legal minimum and 5-times higher than the reported "sector" salary of other the seamstresses (see above). Finally, we asked questions about their work environment (safety and health issues, infrastructure), and their ideal household income. The gathered information still needs to be analysed.

2 This subcategory and its indicators are still not implemented in PSILCA. They will be treated in a separate paper.

3 There is a total of 7 artisans working for the NGO's program.

4 One of the artisans, only worked occasionally for the program due to uneven demand of their products.

5 We also accompanied her to Lima's Gamarra cluster, an urban textile center of wholesalers and retailers, to procure her materials.

6 S/. 4.8. Minimum wage in Peru is S/.850 per month (<http://gestion2.e3.pe/doc/0/0/1/3/8/138872.pdf>). We assumed a standard 8 hours working day and the legal 260 days working year (<http://www.mintra.gob.pe/contenidos/archivos/prodlab/D.Leg.%20713%20-%2008-11-91.pdf>)

7 Considering that materials are not reimbursed

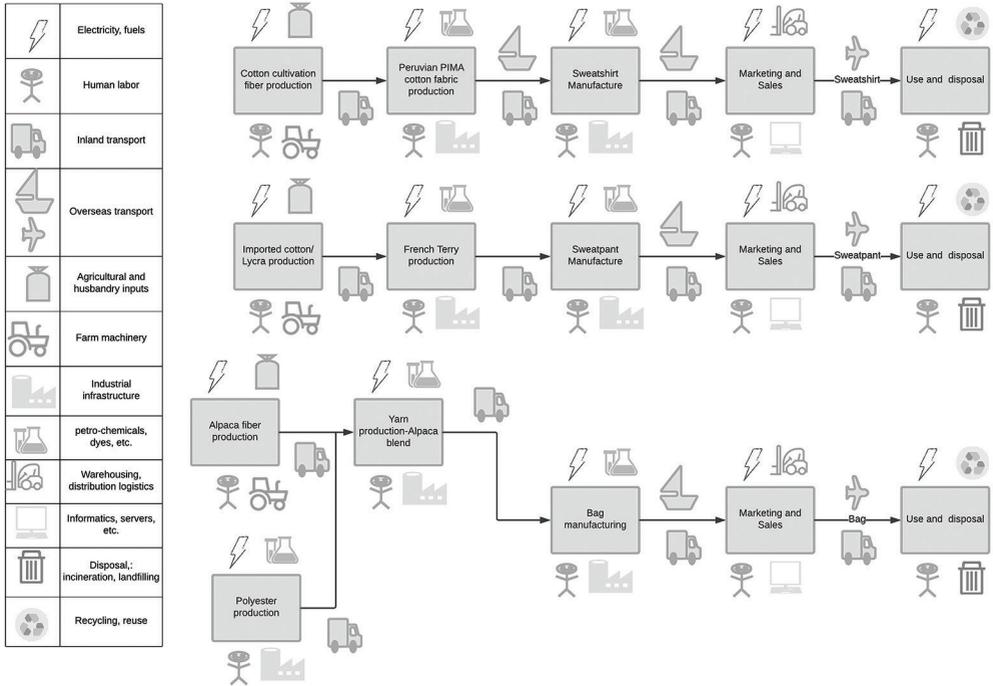


Figure 1: Ideal product life cycle of the three selected products

## Impact Assessment

For the risk and impact assessment, we followed the method and ranking system applied in PSILCA to ensure consistency between the foreground and background system. Table 1 presents a preliminary, non-exhaustive, risk assessment for indicators related to workers of the manufacturing stage, for an average of the three products. The *reference* column shows values of different comparable average products (see footnotes on Table 1) and the risks are assessed based on the evaluation scales used in PSILCA (Eisfeldt and Citroth 2017). To reflect the share, i.e. importance, of each process within the product system, worker hours will be calculated and used as the so-called activity variable (Norris, 2006). For the foreground processes, working time was either directly provided by the artisans in the interviews, or we calculate (an approximate value of) the working hours by dividing the product price by the hourly wage.

Subcategory	Indicator	Unit	Risk	Assessment	
				Case study	Reference product
<b>Child labour</b>	Children in employment, total	% of all children ages 7-14	Risk of child labour in the sector (process) <sup>8</sup>	No risk (0)	High risk (13.7)
<b>Forced labour</b>	Goods produced by forced labour	Y/N	Risk of forced labour in the sector (process) <sup>9</sup>	No risk (No)	No data (5)
<b>Fair salary</b>	Living wage, per month	USD <sub>iv</sub>	Risk that cost of living is high (ratio of living to minimum or industry wage) <sup>10</sup>	Medium to high risk (460 to 622)	
	Minimum (company) wage, per month	USD <sub>iv</sub> /USD <sub>min</sub>	Risk that salary is too low to permit a dignified life <sup>11</sup>	Medium risk (463 USD, 1.2 ratio)	Very high risk (300 USD, ratio > 1.8)
<b>Working time</b>	Hours of work per employee, per week	h	Risk of improper working hours <sup>12</sup>	Very high risk (72)	Very high risk (78)
<b>Discrimination</b>	Women in the sectoral (organization) labour force	ratio	Risk of women being underrepresented <sup>13</sup>	Very low risk (2.2)	Low risk (1.2)
	Gender wage gap	%	Risk of unequal wages.	No risk (0)	High risk (21%)

8 No child labour in the organization. Artisan's children benefit from NGO's program and all are in school. Most of child labour in Peru is rural and is rare in the manufacturing sector (National rate of participation in economic activities 26.4% in 2015, while the rate for urban children is 13.7%), we will use this as a conservative token even though the rate for manufacture and textiles should probably be lower than that (MTPE-OIT, 2016).

9 Artisans worked voluntarily. According to the ILAB database there is no forced good products in the garment sector in Peru, United States Department of Labor. <https://www.dol.gov/agencies/ilab> Therefore we gave the sector low risk the No data risk level as in PSILCA.

10 Depending on the assumption for living wage. When asked, artisans expressed an ideal salary around S/.2000. The lower value is the living wage as reported in <https://wageindicator.org/main/salary/living-wage/peru-living-wage-series-october-2017> (Standard family, two parents + 2 children, 1.8 parents working).

11 "Minimum wages can be used to evaluate the sector average or actually paid wage in a company" (Eisfeldt and Ciroth, 2017). Includes monetization of educational program. The hourly rate received by the artisans prior to their participation in the program was set as reference value. Indicator includes the monthly salary and the ratio of living salary to salary for the company and the sector.

12 Study case extracted from interviews. Values are similar for both scenarios (<http://larepublica.pe/economia/618165-la-jornada-de-trabajo-en-el-peru-es-en-promedio-de-13-horas>).

13 From ILOSTAT. Manufacture of wearing apparel (ISIC-Rev.4) (<https://www.ilo.org/ilostat>).

Table 1: Preliminary risk assessment for worker related indicators, Case study vs. Reference products

## Next steps

More categories and indicators will be evaluated for the foreground system based on literature and NGO reports, the generic information of the PSILCA database will be used for evaluating those processes where no specific information is available or necessary (especially background system). Results will be interpreted through scenario and sensitivity analysis. Finally, it will be concluded how the method of S-LCA and the use of a generic database can be applied on a specific textile product, and if it increases consumer transparency and social awareness. This ongoing study was made possible through volunteer work. Many thanks to the amazing women that shared their life stories with us.

## References

- Benoît, C., Mazijn, B., Valdivia, S., Sonnemann, G., and de Leeuw, B. (2010). Guidelines for social life cycle assessment of products (UNEP/Earthprint).
- Dreyer, L., Hauschild, M., and Schierbeck, J. (2006). A framework for social life cycle impact assessment (10 pp). *Int. J. Life Cycle Assess.* 11, 88–97.
- Eisfeldt, F., and Ciroth, A. (2017). PSILCA—A Product Social Impact Life Cycle Assessment database, Database version 2.1, Documentation, Version 3.
- Fontes, J., Bolhuis, A., Bogaers, K., Saling, P., Van Gelder, R., Traverso, M., Das Gupta, J., Morris, D., Bosch, H., and Woodyard, D. (2014). Handbook for product social impact assessment. Roundtable Prod. Soc. Metr.
- ISO 14044 (2006). Environmental management — Life cycle assessment — Requirements and guidelines.
- Lenzo, P., Traverso, M., Salomone, R., and Ioppolo, G. (2017). Social Life Cycle Assessment in the Textile Sector: An Italian Case Study. *Sustainability* 9, 2092.
- MTPE-OIT (2016). Magnitud y características del trabajo infantil en Perú - Informe 2015 - Análisis de la Encuesta Nacional de Hogares (ENAH) y de la Encuesta sobre Trabajo Infantil (ETI) / Organización Internacional del Trabajo; Servicio de Principios y derechos fundamentales en el trabajo (FUNDAMENTALS); Ministerio de Trabajo y Promoción del Empleo del Perú (MTPE) - Ginebra: OIT, 2016.
- Muthu, S.S. (2015). Handbook of life cycle assessment (LCA) of textiles and clothing (Woodhead Publishing).
- Norris, G. (2006). Social Impacts in Product Life Cycles - Towards Life Cycle Attribute Assessment. *Int. J. Life Cycle Assess.* 11, 97–104.
- Weidema, B.P. (2005). ISO 14044 also Applies to Social LCA. *Int. J. Life Cycle Assess.* 10, 381–381.

# Including social aspects in the sustainability management of organisations – Implications of the application of social life cycle assessment in the energy industry in Sweden

**Sebastian Welling, Michael Martin, Emma Strömberg**

*LCA and Environmental Management, IVL Swedish Environmental Research Institute, Stockholm (Sweden)*

## **Introduction**

Paradigms have changed and the social responsibility of organisations is no longer to only increase profits and gain money. As a consequence, stakeholders got more aware of the impacts organisations have on the world (Hutchins & Sutherland, 2008). Organisations are expected to carry out their activities in a socially responsible manner (Foolmaun & Ramjeeawon, 2013).

Social areas of concern are often closely linked to an organization's management of suppliers. Larger organisations are more likely to be able to set requirements on their suppliers and demand improvements within the social sphere (Hutchins & Sutherland, 2008). However, the lack and applicability of practical tools for social assessments impedes the follow up of these requirements (Sandin et al., 2011). The need for tools that help prioritize efforts for minimizing social impacts throughout the life cycle, are particularly pointed out by organisations (Hauschild et al., 2008).

Social life cycle assessment (S-LCA) is a tool that supports organisational efforts to manage and work with social sustainability issues by analysing social impacts from a life cycle perspective (Jørgensen et al., 2009; Benoit et al., 2010). The analysis helps to identify hotspots for the improvement of the social performance of organisations and their products (Hauschild et al., 2008). However, the development of the methodology for S-LCA is still at an early stage (Jørgensen, 2013) and more case studies are needed, especially related to the application of the method from an industry perspective (Sala et al., 2013).

In addition, external reviews, such as audits, certifications or declarations may be used to increase the transparency of the application of social assessment tools. The results of these reviews can be used in internal and external communication to show efforts and improvements in the field. Many stakeholders, including consumers, and governments benefit from that type of information (Norris, 2006).

## Swedish case study of S-LCA

In 2016, the Swedish energy supplier Vattenfall AB (2016) conducted a S-LCA for electricity from its Nordic wind farms. The S-LCA is based on the framework from UNEP/SETAC (2009), as proposed in a prior study by Welling (2013) and additions from the Roundtable for Product Social Metrics (Fontes, 2016). Relevant indicators for the assessment were identified via the Delphi method and aligned to the requirements of the communication format (Welling, 2013; Dalkey & Helmer, 1963). The results of the study contain both qualitative and quantitative information that were based on the indicators for sustainability reporting of the Global Reporting Initiative.

The results of the study were published externally as voluntary additional information of the environmental analysis for electricity from Nordic wind farms. Both results are publicly available in the form of an Environmental Product Declaration (EPD) in the International EPD® System.

The framework for the environmental analysis in the form of an LCA is described in international standards, such as the ISO 14040 and ISO 14044. Additional communication and calculation rules are set by the programme operators of EPDs and published in the programme instructions and product category rules (PCR). The PCR set among others requirements for the inclusion and communication of additional information. Within the product category electricity, social aspects may be reported as additional information of the LCA.

## Methods

This study conducts a comparative analysis of the communication format and methodological frameworks of the S-LCA and LCA used for Vattenfall's electricity from Nordic wind farms. The comparison of the methodological framework covers the definition and choice of the functional unit, system boundaries, allocation principles, data, and impact assessment. The requirements and use of third party verification is analysed and discussed. A central aspect for the comparison of the communication format is the requirements and compliance of standards and rules for the reporting format. The structure and layout of the communication format as well as the use and impact of qualitative and quantitative information is discussed.

## Results

The results of the study show significant differences in the methodology and reporting format for the LCA and S-LCA. As the base for both frameworks is a life cycle perspective and an analytical approach, the first step of both assessments is the definition of the goal and scope of the study. Part of this first step is the definition of the functional unit. Both frameworks use a functional unit, but the choice of the functional unit differs for the LCA (generated and distributed electricity) and S-LCA (number/employee). Other aspects that are typically defined in the goal and scope definition are the definition of system boundaries and allocation rules. Initially, the same system is chosen for

both assessments. Due to the difference in the methodological approach, the chosen system boundaries are not consistent. The variations in the methodologies also explain the chosen allocation principles. The analysis, including gathering of information and data for the LCA is focusing on a process level and not as in S-LCA an organizational and more aggregated level. The lack of process specific data as well as the focus on more aggregated processes within S-LCA requires a separate approach for the data collection in the life cycle inventory phase. As compared to LCA, generic and process-specific data is usually not available for S-LCA, since social issues are often linked to the activities on an organizational level. The assessments use different databases and data collection methods.

One of the major methodological differences of both frameworks is found in the life cycle impact assessment. Within LCA, classification and characterization methods enable the presentation of results for selected impact categories, e.g. impact on climate change. Characterization of the results from the inventory analysis is not done for the S-LCA. The results are instead presented within the chosen stakeholder categories (workers, local community, and society). The lack of characterization methods for the S-LCA do not allow for further aggregation of the results.

An important part for the presentation of the results of the LCA in the form of an EPD is the third party verification, as required by the programme operator. Even though the PCR does not clearly state that additional information needs to be reviewed, Vattenfall chose to conduct a third party verification of the S-LCA. The rules for the reporting format of the LCA are defined in the PCR, including mandatory and optional elements of the declaration. These rules do not apply for the results of the S-LCA, which imply that the reporting format is less standardized and more flexible. Vattenfall follows the framework from UNEP/SETAC (2009) and the Global Reporting Initiative (2016) for the presentation of the results of their S-LCA. A common approach for the layout for the presentation of the results for both assessments is chosen, using a Eco- and Socio-profile.

## Conclusion

Different rules and standards in the reporting format impede the comparison of the results from the two reports and are a potential obstacle for the use of the results in other applications and sustainability management. Differences in aggregation levels for both the analysis and the presentation of the results are likely linked to the objectives of the assessments. In contrast to the LCA, the results of the S-LCA rather indicate potential social hotspots than to provide absolute figures for selected stakeholder and impact categories.

Despite methodological differences of the compared frameworks, the combined presentation and communication of the environmental and social performance of Vattenfall's products show that there are benefits from the combination of the frameworks. Basic principles such as a life cycle perspective and common approaches in the goal and scope definition facilitate the interpretation of the results from

both assessments. More case studies of communication efforts for the combined assessment of social and environmental impacts are needed though to understand the effects of using a combined approach of presenting the social and environmental performance. Further research on the application of a holistic assessment of social and environmental issues and the use of the results from this assessment in communication and sustainability management is needed to understand potential implications and benefits.

## References

- Benoît, C., Norris, G.A., Valdivia, S., Ciroth, A., Moberg, Å., Bos, U., Prakash, S., Ugaya, C., Beck, T., 2010. The guidelines for social life cycle assessment of products: just in time! In Curran, M.A., Klöpffer, W. (eds.): *Int J Life Cycle Assess* 15(2), 156-163.
- Dalkey, N.C., Helmer, O., 1963. An experimental application of the Delphi method to the use of experts. In Cachon, G.P. (ed.): *Management Science* 9(3), 458-467.
- Fontes, J., 2016. *Handbook for Product Social Impact Assessment*.
- Foolmaun, R.K., Ramjeeawon, T., 2013. Comparative life cycle assessment and social life cycle assessment of used polyethylene terephthalate (PET) bottles in Mauritius. In Curran, M.A., Klöpffer, W. (eds.): *Int J Life Cycle Assess* 18(1), 155-171.
- Global Reporting Initiative (GRI), 2016. GRI version 4.
- Hauschild, M.Z., Dreyer, L.C., Jørgensen, A., 2008. Assessing social impacts in a life cycle perspective - lessons learned. In CIRP (ed.): *CIRP Annals - Manufacturing Technology* 57, 21-24.
- Hutchins, M.J., Sutherland, J.W., 2008. An exploration of measures of social sustainability and their application to supply chain decisions. In Huisingsh, D. (ed.): *J Clean Prod* 16, 1688-1698.
- Jørgensen, A., Hauschild, M., Jørgensen, M., Wangel, A., 2009. Relevance and feasibility of social life cycle assessment from a company perspective. In Curran, M.A., Klöpffer, W. (eds.): *Int J Life Cycle Assess* 14(3), 204-214.
- Jørgensen, A., 2013. Social LCA—a way ahead?. In Curran, M.A., Klöpffer, W. (eds.): *Int J Life Cycle Assess* 18(2), 296-299.
- Norris, G., 2006. Social impacts in product life cycles: towards life cycle attribute assessments. In Curran, M.A., Klöpffer, W. (eds.): *Int J Life Cycle Assess* 11(1), 97-104.
- Sala, S., Farioli, F. & Zamagni, A. *Int J Life Cycle Assess* (2013) 18: 1686. <https://doi.org/10.1007/s11367-012-0509-5>
- Sandin, G., Peters, G., Pilgård, A., Svanström, M., Westin, M., 2011. Integrating Sustainability Considerations into Product Development: A Practical Tool for Prioritising Social Sustainability Indicators and Experiences from Real Case Application. In Finkbeiner, M. (eds.): *Towards Life Cycle Sustainability Management*, Dordrecht, Netherlands: Springer.
- UNEP/SETAC Life Cycle Initiative - Social LCA Project Group, Benoît, C. & Mazijn, B. (eds.), 2009. *Guidelines for Social Life Cycle Assessment of Products*.
- Vattenfall AB, 2016. *Environmental Product Declaration of Electricity from Vattenfall's Nordic Wind Farms - Social impacts from Wind power*.
- Welling, S., 2013. *Assessing the Social Performance of Products: Developing a Set of Indicators for Vattenfall AB connected to the International EPD® System*.

# Specific indicators and challenges for the assessment of life cycle impacts on intangible cultural heritage in South America

**Franziska Eisfeldt<sup>1</sup>, Juan David Villegas<sup>2</sup>, Carolina Chanis<sup>2</sup>, Luis Alejandro Taborda<sup>3</sup>**

<sup>1</sup> SIS Group, Berlin (Germany)

<sup>2</sup> SIS Group, Manizales (Colombia)

<sup>3</sup> UNAL, SIS Group, Palmira (Colombia)

## Abstract

Social risks and impacts of product life cycles depend largely on their societal and local context. A specific social characteristic of Latin American countries is their manifold cultures. Although upheld in many places, more and more traditions diminish or conflate with modern trends due to generalized processes. Especially in times of globalization though, cultures and traditions passed on by our ancestors should be preserved because they contribute to social cohesion, strengthen the cultural identity of communities and transmit valuable knowledge in many areas of life. This highly influences social sustainability.

While global interrelations and supply chains mainly contribute to the loss of local cultures, companies also have the power to actively promote especially intangible cultural heritage understood as e.g. customs, traditional crafts, oral traditions. Within this context, S-LCA seems to be an adequate method to assess the preservation of cultural heritage. Some indicators addressing this topic have already been defined by the UNEP/SETAC initiative on S-LCA. However, in very few studies this theme has been treated scientifically. Therefore, it is the aim of this study to investigate how S-LCA can contribute to measure impacts on cultural heritage along product life cycles. Furthermore, the case should identify specific theoretical and practical challenges regarding indicators, data collection and impact assessment in the field of intangible cultural heritage in a determined location.

The research question will be examined through an S-LCA case study with the Huaywasi artisan project for fashion production in Peru. The apparel industry has been selected because especially textile manufacturing has long traditions in many regions in South America. By means of stakeholder integration in all LCA phases (mainly by interviews), relevant indicators and approaches for impact assessment on cultural heritage will be identified and ways of tradition keeping will be examined. Literature research will complement and classify the findings.

Preserving cultural heritage will probably be identified as a multifaceted challenge influenced by many inherent but also external aspects. Indications determined by the study should include if and how traditional handicrafts are appreciated and protected. Moreover, economic aspects are probably of high relevance when traditional craftsmanship is the main source of income. Expected results of the study will include such indicators, challenges and first solutions to measure impacts on intangible cultural heritage.

Conclusions are expected to 1) refer to ways of addressing cultural heritage within S-LCA and 2) the method's effective contributions to preserve traditions in South American cultures.

## References

Benoit Norris, C., Traverso, M., Valdivia, S., Vickery-Niederman, G., Franze, J., Azuero, L., Ciroth, A., Mazijn, B., Aulisio, D. (2013). The Methodological Sheets for Sub-categories in Social Life Cycle Assessment (S-LCA). Pre-Publication version. Accessed 16 December 2017, <[https://www.lifecycleinitiative.org/wp-content/uploads/2013/11/S-LCA\\_methodological\\_sheets\\_11.11.13.pdf](https://www.lifecycleinitiative.org/wp-content/uploads/2013/11/S-LCA_methodological_sheets_11.11.13.pdf)>

UNESCO (United Nations Educational, Scientific and Cultural Organization), 2003. Convention for the Safeguarding of the Intangible Cultural Heritage. Accessed 16 December 2017, <<https://ich.unesco.org/en/convention>>

Huaywasi. Handmade in Peru. <<https://www.huaywasi.com/pages/about-us>>

# Integration between the territory indicator of VIVA project and the social LCA analysis for the wine sector

**Alessia Acampora<sup>1</sup>, Gabriella Arcese<sup>2</sup>, Roberto Merli<sup>1</sup>, Michele Preziosi<sup>1</sup>, Chiara Montauti<sup>1</sup>**

<sup>1</sup> Dept. of Business Studies, Roma Tre University (Italy)

<sup>2</sup> Ionian Dept. of Law, Economics and Environment, University of Bari Aldo Moro, Taranto (Italy)

## Introduction

The Social Life Cycle Assessment (hereafter SLCA) methodology follows the ISO 14040-44 standards available for environmental Life Cycle Assessment (hereafter LCA) in the absence of a specific standard, in addition to the general principles of the SLCA guideline (UNEP/SETAC, 2009). Social impacts are the result of positive or negative pressures on the endpoints. For the technical and methodological aspects, it preserves the setting of the environmental LCA analysis (Arcese et al., 2016). SLCA analysis is conducted through the identification of five stakeholder's categories: workers, consumers, local communities, companies and value chain actors and the relative impact sub-category. This methodology, being in its development phase, has to deal with several issues from SLCA comprehensiveness up to address its methodology lacks. An issue that often emerges is the double counting with respect to environmental variables, especially considering the integration between environmental and social LCA. This research aims to discuss this issue.

## Methodology

This study, starting from the work of Arcese et al. (2017), tries to integrate the proposed Social LCA for the wine sector with the territory indicator developed by the VIVA project. The objective of this study is the identification of the socio-economic impact subcategories and the consequent inventory indicators definition related to the five stakeholders' categories involved in the wine production. The main goal is to enlarge the comprehensiveness of the Arcese et al. (2017) analysis, opening up to the proposals of private initiatives.

The analysis has employed different typologies of materials for data collection, such as scholars' literature, reports and protocols. Initially, to identify the current state of academic insight with regard to Social LCA in the wine sector, a review of existing literature has been carried out. The first section analyses the four indicators proposed by the VIVA project. The data required for the analysis have been obtained by the program' protocol. The next section aims at integrating the indicators proposed by VIVA and the methodological framework proposed by Arcese (2017). Finally, the last

section provides discussion, implications and limitations of this study, proposing future lines of research.

### ***The VIVA project for sustainable wine and the territory indicator***

The most important and comprehensive Italian initiative is the 'VIVA Sustainable Wine' project, launched in 2011 by the Ministry for the Environment. This program aims to measure the sustainability performance of the vine-wine supply chain, starting from the calculation of carbon and water footprints. The assessment of sustainability in the Italian wine production is carried out through the use of indicators, tested and developed during the project. VIVA provides also a software that allows participating companies to quantify their environmental, social and economic impact, through a guided procedure of data input. The indicators, based on international standards and guidelines, cover the following areas: Water, Air, Vineyard and Territory. The object of the study is the territory indicator. This indicator is a socio-economic one, which must necessarily be satisfied in order to obtain the VIVA Sustainable Wine certification. The territory indicator is composed of 31 conditions that require qualitative information, obtained through the compilation of checklists, which are verified and validated during the audits. The indicator assesses business activity externalities, taking into account both the environment and the human community (employees, local communities, consumers and producers). A toolbox kit of qualitative and quantitative indicators measures the impact of the actions taken by the companies. The indicators focus the analysis on biodiversity, landscape, society and communities, in reference to the economic impact on the territory and on the local community. The guidelines are the "Sustainability Reporting Guidelines GRI G 3.1" and the ISO 26000 standard on Corporate Social Responsibility.

### ***The integration of Social LCA and the VIVA territory indicator***

Starting from the Social LCA framework for the wine sector proposed by Arcese et al. (2017), we confronted the indicators provided in this study with the territory indicator developed in the VIVA project. Table 1 shows the possible integration points and shortcomings of the two indicators set. Additionally, we have highlighted the indicators that seem to overlap with the Environmental LCA analysis creating a possible problem of double counting.

### ***Discussion and Conclusion***

The table shows the aspects covered by the two indicators on a quantitative basis. Results of the study confirmed the greater coverage of the social LCA indicator set. However, this set of indicators present double counting problems associated with the overlapping of social and environmental impacts assessment. To deepen this analysis

Step	Phase/ Activity	Stakeholder	Impact subcategory	Indicator definition					
				Social LCA	VIVA				
Agriculture	Supply	Value chain actors	Fair competition	X					
			Promoting CSR	X	X				
			Suppliers relationship	X					
	Vineyard Management	Workers		Working conditions	X	X			
				Fair salary	X				
				Health and safety	X	X			
				Social benefit	X				
				Equal opportunities	X				
				Professional growth	X	X			
		Local Community			Access to material	X	X		
					Access to immaterial resources	X			
					Safe and healthy leaving conditions	X	X		
					Local Employment	X	X		
					Delocalization and Migration	X			
					Community Engagement				
Society			Technology Development	X					
			Contribution to economic development	X	X				
Transformation	Supply	Value chain actors	Fair competition						
			Promoting CSR						
			Suppliers relationship						
	Production, Storage and Bottling	Workers		Working conditions					
				Fair salary					
				Health and safety		X			
				Social benefit					
				Equal opportunities	X				
				Professional growth		X			
	Local Community			Access to material resources	X				
				Local Employment	X				
				Safe and healthy leaving conditions	X	X			
	Society			Technology development	X				
				Contribution to economic development					
Access to Market	Managing Customers Orders	Workers	Working conditions						
			Fair salary						
			Professional Growth						
			Equal opportunities						
			Health and safety						
			Social benefit						
	Marketing and Selling	Society		Contribution to economic development					
				Workers		Working conditions			
						Fair salary			
		Equal opportunities							
		Health and safety							
		Social benefit							
		Professional Growth							
		Consumers			Transparency	X	X		
					Consumer privacy	X			
Local Community						Area reputation	X	X	
		Local Employment	X						
Society			Contribution to economic development		X				
			Usage	Consumption	Consumers	Health and safety	X	X	
						EoL	Society		Feedback mechanism
Transparency	X								
Impact on National Economy	X								
Consumers	End of Life Responsibility	X							
Workers				Working conditions					
				Fair salary					
				Equal opportunities					
				Health and safety					
				Social benefit					
Local Community				Professional Growth					
				Community Engagement	X				
				Society	Public commitment on sustainable issues	X			

Table1: Indicators of Social LCA in wine sector (Arcese et al., 2017) and VIVA territory indicators

a qualitative investigation of this set of indicators has been conducted. Results show that the socio-economic indicator proposed in the VIVA project is more calibrated on a business logic and developed specifically for the wine sector. The proposed indicators fully capture the critical social aspects of the wine sector. An integration between the two sets of indicators would be desirable. Further analyses could explore the different programs and initiatives, developed by the public and private sector, and try to integrate the indicators developed in the Social LCA analysis. The key consideration is to avoid double counting of the same environmental impacts in both social and physical terms. A primary motivation for the SLCA studies is the difficulty of aggregating data of different nature (qualitative and quantitative) for the entire life cycle and knowing that the environmental impact affects the social one. Double counting can be avoided by using the principle often used in Life cycle costing (LCC), e.g. by applying the "polluter pays principle" or by using information to make impacts visible at the time of decision, "internalizing the impact environment in the category of reference stakeholders" (Swarr et al 2011). This work helps to broaden the study and assessment of social impacts in the wine sector. Moreover, considering that the production and processing phases have been divided, this analysis can have positive repercussions also for other sectors (agriculture for example).

## References

- Swarr, T. E., Hunkeler, D., Klöpffer, W., Pesonen, H. L., Ciroth, A., Brent, A. C., & Pagan, R. (2011). Environmental life-cycle costing: a code of practice.
- Arcese, G., Lucchetti, M. C., & Massa, I. (2017). Modeling Social Life Cycle Assessment framework for the Italian wine sector. *Journal of Cleaner Production*, 140, 1027-1036.
- Arcese, G., Lucchetti, M. C., & Merli, R. (2013). Social life cycle assessment as a management tool: methodology for application in tourism. *Sustainability*, 5(8), 3275-3287.
- Ekenær-Petersen, E., & Finnveden, G. (2013). Potential hotspots identified by social LCA—part 1: a case study of a laptop computer. *The International Journal of Life Cycle Assessment*, 18(1), 127-143.
- VIVA Sustainable Wine, 2013. Product Specification of VIVA Sustainable Wine [WWW Document].

## Functional unit definition criteria in LCA and Social LCA: a discussion

**Ioannis Arzoumanidis, Manuela D'Eusanio, Andrea Raggi, Luigia Petti**

*Department of Economic Studies (DEc), University "G. d'Annunzio", Pescara (Italy)*

### **Abstract**

The definition of a Functional Unit (FU) is essential for building and modelling a product system in Life Cycle Assessment (LCA). A FU is a quantified description of the function of a product that serves as the reference basis for all calculations regarding impact assessment. A function may be based on different properties of the product under study, such as performance, aesthetics, technical quality, additional services, costs, etc. Whilst the FU definition is typical in LCA, this does not seem to be a common practice in Social Life Cycle Assessment (S-LCA), even though a FU definition is required. Unlike LCA, where quantitative data are mainly collected and processed, the assessment of the social and socio-economic impacts in S-LCA is based on a prevalence of qualitative and semi-quantitative data, a fact that renders the assessment to be somehow unfriendly. Moreover, whilst in LCA a product-oriented approach is typical, S-LCA tends to be a business-oriented methodology, where the emphasis of the social assessment lies on the behaviour of the organisations that are involved in the processes under study rather than on the function that is generated by a product. Indeed, several S-LCA case studies were found in the literature in which the FU is not discussed, let alone defined. The objective of this article is to contribute to analysing the criteria used for the definition of a FU in LCA and verifying whether these criteria can be suitable for S-LCA case studies applications. For this reason, a literature review was carried out on LCA in order to identify whether and how this issue has been tackled with so far. In addition, a second literature review was performed in order to verify how the FU has been introduced in the framework of the S-LCA methodology. Finally, an investigation of the analysis results in terms of the selected FU is proposed, in view of an ever-growing need for a combination of the LCA and S-LCA methodologies into a broader Life Cycle Sustainability Assessment (LCSA).

# Complementarity of social and environmental indicators and risks. An example of the mining industry

**Claudia Di Noi, Franziska Eisfeldt, Andreas Ciroth, Diana Bizarro**

*GreenDelta, Berlin (Germany)*

## **Introduction**

Assessing sustainability across life cycles is a complex issue which addresses environmental, social and economic dimensions. To get to an inclusive result, these dimensions need to be evaluated in combination. It is assumed that many environmental, social and economic aspects influence or depend on each other in ways that might not be evident at first glance. This work focuses on the first two aspects and aims at exploring how environmental and social Life Cycle Assessment (e- and s-LCA) complement and sometimes overlap with each other. The research question is applied to mining, a controversial industry with great economic potential and positive effects for local employment, but also risk of significant environmental impacts.

The common perception linked to the mining industry is negative from both social and environmental points of view. In social terms (Tuusjärvi 2013), mining can increase the employment rate in the region, gaining acceptance if local people are hired. On the other hand, according to the Finnish programme “Sustainable Acceptable Mining” (Wessman 2014, 2016), local communities may complain as community costs (infrastructure, day care, and housing for workers) increase. Furthermore, establishing a new mine site may cause the transfer of workforce from other sectors. The negative perception of mining is often linked to a risk of degradation of the quality of the local environment and feelings of insecurity. In particular, in Nordic Countries (e.g. Finland) the rapid growth of this sector has raised the fear of negative effects on other national business sectors, for instance nature tourism.

One of the main issues from an environmental point of view is referred to risks for water ecosystems (Northey 2016), under threat from heavy metal leakage, acid mine drainage (AMD), and impacts on climate change due to energy usage and related GHG emissions (Norgate 2010). Tailings and waste-rock management is another complex topic (European Commission 2007). Furthermore, it is interesting to define in what way environmental and social LCA complement each other regarding impacts, hotspots and risks when referring to a specific case study. Therefore, relevant aspects for environment and society were investigated within the ITERAMS (Integrated Mineral Technologies for More Sustainable Raw Material Supply) H 2020 project, which examines and validates a method to isolate process waters completely from the adjacent water systems, hence aiming at saving water and water pollution.

## Approach

A first screening was performed to identify relevant social and environmental indicators, potential impacts and hotspots. Therefore, representative mining processes related to three different countries (Finland, Portugal and South Africa) were analysed using the LCA software openLCA.

For the social screening, the PSILCA database was used, a transparent database containing comprehensive generic inventory information for almost 15,000 industry sectors and commodities in 189 countries. Social impacts can be assessed by 65 indicators addressing 19 different categories. Regarding these indicators, data is provided as risks by a scale ranging from no/ very low risk to very high risk. Furthermore, risks are quantified by a so-called activity variable, in this case worker hours. This measure allows to determine the relative significance of a process – and thus the associated risks – in a product system. Table 1 includes the parameters used to assign six levels of risk to the different social indicators. Characterization factors are applied for the calculation, increasing exponentially with the risk assessment. Results are finally expressed in medium risk hours.

For the environmental screening, ecoinvent and EXIOBASE were used as databases. Furthermore, different impact assessment methods were selected to obtain a comprehensive overview, namely ILCD, ReCiPe, CML baseline, Boulay et. al (2011) and EXIOBASE.

As for the choice of databases, the social one was selected for its potential to deliver results referred to major societal stakeholders (e.g. workers, local community and society); on the other side, environmental databases can offer impact assessment from more generic to very specific environmental issues, such as different water related impacts which are of major concern for ITERAMS. The following steps were followed for the first analysis of potential social and environmental risks and impacts, and their complementarity:

- Processes that best describe the mining activities and issues addressed by ITERAMS were selected in the mentioned databases.
- For the environmental screening, generic data from databases were analysed and compared with specific data given for ITERAMS. Afterwards, results were calculated to detect major contributing processes. In addition, differences and similarities in the impacts for the three countries subject of study were considered.
- For the social screening, potential social risks were first identified by those indicators assessed by high or very high risk, as reported by mining-related processes already available in the database. Afterwards, results were calculated for the selected processes and their pre-chains to assess overall impacts and detect social hotspots. A comparison with other industries in the country helped to identify especially relevant risks.

Social screening (PSILCA)				
Category	Subcategory	Indicator	Unit	Risk assessment
Local community	Access to material resources	Level of industrial water use (related to total withdrawal or to actual renewable resources)	y, %	risk: $0 \leq y < 10$ very low; $10 \leq y < 20$ low; $20 \leq y < 30$ medium; $30 \leq y < 40$ high; $40 \leq y$ very high
		Extraction of industrial and construction minerals	y, t/cap	risk: $0 \leq y < 2,5$ very low; $2,5 \leq y < 5$ low; $5 \leq y < 10$ medium; $10 \leq y < 15$ high; $15 \leq y$ very high
		Extraction of ores	y, t/cap	risk: $0 \leq y < 5$ very low; $5 \leq y < 10$ low; $10 \leq y < 15$ medium; $15 \leq y < 20$ high; $20 \leq y$ very high
	Safe and healthy living conditions	Certified environmental management systems (CEMs)	y, # per 10,000 employees	risk: $100 \leq y$ very; $10 \leq y < 100$ ; $1 \leq y < 10$ medium; $0,3 \leq y < 1$ high; $y < 0,3$ very high
		Pollution level of the country	y, Index value	risk: $y < 20$ very low; $20 \leq y < 40$ low; $40 \leq y < 60$ medium; $60 \leq y < 80$ high; $y > 80$ very high
		Contribution of sector to environmental load	y, kg, emission to air, total	risk: $0 \leq y < 1E-7$ very low; $1E-7 \leq y < 1E-6$ low; $1E-6 \leq y < 1E-5$ medium; $1E-5 \leq y < 5E-4$ high; $y > 5E-4$ very high
CO2 emissions total	y, kg, emission to air, total, CO2 equiv.	risk: $0 \leq y < 1E-5$ very low; $1E-5 \leq y < 1E-4$ low; $1E-4 \leq y < 1E-3$ medium; $1E-3 \leq y < 1E-2$ high; $y > 1E-2$ very high		
Environmental screening				
Database	Assessment method	Indicator	Unit	Complementarity with social LCA
ecoinvent	ILCD	Resource depletion - water	m <sup>3</sup>	Level of industrial water use
		Resource depletion - mineral, fossils and renewables	kg Sb eq.	Extraction of industrial and construction minerals
	ILCD, CML baseline, ReCiPe	Climate change	kg CO2 eq.	CO2 emissions total, Pollution level of the country
	ReCiPe	Water depletion	m <sup>3</sup>	Level of industrial water use
		Metal depletion	Kg Fe eq.	Extraction of ores
EXIO BASE	EXIOBASE	Water Consumption Blue	m <sup>3</sup>	Level of industrial water use
		Water Withdrawal Blue	m <sup>3</sup>	Level of industrial water use

Table 1: Main impact categories and indicators with potentially high consequences both on society and environment, addressed by social and environmental screening carried out in the context of ITERAMS.

- Together with the interpretation of results, these were also compared to each other. This way, complementarity and overlapping between social and environmental LCA aspects could be outlined. Secondary literature research helped to classify the results and put them into context, especially regarding local and geographic characteristics and relevant aspects inherent to the mining industry (e.g. water and ore extraction).

## Results and interpretation

Elaboration of results from this first LCA screening shows that there is a number of indicators that are relevant for their impacts on both society and environment. Arising from investigation of results, the table below contains the impact categories which provide a complementary view on the topic. This means that PSILCA reports on some common environmental indicators with social consequences. In the same way, environmental databases show how related problems can have an impact on society.

Results of the screening show the significance of water, and related indicators, for the mining activity. From an environmental point of view, water consumption and withdrawal clearly affect resource depletion. Furthermore, main driver for the mentioned impact categories is often electricity production for the three countries subject of study. On the other hand, results of the social screening reveal the significance of water use in mining by the indicator “level of industrial water use”. This indicator represents “the quantity of freshwater, desalinated water and treated wastewater withdrawn for industrial purposes” related to total water withdrawal and to total actual renewable water resources (Eisfeldt 2017). Therefore, it is possible to consider the importance of industrial water use compared to other water uses, but also the pressure on the renewable water resources. Furthermore, it is assumed that high levels of water withdrawal are associated with high levels of water pollution that are linked to different risks for local communities. These risks include health problems, destruction of local economic structures, for instance agricultural practices, and an overall deterioration of quality of life. According to the dependence on local water reserves, vulnerability of local communities can increase at various levels with the use of industrial water.

Water use in the mining sector is a macroscopic aspect where social and environmental assessment complement each other. However, there are more indicators where this interdependency is relevant (UNEP/SETAC 2013). For instance, Figure 1 shows results of a social and environmental screening for two mining-related sectors in Finland as available in two databases for social and environmental assessment.

Investigating these interdependencies, extraction of ores and fossil has an impact on resource depletion, limiting the access to material resources for local community because of commercial or industrial activities in their regions. Together with the environmental burden of destruction of material resources, this indicator is relevant as there are communities which base their life and economy on that and can then incur poverty, resettlements and local conflicts. Finally, CO<sub>2</sub> and other emissions can

Name	Impact result	Unit	Name	Impact result	Unit
▶  Contribution to environmental load	3.15028	CS med risk hours	▶  Water Withdrawal Blue - Total	0.01266	m3
▶  Social responsibility along the supply chain	2.63270	SR med risk hours	▶  Electricity by gas - RU	0.00310	m3
▶  Public sector corruption	2.20370	C med risk hours	▶  Electricity by nuclear - RU	0.00142	m3
▶  Certified environmental management system	1.91564	CMS med risk hours	▶  Water Withdrawal Blue - Manufacturing	0.00390	m3
▶  Minerals consumption	1.73390	MC med risk hours	▶  Plastics, basic - FI	0.00050	m3
▶  Industrial water depletion	1.69155	WU med risk hours	▶  Paper and paper products - FI	0.00047	m3
▶  Sanitation coverage	1.48178	SC med risk hours	▶  Chemicals nec - FI	0.00040	m3
▶  Trade unionism	1.42943	TU med risk hours	▶  Water Consumption Green - Agriculture	0.01621	m3
▶  Safety measures	1.31458	SM med risk hours	▶  Water Consumption Blue - Total	0.00554	m3
			▶  Water Withdrawal Blue - Electricity	0.00876	m3
			▶  Water Withdrawal Blue - Domestic	0.00000	m3

Figure 1: Results for different impact categories in PSILCA (left) and EXIOBASE (right) referred respectively to product system "Mining of metal ores" and "Copper ores and concentrates" in Finland.

also have consequences both on the environment, expressed by the impact category "Climate change", and on the society, affecting healthy living conditions of local populations.

As for a critical reflection on data used, it is important to assure transparency and traceability. Thus, data quality has been considered when identifying risks and interpreting results. Another possible reason of uncertainty might be linked to statistical data taken from several different sources (ILO 2017) to shape the information in databases. In this case, the risk of creating gaps or poor quality data should be taken into account.

## Conclusions and future developments

The work shows that several issues related to life cycle sustainability of the mining sector are of both social and environmental relevance. This means that social and environmental LCA complement and influence each other by triggering and reinforcing risks and impacts on mid-point categories. Further, a complementary analysis might also be instructive while detecting hotspots, e.g. those processes where environmental and social risks are strongly occurring, or associated with risks with high consequences for the other dimension. The latter investigation has not been carried out so far within the project. However, it seems to be an interesting point for future research.

However, it is difficult for social and environmental dimensions to overlap completely as they express different consequences and characters, although they can investigate the same problems. Therefore, it is useful to discuss if s-LCA and e-LCA should generally be conducted together, either in parallel or in a combined method. If this is not possible for any reason, it appears to be beneficial to complement e-LCA by an assessment of its social impacts because most environmental risks and emissions end up in impacts on societal stakeholders (although the emissions are triggered by human activities). The analysis results can be useful when decisions need to be taken for product design, benchmarking and planning. In the described project, they provide valuable input for the validation of the new water efficiency system.

## References

Eisfeldt, F., December 2017, PSILCA – A Product Social Impact Life Cycle Assessment database. Documentation, Accessed 13.12.2017, online available at <[http://www.openlca.org/wp-content/uploads/2017/12/PSILCA\\_documentation\\_update\\_PSILCA\\_v2\\_final.pdf](http://www.openlca.org/wp-content/uploads/2017/12/PSILCA_documentation_update_PSILCA_v2_final.pdf)>

European Commission, 2007, Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities.

ILO (2017) Quick guide on sources and uses of labour statistics. Geneva, Switzerland. ISBN: 978-92-2-130119-6

ITERAMS: Integrated Mineral Technologies for More Sustainable Raw Material Supply, Accessed 12.12.2017, <<http://www.iterams.eu/>>.

Norgate, T., Haque, N., 2010, Energy and greenhouse gas impacts of mining and mineral processing operations, *Journal of Cleaner Production* 18, pp. 266–274.

Northey, S., Mudd, G., 2016, Water footprinting and mining: Where are the limitations and opportunities? *Journal of Cleaner Production* 135, pp. 1098-1116.

Tuusjärvi, M., 2013, From a mine to you – Sustainability of the Finnish mining sector in the context of global supply chains of metals, Department of Geosciences and Geography A23, Helsinki.

UNEP/SETAC Life Cycle Initiative (2013): The methodological sheets for subcategories in social life cycle assessment (S-LCA), Authors: Aulisio, D.; Azuero, L.; Benoit, C.; Ciroth, A.; Franze, J.; Mazijn, B.; Traverso, M.; Valdivia, S.; Vickery-Niederman, G., online available at [http://www.lifecycleinitiative.org/wp-content/uploads/2013/11/S-LCA\\_methodological\\_sheets\\_11.11.13.pdf](http://www.lifecycleinitiative.org/wp-content/uploads/2013/11/S-LCA_methodological_sheets_11.11.13.pdf).

Wessman, H., 20.4.2016, Tekes Green Mining Programme: Sustainable Acceptable Mining (SAM). Executive summary, VTT.

Wessman, H., Salmi, O., et al., 2014, Water and society: mutual challenges for eco-efficient and socially acceptable mining in Finland, Research paper for *Journal of Cleaner Production / Special volume for Mining*.

## S-LCA in agricultural systems – U.S. corn production as a case study

Markus Frank<sup>1</sup>, Thomas Laginess<sup>2</sup>, Jan Schöneboom<sup>3</sup>

<sup>1</sup> BASF SE – Crop Protection, Sustainability Assessment, Agricultural Center, Limburgerhof (Germany)

<sup>2</sup> BASF Corporation, Applied Sustainability, Wyandotte (USA)

<sup>3</sup> BASE SE, Applied Sustainability, Ludwigshafen (Germany)

### Abstract

Social parameters are not addressed specifically in the ISO LCA standards, and there are no other consensus standards that can be referenced to define the criteria for a social LCA. AgBalance™ represents an approach to create a social LCA framework through the identification and use of relevant factors associated with life cycle principles. Even though there are no industry standards available, the recommendations from the UNEP/SETAC working group [1] is a starting point. The social assessment in AgBalance™ is based on the SEEBALANCE® scheme for social LCA, which was developed in 2005 by the Universities of Karlsruhe and Jena, the Öko-Institut Freiburg e.V., and BASF respectively [2, 3]. In an AgBalance™ study, the social impacts are quantified, according to the functional unit, and aggregated for all up- and downstream life cycle segments [4]. During the development process, concrete targets for social sustainability for products and processes were derived. This was done through analysis of more than 60 published studies on the topic of social goals by various institutions. As a result, more than 700 goals and more than 3,200 indicators were systematically recorded, categorized and summarized. For AgBalance™, this set of social parameters has been extended and in parts modified, to address specific agricultural sustainability topics, e.g., access to land, the level of organization or international trade with agricultural products. These topics were initially identified through a stakeholder process in 2009 and 2010, organized by BASF, and were subsequently discussed with leading experts. Feedback from this process was then integrated into the development of these indicators.

### References

- [1] Benoît C., Mazijn, B. (eds) (2009) Guidelines for social life cycle assessment of products. UNEP/SETAC Task Force on the integration of social criteria into LCA. ISBN 978-92-807-3021-0
- [2] Kölsch D., Saling P., Kicherer A., Grosse-Sommer A., Schmidt I. (2008): How to measure social impacts? A socioeco-efficiency analysis by the SEEBALANCE® method. Int. J. Sustain. Dev. 11:1-23.

[3] Schmidt I., Meurer M., Saling P., Reuter W., Kicherer A., Gensch C.O. (2005): 'SEEBALANCE® managing sustainability of products and processes with the socio-eco-efficiency analysis by BASF, Greener Management International.

[4] Frank M., Schöneboom J., Gipmans M., Saling P. (2012): Holistic sustainability assessment of winter oilseed rape production using the AgBalance™ method – an example of 'sustainable intensification?', in: Corson, M.S., van der Werf, H.M.G. (eds.), Proceedings of the 8<sup>th</sup> International Conference on Life Cycle Assessment in the Agri-Food Sector (LCA Food 2012), 1-4 October 2012, Saint Malo, France. INRA, Rennes, France, p. 58-64.

# Integrating odor management tools in Social Life Assessment in rural area: preliminary study

**Angela Trivino, Stéphane Godbout, Joahnn H. Palacios**

*Institut de Recherche et de Développement en agroenvironnement-IRDA, Québec, (Canada)*

## Introduction

The importance of the appropriate use of resources, the care of the environment, the eco-efficiency, the reduction of the greenhouse gases are parameters highly studied for sustainable development. However, sustainable development requires balanced integration of economic, social and environmental dimensions. The social dimension aims to satisfy human needs on issues of well-being, health, housing, consumption, education, employment, culture, etc. Through the last years, assessing social impacts is taking increasing interest.

Social life cycle assessment (S-LCA) is a methodology under continuous development. It is defined as a methodology that aims at assessing the potential positive and negative social impacts related to human beings affected by products or services throughout the life cycle, such as health, living conditions and labor rights of workers, consumers, local community and society (Chang et al., 2016). The literature is abundant concerning workers' health. Nevertheless, there is scarce information available to determine the social impacts of local community. The social impacts are usually evaluated by considering the unemployment rate, numbers of accidents, pollution level, drinking water coverage, sanitation coverage or complaints.

In most agricultural areas, cohabitation between agricultural producers and other residents is increasingly difficult. Many complaints from citizens are made in relation to the odors caused by animal livestock or spreading practices. Agricultural odors have their origin from several sources such as buildings, manure storage systems and manure application. Most of the complaints (70%) about odors is related to the manure spreading. Manure storage structure and livestock buildings are responsible of 20% and 10% of complaints respectively (Lemay et al., 2008).

There is no affordable indicator that represents the larger social issue in the rural area. Current indicators do not measure social impacts due to odors generated during agricultural activities. The objective is to evaluate the feasibility of using odor management tools as a method of assessing social impacts. The selected sector of application is the agricultural sector with spreading and livestock practice because it is the most important social problem in rural areas.

## Results and discussion

Over the years, the analysis and measurement of odors is taking more and more importance to get into a sustainable development. There are three reasons for assessing odors in the agricultural sector. In the first place, the growth of specialized farms with larger farm sizes has increased odor emissions (either in the number of animals or in the area per crop). Secondly, the cohabitation between the city, the nature and agriculture is increasing and generating more complaints related to odors. And finally, the public concerns about the environment protection, reduction of environmental impacts, the well-being, the clean and sustainable production are increasing.

Unpleasant odors are recognized as warning signs of hazards, pollution and quality of life menaces (Schiffman & Williams, 2005, Thu et al., 1997). Unpleasant odors could trigger adverse reactions in the body, change olfactory functions and cause various physiological reactions (irritation of the mucous membranes, eyes, skin and cause nausea, vomiting, headache, sleep disorders, etc.) and psychological disorders (anxiety, depression, anger, fatigue, mood disorders, stress, etc.) (Gingras et al., 2002a, Gingras et al., 2002b, Cole et al., 2000).

Mainly, the odor assessment tools can be divided into two methods: the methods of quantification and the methods of characterization of odors. Generally, the quantification parameters are frequency, intensity, duration, offensiveness and location (Nicell, 2009). Since odorous compounds have an olfactory threshold lower than their toxicity, the use of an odor perception approach in the agricultural sector is used rather than a toxicology approach for the quantification of odors.

The methods of characterization offer three ways for assessing the impacts of odours on local communities that can be used individually or in combination: 1) Source characterization and prediction of impacts with dispersion modelling; 2) Source characterization and direct measurements of impacts in the field; 3) Source characterization and survey for perception evaluation. The analysis of gas and odor concentrations is usually done using gas analyzers and dynamic olfactometry respectively.

As mentioned by Lemay et al. (2008), only social intervention does not significantly increase the population's perception of the agricultural sector. However, the development of new and more effective odor management strategies, technologies and techniques will improve coexistence and relationships between the community and farmers. For example, new spreading techniques such as the injection or incorporation of slurry have reduced odor emissions. The spreading technique which generated less odor was slurry incorporation and, in addition, it obtained a better social acceptability. According to Lemay et al. (2009), the implantation of a new practice improves the social acceptability when the local community is well informed about.

One of the main difficulties of odors measurement is related to the characterization of the perception of odors, which is a qualitative factor to quantify. However, there are normative measures adopted around the world to manage nuisances caused by odors. The regulations of several countries are based on the setback distances approach to reduce social conflicts and ensure harmonious cohabitation (Godbout et al., 2016).

To promote better social acceptability of agricultural activities, various strategies, techniques and technologies have been developed to reduce odors. However, there are only few data on the social impact in the local community when these are implemented.

## Conclusions and future developments

There are still many questions about integrating odors management tools into social impact analysis. However, odors seem to be an indicator that link agricultural activities to acceptability and well-being of community.

The results of the review highlight the relationship between social tensions and odors generated during agricultural activities (livestock production and manure spreading). The adoption of intensity and location odor assessment tools could be a solution to the challenge of social impact evaluation in the agricultural sector.

The management and reduction of odors bring many improvements such as the well-being of workers and neighbours and the productivity and quality of tasks. The combination of source characterization and survey perception allowed both the quantification of the emissions and the evaluation of their impact on the neighbours. This is probably one of the best approach for assessing social impact in rural areas. However, this way is very expensive and difficult to use under rural area context.

S-LCA is a methodology under continuous development. So far, the impacts of odours on the local community are barely covered in the literature and the S-LCA. To assess the social impacts in rural area, there is a clear need to evaluate and define an indicator, especially if it needs to be applied in engineering or research contexts. Even if more researches are needed, adopting odors assessments to S-LCA seems to be a practicable and feasible way to address the challenge in agriculture.

## References

- Chang, Y. J., Finkbeiner, M., & Krüger, J. 2016. Adapting ergonomic assessments to social life cycle assessment. *Procedia CIRP*, 40, 91-96.
- Cole, D., Todd, L., et Wing, S. 2000. Concentrated swine feeding operations and public health: a review of occupational and community health effects. *Environmental health perspectives*, 108(8), 685.
- Gingras, B., J-M. Leclerc, D. Bolduc, P. Chevalier, S. Fortin. 2002a. Les risques à la santé associée aux activités de production animale au Québec. Document de référence. Comité de santé

environnementale du Québec. Ministère de la Santé et des Services sociaux.

Gingras, B., R. Veillette, J. P. Vigneault et C. Côté. 2002b. Avis de santé publique relié aux émissions d'odeurs par l'usine d'équarrissage Alex Couture inc. De Charny au cours de l'été 2001. Service santé et environnement de la Direction de santé publique, de la planification et de l'évaluation de la régie régional de la santé et des services sociaux de Chaudière-Appalaches.

Godbout, S., Palacios, J., Sakka, S., Pelletier, F., Fournel, S., Philippe, F-X., 2016. Inventaire et comparaison à l'échelle mondiale des approches par distances séparatrices pour atténuer les nuisances olfactives en production porcine. JRP, Paris.

Guillam, M. T., Claude, C., Dewitte, J. D., Michel, V., & Ségala, C. 2007. Aérocontaminants et morbidité chez les éleveurs de volailles. Archives des Maladies Professionnelles et de l'Environnement, 68(2), 161-168.

Lemay, S.P., Belzile, A. Veillette, B. Jean, S. Godbout, F. Pelletier, C. Roy, D. Parent, L.D. Tamini, Y. Chen et F. Pouliot. 2009. Mesurer l'acceptabilité sociale en production porcine. Réduire les émissions d'odeurs, de gaz à effet de serre, d'ammoniac et bioaérosols. Fiche. 2 pages

Lemay, S.P., Belzile, A. Veillette, B. Jean, S. Godbout, F. Pelletier, C. Roy, D. Parent, L.D. Tamini, Y. Chen et F. Pouliot. 2008. Mesure de l'impact socioéconomique de pratiques d'épandage combinées à une activité d'information à l'aide d'un indicateur et d'une analyse économique. Rapport final. IRDA, UQAR, MAPAQ, Université Laval, Université du Manitoba, CDPQ. 53 pages.

Nicell, J. A. (2009). Assessment and regulation of odour impacts. Atmospheric Environment, 43(1), 196-206.

Schiffman, S.S. & C.M. Williams. 2005. Science of Odor as a Potential Health Issue. Journal of Environmental Quality 34: 129- 138.

Thu, K., K. Donham, R. Ziegenhorn, S. Reynold, P.S. Thorne, P. Subramanian, P. Whitten et J. Stookesberry. 1997. A Control Study of the Physical and Mental Health of Residents Living Near a Large-Scale Swine Operation. Journal of Agricultural safety and Health 3 (1): 13- 26.

## A global effort: 2019 S-LCA Guidelines

**Catherine Benoit Norris<sup>1</sup>, Sara Russo Garrido<sup>2</sup>, Marzia Traverso<sup>3</sup>, Elisabeth Ekener<sup>4</sup>, Sonia Valdivia<sup>5</sup>, Annekatrin Lehmann<sup>6</sup>, Matthias Finkbeiner<sup>6</sup>**

<sup>1</sup> *Harvard, NewEarth B (USA)*

<sup>2</sup> *CIRAIG, Université du Québec, Montréal (Canada)*

<sup>3</sup> *Institute of Sustainability in Civil Engineering (INaB), RWH Aachen University (Germany)*

<sup>4</sup> *KTH Royal Institute of Technology (Sweden)*

<sup>5</sup> *Pontificia Universidad Catolica del Peru & Leuphana University of Lüneburg (Peru)*

<sup>6</sup> *Chair of Sustainable Engineering (SEE), Technische Universität Berlin (Germany)*

### Introduction

Life Cycle Assessment (LCA) is a technique that was developed at the end of the sixties. Positioned within the field of industrial ecology, LCA is used to assess products' environmental impacts from the extraction of raw materials to the end of life. The field's arguably modest beginnings included developing methods for energy balance and for calculating the environmental impacts of packaging materials. The creation of an ISO standard (14040), the launch of an international scientific journal, the development of databases and specialized software all contributed to make of Life Cycle Assessment an inescapable phenomenon.

Even if the question of expanding the type of impacts taken into account in LCA was discussed in certain circles as early as 1990, it is only from the start of the new millennium that adding a social dimension to LCA became a prominent research topic. Three decades ago, the imperative of adding a social sustainability dimension to LCA was raised by the research community. A SETAC workshop that was held in 1993 and its subsequent report (Fava J. et al., 1993) was credited to represent one of the founding moments for Social LCA (UNEP-SETAC, 2009). The launch of the Life Cycle Initiative, acting under the umbrella of the United Nations Environment Programme and the Society of Environmental Toxicology and Chemistry, has solidified LCA status as a key tool supporting sustainable development. By strengthening its status, the Life Cycle Initiative contributed to accelerate LCA's topical expansion to include all three sustainable development pillars (environment – social – economic).

With a first journal article published in 1996 (O'Brien et al., 1996), a feasibility study conducted in 2006 (Grießhammer et al., 2006) and the first international Guidelines for Social LCA of products published in 2009 jointly by the United Nations Environment Programme and The Society of Environmental Toxicology and Chemistry (UNEP-SETAC, 2009), the field has grown in strength and number and has gathered a strong interest from businesses.

While the Guidelines for Social LCA of products and the methodological sheets have played a decisive role initiating the practice of Social LCA, the landscape has greatly evolved since. We have seen the publication of several handbooks and the proliferation of case studies and implementations. Databases for Social LCA were made available and applied, while impact assessment methods were created and tested. Moreover, an approach for social organizational LCA (SOLCA) was proposed to complement social LCA by adding the organizational perspective (Martínez-Blanco et al. 2015). The main reference still remains the Guidelines but it is evident that a revision is necessary to incorporate new methods, experiences and to better guide the users wishing to perform a Social LCA, social footprint assessment, human rights due diligence or SOLCA.

The revision will be done by considering and incorporating methodological advancements and practical experiences gained in the last 10 years. This includes work published by the Life Cycle Initiative in recent years (Hotspot guidance, Organizational LCA (O-LCA), life cycle sustainability assessment (LCSA)) and by others (eg. Pré Social Roundtable Handbook of Product Social Impact Assessment, the UN Guiding Principles on Business and Human Rights, the UN Sustainable Development Goals (SDGs) and the WBCSD Social Capital Protocol). This revision also includes the integration of SOLCA to broaden the scope of the current guidelines by specifying Social LCA also for organizations.

## **Development process and methodology**

Our project has two phases. The first phase consists in the revision of the 2009 SLCA Guidelines. The revision process aims for a publication and launch of the open source Guidelines planned for August 2019. The second phase consists in the road testing of the Guidelines, where companies and other organizations will engage and apply the updated Guidelines on a range of products or organizations and industrial sectors.

Phase I consists in a development process involving experts' input and stakeholders' engagement to produce an updated version of the 2009 Social LCA Guidelines – 10 years after. The resulting new open source Guidelines will be reflecting the current state-of-the-art and will serve to scale-up Social LCA and broaden its audience. The development of the updated Guidelines will consider and integrate 1) new methodological developments of the SLCA method (e.g. regarding impact assessment), 2) experiences gained from numerous case studies and 3) relevant frameworks published and experiences gained since 2009<sup>1</sup>. The development process will be inclusive and involve stakeholder consultations and continuous bridging with relevant initiatives and organizations including WBCSD, PRé Social Roundtable, Social and Labour Convergence project, World Resources Institute, Global Social Compliance Programme and ISEAL.

---

<sup>1</sup> The latter includes SOLCA, LCI Hotspots analysis, Roundtable of Product Social Metrics, WBCSD chemical sector SLCA guidance, WBCSD Social Capital Protocol, 10 YFP Consumer information social impact communication white paper and many others.

Phase one includes 5 stages. It comprises the development of first drafts in small, topic-based working groups composed of experts and practitioners/ users (e.g., topics include ‘goal and scope’, ‘impact assessment’, ‘inventory’, etc.). These drafts will then be internally reviewed by other experts and practitioners/ users involved in the Guidelines revision process. Next, dedicated resource(s) and the Steering Committee will work to develop an overall coherent draft, based on the first drafts produced. The Phase will also include 2 technical workshops, for face-to-face meetings and collaborative work, as well as 2 external consultations and a peer review. The major activities (steps/stages) to achieve the project objectives, and corresponding deliverables are summarized in the Figure below.

## Calendar Overview – Phase I

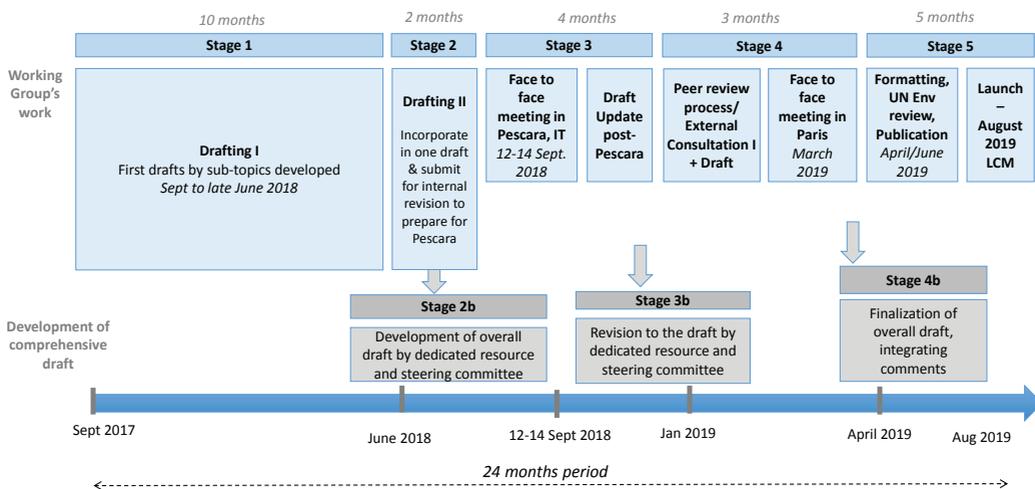


Figure 1: Timeline Phase I

Phase II will road test the new Guidelines in a variety of industries , involving a range of organizations and product types. The learnings and best practices resulting from the road testing will be captured in a subsequent companion resource to the Guidelines that will be published (as a document or web pages) at the end of the project. These resources will aim to support implementation (Q&A, advice, testimony, examples), and training material. The road-testing process is planned to last two years and will be organised in 3 stages including a call for road-testers, the implementation stage and the publication of the results. A detailed presentation of those stages (as in Figure 1 for Phase I) is omitted here, due to space constraints and the fact that this Phase is more distant in the future.

## **Main objectives and expected outcomes**

The main objectives and expected outcomes of the initiative are:

### **1) New Guidelines for practitioners and users**

The new Guidelines will support experts and non-experts that wish to carry a social LCA of products and/or organizations by providing them with all the information they need to conduct an assessment successfully.

Our objectives for the S-LCA Guidelines revision are to:

- Expand the audience of the Guidelines
- Focus on capability development
- Cover methodological developments since 2009
- Recognize a plurality of established approaches
- Integrate SOLCA to extend the focus from products to organization
- Position S-LCA and SOLCA in the current policy and tools context
- Develop the areas where minimum guidance prevails
- To support contribution to the SDGs.

### **2) Harmonization of S-LCA methods**

The revised Guidelines will serve as an up-to-date reference ensuring quality and trust in the S-LCA approach. It will provide an overview and will categorize S-LCA methods currently applied presenting new and established practitioners with the relevant methodology options available to them. The process will foster harmonization when appropriate but will also recognize a variety of approaches, explaining the differences, strengths and limitations between them.

### **3) Specification of SOLCA**

The revised Guidelines will integrate SOLCA as a complementing method offering clarifications about how to apply a social LCA at the organizational level. The conceptual framework of SOLCA with its current focus on scope and inventory will be completed, similarities and differences between S-LCA and SOLCA will be outlined and implementation pathways based on the organization's experience in social and organizational assessments will be described.

### **4) Scale-up of the scientific debate**

The revision of the Guidelines will also act as a catalyst for debates and advances in the field. We expect that the publication of the new Guidelines will boost the related scientific discussion among researchers and method developers and will foster further scientific development of S-LCA and SOLCA.

## Internal governance

The Guidelines review process was launched by the SLC Alliance Steering Committee composed of researchers and practitioners from 5 countries. It is very well connected with the S-LCA community, with nearly 50 researchers/practitioners from around the world already invested and contributing (see Table 1). We will conduct additional outreach to increase representation from Oceania, Asia and Africa in the process.

<b>36</b>	<b>Europe and North America</b>
8	Central and South America
4	Oceania, Asia and Africa

Table 1: Number of participants by region Q1 2018.

## Conclusions

As the last few years have shown, mindfulness and efforts to understand, measure and improve the social sustainability impacts of products life cycles and organizations' supply chains are radically increasing. Social LCA is poised to play a definitive role in public policy, corporate strategy and product sustainability impact communication in the next decade.

The update of the Social LCA Guidelines is fundamental to Social LCA' positioning as a tool of choice for the assessment and reporting of product and companies social and human rights impacts.

As an example, the revision and road testing of the Guidelines for S-LCA of products and organizations will directly support progress towards the SDGs in the following way:

**SDG 12: Responsible Consumption and Production:** By providing updated guidance supporting decision making processes for improving social sustainability impacts of production and consumption.

**SDG 8: Decent Work and Economic Growth:** By offering a practical framework to assess working conditions in product and organization' supply chains and life cycles, strengthening human and labour rights due diligence.

And indirectly by integrating impact categories and subcategories and impact assessment methods that addresses the following SDG goals in its assessment framework and pilots:

SDG 1: Poverty

SDG 2: Zero hunger

SDG 3: Good Health and Well Being

SDG 5: Gender Equality

SDG 10: Reduced inequalities

SDG 11: Sustainable Cities and Communities

SDG 16: Peace, Justice and Strong Institutions

As for any important endeavour, it takes a village! We count on the participation of experts, practitioners, companies, consultants and governments to make of these new Guidelines the practical tool they need.

## References

Fava J (Ed.), Consoli F, Denson R, Dickson K, Mohin T and Vigon, B (1993) A Conceptual Framework for Life-Cycle Impact Assessment. Workshop Report, Society for Environmental Toxicology and Chemistry and SETAC Foundation for Environmental Education, Inc., Pensacola, FL

Griebhammer, R, Benoit, C, Dreyer, L.C, Flysjö, A., Manhart, A., Mazijn, B, Méthot, A.L and Weidema, B (2006) Feasibility Study: Integration of social aspects into LCA. Öko-Institut, Freiburg

O'Brien M, Doig A, Clift R (1996) Social and Environmental Life Cycle Assessment (SELCA). *Int J LCA* 1 (4) 231-237

Martínez-Blanco J, Lehmann A, Chang Y-J and Finkbeiner, M et al.: Social organizational LCA (SOLCA) – a new approach for implementing social LCA, *International Journal of Life Cycle Assessment*, 2015, 18(8), pp.1581–1592

Roundtable for Product Social Metrics. Handbook for Product Social Impact Assessment. Accessed 23 January 2018, <https://product-social-impact-assessment.com>

UNEP-SETAC (Benoit, C. and Mazijn, B., editors). 2009. Guidelines for Social Life Cycle Assessment of Products. UNEP, 104 p.

United Nations. 2011. UN Guiding Principles on Business and Human Rights, Accessed 23 January 2018, [www.ohchr.org%2Fdocuments%2FPublications%2FGuidingPrinciplesBusinessHR\\_EN.pdf&usq=AOvVaw1eXHpXS2jxinTbBidRBbsn](http://www.ohchr.org%2Fdocuments%2FPublications%2FGuidingPrinciplesBusinessHR_EN.pdf&usq=AOvVaw1eXHpXS2jxinTbBidRBbsn)

World Business Council for Sustainable Development. 2016. Social Life Cycle Metrics for Chemical Products

A guideline by the chemical sector to assess and report on the social impact of chemical products, based on a life cycle approach. Accessed 23 January 2018, <https://www.wbcsd.org/Projects/Chemicals/Resources/Social-Life-Cycle-Metrics-for-Chemical-Products>

World Business Council for Sustainable Development. 2017. Social Capital Protocol. Accessed 23 January 2017, <http://www.wbcsd.org/Clusters/Social-Impact/Social-Capital-Protocol/Resources/Social-Capital-Protocol>

# Weighting and scoring in Social Life Cycle Assessment

**Breno Barros Telles do Carmo<sup>1</sup>, Sara Russo Garrido<sup>2</sup>, Gabriella Arcese<sup>3</sup>,  
Maria Claudia Lucchetti<sup>4</sup>**

<sup>1</sup> *Universidade Federal Rural do Semi Arido, Engineering Center, Mossoró, Rio Grande do Norte (Brazil)*

<sup>2</sup> *CIRAIG, Université du Québec, Montréal (Canada)*

<sup>3</sup> *Università degli Studi di Bari Aldo Moro, Bari (Italy)*

<sup>4</sup> *Roma Tre University, Dept. of Business Studies, Rome (Italy)*

## Abstract

Social impact evaluation is one of the cornerstones of products and services sustainability. Social Life Cycle Assessment (S-LCA hereafter) focuses on studying potential social impacts of products' life cycle. As it is a relatively new analytical approach, no globally shared application tools have been developed for it yet. Communicating S-LCA results to decision-makers in order to promote social sustainable decisions is a challenge because it involves the aggregation of companies' performances across impact categories through numerical variables based on value-choices. Currently, the weighting process (used for performance aggregation) considered for type I analysis in the literature presents some limits: lack of transparency, implicit choices, no standard weighting method and the failure to take account the uncertainty of these value choices. This paper aims to address these limits by proposing a standard approach to conduct the weighting process for type I S-LCA. It starts after characterization phase and comprises four stages: (i) impact level scoring, (ii) functional unit aggregation, (iii) weighting factors definition and (iv) performances aggregation across impact categories. This approach is able to consider determinist or stochastic numerical variables, depending on the inclusion or not of the uncertainty associated to people' value judgments. In terms of results, this paper presents an illustrative case study in order to exemplify how to conduct the weighting process in S-LCA. Considering the results, we identified some limits related to our approach: (i) depending on the subjects involved in S-LCA and the subcategory indicators considered for the assessment, it might be not possible defining standard weighting factors for all case studies; (ii) the type of uncertainty tackled on this approach is only associated with value choices – no other source of uncertainty is addressed and; (iii) the method used to assess qualitative social performances (scoring, check list or social hotspot database) can influence the aggregated social performance of product systems.

# Social Life Cycle Assessment for a Biorefinery Project

**Erasmus Cadena<sup>1</sup>, Francesco Christopher Rocca<sup>2</sup>, Jose A. Gutierrez<sup>1</sup>, Antonio Barona<sup>1</sup>, Ana Carvalho<sup>2</sup>**

<sup>1</sup> Vertech Group (France)

<sup>2</sup> CEG-IST, Instituto Superior Tecnico, University of Lisbon (Portugal)

## Introduction

The Social Life Cycle Assessment (SLCA) methodological approach, is used to evaluate the positive and negative social impacts of a product or a service throughout its life cycle. As biorefineries need to be evaluated for the three pillars of sustainability, the objective of this SLCA is to provide a preliminary overview of the less explored pillar, analyzing the potential social hotspots found along the biorefinery life-cycle, that should be taken into account when implementing the project. The scope is to promote improvement of social conditions and of the overall socio-economic performance for all its stakeholders (UNEP, 2009). According to Fontes et al. (2014), SLCA is designed to address three main objectives: i) make positive and negative impacts of products measurable and visible; ii) support decision-making and communication at product level, and iii) contribute to overall sustainability assessment. In the same line, this technique allows the identification of company's key issues and supports the implementation of improvement strategies to mitigate its most pressing negative impacts on social endpoints (Benoit et al., 2010; Fontes et al., 2014). The objective of this work is to provide quantitative and qualitative information on the potential benefits and risks that may affect stakeholders with the implementation of a glycerol biorefining project in The Netherlands.

## Methodology

The research methodology is constituted of four tasks:

- 1) State of the art and data collection - gather information on the biorefinery production process and market characteristics;
- 2) Stakeholders' assessment - identify and classify groups affected by the project to develop an involvement plan;
- 3) Indicators selection - select relevant metrics to evaluate and measure the social impact of the project's activities;
- 4) Social life cycle assessment - interpretation of the results and creation of guidelines for future improvements.

In the data collection, 25 documents were found and analyzed, including academic papers, reports from governmental research projects, private organizations' disclosures and methodological sheets. Then, a benchmark on biorefinery projects, which had undergone a SLCA was performed. 9 projects that had already disclosed material about their SLCA were identified, but it was concluded that social impacts have been measured only in a qualitative manner and no quantitative data are available for any of the past researches. Based on the framework developed by Simões et al. (2014) and Popovic et al. (2017), it was decided to propose a set of 95 indicators, which were judged more relevant for the Biorefinery project. The set of indicators has then been used as basis for the collection of measurable data. The stakeholder assessment started with identification of groups affected by the project. Based on the Choin and Wang (2009) methodology, the stakeholder categories were identified. Then, according to the positive and negative impacts that the biorefinery project would have on the different stakeholders, the groups were positioned in the power-interest grid (Ackerman & Eden, 2011). Based on this analysis, the stakeholder categories were linked to the various mid-points. Then, three semi-structured interviews with relevant experts in the biorefinery field were performed, in order to validate the assessment. Finally, the involvement plan was created to describe how the biorefinery should communicate with stakeholders during their activity. To measure the social impact of the project's activities, quantitative data from active biorefineries in the Netherlands could not be obtained. Therefore, it was decided to use annual/sustainability reports of companies, which can represent the life cycle stages, and proceed with assumptions. The data from 7 companies in the biodiesel and biochemical sector were used to identify the biorefinery hotspots. Three hotspots were found: at the downstream level, the High Turnover and the Freedom of Association and coverage by collective agreement were found and in the upstream stage the R&D investment should be improved.

## Results

From the data collection and the stakeholders' methodologies, the main stakeholders were identified: 1) Employees: people who directly or indirectly have a work relation with the biorefinery; 2) Customers: clients who purchase one or more final products manufactured in the biorefinery; 3) Shareholders: investors who finance the project and expect economic value generation; 4) Suppliers: organizations who provide the raw materials to be employed in the manufacturing processes; 5) Local communities: population living in the areas surrounding the biorefinery; 6) Authorities: public and private organizations with political and administrative power. These stakeholders were classified according to their power and interest in the project and the matrix presented in Figure 1 has been obtained and it has been validated through three semi-structured interviews.

As it can be seen from the location of the stakeholders in the matrix, three clusters with different characteristics can be identified.

- One group is constituted by employees and local communities, which have high interest in the project, because it can be a source of employment, it supports the

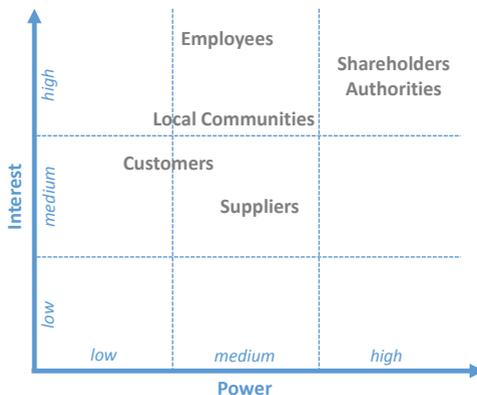


Figure 1: Power-Interest Matrix

economic development of the region and because these stakeholders are the most concerned by its impacts, but on the other hand have medium decisional power.

- The second set entails authorities and shareholders that possess high power and high interest. In fact, the public and private organizations decide whether or not to approve the project realization and regulate macro-economic trends through directives and regulations, but would receive limited direct benefits when compared to individuals. On the other side, shareholders strongly influence the Biorefinery output with their financial investment and, at the same time, are concerned with the economic performance of the project along time.
- The third cluster includes the customers and the suppliers that have mid power and interest. This group should be monitored to guarantee that raw materials are efficiently sourced and final products are sold on the market. However, in this initial stage of the project these stakeholders do not represent the key players on which efforts should be placed.

Shareholders and authorities are the most relevant and influent stakeholders for the biorefinery project, because they will strongly influence the biorefinery system; however, employees and local communities will be mostly affected by the biorefinery project. The stakeholders were then assessed through a set of social mid-point (Figure 2).

From Figure 2, it was possible to conclude:

- The biorefinery system will create important employment opportunities, which can be verified in Figure 2, by the value of the employment Mid-Point (88%, high reliability). This aspect is a value added of the biorefinery project, since it can improve the stakeholders' image when installing the biorefinery in the Netherlands.

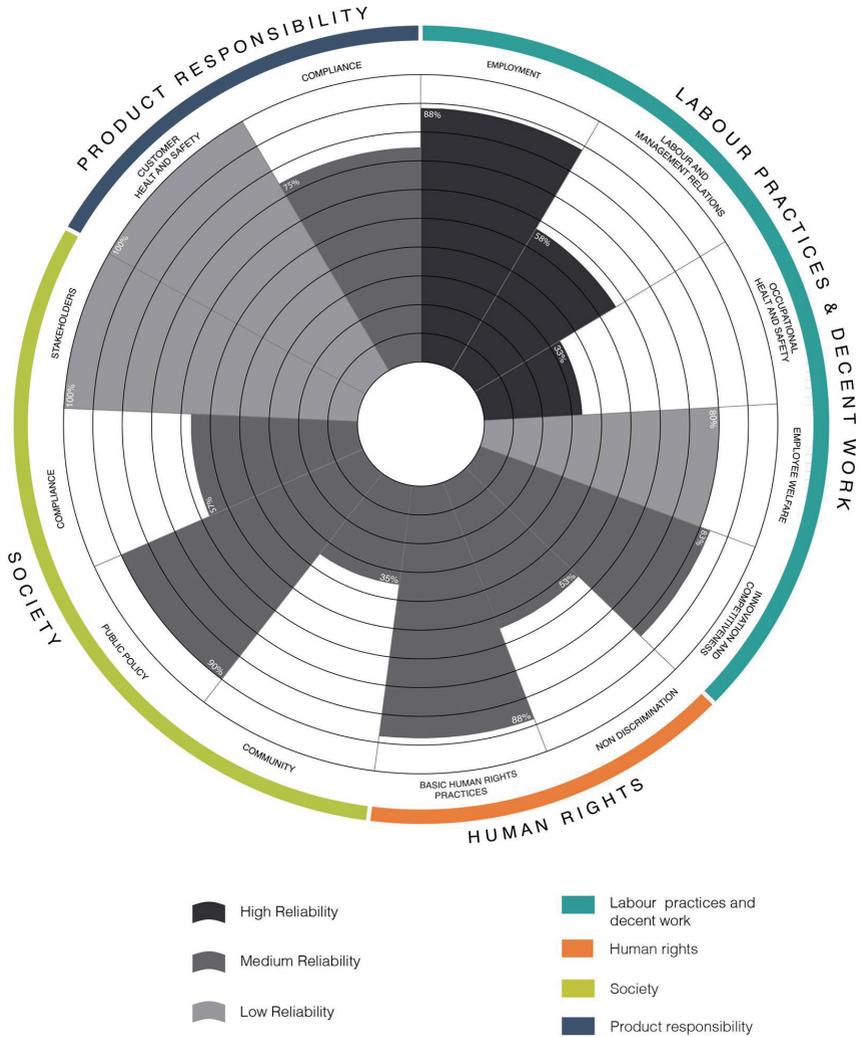


Figure 2: Mid-Point results

- The labor and management relations, obtained a value of 58% with high reliability and are therefore expected to be good in this system.
- The occupational health and safety conditions of the working environment were found to be only 33% (high reliability). This value shows that some health and safety issues might occur.
- The employee welfare shows a good performance (80%). However, this mid-point was calculated based on few data. Since there are very limited practices described for this system regarding employees welfare; it is important that biorefinery project develops different ways on ensuring the compliance and promotion of these aspects. The biorefinery system should guarantee that expenditures for social security, pensions and employees welfare are aligned, or above, the market average. A high satisfaction level of the workforce reduces turnover rate and increases productivity.
- Innovation and competitiveness are expected to be particularly relevant for the biorefinery (83%, medium reliability, Figure 2).
- Non-discrimination practices in the Biorefinery system are expected to be slightly above the average of the sample (53% with medium reliability; Figure 2). The Mid-Point could be improved by hiring younger employees that would reduce that average employees' age and increasing the number of women workers to better balance the gender ratio.
- The biorefinery system is likely to guarantee good basic human rights practices (88%; Figure 2 with medium reliability).
- Investments for local communities (35%, medium reliability; Figure 2) show a hotspot in the system that requires further improvement. It was possible to verify that investments for local communities should be improved to have a greater acceptance from the society and also in order to improve the social responsibility actions of the biorefinery system. Events that promote the contact with the community and actions that aid the development of the local communities should be considered in the implementation plan of biorefinery. In particular, a closer involvement of the biorefinery with social institutions and a more frequent interaction with local organizations would positively influence the project output.
- The public policy mid-point presents a value of 90% with medium reliability (see Figure 2). This seems to be a strong point in the biorefinery project.
- The customer health and safety mid-point has low reliability (Figure 2). Despite the good performance presented in this work, research should be done, when implementing the biorefinery system in order to ensure the safety of the consumers.
- Compliance of the product shows a value of 75% with medium reliability (Figure 2). The studied biorefinery approach has the potential of follow good risk management actions regarding the final product, ensuring in this way a good social performance among stakeholders.

## Conclusions

As for the GRAIL system real data is not yet available, the conclusions derived from this work are a forecast of future social impact and should be used as guidelines for forthcoming actions. From the analysis, three potential hotspots were identified: Occupational Health and Safety (H&S), Local Community and Compliance. To face the above listed issues, the following actions are recommended: increase employees' training to support the implementation of H&S measures, strengthen collaboration and investments in local development initiative, and improve the label certification of the product. Finally, two future research directions are suggested: the extension of the boundaries of the system to more upstream stages of the life-cycle and the execution of a comparative analysis between the GRAIL biorefinery and a reference systems.

## References

- Ackerman and Eden (2011). *Strategic Management of Stakeholders: Theory and Practice*. Elsevier Ltd.
- Benoît C., Norris G., Valdivia S., Ciroth A., (2010). The guidelines for social life cycle assessment of products: just in time! *Int J Life Cycle Assess* 15:156–163.
- Cameron, B. (Minister for Corrections, Victoria) (2007). Construction begins on high security unit, media release, Victoria, 28 March, Accessed 16 April 2007, <<http://www.dpc.vic.gov.au>>.
- Cater-Steel, A, Toleman, M, Kissell, B, Chown, R, (2006). ICT governance - radical restructure, in: Jones, A, Smith, AR (Eds.), *IT Governance International Conference*, Auckland, New Zealand, 13-15 Nov.
- Choin and Wang (2009), Stakeholder relations and the persistence of corporate financial performance, *Strategic Management Journal*, 30 (8): 895–907.
- Fontes, J., Gaasbeek, A., Goedkoop, M. & Evitts, S., (2014). *Handbook for Product Social Impact Assessment*, Amersfoort: Pre-Consultants.
- Hatch, JA (2002), *Doing qualitative research in education settings*, State University of New York, Albany.
- Peirson, G, Brown, R, Easton, S, Howard, P & Pinder, S (2006), *Business finance*, 9th edn, McGraw-Hill, North Ryde, NSW.
- Popovic, T., Kraslawski, A., Barbosa Póvoa, A., Carvalho, A., (2017) Quantitative indicators for social sustainability assessment of society and product responsibility aspects in supply chains, *Industrial Ecology- Submitted*.
- Simões, M., Carvalho, A., Lucas de Freitas, C., Barbosa-Póvoa, A.P. (2014) "Social Life Cycle Assessment- Standardisation of mid-point impact categories"- 4th LCA business Conference.
- UNEP SETAC, (2009). *Guidelines for Social Life Cycle Assessment of Products*, United Nations Environment Programme.
- Van der Geer, J, Hanraads, JAJ, Lupton, RA, (2010). The art of writing a scientific article. *J. Sci. Commun.* 163, 51–59.

## S- LCA based social sustainability tool for companies

**Anu Reinikainen<sup>1</sup>, Karetta Timonen<sup>1</sup>, Sirpa Kurppa<sup>2</sup>**

<sup>1</sup> Natural Resources Institute Finland (Luke), Espoo, Finland

<sup>2</sup> Natural Resources Institute Finland (Luke), Jokioinen, Finland

### Introduction

There is a need for shift towards more sustainable society. Sustainability Development Goals (SDGs) is a set of seventeen “Global Goals” with 169 targets within them (United Nations 2015). There is still a big disconnect between awareness of the SDGs and real corporate action. Companies need to take into consideration the ecological, social and economic aspects of their actions. Companies should develop a better understanding of their potential sustainability impact and opportunities in order to integrate sustainability into core strategy (Jørgensen et al., 2008; Smith & Barling 2014). Integrating SDGs inside a social impact assessment methodology framework with industry relevant social indicators is a way to reveal factors as a way in meeting these goals and therefore helping the company’s decision making process (actions and means) in meeting these SDGs.

S-LCA (Social LCA) is one impact assessment methodology to assess the social and socio-economic impacts of all life-cycle stages from cradle to grave, looking at the complete life-cycle of a product. Inside the S-LCA are working different social impact categories and indicators and factors inside them. S-LCA is defined in the work of UNEP-SETAC (2009) as "a systematic process using best available science to collect best available data on and report about social impacts (positive and negative)." (Benoit et al 2010). According to the UNEP/SETAC life cycle initiative, generic industry average data may be acceptable for use depending on the goal and scope of the study.

In this study a comprehensive S-LCA method framework management tool is to create a framework for social impact evaluation and also indicate the connection to relevant SDGs. The base of this framework and working sheet for S-LCA is in line with the UNEP/SETAC framework. Based on this we have categorized preliminary social indicators and selected the relevant stakeholders. This management tool will make the framework usable for companies when addressing and utilizing social sustainability issues in the business and production processes and measuring social impacts and their connection to global sustainability goals hence the companies are lacking relevant tools to manage social sustainability in the food sector. It reveals the benefits of utilizing social indicator results in companies’ business management for external communication and marketing but also as a tool for companies’ internal development.

Further step is to utilize this framework as a base for modelling S-LCA case study assessments. The S-LCA method is utilized in two side stream processes. The goal is to compare different kinds of side stream based plant protein production processes, explore the production processes and provide an assessment of the social impacts (positive and negative) of the process. This will allow comparisons between the processes and provide the necessary information needed in the decision making process for the companies who utilize the plant proteins in their production processes. The following step is to model the process and assess the indicators with the help PSILCA database.

In this study the S-LCA is implemented following the steps of LCA (which is also conducted in the study): goal and scope definition, inventory analysis and impact assessment. The defined production system was identified based on the LCA flow chart, followed by identification of relevant stakeholders and assessment categories and indicators. The data was collected by utilizing PSILCA database and exploring literature of existing S-LCA studies. We utilize the generic data as a basis for the assessment. The generic data has advantages over using site specific data in relation to practicality, although many authors behind the SLCA approaches claim that reasonable accuracy can only be gained through the use of site specific data. (Jørgensen et al. 2008). The quality of site specific data is very dependent on the auditing approach and, therefore, not necessarily of high accuracy, and that generic data might be designed to take into account the location, sector, size and maybe ownership of a company and thereby in some cases give a reasonable impression of the social impacts that can be expected from the company performing the assessed process. The study will be finished in the spring of 2018.

## References

- Benoît, C, Norris, G.A, Valdivia, S, Citroth, A, Moberg, A, Bos, U, Prakash, S, Ugaya, C, T. Beck, T, 2010. The guidelines for social life cycle assessment of products: just in time! *Int. J. Life Cycle Assess.*, 15 (2010), pp. 156-163
- Jørgensen, A, Le Bocq, A, Nazarkina, L, Hauschild, M, 2008. Methodologies for Social Life Cycle Assessment. *International Journal of Life Cycle Assessment, The (Int.J.LCA)*, 13 (2). 96-103. ISSN 0948-3349
- Barling, D, Smith, J, 2014. Social impacts and life cycle assessment: proposals for methodological development for SMEs in the European food and drink sector. *International Journal of Life Cycle Assessment*, 19(4), pp. 944-949. Doi: 10.1007/s11367-013-0691-0
- United Nations 2015. Sustainable development goals. Available from the internet: <http://www.un.org/sustainabledevelopment/>
- UNEP-SETAC. 2009. Guidelines for social life cycle assessment of products. Available from the internet: [http://www.unep.fr/shared/publications/pdf/dtix1164xpa-guidelines\\_slca.pdf](http://www.unep.fr/shared/publications/pdf/dtix1164xpa-guidelines_slca.pdf)

## Generation, calculation and interpretation of social impacts with the Social Analysis of SEEBalance®

**Peter Saling, Ana Alba Perez, Peter Kölsch, Thomas Gruenenwald**

*BASF SE, CDS/S – Ludwigshafen (Germany)*

### **Abstract**

The Social Analysis implemented in the SEEBalance® calculates results from Social LCA and from a specific Social Hotspot Assessment. Both approaches generate, calculate and interpret the social impacts from different perspectives. Different levels and approaches of data generation and calculation are used to come to conclusions on the social performance of product alternatives, fulfilling the same functional unit. The close link to the environmental LCA enables practitioners a holistic view on sustainability aspects supporting decision-making processes.

Processes and decision trees to harmonize the generation of coherent results were developed and will support the data generation process. Different levels of interpretation of findings to overall results support and harmonize the interpretation of results significantly.

Measuring sustainability is an important prerequisite for making strategic decisions. BASF has developed several instruments to measure sustainability whereby the utilization of each method depends on the concrete purpose or issue in question. The new Social Analysis will contribute by assessing social impacts along the value chain to this setup.

# Social life cycle assessment of rural cassava starch factories in Cauca-Colombia in the post-conflict

**Luis A. Taborda A.<sup>1</sup>, Thierry Tran<sup>2</sup>, Dominic Dufour<sup>3</sup>, Leonor Patricia Güereca<sup>4</sup>, Franziska Eisfeldt<sup>5</sup>**

<sup>1</sup> UNAL (Colombia)

<sup>2</sup> CIRAD (Colombia)

<sup>3</sup> CIRAD (France)

<sup>4</sup> UNAM (Mexico)

<sup>5</sup> SIS-Group (Germany)

## Introduction

The Cauca department has been one of the regions highly affected by the armed conflict in Colombia. The UN is currently receiving weapons from the subversives after signing the peace agreement with the Colombian government. Despite its turbulent past, Cauca has become the region that produces most of the starch consumed and processed in Colombia. The cassava starch agro-industry including the cultivation of the cassava plant is one of the most important economic activities, providing professional opportunities for the local communities and the former subversives/rebels.

To fully analyze this sector regarding social and economic opportunities as well as risks, and to promote the industry appropriately, socio-economic studies need to be carried out. While former studies focused mainly on the workers of the cassava starch production (CSP) (Sandoval & Ruiz, 2005), new analyses should include other stakeholders, as local communities, civil societies etc. as well. S-LCA seems to be an appropriate method to assess the overall and individual impacts – positive and negative ones – of the starch production chain on a broad set of stakeholders. This holistic and integral perspective can provide a basis to evaluate the economic development of Cauca after the armed conflicts.

UNEP-SETAC (2009) published general guidelines for the S-LCA implementation, which is the benchmark for addressing the research. However, the methodological perspective in which this guide was developed excludes realities of cultural context and social characteristics of rural areas to be investigated. Therefore, it is necessary that S-LCA includes indicators that objectively reflect sociopolitical, economic, environmental and cultural realities of the region that was studied.

The results of this research project will be useful for the Colombian authorities to take decisions regarding the economic and social benefits that may be received by hundreds of ex-guerrillas. Further, this work should contribute to S-LCA combining

specific foreground data and generic background data from databases. The study provides an example of how to perform a S-LCA in a specific rural context with inherent local considerations, extended by generic data from international industries.

## Methods

To perform the S-LCA in this work, different categories addressing the stakeholders: workers, society, value chain actors, and local communities were selected. According to the UNEP/SETAC guidelines and based on the PSILCA database (Ciroth, Eisfeldt 2017), which was used for the inventory calculation and impact assessment, the socio-economic indicators shown in table 1 were chosen. PSILCA (2017) is a comprehensive database for S-LCA covering 65 socio-economic indicators for almost 15000 industry sectors. For the collection of specific data, 40 of the almost 60 rural agro-industries operating in Cauca Colombia, and other 10 value chain actors including cassava producers (CP), and cassava bread producers (CBP), were visited. Structured surveys were designed and carried out. The product system was modeled, calculated and analyzed using the openLCA software (GreenDelta). The PSILCA database provided background information.

Category	Subcategory	Indicator	Level
Local Community	Local Employment	Unemployment rate in the country	Medium risk
	Respect of indigenous rights	Human rights issues faced by indigenous people	Medium risk
		Presence of indigenous population	Medium risk
	Safe and healthy living conditions	Drinking water coverage	Very high risk
		Pollution level of the country	High risk
		Sanitation coverage	Very high risk
Society	Contribution to economic development	Illiteracy rate, total	High risk
		Public expenditure on education	High risk
	Health and safety (society)	Health expenditure, total	Medium risk
Value Chain Actors	Corruption	Public sector corruption	Very high risk
Workers	Discrimination	Gender wage gap	High risk
	Fair Salary	Living wage, per month	Medium risk
		Minimum wage, per month	High risk
		Sector average wage, per month	Very high risk
	Child labor	Children in employment, total	Very low risk
	Health and safety (Workers)	Presence of sufficient safety measures	High risk
		Rate of non-fatal accidents at workplace	Low risk
	Social benefits, legal issues	Social security expenditures	High risk
	Working time	Weekly hours of work per employee	Medium risk

Table 1: Social impact assessment using PSILCA (Ciroth & Franziska, 2016)

## Results

Figure 1 shows the relative contributions to the social indicators for the stakeholders: Civil society, local community, value chain actors and workers (UNEP-SETAC 2009), and the differences between the CP, CSP and BP processes are observed. This data was obtained by SILCA database using background and foreground information for select the risk level according to the parameters of Ciroth & Franziska, (2016), and OPENLCA software estimate the relative contribution of impacts per categories and subcategories. The Table 2, shows two examples of this categorization.

For all the stakeholders, the greatest impacts occur in the CP. The reason why the difference was presented is associated with the conditions and the positive gap between the urban perimeter where cassava and bread is produced, and the rural areas where cassava is grown (Galvis, 2014).

The workers of CSP and BP process enjoy greater job stability, and have better working conditions, probability of having benefits and consequently a better quality of life than people who live in the countryside and work as day laborers (Hernández, 2014). This inequality and historical forgetfulness about "deep Colombia" or rural (Taborda A. & Sosa, 2014), was partly what fueled subversive conflicts in the same country for years (Fajardo, 2015)

Indicator	Unit of measurement	Source	Type of information	Indicator value "y"	Risk level	Level
<b>Gender wage gap</b>	(Male w. – female w.) / Male wages * 100	Surveys	Foreground	(257 USD – 167 USD) / 257 USD * 100 = 35%	0% = no risk; 0% < 5% and 0% > 5% = very low risk; 5% < 10% and -5% > 10% = low risk; 10% < 20% and -10% > 20% = medium risk; 20% < 30% and -20% > 30% = high risk; > 30% and < -30 = very high risk	High risk
<b>Public sector corruption</b>	Scores given by Transparency International ranking	www.transparency.org/	Background	37 / 100	y < 100 = very low risk 100 ≤ y < 200 = low risk 200 ≤ y < 500 = medium risk 500 ≤ y < 1000 = high risk 1000 ≤ y = very high risk	Very high risk

Table 2: Example of two indicators from the Social impacts assessment

An integral analysis of the three indicators for fair salary: decent, minimum and sector wage leads us to conclude that, in this sector, as in other agro-industrial value chains in Colombia, it will be necessary for the government and interested parties to determine policies that, instead of increasing the gap of inequality, fan of conflicts and

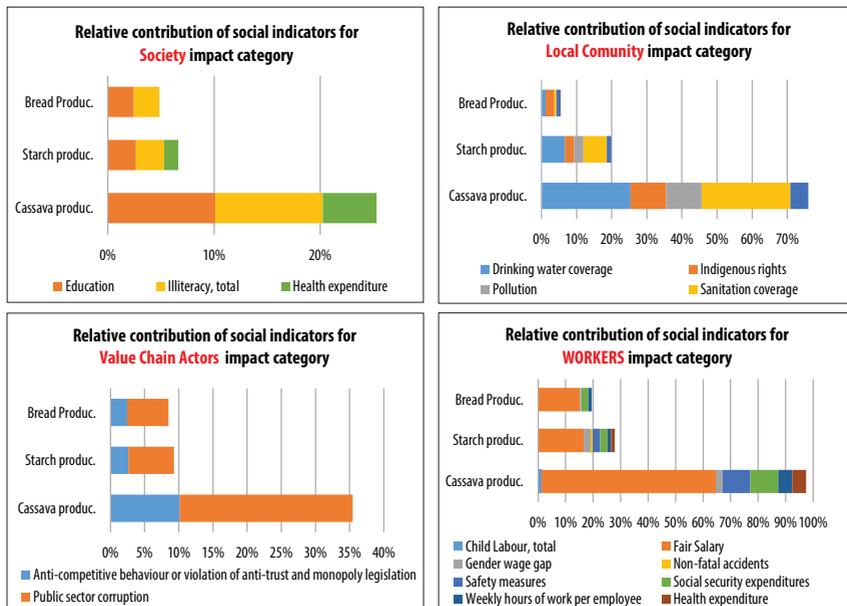


Figure 1: Relative contribution to social indicators in the impact categories for Cassava production, Cassava Starch Production, and Bread Production processes

delinquency (Fajardo 2015), promote rural development and well-being of the people who work to feed the Colombian society through the salary allocation consistent with inflation and living costs calculated and settled in the state statistics databases (Mancera, 2015).

The impacts on "Local Communities" (figure 1) are mainly generated by the lack of adequate water supply and sewerage services, which is more evident in rural areas than in urban areas (Ibáñez, 2016). It is important to note that the impacts regarding indigenous rights are lower than the aforementioned in this category, given that in Cauca, there is an important presence of indigenous communities, which have benefited to a certain extent from the growth of this value chain, since several groups have dedicated themselves to plant cassava and market to starch processors. Even a group of indigenous people came together to form an association and build a "rallandería" where they can process the yucca they produce (García & Montero, 2016).

The indicators analyzed in the subcategories addressing "actors of the value chain" and "society" (Figure 1), have similar interrelations to those discussed above, with CP being the process that has greater impacts than CSP and BP. These indicators were compared to background information, where the impacts of national statistics such as illiteracy, public expenditures on health and education are generally important in rural contexts (Delgado, 2014; Galvis, 2014).

## Conclusions

The results of this research project provide useful information to improve the well-being of the entire Cauca community. Positive impacts can be generated regarding job creation, food security/ sovereignty, gender equality, gender wage gaps, food security and sovereignty, and others.

In future researches it will be reported how the results of this study will be used by Decision-makers, like local or regional politicians in order to promote rural development and well-being of the community, by adapting post-conflict policies that reduce the indicators of high risk of negative impact and potentially the positive impacts.

Another outcome of this study is the methodological contribution to the application of the PSILCA database in a real scenario in the rural Colombia.

## References

- Ciroth, A., & Franziska, E. (2017). PSILCA – A Product Social Impact Life Cycle Assessment database, 1. Retrieved from [http://www.openlca.org/wp-content/uploads/2016/08/PSILCA\\_documentation\\_v1.1.pdf](http://www.openlca.org/wp-content/uploads/2016/08/PSILCA_documentation_v1.1.pdf)
- Delgado, M. (2014). La educación básica y media en Colombia: retos en equidad y calidad.
- Fajardo, D. (2015). Estudio sobre los orígenes del conflicto social armado, razones de su persistencia y sus efectos más profundos en la sociedad colombiana. *Conflicto Social Y Rebelión Armada En Colombia*.
- Galvis, L. A. (2014). Aspectos regionales de la movilidad social y la igualdad de oportunidades en Colombia. *Revista de Economía Del Rosario*, 17(2), 257–297.
- García, J. C. R., & Montero, G. V. (2016). La vida es una lucha. La magia en la guerra y la resistencia en el Cauca, Colombia. *Publicación Impresa*.
- Hernández, C. A. M. (2014). Sector rural colombiano: Dinámica laboral y opciones de afiliación a la seguridad social.
- Ibáñez, A. M. (2016). El proceso de paz con las Farc: ¿Una oportunidad para reducir la pobreza rural y aumentar la productividad agropecuaria? *Revista de Ingeniería*, (44), 8–13.
- Mancera, M. Á. (2015). Del salario mínimo al salario digno. Mexico: Consejo Económico y Social de la Ciudad de México. *Google Scholar*.
- Sandoval, V., & Ruiz, R. (2005). El rol de los recursos locales en la evolución de la agroindustria rural del almidón agro de yuca en el departamento del Cauca, Colombia. *AGROALIMENTARIA*, 22, 41–47.
- Taborda A., L. A., & Sosa, M. D. (2014). Un modelo de emprendimiento agrícola a partir de educación superior rural en la Colombia profunda. *ISEES: Inclusión Social Y Equidad En La Educación Superior*, (14), 49–62.

# Pathways to S-LCA Interpretation – where to start

**Jasmin Werker, Christina Wulf, Petra Zapp**

*Forschungszentrum Jülich GmbH, Institute of Energy and Climate Research – Systems Analysis and Technology Evaluation, 52425 Jülich, Germany*

## Introduction

The development of Social Life Cycle Assessment (S-LCA) originates in the three dimensional definition of Sustainability and was developed to 'assess a product based on social and socio-economic indicators' (Andrews, Barthel et al., 2009). In the same manner as LCA, S-LCA follows the ISO 14044 framework. Therefore, it is equally subdivided into four phases: Goal & Scope definition, Life Cycle Inventory, Life Cycle Impact Assessment, and Interpretation.

The present paper aims to further develop interpretation strategies in technology assessment, which is often neglected in literature in favour of the other phases. In this study the S-LCA is conducted to provide a pathway particularly intended for a generic social assessment using a database based on a global input-output model.

A brief literature overview shows that the interpretation phase is mostly limited to a description of results and an evaluation of the methodology employed. Generally, this also holds true for studies employing comprehensive databases, for example, the Social Hotspot Database (SHDB) (Benoit Norris and Norris, 2015). By applying the SHDB to two mineral fertilizers, Martínez-Blanco, Lehmann et al., 2014 conclude that while databases can provide for the identification of social hotspots, effective data availability limits the informational value of results obtained. In turn, this leads to high uncertainties for data interpretation and hinders concrete recommendations.

In the PROSUITE project, the THEMIS economic input-output model is used. In order to ease Interpretation the PROSUITE handbook entails performance reference points, 'which allow a kind of benchmarking on the level of effect' (Blok, Huijbregts et al., 2013). However, setting appropriate performance reference points requires additional methodological steps that can include value choices, the 'correctness' of which cannot be determined. This paper provides a first attempt to expand the possibility of S-LCA Interpretation based on I/O-databases in a structured manner.

## Methodology

The proposed methodology for Interpretation of S-LCA results based on a global I-O database takes a systematic approach equally inspired by the data provided by the PSILCA database as well as the Guidelines for S-LCA (Andrews, Barthel et al., 2009).

In order to obtain a valid system for Interpretation the first step is to further explain the idea of an I-O based database for social assessment, here the PSILCA database (Ciroth and Eisfeldt, 2016). Based on the global I-O model called Eora the database provides sector-specific data in 189 countries. At the present, there is a harmonized 26-sector classification implemented across all countries. While for some countries data was extrapolated, for others the database contains very detailed data. To obtain indicator values, PSILCA mostly relies on international statistical agencies such as the International Labour Organization (ILO) as well as 'private or governmental databases' (Ciroth and Eisfeldt, 2016). In PSILCA 1.0 data for 56 indicators is provided, which are risk-assessed on a 6-level ordinal scale from 'no risk' to 'very high risk'. In line with the obtained indicator values, risk assessment is based on international conventions and standards but also on subjective experience and evaluation of the authors (Ciroth and Eisfeldt, 2016). To calculate overall risk levels along the life cycle, each ordinal risk level is assigned a numeric value. Worker hours is used as activity variable to depict the 'relevance of impacts caused by a process in a life cycle' (Ciroth and Eisfeldt, 2016). The final output of a calculation provides risk levels, given in medium risk hours, for 35 impact categories, e.g. fair salary; these impact categories can be regrouped into the subcategories provided in the S-LCA Guidelines (Andrews, Barthel et al., 2009). The 35 impact categories includes all 56 indicators.

The S-LCA Guidelines define five relevant stakeholder groups: workers, local communities, society, value chain actors, consumers. Currently, PSILCA 1.0 is only able to provide indicators portraying four of those, excluding consumers.

In order to progress from results to Interpretation and (policy) recommendations, the three levels of results (subcategories, stakeholders, locations) given in PSILCA 1.0 need to be combined in a systematic manner. Hereby, the results level used as starting point is decisive for the course of interpretation. The definition of an appropriate starting point depends on the goal of the study, e.g. whether the study compares different locations or different technologies in the same location.

One aspect that needs to be kept in mind is the fact that, following the S-LCA guidelines, subcategories and stakeholders are closely connected; in other words, any subcategory is already linked to a particular stakeholder group whereas a stakeholder group can entail different subcategories. This limits the number of possible interpretation pathways to four:

- (1) Subcategory (Stakeholder inherent) -> Location
- (2) Stakeholder -> Subcategory -> Location
- (3) Location -> Stakeholder -> Subcategory
- (4) Location -> Subcategory (Stakeholder inherent)

The idea behind this approach is to identify the most problematic impact category for each result level and then follow the pathway along the other result levels to reach a better understanding of the underlying causes. All four pathways combine and link the three result levels in different ways. The recommendations derived consist of a particular combination of subcategories, stakeholders and locations that

need to be considered when implementing technologies or products. By using all pathways for interpretation this approach allows for a comprehensive assessment of a single product or technology. Pathway (1) exemplifies the pre-given relationship of stakeholders and subcategories when following the S-LCA guidelines. For stakeholder and location the weighted average of subcategories is used in order to even out the amount of impact categories per subcategory.

## Case study

In order to illustrate the use of interpretation pathways, a case study investigating the social impact of industrial hydrogen production by alkaline water electrolysis (AEL) is conducted. The case study considers the use of a large-scale pressurized 6 MW AEL, produced in Switzerland and operating in Germany. The social life cycle assessment is limited to the manufacturing and use phase. As a functional unit, the production of 1 kg hydrogen is chosen. For further details on the technical dimensions of this analysis please refer to (Koj, Wulf et al., 2017). As mentioned above, the PSILCA 1.0 database (Ciroth and Eisfeldt, 2016) is used. Overall, the PSILCA analysis results in a risk level of 19.5 medium risk hours for hydrogen production in Germany. Owing to the structure of the database the absolute value of medium risk hours does not provide much informational value. Therefore, a closer look at the results on the subcategory, stakeholder and location level is necessary.

The interpretation pathways introduced above yield the following results:

- (1) Fair Salary (Workers) -> India (22%)
- (2) Society -> Health expenditure -> India (29%)
- (3) Germany (28%) -> Local communities -> Access to material resources
- (4) Germany (28%) -> Access to material resources (Local communities)

The four different pathways lead to three different issues in need for further investigation before AEL hydrogen production should be implemented in Germany. Some of those issues are located directly within Germany, others can be found in upstream industries. The percentages indicate the amount of impact found within the corresponding locations.

The conclusion drawn from pathway (1) is that parameters of fair salary in India need to be considered before implementation. At the same time, pathway (2) reveals that health expenditure is of similar importance. As far as the social issues within Germany are concerned, access to material resources is shown to deserve special attention.

## Discussion & Conclusion

As the presented example illustrates the choice of interpretation pathways can have significant effects on social issue prominence. In the present study the pathways were taken in line with the subcategory, stakeholder group and location exhibiting the highest level of risk. Alternatively, one can also decide to start from a different angle,

choosing a particular stakeholder group, subcategory or location to conduct pathway Interpretation without focusing on the highest risk levels. Generally, the choice of the starting point as well as the appropriate interpretation pathway is closely connected to the goal defined in the first phase of the S-LCA.

One of the limitations lies within the nature of generic S-LCA, which provides information about hotspots of social risks along the value chain. Therefore, the result of such an analysis is not suitable for explicit policy recommendations but provides orientation for further investigations. Such investigation should also include a closer look at the way risks are assessed within the database and where the data for risk assessment originates from.

Additionally, the identification of relevant sectors in each country can bring important insights; however, this aspect was excluded from the present example due to the wide distribution of social risks across all sectors.

This paper presents a first attempt at structured interpretation strategies for S-LCA based on I-O databases. In order to validate this approach further research and the application in case studies is necessary. Such case studies could also test whether the approach is particular to energy technologies or if it can also be applied to other types of products and technologies. Also, an extension of pathways to include sectors or alternative pathways depending on the database employed is conceivable. Overall, the pathways are not intended to provide strict rules but rather a flexible orientation to guide Interpretation. The structured approach is proposed to increase reproducibility and allow for a leveled discussion of issues identified through database-based S-LCA.

## References

- Andrews, E. S., Barthel et al., 2009. Guidelines for Social Life Cycle Assessment of Products: Social and socio-economic LCA guidelines complementing environmental LCA and Life Cycle Costing, contributing to the full assessment of goods and services within the context of sustainable development. Paris, United Nations Environment Programme.
- Benoît Norris, C., G. Norris, 2015. The Social Hotspots Database, in J. Murray, D. McBain, T. Wiedmann, The sustainability practitioner's guide to social analysis and assessment, Champaign, Common Ground Publishing LLC: 52-73.
- Blok, K., et al., 2013. Handbook on a novel methodology for the sustainability impact assessment of new technologies - PROSUITE. Amersfoort, PRé Consultants bv.
- Ciroth, A., F. Eisfeldt, 2016. PSILCA – A Product Social Impact Life Cycle Assessment database: Database version 1.0 - Documentation. Berlin, Greendelta.
- Koj, J., et al., 2017. Site-Dependent Environmental Impacts of Industrial Hydrogen Production by Alkaline Water Electrolysis. *Energies*. 10(7), 860.
- Martínez-Blanco, J., et al., 2014. Application challenges for the social Life Cycle Assessment of fertilizers within life cycle sustainability assessment. *Journal of Cleaner Production*. 69, 34-48.





## *Part 2*

# *Contextualising S-LCA scientifically*

## Choice of social indicators within technology development – the case of mobile biorefineries in Europe

**Birgit Brunklaus, Stefan Molnar, Gustav Sandin, Johan Torén, Mikael Mangold**

*RISE Research Institutes of Sweden, Gothenburg (Sweden)*

### Introduction

The EU Horizon 2020 project Mobile and Flexible Industrial Processing of Biomass (MOBILE FLIP), aims at developing and demonstrating mobile processes for the conversion of underexploited agro and forest biomass resources into products and intermediates. The processes will be evaluated in terms of raw material flexibility, as the biomass resources are typically scattered and seasonal. Process concepts have been designed around the key technologies pelletizing, torrefaction, slow pyrolysis, hydrothermal pre-treatment and carbonisation. The products vary depending on the process concept, such as pellets, biochar for soil, biodegradable pesticides for agriculture and forestry. The mobile concepts are evaluated with the help of researchers and industrial partners in the value chains. For the wider sustainability evaluation, life-cycle based environmental, economic and social evaluations are performed for the process concepts to clarify the potential for flexible raw material valorisation. Table 1 shows the anticipated end products, the corresponding technologies being developed in MOBILE FLIP, the raw material(s) for each technology, and the geographical scope of the assessment.

Product	MOBILE FLIP technology	Raw material	Country
<b>Metallurgical biochar</b>	Slow pyrolysis	Forest residues/bark	Finland
<b>Particle boards raw material</b>	Pellets	Saw dust/carpentry shop residue	France
<b>Soil amendment material</b>	Slow pyrolysis	Forest residues	Finland
	HTC	Agricultural biomass	France
	Torrefaction	Agricultural biomass	
<b>Animal bedding material</b>	Pellets	Forest residues	Sweden
<b>Energy</b>	Torrefaction	Forest residues	Sweden
	HT	Agricultural biomass	France
<b>Activated carbon</b>	HTC	BSG	Finland

Table 1: Products, technology, raw material, country and case within the MOBILE FLIP project (BSG = brewers' spent grain, HTC = hydrothermal carbonisation, HT = Hydrothermal treatment)

## Materials and methods

In the social assessment, potential social impacts of several value chains and technologies are evaluated. A social life cycle assessment (S-LCA) will be conducted that builds on the UNEP/SETAC Guidelines for Social Life Cycle Assessment of Products as well as related information on the subject, such as the social audits SA 8000 standards, the social responsibility standards ISO 26000, or the corporate social responsibility guidelines developed by the Global Reporting Initiative (Benoît and Mazijn, 2009). The social assessment builds on the goal and scope definition of the environmental life cycle assessment (LCA) performed in parallel within the project, which set a cradle-to-gate system boundary. The technical system includes agro- and forest-based raw material acquisition (harvesting, chipping, drying), the mobile units (slow pyrolysis, hydrothermal carbonisation (HTC), pelletizing or torrefaction) and the production of the bio-based intermediaries and end products (e.g. pellets, biochar or animal bedding).

## Results and discussion

A pre-study was performed to identify potential socio-economic impacts of the implementation of mobile biorefinery units, by screening the literature using content analysis for arguments/standpoints about potential socio-economic benefits (“pro”) and drawbacks (“contra”) of the implementation of mobile biorefinery units (compared to stationary units). Primary arguments/standpoints identified were sorted into four categories: costs (5 pro arguments/standpoints, 14 counter arguments/standpoints), feedstock availability (pro = 11, contra = 0), rural development (pro = 1, contra = 0) and forest fires (pro = 2, contra = 0). Secondary supporting arguments were mostly related to transport costs (pro = 44, contra = 1). In total, 104 arguments/standpoints were identified from nine reports, five journal articles and 11 newspaper articles (Table 2, Molnar and Sandin, 2016, based on Höcke and Jacobson, 2015).

A study to adapt the UNEP/SETAC stakeholder categories and impact categories (Benoît et al, 2009) to the general context of mobile biorefineries was performed. Data were collected and analysed using content analysis from the documentation in the MOBILE FLIP description of work. These were complemented with notes taken during participant discussions in internal MOBILE FLIP workshops, to identify stakeholders and potential social impacts which are seen as important by the project participants. The full list of identified stakeholders and potential impacts were categorized in accordance with the UNEP/SETAC social impact categories: human rights, working conditions, health and safety, cultural heritage, governance and socio-economic aspects, as well as 31 sub-categories.

Selecting (social) impact categories and corresponding indicators for social assessments carried out within technology development projects is not an easy task. Narrowing down is essential, and the narrowing down process itself generates a generic understanding of the social impacts/indicators that serve as a base for the subsequent screening assessment. After all, impacts/indicators traditionally in focus in

Primary argument	Outcome		Secondary argument	Outcome	
<b>Costs</b>	Pro	5	Transport costs	Pro	44
				Contra	1
			Production costs	Pro	1
	Contra	2			
	Contra	14	Development costs	Pro	0
				Contra	1
Storage costs			Pro	2	
	Contra	0			
<b>Feedstock availability</b>	Pro	11	Weather constraints	Pro	11
				Contra	0
	Contra	0	Production problems	Pro	7
				Contra	0
<b>Rural development</b>	Pro	1	Rural jobs	Pro	2
	Contra	0		Contra	0
<b>Forest fire</b>	Pro	2			
	Contra	0			

Table 2: Potential socio-economic impacts (in the form of arguments/standpoints) of implementing mobile biorefineries, identified in a content analysis.

social assessments, for example child labour, may not be as important in EU compared to economic poorer regions in Asia or Africa.

The results show that for different stakeholders in the MOBILE FLIP project, there are overlaps between impact categories. For each stakeholder, three to eight potential impacts were deemed relevant for mobile biorefineries. In total 17 potential social impacts were identified and described (Molnar, 2016). The following bullet list shows the stakeholders and potential social impacts:

- Workers/employees: Health and safety, time away from home, education and training
- Local community: Local employment (job creation), rural development (self-sufficiency, education and de-ruralisation), culture, health and safety (forest fires, traffic and water)
- Society: Economic development (Job creation)
- Consumers: Convenience, price, eco motives
- Value chain actors: New opportunities for value chains actors (farmers, entrepreneurs/companies)

For more specific impact categories adapted to each technology, further data will be collected in forthcoming project workshops, with focus-groups for the different technologies, including stakeholders from the value chains of each of the mobile biorefinery technologies. So far, an inventory and participant observation study has been performed in a workshop in France in 2017 focused on some of the MOBILE FLIP technologies. The workshop included visits to the CPCU black pellets biomass district heating in Saint Ouen, the Lin-2000 combustion unit of agricultural biomass flax shives

in Granville, the ETIA torrefaction in Beauvais, the IAR demonstration sites in La Salle, the Semardel greenhouse and waste residues valorisation plant in Vert-de-Grand, and the bioenergy forest wooden biomass production site in Pontault-Combault. The results from this study show that among health and safety issues, body protection of eyes and safety shoes are essential at heating and combustion units (toxic chemicals are less important), while noise protection is essential for the mechanical treatment of flax and torrefaction technologies (Brunklaus, 2017).

## **Conclusions for choosing social indicators**

The results from the pre-study show that a literature study using content analysis helped to identify the arguments for and against the implementation of mobile biorefineries, among others negative arguments regarding costs (14 arguments) and positive arguments regarding feedstock availability (11 arguments). The results from workshops with stakeholder groups and a content analysis helped to narrow down the large number of social impacts/indicators within the UNEP/SETAC Guidelines for Social Life Cycle Assessment of Products and to focus on the relevant geographic area (such as the countries in focus) and the specific technologies (such as mobile biorefineries in focus). The results highlight the positive and negative potential impacts for local communities and workers/employees, particularly aspects such as job creation/education and health and safety. The results from the observation study point to health and safety issues, such as heating protection and noise protection for mechanical treatment in the torrefaction process. In the integrated assessment, the results from the environmental, economic and social evaluations will be integrated into a multi-dimensional matrix and the strengths, weaknesses, opportunities and threats will be discussed in workshops together with internal and external experts.

## **Future work and developments**

As part of the future work within the MOBILE FLIP project, results will be complemented with semi-structured interviews, surveys and participant observations. Stakeholder involvement will be an important part of the data collection, which means that the social hot spots are based on subjective stakeholder views. Therefore, relevant generic data from public sector bodies will also be collected and analysed with help of the developed indicators and impact categories. Eurostat data for employment and working hours, alternatively available social LCA databases PSILCA (2015) or Eco-invent (Benoît et al, 2015) are used. The analysis should result in a generic understanding of relevant positive and negative impacts of the technologies, such as employment, health, education, quality of life, workers' rights etc. Special focus will be on the most important social effects of the technologies – the social hot spots.

Further interpretation will be made in the form of an integrated matrix with help of the Handbook for Product Social Impacts Assessment (HPSIA, 2016), and includes descriptions of social indicators such as health and safety, training and education, work-life balance, and employment. Since the S-LCA is part of an integrated

sustainability assessment, inspired by the Life Cycle Sustainability Assessment (LCSA) framework, the system boundaries are set based on the (environmental) LCA. Instead of the whole life cycle, here only cradle to gate evaluations are performed. For the social assessment, the Handbook for Product Social Impact Assessment and available databases might be of help for the evaluation of specific technologies. The integrated matrix in which the results are presented includes additional aspects more specific for the project, such as the adaption from fossil to bio-economy, or additional aspects for the consumer, such as eco branding. Therefore, data collection and analysis should be seen as an iterative process.

Acknowledgements: This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 637020–MOBILE FLIP. The authors would like to thank the involved industrial and research partners and the EU for financing this research project.

## References

- Benoît, C., Wernet, G. and Norris, G. 2015. Introducing Social Data in Ecoinvent – First Results. LCM Conf in Bordeaux/France.
- Benoît, C. and Mazijn, B. 2009. Guidelines for social life cycle assessment of products. UNEP/ SETAC Life Cycle Initiative. [http://www.unep.fr/shared/publications/pdf/DT1x1164xPA-guidelines\\_sLCA.pdf](http://www.unep.fr/shared/publications/pdf/DT1x1164xPA-guidelines_sLCA.pdf)
- Brunklaus, B. 2017. Workshop and study visits in Paris, 26-28 of June 2017, MOBILE FLIP.
- Höcke, E., and Jacobson, A., 2015. Socio-Economic Assessment of Implementing Mobile Biorefineries: A pre-study with focus on the European Union, Report no. 2015:1, Department of Energy and Environment, Chalmers University of Technology, SE-412 96 Göteborg.
- HPSIA, 2016. Handbook Product Social Impacts Assessment. V3.0. Roundtable of Product Social Metrics.
- MOBILE FLIP, 2014. Mobile and Flexible Industrial Processing of Biomass. EU Horizon SPIRE-02-2020. <http://www.mobileflip.eu/>.
- Molnar, S. 2016. Possible stakeholders and social impacts of mobile biorefineries, (Internal report within MOBILE FLIP).
- Molnar, S., and Sandin, G. 2016. Social assessment. 14-16th of June 2016, Workshop in Umeå, MOBILE FLIP. <http://www.mobileflip.eu/>.
- PSILCA, 2015. PSILCA - A new, comprehensive, interactive database for Product Social Impact Life Cycle Assessment. Eisfeld and Ciroth, LCM Conference in Bordeaux/France.

# Bioeconomy network mapping and assessment of sustainability performance

**Galyna Medyna<sup>1</sup>, Anu Reinikainen<sup>1</sup>, Sirpa Kurppa<sup>2</sup>**

<sup>1</sup> Natural Resources Institute Finland (Luke), Espoo (Finland)

<sup>2</sup> Natural Resources Institute Finland (Luke), Jokioinen (Finland)

## Introduction

Several countries and regions around the world have created strategies to increase the size of their bioeconomies in order to help their economies wean off fossil fuels and other non-renewable resources. For the European Union, the European Commission defined “bioeconomy” as “encompass[ing] the production of renewable biological resources and the conversion of these resources and waste streams into value-added products, such as food, feed, bio-based products and bioenergy” (European Commission 2012). The Finnish bioeconomy strategy builds on this definition and goes on to explicitly mention the importance of aiming for a bioeconomy that promotes sustainability, including the well-being of Finnish people (Ministry of Employment and Economy 2017).

The present work forms part of efforts to provide Finnish bioeconomy companies with tools to innovate and increase their growth while remaining sustainable, thus respectful of the environment, economically viable and contributing to social well-being. At first, the forestry sector, and more precisely construction wood, is considered as over 75% of Finnish land is covered by forests and forestry products make a significant contribution to the overall Finnish economy. Sustainability is assessed through Life Cycle Assessment (LCA), Life Cycle Costing (LCC) and Social Life Cycle Assessment (SLCA), in an adaption of previously proposed approaches commonly referred to as “LCSA = LCA + LCC + SLCA” (Kloepffer 2008).

## Project methodology

In order to elicit innovation and promote growth, a network map is made for a specific product (“construction wood” in the first case study) that looks at actors, stakeholders and influencing factors along and across the value chain as well those adjacent to the value chain (e.g. geographically), and the links among them. The mapping is done using software (Ventana Systems Inc. 2018) that allows the creation of Causal Loop Diagrams (cf. example of partial mapping in Fig. 1) and stock and flow diagrams.

In a first step, an initial network representation is built using literature and internal expert input and attempts to list relevant all actors, stakeholders and influencing factors, from those who simply live next to a forest to end-users of by-products of

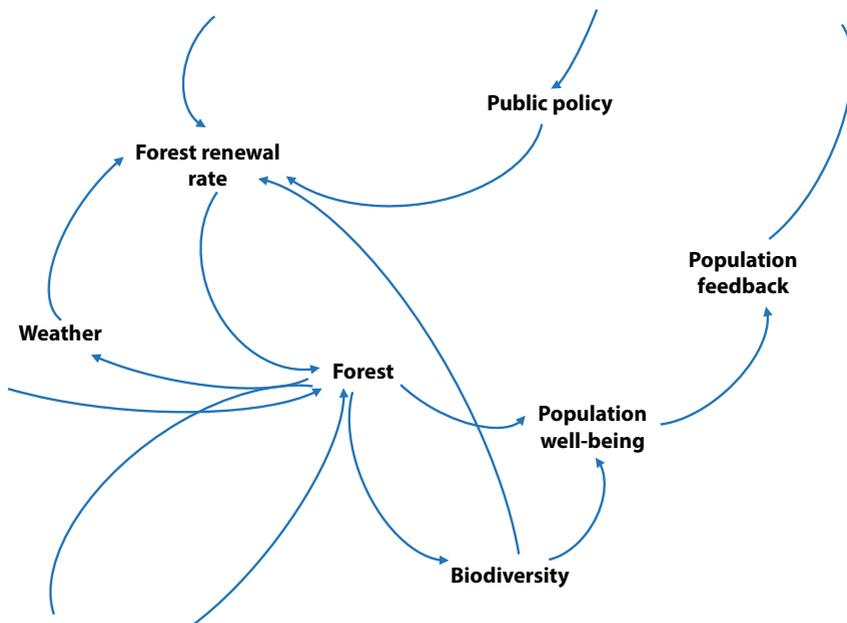


Figure 1: section of early concept for network mapping for “construction wood” case study

the main value chain to alternative products that share the market. The links are qualified and indicators are chosen to quantify the impacts of actions, whenever feasible. The aim of constructing as comprehensive a network map as possible is to spot inefficiencies (e.g. material dismissed as waste instead of being turned into a by-product) and missed opportunities (e.g. “missing” links between actors). Moreover, the qualification and quantification of actors, influencing factors and links allows for discussions on how to improve performance in terms of environmental impacts, economic returns and social well-being. The choice and application of social indicators to a network are further discussed below.

In a second step, a select number of Finnish companies providing the product under study (“construction wood” is the first product case study) will be contacted for interviews and to present and discuss the established initial network mapping. This step is expected to help validate sections of the mapping, establish which links are currently the most important for companies and provide indications as to which other actors and stakeholders should be consulted and/or other influencing factors added. The choice of a visual mapping and an easy-to-use dynamic tool was made to facilitate this step.

Concurrently, the consumption patterns and decisions of end-users for the final products and by-products of the value chain will be analysed. Recent project work has

shown that consumer preferences can shift significantly following the introduction of innovative products (e.g. dairy-free milk alternatives beyond soy milk) and this is especially true in Finland where large companies such as Fazer do not hesitate to launch unconventional products (e.g. bread containing a small portion of flour made of insects (Fazer 2017)) and supermarket chains feature them prominently. As the final aim of the work is to provide sustainable innovation and growth strategies to companies, including strategies that steer consumers towards products and services that contribute overall social well-being, understanding consumers' willingness-to-pay (WTP) and adoption behaviour is essential.

Later steps of the project are expected to include the transposition of the network map into a stock and flow diagram in order to visualise the impact of changes made by actors and stakeholders and evolutions of influencing factors, both on a company's market performance and sustainability performance.

### **Social indicators in the project**

Currently no single method has emerged to qualify and quantify social impacts for products, processes and services and their analysis relies on public data repositories that cover impacts that are considered as important and/or the collection of local data (Sala, Vasta et al. 2015). Moreover, previous studies have highlighted that social indicators are context-dependent (e.g. child labour and education indicators are not always relevant (Smeets, Faaij 2010)) and local stakeholder involvement is crucial (Kurka, Blackwood 2013).

In the case of the forestry sector, several factors highlight the need to consider social impacts that are tailored to the different actors and stakeholders. Indeed, while the focus of the work is on the Finnish forestry sector, recent demographic changes of private forest owners in Finland highlight that social aspects associated with forestry products are not set in stone. Indeed, as summarized by Korhonen et al. (2010), forest owners depend less on the income generated by cutting trees and they increasingly living away from their forest holdings, among other changes.

Thus, in order to understand the most relevant social indicators to consider and quantify, company and other actor interview will include input gathering on this issue. In order to start discussions, the following impacts will be included, based on previous work that considered the social impacts on local forestry stakeholders (Lähtinen 2010) and the guidelines provided by UNEP/STEC (Benoît 2010): health and safety, working time, discrimination, work stability, local community development, and relationships with other companies and suppliers. This list will be augmented throughout the project and the data to qualify and quantify the impacts taken from existing literature and the PSILCA database (GreenDelta 2018). In a similar fashion, consumers and other non-forestry stakeholders will be interviewed to assess the most important social impacts. Currently the most important indicators are expected to be health and safety, transparency and end-of-life treatment of products.

## Future developments

While a proof of concept network has already been established, as well as a transposition to a stack and flow diagram, the majority of company and other stakeholder interviews are expected to be held in the spring of 2018. The content of these interviews will refine the network model for the first use case product, construction wood. The second use case will be milk products. Future work is also expected to include the creation of a dynamic tool to be used by companies to visualize their sustainability performance, external influences and how changes will influence that performance.

## References

- BENOÎT, C., 2010. Guidelines for social life cycle assessment of products. UNEP/Earthprint.
- EUROPEAN COMMISSION, 2012. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Bioeconomy for Europe, COM(2012) 60.
- FAZER, 2017-last update, Fazer Sirkkaleipä. Available: <https://www.fazer.fi/tuotteet-ja-asiakaspalvelu/leipa/fazer-sirkkaleipa/> [8 February, 2018].
- GREENDELTA, 2018-last update, PSILCA database. Available: <https://psilca.net/> [8 February, 2018].
- KLOEPFFER, W., 2008. Life cycle sustainability assessment of products. *The International Journal of Life Cycle Assessment*, 13(2), pp. 89.
- KORHONEN, K., KURTTILA, M. and HUJALA, T., 2010. Typical social networks of family forest owners in timber trade. *Scandinavian forest economics*, 43, pp. 161-171.
- KURKA, T. and BLACKWOOD, D., 2013. Participatory selection of sustainability criteria and indicators for bioenergy developments. *Renewable and Sustainable Energy Reviews*, 24, pp. 92-102.
- LÄHTINEN, K., 2010. Multidimensional sustainability framework to evaluate forest and wood energy production (BioSus-project). *Scandinavian Forest Economics*, (43),.
- MINISTRY OF EMPLOYMENT AND ECONOMY, 2017-last update, Finnish Bioeconomy Strategy. Available: <http://www.bioeconomy.fi/facts-and-contacts/finnish-bioeconomy-strategy/> [7 February, 2018].
- SALA, S., VASTA, A., MANCINI, L., DEWULF, J. and ROSENBAUM, E., 2015. Social Life Cycle Assessment: State of the Art and Challenges for Product Policy Support. JRC Technical Report, EUR 27624 EN. Italy.
- SMEETS, E.M. and FAAIJ, A.P., 2010. The impact of sustainability criteria on the costs and potentials of bioenergy production—Applied for case studies in Brazil and Ukraine. *Biomass and Bioenergy*, 34(3), pp. 319-333.
- VENTANA SYSTEMS INC., 2018-last update, Vensim software. Available: <http://vensim.com/> [8 February, 2018].

# Social life cycle assessment through the framework Multi-Level Social Life Cycle Assessment (ML-SLCA) of the bioelectricity generation in Floreana Island

**Marilyn A. Muñoz Mayorga<sup>1</sup>, Natalia Caldés Gómez<sup>2</sup>, Eva Iglesias Martínez<sup>1</sup>, Irene Rodríguez Serrano<sup>2</sup>, Israel Herrera Orozco<sup>2</sup>**

<sup>1</sup> Food and Biosystems Engineering at Technical University of Madrid. UPM, Madrid (Spain)

<sup>2</sup> Energy Systems Analysis Unit, Energy Department. CIEMAT., Madrid (Spain)

## Introduction

In September 2015, world leaders defined seventeen global goals to eradicate poverty, protect the planet and ensure prosperity for all its inhabitants as part of a new agenda for sustainable development. Almost simultaneously in December 2015, United Nations Framework Convention on Climate Change (UNFCCC-COP21) took place in Paris, where 195 countries signed the first binding global climate agreement (UN 2015a). In this sense, Ecuador has voluntarily adopted different mitigation measures to reduce greenhouse gas emissions, such as the "Zero Fossils Fuels program in the Galapagos Islands", in which the Ecuadorian government promotes the development of biofuels without compromising food security (PNBV 2013). Within this initiative and the program "Renewable Energies for Galapagos" (ERGal) is designed to eradicate the use of fossil fuels in the Galapagos Islands (Ergal 2008), where one of its most noteworthy projects is the pilot project "Jatropha for Galápagos" (JFG), whose purpose is to progressively replace diesel by jatropha oil for the production of electricity. To this end, two rural areas with substantially different socio-economic and environmental environments are involved: rural population of Manabí which produces jatropha by living fences system; and the rural Floreana Island where the jatropha oil is used to generate bioelectricity. Under this premise (Feron 2016) points out the importance of analyzing the social aspects for the progress of the sustainability of rural electrification.

Life Cycle Analysis (LCA) approach allows the identification of environmental, social and/or economic impacts of a product or service (AENOR 2006). Social Life Cycle Analysis (SLCA) methodology described in detail in the work of UNEP-SETAC<sup>1</sup>, is a tool that allows providing elements for the decision making process on the social impacts involved in the production of goods and services (Sala et al. 2015). However, in comparison with the environmental applications of LCA, its application and development is still in a very incipient state. In this sense, the purpose of this study is to identify the social impacts derived from the production of electricity from jatropha oil by the proposed methodological framework "Multi-level Social Life

1 Guidelines for Social Life Cycle Assessment of Products, of United Nations Environment Programmed Society of Environmental Toxicology and Chemistry, (UNEP/SETAC).

Cycle Analysis" (ML-SLCA) and to analyze the positive and negative social impacts on the different actors involved in the different phases that shape the Social Life Cycle Assessment (SHBD, 2016). From the methodological point of view, this research involves a modification of the traditional SLCA methodological framework, due to the consideration of three levels (Multi-Level-ML) of social information (international, country and local), which allow to identify the degree of social vulnerabilities of the actors related to their socioeconomic environment. Besides, project's contributions are identified by surveys conducted to each social actor. These vulnerabilities and contributions are estimated with the purpose of identifying the social impacts of the project, which are aligned to achieve the Sustainable Development Goals (SDGs).

## Context of the case study

The geographic and social scope of the project reveals a bilateral cooperation approach between two provinces. On the one hand, Manabí with a rural population of 44%, has a precarious education and high level of poverty (76.8%) (Muñoz, M et al. 2018), with 60.8% of the population engaged in agriculture, forestry, hunting and fishing activities. In addition, there are environmental problems from the soil erosion and desertification (Muñoz Mayorga et al. 2018). On the other hand, the Galapagos Islands have unique flora and fauna characteristics in the world and it is considered a World Heritage and Biosphere Reserve (UNESCO, 2013). 97% of its total area is protected and belongs to the Galapagos National Park (PNG 2005). However, its marine area is threatened by human activity and by the risk of diesel spills (Gruber 2014). In 2013, jatropha suppliers amount to 3000 between producers and jatropha collectors (IICA 2013). Producers harvest the jatropha from living fences on their farms, while collectors harvest the jatropha from living fences of the third-party farms with prior permission. Besides, 61 local collectors were registered, which buy and store fruits and jatropha seeds (IICA 2013) and they are often community leaders or small grocery stores owners in the community. Additionally, in 2015, 19 employees participated, which were linked to the extraction of raw material, refinery and electricity generation. Users of the electricity are 145 inhabitants of the Floreana Island, in addition to the occasional tourists.

## Methodology

Based on the SLCA framework defined by UNEP-SETAC (UNEP-SETAC, 2013), the "ML-SLCA" proposes four modifications: (i) the implementation of the ML-SLCA is structured in six steps, (ii) the social indicators and risks considered in the analysis are grouped into five impact categories (people, planet, prosperity, peace, and partnerships), which are reflected in the SDGs; (iii) each indicator or considered risk is collected and analyzed in three data level (international, country and local) with the objective of making a diagnosis of the initial situation and identify the vulnerabilities of the actors in each phase of the life cycle, and (iv) it uses data from surveys, publications related to project, and results of field ethnographic work to identify the

contributions of the project to the before identified vulnerabilities. Figure 1 shows, schematically, the six steps of the ML-SLCA.

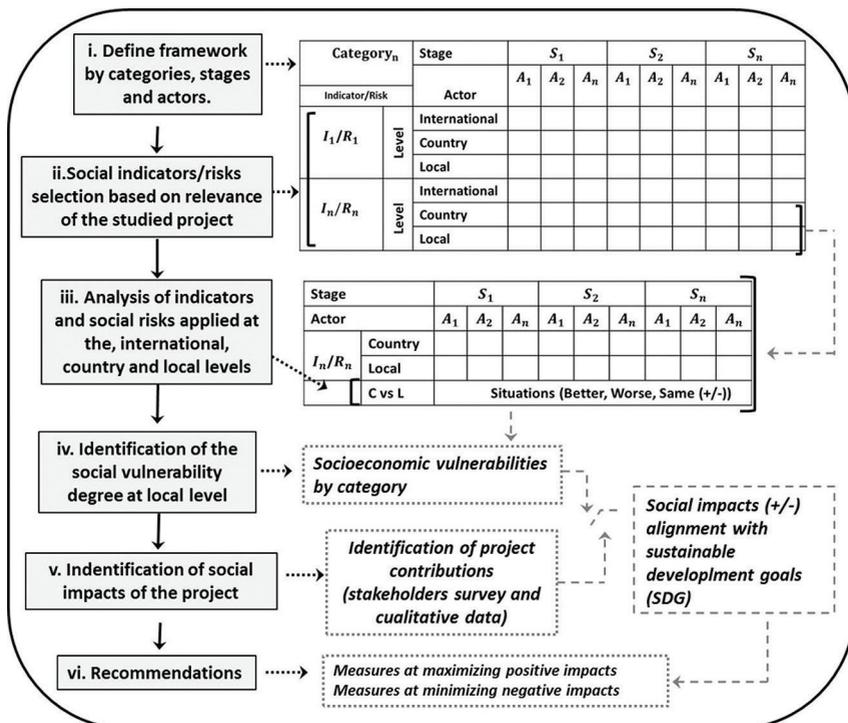


Figure 1: Methodological structure of the framework ML-SLCA

**i. Definition of the framework by categories, stages, and actors:**

Building a matrix as from life cycle phases as well as related actors and social impact categories: . One of the contributions of this framework is the allocation of indicators and social risks to each one of the following categories of the SDGs (UN 2015a): People, Planet, Prosperity, Peace, and Alliances..

**ii. Selection of indicators and social risks based on the relevance of the project:**

For each impact category, indicators/risks are selected according to the objectives, scope and social nature of the project, which must be linked to the SDGs. (UNEP-SETAC 2013) and (SHDB 2016).

### iii. Indicators analysis and social risks for international, country and local levels

The framework considers the selected indicators and, whenever possible, international, country and local data. The international level is considered as a threshold value, which is necessary to recognize the situation of an actor, while the national and local levels are compared against each other to characterize in more detail the socio-economic environment of the actors.

### iv. Identification of the social vulnerabilities at local level:

The degree of vulnerability of the actors, in the "ML-SLCA" presents a procedure to identify four degrees of vulnerability associated with eight possible vulnerability situations.

### v. Social impacts of the project

Once the vulnerabilities are identified, is needed to identify the project contributions. In the ML-SLCA, contributions are considered as to an action or measure by a project when it generates one or more positive/negative social impacts. Data from surveys of the stakeholders and qualitative information from ethnographic research and available literature is used.

### vi. Recommendations

Finally, once the project contributions, vulnerabilities, and social impacts (positive and negative) have been identified, a diagnosis is developed to identify those measures that would be necessary to implement in order to maximize or minimize relevant impacts for the purpose of increasing the social sustainability and its contribution to the achievement of the SDGs.

## Results and discussion

From ML-SLCA analysis, results showed that 33.4% of Manabí's population lives in extreme poverty (less than \$1.48 per day) which is a much larger value than Galapagos with 0.7% (INEC 2010b). Based on the above, jatropa suppliers and local collectors who live in rural zones, show extreme vulnerability. Moreover, at the local level, the enrollment for primary education (89.9% Manabí's rural population) is lower than the rates of the Manabí and Galápagos urban populations with 93.2% and 97.5%. Similarly, the enrollment rate for secondary education in Manabí rural zone is 52.5%, which is lower than rates of Manabí urban zone, and Galápagos of 72.7% and 76.5%. These arguments disclose that suppliers and local collectors of jatropa show extreme vulnerability to poorly educated and consequent social exclusion due to their low education level. Regarding the gender equality, women farmers in Manabí are vulnerable to food insecurity, social exclusion and gender inequality due to lack of access to factors of production, scarce social capital and scarce empowerment.

Related to the project contributions and impacts, 92.4% of providers use the additional incomes of jatropa to meet their daily needs, thus, 84.3% of them consider jatropa incomes to be very important to their household economy. Additionally, the use of

live fences system helps to prevent soil degradation, loss of productivity and is not a threat to food security.

Concerning the SDG of gender equality, the project has a slight positive impact on inequality, since 10.5% of the employees are women and 4.7% are jatropha producers. However, such participations are low and should be increased. Conversely, women's participation help to the 41.5% suppliers to harvest the jatropha but it is considered a negative impact because this participation is non-formal and does not contribute to gender equality or empowerment of women.

Finally, about the SDGs for quality education, the participation of children help to 33.3% of suppliers to harvest Jatropha and it is considered a negative impact, because Manabí shows vulnerability to child labor and low level of education. Therefore, this could increase the risk of early school leaving, which has significant societal and individual consequences. This includes the increased risk of unemployment, poverty and social exclusion.

## Conclusions

The ML-SLCA allows identifying vulnerability associated with the jatropha suppliers such as poverty, poor education and social exclusion, food insecurity, and gender inequality. Suppliers benefit from a series of contributions that generally generate a positive impact, which are aligned with the scope of the SDGs. In this regard, it should be noted that the additional income from the sale of jatropha is used to satisfy basic needs, the live jatropha fence system is considered a natural capital that helps to fight poverty and increase the resistance of producers to climatic events adverse. Notwithstanding the foregoing, measures are needed to combat poverty in a more sustainable manner, through programs focused on capacity building, especially for women and young people. Finally, in order to improve the social sustainability of the project analyzed and to exploit its full potential, it is important to consider the following key factors: strengthened of social capital, actions that maximize the empowerment of women, development of activities that increase the education of children.

## References

- AENOR, 2006. Análisis de Ciclo de Vida, Principios y Marco de Referencia. ISO 14040.,
- Ergal, 2008. Sustitución de combustibles fósiles por biocombustibles en la generación de energía eléctrica en la Isla Floreana, Available at: [http://www.ergal.org/imagesFTP/7734.Estudio\\_de\\_Factibilidad\\_para\\_el\\_Uso\\_de\\_Bicombustibles.pdf](http://www.ergal.org/imagesFTP/7734.Estudio_de_Factibilidad_para_el_Uso_de_Bicombustibles.pdf).
- Feron, S., 2016. Sustainability of Off-Grid Photovoltaic Systems for Rural Electrification in Developing Countries : A Review. , pp.1–26.
- Gruber, G., 2014. Pure Jatropha Oil for Power Generation on Floreana Island/Galapagos: Four Years Experience on Engine Operation and Fuel Quality. Journal of Energy and Power Engineering, 8, pp.929–938.

- IICA, 2013. Sistematización de Experiencias del Proyecto Piñón para Galápagos
- Muñoz Mayorga, M. et al., 2018. Environmental Assessment of Electricity Based on Straight *Jatropha* Oil on Floreana Island, Ecuador. *BioEnergy Research*, 11(1), pp.123–138. Available at: <https://doi.org/10.1007/s12155-017-9883-y>.
- Sala, S. et al., 2015. Social Life Cycle Assessment - State of the Art and Challenges for Supporting Product Policies, Available at: <https://ec.europa.eu/jrc>.
- SHDB, 2016. Social Hotspot Database. Available at: <http://socialhotspot.org/>.
- UNEP-SETAC, 2013. The Methodological Sheets for Sub - categories in Social Life Cycle Assessment (S-LCA), Available at: [http://www.lifecycleinitiative.org/wp-content/uploads/2013/11/S-LCA\\_methodological\\_sheets\\_11.11.13.pdf](http://www.lifecycleinitiative.org/wp-content/uploads/2013/11/S-LCA_methodological_sheets_11.11.13.pdf).
- UNESCO, 2013. Convention concerning the protection of the world cultural and natural heritage. Adopted by the General Conference at its seventeenth session Paris

## Beyond a CSR context towards pluralism in SLCA: exploring alternative social theoretical perspectives

**Henrikke Baumann, Rickard Arvidsson**

*Environmental Systems Analysis, Chalmers University of Technology, Gothenburg (Sweden)*

### Abstract

Most current efforts in social life cycle assessment (SLCA), and in particular the UNEP/SETAC guidelines, have corporate social responsibility (CSR) as underpinning theoretical perspective. However, over 50 years of studies on CSR suggest that the companies themselves have benefitted more than has society. CSR has therefore been criticised for legitimising and consolidating the power of large corporations. In response to this critique and since the social dimension of product life cycles is broader than the corporate perspective, we explore alternative theoretical perspectives that can inform SLCA. Two alternatives not departing from a corporate worldview are the theory of ecologically unequal exchange (TEUE) and actor-network-theory (ANT). TEUE highlights inequalities between different actors along product chains as manifested in today's international trade, in particular between high- and low-income countries (Hornborg 2009). ANT is a descriptive approach for mapping networks of relationships between both actors and material (both technological and natural) entities (Latour 2005). Here, we explore a number of case studies informed by TEUE and ANT in order to identify the contribution of these alternative perspectives to SLCA. The covered cases include studies of airbag systems comparing health impacts mitigated by these devices to health impacts caused during their life cycle and cocoa supply chains through a north-south perspective. The analysis shows that these alternative perspectives add to the current SLCA framework in that they enable description of phenomena and issues hitherto uncovered by it. We go on to discuss the difference between description and assessment in SLCA and argue for greater pluralism in the theoretical and methodological approach to SLCA.

### References

- Hornborg, A., 2009. Zero-sum world: challenges in conceptualizing environmental load displacement and ecologically unequal exchange in the world-system. *International Journal of Comparative Sociology* 50.3-4: 237-262.
- Latour, B., 2005. *Reassembling the social: An introduction to actor-network-theory*. Oxford university press.

# How Product Social Impact Assessment (PSIA) differs from Product Social Value Assessment (PSVA) and why they complement each other

Mélodie Caraty<sup>1,2</sup>, Jean-Pierre Chanteau<sup>1</sup>

<sup>1</sup> Centre de recherche en économie de Grenoble (CREG), University Grenoble Alpes (UGA) (France)

<sup>2</sup> Sustainability dept., ArcelorMittal Global Research & Development, Maizières-lès-Metz (France)

## Introduction

The development of environmental and social impacts assessment methodologies is becoming a key issue for both companies and non-economic actors such as NGOs or public institutions. What is implicitly criticized through such assessments is the functioning of the economic market, which seems unable to deal with environmental and societal negative impacts - what economists use to call negative “externalities”. Environmental impacts are part of those “externalities” and environmental Life cycle Assessment (LCA) of products has reached a wide legitimacy as a decision-making tool for reducing environmental impacts of products. Within the social domain, NGOs and public institutions are pointing out negative impacts such as poverty, economic and social rights’ violations, unemployment, land grabbing, increase of inequalities, etc. As a response and as key market actors, companies are willing to prove they also have positive effects, i.e. they can create value for the whole society with their products: this is what some companies call “the product social value” (PSV) [ArcelorMittal: 2008, 2013, 2014] which also takes into account the product’s positive contribution to the society. This paper provides insights on the nature of PSV and underlines the difference between a PSV assessment (PSVA) and a product social impact assessment (PSIA) and how they can be articulated.

## *The limits of a positivist approach to define the social value of a product*

The theory of value in economics aims at explaining what makes a product valuable to the whole society ( or at least the whole group of people who are participating to economic exchanges). The challenge is therefore to know whether economists have effectively identified the PSV. We can divide their answers into two main groups:

The first group (mostly classical economists) considers that the value of a product is determined by a universal and undisputable reference (either natural or social), as if the value of a product is contained in the product itself and valid for whoever in the society needs this product. In other words, the PSV is an intrinsic and common

characteristic applicable to all products making them comparable. Numerous authors have tried to define the PSV by means of a material constraint such as the product's scarcity [Walras: 1874], its utility/usefulness (also called the use value (as opposed to the product's exchange value) [Condillac: 1776; Turgot: 1769; Jevons: 1871], or the quantity of work needed to produce it [Smith: 1776; Ricardo: 1817; Marx: 1867]. However, none of those criteria is able to fully explain the value of products because material constraints are always subject to social mediation: people react according to the social representations they have of those constraints. Any of those criteria can therefore be pure objective references, i.e neither undisputable nor universal.

The second group (neoclassical economists) considers that the value of a product is encapsulated in its price. Economists who support this vision believe that the product's market price is equivalent to the aggregation of all individual preferences. Accordingly, the price of a product matches its PSV since it becomes an objective value for the whole society by means of an aggregation process in the sense that, under the conditions of a perfect competition<sup>1</sup>, no agent has a market power (eg, the equilibrium price cannot be biased for the benefit of a few). However, it has been mathematically proved that the aggregation of individual preferences does not equal the collective preference [Condorcet paradox – theory of social choice: 1785; Arrow's impossibility theorem: 1954] even if perfect competition would be achieved<sup>2</sup>. In other words, the price of a product cannot be strictly equivalent to its social value, since a preference will always prevail on another one. The price of a product therefore results from market powers.

Both groups fail to define PSV through a positivist approach. In the next section we will look into the perspective of the constructivist approach.

## **Testing the constructivist approach to build a definition of the social value of a product**

Given the limits of the positivist approach, we have decided to test the implementation of a constructivist approach within the frame of a case-study. Constructivist social scientists consider that a value refers to what people give importance to<sup>3</sup>. It is therefore directly linked to human judgements<sup>4</sup>. Accordingly, the PSV is therefore the society's judgement on an identified product, what Dewey calls the society's valuation. Dewey considers that judgments are observable because they belong to the behavioural

1 In its theoretical sense, the situation of perfect competition fulfils the following 4 requirements: agents are price-takers; agents are perfectly informed; products are perfectly homogenous; there is a free movement of production factors in a given activity [F.Knight: 1921].

2 Neoclassical economists demonstrated that market failures occur even in a situation of perfect competition; and they also demonstrated that perfect competition is an unreachable condition.

3 The idea of "value" in the WBSCD social capital protocol is close. But at any time, it provides a definition for the terminology of "social value": "Valuation is the process of determining the importance, worth, or usefulness of something in a particular context" (WBSCD, 2017, Social Capital Protocol, p.48).

4 Whereas in the positivist approach, the scientist tries to identify an objective value which avoids the intervention of any human judgment.

sphere: when a person gives importance to something, it deploys an effort to protect it. We have decided to implement a valuation process which involves the society's involvement and combines two stages: a subjective one where people appreciate ("I like/I don't like") and an objective one where people assess ("I like/don't like because..."). The second stage falls under a deliberation process, when people have to present arguments to justify their subjective judgment, which are inherently value-based judgments. Such value can be of any type: economic, environmental, moral, religious, aesthetic, practical/utilitarian, etc, but such a deliberation is not only based on individual preferences because individuals are not isolated within the society. They interact and their respective preferences also vary according to others. People behave according to social norms and the culture they have incorporated by means of a socialisation process. Since a valuation process always takes place in a cultural context, the objectification process is based on individuals' inter-subjectivity. In order to observe what a society values in a product, we therefore need to conduct such a valuation process. One main outcome will be the possible identification of qualities a product should ideally have in the society's opinion. Those criteria would therefore become what is desirable in a product as an end to achieve.

### ***A comparative analysis between PSIA & PSVA***

OECD published in 2015 a report where it considers "social value" and "social impact" as equivalent [2015, p.3]<sup>5</sup>, whereas we support the idea that PSVA and PSIA do not present the same goal.

PSIA as it is practiced today is in fact not able to contribute to sustainable development as a whole, as it doesn't have a holistic perspective but rather looks at each stakeholder's interests separately. We believe that the role of PSVA is to identify qualities that matter for the society in a product as a scoping approach, whereas PSIA should assess the product against those qualities selected by the society itself.

In this perspective, conducting PSVA should become the first step of any PSIA as it would help S-LCA practitioners to identify the aim of their study and provide a better legitimacy and relevance of the approach. In fact, as an anonymous reviewer of the Social Product Impact Assessment handbook [2016, p.92] has written:

"I would suggest that a company shouldn't count as "social impact" – what matters is whether those procedures help you to achieve the final social outcomes you are aiming for."

The following table summarizes the main features of PSVA and PSIA:

---

<sup>5</sup> "The idea of social impact is strictly related to the social value produced by organisations. The term 'social impact' — which may overlap with 'social value creation' [...] and 'social return'— has many definitions and may also be linked to social accountability".

	PSVA	PSIA
<b>Object of study</b>	Social value (of a product)	Social impacts (of a product)
<b>Definition</b>	Society's judgment on a product	Predefined impacts of a product on stakeholders (SH)
<b>Level of analysis</b>	The whole society	Beneficiaries / Categories of SH
<b>Ontological conception</b>	Collective	Groups of interest
<b>Aim</b>	Assess the product's net contribution to the society	Assess the causality link between a product and a SH category (i.e how a product affects a category of people)
	Scoping aim: identification of an end to achieve, i.e of qualities a product should have in society's opinion	Conformity aim: how a product achieves the qualities identified in a PSVA
<b>Assessment method</b>	Pluralistic deliberation based on inter-subjectivity and internormativity (valuation process)	Compliance check (legal or performance reference points) – audits
<b>Type of approach</b>	Constructivist	Positivist
	Bottom-up oriented	Top-down oriented
<b>Legitimization process</b>	Public involvement	Experts' knowledge
<b>Scope</b>	Values of people that can be moral, ethical, environmental, economic, aesthetic, utilitarian, religious, etc...	Social topics associated to each SH category
<b>Associated "concepts"</b>	General interest, Common good, Sustainable development (SD), Art of living-together, Society's wellbeing, Social usefulness, etc.	Impacts, Risks, Hotspots, Materiality, Performance, Social engineering, Stakeholders' wellbeing, etc.

Table 1: Comparison between PSVA &amp; PSIA

## Results and discussion

In order to identify what matters for the society in a product (the PSV), we have invited 500 people to get involved in a valuation process. The main conclusion of our work is that PSV can never be revealed as an objective value, even with the implementation of a constructivist approach we have adopted. Social topics, social reference values, social indicators' choices are subject to different visions and can even support different conflicting ideas. Those choices cannot be scientifically-based through any positivist or constructivist approach. The choice of the relevant PSV would always require an arbitration and the judgement of an authority taking the final decision. Despite this outcome, it is still absolutely crucial to conduct a PSVA before launching any (Social) LCA for two main reasons:

- 1) Avoid never-ending discussions on the choices practitioners make: there will never be scientific justifications to those critical choices;
- 2) Empower – by means of a democratization process- the whole society who is directly concerned by the issues practitioners try to assess.

## Conclusions and perspectives

PSVA and PSIA fail in the research of an objective definition for PSV but PSV should drive Life Cycle Sustainability Assessment (LCSA): society can value that a product should meet criteria based on its price (evaluated in a LCSA through Life Cycle Costing, or LCC) or its environmental performance (environmental LCA), as well as any other criteria people value as “things that matter” for a product (working conditions, product usefulness, etc). In fact, in our case-study, most participants have primarily favoured environmental issues when assessing PSV and have considered that each stage of the product life-cycle was important and should be taken into consideration in a holistic perspective (i.e PSV goes beyond the product’s utility). Conducting a PSVA will therefore help companies to identify what a truly “sustainable product” is according to the society’s opinion, which is one of the recommendations in the UNEP/SETAC guidelines (p.82): “In relation to the development of sustainability LCA, the issue of which products can be called sustainable needs to be handled [...] and to be further researched.”

## References

- Caraty, M. & al. 2014. How to assess the social value of a steel product? Some ontological thoughts, in Social LCA in progress: Pre-proceedings, 4th SocSem, Montpellier-France, 19-20 Nov. 2014, 63-69 p.
- Eames, E.R. & Field, R.W. 2002. Experience and Value: Essays on John Dewey & Pragmatic Naturalism, 184 p.
- Iofrida, N. & al. 2014. Social Life Cycle Assessment in a constructivist realism perspective: a methodological proposal, in Social LCA in progress: Pre-proceedings, 4th SocSem, Montpellier-France, 19-20 Nov. 2014, 44-50 p.
- Iofrida, N. & al. 2016. Can social paradigms justify the diversity of approaches to SLCA. In IJLCA.
- Macombe, C. 2014. Searching for social peace: A theory of justice to determine the nature of impacts in social LCA, in Social LCA in progress: Pre-proceedings, 4th SocSem, Montpellier-France, 19-20 Nov. 2014, 56-62 p.
- Pizzirani, S. & al. 2014. Is there a place for culture in life cycle sustainability assessment. in IJLCA, published online.
- Roundtable for Product Social Metrics. 2016. Handbook for Product Social Impact Assessment, version 3.0.
- Thomas, J.-S., Birat, J.-P., Carvallo, A. 2013. A metrics for the sustainability value of steel, Seminar “Which transition for our societies”, Namur-Belgium, February.
- UNEP/SETAC. 2009. Guidelines for Social Life Cycle Assessment of Products
- WBCSD. 2017. Social Capital Protocol. 94 p.





## *Part 3*

# *Fields of applications*

# The role of social aspects evaluation in the industrial symbiosis models

**Gabriella Arcese**

*Università degli Studi di Bari Aldo Moro, Bari (Italy)*

## **Introduction**

The circular economy model not only concerns economic models and political guidelines but also represents a cultural model and behaviour that is becoming increasingly important on a global scale to the level of production, consumption and institutional framework in order to pursue the reduction of the usage of primary raw materials towards models of reuse and recycling of quality materials (Notarnicola et al, 2016). Industrial symbiosis also explains the different modes with which it is possible to make the practices of symbiosis (utility-sharing or sharing of resources and how it is possible to initiate the transfer of materials) (Chertow, 2000).

In the processes of the formation of collaborative relationships, it is possible to distinguish the different stages of development:

1. The first phase is given by the progressive affirmations of the network, in which there must be some essential conditions of mutual exchange.
2. The second phase is the development of the network, known in the literature as the probation phase. This phase allows the establishment of relationships of trust, reduction of the risks associated with trade and the process of learning by doing.
3. The next phase of expansion and development allows one to establish new connections and deepen relationships due to the continuous interaction and accumulation of experience. In this phase, there is a reduction in transaction costs. This is due to cooperation based on strengthening, trusting relationships and the increased ability to resolve any problematic situations in an appropriate manner.
4. Finally, the phase of maturity of the network enables the consolidation of best practices and research of new exchanges symbiotics.

All the steps include social implications and is useful to define a set of indicators for social aspect evaluation.

## **Theoretical background**

However, it is generally recognized that the actual benefits or opportunities for improvement that these models generate must be evaluated. Through the analysis

of the case studies, a series of bilateral trade agreements and experiences, the author identify the main social implications. In example, Kalundborg symbiosis has managed to achieve significant tangible benefits which have not only benefited companies in economic terms, but also the population and the environment. Thereafter, Christensen (2000) suggests a number of preconditions for the success of industrial symbiosis. Kurup, instead, in 2005, developed a set of indicators based on the triple bottom line accounting, allowing for improved identification and reporting of the economic, social and environmental benefits of industrial symbiosis projects.

From the analysis of numerous internationally important cases of industrial symbiosis and by numerous publications taken into analysis, we reveal the existence of three basic tools:

1. "Input-Output Matching": This is the fundamental instrument that allows the identification and matching of inputs and outputs of various entities that can participate in the symbiotic processes.
2. "Stakeholder Processes and Involvement": This is an instrument that aims to improve the involvement and cooperation of common agreements between all stakeholders that are relevant to the symbiosis processes.
3. "Material Budgeting": This is the "mapping" of flows of materials and energy of a selected system.

In the processes of the formation of collaborative relationships, it is possible to distinguish the different stages of development. All the steps include social implications and is useful to define a set of indicator for social aspect evaluation. The community must be small enough that they all feel that they have a stake in the outcomes (important stakeholders role).

## **Social Aspect in Industrial Symbiosis**

Already in the second half of the nineties, several studies were carried out which showed that the presence of innovative networks among companies can influence the behavior and the outputs of the companies involved (Arcese et al, 2014). According to Rullani, the idea of clusters, developed in Italy as an industrial district according to the Marshalliano model (industrial district), has had the great merit of transforming the territories into resources in recent years. They are not just circumscribed territories containing economic activities but generate economic value by sharing. The cluster thus understood exploits geographical proximity and social coexistence (Rullani, 2007). Kurup (2005) has emphasized that the economic, social and environmental implications need to be considered for each stage of the synergy project life cycle (i.e., planning, design, construction, operation, maintenance and decommissioning) and listed the indicators for each dimension. Starting from the Social LCA framework, useful basis social indicators are: Job creation, Job security, Health and well being, Community stability, Education standards, Community services, Crime rates, Equality/Accessibility, Protecting and Enhancing Cultural Heritage, Local Identity and Assets.

## Conclusions and future developments

The trade-off between the three dimensions of sustainability must be approached with the utmost care, in order to maintain a sustainable balance, and just that, turns out to be the main problem still not resolved. The strands of thought are essentially two: the first part of experts who want to "weigh" the three dimensions of sustainability in a single-score, and a part of scholars who are deeply opposed. In the first case, you are facing a new construction of the framework of the LCA which includes LCC and SLCA in a single analysis, including additional impact categories in the inventory. The advantage, in this case, is to have a single inventory of data and consequently of impact categories and a single analysis model with objective and common purpose. In the second case, the LCSA is based on three distinct assessments of the life cycle consistent with the boundaries of the system, ideally identical, as in the general formulation, and composed of the three tools that reflect the three branches of sustainability.

The three methods should be standardized (as for LCA) or at least harmonized, performing a formal weighting between the three pillars. The main advantage of this approach is its transparency and the reduction of subjective assessments and even more advantageous is the absence of the possibility of compensation between the pillars. In the future, it is necessary to develop a general framework for social life cycle implementation in support to the industrial symbiosis model.

## References

- Arcese G., Lucchetti M., Massa I. 2017. Modeling Social Life Cycle Assessment Framework for the Italian wine sector, *Journal of Cleaner Production*, DOI:10.1016/j.jclepro.2016.06.137, Elsevier Publisher.
- Arcese G., Lucchetti M., Massa I., Valente C. 2016. State of the art in S-LCA: integrating literature review and automatic text analysis, *The International Journal of Life Cycle Assessment*, DOI: 10.1007/s11367-016-1082-0, Springer Publisher.
- Lucchetti M.C., Arcese G. 2014. Tourism management and industrial ecology: a theoretical review. *Sustainability*; 6(8):4900-4909, doi:10.3390/su6084900, MDPI Publisher.
- Arcese G., Lucchetti M.C., Merli R. 2013. Social Life Cycle Assessment as a Management Tool: Methodology for Application in Tourism. *Sustainability*; 5(8):3275-3287, doi:10.3390/su5083275, MDPI Publisher
- Chertow, M. R. 2000. Industrial symbiosis: literature and taxonomy. *Annual review of energy and the environment*, 25(1), 313-337.
- Notarnicola B., Tassielli G., Renzulli A.P., Arcese G., Di Capua R., 2016a. Simbiosi industriale in Italia: stato dell'arte e prospettive di sviluppo future in Italia, *Annali del Dipartimento Jonico*, in: *Annali del Dipartimento Jonico*. ISBN: 978-88-909569-6-6.
- Notarnicola, B., Tassielli, G., & Renzulli, P. A. 2016b. Industrial symbiosis in the Taranto industrial district: current level, constraints and potential new synergies. *Journal of Cleaner Production*, 122, 133-143.

# Transitioning towards bioeconomy: assessing the social dimension through the lenses of the stakeholders

**Pasquale Marcello Falcone, Enrica Imbert, Almona Tani, Valentina Elena Tartiu, Piergiuseppe Morone**

*Bioeconomy in Transition Research Group, Unitelma Sapienza - University of Rome (Italy)*

## Introduction

Transition towards bioeconomy is expected to deliver social and socioeconomic benefits in a broad spectrum of areas spanning from health and safety, to working conditions, employment and prosperity, access to material and immaterial resources, food and energy security, and gender issues (Rafaani et al., 2017; Sillanpää and Ncibi, 2017). These areas are deeply intertwined with Europe 2020 objectives and UN sustainable development goals (SDGs) (Anand, 2016; Kline, 2016). Specifically, a bioeconomy transition is expected to bring about improvements to goal n.1 (poverty), goal n.3 (good health and well-being), goal n.5 (gender equality), goal n.8 (decent work and economic growth), goal n.10 (reduced inequalities) and goal n.12 (responsible consumption and production). In this vein, measuring and communicating these social improvements is of utmost importance for promoting market uptake of bio-based products.

Yet, social sustainability, has been considerably less investigated until recently. This is mainly due to the fact that assessment and measurement of social sustainability are intrinsically more challenging compared to the other pillars as many social criteria are often subjective (Lehtonen, 2011). Moreover, when it comes to bio-based products the situation still lags behind (Siebert et al., 2017), given that bio-based products involve longer and more complex value chains (IEA, 2014) that make the assessment of social and socio-economic impacts extremely challenging. Since the economic cost of bio-based products is generally higher than fossil-based counterparts (Haer, 2012), demonstrating that bio-based products are sustainable from a social and socioeconomic perspective is critical to augment public acceptance and boost demand (Elghali et al. 2007). Therefore, the success of a sustainable bioeconomy depends on stakeholders' acceptance – especially consumers and manufacturers – leading to a growth in demand for such products.

In this context, there are some examples worth mentioning within a life cycle perspective, which make increasing efforts to investigate the social and socio-economic impacts of bio-based products; however, most of them have a strong focus on biofuels (e.g. Manik et al., 2013; Macombe et al., 2013; Ekener-Petersen, 2014; Raman et al., 2015). As it clearly appears, there are important topics common to these

studies such as health and rights of workers and contribution to employment, while others such as community engagement are less frequently addressed. Moreover, these studies have often taken different approaches since there is still not a standardised methodology for S-LCA.

Thus, the use of S-LCA, as a tool to measure social impacts of bio-based products, need to be better defined so as to put into action improvements to the well-being of stakeholders. One crucial aspect is to make the analysis as context-based as possible by integrating the relevant stakeholders. In this sense, the evaluation approaches have to take into account not only the experts' opinions on the choice of impact indicators, but also the viewpoints of other subjects, both of which may be directly and indirectly affected. Indeed, the choice of 'what is to be measured' is the critical point in S-LCA, and, by using recognised participative techniques, the stakeholders' involvement can be used to shape the final sustainability criteria and regulatory recommendations.

Against this background, our study aims at investigating the social dimension of the transition towards bio-based products, by identifying and validating the main social impact categories pertaining to the bio-based products realm.

The study is conducted within the framework of STAR-ProBio (Sustainability Transition Assessment and Research of Bio-based Products) EU H2020 project.

## **Methodological framework**

In order to achieve the objective of our study, we employ a robust three-step methodological framework encompassing: (i) social impact categories identification, (ii) stakeholders mapping, and (iii) social impact categories validation. These three steps are briefly outlined as follows.

### **(i) Social impact categories identification**

Focusing on the social sustainability and S-LCA applied to bio-based products, an in-depth literature review analysis is performed. This review analysis is further complemented with information gathered from the so-called "grey literature" (e.g., dissertations, reports, white papers). Thus, a preliminary list of social impact categories is identified.

This list is built upon a set of frameworks that have already been applied in the literature with the aim of identifying the main indicators along the whole social life cycle assessment of the impacts of bio-based products. Particularly, this overview specifies a set of socio-economic themes (i.e. health and safety, social acceptability, food security, employment, income, human rights and working conditions, gender issues and discrimination, and access to material resources and land use change), and related potentially affected stakeholders (i.e. workers, consumers, local community, value chain actors and society), that should be taken into account for the appraisal of case studies from a social point of view.

## (ii) Stakeholders mapping

In the second step of our investigation, we carry out a stakeholder analysis to identify the potential actors involved in the development of bio-based products. To this end, we employ a triangulation-based strategy (Falcone et. al, 2017) that enables us to provide robustness to our outcomes. Particularly, we firstly conduct an ex-ante semi-structured interview with a leading figure in the bio-economy debate in Italy. Information collected with this interview merges with supplementary details gathered by means of the “grey literature” – namely, websites, technical reports, fora, guidelines, etc. To corroborate these preliminary findings, we administer a follow up questionnaire to two experts with a long-term expertise in the field of the bio-based products who are asked to validate or confute the set of actors preliminary identified and categorize them according to the type of pressure exerted. This allows us to classify the actors according to their characteristics. In particular, we assume that stakeholders can be identified according to their power and interest as active, inactive or passive stakeholders, with regards to bio-based products development. The stakeholder analysis is carried out distinguishing between impact on local community and impact on global community (fig. 1).

## (iii) Social impact categories validation

The third and final step of our investigation is addressed to validate and integrate the impact categories identified in step (i) by means of stakeholders’ knowledge and perspectives. This goal is achieved through the knowledge elicited from various stakeholders, such as: farmers, forest owners, producers and distributors of bio-based

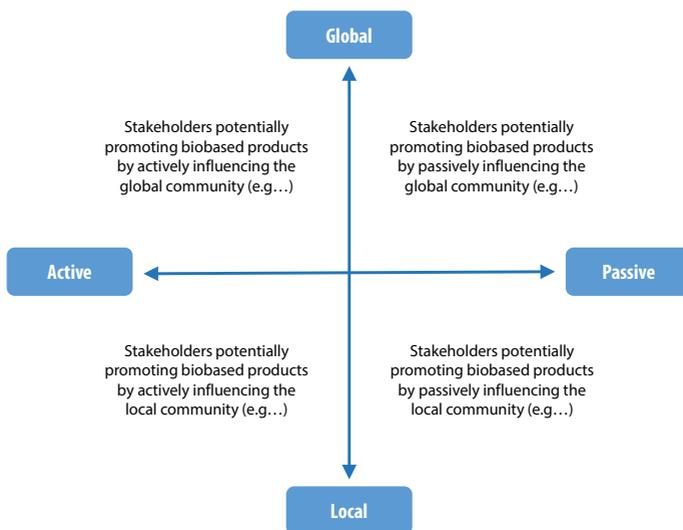


Figure 1: The stakeholder mapping (adapted from Falcone et. al, 2017)

products, policy makers, environmental NGOs, end-users, consumer associations and companies involved in waste management. In particular, within the STAR-ProBio project, different focus groups and Delphi surveys are conducted with a selected group of stakeholders with the specific aim of eliciting knowledge on the social dimensions of bio-based products.

## Conclusions and future developments

Social sustainability of the bioeconomy has become a challenging research topic with a paramount of importance for the market uptake of bio-based products. In recent years, social and socio-economic aspects have progressively been included in both the discourses and sustainability analyses concerning bioeconomy. Social sustainability may be assessed using a variety of methods and indicators, such as the social footprint, social impact assessment, or wellbeing indices. The UNEP guidelines on social life cycle assessment provide key elements concerning life cycle-based social sustainability assessment for product-level. However, it is of utmost relevance to provide indications on the effective actors' involvement. Essentially, stakeholders' viewpoints can be considered to shape the final sustainability criteria and regulatory recommendations by means of recognition of local and global specificities arising from experts and stakeholders' knowledge.

By providing empirical evidence on the social dimension, which incorporates different visions of the stakeholders involved in the bio-based value chains, our study paves the way for further developments concerning the integration of social assessments within the bioeconomy context.

## References

- Anand, M. 2016. Innovation and sustainable development: a bioeconomic perspective. Brief for global sustainable development report, GSDR.
- IEA 2014. IEA Bioenergy Task42 Biorefining. René van Ree and Alniek van Zeeland (Eds.) Wageningen.
- Ekener-Petersen, E., Höglund, J., & Finnveden, G. 2014. Screening potential social impacts of fossil fuels and biofuels for vehicles. *Energy Policy*, 73, 416-426.
- Elghali, L., Clift, R., Sinclair, P., Panoutsou, C., & Bauen, A. 2007. Developing a sustainability framework for the assessment of bioenergy systems. *Energy Policy*, 35(12), 6075-6083.
- Haer, T. 2012. Environmental, Social and Economic Sustainability of Biobased Plastics. Biopolyethylene from Brazil and polylactic acid from the U.S. Default journal.
- Falcone, P.M., Morone, P., Sica, E. 2017. Greening of the financial system and fuelling a sustainability transition: A discursive approach to assess landscape pressures on the Italian financial system, *Technological Forecasting and Social Change*. Available online 24 May 2017
- Kline, K. L. 2016. Sustainability Standards: A call for reason. In workshop on.
- Lehtonen, M. 2011. Social sustainability of the Brazilian bioethanol: power relations in a centre-periphery perspective, *Biomass and Bioenergy*, 35 (6), pp. 2425-2434.

Macombe, C., Leskinen, P., Feschet, P., & Antikainen, R. 2013. Social life cycle assessment of biodiesel production at three levels: a literature review and development needs. *Journal of Cleaner Production*, 52, 205-216.

Manik, Y., Leahy, J., & Halog, A. 2013. Social life cycle assessment of palm oil biodiesel: a case study in Jambi Province of Indonesia. *The International Journal of Life Cycle Assessment*, 18(7), 1386-1392.

Raman, S., Mohr, A., Helliwell, R., Ribeiro, B., Shortall, O., Smith, R., & Millar, K. 2015. Integrating social and value dimensions into sustainability assessment of lignocellulosic biofuels. *Biomass and Bioenergy*, 82, 49-62.

Rafiaani, P., Kuppens, T., Van Dael, M., Azadi, H., Lebailly, P., & Van Passel, S. 2017. Social sustainability assessments in the bio-based economy: Towards a systemic approach. *Renewable and Sustainable Energy Reviews*.

Siebert A., Bezamaa O'Keeffe, S., Thränab D., 2017. Social life cycle assessment indices and indicators to monitor the social implications of wood-based products. *Journal of Cleaner Production*, Available online 9 March 2017.

Sillanpää, M. and C. Ncibi. 2017. *A Sustainable Bioeconomy: The Green Industrial Revolution*. Springer, 2017.

# Social Life Cycle Assessment of Niobium Mining in Brazil in a Circular Economy context

**Sabrina Neugebauer<sup>1</sup>, Marzia Traverso<sup>1</sup>, Gian Andrea Blengini<sup>2</sup>, Fabrice Mathieux<sup>2</sup>, Carlos Cesar Peiter<sup>3</sup>**

<sup>1</sup> INaB, RWTH Aachen University, Aachen (Germany)

<sup>2</sup> European Commission, DG JRC – Joint Research Centre, Sustainable Resources Directorate, Unit D3 – Land Resources, Ispra (Italy)

<sup>3</sup> Centro de Tecnologia Mineral – CETEM, Ministerio da Ciencia, Tecnologia, Inovações e Comunicações (Brazil)

## Introduction

Niobium as an essential alloying element is used in various applications, such as high-strength steels, electronic devices and imaging equipment, for automotive industry, construction and petroleum industry. It is considered as a strategic material with high importance for the EU manufacturing sector and, at the same time, with a high risk of possible supply disruptions. Together with further rare earth materials, e.g. indium or gallium, it is therefore counted to the list of critical raw materials (CRMs) for the EU – compare Table 1.

Similarly, to other CRMs, whose global supply is highly concentrated in a very few countries, and often dominated by China, Niobium mining and production do not take place in Europe either. Consequently, as the EU almost entirely relies on imports from one single country, in this case Brazil, Niobium has been included in all the three editions of the list of CRMs for the EU (EC 2011, 2014, 2017).

The list of CRMs for the EU is the backbone of and a precise commitment to the Raw Materials Initiative (RMI, 2018), which defines three pillars to secure and improve access to raw materials:

- I. Fair and sustainable supply of raw materials from international markets
- II. Sustainable supply within the EU should be fostered
- III. Resource efficiency and recycling of those materials should be promoted

As Niobium contains a high supply risk but is also of high economic importance for the EU, the consideration of Niobium's mining, production and recycling is of concern, especially in a circular economy context.

While various studies on Niobium's manufacturing, material performance and at least some studies on its environmental performance have been published (e.g. Nakamura et al. 2017), almost no studies considered the social implications of Niobium mining

Antimony	Baryte	Beryllium	Bismuth	Borate	Cobalt	Coking Coal
Fluorspar	Gallium	Germanium	Hafnium	Helium	Heavy rare earth	Indium
Heavy rare earth	Magnesium	Natural graphite	Natural rubber	<b>Niobium</b>	Platinum group metals	Phosphate rock
Phosphorus	Scandium	Silicon metal	Tantalum	Tungsten	Vanadium	

Table 1: Critical raw materials listed by the EU for 2017 (adapted from TIC 2017)

and production. The aim of this study is accordingly, to address the first pillar defined by the EU, for assessing social indicators and consequences resulting from Niobium mining and production.

Therefore, we concentrate on Brazil as the largest producer of primary Niobium, holding about 97 % of world's primary production and 95 % of the global reserves. The country plays on the one hand a key role for Niobium's availability, yet, on the other hand Brazil is exposed to a structural change by the raising adoption of a Circular Economy thinking. Indeed, the Circular Economy Action Plan, proposed by the European Commission in 2015, envisages the recovery of critical raw materials in the EU for ensuring the supply security of these materials. This might create changes in supply and demand of primary materials in this area, including Niobium mining. Resulting threats and opportunities for Brazilian Niobium mining from a societal point of view will accordingly be addressed.

## Methods and Results

The Social Life Cycle Assessment (SLCA) (Benoit et al. 2009) method is used to reflect positive and negative social impacts along the value chain of primary Niobium production originating from Brazil, including e.g. workers, local communities and supply chain actors. Consequential aspects and risks including potential changes through Circular Economy efforts are also taken into account.

Primary data for the SLCA study are provided by a case study on a Brazilian mining and its related industries. Hence, a thorough assessment of potential social impacts going beyond the typical evaluation of social hotspots (e.g. by means of the Social Hotspot Database (SHDB)) can be performed. In addition to the primary data, secondary data on Niobium manufacturing and recycling are considered to reflect social impacts along the complete life cycle. Common databases, such as SHDB and/or PSILCA are used in addition to data provided by organisations, like ILO or UN.

The results provide the positive and negative impacts for different stakeholder groups, such as workers and supply chain actors, as well as the social opportunities and threats resulting from Niobium production for both Brazil seeing Niobium as a strategic material and for Europe facing criticality challenges of it. Current and future

implications are as well analysed with regard to societal development and changes from a Brazilian and European perspective, also considering the possible deployment of a more circular economy, both in Brazil and in Europe. This will provide insights on the necessary trade-offs to be made.

## Conclusions and future developments

Conclusions on the social performance can be drawn from the European perspective on specific CRMs and related industries, depending on Niobium production and consumption, as well as for future opportunities and threats of the Brazilian mining sector. The study will not only provide insights on the social performance of a specific sector of the Brazilian mining industry, but can also function as a valid source for social data related to the mining industries, a topic hardly covered by current databases. In addition, social consequences are indicated addressing the future performance of the Brazilian mining industry but also the socio-economic chances and challenges for the EU in terms of Niobium's criticality.

## References

- C. Benoit and B. Mazijn, Eds., Guidelines for social life cycle assessment of products. UNEP/SETAC Life Cycle Initiative, 2009.
- EC 2011. Tackling the Challenges in Commodity Markets and on Raw Materials, COM (2011) 25 final. European Commission, Brussels, Belgium
- EC 2014. Report on Critical Raw Materials for the EU, Report of the Ad-hoc Working Group on Defining Critical Raw Materials. European Commission. Brussels, Belgium
- EC 2017. Communication from the Commission to the European Parliament, the Council, the European economic and social Committee and the Committee of the regions on the 2017 list of Critical Raw Materials for the EU
- S. Nakamura, Y. Kondo, K. Nakajima, H. Ohno and S. Pauliuk. 2017. Quantifying Recycling and Losses of Cr and Ni in Steel Throughout Multiple Life Cycle Using MaTrace-Alloy. Environmental Science & Technology. 51.9469-9476
- RMI 2008. The Raw Materials Initiative—Meeting our Critical Needs for Growth and Jobs in Europe, COM (2008) 699 final. European Commission, Brussels, Belgium (2008)
- TIC 2017. How to make Tantalum. Tantalum-Niobium International Study Center. Bulletin No. 171. ISSN: 1019-2026

# Using the social hotspots database to assess the social risks of prospective value chains: The case of D-Factory

Diego Peñaloza<sup>1</sup>, Heiko Keller<sup>2</sup>

<sup>1</sup> IRISE-Research Institutes of Sweden, Göteborg (Sweden)

<sup>2</sup> IFEU – Institute for Energy and Environmental Research Heidelberg, Heidelberg (Germany)

## Abstract

D-Factory is an EU-funded research project that aims to develop a novel concept for a micro algae biorefinery, based on the cultivation and processing of *Dunaliella salina*. The target of D-Factory is to produce multiple nature-based products for multiple markets. The main novelty of the concept is the separation of high-value carotenoid products for specific markets. An integrated sustainability assessment was carried out as part of the project, where the potential impacts of the D-Factory concept were analysed with a life cycle perspective.

Many attempts to define sustainable development, but many of these definitions agree on a well-known “Triple bottom line” definition: people, economy and society must be developed while sustaining nature, life support and community (USNRC, 1999). Microalgae-based processes are increasingly being considered as a promising alternative to traditional high-impact technologies such as fossil fuels; and while much is discussed about the contrasting interests of achieving economic feasibility and decreasing their environmental impacts, social aspects are often ignored (Malcata, 2011). Social issues of algae-based processes have been discussed qualitatively, namely local work creation in low-employment areas, negative public opinion and competition with tourism (Montagne, 2013). Even if more recent research projects may offer some further insights, few studies with quantitative social assessments have been published (Hingsamer, 2014). Further knowledge is needed concerning the social impacts of algae-based products.

The goal of the work presented in this abstract is to quantify the risks of social negative and positive impacts of the D-Factory concept under multiple scenarios and to identify early potential social hot-spots in these scenarios, by applying social life cycle assessment (S-LCA). The results are meant to be used as guidance for further development of the D-Factory concept from research to a full-scale business model rather than to make comparative assertions to be disclosed to the public.

## Method

The scope of the assessment is cradle-to-grave. Given that the D-Factory technology is still in an early stage of development, there is not an actual supply chain to model and evaluate. Therefore, scenarios based on expert estimates supplemented by generic data were used to model the processes within the system boundaries. Uncertainty was taken into account by creating bandwidths depicting conservative and optimistic future developments. The activity variable used to measure the relative importance of each process is the amount of working hours, which are normalized in reference to the functional unit. Quantitative models were available for the foreground system in the form of scenarios on potential mature D-Factory plants depicting mature technology in 2025. The functional unit (FU) used is kilograms of dry algae paste produced. The D-Factory plant produces multiple products, posing a challenge for allocation of impacts. To solve this allocation problem, system expansion is applied to the social impacts of the D-Factory.

The working hours per unit of output for each of the processes (also for each potential location of these processes) within the studied system were calculated using country-level statistics for different industrial sectors. Data for total output and total expenditures in wages and salaries (in MUSD) was accessed from the United Nations Industrial Development Organisation - UNIDO databases MINSTAT and INDSTAT (UNIDO, 2017). This data is aggregated per year and per industrial sector based on the International Standard Industrial Classification of all Economic Activities - ISIC, an aggregation that varies for each country depending on data availability so the best data available was used for each process. The amount of working hours per process was finally obtained using the approximate price of goods (unit of output from each process) and an estimation of the average hourly wages in the respective country. The data for average country hourly wages was extracted from the OECD statistics database for OECD countries (OECD, 2017) and from the International Labour Organisation – ILO statistics for non-OECD countries (ILO, 2017). This approach was particularly sensitive to the choice of data for price of good for high-value products because of the uncertainty surrounding the relationship between the price of the good and the costs from labour, amplified by the relatively high price of the good per unit of mass. As a consequence, a different approach was used for these, where data for wages or value created for employees in relation to total output was obtained from sustainability or financial reports from well-known manufacturers. Similarly for these products, more accurate data for the wages and salaries in the nutraceuticals and pharmaceuticals sectors was extracted from the web portal “Payscale” (Payscale, 2017).

To obtain data for the associated social impacts of each of the processes in the studied system (raw material extraction, manufacturing of specific inputs or energy generation), the Social Hotspots Database (SHDB) has been used; a tool conceived for use in social life cycle assessments (SLCA) (SHDB, 2013). The social risks of the D-Factory were estimated by multiplying the working hours required from each process per functional unit by the social risk of each process for all the social themes

and categories in the SHDB. The same is applied for the working hours required to produce the avoided production of the benchmark for all co-products, and their corresponding social risks. The final result of the assessment is the sum of the social risks from all the processes in the system, in working hours-risk per functional unit.

Since the studied system consists of a prospective supply chain, the results come with significant uncertainties. To overcome these, sensitivity analyses were performed testing different key variables: the setting of the D-Factory (different pathways that were identified internally in the project), location of the plant, staffing requirement for the plant and efficiency of the up-scaled plant. This resulted in a total of 18 different scenarios. Furthermore, this study was embedded into a comprehensive integrated life cycle sustainability assessment covering further sustainability impacts such as environmental and economic aspects.

## Results

As can be observed in Figure 1, significant share of the positive impacts from D-Factory can be attributed to the substitution of high-value products. This is due to the fact that these products have both a high value and significant social impacts. With regard to social hotspots, the main social impacts caused by the D-Factory production system are concentrated in the health and safety and governance impact categories. The high risk of negative impacts in health and safety are due to the fact that besides energy, most of the inputs required by the D-Factory come from the chemical industry, which is commonly associated with occupational hazards in Spain and Europe. On the other hand, the high score for governance are caused by the use of oil-based materials such as heptane, hexane, ethyl acetate, methanol and ethanol, whose market is dominated by high-risk countries. The processes that have the highest contribution to the negative social impacts of the D-Factory have been identified.

The results suggest that the outcome of the social risk assessment is not particularly sensitive to the choice of D-Factory setting (in relation to the possible settings for development decided within the project). On the other hand, the results are significantly sensitive to the level of development of the D-Factory system that could be achieved during up-scaling and underlines that optimisation guided by the results of this study is very important. The amount of staff personnel required for the plant does not have a significant influence on the outcome of the assessment either. Finally, the results depend heavily on the country where the D-Factory is located, as figure 2 shows.

## Conclusions and future developments

The main conclusion of the social risk assessment is that the D-Factory concept shows a significant potential for mitigation of negative social impacts. Still, the magnitude of this potential can be affected by certain key variables, which leads to the following key conclusions:

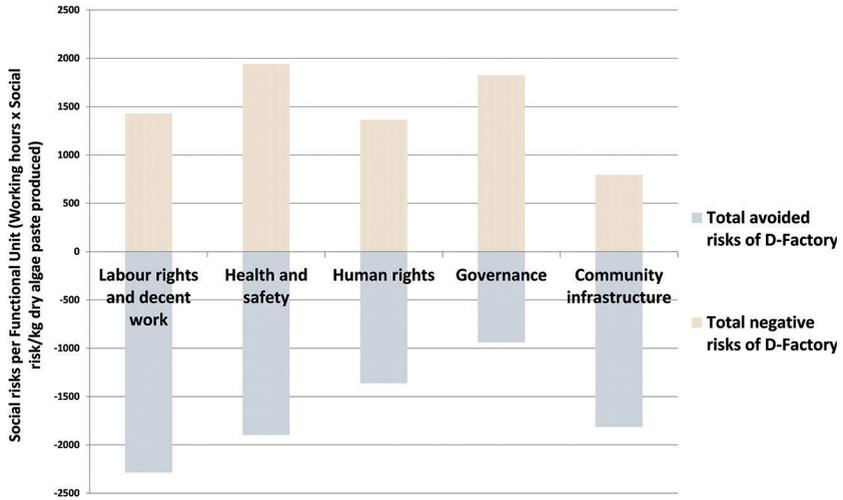


Figure 1: Social risk assessment results for the base case scenario, located in Spain, with optimistic assumption for up-scale productivity

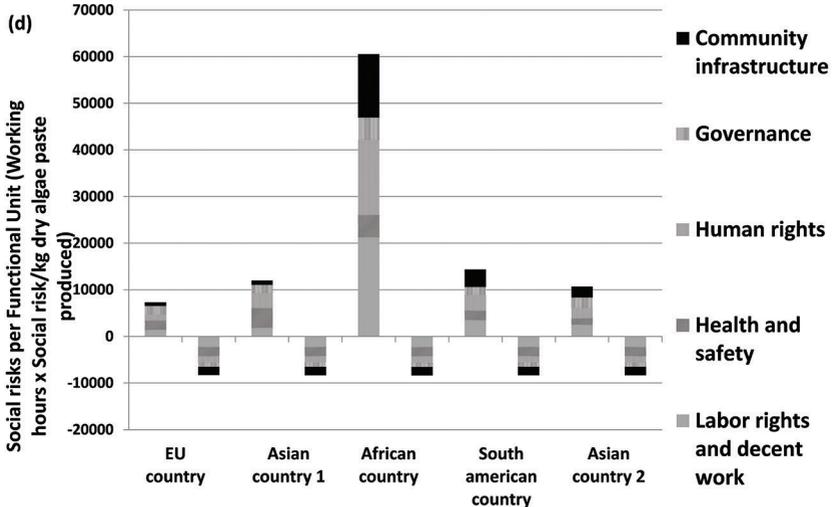


Figure 2: Social impact results for the sensitivity analysis. The figure shows only the scenarios analysed concerning D-Factory location, with countries selected because they offer adequate climate and where potential investors have expressed interest throughout the project. Each scenario features two bars; one with positive values (risks of negative social impacts with D-Factory) and another with negative values (avoided impacts with D-Factory)

- The social impact mitigation potential of D-Factory depends heavily on the assumption that the aimed high-value products can be substituted, and any change in that regard would affect significantly the outcome of this assessment. If D-Factory fails to substitute these high-value products in the market, the substitution of lesser value products would not be enough to offset the negative social impacts.
- The results of the social assessment depend heavily on the country where the D-Factory is located. If D-Factory is implemented in any country outside the European Union, special measures need to be implemented in order to avoid local social risks.
- The dependency on location for the social impact mitigation potential of D-Factory does not mean that the system should not be implemented in the above mentioned countries. It rather means that if that was the case, the implementation should be closely followed so negative social impacts are avoided, especially concerning the impact categories identified as hot-spots.
- The results should not be interpreted as a red or green light for the D-Factory concept, but rather as a roadmap for future developments. The main recommendation for stakeholders is to keep in mind the dependency on three key variables; the successful substitution of the aimed high-value products, the productivity of the system after upscaling and the location of the plant. Finally, stakeholders should also be especially aware of the hot-spots identified in future developments.
- The study has weaknesses and limitations inherent to the status of the D-Factory concept. The scenarios evaluated do not exist because they occur in the future and they do not represent an established value chain. This is why the assessment focuses on risks rather than impacts, a method in accordance with the goal of the study. Nevertheless, it is important that the recommendations are read carefully if the results are to be used by stakeholders for decision-making.
- Another limitation is the data used for the estimation of working hours, which was missing for certain countries and time periods. This may affect the accuracy of the result, but not the main conclusions. What is more, the data used for social impact risk (from the SHDB) does not have this kind of limitation.

Additionally, this study shows how challenges can be overcome to assess social impacts of innovative and therefore necessarily uncertain value chains harmonised with parallel assessments of environmental and economic impacts. This way, recommendations from a social perspective can be made available to decision makers otherwise limited to only economic and/or environmental guidance.

## Acknowledgments

This work has been carried out with funding from the EU 7<sup>th</sup> framework programme for research, technological development and demonstration under grant agreement no. 613870.

## References

- Hingsamer, M., Jungmeier, G. (2014). Towards a Standard Methodology for the Sustainability Assessment of Energy Systems with Algae – An European Approach in FUEL4ME. Presentation, available at: <http://www.fuel4me.eu>
- International Labour Organization – ILO (2017). “Mean nominal hourly earnings of employees” and “Average monthly earnings (local currency)” indicator datasheets. Accessed on January and July 2017 from [www.ilo.org/ilostat](http://www.ilo.org/ilostat)
- Malcata, X. (2011). Microalgae and biofuels: A promising partnership?. Trends in Biotechnology, Volume 29, Issue 11, November 2011, pp 542-549.
- Montagne, X., Porot, P., Aymard, C., Querleu, C., Bouter, A., Lorne, D., Cadoret, J., Lombaert-Valot, I. and Petillon, O. (2013). Algogroup: Towards a Shared Vision of the Possible Deployment of Algae to Biofuels. Oil & Gas Science and Technology – Rev. IFP Energies nouvelles, Vol. 68 (2013), No. 5, pp. 875-898.
- OECD statistics (2017). “Labour – Earnings - Average annual wages” indicator datasheets. Accessed on January 2017 and July 2017 from [www.stats.oecd.org](http://www.stats.oecd.org)
- PayScale (2017). Payscale salary survey. Data accessed on May 2017 from [www.payscale.com](http://www.payscale.com)
- SHDB, (2013). Social hotspots database. <http://www.socialhotspot.org/>. Accessed November 2017.
- United Nations Industrial Development Organisation - UNIDO (2017). “INDSTAT 2016” and “MINSTAT 2016” databases. Accessed on January and July 2017 from [www.stat.unido.org](http://www.stat.unido.org)
- USNRC – United States National Research Council, Policy Division, Board on Sustainable Development (1999). Our Common Journey: A Transition toward Sustainability. Washington, DC: National Academy Press, 1999.

# Assessing fair wages in social life cycle assessment of agricultural product: case of Thai sugarcane

Jittima Prasara-A<sup>1</sup>, Shabbir H. Gheewala<sup>2</sup>

<sup>1</sup> *Climate Change and Adaptation Research Unit (CCARE), Faculty of Environment and Resource Studies, Mahasarakham University (Thailand)*

<sup>2</sup> *Graduate School of Energy and Environment, King Mongkut's University of Technology Thonburi, Bangkok (Thailand)*

## Introduction

Social Life Cycle Assessment (S-LCA) is a tool used to assess the potential positive and negative social impacts along product's life cycle. It helps to identify social hot spots in its life cycle stages in order to facilitate product improvement (UNEP/SETAC 2009). Despite the framework of S-LCA being established, Social Life Cycle Impact Assessment (S-LCIA) methodology is not yet settled. Several contributions on development of S-LCIA methodologies are reviewed in Chhipi-Shrestha (2014). Another issue of S-LCA is that the indicators used in social impact assessment are not yet consensual (Neugebauer et al. 2014). Neugebauer et al. (2014) point out that impact indicators and inventory indicators are found to be mixed up when used in S-LCAs.

Sugarcane is one of the most significant agricultural products in the Thai economy (Office of Agricultural Economics 2016). A recent work of the authors made a first step to apply S-LCA tool in sugar industry (Prasara-A and Gheewala 2018); as well as a work of Sawaengsak et al. (2015). The results suggest that main life cycle stage contributing to social impacts is the sugarcane production sector. From field data collection, one challenge found is related to indicator choices to assess fair wages aspect. In addition, results in Prasara-A and Gheewala (2018) show that fair wages issue is identified the most important aspect for stakeholder "workers" in sugarcane farms. This paper attempts to identify appropriate indicators to assess fair wages in S-LCA of Thai sugarcane product. In addition, recommendations on how to interpret the inventory indicators will be provided.

## Fair wages in Thai sugarcane sector

Fair wages is defined in UNEP/SETAC (2009) as "a wage fairly and reasonably commensurate with the value of a particular service or class of service rendered". A more detailed definition of fair wages is given in Fair Wages Network (2015) as "Wages levels and wages-fixing mechanisms that provide a living wage floor for workers, while complying with national wages regulations (such as the minimum wages, payment of wages, overtime payments, provision of paid holidays and social insurance payments), ensure proper wages adjustments and lead to balanced wages developments in the

company (with regard to wages disparity, skills, individual and collective performance and adequate internal communication and collective bargaining on wages issues)”. More specifically, Fair Wage Network (2016) describes fair wages in different dimensions; i.e. payment of wages, living wages, minimum wages, prevailing wages, payment of working hours, pay systems, communication and social dialogue, wages discrimination and wages disparity, real wages, wages share, wages costs, work intensity and technology and up-skilling. Despite descriptions of fair wages for each dimension are given, indicators used to assess each dimension are not provided.

Inclusion of the fair wages subcategory in S-LCA is recommended in the UNEP/SETAC guidelines for S-LCA of products (UNEP/SETAC 2009). Fair wage is believed to link to social justice and social well-being. Neugebauer et al. (2014) propose impact pathways of fair wages to the mentioned social themes. Moreover, Neugebauer et al. (2014) propose indicators to assess fair wages in S-LCA studies. However, the indicators suggested are for general sectors and not for specific country.

In Thailand, most jobs in the sugarcane sector are normally temporary and not contracted jobs. The employers are sugarcane farm owners. Sugarcane farm owners are either individuals or sugar factories (normally these are large farms and not the majority). Majority of the sugarcane farm owners in Thailand are individuals. Some of the sugarcane farms are contracted with the sugar factories, but some are not. In small farms, there are both self-employed and employed workers (laborers). In general, owners of small farms also work for themselves and hire laborers when needed. In small farms, laborers are normally from local area. In larger farms, laborers may be both from local and other regions.

In order to assess the fair wages aspect of the Thai sugarcane sector, each job in the sugarcane production stages has to be considered in detail. There are different norms of payment basis for each job. This may make it difficult to calculate wages to the desired indicators. However, several jobs in sugarcane production are paid per day. It may be worthy to estimate payment of other jobs converted to daily wages equivalent. This will make it easier for comparison of wages paid in different jobs.

### ***Selection of indicators for the Thai sugarcane sector***

A variety of indicators could be used to assess fair wages aspect in S-LCAs. It was suggested in the guidelines for S-LCA of products (UNEP/SETAC 2009) that selection of indicators to be used is dependent on the objectives of the study. Like other S-LCA studies, the objective of the S-LCA of Thai sugarcane product is to improve social well-being along the life cycle stages. The fair wages aspect directly involves workers. Therefore, indicators selected should reflect fair wages for all workers involved in all sugarcane production stages. The common indicators used for fair wages assessment in S-LCAs are selected to analyze their aspects of validity, practicability and usability following the concept presented in Jørgensen (2010). A summary of these aspects of the indicators are presented in Table 1.

Indicators	Validity	Practicability	Usability
Wages amount to at least country legal minimum wages	?	/	/
Wages amount to at least living wages for the concerned region	/	?	/
Wages amount to at least prevailing sector wages	?	?	/
Wages amount to at least non-poverty wages	?	?	/
Overtime wages are paid at premium rate	/	/	/
Wages are paid on time with regular intervals	/	/	/
Deductions in wages are only made with the consent of the employees and never for disciplinary purposes	/	/	/
Satisfaction in wages paid by employers	/	/	?
There is no wages discrimination	/	/	/

Table 1: A summary of validity, practicability and usability analyses of the indicators for fair wages assessment in S-LCAs

It should be noted that the indicator “Wages including bonuses and other benefits additional to ordinary wages” is not taken into consideration. Although this indicator seems to be valid in assessing the fair wages aspect, it is not seen to be relevant to the workers in the Thai sugarcane sector. Most jobs in Thai sugarcane farms are temporary and not contracted. The workers received fixed wages and there is no bonus system in the employment. Though wages discrimination is not found to be used as an indicator to assess fair wages aspect in S-LCA literature, it should also be taken into consideration. Wages discrimination is one of the twelve dimensions of fair wages defined in Fair Wage Network (2016). They suggest that equal work should be paid equal wages. In this sense, the assessment could be done to see whether there is wages discrimination based on gender, age, race or original location of workers. The authors then take this indicator to analyze along with the other selected indicators.

### **Proposed indicators to use and their interpretation**

Based on their validity, practicability and usability of indicators, a list of proposed indicators to assess fair wages in S-LCA for the Thai sugarcane sector and their suggested interpretation guides are shown in Table 2.

#### **Difference of wages received and wages required**

This indicator is thought to gauge whether the workers earn enough to live. Normally, this can be calculated by subtracting wages received by standard living wages in the area study. However, in Thailand, there is no standard living wages in different areas. Moreover, living wages differs among workers. The authors then propose using an average of difference values of wages received and wages required for each worker. This is calculated by subtracting wages received by wages required for each worker. Then, all values obtained are averaged. This average value is then used to interpret. For this indicator, the large positive value shows best performance. This means that

worker earn more wages than needed. If the value is negative, this is crisis. This would need urgently improvement.

### **Difference of wages received and legal minimum wages**

This indicator shows whether wages paid in the Thai sugarcane sector comply with the country regulated minimum wages. This indicator is calculated by subtracting average wages received by legal minimum wages. Like the first indicator, the large positive value shows best performance. If the value is negative, improvement is needed.

### **Overtime wages, regular wages, absence of deductions in wages, wages satisfaction and wages discrimination**

Workers are considered receiving fair wages if their overtime work is paid at premium rate; their wages are paid on time with regular intervals; no deduction in wages occur without the consent of workers, workers are satisfied with wages received and there is not wages discrimination. However, at present, Thailand has no specific regulations for payment mechanism in sugarcane sector. Relevant international standards such as Bonsucro (2014) and UNEP/SETAC (2013) suggest that a hundred percent of workers should report that their overtime work is paid at premium rate; their wages are paid on time with regular intervals; there is no wages discrimination; and there is no deduction in wages. Therefore, a hundred percent is set as best practice for these indicators.

## **Conclusions and future developments**

S-LCA is a tool used to assess social impacts of product/service along its life cycle stages. Interest in S-LCA has been increasing recently. With interest in using S-LCA to help improve social conditions of the Thai sugarcane sector, this paper aims to find appropriate social indicators to assess fair wages in this sector. Fair wages aspect is focused on in this paper as it is identified as the most important social subcategory in the Thai sugarcane sector. Based on literature review and authors' experience on the field, a list of indicators to use is proposed. The selection is based on validity, practicability and usability. These indicators include daily wages received, daily living wages required, legal minimum wage, overtime wages, regular wages, absence of deductions in wages, wages satisfaction and absence of wages discrimination. For living wages indicator, the authors propose using difference value of wages received and wages required for each worker as an indicator. This is because, at present, Thailand has no standard living wages in different areas. In addition, living wages are subject to each worker. For payment basis indicators, it is suggested to calculate the indicators to percentages of numbers of workers answering "yes" to a question asked for each indicator. In addition, suggested interpretation approach of the proposed indicators is provided. It should be noted that the same approach proposed in this paper could also be applied for other social subcategories such as health and safety, working conditions, water and land rights. Moreover, it is suggested for future research to find weighting values for each indicators for an improvement of interpretation.

Inventory indicators	Calculated indicators	Worst practice	Acceptable practice	Better practice	Best practice
Wages received (B/day)	Average (wage received - wages required)	Largest negative results	0	Positive results	Largest positive results
Wages required (B/day)					
Legal minimum wages (B/day)	Average wages received - Legal minimum wages	Largest negative results	0	Positive results	Largest positive results
Overtime wages are paid at premium rate (yes/no)	Percentage of workers answering "yes"	0-89	90-100	91-99	100
Wages are paid on time with regular intervals (yes/no)	Percentage of workers answering "yes"	0-89	90-100	91-99	100
Deductions in wages are only made with the consent of the employees and never for disciplinary purposes (yes/no)	Percentage of workers answering "yes"	0-89	90-100	91-99	100
Satisfaction in wages paid by employers (yes/no)	Percentage of workers answering "yes"	0-89	90-100	91-99	100
There is no wages discrimination (yes/no)	Percentage of workers answering "yes"	0-89	90-100	91-99	100

B is Thai Baht, Thai currency unit

Table 2: Proposed indicators and their interpretation

## References

Chhipi-Shrestha GK, Hewage K, Sadiq R (2014) 'Socializing' sustainability: a critical review on current development status of social life cycle impact assessment method *Clean Technologies and Environmental Policy* 17:579-596 doi:10.1007/s10098-014-0841-5

Fair Wage Network (2015) Definition of Fair Wages. Fair Wage Network. <http://www.fair-wage.com/en/fair-wage-approach-menu/definition-of-fair-wages.html>. Accessed 21 November 2015

Fair Wage Network (2016) The 12 Fair Wage Dimensions. Fair Wage Network. <http://fair-wage.com/en/fair-wage-approach-menu/12-fair-wage-dimensions-menu.html>. Accessed 4 March 2016

Neugebauer S, Traverso M, Scheumann R, Chang Y-J, Wolf K, Finkbeiner M (2014) Impact Pathways to Address Social Well-Being and Social Justice in SLCA—Fair Wage and Level of Education Sustainability 6:4839-4857 doi:10.3390/su6084839

Office of Agricultural Economics (2016) Agricultural Product Calendar: Year 2015/2016. Office of Agricultural Economics. [http://www.oae.go.th/download/banner\\_files/calendar1-10-57.pdf](http://www.oae.go.th/download/banner_files/calendar1-10-57.pdf). Accessed 27 February 2016

Prasara-A J, Gheewala SH (2018) Applying Social Life Cycle Assessment in the Thai Sugar Industry: Challenges from the field *Journal of Cleaner Production* 172:335-346 doi:https://doi.org/10.1016/j.jclepro.2017.10.120

Sawaengsak W, Assavarak P, Gheewala SH (2015) Identifying Suitable Social and Socio-economic Indicators for Biofuel Systems in Thailand *Journal of Sustainable Energy and Environment* 6:37-41

UNEP/SETAC (2009) Guidelines for Social Life Cycle Assessment of Products.

# How experiences and existing data of companies can be used to define the Goal and Scope in a Social Organisational Life Cycle Assessment (SO-LCA)

**Manuela D'Eusanio<sup>1</sup>, Annekatrin Lehmann<sup>2</sup>, Alessandra Zamagni<sup>3</sup>, Matthias Finkbeiner<sup>2</sup>, Luigia Petti<sup>1</sup>**

<sup>1</sup> Department of Economic Studies (DEc), "G. d'Annunzio" University, Pescara (Italy)

<sup>2</sup> Department of Environmental Technology, Technische Universität Berlin (Germany)

<sup>3</sup> Ecoinnovazione Srl – ENEA spin-off, Ponte San Nicolò (Italy)

## Introduction

Companies need to assess the social sustainability of their supply chain, in order to improve their awareness of the corporate sustainability (Draucker L., 2013). Indeed, companies are aware that their own supply chain's engagement is a determinant to reach the business goal in sustainability terms (Mentzer et al., 2001; Seuring and Müller, 2008; Fallahpour et al., 2017). The O-LCA methodology can be suitable for achieving a sustainable supply chain management, in order to recognise in which areas it is necessary to act, so that the sustainability may be improved (D'Eusanio et al. 2017). O-LCA evaluates input, output and potential environmental impacts of the activities in the entire organisation or in a portion of it (i.e. business division, brand, facility) from a life cycle perspective (UNEP/SETAC, 2015). This approach allows to have an overview of the entire life cycle of the analysed organisation and be aware of which levels require to be improved. O-LCA technical framework may be adapted from social sustainability perspective in order to support the decision-making process of the company.

## Social Organisational Life Cycle Assessment

Social Organisational Life Cycle Assessment (SO-LCA) is a methodology to evaluate the social performance of the organisation along its supply chain. Martínez-Blanco et al., (2015) give a first definition of SO-LCA as "a compilation and evaluation of the social and socio-economic aspects and the positive and negative impacts of the activities associated with the organization as a whole or a portion thereof adopting a life cycle perspective." (pp.1590). Furthermore, it may overcome the challenges of the Social Life Cycle Assessment (S-LCA), such as the allocation of the indicators or impacts to a product level, the absence of databases and the consideration of the whole life cycle in the case-studies (Martinez-Blanco et al. 2015). SO-LCA supports the organisation within decision-making processes, by optimising the efforts and resources of the company in order to achieve the social sustainability of its own products portfolio. Moreover, this methodology allows to support the informed

decisions on the potential social impacts of the analysed processes towards an opportunity for improvement (D'Eusanio et al. 2017). SO-LCA acquires the same technical framework adopted by O-LCA and S-LCA according to the ISO 14040:2006 standards. Four phases are proposed: goal and scope definition, life cycle inventory analysis (LCI), life cycle impact assessment (LCIA) and life cycle interpretation. The implementation of this methodology in a company may be supported using existing experiences of the company that Martinez-Blanco et al. (2015) classify into three categories: experience with social organisational approaches, with environmental life-cycle approaches and with product social life-cycle approaches. Figure 1 shows the experiences supplied by other methods to SO-LCA, as illustrated below: a) the social indicators at an organisational level according to the Global Sustainability Standards (such as the Global Reporting Initiative (GRI), Social Accountability 8000, AccountAbility 1000, Social Impact Assessment (SIA)); b) the social product life cycle assessment by the S-LCA, which includes the consideration of stakeholder categories and subcategories; c) the guide to assess the sustainability at an organisational level, provided by the O-LCA (D'Eusanio et al., 2017). In addition, if the organisation has a previous experience with environmental or social methods could follow three types of pathways to facilitate the implementation of SO-LCA. Pathway 1 is followed when the organisation has the experience with social organisational approaches. Pathway 2 is conducted if the organisation has the experience on product life cycle approaches and Pathway 3, if it has an experience with environmental life cycle approaches (Martinez-Blanco et al. 2015). In order to be implemented and the assessment of the social performance of the organisation to be obtained, it may be appropriate the integration of different approaches and methodologies.

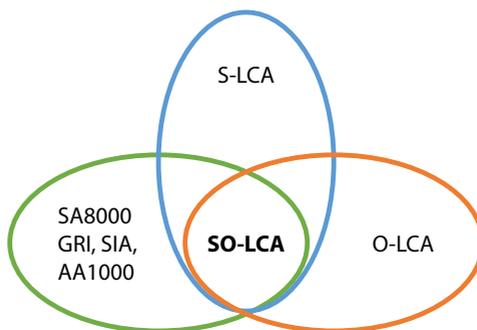


Figure 1: The conceptual framework of SO-LCA

### Goal of the paper

This paper is aimed at showing how the existing experiences of the organisation, including e.g. availability data on the supply chain, are considered for the definition of the goal and scope phase in the SO-LCA. For this purpose, a pilot case-study in a company from the wine sector is used to identify the potential advantages, limitations

and recommendations for the further steps. This paper is a preliminary analysis to reach the ultimate goal to implement the first SO-LCA case-study in the wine sector. The next section begins with the wine case-study description and an overview of the Italian wine sector, followed by the description of how to define the goal and scope phase. The results are finally presented. After drawing the conclusions, suggestions for a future research are recommended in the last section.

## Case study

### Italian Wine Sector Overview

The wine is the most characteristic Made in Italy agro food product (Carbone and Henke, 2010; Istat, 2017). The global wine production (resulting from the grapes harvested in autumn 2016) falls to 267 million in 2016, a decline compared to the preceding years (270 mhl in 2014 and 276 mhl in 2015 production) (OIV, 2017). At EU level, Italy is the second largest wine producer after France (9.7 billion for France

<b>Description of the organisation</b>	The wine company analysed is a consortium located in the Abruzzo, a region in Central Italy. It gathers 9 wineries in the province of Chieti and these wine grower associations collect 3 000 members. They also are the grape supplier of the 9 wineries. Indeed, the business of the consortium is bottling the wine. The production process starts with the transfer of wine from the 9 wineries cooperative to the consortium.
<b>Previous experiences of the organisation</b>	The company has certifications to ISO 9000:2008 Quality, ISO 14001:2004 on Environmental Management Systems and ISO 22000 on Food Security Systems. The company obtained the BRC (British Retail Consortium) and ISF (International Featured Standards) to guarantee the consumer the quality of the final products. Furthermore, the company has SA8000 certification to verify the working condition and ethical sourcing of the products.
<b>Goal</b>	The goal of this study is to provide a better comprehension of the social performance of the entire cycle of the wine company. The main objective is to achieve an efficient solution to time-saving in the social data management in the Supply Chain Management perspective and create a tool to support the social decision making of the organisation.
<b>Scope: Reporting organisation and reporting flow</b>	<i>Subject of study:</i> The NIRO brand of the company is the object assessed. It is composed by five wines types (e.g. Montepulciano d'Abruzzo, Cococciola, Passerina, Cerasuolo, Pecorino) which obtained the EU quality logos. <i>Consolidation method:</i> The wine company possesses absolute control on financial and operational terms. <i>Reference period:</i> 2017 <i>Reporting flow:</i> Economic revenue of the analysed brand
<b>Scope: System boundary</b>	Cradle-to-gate

Table 1: Goal and scope definition of the case-study

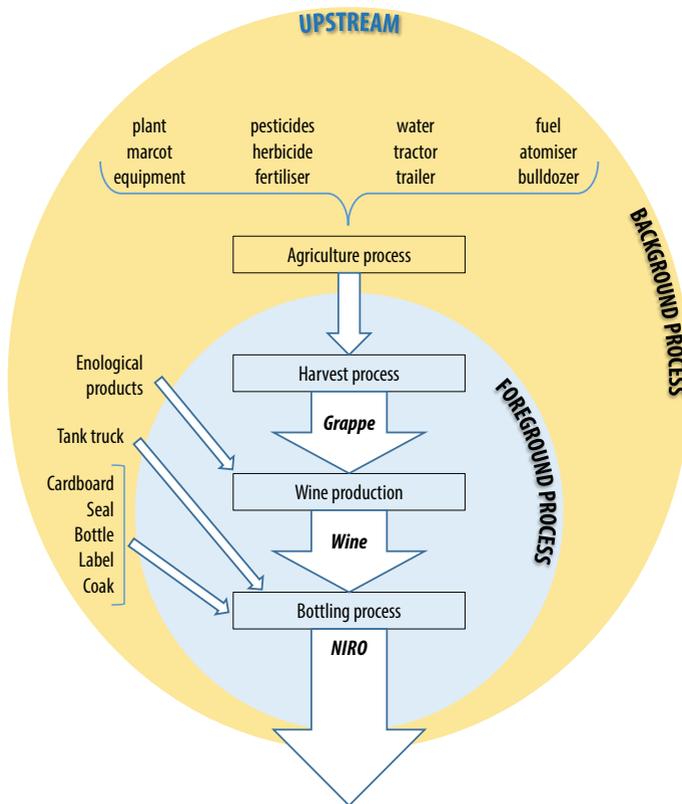


Figure 2: Flow chart of the NIRO brand life cycle

and 6.6 billion for Italy on an average of five years); followed by Germany and Spain (OIV, 2017). In addition, Italy is the European country with the highest number of agro-food products with quality logos. At EU level, the EU Quality Logos guarantee legally that the products are authentic or made in the original town or region with real ingredients. The Protected Geographical Indications (PGI) label shows that the quality or reputation of the food is linked to the place or region where it is produced, processed, or prepared. The Protected Designations of Origin (PDO) label guarantees that the product is produced, processed and prepared in a specific geographical area, using ingredients from the involved region and the know-how of local producers (Council Regulation, 2006). In Italy, the quota of PDO wine production is equal to 39% of the total, adding to this a 31,7% of PGI (Istat, 2017). Generally, there are 408 Italian PDO wines and 118 Italian PGI wines that constitute the cultural heritage of the local community where the grapes and wines are produced. The wine is closely related to the life and work of the people who generate it (Gottardo, 2014). Furthermore,

Figure 2 shows the flow chart of the life cycle of one specific wine brand (called NIRO) distinguishing between background and foreground processes.

### Goal and scope definition in the case study

The definition of the goal and scope of the case-study is shown in the Table 1, according to the Guidance on O-LCA (UNEP/SETAC, 2015). Several elements have been taken as such by the O-LCA methodology, i.e. goal, reporting organisation and system boundary. Otherwise the reference flow has been adapted to the inclusion of social aspects. Indeed, the reference flow based on non-physical elements as the social aspects may do not have a direct connection with input and output of the process (Martinez-Blanco et al., 2015).

### How existing experience and data of the company helped to define goal and scope

The existing experience and data on social and environmental practices of the company provide information on the organisation, suppliers and workers which is also needed for defining the goal and scope phase in SO-LCA (see Table 2). More in detail, the ISO14001:2004 and ISO 9001:2008 provide data collection schemes on the lay out of the company for the business system working. Indeed, it is provided a specific processes mapping, such as the description of the generic and operational company activities. The British Retail Consortium (BCR) may help to identify the system boundary, providing an overview of unit processes and supplier involved in the subject of the study. The identification of the suppliers, their location and the traceability of the raw materials can be a starting point for defining the system boundaries of the study. Thus, it is possible to define the suppliers involved in the life cycle of the subject analysed in the examined reference period. SA8000 helps to define the supply chain of the company but also it allows to obtain a starting point

Existing data	Foreground processes involved			Information provided
	Harvest	Wine production	Bottling	
ISO 14001:2004 ISO 9001:2009	x	x	x	Structure of management team
		x	x	Mapping of unit processes
			x	Lay out of company
		x	x	Evaluating and monitoring of the suppliers
BRC		x	x	Information on suppliers Health and Safety on facilities and workers
			x	Mapping of supply chain
SA8000		x	x	Workers conditions (Salary, Child Labour; Discrimination, Health/Safety, Working Hours, Freedom of Association)

Table 2: The information provided to the different parts of the life cycle through the existing practices and certifications applied in the company

for data collection about the worker's conditions, supplier's ethical behaviour and the stakeholder identification. In this way, several challenges have been overcome for the practitioner, such as to communicate with a company, know where it looks, obtain necessary data and identify which data are necessary to implement SO-LCA. The existing data of the organisation helps the practitioners to implement SO-LCA by providing a starting point to define Goal and Scope phase. The SO-LCA methodology allows to provide a comprehensive social performance assessment of the organisation by involving different departments and management levels. Thus, the involvement of different resources may lead a long term benefit in the data collection phase.

## Conclusions and Future Developments

This work presents which available information in the organisation may be collected and analysed to define the goal and scope phase of SO-LCA. A pilot case-study on a wine company has been conducted to show these benefits. The practitioner or the consultant has a lot of information on social and environmental aspects of the organisation, such as the mapping of the suppliers, the evaluation of some indicators, the social policy and the system practices made by the organisation. This information allows to have a preliminary knowledge of the aspects and topics to analyse. In this way, time and resources saving should be expected to apply to goal and scope phase. This preliminary application suggests maybe there is also an advantage in the application of the other phases of the SO-LCA. For this reason, further developments relate to the need to identify if and how the existing experiences can support also for the other phases, especially the LCI. Indeed, the data collected in the previous experiences allow to get the information on the supply chain and answer to some indicators suggested by UNEP/SETAC, (2013) (e.g. worker conditions; fair salary; child labour; working hours and forced labour). To validate this assumption, an implementation of the pilot case-study for the LCI phase may be suitable.

## References

- Carbone A., Henke R. 2010. Performance e competitività del vino italiano sui mercati internazionali. *Agricoltura nei paesi in via di sviluppo*. Agrireregionieuropa 6(22).
- Council Regulation (EC). 2006. On the protection of geographical indications and designations of origin for agricultural products and foodstuffs. No 510/2006. 20 March 2006
- D'Eusanio M., Zamagni A., Petti L. 2017. La Social Life Cycle Assessment a supporto del Supply Chain Management. Atti del XI Convegno della Rete Italiana LCA, Resource Efficiency e Sustainable Development Goals: il ruolo del Life Cycle Thinking. Siena, Italy. ISBN: 978-88-8286-352-4
- Draucker, L., 2013. In: GHG Protocol: Moving Corporate Accounting beyond GHGs. Abstr. B. SETAC North Am. 34th Annu. Meet. Nashville, USA.
- Fallahpour, A., Olugbu, E.U., Musa, S.N., Wong K.Y., Noori S. 2017. A decision support model for sustainable supplier selection in sustainable supply chain management. *Computers&Industrial Engineering* 105:391-410.

- Gottardo G. 2014. Quando il vino interpreta il territorio. Editoriale Turismo e Psicologia Vol.7, Issue 1. DOI: 10.14658/TP-2014-1
- ISO/TS 14040, 2006. Environmental management—life cycle Assessment—principles and framework (ISO 14040); ISO: Geneva, Switzerland.
- Istat, 2017. L'andamento dell'economia Agricola. Anno 2016. Statistiche report. 19 maggio 2017.
- Martinez-Blanco, J., Lehmann, A., Chang, Y.J., Finkbeiner, M., 2015. Social organizational LCA (SOLCA): a new approach for implementing social LCA. *Int J Life Cycle Assess.* 20,1586–1599.
- Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D. and Zacharia, Z. G. 2001. Defining Supply Chain Management. *Journal of Business Logistics.* 22,1–25.
- Organisation Internationale de la Vigne et du Vin (OIV). 2017. State of the vitiviniculture world market. April 2017.
- Peirson, G., Brown, R., Easton, S., Howard, P., Pinder, S. 2006. *Business finance*, 9th edn, McGraw-Hill, North Ryde, NSW.
- Seuring, S., Müller, M., 2008. From a literature review to a conceptual framework for sustainable supply chain management. *J Clean Prod.* 16,1699–1710.
- Van der Geer, J., Hanraads, J.A.J., Lupton, R.A., 2010. The art of writing a scientific article. *J. Sci. Commun.* 163, 51–59.
- UNEP/SETAC, 2009. Guidelines for Social Life Cycle Assessment of Products. Life-Cycle Initiative, United Nations Environment Programme and Society for Environmental Toxicology and Chemistry, Paris, France.
- UNEP/SETAC, 2013. The Methodological Sheets for Sub-categories in Social Life Cycle Assessment (S-LCA). Life-Cycle Initiative, United Nations Environment Programme and Society for Environmental Toxicology and Chemistry, Paris, France,
- UNEP/SETAC, 2015. Guidance on Organizational Life Cycle Assessment. Life-Cycle Initiative, United Nations Environment Programme and Society for Environmental Toxicology and Chemistry, Paris, France.

# How can Social organizational LCA (SOLCA) benefit from existing and improve future sustainability reporting of companies?

Annekatriin Lehmann<sup>1</sup>, Masaharu Motoshita<sup>2</sup>, Matthias Finkbeiner<sup>1</sup>

<sup>1</sup> Technische Universität Berlin (Germany)

<sup>2</sup> National Institute of Advanced Industrial Science and Technology, Tsukuba, Ibaragi (Japan)

## Abstract

The concept of Corporate Social responsibility (CSR) becomes more and more relevant all over the world and a growing number of companies already incorporates CSR in their strategy and discloses social and environmental information in CSR or sustainability reports. However, existing reports vary significantly, e.g. regarding the number and type of social issues addressed and the level of detail in which the supply chain is considered. Generally, tools such as social life cycle assessment of products (S-LCA) can help to assess social issues and provide information for CSR sustainability reports. However, current product S-LCA is not yet broadly implemented because of the gap between theory and practice, e.g. many social indicators are rather related to the organizational than the product level. To support implementation of social life cycle assessments in practice, a new approach – the social organizational LCA (SOLCA) – was proposed. The conceptual framework of SOLCA builds on S-LCA and organizational LCA (O-LCA) and is currently focused on scope and inventory. The overall goal of this study is to further develop the SOLCA framework by proposing an applicable indicator set to support future life cycle based social assessments in companies. To achieve this a two-fold approach was chosen: First, a status quo and gap analysis of several CSR/ sustainability reports from different sectors and regions is currently conducted to identify which social issues and indicators from existing product S-LCA are already assessed and to which extent the supply chain of the company (and life cycle of products) is considered. Second, the findings will be used to develop an applicable indicator-set by using a combined bottom-up and top-down approach (using both existing companies' experience and available guidelines). The analysis of the CSR/sustainability reports is still ongoing, but it is already shown that they vary significantly with regard to the addressed social issues, indicators and supply chain stages. While social issues related to workers are addressed in all reports, information e.g. related to the local community are seldom disclosed. Moreover, most of the social issues addressed in the reports refer to only selected supply chain stages. Based on this analysis an applicable indicator set for SOLCA will be proposed taking into account their level of methodological development and the availability of data. This study delivers guidance for the potential use of SOLCA within companies and hence supports future life cycle based social assessments. Moreover, it highlights further research demand regarding indicator development.

# Setting the SOLCA concept framework to the artisanal and small-scale mining sector: a case study

**Elisabetta Zerazion<sup>1</sup>, Annekatriin Lehmann<sup>2</sup>, Matthias Finkbeiner<sup>2</sup>, Anna Maria Ferrari<sup>1</sup>**

<sup>1</sup> Dept. of Sciences and Engineering Methods, University of Modena and Reggio Emilia (Italy)

<sup>2</sup> Dept. of Environmental Technology, Technische Universität Berlin, Office Z1, Berlin (Germany)

## Introduction

In discussing extractive sector, reference is made solely to the mining industry especially if the focus concerns the sustainable aspects of the social dimension (e.g. the need of promoting social initiatives in the local communities by the mining enterprises). This view alongside the widespread negative perceptions of ASMs has contributed to isolate the ASMs and to exclude them from the progress programs.

Latterly it is possible to observe an initial inversion of this pattern due to either internal and external reasons to the mining world resulting in the incremented numbers of studies related to ASM activities. As said the grounds are multiple, starting from the great interest to the supply chain of critical materials (e.g. precious metals) and to the international efforts for attaining the SDGs, that considering the geographical location of ASMs and the numbers of people involved (25-50 million). The promotion of sustainable practices in ASMs could bring improvements to the sector as well as to the affected countries and thereby be contributing to achieving the SDGs. As far as the internal reasons, the incremented conflicts between ASMs and the relative states (e.g. informality issue) and between ASMs and Large Scale Mining (LSM) companies (e.g. land rights disputes) and last but not least the social pressure on local communities by the ASM activities, all this factors have contributed to bring to light the ASMs reality.

In line with this perspective, the study aims to identify and develop a framework suitable for assessing the social performance of ASMs in order to promote and achieve a more inclusive and responsible mining sector. Besides, the research focuses on testing the applicability of SOLCA concept framework to ASM context applying in this way a life cycle approach to solve this query.

Consequently, the main research questions of the work are as following:

- Can social issues associated with ASMs be analysed from a life cycle perspective?
- Is the Social Organizational LCA concept framework a valid structure for developing a social assessment?
- Can the Social Organizational LCA being adopted for the particular ASM context and being adjusted to this specific case?

## Methods

Considering the Social LCA as well as the Social Organizational LCA, one of the main features that characterized both frameworks is the goal and scope phase, in which the assessment framework's and the stakeholder map play a relevant role in affecting directly the final results of the social assessment. Hence, in order to answer the identified research questions, it was opted for focusing on this two main steps of the goal and scope phase.

To accomplish this both the S-LCA Guidelines (Benoît Norris 2009) and the SOLCA concept framework (Martínez-Blanco et al. 2015) a literature review on the existing studies developed on Social LCA and ASM sector was conducted, since SOLCA was not applied at the present time of the work (2016). Then, based on this, each step considered in the "goal and scope" phase was defined both according to S-LCA and according to SOLCA - as though constructing two separate studies for assessing the social performance of ASM. The main aim of this step was to underline, when present, the main gaps for accomplishing a social assessment of ASM sector and to compare both frameworks and find out which of the two frameworks can be more suitable for describing the ASM sector.

Then, the systematic literature review was carried out in scientific papers, international reports, international standards, etc. dealing with at least one social aspect associated with ASM organizations, aiming a better understanding of the social ASM context. Besides, this top-down approach was applied to identify the main social issues related to ASM, that should be investigated in a SLCA/SOLCA study, i.e. to define categories, subcategories, and indicators suitable for the ASM as well as to identify/map of stakeholders.

The top-down approach (which leads to a "theoretical" list of social topics/stakeholders) was accompanied by a bottom-up approach: In a case study, this theoretical framework was applied for studying the social performance of a gold ASM situated in Colombia. In Autumn 2016, the field activity was conducted pursuing several objectives: i) carrying out semi-structured interviews with the stakeholders identified throughout the literature analysis; ii) consultation of different actors apparently not directly affected by the ASM impacts (open interviews); iii) integration of the top-down results with the primary data obtained through a participatory approach (International Finance Corporation 2014; Mathe 2014; McCabe and Halog 2016), this both for realizing the stakeholder map and the framework of categories, subcategories, and indicators chosen for describing the ASM organization in its entire life-cycle.

## Results

The confrontation of each step considered in the "goal and scope" phase has allowed to highlight the specific features of ASM sector for assessing its social performance. For brevity it is reported the result related to the definition of the Functional Unit (Table 1) which represents one of the most significant gap between the two analysed framework.

S-LCA	SOLCA	NOTES
<ul style="list-style-type: none"> <li>The object of study is the gold produced by a Colombian ASM.</li> <li>The functional unit is 1 kg of gold produced in the studied ASM over a certain period of time.</li> </ul>	<ul style="list-style-type: none"> <li>The reporting unit is the organization itself, i.e. the ASM and its portfolio is represented by the gold production.</li> <li>The reporting flow is indicated as the total revenue of the ASM obtained in the considered time frame.</li> </ul>	<ul style="list-style-type: none"> <li>Although Martínez-Blanco suggests to express in non-physical terms the reporting flow, it is still observed a non-overlapping whether generic indicators are considered in the assessment (e.g. governance related indicators). Besides, the suggested quantification of the product portfolio, i.e. the economic revenue, is not an easy term to define in ASM context.</li> </ul>

Table 1 Confrontation of the analysed system and F.U. (Reporting Unit and Reporting Flow) applying both S-LCA and SOLCA in ASM context, expressed using a Colombian gold ASM as case study.

During the analysis of the state of art, it was observed an evident gap in the literature regarding the correlation between S-LCA and ASM. This is valid independently of the type of the article (i.e. quantitative, qualitative, etc.). In fact, there are few examples of applying the Social LCA in ASM sector (Tsurukawa, N., Prakash, S., & Manhart 2011; Ochoa et al. 2014), where the authors set up their work on the basis of the Social Guidelines instructions (Benoît Norris 2009). Therefore, the latter was taken as the reference mark for the current study.

Consequently, the resulting main literature references for this study are the Social Guidelines and the work of Martínez-Blanco (Martínez-Blanco et al. 2015) and, analysing how both track the stakeholder map and the framework of categories, subcategories and indicators, it is possible to highlight that the studied steps of the goal and scope are not defined following a standardized method. The common element is represented by the UNEP/SETAC Methodological Sheets (UNEP 2013) that were used as starting point for setting up the framework of the categories, subcategories and indicators and the stakeholders identification in the current study. This framework was modified according to the resulting input obtained from the literature review focused on ASM sector and subsequently integrating the findings obtained from the participatory approach.

Once identified the social themes that are relevant for carrying out the social assessment of the ASM organization, it was defined the stakeholder map as well as the categories, subcategories, and indicators. The actors that are considered to be involved in the ASM activities are as follows:

- Organization: bosses and/or administrators and the employees (indicating the rank and task, e.g. Chatarrero, i.e. scrap mining and barequeo, i.e. gold panning).
- Suppliers: sellers, traders and transporters.
- Customers: sellers (e.g. local gold shops), traders and transporters.
- External actors: Government authorities (both local and national), Responsible for the public health, Health workers, Local community, International or civil society organizations, i.e. NGOs., Trade Unions and/or Committees, Farmers.

Impact categories	Subcategories	Indicators
<b>Food security and Land degradation</b>	Food insecurity	Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES).
	Agri-food production	Volume of production per labour unit by classes of farming/pastoral/forestry enterprise size.
	Food price	Indicator of food price anomalies.
	Land degradation	The portion of degraded land out of the total land area due to ASM activity.
	Ecosystem services loss	According to the potential ecosystem services of the mining area, indicate its loss due to the ASM activities as the gap out to the previous conditions.
	Mine site closure	Seek to mitigate, in greater detail, the broader negative effects of site closures on mining communities, especially the social, economic and environmental effects associated with site closure.
	Waste treatment	Properly treat or dispose of hazardous material and waste from its site(s). Presence or provide for safe storage and disposal of residual wastes and process residues.
	Transport of hazardous materials	Safe handling and transport of hazardous materials.
	International Cyanide Management Code	Application and respect of the International Cyanide Management Code.

Table 2 Fragment extracted from the framework of categories, subcategories and indicators developed for ASM context.

The entire developed framework is constituted by eight main categories, i.e. Working conditions, Occupational health and safety (OHS), Health and Safety, Governance, Community infrastructure, Food security and Land degradation, Trade; for the sake of brevity, it is reported a fragment in Table 2.

As summarized in Table 2, one of the aspects emerging from the study is the relationship between the ASM activities and other economic business, such as the Agri-food sector. This link has relevant consequences in terms of food security and land degradation, both aspects that shall be investigated following the presented indicators.

## Conclusions and future developments

The social themes inherent to the ASM activities along the life cycle have been well defined thanks to the SOLCA concept framework, the Methodological Sheets and the specific literature on ASMs. The framework of categories, subcategories, and indicators was developed considering the ASM organization and not the resultant product from its activities. However, for answering the second research question is needed to develop an assessment for emerging the criticalities of SOLCA concept framework and of this implemented set of categories, subcategories, and indicators. Although,

the authors stress out that the shift in considering the organization as the subject of the analysis instead of the product could bring to several levels of interpretation since the considered assessment framework is more comprehensive as well as the studied stakeholders.

As mentioned above, the literature review has played a significant part for setting the SOLCA concept framework, but the authors also highlight the crucial role of the participatory approach for investigating and defining the social hotspots and the people affected. The integration of the top-down and bottom-up approaches by relying on the participatory approach is also recommended by the authors, because it makes possible to take in considerations the opinions of public decision-makers who affect the evolution of these impacts through regulatory measures as well as the main stakeholders.

## References

- Benoît Norris, C. , 2009. Guidelines for social life cycle assessment of products. BENOÎT, Ca. UNEP/Earthprint, Druk in de weer, Belgium. Available at: [http://www.unep.fr/shared/publications/pdf/DT1x1164xPA-guidelines\\_sLCA.pdf](http://www.unep.fr/shared/publications/pdf/DT1x1164xPA-guidelines_sLCA.pdf) [Accessed April 5, 2017].
- International Finance Corporation. , 2014. A Strategic Approach to Early Stakeholder Engagement A Good Practice Handbook for Junior Companies in the Extractive Industries. 1–170. Available at: [https://commdev.org/userfiles/FINAL\\_IFC\\_131208\\_ESSE\\_Handbook\\_web\\_1013.pdf](https://commdev.org/userfiles/FINAL_IFC_131208_ESSE_Handbook_web_1013.pdf).
- Martínez-Blanco, J, Lehmann, A, Chang, Y-J, and Finkbeiner, M. , 2015. Social organizational LCA (SOLCA)—a new approach for implementing social LCA. *Int. J. Life Cycle Assess.* 20, 1586–1599. Available at: <http://link.springer.com/10.1007/s11367-015-0960-1> [Accessed April 4, 2017].
- Mathe, S. , 2014. Integrating participatory approaches into social life cycle assessment: the SLCA participatory approach. *Int. J. Life Cycle Assess.* 19, 1506–1514. Available at: <http://link.springer.com/10.1007/s11367-014-0758-6> [Accessed April 6, 2017].
- McCabe, A, and Halog, A. , 2016. Exploring the potential of participatory systems thinking techniques in progressing SLCA. *Int. J. Life Cycle Assess.* 1–12. Available at: <http://link.springer.com/10.1007/s11367-016-1143-4> [Accessed April 13, 2017].
- Ochoa, K, Castaño, I, and Alvarez, B. , 2014. Social Life Cycle Assessment for Open Pit Gold Mining in Colombia : a case study in Tolima. *Soc. LCA progress, Pre-proceedings 4th Int. Semin. Soc. LCA90–92.*
- Tsurukawa, N., Prakash, S., & Manhart, A. , 2011. Social impacts of artisanal cobalt mining in Katanga, Democratic Republic of Congo. Freiburg. Available at: [http://resourcefever.com/publications/reports/OEKO\\_2011\\_cobalt\\_mining\\_congo.pdf](http://resourcefever.com/publications/reports/OEKO_2011_cobalt_mining_congo.pdf) [Accessed January 12, 2018].
- UNEP. , 2013. The Methodological Sheets for Sub-Categories in Social Life Cycle Assessment (S-LCA). UNEP/SETAC [ed.]. Available at: [http://www.lifecycleinitiative.org/wp-content/uploads/2013/11/S-LCA\\_methodological\\_sheets\\_11.11.13.pdf](http://www.lifecycleinitiative.org/wp-content/uploads/2013/11/S-LCA_methodological_sheets_11.11.13.pdf) [Accessed April 25, 2017].

# Social risk in raw materials extraction: a macro-scale assessment

**Umberto Eynard<sup>1</sup>, Lucia Mancini<sup>1</sup>, Franziska Eisfeldt<sup>2</sup>, Andreas Ciroth<sup>2</sup>,  
David Pennington<sup>1</sup>**

<sup>1</sup> *European Commission Joint Research Centre, Ispra (Italy)*

<sup>2</sup> *GreenDelta GmbH, Berlin (Germany)*

## Introduction

Raw materials are essential for any modern society and they can contribute to the achievement of many of the Sustainable Development Goals launched by the United Nations [1]. On the other side, the production of materials can generate severe social impacts, especially in case of poor governance and weak institutional and legal framework [4]. Improving social performance is a relevant objective for industries involved in raw materials production, in terms of good business practice, including in view of gaining trust and acceptability. This is e.g. reflected in the growing role of Corporate Social Responsibility (CSR) and information disclosure practices, like the Global Reporting Initiative (GRI) [5]. Several individual companies and also governmental authorities are equally increasingly addressing social performance of supply chains. From a trade perspective, the import of minerals from conflict-affected and high-risk -areas<sup>1</sup> is an issue of concern for policy and downstream operators trying to sustain legitimate trade.

The interconnections among the various economic sectors in the global economy are becoming more and more complex. In many cases raw materials and final goods used in the developed countries are produced in other regions, where economic, environmental and social conditions may be critical. However, these impacts are hidden to the final customers, as they occur in the upstream phases of the supply chain. Global trade has therefore a fundamental role in influencing social conditions. From a customer and societal perspective, awareness, requests, and obligations for transparency on hidden impacts are increasing. In the case of electronic products supply chains, production phases of components and manufactured goods often take place in e.g. Asia. In many cases raw materials are extracted in countries where economic and geopolitical conditions happen to be considered very critical, such as in the Democratic Republic of Congo (DRC). In this area some mineral extraction and trade has been proved to finance conflicts and civil wars, leading to the definitions of "conflict minerals" [6].

---

1 "conflict-affected and high-risk areas" means areas in a state of armed conflict, fragile post-conflict as well as areas witnessing weak or non-existent governance and security, such as failed states, and widespread and systematic violations of international law, including human rights abuses" [2]

In order to face this challenge and to separate good from bad practice, many countries, including in the European Union, have issued e.g. regulations to improve transparency in product supply chains. In the case tin, tungsten, tantalum and gold companies are required to perform a supply chain due diligence, in order to facilitate that suppliers are not involved with conflicts, human rights violations, illegal trade, etc., based on guidance from the Economic Co-operation and Development (OECD) [7]. An additional challenge related to raw materials, of high concern to governments and to companies, is their security of supply. To help address this challenge at e.g. the EU economy scale, the European Commission published a list of Critical Raw Materials (CRMs), based on their economic importance for the EU industrial sectors and their supply risk. In order to support the EU raw materials policy, the European Commission is developing the Raw Materials Information System (RMIS)<sup>2</sup> and issued the 2016 Raw Materials Scoreboard [8].

Given the above context, assessing social impacts associated with supply chains could support decision making in policy and business contexts, in order to progress towards the sustainable supply of raw materials and sustainable development goals. Adopting life cycle approaches in such assessments could highlight the main considerations in supply chains, and help to avoid burden shifting among impacts and geographical regions. Within the Life Cycle Assessment (LCA) methodologies, Social LCA (SLCA) addresses social and sociological aspects of products, their actual and potential positive as well as negative impacts along the life cycle.

The purpose of this study is to apply SLCA databases to perform a macro-scale assessment of social performance of the mining and quarrying sector in six extra-EU countries, compared to the EU-28 average. This approach has also been considered in background developments for the “2018 Raw Material Scoreboard” developed by European Commission. The analysis offers a chance to reflect upon the current feasibility and robustness of a prominent quantitative assessment approach of social sustainability and the use of this information for supporting e.g. policy making in the European context. In particular, we highlight the potential and the limitations of using this SLCA approach and databases for performing supply chain due diligence analyses.

## Methodology

In order to analyse social considerations associated with supply chains of raw materials we selected the PSILCA database among the existing SLCA data sources as a prominent example. The underlying reasons for this choice are that PSILCA is a relatively well updated data source with transparent documentation of original sources. Moreover it provides a data quality assessment [9]. The software used for calculations was openLCA v 1.6.3. Equally important, it is somewhat comprehensive in terms of the social considerations to be assessed in this study. This database was therefore considered representative of good practice for the approach assessed here.

---

2 <http://rmis.jrc.ec.europa.eu/>

For the comparison among countries and at the EU-28 scale, we proceeded with the selection of relevant Country-Specific Sectors (CSS) (such as “iron ore mining in Australia”) from the database, and the aggregation of European CSS for the 28 EU countries, in order to have an average EU-28 result. The analysis of the social performance regards the EU mining sector, in comparison with six extra-EU countries: Australia, Brazil, China, Russian Federation, South Africa and United States. Results are expressed in medium risk hours, which is the number of worker hours along the supply chain that are characterized by a certain social risk. We aggregated the EU countries with a weighted average, where the production values for each economic sector are used as weighting factors, using latest available data from Eurostat. In order to select the relevant impact categories from those present in PSILCA, we developed a set of seven criteria. They refer to the relevance of the topic for the RM sectors and policy, the impact assessment method used to assess the social risk and the quality of the data available in the database. The final category selection includes: Child labour; Contribution to economic development; Corruption; Fair salary; Freedom of association and collective bargaining; Health and Safety (for workers); Migration; Respect of indigenous rights; Working time.

## Results

The countries selected for the investigation are compared based on their social indicators, for a set of impact subcategories. In Figure 1, overall social indicator results for the nine impact categories are displayed for the mining and quarrying sectors for the seven countries/regions. The different impact categories are displayed on the x-axis and the respective social indicators for the separate countries can be compared on the basis of the coloured bars. Social indicators are presented in medium risk hours. In addition, results of the study offer an insight into the contribution of country-sectors in a certain supply chain. In the case of the EU mining and quarrying sector, the three top locations contributing to the social indicator for the impact category “fair salary” are India, China and UK. The pie charts in Figure 2 present which sectors are mainly contributing to the social risk results in the corresponding countries.

## Data quality and uncertainty

For every process and indicator, PSILCA provides a data quality assessment based on a pedigree matrix [9]. In our analysis, main data quality concerns are mainly for the following impact categories:

- Child labour: estimates are not specific for the sectors; they are sometimes old.
- Corruption: low reliability of data source for one of the indicators.
- Freedom of association and collective bargaining: for some indicators in data are not specific for the sector.

Concerning the methodology used in this study, the main sources of uncertainty are likely to include the aggregation of countries in the EU-28 group and the application of cut-off criteria ( $1E-04$ ), necessary to run the calculation in a reasonable timeframe.

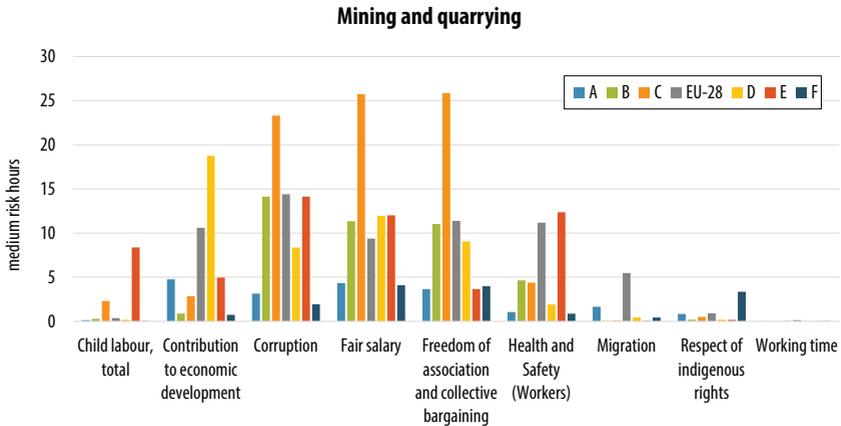


Figure 1: Comparison of social indicator results of this study for the mining and quarrying sector, in all selected countries and in EU-28

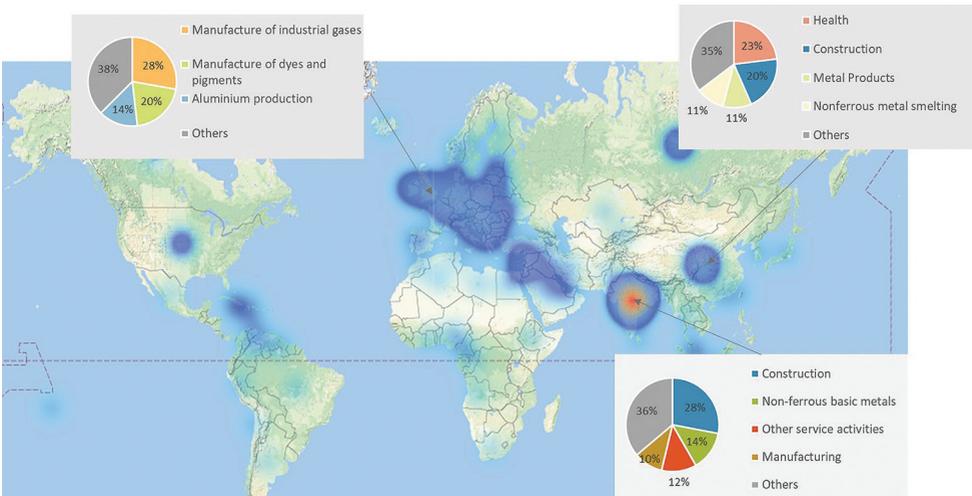


Figure 2: Map with locations hotspots and sector contribution to the impact category indicator “Fair salary” in the mining and quarrying sector, in EU

Concerning the SLCA methodology used here and the PSILCA database used for this analysis, uncertainty derives from the underlying multi-regional input/output model, as described in Lenzen et al. (2010) [10]; in the data on social aspects retrieved from international statistical agencies; as well as how the different sources of information are integrated to e.g. align sectors. The international statistical data are from different

sources (e.g. surveys, administrative records, etc.), each of them having its limitations in terms of data quality, uncertainty, and gaps.

## Conclusion and outlook

In this study we used the SLCA database PSILCA with a top-down (I/O-based) LCA approach to assess at macro-scale the social performance attributable to the mining sector, providing a quantitative comparison among different countries. Results give an overview of overall social performance, and hotspots concerning countries, impact categories, and sectors. This could be a basis for an evaluation of e.g. social footprint assessments and evaluation of trading partners. Results offer also insights into the supply chains at a macro scale, showing which upstream country-sectors are mostly contributing to different indicators. While we focused on the extraction phase of raw materials, similar analyses could include the end-of-life phase, which is also critical in terms of social conditions of workers, local communities, etc. It should be noted that the life cycle approach adopted in this study and the database chosen to be used reflect typical current practice for macro scale insights. Uncertainties and robustness of the results must be carefully evaluated. More detailed studies will remain necessary for insights related to specific products/sectors, including supply chain modelling and site/domain-specific information for social considerations to be assessed.

## References

- [1] UN General Assembly, "Transforming our world: the 2030 Agenda for Sustainable Development," New York: United Nations. 2015.
- [2] European Union, Regulation (EU) 2017/821 of the European Parliament and of the Council of 17 May 2017 laying down supply chain due diligence obligations for Union importers of tin, tantalum and tungsten, their ores, and gold originating from conflict-affected and high-risk areas. 2017.
- [3] UNEP/SETAC Life Cycle Initiative, Guidelines for Social Life Cycle Assessment of Products. 2009.
- [4] L. Mancini and S. Sala, "Social impact assessment in the mining sector: Review and comparison of indicators frameworks," Resour. Policy, 2018.
- [5] Global Reporting Initiative, "G4 Sustainability Reporting Guidelines. Reporting principles and standard disclosures," 2013.
- [6] P. Le Billon, "The political ecology of war: natural resources and armed conflicts," Polit. Geogr., vol. 20, no. 5, pp. 561–584, Jun. 2001.
- [7] OECD, "Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas. Third Edition," 2016.
- [8] EC, "Raw Materials Scoreboard - European Innovation Partnership on Raw Materials," 2016.
- [9] A. Ciroth and F. Eisfeldt, "PSILCA – A Product Social Impact Life Cycle Assessment database. Documentation." 2016.
- [10] M. Lenzen, R. Wood, and T. Wiedmann, "Uncertainty analysis for multi-region input-output models – a case study of the UK's Carbon Footprint," Econ. Syst. Res., vol. 22, no. 1, pp. 43–63, Mar. 2010.

# The experience of Urban Wellbeing Laboratories. A study of the social, energy and environmental costs of the food supply chain in Campania Region

**C. Vassillo, D. Restaino, R. Santagata, S. Ulgiati**

*Department of Sciences and Technologies, Parthenope University of Napoli (Italy)*

## **Abstract**

Nowadays, the growing interest in energy shortages and environmental integrity issues is leading to reconsider the impacts of human activities on the dynamic of the planet. Loss of biodiversity, increased waste and pollution, water contamination, energy constraints and poverty, deforestation, toxicity are no longer unknown words in daily life. According to the media, experts, and social society, topics such as climate change, energy efficiency, reduction of carbon footprint, sustainable development, resources distribution, are increasingly becoming important topics of discussions and it is important to engage stakeholders to manage these situations.

Communicating with stakeholders and providing them all the information considering energy, environmental, economic and social aspects and impacts, is not easy, especially in situations where a large number of different stakeholders, with different stakes, interact.

Engaging the stakeholders is equivalent to structuring a systematic pattern of interactions, which can be followed through the entire life cycle of the project, plan, program or activity. Planning their involvement in a systematic process at different stages of an activity, gives the possibility to support the activity itself, and government and policies that might be successful thanks their involvement. For this reason, we designed and implemented a proposal for urban wellbeing laboratories, i.e. opportunities to work together, compare problems and solutions, identify patterns for improvement.

In the present study, the urban wellbeing laboratory team focused on the food supply chain in Campania Region, in order to analyze all the impacts and potential improvements, all over the supply chain, from agricultural activities to distribution, by means of questionnaires, focus groups, statistical data processing and social and LCA approach. Results suggests that the perfect solution does not exist, while instead an optimum compromise can be reached to meet at least partially the expectations and the needs of all the stakeholders and, at the same time, gain energy and environmental benefits.

# The Product Social Metrics consensus developed by major companies

Mark Goedkoop<sup>1</sup>, Ilonka de Beer<sup>2</sup>

<sup>1</sup> PRé Sustainability, Amersfoort (The Netherlands)

<sup>2</sup> Sandalfon Sustainability

## Introduction

Since 2013 a group of sustainability experts from over a dozen leading companies have come together in the Roundtable for Product Social Metrics, aiming to make social impact assessment more accessible and meaningful through the development of a handbook for social impact assessments of products and services along value chains.

## Development process

The initial step was to bring internal sustainability experts from a few proactive companies together, and discuss how a method can be developed, that can work in a decision-making context as well as for communicating social impacts. After three meetings the companies decided to fund a project to start a development process, which is illustrated in the figure below:

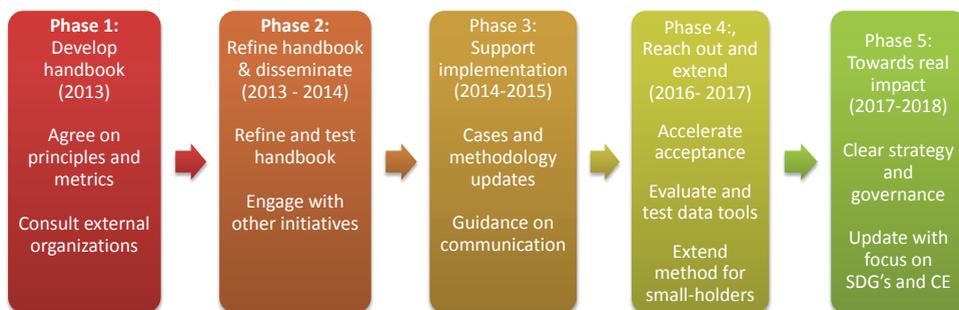


Figure 1: Overview of the 5 development stages

## The method

The methodology was developed by carefully evaluating existing publications, such as the UNEP-SETAC LC initiative Social LCA handbook (UNEP/SETAC 2009), and comparing this with what companies can realistically handle. The core function of the roundtable is thus to develop a compromise between sophistication and practicability. This also

means much effort is spent on developing case studies to test the method and learn how it can be improved.

The method is described in a freely available handbook (Fontes et al. 2016). It assesses the impacts on workers, users and local communities using in 19 topics (or impact categories). The previous handbook contained a quantitative and a qualitative version. The quantitative version proved very difficult to use, and was dropped. The qualitative version uses a five point scale. The measurement itself is done with performance indicators. The measured values of the indicators determine a position on the 5-point scale. During the fourth phase of the project, the roundtable has also started to work with on-line data collection tools such as the SupplyShift tool and an extension of the method was developed to include an additional stakeholder group – smallholders.

+2	Ideal performance; a positive output achieved and reported
+1	Progress beyond compliance is made and monitored
0	Compliance with local laws and/or aligned with international standards
-1	Non-compliant situation, but actions to improve have been taken
-2	No data, or Non-compliant situation; no action taken

Figure 2: The handbook describes two versions of the method; one with a qualitative 5-point scale and a quantitative method. Above an example of the 5-point scale is provided from the previous version of the handbook; the third level is the reference level

As the companies developed about a dozen case studies (mostly internal), much experience was gathered on the practical applicability and we got insights what works and what does not. Furthermore, the recent interests in Sustainable Development Goals (SDGs) and Circular Economy (CE), as well as the experiences from the development of the smallholder extension prompts us to move from measuring compliance to measuring real progress.

## The planned update

This presentation will provide an overview of the results of the update process. This update has the following elements: (1) a better link with the SDGs, (2) a better link with CE, (3) a full integration with the recently developed fourth stakeholder category: smallholders (Indrane 2017(1)), (4) moving focus from measuring of compliance to measuring positive (or negative) outcomes, using the Theory of Change (C. Chris et al. (2011), (5) a more consistent link between indicators and the 5-point scales, (6) a much more efficient data collection procedures by adding a hotspot screening step before the actual data collection, (7) experimenting with hotspot databases and tools and finally (8) making the handbook more in a “how to” mode.

## **Better link to the SDGs**

The SDGs brought clarity in the direction society and thus companies will develop. Thus, companies are very active in trying to understand what this means for them and they are trying to understand and communicate to what extent they are and will be contributing to SDGs. At the end of phase 4 of the project, the consensus was that we need to link the methodology to the SDGs. While this sounds attractive; it is much harder than it seems if one wants to substantiate these linkages. The problem is that the indicators underlying the SDGs are developed for governments and not for companies. Our research also led to the realisation that in the current handbook the emphasis is on compliance, and not on measuring progress. Now companies agree that indeed we must move beyond compliance and see if and how actors in the supply chain are making progress. The SDGs can never be met without such progress. For these reasons, all the topics are updated to move away from measuring compliance to measuring progress. The Smallholder extension was already developed with this principle in mind (Indrane et al. 2017(2)).

## **More efficient and realistic data collection procedures to assess the supply chain**

While pragmatism and efficiency are in the core of the mission of this roundtable, in practice data collection was really cumbersome. Based on the inputs from some of the roundtable members, the data collection will be split up into two steps. The first step is to perform a screening for hotspots; the second step is the actual data collection from these hotspots. The screening can be done with various tools, like the Social Hotspot database or the PSILCA database on the sector and country level, or more specific with commercial tools, who assess individual companies using human and artificial intelligence to interpret messages that can be found on internet and sustainability reports. The screening is also a good check on the compliance level, as companies will probably never admit in a questionnaire they are not compliant. In the second step questionnaires are used to find out more about the hotspots, via Excel or commercial tools developed for this purpose.

## **Addressing the use-phase and the Circular Economy Concept**

In the previous handbook the impacts in the use-phase were measured in terms of Health and Experienced Wellbeing. Especially the latter proved difficult to apply. A new development is also the popularity of the Circular Economy (CE) concept. It is important to understand that CE is not only about recycling and reuse, but also about reinventing business models, like offering product service systems. This experience and the new CE perspective has led to developing a separate assessment where the product functionality and the services associated with the products are assessed, and where possible linked to the SDGs. The big benefit of this separation is that often a certain business unit has one supply chain, but makes many different products. This

means it is not necessary to repeat the data collection each time a new product is developed that uses the same supply chain. Consistent with the CE concept, the end of life processes are handled as if they are part of the supply chain, either for the product at hand or for the next product.

## Conclusions

Working with companies is a great way to find out what will work in a business context and what will not. This means we are not trying to focus on the best possible science, but we are bringing the science around us on to the table of the decision makers. The companies also find it very important that we also link to other initiatives in this area and we have an open dialogue with science, NGO's and other initiatives, and therefore our initiative must remain open source and freely available for all.

## References

- UNEP/SETAC. (2009). Guidelines for Social Life Cycle Assessment of Products. Management (Vol. 15). <https://doi.org/DTI/1164/PA>
- Fontes et al, 2016. Handbook for Product Social Impact Assessment, Version 3.0. PRÉ Sustainability 2016 (<https://product-social-impact-assessment.com/wp-content/uploads/2014/07/Handbook-for-Product-Social-Impact-Assessment-3.0.pdf>).
- Indrane et al, 2017 (1). Small but Complex: Assessing social impacts on smallholders in agri-food sector. Manuscript submitted to the SLCA Conference, 2018 in Pescara.
- Indrane et al, 2017(2). Consistent assessment of positive impacts. Manuscript submitted to the SLCA Conference, 2018 in Pescara.
- C. Chris et. al (2011). "A Systematic Review of Theory-Driven Evaluation Practice from 1990 to 2009". American Journal of Evaluation. 32 (2): 199–226. doi:10.1177/1098214010389321.

# Challenges and opportunities of using Social LCA in the Norwegian construction and public procurement

**Selamawit Mamo Fufa, Åshild Lappegard Hauge, Sofie Mellegård**

*SINTEF Building and Infrastructure, Oslo (Norway)*

## Introduction

The building industry is responsible for over one-third of all final energy and half of global electricity consumption and also responsible for about one-third of GHG emissions. Accordingly, the construction sector has major impact on the reduction of energy use and GHG emissions. In response to Paris deal in 2015, Norway is committed to a target of a minimum of 40 % reduction in GHG emissions by 2030 (compared to 1990 levels) and to becoming a low emission society by 2050 [1]. The Norwegian government's expert committee for green competitiveness proposed 10 principles to form the basis for policy-making for the green shift, including: 1) informed decision-making should be facilitated; 2) public procurements should require green solutions; and 3) a life cycle perspective has to be the basis for all public investments and procurements [2]. Furthermore, the revised Norwegian guidance to public procurement include regulation that require to include pay and working conditions in public contracts (in order to combat social dumping) and consideration of socially responsible public procurement which verifies that human right and the ILO core conventions are respected during the production process.

The use of life cycle thinking enables to support different stakeholders in the building industry to make informed decision-making. In Norway, there are strong research environments and a growing market demand for the application of life cycle assessment (LCA) in buildings. Environmental product declaration (EPD) is also used as a tool to evaluate, document and communicate the LCA results of building products in order to facilitate fair comparison and help users to make informed material selection [3]. EPD has gained ground in the Norwegian building industry, especially after the launch of BREEAM-NOR, which awards credits to projects that use products documented by EPDs.

Evaluation of buildings should not only capture the functional and environmental performance required, but should also consider the economic and social impacts originated during the product life cycle. The LCA methodology has been extended to address the associated social and socio-economic aspects, and potential positive and negative impacts of a product throughout its life cycle, using Social life cycle assessment (SLCA). SLCA can be used to identify social hot spots, communicate, and report social impacts, set up strategies and action plans to minimize negative impacts and inform management policies and purchasing practices. Unlike LCA and

Life cycle costing (LCC) used for economic analysis, SLCA still lacks clear definitions of impact categories and social indicators, sufficient analytical and theoretical tools, and a standardized approach [4]. The social aspects are context dependent, and may be considered by different stakeholders (workers/employees; local community; national and global community and consumers), different countries, and regions in diverse manners.

## **Aim and Methodology**

The objective of this study is to identify and evaluate the main challenges and opportunities of SLCA in the Norwegian construction industry. Further, the aim is to identify social hotspots and encourage socially sustainable production and use of products for the Norwegian construction industry. The findings are based on literature review of research on challenges in the Norwegian construction industry, in order to evaluate and relate previous research to SLCA studies.

## **Results and discussions**

The Guidelines for SLCA of products published by a working group within the UNEP/SETAC life cycle initiative [5] have been evaluated for their usability and applicability by different researchers around the world. The European standard NS-EN 15643-3:2012 Sustainability of construction works - Assessment of buildings - Part 3: Framework for the assessment of social performance defines a general framework for the assessment of social performance of buildings based on a life cycle approach, with a list of social performance categories to be addressed. General guidelines for the evaluation of social performance categories for the user phase of a building are provided by standard NS-EN 16309:2014+A4:2014 Sustainability of construction works - Assessment of social performance of buildings - Calculation methodology, and its effective assessment is mainly based on qualitative criteria and a checklist approach. These criteria and checklists are also evaluated by some studies [6].

In Norway, there is a lack of SLCA studies in the construction industry even if SLCA guidelines are tested and evaluated in some other areas [7, 8]. Incorporating the SLCA can enable evaluation of the social impact, not only from local production, installation, use and end of life phase of building products and buildings, but also throughout the supply chain. This can also help to prevent negative social impact along the supply chain, as most construction materials are imported from abroad.

One recent study from the Norwegian University of Science and Technology (NTNU) shows that counterfeit or fake materials is an increasing problem in the construction industry. This leads to increase costs, and affects quality, health and safety of the end users [9]. Lack of awareness and anti-counterfeit strategies, a high degree of trust combined with lack of controls and a constant time- and cost pressure, are parameters that make the construction industry vulnerable to counterfeit materials. Especially, new type of products seems to be vulnerable due to lack of knowledge, standards

and documentations. Although testing and certification of products helps to assure quality, fake documentations are also in use.

SLCA studies are incorporated in very few environmental product declarations (EPDs) published from the Swedish programme operator (International EPD system). SLCA is recommended to evaluate the social performance of a product as the inclusion of economic and social aspects as additional information in EPDs as suggested by the programme operator [10]. This enables to avoid burden shifting from one sustainability issue to another. However, there is no EPD from EPD Norway declared with SLCA included in the EPD. Development and introduction of SLCA in the well-used Norwegian EPD system can contribute to the expansion of SLCA with the accepted set of indicators for evaluation of social sustainability.

Evaluation of the social implications of building products and buildings along the full life cycle, results in possibilities not only to address the “social dimension” in sustainable material production and selection, but also possibilities for improving the circumstances of affected stakeholders involved in different life cycle stages of the building. The Norwegian government has introduced laws and regulations at the beginning of 2008 which require employers in the construction industry to supply all their employees with identity (ID) cards. The ID cards were introduced with the aim to facilitate control measures, and to prevent undeclared work and social dumping. The ID cards were also introduced to improve the health conditions of the workers, and increase the focus on the work environment and safety at the construction sites. However, these laws are not always applied. Building owners and developers may use undeclared labour, mainly foreign workers, for example for maintenance, replacement and refurbishment of buildings, to get the job done as cheap as possible. Another challenge is the use of modules or prefabricated products during the construction phase. These modules can be environmental-friendly due to shorter construction period and the associated emissions, however the modules can have negative impacts on local employment, if the prefabricated materials or modules are imported.

The Norwegian regulation requires contracting authorities to include a clause in their contracts that obliges contractors and subcontractors to make sure that collective agreements or minimum pay and working conditions considered normal for the place and profession concerned are respected. For the production of products in countries where national legislation and internationally recognised principles relating to human rights and labour standards are not fully respected, supplier is responsible for safeguarding contract clauses concerning socially responsible production. Even if the revised Norwegian guidance to public procurement include regulations that require socially responsible public procurement (SRPP), only few public institutions have the capacity or expertise to monitor whether their suppliers do so. There are success stories in SRPP where framework agreement on monitoring ethical standards in the supply chains of municipal contract is established. A clarification of this can enable the construction industry to be more offensive in battling labour crime, and more proactive in achieving healthy working conditions. BREAM-NOR was one of the main drivers for Norwegian construction industries to evaluate and document

the environmental performance of their products. Cooperation with BREEAM-NOR for including a requirement for documentation of SLCA in the 15 EPDs they currently require for providing credits, can be one way of increasing the use of SLCA in Norway.

## Conclusions and future developments

The challenges of Norwegian municipalities to claim social sustainability in public procurement are partly known. In order to reach the goal that Norwegian construction sites comply with the new rules on healthy working conditions and the use of construction materials that are produced fairly and in accordance with human rights, it is necessary to raise the level of competence among the stakeholders' subject to the new regulations and the opportunities offered by public procurement.

In this study, health and safety of workers and end users, local employment (work force hired locally), fair competition, social responsibility along the supply chain, and transparency using labels or certifications, are some social hot spots identified in the Norwegian construction industry. These are preliminary results.

SLCA can provide different stakeholders with a method to measure and document social sustainability and contribute to innovation in public procurement in the field of social sustainability. Thus, further evaluation of social sustainability aspects, social hotspots and social indicators should be conducted through interviews and questionnaires of different stakeholders in the construction industry. Network and collaboration between researchers, municipalities and state actors will help sharing experiences and best practice, and increase awareness for social hotspots. A network of this type could develop strategies for socially sustainable construction sites and products through innovative public procurement using SLCA. Furthermore, cross-disciplinary teamwork between LCA practitioners and social scientists together with different stakeholders in the construction industry will help to develop expertise in this field and break barriers between different fields of expertise.

## References

- [1] Lovdata, Lov om klimamål (klimaloven) in LOV-2017-06-16-60. Klima- og miljødepartementet. Lovdata: Norway. 2017.
- [2] Green Competitiveness. Executive summary of report from the Norwegian government's expert committee for green competitiveness. October 28, 2016 Oslo.
- [3] Ibáñez-Forés, V., B. Pacheco-Blanco, S.F. Capuz-Rizo, and M.D. Bovea, Environmental Product Declarations: exploring their evolution and the factors affecting their demand in Europe. *Journal of Cleaner Production*, 2016. 116: p. 157-169.
- [4] Siebert, A., A. Bezama, S. O'Keeffe, and D. Thrän, Social life cycle assessment indices and indicators to monitor the social implications of wood-based products. *Journal of Cleaner Production*, 2017. 172: p. 4074-4084.
- [5] UNEP/SETAC, The Methodological Sheets for Subcategories in Social life cycle assessment (S-LCA). UNEP/ SETAC Life Cycle Initiative. 2013.

- [6] Santos, P., A. Carvalho Pereira, H. Gervásio, A. Bettencourt, and D. Mateus, Assessment of health and comfort criteria in a life cycle social context: Application to buildings for higher education. *Building and Environment*, 2017. 123(Supplement C): p. 625-648.
- [7] Veldhuizen, L.J.L., P.B.M. Berentsen, E.A.M. Bokkers, and I.J.M. de Boer, A method to assess social sustainability of capture fisheries: An application to a Norwegian trawler. *Environmental Impact Assessment Review*, 2015. 53(Supplement C): p. 31-39.
- [8] Valente, C., A. Brekke, and I.S. Modahl, Testing environmental and social indicators for biorefineries: bioethanol and biochemical production. *The International Journal of Life Cycle Assessment*, 2017.
- [9] Engebø, A., N. Kjesbu, O. Lædre, and J. Lohne, Perceived Consequences of Counterfeit, Fraudulent and Sub-standard Construction Materials. *Procedia Engineering*, 2017. 196(Supplement C): p. 343-350.
- [10] Vattenfall, Social impacts from Wind power, Appendix to Vattenfall AB Certified Environmental Product Declaration EPD® (S-P-00183 EPD) of Electricity from Vattenfall's Nordic wind power. 2016.

# Integrating SLCA in Product Design at Nestlé

**Urs Schenker, Karen Cooper, Sharla Halvorson**

*Nestlé Research Center, Lausanne (Switzerland)*

## Introduction

Product design is a key driver for the environmental and social performance of future products, in particular for fast moving consumer goods. Nestlé sells close to 100'000 different items (SKUs, stock keeping units) across many different business units and in all major markets across the globe. The resources required to assess and improve the sustainability performance of those products in one go would be enormous. Therefore, the product design process is a key window of opportunity to integrate sustainability into the next generation of products at their design.

Eco-design has been systematically integrated into the product design process of Nestlé (Espinoza-Orias et al, 2016), and many competitors use similar tools and processes (see de Bruin et al, 2017 or Piette & Bayart, 2017) to optimize environmental performance. However, social sustainability is currently not considered in most companies during product design. At best, social assessments are used as risk-avoidance tools: if potential social impacts are identified, the sourcing region or corresponding ingredient type is avoided. While risk avoidance may be useful to reduce environmental impacts (e.g. avoiding dairy-based ingredients by plant-based equivalents, avoiding sourcing from water scarce areas), risk avoidance is counter-productive for social impacts: avoiding to source from communities with poor labor standards will not improve those standards and may increase unemployment in that community, further lowering the bargaining power of the working population.

Here we present a three-tiered approach that has been rolled-out at Nestlé R&D. We have chosen this approach, because it is sufficiently simple to enable product developers to address social impacts systematically, while focusing on the business opportunities and the companies' public commitments towards society, ensuring that this is perceived as value added rather than a tick-box exercise. The latter also ensures that social impacts are not seen as potential risks that should be avoided, but as opportunities to improve and to contribute to the social commitments of the company. The three-tiered approach starts with a very simple qualitative assessment (1st tier), followed by a second and third tier assessment that become more complex but also more insightful. This ensures that the approach (at the first tier) can be rolled-out globally, and the more complex assessment types are applied only to those products that are identified as "interesting" by the first-tier assessment.

## Methods

Social impacts are evaluated using a three-tiered approach where only the first tier is compulsory and systematically applied. The second tier is recommended if the first tier suggests that there may be an opportunity or issue in the given product system. The third tier is applied if the second tier assessment suggest that a comprehensive evaluation should be performed (e.g. to make comparative assessments with competitors or the previous product iteration).

At the first tier, product designers, in discussion with a sustainability specialist, evaluate potential opportunities or issues of the product system in light of the company commitments and the material issues (as reported in the companies' materiality assessment). They identify actions to mitigate potential issues or build on opportunities. This tier assessment is integrated into the Nestlé project management system and needs to be compiled for any product development project at given stages in the project life cycle. It is expected that such an assessment can be completed in approximately one hour (excluding the identification and definition of actions), but can be subjective because it is influenced by the judgement of the project designer and sustainability specialist. Basic information on key social risks in supply chains is built into the tool to trigger discussion, and to help project managers that are not yet familiar with this topic.

At the second tier, we use simplified social assessment methods based on input/output or other financial metrics. We have tested and applied two approaches that have previously been described in more detail (Weidema 2016, Schenker & Weidema 2017, Vionnet & Pollard 2017). These approaches can integrate primary data (e.g. salary paid) if easily available, but they can also be used with data from economic input/output tables and are therefore applicable with very limited efforts. Using a standardized approach, they can identify potential hotspots in a supply chain and remove much of the subjectivity of the first tier. Also, the quantitative nature allows identification of trade-offs.

The third tier is used primarily if external communication on a specific issue and product are expected. At the third tier, we use conventional social LCA based on the methodology described in the Handbook for Product Social Impact Assessment (Fontes et al, 2016). The currently published version of the Handbook does not explicitly recognize farmers as a separate stakeholder group – we have therefore contributed to a project to extend the handbook with a new stakeholder category. This new version of the handbook is presented in a separate manuscript (Indrane et al, 2017).

## Results

In the short time since the full roll-out of the assessment approach in fall 2017, the product designers have mostly been working on first tier assessments (as expected and intended). They have submitted about 100 case studies, and the area that has

attracted the most attention are nutritional improvements (removal of sugar, salt, and saturated fats, as well as the addition of (micro-)nutrients). Furthermore, where “sensitive” ingredients are used (e.g. cocoa, where child labor is known to be a potential issue), product designers refer to the “Responsible Sourcing Standards” that are in place for such ingredients.

At the second tier level, we have tested the approach with several case studies, as described in Schenker & Weidema (2017) and Vionnet & Pollard (2017). In all these case studies, it became very clear that the smallholder farmers and farm workers are the key stakeholder group for potential social issues as well as for improvement opportunities. Given that in many countries, smallholder farmers and farm workers are amongst the poorest members of society, improvements in the prices paid to farmers (or salary increases for farm workers) play an important role in improving the social performance in a supply chain. This did not necessarily come as a surprise, but it confirms with a quantitative measure that responsible sourcing programs are the current best lever to improve the social performance in a food company’s supply chain.

At the third tier, we have performed an assessment in collaboration with the Roundtable for Product Social Metrics, which has resulted in a new draft version for the Handbook for Product Social Impact Assessment (Fontes et al, 2016). The assessment focused on coffee supply chains, and has concluded that data collection is a very important and costly element of a well-planned social assessment: a typical coffee supply chain in a given coffee sourcing region can be based on several thousand smallholder farmers. The sample size for such a diverse supply chain must be large, and requires considerable effort, if a comprehensive set of indicators is to be evaluated (necessitating a comprehensive set of questions to be discussed). Even if considerable effort is spent on surveys, it is sometimes challenging to accurately rank the social performance:

- a) the participants of a survey may not be ready to share honest answers (e.g. regarding child labor, if they fear repercussions),
- b) may prefer to pretend not to know the answer (if they expect to perform poorly),
- c) or may not have documented evidence that a situation is under control in circumstances where issues are unlikely (e.g. child labor in Switzerland: there may not be a control system in place to insure this is not happening).

## **Conclusion and Outlook**

We currently focus on rolling out the social assessment approach as broadly as possible. This will likely mean that we focus on the first tier assessments, given that these are most widely applicable, assisting embedment of the social sustainability concept. We believe that this approach is most meaningful for the R&D and product design teams, given that procurement and responsible sourcing teams work in close collaboration

with our supply chain and are in a better position to implement measures “on the ground” (which will be better covered by the second and third tier assessments).

Admittedly, product designers will initially not have a sufficient understanding to fully grasp social impacts in all Nestlé supply chains. However, we expect the learning process to be beneficial in itself, because it will raise the interest and ultimately the understanding of the employees for these topics. As we have already observed for the eco-design process, this will then enable product designers to implement products with improved social performance right from the beginning of the product design process.

We also expect to find clarification on how the R&D teams can best contribute to implementing social measures in the supply chain of a multinational company by evaluating the first tier assessments of a wider sample size over the next 12-18 months. Furthermore, we would like to test how well the three tiered assessments can be used in sequence, given that each of them uses a rather different methodology – there is a risk that methodological differences will result in different results at the different tiers, which would be confusing to the target audience. A better methodological alignment of the three tiers could be a promising next step for the assessment framework.

## References

- De Bruin et al, 2017. Driving sustainable innovation in FMCG by democratising lifecycle assessments, plenary presentation at LCM Conference, September 2017, Luxembourg.
- Espinoza-Orias et al, 2016. Eco-design shapes product innovation and development, Food Science and Technology (<https://fstjournal.org/features/30-2/Eco-design-of-foods>)
- Fontes et al, 2016. Handbook for Product Social Impact Assessment, Version 3.0. Pré Sustainability 2016 (<https://product-social-impact-assessment.com/wp-content/uploads/2014/07/Handbook-for-Product-Social-Impact-Assessment-3.0.pdf>).
- Indrane et al, 2017. Small but Complex: Assessing social impacts on smallholders in agri-food sector. Manuscript submitted to the SLCA Conference, 2018 in Pescara.
- Piette & Bayart, 2017. Developing a Packaging Eco-Design Process to Achieve Danone's Sustainability Commitments, plenary presentation at LCM Conference, September 2017, Luxembourg.
- Schenker & Weidema, 2017. Social Footprint Whitepaper, available here: <https://lca-net.com/files/White-Paper-Social-Footprint-Final.pdf>
- Vionnet & Pollard, 2017. Social Impact Valuation Whitepaper, available here: <http://www.nestle.com/asset-library/documents/creating-shared-value/social-impact-valuation-white-paper-2017.pdf>
- Weidema, B.P. Int J Life Cycle Assess, 2016. <https://doi.org/10.1007/s11367-016-1172-z>

# Product Social Impact Assessment: a case study from the automotive sector

**L. Zanchi<sup>1</sup>, A. Zamagni<sup>1</sup>, R. Riccomagno<sup>2</sup>, S. Maltese<sup>3-4</sup>, M. Delogu**

<sup>1</sup> Ecoinnovazione srl, Spin-off ENEA, Padova (Italy)

<sup>2</sup> Magneti Marelli S.p.A. - Powertrain Division, Bologna (Italy)

<sup>3</sup> Dept. of Civil, Chemical, Environmental and Materials Engineering, University of Bologna (Italy)

<sup>4</sup> Dept. of Industrial Engineering, University of Florence (Italy)

## Abstract

This paper shows and discusses one of the first example of S-LCA application in the automotive sector by means of the Product Social Impact Assessment (PSIA) method, developed by the Roundtable for the Product Social Metrics. The case study concerns a vehicle component produced by Magneti Marelli. The main companies involved in the production stage have been engaged in the data collection; therefore this work gave the opportunity to test the method applicability and usability as a supporting tool in the design phase of Magneti Marelli.

The main outcomes from this work concerns: i) product system and system boundaries definition, two important aspects to support data collection at site level and the following data elaboration and interpretation in a practical way; ii) data collection feasibility; iii) allocation procedure to Functional Unit and referencing practicability. The PSIA quantitative approach proved to be practicable, even if opportunities for improvements have been identified especially regarding the social indicators granularity in terms of their capability to reflect the differences among the alternative design options from a social point of view. This is a decisive aspect to enhance the assessment of social impacts during the product design phase.

## A new scheme to evaluate socio-economic impacts of products: a well-being indicator approach

**Silvia Di Cesare<sup>1,2</sup>, Alfredo Cartone<sup>1</sup>, Luigia Petti<sup>1</sup>**

<sup>1</sup> Department of Economic Studies, University "G. d'Annunzio", Pescara (Italy)

<sup>2</sup> CIRAD, UPR GECCO, Montpellier (France)

### **Abstract**

In this paper, the evaluation of socio-economic performance through an approach based on well-being is proposed. The aim is to build a composite indicator for the evaluation of socio-economic impacts, through the development of a methodology based on the literature on well-being indicators. A weight connecting each dimension of well-being to the actions implemented by the organization is adopted. This was performed in order to synthesize the behavior of the organizations based on a statistical approach. Then, the links between the variables and the inventory indicators are identified by adopting a Delphi expert consensus method on the basis of the "Wisdom of crowds" theory.

# What social priorities for agro-business now if the future is realized as planned?

**Catherine Macombe**

*IRSTEA, Montpellier SupAgro, Univ Montpellier (France)*

## **Introduction**

In the near future, some authors (Radanne, 2006) guess that new ways of life are emerging, induced by the constraints coming from three geophysical factors: rise of sea level; climatic disasters higher frequency; scarcity of material resources, and especially of transportation's energy. The effects of the coming change upon agriculture are a regular study topic, while the likely evolutions of the food systems as a whole remain quite overlooked (Servigne, 2013). The life-cycle thinking teaches us that-when the scarcity of resources is general - the process doesn't work anymore. Only frugal agro-food value-chains can expect to last. Accordingly, we describe the likely future evolutions of the agro-food value-chains in response to the geophysical constraints. In the few next decades, the main social impacts caused by the companies' today strategies will be to drive –or not – societies towards a viable future for mankind.

## **Method**

We set three optimistic assumptions. The first one is that the transition can run without “collapsing” (Bihouix, 2014). The second one is that policies will be reasonable enough to give priority to food and agriculture issues. The third is that long-term agronomic performances (productivity by hectare or by cattle) will be widely higher than before the agro-industrial revolution. It is yet possible, provided we are aware of the necessity to prepare for such a future. The discussion extends the models set by many authors for the agricultural step alone (e.g. Altieri et al., 2015 ; Malézieux, 2012). We do not split between developing and developed countries, because they will experience the same evolutions, yet at a different pace. From the geophysical constraints and life-cycle thinking, we infer the different models of value-chains that are frugal enough to develop in the new context. We deduce the different models of value-chains that are logically emerging, thus converging with some authors (Servigne, 2013). We therefore 1) discuss the effects of the three constraints on agriculture, processing and delivery; 2) present the different business-models generated. We then will discuss 3) the necessary adaptations for the agro-food companies, and the offered business opportunities.

## Results

### Effects of the three factors on agro-food value-chains

The Intergovernmental Panel on Climate Change envisions a supplementary sea level rise ranging in average from 26 to 82 cm during the 21st century (Guéguen and Renard, 2017). Large coastal territories are disappearing. The increased frequency and gravity of the climatic disasters is the present reality. In the future, disasters are becoming commonplace. The biofuels will be set aside for priority activities (Radanne, 2006). Agriculture will be forced to do without oil, nor inorganic pesticides and fertilizers. The management of the humic fertility of soil (Altieri et al., 2015) will compel farmers towards diversity of crops. Indeed, the solution is diversity: forest or grassland systems when tillage is not possible, and systems associating several crops (e.g. agroforestry), because they are the most resilient (Malézieux, 2012). It will not be rentable to send harvested crops out to far-away processing plants. Today, in the European Union, most raw agricultural products and food travel by road (Martinez Palou & Rohner-Thielen, 2011). In the future, agricultural products will be processed on site, and consumed within a distance of a few km. Only the farms located nearby the ports will get the possibility to board the harvest on international trade boats. International transportation by sea will involve scarce foodstuffs (coffee, salt...) and will be elicited also to manage emergency situations.

### The agro-food value-chains models in the future

The different business-models are summarized in the table 1. During a while, new models will go together with the ones born from the agro-industrial revolution. Among the 6 models, the first is dominating at present, while the second tends to develop. The n°3 and 4 are slowly emerging (Lamine et al., 2012). The 5th becomes a necessity to escape the "hunger gap", often experienced by pre-industrial societies. The 6th has always working, from antiquity to our days. Because of the three geophysical constraints, we need to combine the models from 3 to 6.

### At short-term, adapting to the risks and seizing opportunities

Becoming aware of its own vulnerabilities allows preparing emergency plans to run again. The agro-food company can perform a test by imagining how it would endure the higher price (for instance, sharply multiplied by three in Servigne, 2013) of fossil oil. Often it will be relevant to draw a collective action plan with the other actors of the value-chain. Companies already train their workers because of the evolution of competencies. Why not to train them for the new tasks generated by the consequences of oil scarcity? How to reorganize if lasting oil or electricity scarcity? In most of the case, the company will conclude that supplementary workers are needed. Who the company can turn to for assistance? Anyway, how to quickly train the new comers? In a nutshell, the agro-food companies need to design another business-model decreasing the dependencies to fossil energies and to non-renewable minerals, and to adapt to climatic disasters.

N°	What?	Where?	When?	Which constraint associated?	Corresponding agriculture and Delivery
<b>1: today</b>	everything	everywhere	At any time	Cheap	Specialised intensive agriculture/ large farms/ group purchasing/ mass distribution
<b>2:Amazon</b>	everything	Metropoles	At any time	Expensive, in densely populated areas only	Many kinds of farms/ Delivery assisted by TIC (Amazon model)
<b>3:Chariot</b>	Mainly local food	everywhere	Seasonal products	Affordable but low diversity of food, irregular availability	Small farms around cities, Delivery by chariot
<b>4: Roman villa</b>	Local food	everywhere	Seasonal products	Affordable, low diversity of food, irregular availability	Direct pick-up at farm, multi-products cannery and mills
<b>5: Survival</b>	Survival food (rice, sugar...)	specific location	In response to climatic disasters or to "hunger gap"	Stock managed by public authorities	Routed by trains, ships as humanitarian aid, from large industrial mills.
<b>6 Export crops</b>	Spices, salt, ...	Specific location	At any time	Expensive, at certain periods only	Routed by ships

Table 1: Possible models for value-chains in agro-food

Business opportunities are visible right now. The first need will be the work force, and accordingly new tools to carry materials, to till soil, to eradicate weed, to harvest, to process etc. The new agriculture will execute robust equipment, easy to handle, and using mechanic power instead of oil. We can find ideas from tools of Asian and African peasants. Agricultural machinery companies have a major role to play to design and to spread the use of these new tools. Business for creation of plants' varieties will be elicited also, to fine-tune a range of species and vegetal crops designed according to the criteria of easy management. The stake is high for the research about varieties. Concerning cattle, two trends will shape the picture: i) decrease of the cattle pool consuming cereals and ii) need for transformation of forages, traction and transportation (Clark, 2011). Indeed, the largest part of mobile agricultural tasks will depend on the cattle's power, while the static tasks (crushing grains...) will make use of wind and hydraulic power. Many business opportunities are to seize in this domain too. The Future also claims for universal multi products canneries (dairy, salting tub, mills...) working thanks to renewable energies, easy to manage and to maintain. They will remain small, and will be scaled regarding the size of the served farm(s), because they will supply local markets in priority (Clark, 2011). They require a huge design effort. Indeed, it runs counter to the specialized current one. The transportation modes must be designed without drawing from fossil fuels, neither from scarce resources. To help transportation towards adjacent regions, inland boats seem relevant. For long-distance transportation, the "new offshore vessel" provides a stimulating project. About long-run trade, the first companies capable to identify the relevant locations and to set up there, will handle a substantial competitive advantage.

## Conclusions

We warn companies against fashionable « temptations ». Indeed, certain business-models can be viewed as advantageous in the short-time, but they will not contribute to the emergence of a frugal economy, neither to the company's permanence. High tech is often a "heavy harmful headlong rush towards a useless spree of our natural resources" (Bihouix, 2014). About priority impacts, the strategic priorities of all agro-food companies are the same. They have to prepare and to adapt, in order to last. It is the top priority, because here is the prerequisite for contributing to the rendered service to society: meeting food needs. Continuation of the activities, jobs, and finally own permanence, depend on this strategy. To survive the ongoing change, one can't avoid upsetting present business-models. The emergence of the new ways of life is devaluing the current notion of financial value. What will be the new measure of the value? We guess that the decision tools signaling the fair way – right now, are based on the anticipated assessment of the improvement regarding human populations' and ecosystems' health. Any change might be assessed regarding progress in health. Health is the metric of the future, and therefore deserves the full attention of researchers in social LCA.

## References

- Altieri, MA, Nicholls, CI, Henao, A, Lana, MA 2015. Agroecology and the design of climate change-resilient farming systems, *Agronomy for Sustainable Development*, July 2015, Volume 35, Issue 3, pp 869–890, DOI 10.1007/s13593-015-0285-2
- Bihouix, P 2014. La high-tech nous envoie dans le mur, entretien recueilli par Laure Noualhat, *Libération*, 04/07/2014, Accessed 29 November 2017, [http://www.liberation.fr/terre/2014/07/04/la-high-tech-nous-envoie-dans-le-mur\\_1057532](http://www.liberation.fr/terre/2014/07/04/la-high-tech-nous-envoie-dans-le-mur_1057532)
- Clark, E.A., 2011. The future is organic: but it's more than organic. <http://www.resilience.org/stories/2011-03-07/future-organic-its-more-organic/> (February 2018)
- Guéguen, A, Renard, M, 2017. La faisabilité d'une relocalisation des biens et activités face aux risques littoraux à Lacanau, *Sciences Eaux & Territoires*, 2017/2 n° 23, 26- 31
- Lamine, C, Renting, H, Rossi, A, Wiskerke, JSC, Brunori, G, 2012. Agri-Food systems and territorial development: innovations, new dynamics and changing governance mechanisms. In: Darnhofer I, Gibbon D, Dedieu, B (eds) *Farming Systems Research into the 21st Century: The New Dynamic*. Springer
- Malézieux, E, 2012. Designing cropping systems from nature, *Agron. Sustain. Dev.* (2012) 32:15–29
- Martinez Palou, A, Rohner-Thielen, E, 2011. From farm to fork-A statistical journey along the EU's Food chain. statistics, Eurostat, *Statistics in focus*, vol 27/201, page 12, European Union.
- Radanne, P, 2006. Changement climatique et société(s), *Ecologie & Politique*, 2006/2 n°33, 95-115.
- Servigne, P, 2013. Nourrir l'Europe en temps de crise : vers des systèmes alimentaires résilients, Les Verts/Alliance Libre Européenne au Parlement Européen, rapport.

# SLCA of events: application of an LCA-based method in the event impact analysis

**Juliana R. V. Tkatch<sup>1</sup>, Osvaldo Quelhas<sup>1</sup>, André Teixeira Pontes<sup>2</sup>,  
Cassia Ugaya<sup>3</sup>**

<sup>1</sup> UFF – Universidade Federal Fluminense, Faculdade de Engenharia, Niterói (Brazil)

<sup>2</sup> UFF – Universidade Federal Fluminense, Faculdade de Farmácia, Niterói (Brazil)

<sup>3</sup> UTFPR – Universidade Tecnológica Federal do Paraná, Curitiba (Brazil)

## Introduction

The increased attention on sustainability by stakeholders has led businesses to adopt several tools for sustainable development and corporate social responsibility. The development of an evaluation of social impacts is one of the cornerstones of products and services sustainability. It is in such scenario that the discussions about Social Life Cycle Assessment-SLCA have been gaining more importance and visibility, both in the academic sphere and in organizational decision-making processes. SLCA enables an understanding of the organization's behavior and its relationship with stakeholders. A maintenance shutdown in the chemical industry has the features of an event because it is an intentional and programmed gathering of people with a specific goal during a determined period of time (ALLEN, 2008). Given its delimited time span, isolating the social impacts of an event from the routine impacts of the industry is both a challenge for SLCA analysis and an opportunity for application of the methodology.

As pointed by Benoit et al. (2010), the goal of the study is to assess the social impacts of the event with a view to increasing the company's knowledge, informing choices and promoting improvements of social conditions during the life cycle of an important process for the chemical industry known as "maintenance shutdown". The event analyzed is a 60-day planned maintenance shutdown of a chemical plant, during which production units must stop operating so the services can be performed. The event took place between July and September 2016 in the Southern region of Brazil. The Local Community is the stakeholder that experiences the most significant impacts from this event. For this reason, nine subcategories suggested in the UNEP/SETAC (2013) guidelines for this stakeholder were analyzed. Empirical knowledge was considered through semi-structured interviews. A questionnaire with 29 open questions based on the UNEP/SETAC Guidelines (2006) and Methodological Sheets (2013) enabled us to identify positive and negative impacts noticed in the community. Site-Specific Data were collected from three different segments of stakeholders for triangulation of information sources: community members, local governmental agencies and company representatives (from its production, maintenance, security and social responsibility areas) with professional or experiential knowledge of the impacts of a maintenance shutdown. Data from organization-specific reports, such as

its code of ethics, conduct guidelines, complaint records, reports of visits and meetings with the community, sponsorships and maintenance worker logs, were also taken into account. Among the inventory data, it was considered relevant that maintenance shutdowns cause temporary migration into the city and generate negative impacts to public health such as increase of STDs and unintended pregnancies. There are reports of recurrence of diseases previously eradicated in the region. There are indications that those came from other parts of the country with migrants, as they are common in their home states.

While people in the company report specific actions on this regard, the community does not acknowledge the efforts of the company to integrate the migrant workers with the community. Was possible to recognize the strength of written policies on community engagement at the organization level. The interviews showed that the maintenance topic was discussed in routine meetings by the so-called "community committee". Given the diversity of stakeholders engaged with the organization, formal community leaders are invited to the meetings and contacted proactively in case of production events that break plant routine.

It was not possible to identify the strength of local heritage protection policies. Concerning availability and accessibility of company information to the community, the commitment to "communicate with clarity, objectivity and transparency" was identified in company documents, but there were misgivings about the scope of information shared by the company during meetings with the community and the efficacy of the adopted means. Education level and restricted access to the Internet were mentioned as points that could alienate the population from company content. There are corporate sponsorship guidelines about "equality in issues (...) traditional communities and indigenous peoples", but the existence of a tribe near the plant was only acknowledged recently. Issues related to the percentage of workforce hired locally and hiring preference policies are relevant in the analyzed context. There are high expectations from workers seeking jobs during maintenance shutdowns, but the issue of low qualification among local workers is recognized as a hindrance to local hiring, particularly for jobs with better salaries.

Positive impacts – boosting of local economy, creation of direct and indirect jobs, increase of economic activity – are noticed. On the importance of maintenance shutdown events for the local economy, it is unanimous that such events generate an increase in hotel, food and transportation services in the region, as well as a considerable amount of tax income that must be invested in social welfare by the local government. Other interviewees, while recognizing the benefits to the local economy, warned about inflationary effects provoked by the event and the overcrowding of public and private services in the region during this period.

There are reports of community protests related to traffic and mobility issues that affected the routine of the organization, leading to an infrastructure project that provided accessibility and benefits for the community. On the presence or the

strengths of educational initiatives in the community, it is clear that most initiatives sponsored locally by the company are linked to education.

About the assessment of organizational risks, company representatives showed a good grasp of the possible focus on future discussions, which would center on material resources. This view does not seem to be shared by the community, which apparently ignores possible future impacts from the organization. Company documents show that it has a robust environmental management system in place, with ongoing sustainability actions following international parameters. Safety issues are important to the organization. There were reports of programs such as safety operational alerts and evacuation training with community. About community health efforts, the company claims that its monitoring parameters are stricter than those required by national law. The company also claims to be modernizing its equipment to minimize the use of dangerous substances. Concerning management policy related to security, there are reports that the company acts with a focus on the protection of life and respect of human rights, seeking to prevent and mitigate negative impacts from its direct activities and from those of its supply chain and fighting discrimination in all possible ways.

Different methods would provide different types of information regarding social aspects (Parent, Cucuzzella and Reveret, 2010). To classify the impacts identified in the inventory phase, an analysis was performed using the SAM method, which defines the basic requirements (BR) for each subcategory. No basic requirement was defined in this analysis. Instead, the organization's knowledge of its own impact was assessed. Adaptations were made in the scale to classify the extent to which the company recognizes and acts towards identified impacts (Table 1). The context was not considered in the assessment. In contrast, the company's knowledge of its impacts and its proactivity towards minimizing them gained importance in the assessment, as shown by the criteria. The inventory assessment by subcategory, considering UNEP/SETAC inventory indicators and including a description of the evidence found in the documents and in the performed interviews, is shown in Table 2.

Two issues received D on the scale due to negative impacts with no evidence of mitigating actions. The first is related to the integration of migrant workers into the local community. Some direct impacts, such as the increase of STDs and unplanned pregnancy, might be indirectly caused by this shortcoming. The second is related to the strength of local workforce hiring policies. No efforts to mitigate the impacts of temporary migration were reported. These are the hotspots where the organization should focus their effort.

In conclusion, the application of SLCA reached the goal and was adequate for identifying social impacts from a relevant event in the chemical industry, highlighting hotspots in company performance. The data shows that UNEP guidelines are able to surface issues that are relevant to the local community. The SAM methodology was able to classify the most relevant aspects of company performance in a simple and direct way and can be used for prioritizing corporate social responsibility investments.

As pointed by Jørgensen (2013), SLCA can be a methodology that provides decision support about social impacts.

The application of the SLCA model in the context of a specific industry, with an event as a functional unit, achieved the goal of analyzing social impacts in a way that not only allows one to propose improvements in social responsibility actions by the studied industry, but also contributes to the advancement of the methodology applied to events.

## References

- Allen, J, O'Toole, W, Harris, R, McDonnell, I, 2008, Festival and special event management, 4th edn, Wiley, Milton, QLD.
- BENOÎT, C, Norris, GA, Valdivia, S, Ciroth, A, Moberg, A, Bos, U, Prakash, S, Ugaya, C, Beck, T, 2010. The guidelines for social life cycle assessment of products: just in time! *Int J Life Cycle Assess*, 15, 156-163.
- Jørgensen, A, 2013. Social LCA: A way ahead? *Int J Life Cycle Assess*, 18, 296-299.
- Parent, J, Cucuzzella, C, Reveret, JP, 2010. Impact assessment in SLCA: sorting the sLCIA methods according to their outcomes. *Int J Life Cycle Assess*, 15, -164–171.
- Ramirez, PKS, Petti, L, Brones, F, Ugaya, CML, 2016. Subcategory assessment method for social life cycle assessment. Part 2: application in Natura's cocoa soap. *Int J Life Cycle Assess*, 21, 106-117.
- Ramirez, PKS, Halerland, NT, Petti, L.; Ugaya, CML, 2014. Subcategory assessment method for social life cycle assessment. Part 1: methodological framework. *Int J Life Cycle Assess*, 19, 1515–1523.
- UNEP/ SETAC Life Cycle Initiative. 2009 Guidelines for Social Life Cycle Assessment of Products. Suíça.
- UNEP-SETAC Life Cycle Initiative. 2013 The Methodological Sheets for Sub-categories in Social Life Cycle Assessment ( S-LCA ).

Evaluation	SAM Method	Study scale
<b>A</b>	Have a proactive behavior relating to the basic requirement	Add positive impacts Does not cause negative impacts and there is no improvement opportunities
<b>B</b>	Fulfill the basic requirement	Does not cause negative impacts, but there is clear improvement opportunities that can lead to positive impact Cause negative impacts, but act to mitigate the impacts.
<b>C</b>	Not fulfill the basic requirement and operates in a negative context	Cause negative impact, but does not know Does not know if is causing negative impacts
<b>D</b>	Not fulfill the basic requirement and operates in a positive context	Cause negative impacts and do not act to mitigate the impacts

Table 1: Comparison between SAM Method and study scale

Sub-categories	Inventory Indicator	Qualitative Data	
<b>Delocalization and Migration</b>	Number of individuals who resettle (voluntarily and involuntarily) that can be attributed to organization	No evidence or information about delocalization related to event or organization	A
	Strength of organizational policies related to resettlement (e.g. due diligence and procedural safeguards)	No evidence or information about delocalization related to event or organization	A
	Strength of organizational procedures for integrating migrant workers into the community	No evidence of procedures for integrating migrant workers into the community	D
<b>Community Engagement</b>	Strength of written policies on community engagement at organization level	There is written procedures on community engagement and there is evidences that is current practice	A
	Diversity of community stakeholder groups that engage with the organization	There is evidence of diversity of community stakeholder groups that engage with the organization, but it can be improved.	B
	Number and quality of meetings with community stakeholder	The company promotes four meetings per year with community stakeholders, but the number of participants is not constant.	B
	Organizational support (volunteer-hours or financial) for community initiatives	There is evidence that the organization supports financially many community initiatives	A
<b>Cultural heritage</b>	Strength of policies in place to protect cultural heritage	That is no policies in place to protect cultural heritage, but there is evidence of a single initiative.	B
	Presence/Strength of organizational program to include cultural heritage expression in product design/ production	There is no organizational program to include cultural heritage expression in product design/production	B
	Is relevant organizational information available to community members in their spoken language(s)?	All organizational information are available to community members in their spoken language. The organization can improve the access of the information.	B

Table 2: Inventory assessment (continued on next page)

Sub-categories	Inventory Indicator	Qualitative Data	
<b>Respect for indigenous rights</b>	Strength of policies in place to protect the rights of indigenous community member	There is policies in place to protect the rights of indigenous but there was no knowledge that there is an indigenous tribe near the industry.	A
	Annual meetings held with indigenous community members	There was no meeting with indigenous community members ever	C
	Response to charges of discrimination against indigenous community members	There is no charges of discrimination against indigenous community members	A
<b>Local employment</b>	Percentage of workforce hired locally	The company declares that more that 90% of the employees of the event were hired locally. Community member complain a lot about the subject, not recognizing this number.	C
	Strength of policies on local hiring preferences.	There is no policies on local hiring preferences, but the company declares this preference.	D
	Percentage of spending on locally based suppliers	The interviews shows that all stakeholders believes that the event contributes to the local economy.	A
<b>Access to immaterial resources</b>	Annual arrests connected to protests of organization actions	There is no evidence or complaint about arrests connected to protests of organization actions	A
	Do policies related to intellectual property respect, moral and economic rights of the community	There is no policies about intellectual property respect, moral and economic rights	C
	Presence/strength of community education initiatives	There is significant evidence of financial support to community education initiatives.	A
<b>Access to material resources</b>	Has the organization developed project related infrastructure with mutual community access and benefit	There is evidence of a project related infrastructure with mutual community access and benefit	A
	Strength of organizational risk assessment with regard to potential for material resource conflict	Substantial organization knowledge about risk assessment with regard to potential for material resource conflict..	B
	Does the organization have a certified environmental management system	The organization have an environmental management system, but it is not certified anymore.	B
<b>Safe and Healthy Living Conditions</b>	Management oversight of structural integrity	There is evidence of management oversight of structural integrity. The event analyzed is a periodic check in the integrity of the structure.	A
	Organization efforts to strengthen community health (e.g. through shared community access to organization health resources)	There is complain about negative impact of the event on the public health system.	C
	Management effort to minimize use of hazardous substances.	There is report that the organization invested in improvements on it hardware to minimize use of hazardous substances on it products.	A
<b>Secure Living Conditions</b>	Management policies related to private security personnel	Solid management policies related to private security personnel.	A
	Number of legal complaints per year against the organization with regard to security concerns	No evidence of complaints against the organization with regard to security concerns.	A
	Number of casualties and injuries per year ascribed to the organization	No locally casualties and injuries ascribed to the organization local.	A

# The role of social sustainability in aviation biofuel supply chains

**Zhizhen Wang, Farahnaz Pashaei Kamali, Patricia Osseweijer, John Posada Duque**

*Department of Biotechnology, Faculty of Applied Sciences, TU Delft, Delft (The Netherlands)*

## Introduction

Aviation fuel derived from biomass has been recognized as a promising way to reduce greenhouse gas (GHG) emissions of aviation industry (IATA 2013, Moraes et al., 2014, De Jong et al., 2015, Hileman & Stratton 2014). Due to the use of renewable feedstocks, aviation biofuel is generally perceived sustainable (Agusdinata et al. 2011, Li & Mupondwa et al. 2014). However, sustainability is about the balanced development of environment, economy and society. The overall impact of bio-based production requires a full investigation from the perspective of sustainability (Parada et al. 2017). While many studies have evaluated the environmental impacts and the techno-economic feasibility of aviation biofuel, very few have taken the social aspects into consideration in a systematic manner. Thus, the goal of this study is to evaluate social/socioeconomic impacts of aviation biofuel on the supply chain level. Since sustainability issues, and particularly social, and socioeconomic issues, emerge at various stages of supply chain, it is important to consider the whole supply chain in the process of impact assessment.

Socioeconomic effects (i.e., employment, GDP development and trade balance) over aviation biofuel supply chains are assessed with a scenarios-based input-output (I/O) analysis. This approach is exemplified for the case of Brazilian aviation biofuel. Despite of the ongoing research and development, large-scale commercialization of aviation biofuel is still at its infant stage. That is, available knowledge and data on the deployment of aviation biofuel are limited, resulting in a high level of uncertainty. Hence, we use scenarios to explore how possible futures of aviation biofuel development in Brazil may unfold. To do so, the exploratory scenario approach (Kowalshi et al. 2009, Reilly and Willenbockel 2010) is employed to build plausible but different future storylines. The timeframe of our scenarios is set till 2050, which is the reference year that many climate change and renewable energy policies establish their targets for. The aim of the scenario analysis is to quantify the future demand of aviation biofuel under different conditions, which will be subsequently used in the I/O analysis to determine the socioeconomic effects attributed to aviation biofuel. With I/O analysis, it is possible to evaluate not only direct but also indirect macroeconomic effects in various economic sectors involved in aviation biofuel supply chains (Wicke et al. 2009, Silalertruksa et al. 2012). Nevertheless, one of the main weakpoints associated

with I/O analysis is the so-called “constant returns to scale”, which is represented by the fixed technical coefficients in the I/O matrix (Allan 2015). To address this weakness, we propose a stochastic simulation approach to examine the uncertainty of the technical coefficients. This is achieved by performing a Monte Carlo (MC) simulation for each technical coefficient in the I/O table, based on the mean value and standard deviation calculated with historical data. The stochastic simulation provides insights into the robustness and reliability of the assessment results. To the best of the authors’ knowledge, this is the first attempt to address uncertainty of I/O analysis in the context of socioeconomic assessment by using stochastic simulation to capture the uncertainty in technical coefficients based on historical data.

Since the analysis is still ongoing, only preliminary results (of employment) are shown in this abstract. Four scenarios are developed here, representing diverging trends of two key driving forces: i) biofuel policy (conservative or proactive) and ii) technological advancement (gradual or breakthrough). The storyline of each scenario is further elaborated on the demand of aviation biofuel, conversion technologies, selection of feedstocks, potential competition for biomass, and feedstocks prices. Different demands of aviation biofuel are estimated for each scenario, ranging from 3% to 15% of total aviation fuel demand. The following combinations of technological pathways and feedstocks for aviation biofuel production in Brazil are considered: hydro-processed esters and fatty acids (HEFA) with macauba, Fischer-Tropsch (FT) with eucalyptus, and alcohol to jet (ATJ) with sugarcane.

Different scenarios result in different employment effects, with the highest employment potential in Scenario 3 (where proactive biofuel policy goes hand in hand with advanced technology), followed by Scenario 4 (where jet biofuel technology sees a breakthrough despite of less effective biofuel policy). In contrast, the lowest number of jobs is expected in Scenario 1, in which biofuel policy is conservative and jet biofuel technology progresses slowly, whereas the expected number of jobs in Scenario 2 (in which biofuel policy is proactive although technology sees little innovation) is higher than that in Scenario 1, but less than that in the other two scenarios. In terms of direct employment, the majority of jobs are allocated in agriculture, forestry, chemicals and transportation sectors. On the other hand, the key sectors of indirect jobs include trade and transportation. With a closer look, in each scenario, FT with eucalyptus tends to create around 15% more jobs than ATJ with sugarcane, while the number of jobs attributed to HEFA with macauba is estimated to almost double that of ATJ with sugarcane.

To conclude, the diverging trends of biofuel policy and technological advancement play a significant role in the development of aviation biofuel, as well as the related employment effects. It is worth noting that in each scenario, distinct differences of employment effects are estimated when using different technologies and feedstocks to produce the same demand of aviation biofuel. HEFA with macauba stands out with regard to employment effects, as the labor-intensive sectors in this supply chain are more activated. Overall, under certain conditions, positive socioeconomic impacts associated with aviation biofuel are expected in every scenario, even when taking

the displacement effects in the fossil sector into account. Enabling policy such as a biofuel blend mandate, mature HEFA technology and available macauba feedstock potentially lead to the highest level of employment benefit. This work is one of first studies to address socioeconomic impacts as well as the uncertainty of assessment results related to aviation biofuel. The outcomes of this study contribute to an informed decision-making process from the perspective of social sustainability.

## References

- Allan, G.J., 2015. The regional economic impacts of biofuels: a review of multisectoral modelling techniques and evaluation of applications. *Regional Studies*, 49(4), pp.615-643.
- Agusdinata, D.B., Zhao, F., Illeleji, K. and DeLaurentis, D., 2011. Life cycle assessment of potential biojet fuel production in the United States. *Environmental science & technology*, 45(21), pp.9133-9143.
- De Jong, S., Hoefnagels, R., Faaij, A., Slade, R., Mawhood, R. and Junginger, M., 2015. The feasibility of short-term production strategies for renewable jet fuels—a comprehensive techno-economic comparison. *Biofuels, Bioproducts and Biorefining*, 9(6), pp.778-800.
- IATA (International Air Transport Association), 2013. IATA technology roadmap 2013.
- Hileman, J.I. and Stratton, R.W., 2014. Alternative jet fuel feasibility. *Transport Policy*, 34, pp.52-62.
- Lenzen, M., Wood, R. and Wiedmann, T., 2010. Uncertainty analysis for multi-region input–output models—a case study of the UK's carbon footprint. *Economic Systems Research*, 22(1), pp.43-63.
- Li, X. and Mupondwa, E., 2014. Life cycle assessment of camelina oil derived biodiesel and jet fuel in the Canadian Prairies. *Science of the Total Environment*, 481, pp.17-26.
- Moraes, M.A., Nassar, A.M., Moura, P. and Leal, R.L., 2014. Jet biofuels in Brazil: Sustainability challenges. *Renewable and Sustainable Energy Reviews*, 40, pp.716-726.
- Parada, M.P., Osseweijer, P. and Duque, J.A.P., 2017. Sustainable biorefineries, an analysis of practices for incorporating sustainability in biorefinery design. *Industrial Crops and Products*.
- Silalertruksa, T., Gheewala, S.H., Hünecke, K. and Fritsche, U.R., 2012. Biofuels and employment effects: Implications for socio-economic development in Thailand. *Biomass and bioenergy*, 46, pp.409-418.
- Wilting, H.C., 2012. Sensitivity and uncertainty analysis in mrio modelling; some empirical results with regard to the dutch carbon footprint. *Economic Systems Research*, 24(2), pp.141-171.
- Wicke, B., Smeets, E., Tabeau, A., Hilbert, J. and Faaij, A., 2009. Macroeconomic impacts of bioenergy production on surplus agricultural land—A case study of Argentina. *Renewable and Sustainable Energy Reviews*, 13(9), pp.2463-2473.
- Yamakawa, A. and Peters, G.P., 2009. Using time-series to measure uncertainty in environmental input–output analysis. *Economic Systems Research*, 21(4), pp.337-362.

## Towards a harmonized communication of products' social impacts

**Marzia Traverso<sup>1</sup>, Catherine Benoit-Norris<sup>2</sup>, Bettina Heller<sup>3</sup>**

<sup>1</sup> Institute of Sustainability in Civil Engineering (INaB), RWTH Aachen (Germany)

<sup>2</sup> New Earth, York, Maine (USA)

<sup>3</sup> UN Environment, Paris (France)

### Introduction

Production which provides or enhances positive social impacts is beneficial for businesses and consumers. Alongside governments, all have a role to play in awareness-raising and promoting socially conscious consumption and production. This has also been recognized internationally through the Sustainable Development Goals (SDGs), especially SDG 12 which focuses on Sustainable Production and Consumption. From the consumer's perspective, purchasing and using products that do not harm individuals and society is a responsible way to contribute to collective wellbeing. To do so, consumers require access to reliable information, to decide which products to buy, how to use them and what to do with them at the end of their life. To drive progress in the area of social impact communication, the EC's Joint Research Centre, New Earth and UN Environment have led a multi-stakeholder working group under the 10 Year Framework of Programme on Sustainable Consumption (known as the One Planet Network). This resulted in a white paper, which provides recommendations to private and public sector actors for developing and improving the communication of the social impacts of products, to consumers (B2C) and value chain partners (B2B).

Even though a product life cycle social impact assessment standardized methodology has not yet been defined, many tools and guidelines have already been developed to assess and communicate about products' social impacts. The white paper is thus a first attempt to assess the state of the art of existing communication tools and to identify best practices that others can follow. It does so by identifying relevant principles, criteria and means to communicate such impacts, including recommendations on integrating social impact communication with more well-established environmental impact communication tools. The white paper further lists examples of on and off product communication of social impacts, to identify good practices for further upscaling and replication.

The white paper concludes with a set of direct recommendations for the communication of products' social impacts and recommendations for enabling frameworks needed to further drive progress in the area. The former focuses on the 'how and what' to communicate, and follows closely the UN Environment and International Trade Centre

Guidelines for Providing Product Sustainability Information. The latter provides a list of actions that can be taken by governments, NGOs and companies, as well as multi-stakeholder efforts needed around collaboration and harmonization of existing schemes.

## References

UN Environment, JRC, New Earth. Communicating Products' Social Impacts. A White Paper (forthcoming)

UN Environment, International Trade Centre. Guidelines for Providing Product Sustainability Information. 2017







**FruiTrop Thema** is a collection of **FruiTrop**

**Publisher**

CIRAD  
TA B-26/PS4  
34398 Montpellier cedex 5, France  
Tel: 33 (0) 4 67 61 71 41  
Email: [info@fruitrop.com](mailto:info@fruitrop.com)  
[www.fruitrop.com](http://www.fruitrop.com)

**Publishing Director**

Eric Imbert

**Editor-in-chief**

Denis Loeillet

**Editor**

Catherine Sanchez

**Computer graphics**

Catherine Sanchez

**Printed by**

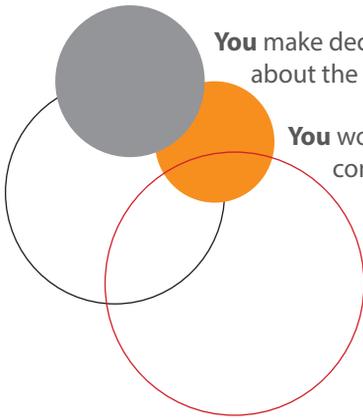
Impact Imprimerie  
n°483 ZAC des Vautes  
34980 Saint Gély du Fesc, France

ISSN: 2426-9654  
ISBN: 978-2-9562141-1-3

© Copyright Cirad, July 2018







**You** make decisions  
about the future of industrial sectors.

**You** would like to understand the social  
consequences of these decisions.

**You** belong to one of the following groups:  
entrepreneurs, public decision-makers, public  
authorities, consultants, researchers or students.



The **SocSem** seminars have generated the emergence of a community of scholars engaged in the social assessment of the life cycle. The Special Issue of the International Journal of Life Cycle Assessment is part of this movement of enthusiasm. However, research is still underdeveloped and very dispersed. LCA conferences hosting “social LCA” or “sustainability assessment” sections struggle to bring together quality papers.

The **6<sup>th</sup> International Seminar** in Social LCA testimonies for concern for People and Places, and especially for partnership. It provides a forum for communicating and discussing recent progress in social evaluation.

**These pre-proceedings** bring together all the contributions received and accepted following on from the Call. They are in the format either of extended abstracts or short abstracts.



Thema is a collection of FruiTrop  
www.fruitrop.com / info@fruitrop.com  
ISSN: 2426-9654  
ISBN: 978-2-9562141-1-3  
Price: 20 euros