

Editor
Catherine Macombe

**Social LCA
Researcher School**

Sète, France
March 14-18, 2016

Social LCA Researcher School Book

*Social evaluation
of the life cycle,
application to the
agriculture and
agri-food sectors*

Collection FruiTrop Thema

Editor: Catherine Macombe

Researcher school book

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Collection FruiTrop Thema:

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

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

This book is compiled from the presentations and discussions held during the **researcher school**

"Social evaluation of the life cycle, application to the agriculture and agri-food sectors",

at Sète (France) from the 14th to the 18th March 2016.

The school was organized by CIRAD (UR GECO)
and IRSTEA (UMR ITAP),
with the support of the Industrial Chair ELSA-PACT.

CIRAD has accredited this school for continuing education.

With this book, we are provisionally rounding off the “researcher school” phase, which represented an end point on our route toward better consideration of the social impacts of value chains in the development strategies of companies, backers and local or national authorities. So now the time has come for the acknowledgements. They go firstly to Catherine Macombe, who in heading up the Scientific Committee, was able to convince the authors to take the field first in oral form, and now in writing. Similarly we would like to express particular thanks to Pauline Feschet, who besides her contribution to the scientific work, has done a remarkable job within the organisation committee and during the seminar. This book, providing an indelible footprint of the work and discussions of this research school, was made possible thanks to the presentation and publishing know-how of Catherine Sanchez. The authors – mostly very young researchers – took up the challenge of presenting works still at the development stage (this is the privilege of the research school), with great courage and conviction. Their commitment is a positive signal for the future. We would also like to acknowledge the boldness of all the participants, who took the scientific risk of blazing the trail in the field of assessing social impacts, which is still in its infancy. Thanks go also to our institutions, IRSTEA and CIRAD, which through their financial support enabled the scientific content to be expressed in a user-friendly “package”. Finally, thanks to you readers, whether devotees of assessment or merely “explorers” of the social field, for checking out this work. We can bet that it will give rise to criticisms, controversies, or even frustrations, but we all hope a great many missions.

Denis Lœillet

Foreword

Some background issues in social LCA

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Social Life Cycle Assessment (social LCA) is more recent than methodologies to assess the economic and environmental impacts of supply chains, but this type of analysis is essential if all aspects of the sustainability of supply chains are to be assessed and improved. Social LCA differs from environmental LCA (eLCA) in a number of fundamental respects; indeed, the limited acceptance and success of the UNEP/SETAC approach to social LCA (Benoît and Mazijn, 2009) is attributable in part to being modelled too closely on eLCA. The chapters in this book set out significant contributions to the development of social LCA beyond the UNEP/SETAC approach. This Foreword is intended to provide a backdrop to these developments by positioning social LCA in the context of established approaches and current developments in environmental LCA (eLCA), setting out some of the fundamental differences between social LCA and eLCA, and outlining some of the challenges still to be overcome in developing a consistent operational approach to social LCA.

1. Social LCA and Life Cycle Sustainability Assessment

Sustainable development is not to be interpreted in the narrow sense of economic development within environmental constraints. The Brandt Commission (1980) pointed out firmly that:

"One must avoid the persistent confusion of growth with development, and we strongly emphasise that the prime objective of development is to lead to self-fulfilment and creative partnership in the use of a nation's productive forces and its full human potential."

In other words, sustainable development implies enhancing quality of life and well-being for current and future generations, not just increasing consumption (Clift et al., 2013). To express this interpretation, "sustainability" is commonly represented as having three groups of components: techno-economic; environmental or ecological; and social or societal (e.g. Clift, 1995; Mitchell et al., 2004; Blewitt, 2008), sometimes articulated as "profit, people and planet". The relationship between them is frequently represented as a Venn diagram, as in figure 1, in which the three lobes represent decision spaces, bounded by "hard" or "soft" constraints which cannot be transgressed if human activities are to remain sustainable. Although the priority attached to each component may differ according to the context, each of the three sets of constraints must be respected; in legal terms, they are not fungible. As a specific and important example, environmental sustainability cannot be relaxed to improve economic or social sustainability. In the prevailing economic system, economic pressures ensure that human activities meet the requirements of techno-economic efficiency. However, the other two sets of constraints are commonly violated or simply ignored. Furthermore, following the statement from the Brandt report quoted above, economic growth is to be seen as a means towards human development rather than as an end in itself. Therefore, "sustainable development" implies finding a path from current activities

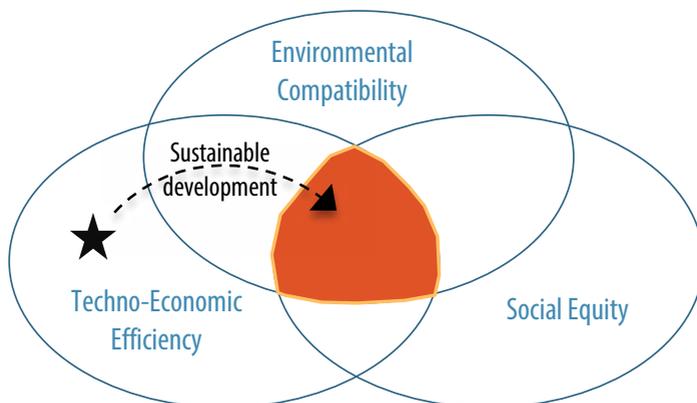


Figure 1: Sustainability and sustainable development (adapted from Clift, 1995 and Clift et al., 2013)

(point X in figure 1) to the region at the centre of the diagram where all three sets of constraints are respected.

To sum up, *sustainability* is a state – an emergent property of a complex system – whereas *sustainable development* is a process of change towards a more sustainable state. There is some confusion in the literature over whether "sustainability assessment" is directed at assessing the state of a system or a change in the system. LCA addresses changes and is therefore usually directed at assessing whether a change contributes to sustainable development.

Tools to guide sustainable development by improving the sustainability (or, more realistically, reducing the unsustainability) of supply chains delivering specific goods or services address the three components: Life Cycle Costing (LCC), environmental Life Cycle Assessment (eLCA) and social Life Cycle Assessment (social LCA) (Guinée, 2016). Life Cycle Sustainability Assessment requires all three groups of tools if it is to address the three components of sustainability; this lies behind the continuing efforts to improve eLCA and to develop an operational approach to social LCA. LCC is the longest established and arguably the least contentious of the tools (e.g. Swarr et al., 2011), although its results are dependent on human constructs including fiscal regulations and so inevitably lack the universality to which eLCA aspires: the laws of thermodynamics are carved into stone whereas the laws of economics are written on paper!

Recent attempts to define the constraints bounding the Environment lobe in figure 1 have mainly focussed on the Planetary Boundaries approach, originally articulated by Rockström et al. (2009) to define the "safe operating space" represented by this lobe, and developed further by various authors to refine the scientific basis (e.g. Steffen et al., 2015) and to use the Planetary Boundaries approach as the basis for operational

environmental management tools (e.g. Bjørn et al., 2015; Clift et al., 2017). In the context of LCA, identifying and quantifying the constraints defining the Environmental compatibility lobe opens up the possibility of going beyond "relative sustainability" – i.e. reducing resource use and environmental damage without specific targets – to "absolute environmental sustainability" with carrying capacity used as the benchmark to compare environmental impacts to what could be sustainable" (Clift et al., 2017).

Whereas the Techno-economic and Environmental lobes are defined by financial and scientific parameters, the Social equity lobe represents ethical goals. For social LCA to be accepted as valid, the goals themselves must have received wide acceptance; for example, they could plausibly be based on the global Sustainable Development Goals agreed by the United Nations (Griggs et al., 2014; United Nations, 2015). Raworth (2012) and Dearing et al. (2014) have considered how to reconcile the social



Figure 2: Planetary and Social Boundaries
(source: University of Surrey, Practitioner Doctorate Programme in Sustainability, 2017; surrey.ac.uk/pds)

foundations of human development with the Planetary Boundaries, with Raworth complementing the "safe operating space" idea of Rockström et al. (2009) to present "a visual framework for sustainable development ... which brings planetary boundaries together with social boundaries (to indicate) a safe and just space between the two, in which humanity can thrive". Figure 2 shows a similar "visual framework" to emphasise that the social boundaries must be met within the Planetary Boundaries.

By contrast with eLCA which only considers environmental damage, social LCA should consider both positive and negative social impacts in assessing whether a change contributes to sustainable development. The background thinking is that a supply chain should be seen not just as a sequence of material and energy transfers delivering a product or service but as a set of relationships that can deliver benefits in both directions along the supply chain (Clift et al., 2013). The UNEP/SETAC approach to social LCA (Benoît and Mazijn, 2009), modelled closely on eLCA with a "check-list" approach to impacts, is too prescriptive to capture any nuances affecting the significance of particular impacts or to recognise that the social consequences of a supply chain may be positive or negative according to the local context. As a specific example, Arvidsson et al. (2015) have pointed out problems in the way working hours, child labour and property rights are currently included in social LCA.

Some more specific common aspects and differences between eLCA and social LCA are explored in Section 2.

2. System Definition and Analysis

2.1 Linear and Non-linear System Models

The results of eLCA are normally reported as impacts per *functional unit*, i.e. per unit of product or (preferably) service delivered. This simple representation hides an issue in system modelling, shown schematically in figure 3 (for simplicity plotted only in terms of contribution to climate change although the basic concept applies to any impact). The production rate to which the eLCA results apply is shown by point A in figure 3. Citing single values for impacts without further qualification is valid if the system behaviour is linear and homogeneous, corresponding to the black line from the origin to A, so that the impact per functional unit is independent of production rate. The gradient of this line gives the average impact per functional unit.

Real product systems are rarely so simple. If the product system requires substantial "baseline" activity just to keep it in operation, as is the case for many chemical and petrochemical products for example, then the system behaviour is described by the blue curve in figure 3. Point A is still on the curve describing the behaviour of the product system, so the average impact per functional unit is the same as for the linear homogeneous case. The increase in impact resulting from a marginal increase in production – i.e. the marginal impact – is represented by the gradient of the tangent

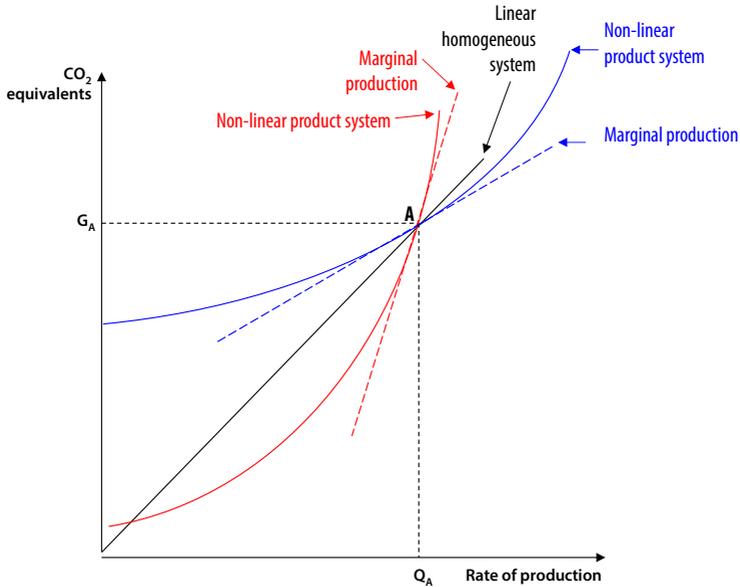


Figure 3: Linear and Non-linear System Models

to the blue system curve at point A. For this case, the marginal impact is lower than the mean value. The red curve in Figure 3 represents a product system requiring limited maintenance but in which the impacts increase non-linearly with output; many agri-food systems correspond to the red case. The marginal impact per functional unit is now larger than the average value.

The distinction between average and marginal impacts is sometimes recognised in eLCA; for example, the choice of marginal or average impacts of technologies is a contentious issue in whether there should be methodological differences between attributional and consequential LCA (see section 2.3). Most approaches to social LCA, including those set out in this book, consider marginal changes in output or technology.

2.2 Foreground and Background Systems

LCA aspires to describe the complete product system, from "cradle to grave"; indeed, an analysis limited to part only of the supply chain is not a full LCA. In process-based LCA, i.e. analysis that considers the specific processes making up the product system, it is necessary to apply cut-off rules to establish the boundaries of the system under study; this is an essential part of the Goal and Scope Definition phase of LCA (ISO, 2006).

The "whole system" approach makes LCA notoriously labour-intensive, particularly because it requires compilation of extensive data. To limit this task, it is common practice (although not always made explicit) to distinguish, as shown schematically in figure 4, between:

Foreground System: the set of processes whose mode of operation is affected directly by decisions based on the study;

Background System: all other processes which interact directly with the foreground system, usually by supplying materials or energy to the foreground or receiving materials or energy from it.

Ensuring that social LCA includes all impacts in the life cycle requires an equivalent approach.

The distinction between foreground and background is to an extent arbitrary. The details of where the boundary is drawn must be made clear as part of Goal and Scope Definition, and are often revised as the study develops. A sufficient (but not necessary) condition for a process or group of processes to be in the background is that the exchange with the foreground takes place through a homogeneous market. Making the distinction helps to constrain the process of data collection because only the foreground processes need to be described by specific primary data, while the background processes can be described by generic eLCA data, for example from one of the commercial or open-access inventory databases. By common convention, the impacts resulting from exchanges between the background and foreground are assessed according to the average behaviour of the background system (BSI, 2011).

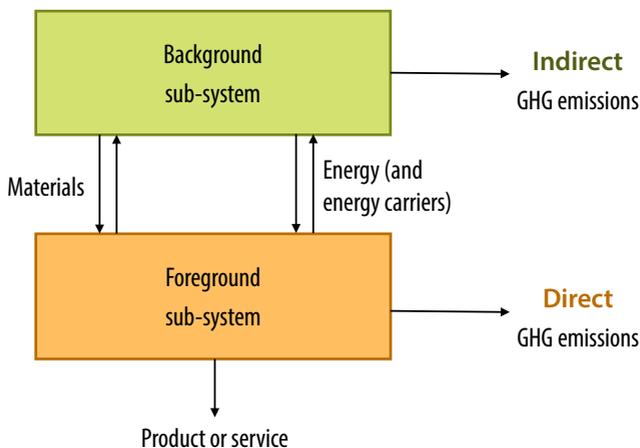


Figure 4: Foreground and Background (sub-) Systems (Clift et al., 2000)

The material and energy exchanges within a product system are sometime described in terms of Input/Output (I/O) analysis. The environmental impacts associated with material and energy exchanges are also included in Environmentally Extended Input/Output (EEI/O) analysis. I/O and EEI/O models are inherently linear; therefore these modelling approaches embed the assumption that the system is linear and homogeneous (see section 2.1). This type of analysis is particularly valuable for exploring macroscopic questions such as the impacts embodied in trade (e.g. Wiedmann, 2016) or waste arising from industrial processes and consumption (e.g. Moriguchi and Hashimoto, 2016). In principle, I/O analysis could also be used to describe marginal changes but data are rarely available in the form needed to enable marginal analysis. Some advocates of the EEI/O approach claim that it covers all activities in a product system and avoids the problem of applying cut-off rules. Set against that possible advantage is the disadvantage that available I/O data are generally highly aggregated, usually at a national level; therefore, EEI/O can be used to explore major changes such as alternative sourcing but can only rarely be used to explore differences between alternative production processes using the same inputs. Some analyses attempt to overcome this limitation by applying a "hybrid" approach in which the foreground sub-system is assessed by process-based LCA while the exchanges with the background are modelled by EEI/O. This approach is consistent with the convention of using averages to describe the behaviour of the background.

I/O modelling has been used as a screening tool in social LCA (e.g. Hutchins and Sutherland, 2008), for example to identify "hot spots" in a life cycle where social impacts are likely to be of concern (Benoît-Norris et al., 2012) and the social impacts embodied in international trade flows (Wiedmann, 2016; Xiao et al., 2017). As in EEI/O, the databases are (at least at present) aggregated at a national level and therefore not appropriate for examining specific changes in the foreground. The approach on which the developments in this book are based, assessing the foreground by primary data, is therefore to be seen as hybrid in the terminology of eLCA. This is consistent with the approach of assessing marginal foreground changes using the average behaviour of the background.

2.3 Attributional and Consequential Assessment

The distinction between *attributional* and *consequential* eLCA was first articulated by Tillman (2000). In brief, attributional LCA (also known as accounting LCA) examines the direct environmental impacts of an existing or hypothetical supply chain, whereas consequential LCA (also known as prospective LCA) includes the consequences for the background system of introducing a new product or supply chain or expanding an existing supply chain. The distinction between the two types of LCA came to prominence for biofuels: attributional LCA considers only the system producing an energy crop whereas consequential LCA attempts to include the effects of changes outside the foreground product system, primarily changes in land use from, for example, producing food to producing the energy crop. The distinction becomes significant when there is competition for a scarce resource – land in the case of biofuels.

Methodological differences between the two approaches have been discussed with more intensity than constructive resolution (e.g. Plevin et al., 2014; Ekvall et al., 2016).

The terminology *attributional* vs. consequential is firmly embedded (if not always clearly articulated) in the literature on eLCA. It is therefore important to be clear on how social LCA methodologies fit into the distinction. From the outset, it has been recognised that social LCA should encompass governance – the “*controls over, organisation of and actions in the life cycle*” – to show how social, cultural and political structures are connected to environmental impacts (O’Brien et al., 1996). Although the distinction had not yet been articulated, O’Brien et al. were arguing in part that social LCA should be consequential. On the other hand, Suckling and Lee (2017) argue that the potential for social assessment to become all-embracing implies that particular care is needed at the Goal and Scope Definition stage of any specific social LCA: the question to be addressed must be matched to the resources available if it is to stand any chance of being answered. This mirrors a familiar problem in eLCA: consequential assessment is even more labour-intensive than attributional. For this reason, routine assessments, such as product labelling, are normally attributional rather than consequential (BSI, 2011; Brandão et al., 2014); as a simple example, if the objective is to provide an environmental label for a packet of potato chips, life is too short to ask what the field would be used for if not for growing potatoes.

Approaches to assess the social consequences of expanding or developing a supply chain, such as those by Feschet et al. (2013) and Bocoum et al. (2015), address only the direct foreground impacts; for example, the analysis of banana production in Cameroon by Feschet et al. assumes that there is a market for the increased banana production so that production elsewhere is not displaced. According to eLCA terminology, this type of assessment is attributional. A consequential analysis would consider the effects in the background of the foreground production of bananas, for example by displacing bananas produced elsewhere from a finite market if consumer demand constitutes a scarce resource.

The intention in pointing this out is not to deny the value of these approaches but to clarify how they relate to practice and terminology used in eLCA: social LCA is currently an attributional approach. Ways to pursue consequential social LCA can be conceived but their development is unlikely to be productive until a methodology for attributional social LCA has achieved widespread acceptance.

2.4 Predictive and Verifiable Models

Environmental LCA has its origins in risk assessment. Like models used in risk assessment (and in other fields such as economics), the objective of eLCA modelling is to combine scientific evidence, sometimes from widely disparate disciplines, to provide “best” predictions for the potential environmental consequences of the activities making up a product system (although “best” is rarely defined). Although the models are based in empirical evidence, eLCA has never been “scientific” in the

sense of making predictions amenable to Popperian empirical testing, a point that is sometimes overlooked by critics of LCA (e.g. Plevin et al., 2014). Furthermore, the impacts predicted rarely have the geographical specificity needed for spatial planning tools such as Environmental Impact Assessment (Clift et al., 2000). These fundamental limitations should be emphasised by describing the results of Life Cycle Impact Assessment as *potential* impacts (ISO, 2006), but the word is frequently omitted in reporting results so that the limitations can sometimes be forgotten.

Those concerned with developing social LCA need to address whether they aspire to predictive or verifiable modelling or some combination of the two. In eLCA, environmental impacts are predicted by well-established impact pathway modelling. Comparable pathway modelling is yet to be established for social LCA, although Feschet et al. (2013), Bocoum et al. (2015) and some of the chapters in this book present significant steps in this direction. Until pathway models are more established, field studies are commonly used to obtain primary data on the social impacts of economic activities. In any case, this kind of primary social data is needed to test predictive models. Social "hot spot" databases (e.g. Benoît-Norris et al., 2012) can be used to focus social impact assessment on the activities most likely to be significant.

3. Challenges and Prospects

Social LCA started as an attempt to assess the social impacts of supply chains by a methodology as close as possible to that established for environmental LCA. Given that eLCA is already well established with a general methodology that is widely accepted (subject to some continuing debate at a detailed level, for example around attributional vs. consequential assessment), acceptance of a methodology for social LCA, such as that set out in this book, will be helped if the common ground with and differences from established methodologies for eLCA are set out clearly. Experience has shown that social LCA differs from eLCA in sufficiently many respects that the methodology must be re-evaluated at a more fundamental level: what exactly is social LCA intended to reveal? how is the assessment to be used? how does this affect selection of an appropriate methodology? Given that both positive and negative impacts are included in social LCA, should the focus be on minimising risk or on maximising benefit?

One of the major respects in which social LCA differs from eLCA is that measures of social performance necessarily have a strongly normative aspect; the specific cases of working conditions, child labour and property rights were noted above. LCA in general introduces unusual ethical problems because the subjects affected by a supply chain constitute a distributed community of ethical concern – distributed both geographically and in time. It has been pointed out (Macombe et al., 2016) that social LCA is an area where the approach known as "post-normal science" should be deployed, using an "extended peer community" to ensure that the assessment can

achieve general acceptance (Ravetz, 1993). However, the kind of extended community recommended in the post-normal science approach is usually not accessible in LCA because some of the subjects and stakeholders are too geographically remote or, even more starkly, because members of the future generations whose welfare is supposed to be a prime concern in sustainability have yet to be born. To avoid imposing current ethical norms on future generations, a possible approach is to base assessments on ensuring that the range of options and life-styles available to future generations is as wide as possible (see e.g. Nussbaum and Sen, 1993). This approach is consistent with the interpretation of sustainability summarised by figure 1. However, it highlights the need for a more complete debate than has yet taken place over the ethical foundations of social life cycle assessment.

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Matrix of the researcher school's contents

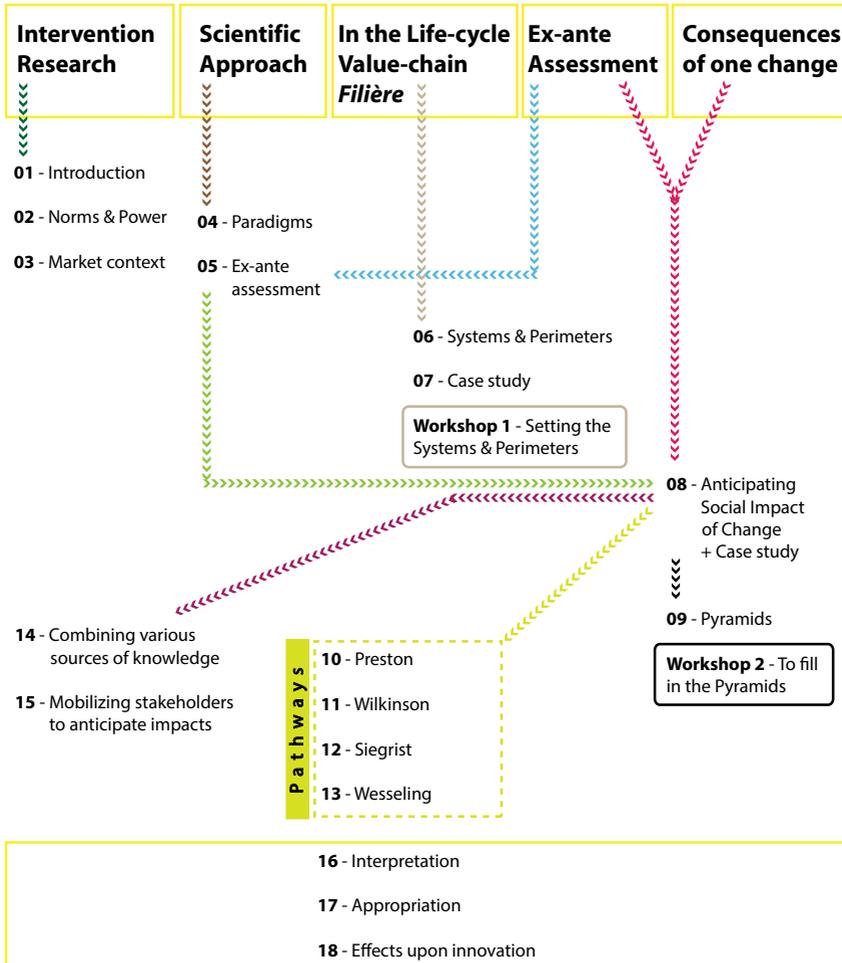
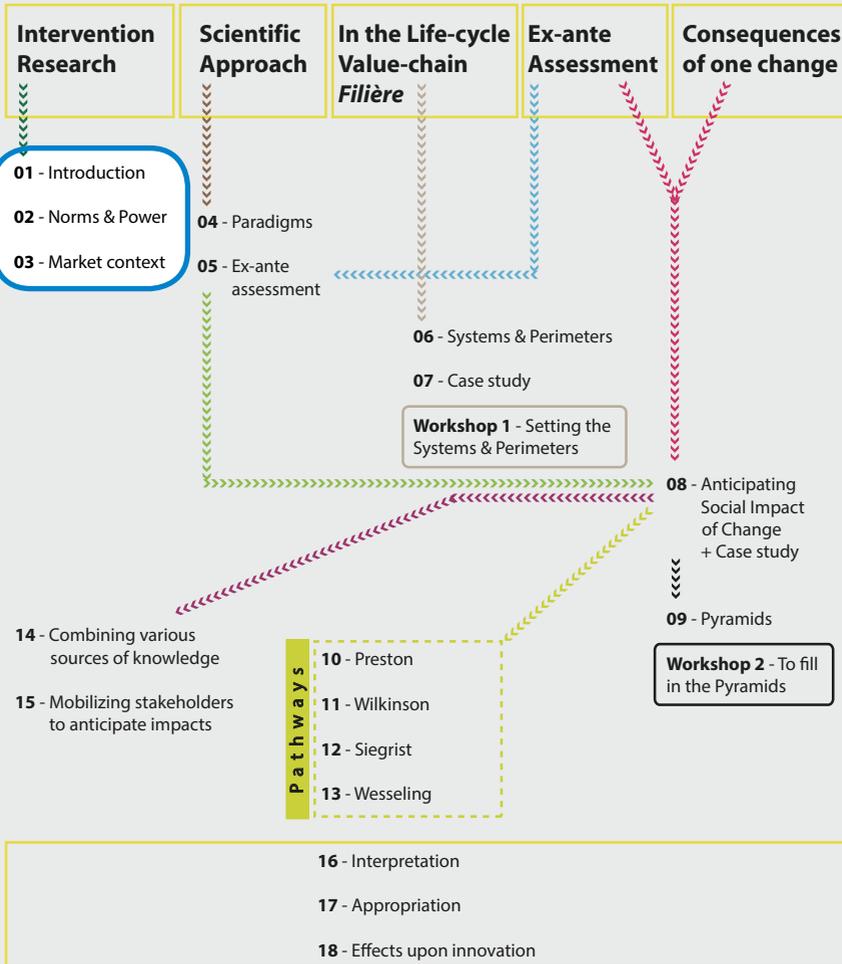


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Matrix of the researcher school's contents



Part 1

Context

01 Introduction

Catherine Macombe, IRSTEA, UMR ITAP, Univ Montpellier (France)

To sum up

This introduction displays five ideas, which are important to present the whole of the researches developed during the researcher school. Some are dealt with in this chapter. Some others will be detailed in the next chapters.

Outlook:

1. For Management Sciences, social LCA is "intervention-research"
2. A scientific approach
3. Three concepts: life cycle / value chain / "filière"
4. Performing "ex-ante" assessment
5. Consequences of one change

1. For Management Sciences, social LCA is intervention-research

From David, Hatchuel and Laufer (2000) the research we practice is "intervention-research" because:

- we build new management tools with companies and devoted to companies;
- we are willing to provide knowledge for science, and for action too;
- it is possible to design a "modeling of the ground".

In Management Sciences, the kind of research matching these features is called "intervention-research".

In the research program of social LCA, all the researches activities (even the more theoretical and academic ones) are driven by social stakes and social demands, in the end.

The generation of knowledge delivers two outputs:

- the provision of tools and new ways of thinking to act about real concrete issues,
- the elaboration of scientific knowledge, by elicitation of tacit knowledge and by generalization.

The implementation of a case study always involves the design of the system, in order to highlight the objects which are remarkable from the social LCA scope. **The remarkable objects of social LCA are organizations (workshop, plant, factory, etc.), flows of goods and services, and groups of people.** Indeed, social LCA doesn't



work on an individual scale. It works on middle-scale (group of workers in the factory, population of one village, etc.) and on macro-scale (country population, group of users, etc.).

The title of the researcher school contains "Application to agriculture and agro-food sector", because the bio-economy has been the implementation field of the Montpellier's researchers in social LCA, to date.

2. A scientific approach

We are not seeking for engineering only. We try to build a scientific approach. Thus, we will present epistemological roots of social LCA in the chapters 04 and 05.

3. Three concepts: life-cycle / value chain / filière

The object evaluated by social LCA is a "social life-cycle". It is worth sorting out the three concepts.

3.1 Three viewpoints

In fact, the three concepts "life cycle", "value chain" and "filrière" stand for three viewpoints about the same real system. The three scopes stem from three different history and disciplines. They all describe the articulations of flows (at least material flows) during the making of the good.

"Life-cycle" is the vocabulary of LCA engineers. Its origin pertains to the "industrial ecology" concept, where engineers try to "close the loops" between flows stemming from different plants and feeding other plants. In "life-cycle" thinking, the conceptual framework is thinking about the system as industrial making of standardized industrial goods, and taking into account all the steps (extraction, processing, usage, recycling when relevant). Because of supposed standardization of goods, the reasoning is made for one given item (e.g. 1 kg of tomatoes). In general, there is no reflection about tricky downscaling or upscaling of data, which would be necessary to take into

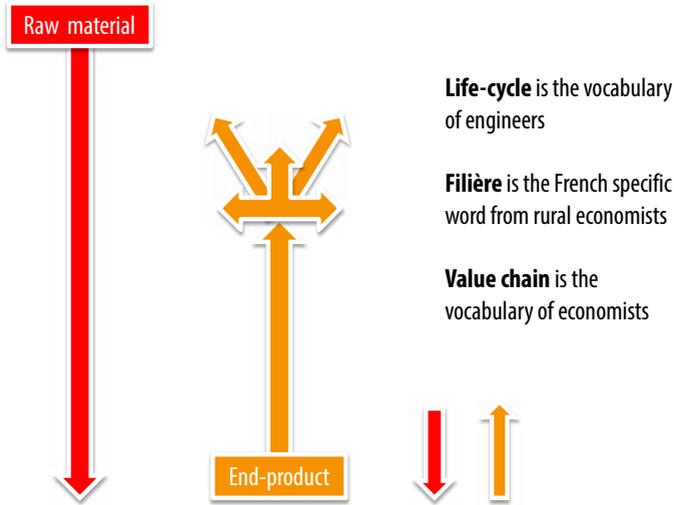


Figure 1: Comparison between filière (red) and value-chain (orange)

account the making of numerous real items. Because of this industrial origin, the issue of implementation of LCA to items from biologic origin remains open. The life-cycle design represents the different flows of the good and of the antecedents of the goods, from the raw extraction of materials to the end-of-life. In Environmental LCA, actors play few roles.

The added-value of LCA thinking for social LCA is about ability to highlight the "transfer of impacts" from one step of the life-cycle to another, from one kind of impact to another, or from one group of actors to another, when comparing scenarios.

"Filière" is the French specific word from rural economists for the concept invented to describe the entity shaped by all the actors depending on each other, because they are linked by the processing of one common agricultural raw commodity¹. The design of the "filière" takes into account all the organizations (farms, factories, outlets, etc.) involved in the progression of the raw commodity, and pays attention to actors' strategies because of the flows of goods and services they are linked by. Real filières are more and more becoming networks (see chapter 3).

The reasoning is made globally, for the whole capacity of the filière. So, the order of magnitude of each filière is one important feature of the study. It is not possible to copy the results of one study to another if the orders of magnitude are different or if the actors strategies are different.

¹ By extension, the concept of filière has been used for agricultural products outside the field of raw commodities (e.g. organic local filière)

The added-value of the filière concept, for social LCA, is to acknowledge that the different actors' behaviours are linked through their common involvement in the same agricultural material.

Value-chain is the vocabulary of economists. It is driven by the final demand concept. Indeed, while the filière studies the processing from the start (e.g. the raw wheat collected in the field), the value-chain concept starts from the other side (e.g. the bread sold to customers). The main questions raised by the value-chain concept are about the nature of the process which made the crafting of the final good, and about the generation of value, and its location among the different steps of the value-chain. Indeed, the name "value-chain" means that the whole process is considered as a succession of steps generating value.

The added-value of the value-chain concept, for social LCA, is the possibility to calculate values generated at each step of the value-chain, because values can often be translated into social effects (see chapters 10 & 11).

3.2 Life cycle or filière? Both

It is not a surprise that the original concept of life cycle, inherited from environmental life cycle assessment, is not enough for social LCA design. All the same, it is not surprising the filière concept to be helpful. Indeed, for social LCA it is important:

- to see the system as a follow-up – or as a network – of organizations, linked by the goods process in which they are involved;
- to take into account the actors' strategy to assess impacts (e.g. to design the impacts of competition or synergy between actors).

On the other hand, when it comes to agricultural products, the usage and recycling steps exhibit particularities. Indeed, mainly for food, the function is obvious. So, in most cases of developed countries, there is nothing to say about the usage step. If the filière of the specific food under scrutiny didn't exist, it would be replaced by some other food. Of course, it is not the same when the food plays an important role and could not be replaced easily (e.g. for some deprived populations) or for other items than food (e.g. mobile phones, etc.). Moreover, when comparing scenarios, they are set in order to provide exactly the same function to users. So, the impacts generated from the usage step are not studied. In general, there is not a great deal to say about the recycling step of food (except for some packaging).

Here are the reasons why – when designing social LCA study for food – the design seems to borrow more from the filière concept than from the Life cycle concept. Nevertheless, social LCA is not a filière study only, because of the attention paid to social impacts, and because of searching for generalization. Neither social impacts caused by changes, nor generalization are at the core of the filière concept.

So, social LCA as presented here borrows:

From the filière concept:

- design of follow-up or network of organizations linked by the same good processing;
- attention paid to actors' strategies;
- often carelessness about the usage and the recycling steps;
- careful attention paid to the scale (no "wild" down or up scaling!).

From the life cycle concept :

- main goal is assessing effects and impacts;
- attention paid to transfers of social impacts of three kinds (between steps, between nature of impacts and between groups of people);
- search for generalized pathways (relationships of cause-effects). The generalization is made under conditions for use, the respects of the order of magnitude being the first.

3.3 Designing social life cycle

To design social life cycle of the good X, we start from the filière of good X. Here is (figure 2) an example of filière, designed at national scale and at regional scale.

To design the social life cycle from the figure 2, we first design the system of product of the good X, by adding the usage step and the end-of-life step to the regional filière design (figure 3).

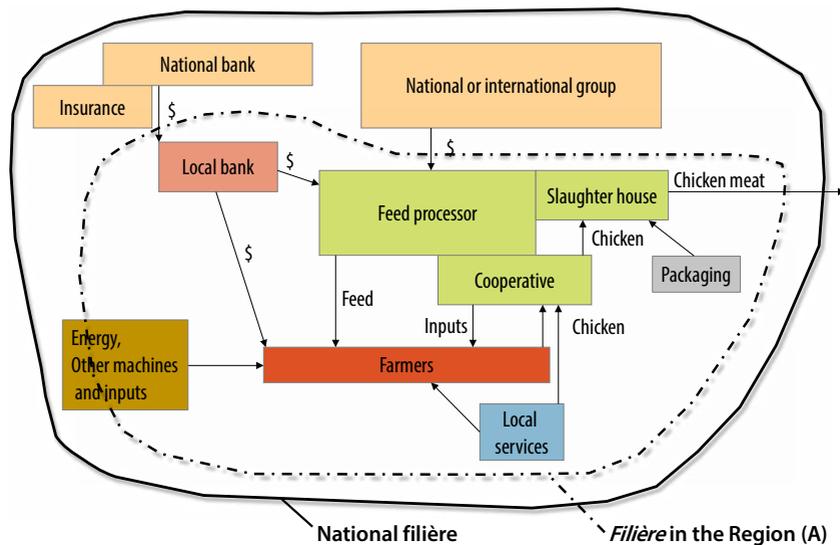


Figure 2: National and regional filières

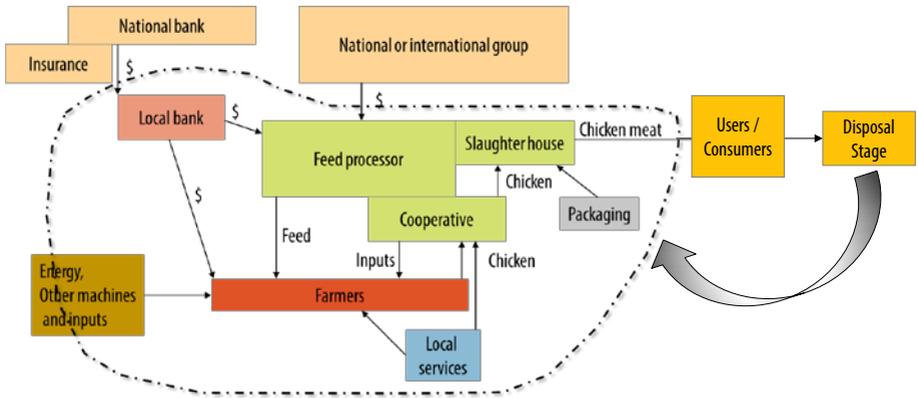


Figure 3: Adding usage and end-of-life stage to the regional filière to complete the system of product

From this figure 3, we are able to design the perimeter (in red in figure 4) of one environmental life cycle analysis study for the good X. The figure 4 displays an example.

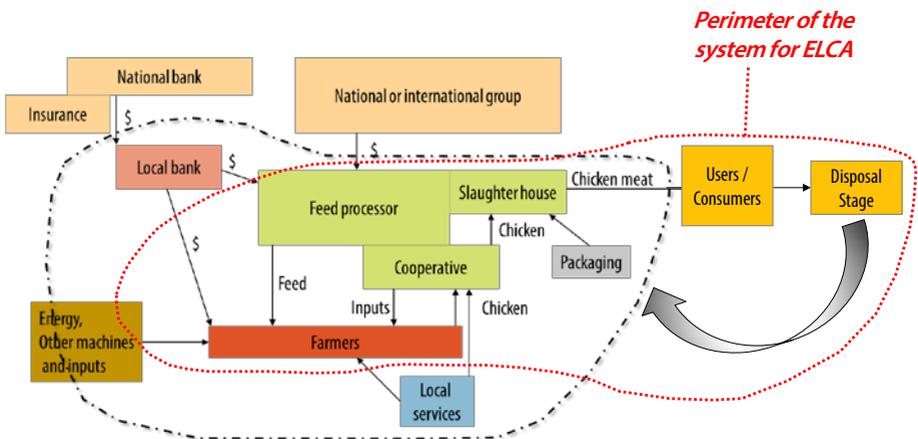


Figure 4: Example of design for the perimeter of the ELCA study (in red)

From the figure 3 again, we are able to design the perimeter (in blue in figure 5) of the social LCA study. The figure 5 displays an example. Here, we do not take into account the usage step because the study is a comparison between two different scenarios to provide the same service to users.

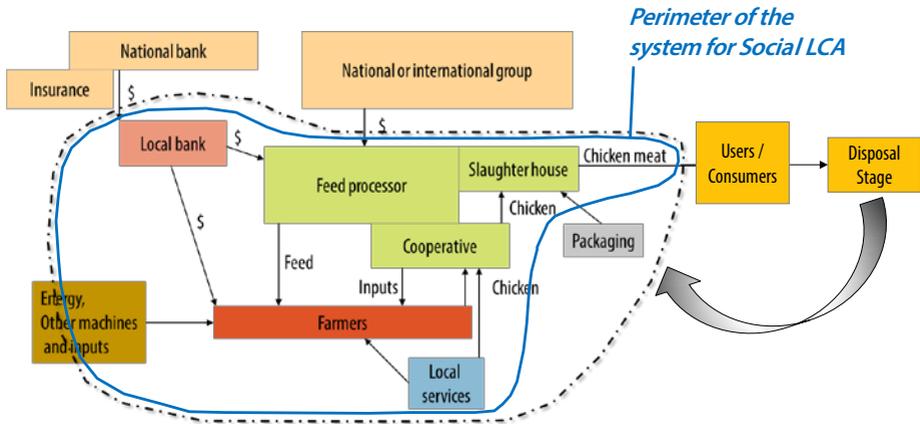


Figure 5: Example of design for the perimeter of the social LCA study (in blue)

4. Performing "ex-ante" assessment

The chapter 08 in general, and the chapters 10,11,12,13, 14 & 15 for different pathways, will present implementations performing "ex-ante" assessment of one given change.

5. Assessment of the consequences (impacts) of one change

It is of the utmost importance to understand that this research program is focusing on impacts, and not on performances (table 1). It is the same as in Environmental Life Cycle Analysis (ELCA). ELCA isn't interested by performances like the "temperature of the ground", or other features like that. ELCA study is interested in the environmental consequences caused by:

- i) the existence of the good or
- ii) by changes in the filière of the good.

Context	This is a performance	This is an effect	This is an impact
One situation (within one company)	Feature of the situation		
One change (driven by one company)		Phenomena caused by the change that could have impacts	Consequence of the change that is felt by people directly in life
Examples in social realm	Gender issue, child work, or freedom to organise within the company	Loss of jobs, creation of jobs, or creation of new networks	Changes in health status or changes in sense of confidence
Examples in environmental realm	Temperature of the ground, pH of water, eutrophication state	Increase of global warming, decrease in ecotoxicity, resource depletion amplitude	Consequences on human health

Table1: Differences between performance, effect, impact for social and environmental life cycle studies.

Social LCA is interested in the social consequences caused by:

- i) the existence of the filière of the good or
- ii) by changes in the filière of the good.

All these notions are important to understand the follow-up of the book. Bonne lecture!

02 Norms & power

Occupational safety and health "managerialization" through international standardization: a study on the future ISO 45 001 standard

Camille Gasnier, *EHESS, Cermes3 (France)*

To sum up

In this chapter we describe the development of ISO 45 001, an international standard on occupational safety and health management. We aim at showing that standards stem from power relationships between occupational health actors, and that they adjust legal framework and management tools in this field. The resulting tool strengthens management practices for risk prevention on occupational health, rather than risk assessment.

Outlook:

1. A political issue: the rise of a neoliberal government on working conditions
2. The ISO: a more inclusive democracy? The stakeholders framework
3. How to shape the market: power relationships between stakeholders
4. The development of the standard and the consensus principles
5. The "managerialization" of occupational health

Methodology

The following statements result of a 3-year inquiry on standardization. We have carried out ethnography of the French standardization committee on ISO 45 001 at AFNOR (Association Française de Normalisation) as soon as it was set up, and we have performed interviews with actors involved in the process: Labour Ministry, trade unions, occupational health agencies, health and safety managers, consultants, auditors and so on. Interviews have also been conducted with managers of the Central Secretariat at the International Organization for Standardization and with members of the Central Body of the International Labour Organization.

1. A political issue: the rise of a neoliberal government on working conditions

1.1 History of a controversy

In the wake of ISO management quality standard (ISO 9000 series) and environmental management standards (ISO 14 000 series), an international standard on occupational safety and health management is under development. The first proposal to develop such a standard dates back to the beginning of the 1990s. Indeed, the British standardization body wanted to promote occupational health through standards, after the publication of the European directive on the improvement of working conditions in 1989. They faced international refusal, especially because of the International Labour Organization's concern to preserve social partners and public authorities' prerogatives. The British standardization body therefore decided to develop its own national standard, called OHSAS 18 001 (Occupational Health and Safety Assessment Series).

In 2013, the British stated that this standard is nowadays widely spread, and succeeded in convincing a majority of ISO members to involve in the development of an international standard, based on OHSAS 18 001. The future ISO 45 001 should be published at the beginning of 2018.



Picture 1: ISO's headquarters, in Geneva's international business center (source: C. Gasnier)

1.2 A neoliberal government on working conditions

The ISO was created in 1947 to build a free market. Standards are indeed recognized by the World Trade Organization as they facilitate trade by removing trade barriers. ISO is composed of 164 members, whose two thirds are public organizations. But its more influential members belong to the last third and are private organizations in West European countries (Murphy and Yates, 2008). ISO is therefore a "hybrid" organization, that designs a new way of regulating, by investing "in a space where endogenous logics of nation state and exogenous logics characteristic of transitional capitalism intermingle" (Graz, 2006).

Originally, the International Labour Organization (ILO) disagreed on the development of an international standard on occupational health and safety management. Since the standard is now under development, the ILO and some public authorities see this

standard as an opportunity to help companies to conform international and national laws. They therefore aim at including inside requirements of international conventions.

ISO 45 001 is the product of an adjustment between a consistent legal corpus in this field, and management tools on occupational safety and health, especially OHSAS 18 001. That is why we can speak of the "rise of a neoliberal government of working conditions" (Foucault, 1978), where public authorities rely on the spontaneous dynamics of the market to regulate. Indeed, the certification to ISO standards is a contractual requirement. Public authorities aim at creating the framework of a free market while making firms to conform legal requirements.



Picture 2: The International Labour Organization's Governing Body, composed of workers delegates (on the left), employers delegates (on the right) and governments' delegates (in the middle) all sitting in front of the Bureau (at the back) (source: C. Gasnier)

2. The ISO: a more inclusive democracy? The stakeholders framework

The public authorities' strategy is quite a challenge. They have to negotiate with all the delegates involved in working groups and representing diversified interests or expertise. Delegates come from around 60 countries with various legislations, some of them refusing international conventions or wishing to lower the conventions requirements. Some governments and industries already used standardization as a bypass strategy regarding environmental regulation. The development of ISO 14 001 was a way to lower the requirements of the European standard EMAS (European Eco-management and Audit Scheme) (Reverdy, 2005).

The ISO's Central Secretariat claims that ISO is "a more inclusive democracy" than intergovernmental organizations, to negotiate on rules and conventions relative to work. Without ISO, intergovernmental organizations gather only workers, employers and governments' representatives.

ISO has elaborated a new list of participants to strengthen its transparency and legitimacy in the field of public policy (Ruwet, 2010). Seven stakeholders categories have been defined for ISO 45 001 development:

- Industry and commerce,
- Government,
- Consumers,
- Labour,
- Academic and research bodies,
- Standards application,
- Non-governmental organization.

Each national standardization body sends a delegation at international meetings for the standard development. Actually, the analysis of the list of participants underlines that **they belong to the following categories only**:

- management consultants,
- members of standardization bodies,
- assessors,
- QSE managers (Quality, Safety and Environment managers, managing risks in firms),
- members of occupational risk prevention and insurance organizations.

International organizations are also represented, such as the International Labour Organization, the International Employers Organization, the International Trade Union Confederation. Those stakeholders are nevertheless under-represented.

The stakeholder framework defined by ISO must be questioned. We can ask ourselves whether it is relevant to include all the stakeholders equally, whereas they are not similarly affected. Workers would be the first affected by the standard, **whereas they are the less represented in its development**.

3. How to shape the market: power relationships between stakeholders

Beyond public authorities' will to include international conventions requirements in the standard, diversified interests confront in the development of the standard.

QSE managers belong to firms that could be compelled to comply with the standard, to access to public markets. Indeed, ISO 45 001 could become mandatory for public

markets, as ISO 9001 is. The firms are already in compliance with the British standard OHSAS 18 001, and want ISO 45 001 to be similar to OHSAS 18 001, so that they would easily come into compliance with the ISO standard.

Furthermore, as we have seen, most of the delegates are **"supporting actors" of standardization** (management consultants, assessors, certifiers) rather than direct consumers of standards (Tamm Hallstrom, 1996). These actors confront each other to get the standard market, especially the certification business. Who will certify companies against the ISO standard: QSE assessors, financial auditors, occupational health and safety experts? It depends on the content of the standard, so each group tries to include vocabulary and requirements specific to its field of expertise.

Finally **some countries** such as India, Malaysia, Morocco or China fear that principal companies would state social requirements that would be too high for them. So they try to lower down those requirements. Nevertheless, we should not overestimate this idea, as those countries send few delegates to international meetings (figure 1), which shows their relative interest for the standard.

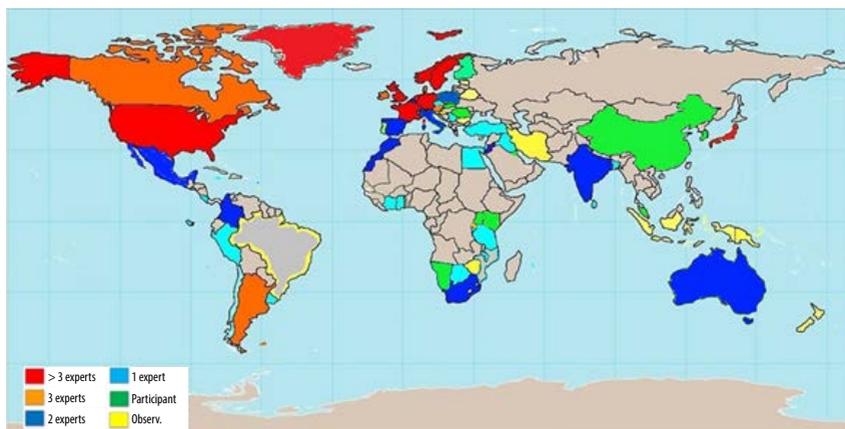


Figure 1: Map of the level of involvement of countries members of the project committee for ISO 45 001 (March 2015). The author thanks Catherine Montagnon (Institut National de Recherche et de Sécurité) who drew this map for the Euroshnet conference held in Sevilla in October 2015.

4. The development of the standard and the consensus principles

To negotiate the content of the standard, delegates meet twice a year. The working groups are dedicated to specific chapters. Several constraints make it difficult for the standards former opponents to make their point.

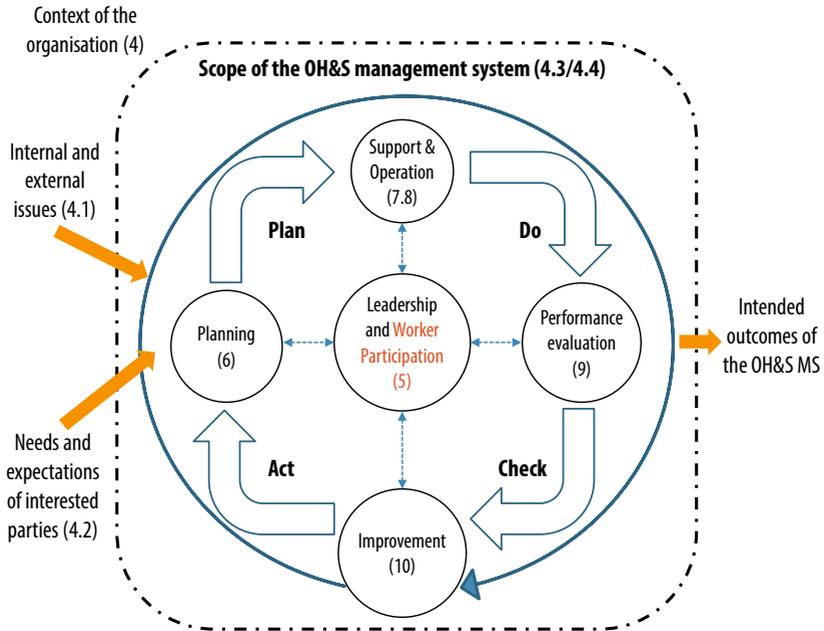


Figure 2: PDCA scheme extracted from the ISO 45 001 draft in June 2015

Consensus principles guide standards development. Nevertheless, it is up to the working groups leaders to evaluate whether the group has reached a satisfying level of consensus. The leaders were all part of the development of the British national standard, OHSAS 18 001, that is the initial draft of the standard.

Quality management guidelines and vocabulary pervade the standard, as 30% of it is not alterable and therefore non-negotiable. Those 30% constitute the High Level Structure of ISO management system standards, which is made mandatory by ISO for all management system standards. So, all these standards are structured according to the same plan, the same chapters, and the same vocabulary. The structure reflects the PDCA ("Plan, Do, Check, Act") philosophy, presented in the figure 2. According to this management philosophy, in order to manage occupational health and safety risks, a firm must define a strategy with associated human and material resources (Plan), operate actions (Act), evaluate its performance through internal control (Check) and define corrective actions (Act). Management commitment and workers participation spread in all the steps of the management system.

5. The "managerialization" of occupational health

The standard sanctifies the role of Quality, Safety and Environment managers in companies, while minimizing the role of other actors on occupational health. For example, there is no definition of "workers representatives" in the standard, as delegates might not agree on its content, some of them refusing to mention a voting process to elect the workers representatives. The standard frames occupational health as an object of management process.

Occupational health is organized and made amenable to process and practice of intervention in a global risk management system. It therefore depoliticizes the debate on working conditions, by minimizing the role of workers representatives. Occupational health is integrated in a whole management set made of actors (health and safety managers, consultants, certifiers) with their own organizations (standardization and certification bodies) structured by shared beliefs and faith in management sciences (risk management, Deeming wheel, Plan Do Check Act scheme). The management set reframes the function of other OSH experts, such as government organizations on occupational safety and health, health and safety associations, occupational physicians. These actors had to struggle to include in the standard a certain definition of OSH risk ("combination of the likelihood of occurrence of a work-related hazardous event or exposure and the severity of injury and ill health that can be caused by the event or exposures") because the High Level Structure of all ISO management system standards **imposes a definition of risk as "the effect of uncertainty"**. The two definitions coexist in the standard, and encourage considering occupational health both from employee and employer viewpoints, and to consider also risks caused by occupational health for companies.

Conclusion

Standardization on occupational safety and health management is a symptom of a paradigm shift about occupational health. The organizational paradigm integrating occupational health at all managerial levels slowly replaces the scientific paradigm focused on individuals, involving occupational physicians, ergonomics and toxicology. The technical dimension of risk prevention should take a back seat in front of the rising managerial dimension. The latter also aims at shaping accountable organizations with formalized practices and procedures (Power, 1999). Quality, Safety and Health managers still rely on few physical measures, but most of their work consists in planning, controlling, auditing, and drawing analyses for continual improvement. Risk management seems to substitute to risk prevention and work analysis.

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03 Market context for social LCA

The market is *almost* ready for holistic approach of sustainability

Denis Lœillet, CIRAD, UR GECCO, Univ Montpellier (France)

To sum up

How the business sector is progressively taking into account the social impacts (consequences) of its activity is the topic of this chapter.

Outlook:

1. The CIRAD Market news service
2. What does the market face to?
3. Where is the market going?
4. Why are the assessment tools so numerous?
5. Our dream with social assessment

1. The CIRAD Market news service

For 30 years, the CIRAD Market news service has focused on... Market intelligence AND (since 2008) Social Impact Assessment in the value chain. It involves five persons, including 1.5 person whose job is to analyse the world fruits and vegetables market weekly. They create primary data (price, marketed volumes, etc.).

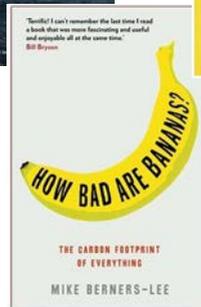
The service delivers a large range of editorial products:

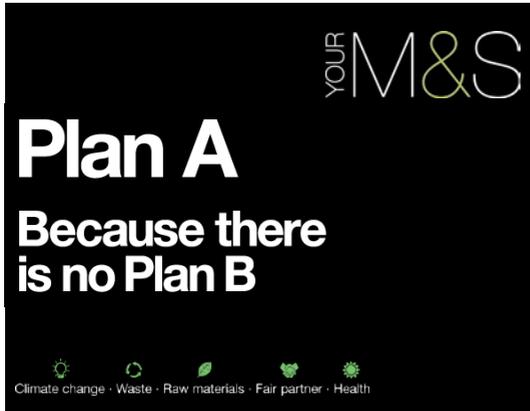
- weekly reports (5),
- a monthly magazine (FruiTrop),
- a website (www.fruitrop.com),
- statistics yearbooks,
- a lot of invited conferences,
- consulting for private and public body.



2. What does the market face to?

Watchdogs (mainly NGOs: Non Governmental Organizations) are very proactive in the markets (Lœillet, 2013).





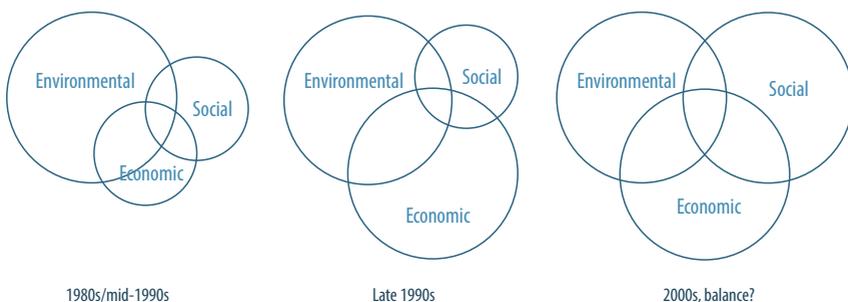
Watch over them strongly influences the big outlets companies, like Marks & Spencer.

3. Where is the market going?

The three pillars have not been equally prioritized by policy makers, when focusing on sustainability.

There is a general acceptance that over the last thirty years, the three pillars have not been equally prioritized by policy makers focused on sustainability. It is only recently that the social pillar has achieved parity as a priority, alongside the economic and the environmental ones. One of the arguments proposed by some authors is that the assessment of social aspects presents measurement problems.

In our research group, we argued that social health is a good indicator of the environmental and economic "health" of a society.



Source: Marghescu, 2005

3.1 From CSR to SCR

As for the concept of sustainability, the concept of social responsibility of companies has evolved over the last 20 years. They are moving from CSR (Corporate Social Responsibility) concept to SCR (Supply Chain Responsibility) concept: they become aware to be fully accountable for all negative impacts that their value chain could produce. **This is the first step.**

The second step will be the evaluation of the positive and negative impacts of their activity (and not only the evaluation of performances).

And we can testify that some firms are on the way to do it well.



<http://www.emeraldinsight.com/doi/pdfplus/10.1108/13598540910970126>

CSR to SCR (Laura Spence and Michael Bourlakis, 2009)

CSR

The consideration of, and response to, issues beyond the narrow economic, technical and legal requirements of the firm to accomplish social (and environmental) benefits along with the traditional economic gains which the firm seeks.

SCR

Supply chain responsibility is the chain-wide consideration of, and response to, issues beyond the narrow economic, technical and legal requirements of the supply chain to accomplish social (and environmental) benefits along with the traditional economic gains which every member in that supply chain seeks.

3.2 There is still a long way to go

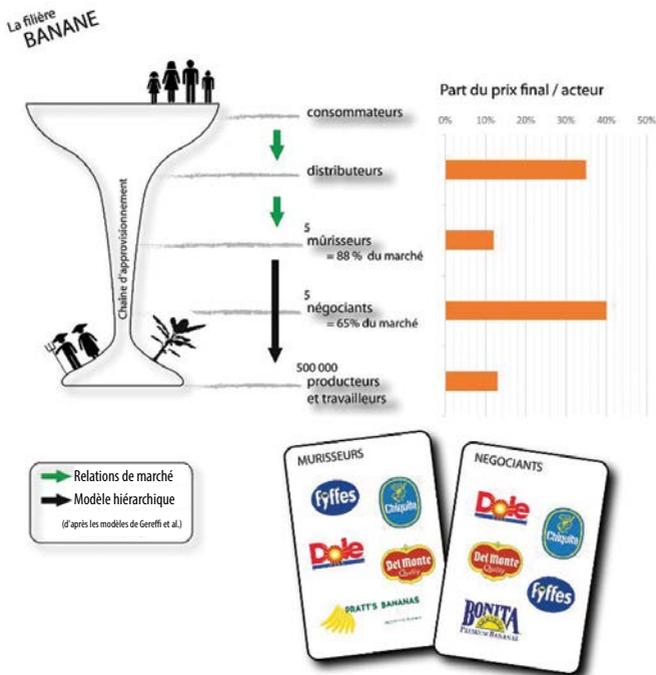
Crises are still numerous. The scandal of the "shrimps of the blood", revealed by *The Guardian*, shows that there is still a long way to go.

In this case, the supply chain of shrimps implemented inhuman practices.

A six-month investigation has established that large numbers of men bought and sold like animals and held against their will on fishing boats off [Thailand](#) are integral to the production of prawns (commonly called shrimp in the US) sold in leading supermarkets around the world, including the top four global retailers: [Walmart](#), [Carrefour](#), [Costco](#) and [Tesco](#). (source: The Guardian)

At least, we expect that the fishing or breeding was not certified sustainable!

All the large world distributors recognized that **they did not know the social functioning of their supply chains**. The reason given is the extreme complexity of the supply chain.

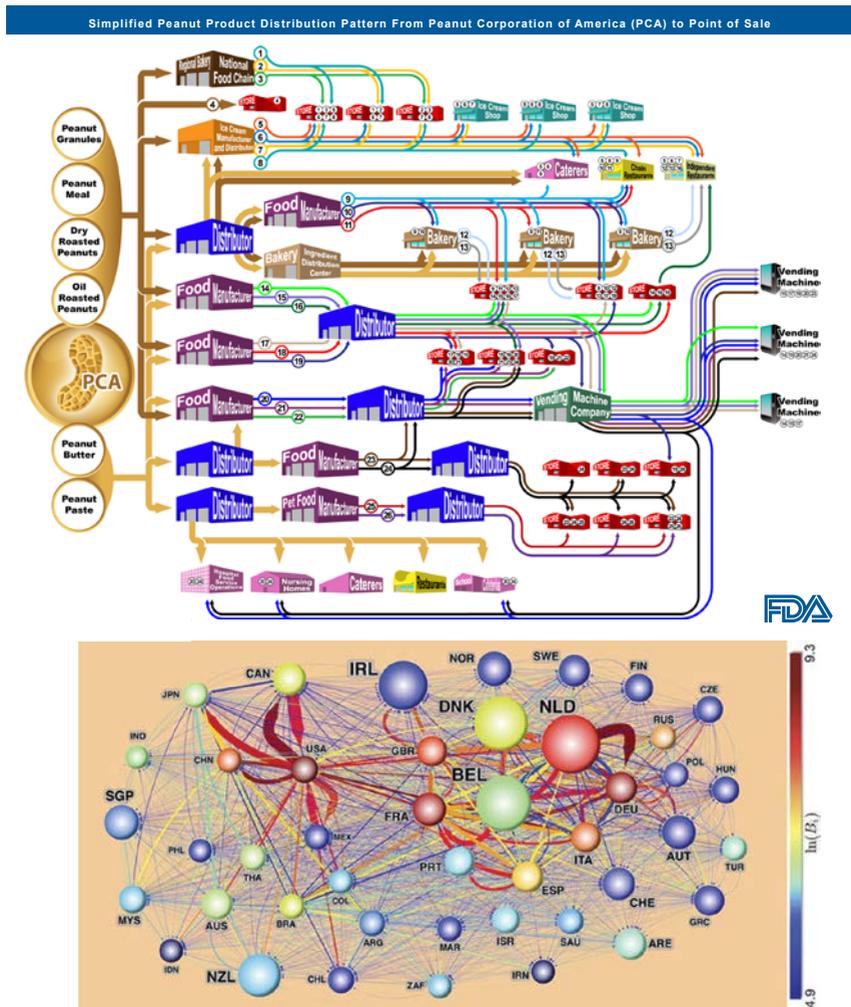


Chaîne globale de valeur de la banane
Source: BASIC

3.3 Who is responsible for what?

In the banana case (see previous page), the few end-intermediate operators (less than twenty for Europe) are responsible for the **sanitary, social and environmental health** of the sector (network). In fact, the sector has become a **complex network** (Basic, 2015).

The growing complexity of the network (supply chain) increases the risks. Hereafter are two examples of the network complexity about 1) peanut supply chain for fresh and processed product; 2) the world food system. Here we highlight the interdependence, the intensity and the complexity of chains.



Nowadays, large companies don't know the social content of their supply chain yet!

Two of the world's biggest coffee companies, **Nestlé** and **Jacobs Douwe Egberts**, admit that beans from Brazilian plantations using slave labour may have ended up in their coffee because they do not know the names of all the plantations that supply them. (source: The Guardian)

Labels do not alleviate the responsibility of the distributor.

The multiplication of labels, standards, good practices guidelines, etc., does not change the responsibility of the central firm. Here is below an example with Tesco, one of the leaders in the world distribution sector. We display a screen copy of only a part of the section of the Tesco corporate website dedicated to prove the commitment of Tesco to the traditional pillars of sustainable development!!!

But... it is obvious that the long list of labels does not protect against bad practices. Whatever the Fair trade label certification already used, Tesco must go further.

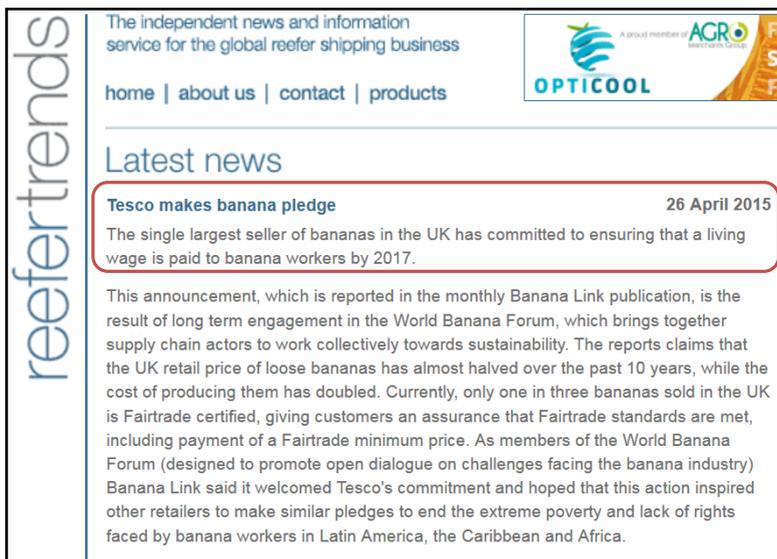
The screenshot displays a list of sustainability initiatives and labels:

- United Nations Global Compact**: A commitment to the principles of the UN Global Compact, focusing on human rights, labour rights, environment, and anti-corruption.
- The Consumer Goods Forum**: A global industry association for consumer goods companies, committed to responsible consumption and production.
- IGD**: The International Goods Distributors Association, committed to responsible consumption and production.
- Retailer's Environmental Action Programme (REAP)**: A commitment to reducing environmental impact through various initiatives.
- Roundtable on Sustainable Palm Oil**: A commitment to responsible palm oil sourcing.
- RSPO**: Roundtable on Sustainable Palm Oil, a multi-stakeholder initiative to promote responsible palm oil production.

The screenshot shows a news article from the Fairtrade Foundation dated 12th December 2014. The headline is "Asda and Tesco receive 100,000 requests for Fairtrade bananas". The article text states: "UK shoppers have bombarded Asda and Tesco with over 100,000 emails in a campaign calling on the retailers to Fairtrade bananas." There are social media sharing buttons for Twitter, Facebook, and Google+.

But the low prices paid back along the chain are not enough to secure a move towards decent work in the long term as Sintrainagro's President points out. Decent work and more sustainable production systems have a cost that the conventional market has to count and pay. (sources: Reefer Trends, Banana Link)

Tesco has to announce his commitment in an international stakeholders round table, in order to show his concern to warranty a living wage for the workers in the banana supply chain.



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Latest news

Tesco makes banana pledge 26 April 2015

The single largest seller of bananas in the UK has committed to ensuring that a living wage is paid to banana workers by 2017.

This announcement, which is reported in the monthly Banana Link publication, is the result of long term engagement in the World Banana Forum, which brings together supply chain actors to work collectively towards sustainability. The reports claims that the UK retail price of loose bananas has almost halved over the past 10 years, while the cost of producing them has doubled. Currently, only one in three bananas sold in the UK is Fairtrade certified, giving customers an assurance that Fairtrade standards are met, including payment of a Fairtrade minimum price. As members of the World Banana Forum (designed to promote open dialogue on challenges facing the banana industry) Banana Link said it welcomed Tesco's commitment and hoped that this action inspired other retailers to make similar pledges to end the extreme poverty and lack of rights faced by banana workers in Latin America, the Caribbean and Africa.

Carrefour undertook more or less the same initiative recently. Carrefour has launched a large consultation of all the stakeholders of selected food supply chains (tomato, egg, banana, etc.). The aim of this initiative is:

- meeting the stakeholders of the supply-chain,
- designing or redesigning the supply chain, especially at the production stage,
- improving the "health" of their supply AND
- communicating.

All is "on the table" except price... But this is another story.

3.4 There are available solutions...

About banana industry, there are solutions.

Two agricultural practices could be used to limit pesticides use:

- smart fallow (sanitation of the soil, improving soil structure and nitrogen balance),
- and cover plants that directly decrease the use of pesticides.

The effects are direct. These new practices are more environmentally friendly for workers and for residents. They bring potential to lower worker exposure and painfulness. These practices would improve the productivity and the resiliency of the banana sector, and could help to decrease the production price also.

It works! In the French West Indies, re-design of the production systems (with the aim to increase the sustainability of the production stage) has been done.

To conclude this section, why changing? Converting?

We answer: "for 4 reasons at least, which are 4 ruptures or disruptions":

- **technical:** like invasive diseases...
- **commercial:** like higher competition...
- **societal:** like pressure from consumers...
- **regulation:** like less authorized pesticides or banned techniques

What is the bet?

As highlighted by the chart (<http://www.footprintnetwork.org/2016/07/20/measure-sustainable-development-two-new-indecis-two-different-views/>), the "sustainable" zone both supporting high human development and located within the biosphere's average capacity, is small (grey quadrant at the bottom of the chart). Usually, when Human Development Index increases, the corresponding humane society goes out from this "sustainability" zone.

Sometimes, decreasing environmental cost improves social benefit... Here is an example with industrial and traditional fisheries.

Avantages comparés des pêches industrielle et artisanale dans le monde		
	Pêche industrielle	Pêche artisanale
Subventions annuelles	25-27 milliards de dollars	5-7 milliards de dollars
Nombre de pêcheurs concernés	≈ 0.5 million x 24	Plus de 12 millions
Prises annuelles destinées à la consommation	≈ 30 millions de tonnes	≈ 30 millions de tonnes
Prises annuelles recyclées en dérivés alimentaires (chair et huile)	35 millions de tonnes	Négligeable
Poissons (et autres espèces marines) rejetés à l'eau chaque année	8-20 millions de tonnes	Négligeable
Consommation annuelle de carburant	≈ 37 millions de tonnes	≈ 5 millions de tonnes
Quantité de poissons pêchée par tonne de carburant	1-2 tonnes x 4	4-8 tonnes

From Le Monde, 19-20 octobre 2008 / source: Conservation Biology

3.5 Conclusion: performances versus impacts

Nowadays, business wants to know **not only its performances**, but **also its impacts**. What is the difference? (see Vanclay, 2003)

We are taking the example of one company, which sets up schools in one developing country.

Either the company communicates

about the performance "we built one school"

or the company communicates

about the impact "X pupils have reached such a graduation..."

In the first case, you give information about bricks and cement... in the second case you evaluate the real effects on the target population, which is the **gain in the level of education** of the participants, in the present case.

4. Why are there so many social assessment tools?

When screening practices on the ground – regarding agro-food life cycle assessment – one can't help to be surprised by the abundance of "tools". This means that something important is at stake, which **meets social demand**. Moreover, there are many diverse tools under the umbrella of "social LCA", because **there are different usages** matching different needs.

—> What kinds of social needs do these tools match?

We proposed a classification of the different needs for social assessment tools (Macombe & Lœillet, 2015).

4.1 Needs to reassure oneself

According to us, here is the most usual usage of social LCA. It also explains the behaviour of some companies (especially food retailers) which think that the label got by the supplier is a warranty for quality, and that it protects their own responsibility. Any drift, any accident might occur in such conditions!

The companies believe that they can give up their responsibility because a third party is in charge of verifying, controlling and guaranteeing the social or environmental health of their own supply chain. Nevertheless, the alone company faces its responsibility. It is not because one multiplies the labels that one covers his/her responsibility more efficiently. You can reduce the risk but "never say where the cannon ball is coming from"!

4.2 Needs to know for decision-making

In this group, we account for the decisions whose purpose is choosing between alternatives systems, regarding environmental and/or social effects.

European commission (Europaid) wants to be "armed" to choose what project would be supported among all the applicant projects.

But we are not sure to anticipate all the real social effects stemming from one change. In particular, it is difficult to anticipate rebound effects. Because of its incompleteness, social LCA is not a tool for decision making. **It is a tool to adjust the action.**

4.3 Needs to know, to adjust action

With social LCA, we can take into account the decisions whose purpose is improving a system regarding environmental and/or social effects.

We suggest some examples:

- An African company wanted to know the consequences of its social expenditures.
- Tesco, Walmart, etc., wanted to make their supply chain delivering living wages.
- Flo and Max Havelaar want to know the level of minimum price to be set, and the impacts of minimum prices on the smallholders' life.

We are quite powerless in front of soil erosion, or in front of social solidarity loss, including the cases where these impacts are the most important. In the absence of assessment method, we are more or less committed to neglect these impacts.

However, as highlighted by Heiskanen (2002) the available impact pathways "taken together" build a new general normative representation of "what are the impacts to be taken into account when deciding"? Thanks to LCA studies, decision-makers become aware of new problems and new drivers. Indeed, the impact pathway highlights the causes, and so the possible drivers and solutions.

Maybe, when we think that life cycle assessment is a tool for accompanying decision making, we are still too naïve. Visiting some arena has persuaded us that LCA is often a good mean to eliminate opponents first.

4.4 Needs to ensure power on markets

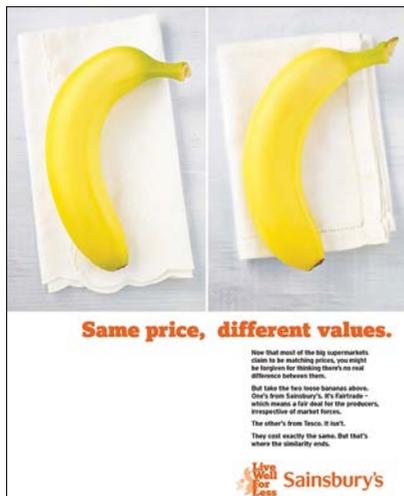
Certifications, standards and labels are a good mean to eliminate potential competitors.

We suggest some examples:

- Grenelle de l'environnement (France).
- Private labels, which are non-tariff trade barriers.
- Soft law, like the "GlobalGap" Initiative.

By enforcing new norms, one builds non-tariff trade barriers. They are power instruments not only among the opponents of the same arena, but also among the same value chain partners. The holder of the norm therefore culturally colonizes the other steps of the value-chain, because who would dare to contest the fairness of the highlighted humanistic goals of the new norm?

5. Our dream with SOCIAL ASSESSMENT...

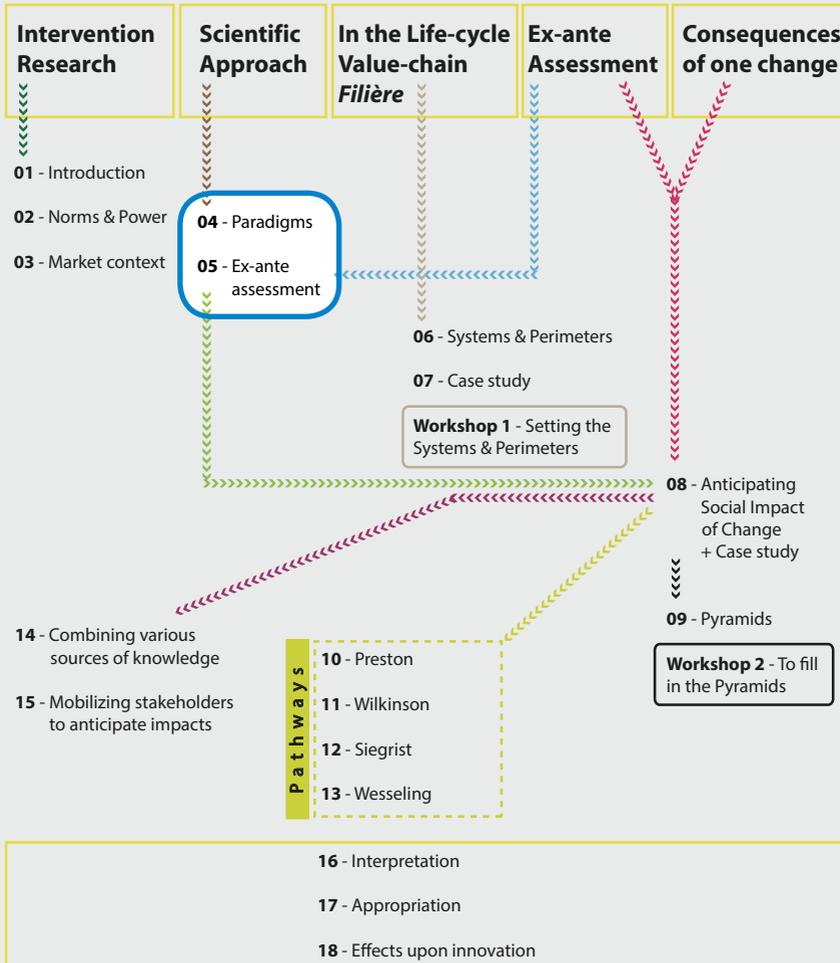


Our "Social assessment" dream would be to make a difference between these two supply chains !

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Matrix of the researcher school's contents



Part 2

Epistemology

04 Scientific paradigms in social LCA

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To sum up

This chapter reminds some basis for epistemological building of scientific theory of social LCA, and deals with the diversity of paradigms in social LCA.

Outlook

Introduction

1. Methodological diversity in social LCA
2. The scientific and disciplinary inheritance of social LCA
3. Scientific paradigms in social research
4. Paradigms applied in social LCA: insights from a brief review

Conclusions

Introduction

First felt mainly as being an environmental problem, sustainability topics have slowly moved toward human well-being and societies. The Sustainability Science is difficult to conceptualize, to plan and to implement, due to the broad range of epistemological commitments and methodological approaches (MacGillivray and Franklin, 2015).

The limits to growth (Meadows et al., 1972)	“The second category of necessary ingredients for growth consists of the social necessities.”
United Nations Conference on the Human Environment (UN, 1972)	“Principle 1 - Man has the fundamental right to freedom, equality and adequate conditions of life. ”
Brundtland Report (WCED, 1987)	“Principle 1 - All human beings have the fundamental right to an environment adequate for their health and well-being. ”
Rio Declaration (UNCED, 1992)	“Principle 1 - Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.”

Table 1: Some sustainability references

In table 1 are reported some of the principal references of sustainability that shifted the attention to the centrality of human beings in the concerns for sustainable development.

There is no consensus on a definition of sustainability or sustainable development (the two terms are often interchangeable), and many conceptions are available in literature. The most diffused are:

- **The Three Pillars (TP) approach:** sustainability would be the overlap of three separate dimensions concerning environment, economy and society. The most quoted references are WCED (1987) and UNCED (1992);
- **The Triple Bottom Line (TBL)** consists of three "Ps": profit, people and planet. It aims at measuring the financial, social and environmental performance of the corporation over a period of time (Elkington, 1997);
- **The "Capitals" approach** describes country's wealth as the combination of various forms of capitals: produced, natural, and human capitals, that represent stocks of wealth (World Bank, 1997);
- **The systemic approach** claims that what should be sustained in a sustainable community is not economic growth or development, but the entire web of life on which our long-term survival depends, because we are all connected (Capra, 1996; 2002).

In social LCA literature, 69% of studies can be associated with the TP approach, 13% with the TBL, 12% with the capitals approach, and only 6% with the systemic approach. However, these references are not explicitly linked to the methodologies proposed or applied.

Actually, we are trying to assess something that is neither definite nor consensual!

Indeed, many questions still remain open:

- How many pillars sustainability is composed by? Why just three? Actually, in literature, many others have been proposed, such as "governance", "culture", "education", among others.
- Do they have the same importance, or do they have different weights?
- Are they related/connected? Which is the relationship among them?
- What does it happen in the long run when assessing these dimensions separately?

The fact that social LCA has been conceived in the technical and academic *milieu* of ELCA, and that most of its practitioners and scholars are usually engineers, chemists, physicians, led to frame and shape the assessment methodology of social impacts in the same way as it has been done for environmental impacts in ELCA. However, while LCA and LCC (partially) are today standardized by specific ISO norms, this is not the

case for their social peer, social LCA. In the process of "inclusion of social aspects" in life cycle studies, many issues emerged with the typical features of the life cycle approach, such as:

- the use of a Functional Unit (FU) to which impacts could be referred;
- the definition of System Boundaries and the cut-off criteria;
- the typology of data for inventory phase: there are many databases available for ELCA study, but not for social impacts (this also depends on the fact that there is no methodological consensus in social LCA);
- the impact assessment method to be applied: there are specific softwares and models available for ELCA, just one for social LCA (the Social Hotspot Database), but for one specific type of assessment method;
- the interpretation of results is made upon quantifiable cause-effect relationships results in ELCA and LCC, while in social LCA results are often qualitative or referred to behaviours and not to the very nature of the life cycle.

1. Methodological diversity in social LCA

The integration of social impacts in ELCA studies has been proposed since 1990's (O'Brien et al., 1996) but until today there is no consensus on a specific methodology for social LCA. Indeed, different approaches have been proposed and applied. The main points of difference concern:

- objectives: social LCA results are expressed by some authors in terms of *performances* at a given moment (like a "snapshot"); other scholars evaluate effects of an action compared to a baseline reference, or the consequences of a change in the system under study;
- the definition itself of social LCA, defined in literature as:
 - 1) methodology (e.g. Jørgensen et al., 2008),
 - 2) systematic process (Benoît et al. 2010),
 - 3) framework (Benoît Norris, 2012),
 - 4) technique (Ramirez et al., 2014),
 - 5) technology (Fan et al., 2015),
 - 6) method – not a technique – (Macombe et al., 2011),
 - 7) phenomenon (Benoît Norris and Revéret, 2015),
- the underlying social sustainability concept can differ, but it is rarely explicitly described;
- the source of impacts can be referred to the very nature of the life cycle or to the actors' behaviour;

- whether social LCA should follow the same standardised steps of ELCA or not (concerning FU, SB, cut-off criteria, inventory analysis, etc.);
- the time and spatial scale of assessment: global or local or both?

But the most important point of difference concerns the core issue of the methodology, i.e. the so-called "impact assessment method", directly linked to the objective of the study and to the epistemological position of the scholar (Iofrida et al., 2016).

2. The scientific and disciplinary inheritance of social LCA

To understand from where this difference comes, it is necessary to look at the disciplinary and scientific inheritance of social LCA (figure 1). In the following picture we make a comparison with its environmental peer, ELCA.

ELCA analyses and evaluates environmental impacts, trying to model cause-effect relationships between quantities of emissions and damage to natural environment. Environmental impacts are the object of study of disciplines such as biology, physics, chemistry, etc., that belong to the realm of natural sciences.

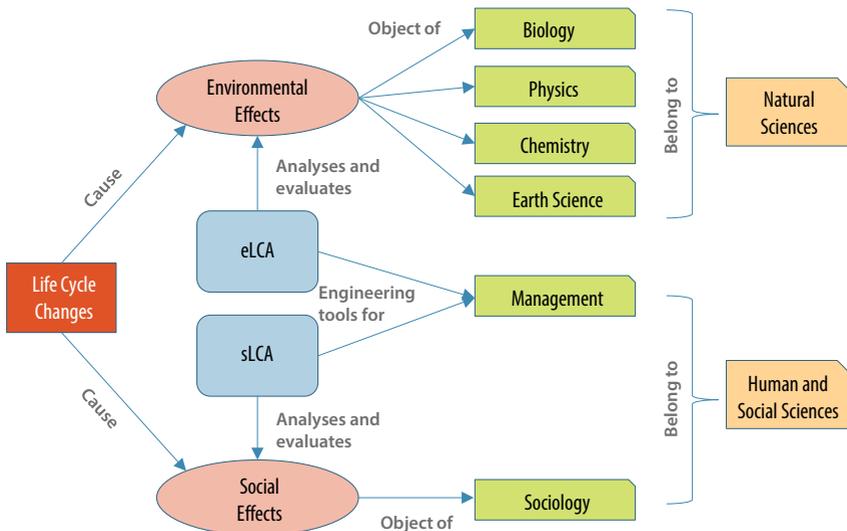


Figure 1: The disciplinary inheritance of LCA and social LCA (source: Iofrida et al., 2016)

social LCA analyses and evaluates social impacts, that are also the object of study of sociology, which, together with management science, economics, behavioural sciences, etc., belongs to the realm of human and social sciences.

Both methodologies, as well as Life Cycle Costing and Life Cycle Sustainability Assessment, are then used for decision making processes (sometimes with the help of multicriteria methods) mainly for management purposes; therefore, the whole research process (the thought-action chain) can be interested by different paradigms.

Natural sciences and human and social sciences are very different. The first ones have always been consensually dominated by positivism-oriented philosophies, mainly characterised by quantitative methodologies devoted to the explanation and prediction of phenomena, to the application of experimental approaches, and to empirical validation according to a deductive principle. For a long time, the disciplines of natural sciences have been considered the only ones that deserved the mention of "science" and their typical methods were considered the only "scientific methods". In fact, when sociology was firstly developed by Auguste Comte, it was conceived as the study of society with the same scientific rules of natural sciences. Only after many decades sociology has been recognized as a multiparadigmatic science (Corbetta, 2003).

The objects of study of sociology are relationships, social facts, social phenomena; management science concerns human relationships, social facts and actions. After the advent and the success of positivist philosophy in science, many scholars acknowledged that when the human dimension, the context, the interactions between researcher and his/her object of research become relevant, the narrow rules of natural sciences become difficult if not impossible to follow (Avenier and Gavard-Perret 2012). This is the main reason why, in social sciences, many perspectives are possible and multiple paradigms can exist (Corbetta 2003; Abercrombie et al. 2006).

3. Scientific paradigms in social research

During the twentieth century, a great debate interested academia around one of the most important problem of philosophy of science, i.e. the problem of finding a criterion that demarcates science from non-science. Karl R. Popper and Thomas S. Kuhn were two of the most influential philosophers and their works are considered milestone references up to now.

Popper (1962) strongly criticised inductivism as logical process, in favour of deductive methods, and he rejected the demarcation criterion of verifiability (confirmability) defended by logical positivists at that time, in favour of the criterion of "falsifiability" affirming that scientific progress consists of continued cycles of conjectures and refutations.

Kuhn (1962) refuted the traditional conception of the sciences as a cumulative and linear progression of new acquisitions (Corbetta 2003). He shared with Popper the opposition to the traditional verifiability conception.

However, on the other hand, he criticized Popper's principle of falsification, introducing the concept of "normal science" to describe the period in which scientists adhere to the same paradigm. In Kuhn's view, scientific knowledge progresses through paradigm shifts.

Kuhn (1962) gave notoriety to the term paradigm with his book *The Structure of Scientific Revolutions*, where he interpreted it as the shared set of philosophical background and methodological tools that enable scientists to solve their research issues. Despite the critics received by Kuhn, the concept of paradigm still remains up-to-date and preserves its centrality in the meta-research debate of social sciences (Darlastone-Jones 2007; Phoenix et al. 2013; David et al. 2013; Thiétart et al. 2014). It is useful to understand the main epistemological differences between positivism-oriented paradigms and interpretivism-oriented ones.

Here are reported some clarifying definitions from literature:

- "Paradigms are universally recognized scientific achievements that – for a time – provide **models, problems and solutions** to a community of practitioners" (Kuhn 1970:viii).
- "A research paradigm is a perspective about research held by a community of researchers that is based on a set of shared **assumptions, concepts, values, and practices**" (Johnson and Christensen 2014:31).
- "A paradigm is a **fundamental image** of the subject matter within a science. It serves to define what should be studied, what questions should be asked, how they should be asked, and what rules should be followed in interpreting the answers obtained" (Ritzer 1975:7).

A paradigm is composed of three main elements, namely ontology, epistemology and methodology. Each of them answer to different questions:

- **Ontology:** What is reality?
"Ontology raises basic questions about the nature of reality and the nature of the human being in the world" (Denzin and Lincoln 2005:183).
- **Epistemology:** How do you know?
"A philosophical standpoint onto the research process that asks such questions as: 'What can we know and who can know?' A researcher's epistemology encompasses her/his standpoint on the nature of knowledge and learning" (Hesse-Biber 2010:126).
- **Methodologies:** How do you find it out?

"The delicate passage from theory to empirical research, from hypotheses to concepts, indicators and variables; in other words, to the question of so-called operationalization" (Corbetta 2003:2).

Many different paradigms exist, and they can take different names according to the discipline of reference. Moreover, as the boundaries can be very thin, a perfect separation is not always possible. In some cases, one paradigm can be included in another. For this reason, in the table 2, only two examples from two different families of paradigms are shown.

Families of paradigms	Positivism-oriented		Interpretivism-oriented	
	Positivism	Post-positivism	Constructivism	Interpretivism
Ontology: What is reality?	Naïve realism. It exists only one objective reality, seizable, patterned and predictable.	Critical realism. It exists only one objective reality, but it is probabilistically seizable.	Relativism. Subject and object are dependent. The real essence of the reality cannot be known. Reality is constructed and interpreted trough perceptions.	
Epistemology: How do you know?	Dualism researcher-research. Replicable findings are "true". Reality can be explained.	Dualism is not possible. Replicated findings are "probably" true. The fully explanation of reality is impossible.	Knowledge is constructed. Reality can be constructed.	Knowledge is interpreted. Reality can be understood and described.
Methodologies: How do you find it out?	Experimental, deductive, nomothetic. Purely quantitative. Verifiable relationship cause-effect.	Experimental. Mainly quantitative methods, manipulative. Scientific Community plays a role of validation. Statistical analysis. Probability sampling.	Mainly qualitative methods. Purposive and multipurpose sampling. Stakeholders' experience.	Hermeneutical, dialectical. Mainly qualitative methods. Stakeholders' perceptions.
Goodness or quality criteria	External validity, verifiable data through repeatable methods.	Statistical confidence level and objectivity in data produced.	Intersubjective agreement and reasoning reached through dialogue, shared conversation and construction.	

Table 2: Characteristics of two main families of paradigms, with examples
(source: Iofrida et al., 2014; Iofrida et al., 2016)

4. Paradigms applied in social LCA: insights from a brief review

There are few but significant references in social LCA literature about the necessity to take into account the possible epistemological foundations of social research.

- O'Brien et al. (1996): the inherent nature of the impacts under assessment are different in social LCA from ELCA, as these methodologies have their roots in **different fields of study and disciplines**.
- Jørgensen et al. (2010): **several research paradigms within social science** provide answers to the different possible viewpoints in social LCA.
- Reintinger et al. (2011): the importance of the **disclosure of one's presumptions**, as researchers "have tendency to investigate ethical or social issues with our pre-conceived values".
- Sala et al. (2013a, 2013b): **epistemological foundations** of life cycle tools (therefore, including social LCA) and their **scientific robustness**.
- Baumann et al. (2013:2): "a coherent discussion about the **social values and ethical and ideological positions** that underlie the indicators of social impacts is missing".
- Arvidsson et al. (2015): the fields of social science and economics may be fruitfully considered when seeking **scientific justification for topics to assess** in social LCA.
- Iofrida (2016): Social sciences are multiparadigmatic and this influenced the methodological diversity in social LCA.

A critical review has been conducted on social LCA literature (Iofrida et al. 2016). From a first population of about 200 papers published from 1996, 133 have been selected and critically analysed. They have been published from 2003 to July 2015, including some grey literature (PhD theses and dedicated conference proceedings). Most of them are represented by journal articles (58%), followed by conference proceedings (25%) and books (12%). Publications slowly increased (figure 2) with a peak of 41 in 2014, probably impelled by the publication of UNEP-SETAC (2009) guidelines.

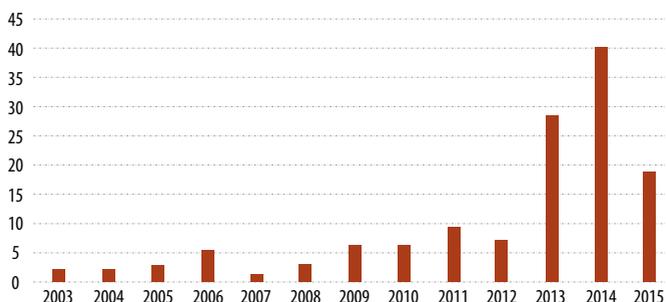


Figure 2: Trend of publications (source: Iofrida et al., 2016)

Analysing the literature according to the impact assessment method applied, **three main groups** can be distinguished.

The first group follows the UNEP-SETAC (2009) guidelines (type I) and the Methodological Sheets (UNEP-SETAC 2013). Paper belonging to this groups share the following characteristics:

- they focus on one or more of five stakeholder groups,
- they apply static indicators,
- "impact" categories are chosen according to international laws and agreements,
- they evaluate performances providing a "snapshot" of a current situation,
- their framework is similar to Corporate Social Responsibility (CSR),
- type I impact assessment is applied (see figure 3).

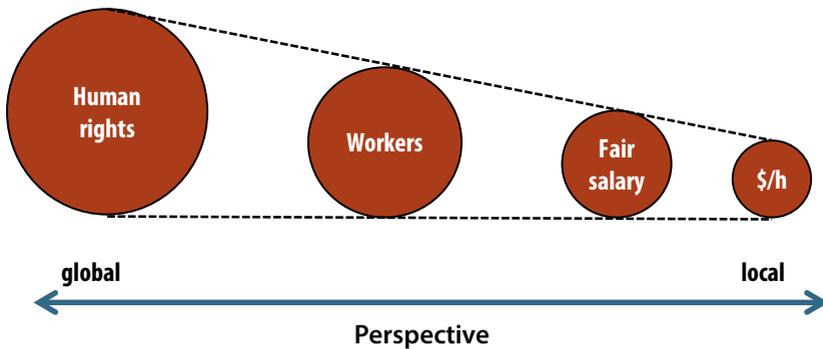


Figure 3: Example of UNEP-SETAC (2009) inspired approach

The second group applied the so-called "social impact pathways" (e.g. Feschet et al. 2013; Bocoum et al. 2015), in line with ELCA, and had the following characteristics:

- evaluated the consequences of a change in the life cycle,
- highlighted relationships between causes and effects,
- with a framework similar to ELCA,
- can be used for planification,
- type 2 impact assessment methods are applied (see figure 4).

The third group has been associated to the Capacities and Capabilities approach (Reitinger et al. 2011; Feschet and Garrabé 2013), also in line with ELCA. This group concerned:

- the capabilities people can freely practice in their lives,
- accounting for the practical consequences for people of variation of capital stocks due to changes in life cycles.

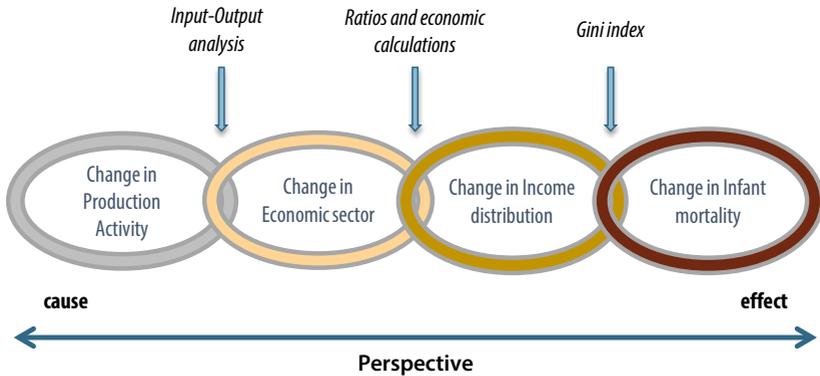


Figure 4: Example of impact pathway approach (Bocoum et al. 2015)

In the example of the first group of methodologies (figure 3), an internationally recognised right is connected to a group of stakeholders, divided in sub-categories, and assessed through indicators; these last are chosen according to the literature or to the choice of the researcher. The dotted lines show that there are no relations of causality among the elements.

The figure 4 shows the example retrieved from Bocoum et al. (2015), who showed the cause-effect relationship between a change in life cycle that provokes a change in the economic sector (measured through I-O analysis), that in turn modifies the income distribution in a nation (or region). This change of distribution is measured through Gini index, that provides also a quantification of population health change in terms of infant mortality.

In the third group, a change in the life cycle provokes variations in terms of capital stock, that in turn modifies people's capabilities (figure 5).



Figure 5: Example of capacities and capabilities approach

But the methodologies alone are not sufficient to explain the scientific paradigm applied. For this reason, the papers gathered have been scrutinized according to a list of literal parameters to ascribe them into two main epistemological groups: post-positivism-oriented or interpretivism-oriented.

Results (figure 6) showed that 73% of the selected studies could be ascribed to the group of interpretivism-oriented paradigms, only 24% can be ascribed to the post-positivist ones, and 3% presented characteristics of both families. These data deserve some attention, because since the beginnings of social LCA, most of the scholars supported the idea that the assessment perspective of ELCA should be applied to social impacts.

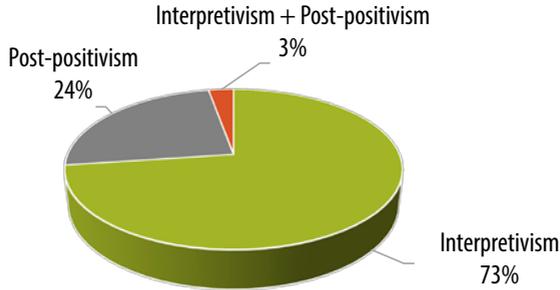


Figure 6: Paradigms applied in social LCA literature (source: Iofrida et al., 2016)

Each paradigm family has its strengths and weaknesses. Papers classified into the post-positivism oriented group provided a smaller range of impact categories, focusing only on few social aspects, but provided explanations of the cause-effect relationships between inventory data and impacts. This could allow predicting which changes would be suitable in life cycle management to obtain more sustainable results and impacts. The most applied impact assessment methods were the impact pathways and the capacity/capabilities approaches.

Papers belonging to the interpretivism-oriented group provided a broad assessment of several impact categories, furnishing a description of a situation at a certain moment. Very often, they involved stakeholders at different points of the research process, such as the step for choosing what is worth assessing (impact categories), the step for choosing the most relevant indicators, or scoring tasks to discriminate the importance of results. They often took into account the experience of privileged witnesses, as well as the expertise of local actors, thus performing a more coherent context-based assessment (De Luca et al. 2015). Most of this kind of evaluations focused on performances at a specific temporal moment, and referred, among others, to UNEP-SETAC (2009) guidelines and methodological sheets, or to the Social Hotspot Database.

Both realism and relativism (see table 2) can be suitable for social impacts evaluations, but the choice should be done in accordance to the purposes of the studies and with the awareness that results can differ in terms of significance.

In this pre-scientific phase of social LCA development, it is of utmost importance to shift the academic debate to an epistemological level, in order to solve methodological problems about indicators and impact assessment methods in a coherent way.

Conclusion

- It is doubtless that social LCA addresses social impacts, which are a concern of sociology, and social LCA results are also used for management purposes.
- Sociology and management are epistemologically eclectic and multi paradigmatic.
- This eclecticism has had consequences in social LCA literature.

Thanks to the critical review of social LCA literature, some questions found their answers:

- Is there place in social LCA for different paradigms?
Actually, yes, as the literature review demonstrated.
- Why is it important to be aware of the underlying paradigm?
To link the chosen method to the objective of studies, and therefore to make a coherent methodological choice.
- Which issues can be solved by the different paradigms?
*Explanations by scientific laws and anticipation of consequences —> post-positivism (e.g. statistics).
Comprehension of reality, wide assessment, values —> interpretivism (e.g. participatory methods).*
- For what and for who can these solutions be useful?
*E.g. Public deciders —> to assess consequences as consensually as possible.
Local communities, single actors —> depending on stakeholders' desiderata and values.*

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05 Science & ex-ante assessment

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To sum up

The research program in social Life Cycle Analysis is pretending to develop methods for sound ex-ante assessments. This chapter discusses the epistemic position of the program of social LCA presented in the researcher school, and explains that the technique stemming from the method stands for a **coordination technique between actors**. The end of the chapter is devoted to clarify the differences between forecast, prospective and ex-ante assessment.

Outlook

1. Epistemic position of the research program in social LCA
2. Management or coordination technique?
3. Differences between the concepts of forecast, prospective and ex-ante assessment

1. Epistemic position of the research program in social LCA

The program borrows its general frame from constructivist researches, while some small parts are crafted from neo-positivist views (figure 1).

Indeed, the conception of the program is underpinned by the following hypothesis (from Wacheux, 1996):

- we can't handle directly the reality. So the researcher doesn't work upon reality, but **from representations** built from actors' perceptions (the figure is not the thing);
- the researcher seeks for causality relationships to frame a theory, so a new representation of the phenomenon, to **better understand** the phenomenon;
- there is no objectivity (only diverse subjectivities), so researcher must **manage inter-subjectivity** with the topic.

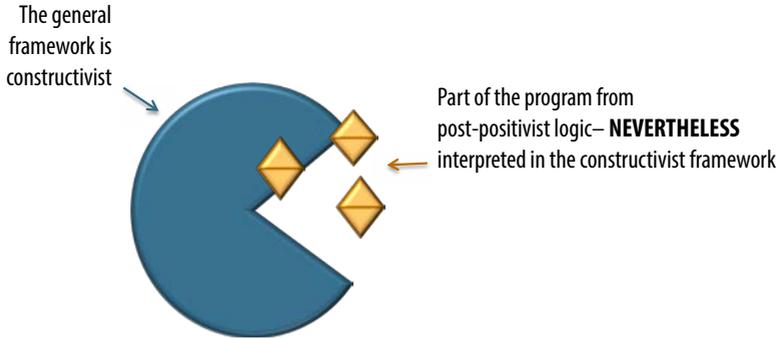


Figure 1: Representation of the general program in social LCA (from Macombe, 2014)

Within this epistemic position, the criteria of trustworthiness of the research are (from Gohier, 2004):

- **credibility**: the result is confirmed by multi-angulation;
- **transferability**: it is possible to implement it (even scarcely) to another context;
- **internal stability** (constance): results are independent from the period of observing, from the researcher leading the research, and so;
- **fiability**: for the results of analysis to be independent from the ideology of the researcher, he/she must explain his/her ideological presumptions.

Nevertheless, for some small parts of the program (figure 2), adopting the post-positivist view is enough. Indeed, post-positivist view is simpler, because "the figure can stand for the thing". Albert David (2000) explains that post-positivist logic may be enough for partial exam or partial statement or a posteriori control.

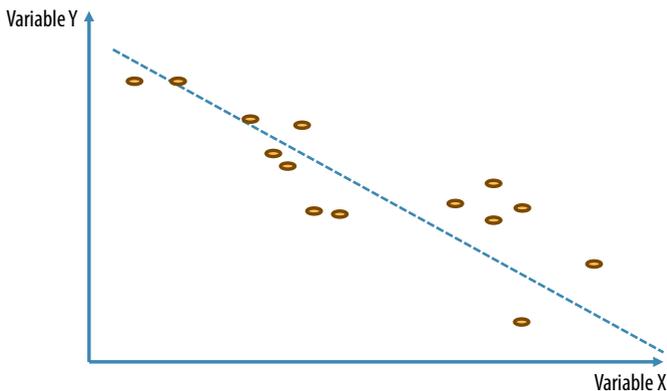


Figure 2: Adopting post-positivist view when making correlations

For instance, when we build one pathway thanks to statistical data taken from the past, we only need **partial exam** of the phenomena. **We do not try to understand all the links** between different phenomena. We only seek for **correlations** between figures, in order to predict phenomena thanks to **regularities** in the past. As usual, we can infer causality from correlations **thanks to other qualitative researches** (for instance, from monographies). In this case, post-positivist position is enough.

On the contrary, **when the pathway encompasses understanding complex phenomena** (like setting the multiple links between work conditions and workers' health), this part of the research remains in the constructivist realm.

Nevertheless, in both cases, the **interpretation of results is made within the constructivist paradigm**. It means that **the figures are considered to be meaningless in absolute value**. So, the numerical results are interpreted in comparison between scenarios set **in the same context**, while caring about actors' interpretation.

2. Management or coordination technique?

We make a distinction between axiologic judgement, and arithmetic or statistic process for assessment (Ogien, 2013).

In the first case (axiologic judgement) we have to make a practical judgement by deciding something according to given criteria. For instance, is it beautiful or ugly? So, **everyone is aware that the judgement is relative and subjective**. No one pretends the choice is made with objectivity. We are in the constructivist realm.

In the second case (arithmetic or statistic process) there is a huge risk of **pretending¹ that the process is objective**, despite it is no more objective than in the first case. Indeed, this process provides quantification of reality under arithmetic or statistic format. Nevertheless, subjectivity is present (especially because of the hypothesis set to be able to calculate something), but is **hidden behind the figures**.

The only one way to deal with inherent subjectivity is to clearly "put hypotheses on the table".

Here, we try to be **aware of subjectivity of figures**,
by explicating the assumptions which allow us to make the calculations.

Assessment through arithmetic or statistic process may be either a coordination technique, or a management technique (Ogien, 2013):

1 For constructivist researchers, pretending that the process is objective is a positivist position.

Coordination technique uses assessment **to provide information to actors**. For instance, when FAO (Food and Agriculture Organization) assesses the state of agricultural markets, the objective is to help actors to coordinate together.

Management technique uses assessment **for mastering of people**, and especially of people at work, like in the "new public management" domain.

Here, we use assessment as a **coordination technique**, to provide information to actors, in order to help them to coordinate.

Now, we are ready to discuss the principal usages of the social LCA method presented in this researcher school (see table 1). We highlight also what it is not designed to do.

The principal usages of Social Life Cycle Assessment	
ARE	ARE NOT
Providing knowledge	Monitoring the suppliers
Helping for coordination	Monitoring the workers
Influencing decision	Covering the responsibility of the firm
Fine-tuning of the social side	Preventing competitors to enter the field
Generating innovations	Aggregating "social indicators" with others

Table 1: The principal usages of social LCA in the presented program

In this program, **the principal usages of social Life cycle analysis are:**

- providing knowledge about some likely main consequences of the change (what are the likely main impacts in terms of public health and in terms of involved workers' health);
- helping for coordination of actors (for instance, as a basis for discussions of the configuration of the project);
- influencing decision about future projects. The studies stemming from social LCA highlight the main social issues, and claims for changes in the present project which may be marginal from the technical point of view, but very important from the social scope. So, social LCA studies are influencing the project design, more than providing social criteria to choose between very different projects from the social scope;
- helping fine-tuning the social side of projects. Social LCA fills in the social side of projects, by reporting on several social aspects (expected and unexpected), and by claiming for modifications when necessary;
- generating innovations driven by social considerations (e.g. mitigating health impacts of pesticides use).

As highlighted in table 1, the principal usages of Social Life Cycle analysis are not monitoring the suppliers, or the workers, or someone else...; covering the responsibility of the central firm; preventing competitors to enter the business field; aggregating the social indicators with other indicators (environmental, economic, institutional, etc.) in order to score different projects.

3. Forecast, prospective, ex-ante assessment

Forecast is the description of the future, including the consideration of alea (e.g. meteorological forecasts for next week).

Prospective is a technique to elaborate potential scenarios to shape the future (e.g. How to fund retirement pensions?).

Ex-ante assessment is a technique to evaluate **some possible important impacts** of one planned change, in order to mitigate the project (e.g. environmental life cycle analysis is often used with such a purpose).

In this book, we present ex-ante assessment of the social impacts caused by the existence of one life-cycle, or by changes in life-cycles.

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Part 3

Ontology

06 Systems and perimeters

Designing the competitive perimeter of social LCA

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To sum up

This chapter aims at helping readers to become aware of the importance of setting fairly the perimeter at an early stage of any study, and at suggesting tools to set up the perimeter correctly.

Outlook

Introduction

1. Determination of the perimeter
2. Crossing width and depth: the strategic arena
3. The value net
4. Synthesis: the systematic competitive model of the product system
5. Exclusion: significant dependency criteria

Conclusion

Introduction

We start with a true story. **In April 1994, Kevin Carter won Pulitzer Prize with this photo** (photo 1). It entailed International emotion and attacks for ethical reasons. "The photographer didn't help the girl, he was more vulture than vulture..." and so. In July 1994, Kevin Carter committed suicide, by poisoning himself by carbon monoxide in his car.

In 2011, Alberto Rojas, from "El Mundo", performed investigation and provided counter-inquiry.

- 1) He was a boy.
- 2) He was not abandoned, his mother was just before him making tail provisioning NGO (photographer could not do anything more).
- 3) The boy lived, but died 14 years later from malaria.
- 4) It is usual to see many vultures around villages in this country.

African people were not shocked by this photo because it is usual for them, while European and American people were shocked.

Analysis:

- The framing of the photo conditioned the vision of the facts.
- Interpretation of social facts are subjective because of social and cultural (national, family, personal, etc.) context.

For social LCA studies, it entails recommendations:

- To stick to the facts, do not use value judgment (this is the opposite to various, social, ethical, fair, etc., certifications and labels position).
- To propose data to the decision makers who make their own choice.
- To design the perimeter (scope/framing) with discernment.

What is the issue about perimeter?

Is there a conceptual model to design the perimeter for social LCA studies? Social LCA should use more tools of social sciences. What are Economics and Management Sciences (strategy) providing us to **design the perimeter of social LCA?**

Strategy is interested in **value generated by firms**, of which **the social value**. Strategy handles tools to define the perimeters of firms activities:

- including all organizations liable to enter into the boundaries of the study,
- setting cut-off criteria to set the boundaries.



Photo 1: by Kevin Carter, Soudan, March 1993, New York Time

1. Determination of the perimeter

The perimeter has to be designed around the central firm (Dreyer et al., 2006).

1.1 Differences among approaches

Here, we stress the differences between two ways for identification of affected actors. The first one is the approach according to the Guidelines of social LCA (UNEP/SETAC, 2009), while the second one is the **approach presented in this chapter**.

In the Guidelines, the categories potentially impacted by the life cycle of a product are pre-defined (figure 1). Nevertheless, it is possible to add other categories or subcategories of impacted people, if needed. They do not depend on the product system. They are:

- workers/employees,
- local community,
- society,
- consumers,
- value chain actors.

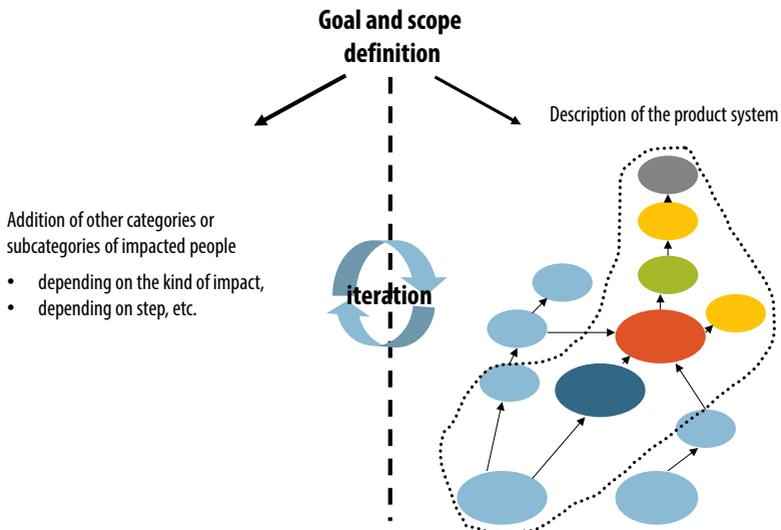


Figure 1: Impacted categories of stakeholders are pre-defined in the Guidelines (source: Lagarde and Maccombe, 2012)

On the contrary, in the presented approach (figure 2), the identification of the affected actors stems from the nature of the assessed impact (one pathway means one specific category of affected actors) and from the identification of the involved organizations which are sensitive to the change under scrutiny.

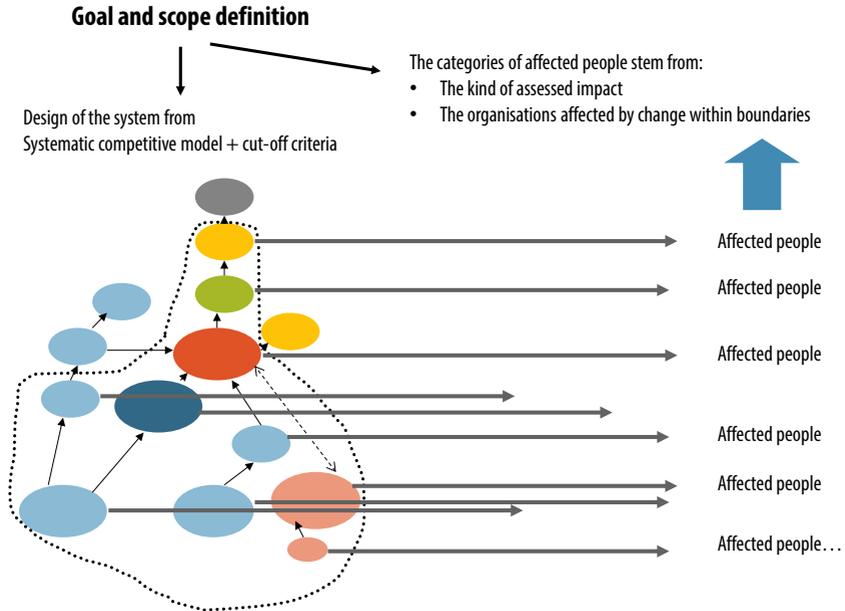


Figure 2: Impacted stakeholders are defined after the perimeter to be set (source: Lagarde and Macombe, 2012)

1.2 Width of the field

To handle the width of the field, the traditional framework to identify actors and to analyse the competitive structure of an industry is the **PORTER'S 5 FORCES** (1979) which deals with the Competitive context of an activity or product (figure 3).



Figure 3: Traditional competitive model of 5 forces (source: from Porter, 1979)

The model accounts for the intensity of competition between firms:

- 2 vertical competitions: bargaining power of suppliers and power of customers (buyers),
- 3 horizontal competitions: established rivals, substitute, new entrants.

The "5 forces" model is a practical tool to begin an analysis.

But it presents some limits:

- relations are limited to economic competition (what about collaboration?),
- it is not possible to identify levels of performance and value in social fields,
- it does not include concepts of products and value chains (lack of depth).

1.3 Length of the field: value chain and/or "Filière"

The length of the framework is provided by the value-chain or by the "filière" concepts.

1.3.1 Value chain

For Porter (1985), value chain describes the full range of activities which are required to bring a product or service from conception, through the different phases of production, to delivery to final consumers.

USEFULNESS of the Porter's value chain

It seeks where value is created in the firm, and **it can integrate social value**. It can be extended beyond individual firms (even through the countries), to the GLOBAL VALUE CHAIN. It must identify central firm which "controls" the rest of the chain ("buyer driven" chain or "producer driven" chain) (Gereffi, Humphrey, Sturgeon, 2005).

Analysis based on Value Chain is often used in LCA (both environmental and social).

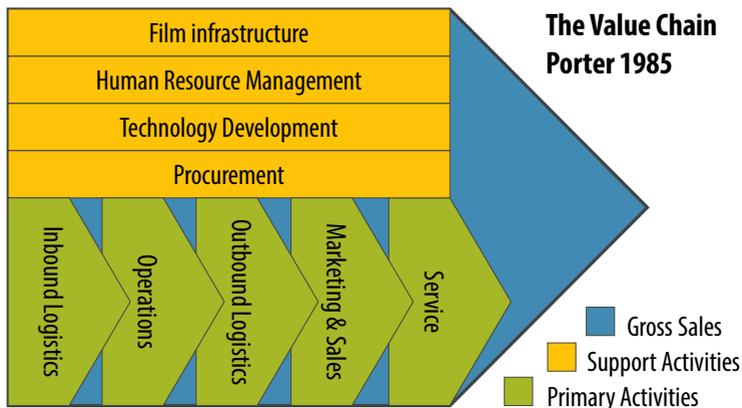


Figure 4: The value chain (source: Porter, 1985)

LIMITS of the Porter's value chain

Only linear and vertical relations between purchasers and suppliers are accounted for. So, this model undervalues competition (competitors, substitutes) and coordination (collaboration) on the same level of the value chain.

1.3.2 "Filière"

Another concept has been developed by French Agricultural institutions for the analysis of distribution systems of agricultural goods.

The "filière" is a succession of operations from upstream raw material to downstream, through several stages of transformation to one or more end products, until the consumer. This approach insists on flows between firms and on the relations of dependences and predominance between the various actors of the chain.

USEFULNESS of the "filière" concept

It encompasses concepts of **value chains** and of global value chains (+ links to Global Commodity chain). It is particularly **recommended for agricultural** analysis. It **compares** respective **competitiveness** of filières (margins/value) and strategies of actors (competitors). It crosses several analyses (agents, flow, value, modelled calculations). It is therefore **useful for LCA**.

LIMITS of the "filière" concept

It is not broad enough (it is still vertical analysis, competitors are included but not their links), the substitutes are not taken into account, and collaboration between firms is not dealt with.

Do we use value chain or filière?

It depends on :
the context,
what you look for,
information you got,
and your preferences...

2. Crossing width and depth: the strategic arena

To set the perimeter of the study, it is important to identify **in an exhaustive way** the companies which are in direct or indirect relationships with the main filière, with various degrees.

We suggest to draw the strategic arena (Rotchild, 1984 ; Bidault, 1988) **of the central firm** (figure 5). The strategic arena includes:

- the filière (or value chain) of the main sector (industry),
- + all the filières of substitutes products,
- and all the filières of complementary products.

INTEREST of the strategic arena

It combines the concepts of the Competitive environment (Porter's forces), and the concepts of value chains (or filières) in competition or in collaboration.

LIMITS of the strategic arena

Only simple links are considered (vertical or horizontal, and not networks). It is complex and heavy, and it is static modelling.

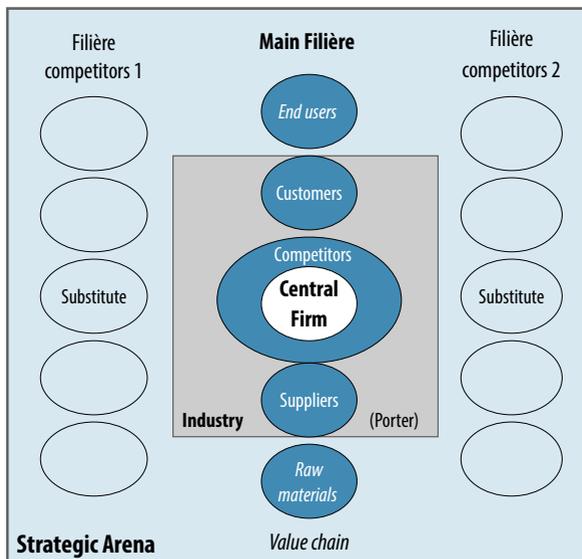


Figure 5: The strategic arena (source: Rotchild, 1984; Bidault, 1988)

3. The value net

The "value net" (figure 6) is an actuation of the field, and an attempt to include social value.

While analyzing **coopetition** between firms, Brandenburger and Nalebuff (1996) propose the model of **value net** to explain new relations between firms, which create some value (in particular social value) by doing so.

The classic models (e.g. 5 forces) are insufficient, because the real relations are established in all directions (it is a network). There is value creation rather than destruction by competition, and we must take into account a new actor, the complementor. Two new concepts are at stake:

- **your complementors are** other firms independently making products or services that increase your offerings' value for your customers;
- **coopetition** (cooperative-competition) occurs when competitors firms decide to work together for parts of their business, staying in competition for all the rest.

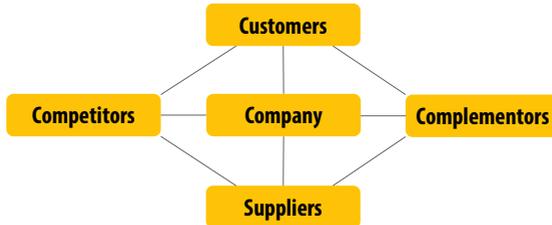


Figure 6: The value net (source: Brandenburger and Nalebuff, 1996)

4. *Synthesis: the systematic competitive model of the product system*

The model of the "systematic competitive model of the product system" has been proposed by Lagarde and Macombe (2012). It makes an attempt **to gather the advantages** of the previous models. The main filière (the filière whose product or service is studied by social LCA) is at the centre of the perimeter. The model accounts for the width of the field, by looking at competitors' and complementors' filières. It accounts for the length of the field, by considering all the steps of the value chains or filières. Moreover, it accounts for the depth of the field by screening the present and the future states of the arena.

It allows describing the whole of the perimeter which deserves to be taken into account when performing social LCA studies. It is recommended to interview experts of the field (with different backgrounds) in order to capture current features of the competitive model, and likely evolutions... if the planed change under scrutiny occurs. Doing so, this competitive model is dynamic.

Nevertheless, depending of the kind of products (consumer goods, industry equipment, etc.) the validity of the model can be set between five years and... less than one year!

Nota Bene: This tool is helpful to perform "consequential assessment". Instead of proposing economic modelling, it offers "strategic modelling" to take into consideration the changes in the organizational structures of the field, stemming from the change under scrutiny. The strategic modelling keeps close to the agent-based model quoted in Frischknecht et al. (2017).

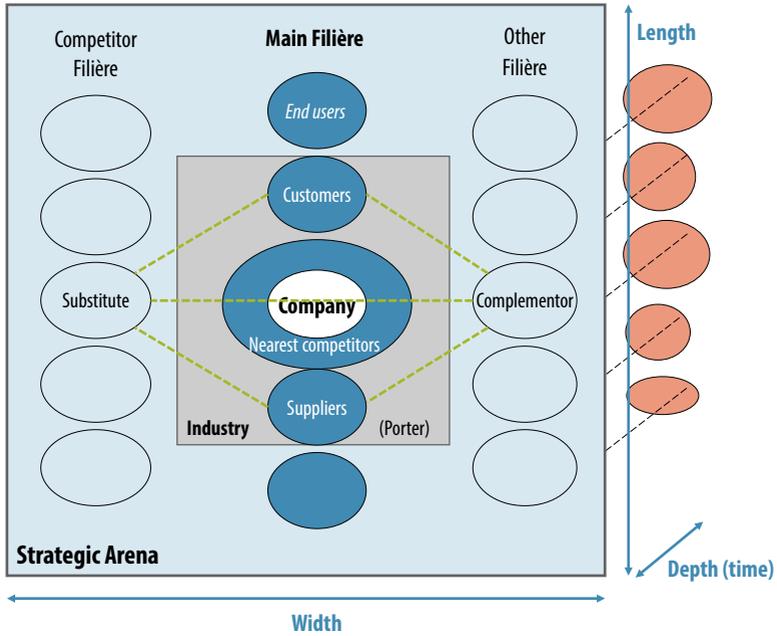


Figure 7: the systematic competitive model (source: Lagarde and Macombe, 2012)

5. Exclusion: significant dependency criteria

After implementing the former competitive model, many organizations are included in the study field. Nevertheless, it is useless and impossible to study all of them. We need one CUT-OFF CRITERIA (Jeorgensen et al., 2008) to eliminate some organizations from inside the boundaries of the study.

The criteria for elimination of organizations is either "expert judgements" (Spillemaeckers et al. 2004) or "social significance" (Barthel et al., 2005). The limits "need to be expended on the quantification of inputs and outputs that will not significantly change the overall conclusions of the study".

Organizations that must therefore figure within the boundaries of the system are those whose behaviour with social effect is **sensitive** (e.g. linked) **to the change** of the life cycle under scrutiny.

Indeed, the sensitive organizations' social behaviour would change,
if the functioning of the life cycle under study changed.

Only the sensitive organizations deserve to be involved in the study. Sensitive organizations are the organizations which display a **significant dependency** to the central filière.

For each study, we need to set a cut-off criteria of significant dependency. For instance, we can choose the criteria "*depending from the central firm for more than one half of its turn-over*". It means that when designing the perimeter of the study, we put inside each organization whose part of the turn-over provided by the central firm is more than one half. So, we put outside the boundaries (we do not study) the organizations whose turn-over provided by activities with the central firm, is less than one half.

As a consequence, **some organizations pertaining to the central filière can be let aside**. For instance, if the outlet of the product is supermarket, it is likely that less than half of the turn-over of the supermarket stems from sales from the product alone. So, the supermarket must not be included in the perimeter of this study, despite it is the outlet of the good.

Conclusion

In social LCA, fairly setting the perimeter requires to handle the **strategic vision** of the consequences of the change under scrutiny. It means that to set the perimeter, we must understand¹ what the competitors and complementors of the central firm will likely do if...

From the practical point of view:

- For fairly setting the perimeter, we must check **all the value chains of the strategic arena** of the central firm.
- This includes value chains in competition or synergy for use of resources (water, land, steel, etc.) and for outlet also (goods and services sold, including co-products).
- **Only when this is done**, we can select which will be the investigated organizations among them.

Finally, we can study the effects/impacts caused by the change in the behaviour of these organizations upon different "targets".

As noticed above, the systematic competitive model provides "strategic modelling", stemming from the likely behaviour of actors, like in the agent-based model quoted in Frischknecht et al. (2017). It is therefore suitable to perform social assessment of the change, as an alternative to the economic modelling.

¹ Neglecting the role of the other actors is a limit of the systematic competitive model of the product system.

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07 Setting the systems and perimeters

Insect bio refinery and Implementation of the case study "Brown chemistry scenario" (workshop 1)

Frédéric Maillard, IRSTEA, UMR ITAP, Univ Montpellier (France)

To sum up

The aim of the chapter is allowing the participants to get use of the methods for defining the system and setting the perimeter in social LCA, thanks to the presentation of one case study, and thanks to the implementation of the second case study during the workshop 1.

The system chosen for the first case study is described by two contrasted "scenarios of insects bio refinery", borrowed from the ANR DESIRABLE project (DESigning the Insect bio Refinery to contribute to a more sustainABLE agro-food industry).

Beforehand, by presenting the Desirable project, we explain what insect bio refinery is, and we illustrate how a joint team of researchers, engineers in environmental LCA (UMR SAS, INRA Rennes, France) and in social LCA (UMR ITAP, IRSTEA, Univ Montpellier, France) obtained, selected and built those scenarios. This feedback is also the opportunity to demonstrate the benefits of such a close and regular cooperation.

Outlook

1. The Desirable project
2. Presentation of the case study No. 1 "Territorial bio refinery scenario"
3. Workshop case study No. 2 "Brown chemistry scenario"

Conclusion

1. The Desirable project

1.1 Context of the Desirable project

In the context of resources scarcity, population growth, environment destruction and food supply dependency, insects as a new supply seems to be a relevant solution for animal feed, but can also be useful for biomaterial and pharmaceutical applications.

The French project DESIRABLE (funded by the French National Research Agency) aims at assessing the performances (social, technical and environmental) of the use of larvae of the mealworm *Tenebrio molitor* and soldier fly *Hermetia illucens* in fish and poultry diets, while these species naturally incorporate insects in their diet.

The project includes a social and environmental study of the impact of circular integration of insect industries in connection with agro food systems (<http://www.projet-desirable.fr/en>).

In the Working Package 4 (WP4), the joint team of researchers and engineers has performed:

- field visits of pilots (from lab scale to pre-industrial stage) and visits of commercial insects farms;



Figure 1: Tasks by work package in Desirable project

- integration of data from upstream WPs to design bio refinery systems and to perform Life Cycle Inventory;
- facilitation of working groups to select the three best (more promising) scenarios;
- definition of the perimeters and common framework for ELCA and social LCA for the three selected scenarios.

1.2 Technical description of insect bio refinery

An insect bio refinery is composed of two parts:

- rearing workshop, divided in breeding area and fattening larvae area (figure 2),
- processing area where insects are transformed into meal, oil, etc. (figure 3).

During each site visit, we collected data in order to perform LCA (infrastructures, equipment, process, material and energy flows, human organization, work conditions, sanitary aspects, etc.). These technical data were completed with experts, estimates and literature data.

1.3 Study and selection of possible technical scenarios

Regarding the collected data, we face a large number of possible combinations of technological bricks and ways to size them, as illustrated by the figure 4.

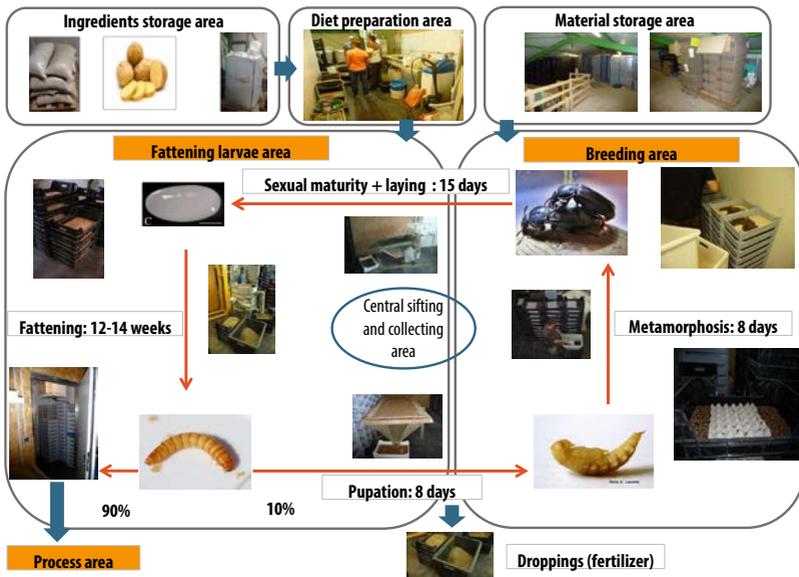


Figure 2: Mas-rearing of mealworm *Tenebrio molitor* at pilot scale (25 t/year)

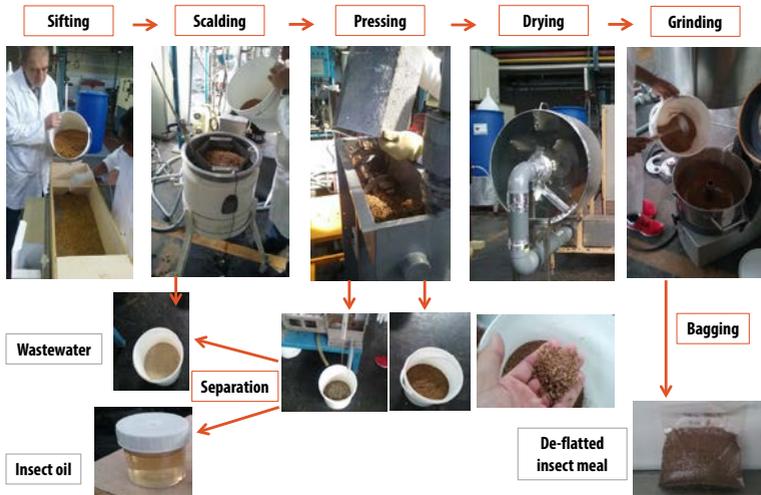


Figure 3: Processing of Tenebrio molitor larvae in insect meal – Pilot scale ParisTech

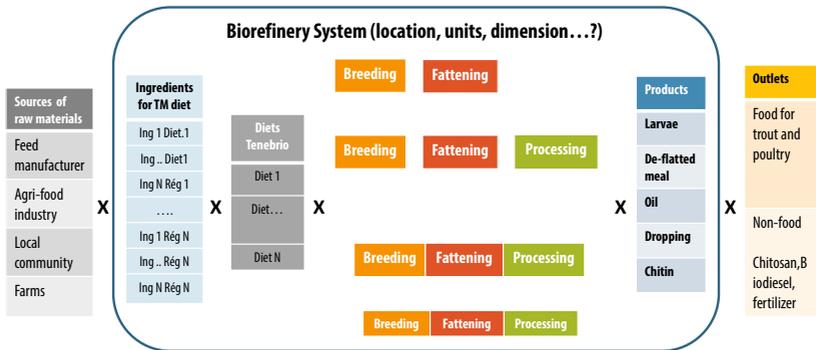


Figure 4: Possible combinations of technological bricks in a bio refinery system

So, how to explore, chose and build those scenarios?

Drawing on the Michel Godet's method (CNAM, French school of prospective) we gathered a working group composed of experts in insects and animal rearing, social and environmental assessment, entomo industry, economy, etc.

The working group of experts achieved:

- to identify 6 key variables and related modalities, in order to describe bio refinery systems (table 1);

- to define 400 possible technical scenarios for bio refinery system;
- to describe 23 scenarios among the 400 possible;
- to select the 3 best scenarios (the most promising from the stakeholders' opinion).

6 variables	Modality 1	Modality 2	Modality 3	Modality 4
Nature of the insects feed	Organic waste	By-products	Products	
Bio refinery configuration	Artisanal rearing / artisanal process	Artisanal rearing / industrial process	Industrial rearing / industrial process	
Bio refinery proximity to deposits or outlets	Near both	Near deposits	Near outlets	Far from all
Valorisation of product	Alive/dried larvae	de-fatted meal	de-fatted and de-chitinised meal	
Consumption of trout and poultry meat in society	increasing	decreasing		
Valorisation of by products	high	low		

Table 1: Key variables and related modalities in the bio refinery systems

1.4 Feedback on collaboration between environmental and social LCA teams

The reciprocal benefits from this experience between ELCA and social LCA teams (field visits, scenarios building, brainstorming, shared reflections) are:

- efficiency and accuracy during data collection, thanks to multi-angulation;
- mutual awareness, overcoming prejudices between different fields of knowledge;
- open-minded, creativity;
- synergy effect.

2. Presentation of the case study No. 1: "Territorial bio refinery scenario"

Among the three selected scenarios, the "Territorial bio refinery scenario" (figure 5) is made of multiplicity of entomo-farms, fattening the larvae *Tenebrio molitor*, and supplying one centralized processing cooperative.

The cooperative produces de-fatted meal and oil, from insects. In the terms of the table1, the bio refinery is located both "next to upstream" (productive area of cereal and by products to feed insects) and "next to downstream" (trout and poultry farms).

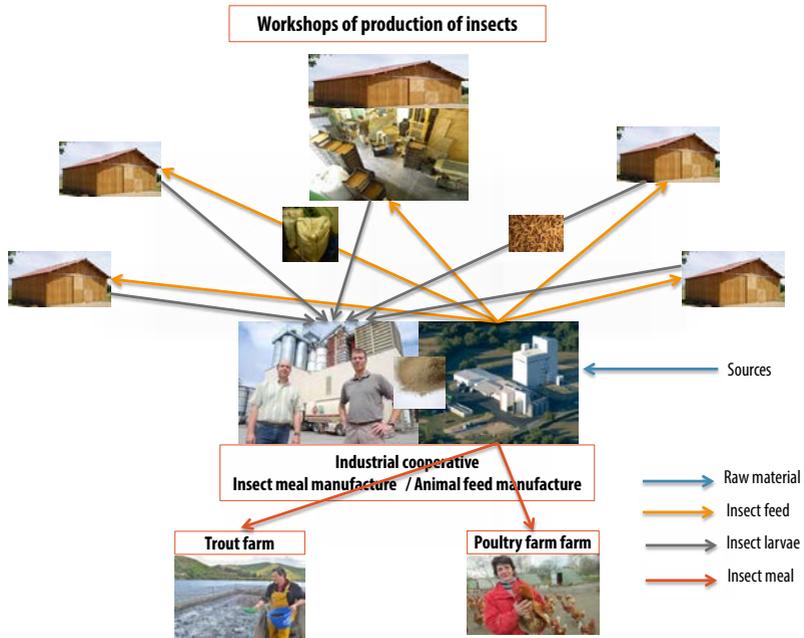


Figure 5: Scheme of the Territorial biorefinery system

2.1 Goal and scope definition

In the "Territorial bio refinery scenario" the objective is comparing current state (routine production of about 300 t of insect meal per year in France) to the new state after suffering the change. The studied change is **strong demand increase of insect meal**, due to the decrease of fish meal availability and to the poultry sector's wish to substitute soybean.

Question: what are the system and the perimeter of the system "Territorial bio refinery scenario" that allow us to study social effects generated by the change "**strong demand increase on insect meal**"?

2.2 Description and sizing of the system

First, we have to fine-tune the scenario, in order to make it as realist as possible, while respecting the modalities of the variables previously chosen. For example, in the territorial bio refinery scenario, we specify its location (see figure 6) and the economic regional context from data found in literature or calculated, to size the "filière", and the market trends (table 2).

Poultry: 160 000 t of standard poultry only on the region Pays de Loire



Trout: 25 000 t produced on the 3 surrounding regions (Bretagne, Normandie, Aquitaine) – 70% of the national production

Figure 6: Potential market of poultry and trout of the region Pays de Loire

Potential market of insect meal

	Trout (IC = 1.2)	Standard poultry (IC = 1.6)
Pays de Loire regional market	25 000 t	160 000 t
Needed feed	30 000 t	256 000 t
Incorporation rate	15 % fish meal	20 % soya bean
Quantities	4 500 t fish meal	51 200 t soya bean
Situation in routine	4 500 t	512 t
Insect meal provided	45 t (1 %)	250 t (0.5 %)

Market trend (= change)

- The trout sector is encountering supply difficulties in fish meal (lack of 500 t/year).
- The poultry sector wants to become less dependent to soya bean, then try to decrease its consumption of 1%/year for the next ten years.

Table 2: Sizing the scenario by market trends

2.3 Setting the perimeter

It is noticeable that, before designing the perimeter, we performed a specific study of the large value chains which could become affected by the change:

- either because they provide both feed for insects and for other usages (food, energy processing, etc.);
- or because they are in competition with insect meal in feed for farm trout and poultry (soybean, peas, etc.).

Because the preliminary studies have demonstrated that the change were not large enough to affect those large value chains, we may focus on the neighbourhood of the cooperative only.

The bio refinery cooperative is the "central firm". From the technical and organizational aspects of the insect bio refinery previously specified, we are able to design a map (figure 7). It is the map of the organizations in interactions with the territorial bio refinery (suppliers, customers, administration, transport companies, etc.). Some of those organizations in interaction will be affected (they will cause social impacts) by the change. Called "sensitive organizations", they allow us to design the spatial perimeter (figure 8) of the social life cycle study (organizations included inside the orange line).

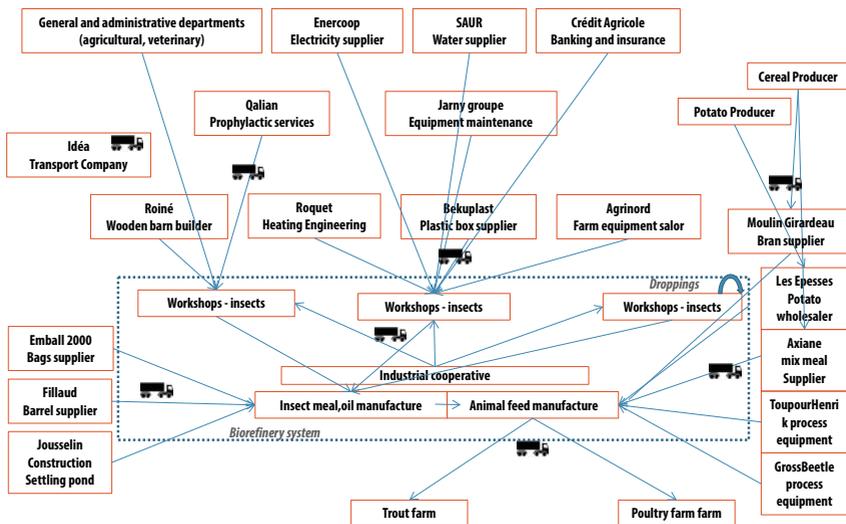


Figure 7: Organizations in interaction with "Territorial Bio refinery scenario"

Concerning the temporal perimeter, we assume that the data for this assessment are valuable for three years only.

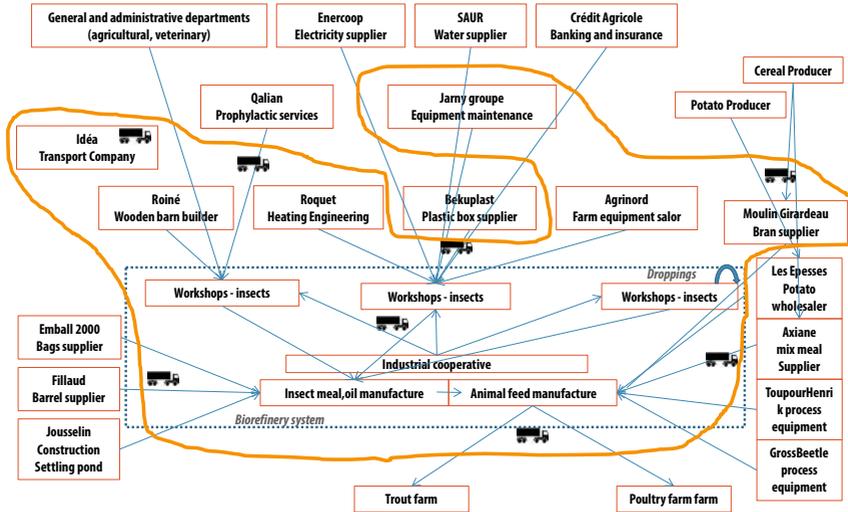


Figure 8: Organizations affected by the change. They allow designing the perimeter (orange line)

Through the presentation of an original and innovative project (DESIRABLE) concerning the sustainability assessment of an emergent production system (industrial insects production), we dealt with different questions (how to describe, build and size scenarios) and we realized the benefits of a joint team (environmental and social LCA) at different stages of the project.

3. Workshop case study No. 2 "Brown chemistry scenario"

3.1 The aim

For this second scenario "Brown Chemistry" (figure 9), the challenge is significantly different than for the first one. The challenge is:

- drawing the map of the organizations in interaction with the system,
- identifying the "sensitive organizations",
- defining the corresponding spatial perimeter.

In this second scenario, the type of insect is the fly *Hermetia illucens*, so-called "black soldier". So, its biological cycle is different. In consequence, rearing facilities, techniques, equipment, nature and source of diet (mainly from waste) are different from the features of the first scenario. The preferred place for setting the bio refinery depends on the availability of food waste and outlets. For instance, it can be set in the suburbs of large cities. The integrated bio refinery process is different, and the main products and by products are chitin, insect meal for pet food, insect oil for bio diesel, and bio fertilizer for gardens and compost.

3.2. Pedagogical aspects

During three hours, participants were divided into six groups. The workshop was carried out in three consecutive phases:

- **Half an hour** to share information: goal and scope, technical aspects, context, location, dimensions, data – and to remind the method. A complete documentation has been distributed to the six groups.
- **Two hours** for the six groups to produce a map of organizations and to set the perimeter.
- **Half an hour** for restitutions and discussions.

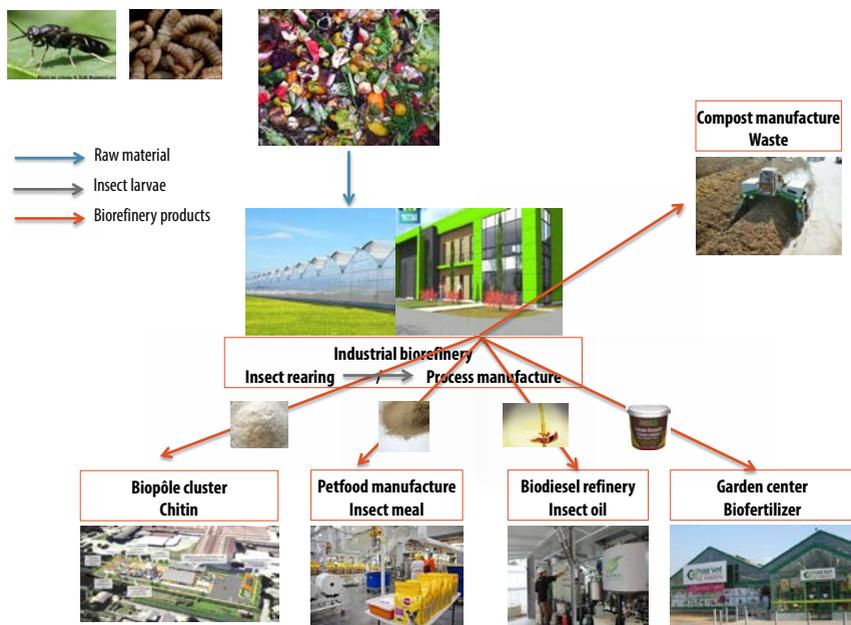


Figure 9: Scheme of "Brown Chemistry scenario"

3.3 Results – Discussion

All the six groups achieved a relevant map of organizations, because they achieve the identification of the organizations affected by the change. All the groups have drawn the perimeter. A rich discussion followed, concerning the diversity of organizations identified and affected (either in an evident or hidden manner) among the different groups, or the place of potential competitors (feed manufacturers).

Conclusion

By learning and training with the two case studies of "territorial bio refinery" and "brown chemistry" scenarios, the participants may have become familiar with the method to define the system and to set the perimeter in social LCA.

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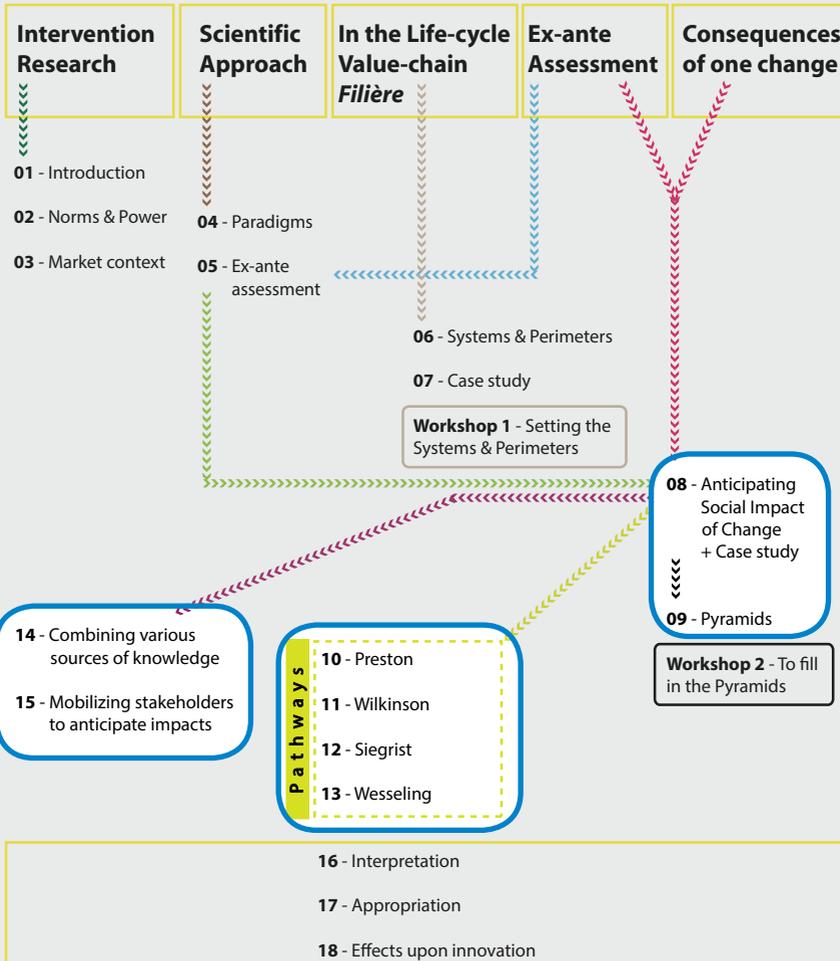
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Matrix of the researcher school's contents



Part 4

Methods for impacts assessment

08 Anticipating social impacts of changes in value chains

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To sum up

This chapter deals with the question: how is it possible to anticipate social impacts of changes in value chains? Here, we present four different ways to craft the pathways (the pathways are the causes-effects relationships towards anticipated impacts upon people life).

Outlook

Introduction

1. Asking people what is likely to happen if...
2. Finding relationships from the past
3. Using ELCA models
4. Crossing all the sources
5. Sum up of the different methods to anticipate changes.

Conclusions

Introduction

In this chapter, we are searching for the different ways of proceeding to achieve anticipation of effects and impacts (either qualitative or quantitative also). We remain in the domain of anticipating **changes occurring in agro-food value chains**, but several methods might be implemented to other fields. We choose to focus on the assumptions underpinning each way of proceeding, and to compare the four families of methods along certain features.

For the advisor or researcher carrying a social LCA study, choosing to implement one family of methods instead of another, depends on several conditions. We try to emphasize the most relevant ones.

1. Asking people what is likely to happen if...

Asking people is likely the most intuitive idea to get anticipated insights about the social consequences of one change. This way of proceeding is underpinned by three assumptions:

- There are **people** somewhere (experts, inhabitants, workers, stakeholders of the value chain) **who know** what will happen if the change occurs.
- We can **find**, select and ask the relevant people.
- If we **correctly ask** the relevant groups, they will tell us "what will happen if...".



Each assumption requires complementary explanations.

About the "knowledge of people", either it is lay knowledge (then, people can tell the story very simply) or it is collective knowledge (to be collected from focus groups), or co-built knowledge that must be elicited (for instance thanks to prospective methods).

About "finding the people", either it is obvious (for instance, we must ask the inhabitants of the place which will be upset by the planned change) or it is not. If not, we must implement sound methods (like stakeholder analysis by Mitchell, Agle and Wood, 1997) to select all the categories of actors to be surveyed about the issue at stake.

About "correctly asking people", it is never obvious. Indeed, "correctly asking people" is taught as methodologies included in scientific disciplines like Sociology or Management science. So, we need to implement protocols of interaction with people (Who? Where? When? How many times? Telling what? Doing what? etc.). The protocol of interaction takes **everything** into account, for instance, the previous experience of people about the issue, and the role the investigator plays (Favret Saada, 1985). The final protocol encompasses (in general several) participatory methods.

In social LCA, Mathé (2014) and Myllyviita et al (2013) have already published scientific works presenting future impacts which have been designed by asking people.

For the first family of methods, the core issue is about **setting efficient protocols**, to **interact** with actors. Here is the difficult and sensitive part of the method. Of course, getting in touch, presenting the work to authorities, and carrying interviews are very long task too. The topic may be so sensitive than the researcher cannot get any of the expected results. Moreover, setting efficient protocols requires for specific skills and knowledge. Indeed, if the protocols are not sound, the results are not valuable. In sum, these methods are very demanding.

The family of methods designed to interact with actors is called "participatory methods".

Each participatory method encompasses its own usage conditions and at least one (and more often several) elementary tools for participation, articulated and crafted within a protocol for interaction.

The table 1 displays examples of elementary tools for building participatory methods, according to the principal objective and desired degree of participation.

2. Finding relationships from the past

		Degree of participation	
		Consultation	Involvement
Objectives of the tool	Mapping	Policy exercises* Scenario workshops* Envisioning workshop Policy delphi Focus groups World café Policy conference Open/Public meetings Mystery shopping Web forums	Users panels Users forums Planning for real Community profiling/appraisal Community visioning Open space event
	Convergence	Consensus conferences* Conventional delphi Expert panels	Participatory modelling Charrette Future search conference Citizens' juries* Planning cells
	Democratization		Participatory planning* PRA: Participatory Rural Appraisal PAM&E*: Participatory Assessment Monitoring and Evaluation

* means that method includes high co-learning potential / Sources: Bousset et al. (2005) page 28

Table 1: Elementary tools for building participatory methods and interaction protocols

Here, the idea is screening the past, to find regularity, e.g. relationships linking one easy-to-quantify variable with another variable contributing to "health state". For instance, the easy-to-quantify variable may be "changes in income inequality" (assessed by Gini coefficient), and the variable contributing to human well being will be "changes in infant mortality" in this case. If the relationship held in the past and is still up to date, **it is likely that it will be the same in the future**. So, the relationship

and the future value of the easy-to-quantify variable, will help us to assess future state. This way of proceeding rests on three assumptions:

- There are generic relationships between variables (easy-to-quantify and stemming from the change in the life-cycle) and health state.
- If the relationship held in the past and nowadays, it is reasonable to think it will hold in the future too, under certain conditions for use.
- Each relationship matches:
 - a) one and only one scale,
 - b) one specific group of target actors.

About finding the generic relationships from the past, we neither imagine them,



Each assumption requires complementary explanations.

nor create them. We handle generic relationships which are already acknowledged in the scientific literature. In general, either they are controversial, or they are split in several pieces never gathered before. Our first task is to test again the relationship under the form of variations (it means that we try to build the mathematical relationship between **variations of the first variable and variations of the second variable**). Another task is finding its conditions for use for social LCA implementations, and finally implementing a case study to display the whole functioning of the pathway.

As the generic relationship held true in the past, it has been studied several times and for different locations and people. So, we use the experience learnt from these previous studies, in order to define **in which specific conditions** the relationship could hold true in the future. We make the assumption that – if these conditions are met again in the future – the relationship will hold true again.

From literature, we got some examples highlighting that the **scale is specific of each relationship**. For instance, Rostila et al. (2012) demonstrated that the well known relationship between income inequality and health counteracts when downscaling. That is the reason why we do not downscale nor upscale one given relationship. In the social LCA method, some pathways must be implemented at macro-scale (country, large region) and other pathways must be implemented at meso-scale (workshop in the plant, group of households). The explained variable of the relationship is built for one specific population. For instance, the variable "infant mortality in the country population" means that the target is the country population. So, **each relationship is specific of one target population**. It would not be fair to use it for anticipating effects upon another group of actors, without new study and new demonstration.

The table 2 displays the list of pathways we have designed thanks to relationships from the past, within the research programme, to date.

Name of the pathway	Target	Starting point	Nature of the impact	Temporal horizon	Comments
Preston	Population of the country	Change in added-value	Change in LEX (Life Expectancy)	Delay	General under conditions for use
Wilkinson	Population of the country	Change in repartition of added-value	Change in infant mortality	Delay	General under conditions for use
Wilkinson region	Population of the region	Change in repartition of added-value	Change in mortality rate	Delay	Demonstrated for one region
Siegrist	Workers of the life cycle	Change in work organization	Change in morbidity and mortality rates (many criteria)	Middle and long term	General under conditions for use
Wesseling	Agricultural workers/ pesticides	Change of the ITK (cultural process)	Change in morbidity rates (many criteria)	Middle and long term	Under way for one crop (banana)

Table 2: List of pathways rooted in past general relationships in the social LCA program

3. Using ELCA models

Another way of proceeding for anticipating health impacts of changes is using Environmental Life Cycle Analysis. More accurately, it is possible to implement the calculation of the impact called "Human Health" from the environmental life cycle assessment (ELCA) methods, when the product system is very large (involving one continent or one large country). The result is an estimation of the "damage to human health"(in fact to an average human being) caused by the different issues at hand in environmental LCA (emissions of pollutants and radiations, climate change, etc.).

We will not focus on the different assumptions underlying this way of proceeding. The models in use are very controversial, and cast doubt upon its soundness.

The figure 1 displays the filiation between the different environmental life cycle methods regarding the impact "Human Health". Many current methods stem from the old eco-indicator 99's principles.

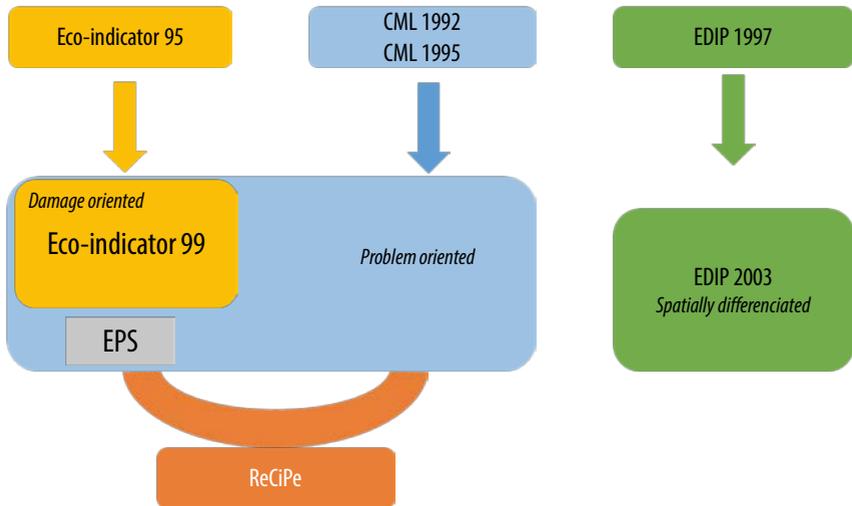


Figure 1: Filiation between the different Environmental Life Cycle Assessment methods, regarding the impact "Human Health"

The huge advantage of using the "Human Health" impact from ELCA is that **there is no need of other data** than the ones to be used for the calculation of the other impacts in ELCA. Indeed, only physical factors (quantity of products, material flows, etc.) are taken into account.

The main disadvantage is that many researchers and stakeholders think that **this method does not provide meaningful insights** about the potential damage caused to human health. Nevertheless, it can be used as first draft assessment in certain conditions. It can be used in comparison to contrast different scenarios, and if nothing important (regarding **people exposition**) changes between one scenario and the other. Thus, this calculation can provide a first indication of the ranking of different scenarios regarding the "general" damage to world population health.

4. Crossing all the sources

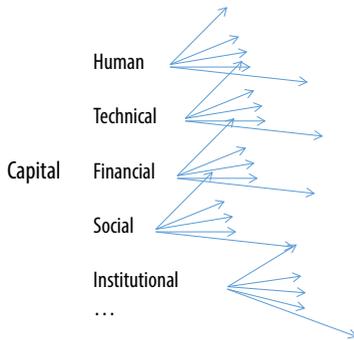
In practice, when we perform one given study by social LCA, we **often mix all the possible sources of information**. So we use all the former different methods, to collect data and to anticipate the impacts of change. The aim is being able to anticipate the more important social impacts caused by the change at hand, by any means. Gillet and Lœillet (2013) presented an example.

To do so... we collect all the available documents

we ask people about their feelings about the future state,

we use participatory methods... and prospective,

we make the calculations thanks to the available pathways, etc.



When crossing all data sources, data are sorted out in several categories thanks to the Multiple Capital Model (MCM) Theory. Indeed, Capitals Theory acknowledges that human beings handle different kinds of Capital (e.g. Technical, Financial, etc.). MCM assumes that growth can be modelled by one given production function depending on the stock of these different kinds of Capitals.

Moreover, Capacities social LCA (Garrabé and Feschet, 2013) drawing from the Sen's theory of Capabilities, **expects to make the link between performances and impacts,**

by getting as closer as possible to effects (and impacts when possible). The figure 2 illustrates the linkages between one performance ("vocational training exists") and one impact ("the satisfaction of the worker is changing").

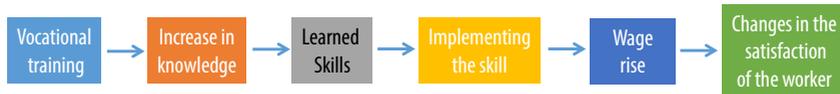


Figure 2: From performance to impact by Capacities LCA (from Garrabé and Feschet, 2013 page 90)

The next paragraph is devoted to screen and to compare the four ways of processing, to anticipate impacts.

5. Sum up of the different methods to anticipate changes

In the next 5 tables, we provide a general picture by comparison.

	Advantages and drawbacks of
	Asking people
Number of criteria to be collected	Between 20 and 200
Initially designed for... studied system	Assessing politics, appropriation
Feasibility (availability of data)	***might be sensitive
Relevance	***
Interoperability with other dimensions	*
Affordability	*very long (at least 6 months)
Social consultation as source of data	yes
Communicability of results	**
Ability to pinpoint 'hotspots' felt by people	***
Hierarchy of actions	***

Caption: * means low; ** means average; *** means good

Table 3: Features of the method "asking people"

	Advantages and drawbacks of
	pathways from past
Number of criteria to be collected	2 or 3 criteria for each pathway
Initially designed for... studied system	Value chains
Feasibility (availability of data)	***
Relevance	From * to ***
Interoperability with other dimensions	*
Affordability	***
Social consultation as source of data	no
Communicability of results	***
Ability to pinpoint 'hotspots' felt by people	*
Hierarchy of actions	no

Caption: * means low; ** means average; *** means good

Table 4: Features of the method "pathways from past"

	Advantages and drawbacks of
	Using ELCA
Number of criteria to be collected	The same data as ELCA
Initially designed for... studied system	Value chains
Feasibility (availability of data)	***
Relevance	?
Interoperability with other dimensions	*
Affordability	**
Social consultation as source of data	no
Communicability of results	***
Ability to pinpoint 'hotspots' felt by people	*
Hierarchy of actions	no

Caption: * means low; ** means average; *** means good

Table 5: Features of the method "using ELCA"

	Advantages and drawbacks of
	Crossing all the sources
Number of criteria to be collected	Around 120 criteria
Initially designed for... studied system	Assessing projects
Feasibility (availability of data)	***
Relevance	***
Interoperability with other dimensions	*
Affordability	**
Social consultation as source of data	yes
Communicability of results	***
Ability to pinpoint 'hotspots' felt by people	***
Hierarchy of actions	**

Caption: * means low; ** means average; *** means good

Table 6: Features of the method "crossing all the sources"

Groups of methods	Advantages and drawbacks of the different approaches			
	Asking people	Pathways from past	Using ELCA	Crossing all the sources
Number of criteria to be collected	between 20 and 200	2 or 3 criteria for each pathway	1 synthetic criteria	around 120 criteria
Initially designed for... studied system	assessing politics	value chains	value chains	assessing projects
Feasibility (availability of data)	***	***	**	***
Relevance	***	***	?	***
Interoperability with other dimensions	*	*	*	*
Affordability	* very long	***	**	**
Social consultation as source of data	yes	no	no	yes
Communicability of results	**	***	***	***
Ability to pinpoint 'hotspots' felt by people	***	*	**	***

Very long, sensitive but always efficient, whatever the impacts

Quick, easy, but few impacts involved

Included in ELCA, but not very relevant

Good trade off between rapidity, completion and relevance

Table 7: Comparison of the 4 methods

Conclusions

Our aim was presenting the different ways of proceeding to anticipate impacts, which are used in the research program for building social LCA.

"Asking people" involves participatory methods. It is so demanding that we think it is worth only when the main purpose is helping stakeholders to take ownership of the topic at stake. So, social assessment becomes a co-product of the process to facilitate the appropriation.

Using pathways elaborated from the past is quite quick, because data are easy to collect. Nevertheless, only few pathways have been designed to date. Moreover, we must overcome the risk to neglect some important impacts... because we do not know the pathway to calculate them!

The calculation of the general impact "human health" by ELCA software is the quickest and easiest method, when the scale of the issue must be large (continent, large country). Anyway, the interpretation deserves many precautions.

The field method mixing all the available ways of proceeding, depending on the scale, time, and availability of data, seems to be a good compromise. Capacity modelling is helpful to present results of investigations to backers too.

Stemming from both "asking people" and "using pathways", is the so-called method "**Ranking the social determinants of health**". Its main contribution is not anticipating amplitude of impacts, but setting a hierarchy among the nature of impacts. This fifth method will be presented in the chapter 9.

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09 Deciphering the Pyramids

From CSDH to pyramids (workshop 2)

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To sum up

Among the methods helpful to hierarchize social impacts, we choose to present the one inspired by the Commission on Social Determinants of Health (WHO, 2009). We call it "pyramids". The purpose of using the pyramids is identifying the important social impacts, while classifying them. The cause of impacts is one change, affecting people health at two scales:

- at the nation/region level for one developing country,
- at the rural household level for one developing country.

The principle of the pyramids is that they display ranked "bricks" which are the "social determinants of health". The metric of the pyramids is health of population/health of households. Also, this chapter presents the workshop held about filling in the pyramids, during the researcher school, and highlights the main results in terms of outputs from participants.

Outlook

1. Presentation of the pyramids
2. Workshop 2: using the pyramids

Conclusion

1. Presentation of the pyramids

1.1 Story of LCA from the metric point of view

From the very beginning of societies, it has been useful to assess wealth of people (for example to organize storage of food or collective defense). Tax was collected in the

form of grains, and later in the form of money. So, the spontaneous metric of wealth is exchange money. Along the time, diversification and complexification of societies drive us to assess more and more issues, paying preferential attention to money as metric.

Suddenly and recently, we became aware of the "limits of growth" or, more accurately, of the limited natural resources of our planet. One consequence of this revolution of minds is a general attempt to assess all human activities in terms of impacts on the natural environment. After money, **another metric was born**, the metric of "environmental state".

With social LCA, a third metric is at stake, which accounts for the social realm. In the social LCA research program, we have chosen **the metric of "state of human health"** (relating to public health).



Of course, there is **no equivalence nor compensation** between the first and the second or the third metric.

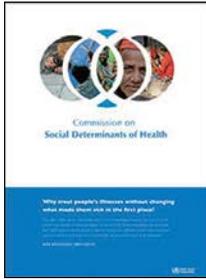
As for the older one, each new metric provides results in several possible units.

- 1) The units of the exchange money are the Egean turtle, seashells, dollar, yen, euro, etc.
- 2) The units of the environmental state (used in ELCA) are "g of CO2 equivalent", "DALY", "PDF x m2x year/kg", "MJ/kg", etc.
- 3) The units of the human health state (used in social LCA) are "days of Life Expectancy", "mortality rate", "morbidity rate" etc.

1.2 Story of the social determinants of health

Between 2005 and 2008, the World Health Organization decided to set up a "Commission of Social determinants of Health" (CSDH), in charge of explaining the relationships between health of population/households and many other factors (e.g. land rights, decent work, bribery etc.). The purpose was to officially acknowledge the **links between relevant social conditions and health**, in order to advise policy makers for sound (inter sectoral) policies for health.





The 19 members of the Commission (including Amartya Sen) are outstanding authority specialists of relationships between social conditions and public health, from the practical and the scientific scopes. The President of the CSDH is Sir Michael Marmot, who devoted his life to the study of relationships between inequalities and health. The results of the CSDH works came out in 2009. The main idea of the CSDH is that:

Social Injustice is killing on a massive scale.

It is noticeable that the members of the CSDH have chosen certain relationships (between social conditions and health) because of **their own experience, even when the relationships are still in debate in the scientific community.**

In the report of the CSDH (WHO, 2009), the authors have split the social determinants into two scales:

- the "macro" scale of one state, or large region, in developing countries (LCD),
- the "meso" scale of a group of rural household, in rural regions of developing countries (LCD).

The diagrams of flows displaying the relationships at the macro-scale (figure 1) and at the meso-scale (figure 2) are depicted hereafter.

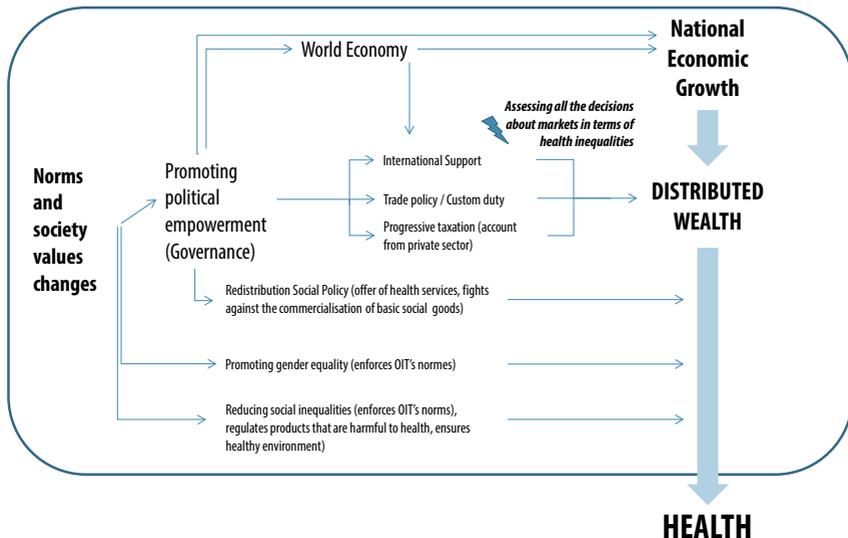


Figure 1: Diagram of flows at macro-scale

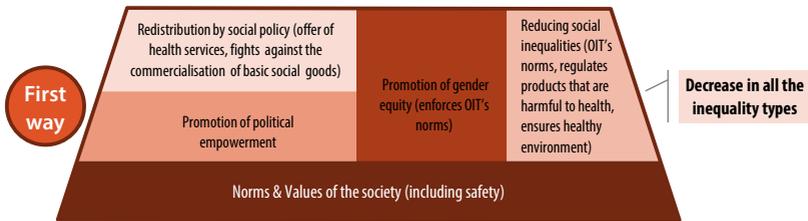


Figure 4 : ... which is translated under the shape of several bricks, forming all together a pyramid

1.3 Presentation of the resulting pyramids

At the macro scale, we present the three elementary pyramids in one specific order, despite there is no hierarchy among them. The specific order accounts for history. Indeed, we remark that:

- at the Neolithic age (growth is nearly zero for long time and international trade is low) only the bottom pyramid exists;
- in a more recent society, when there is not real economic growth yet, only the bottom and the middle pyramids exist;
- when there is significant economic growth, the three pyramids are relevant.

Here below (figure 5) is the resulting representation of the 3 elementary pyramids at macro-scale. All together, they shape a new bigger pyramid.

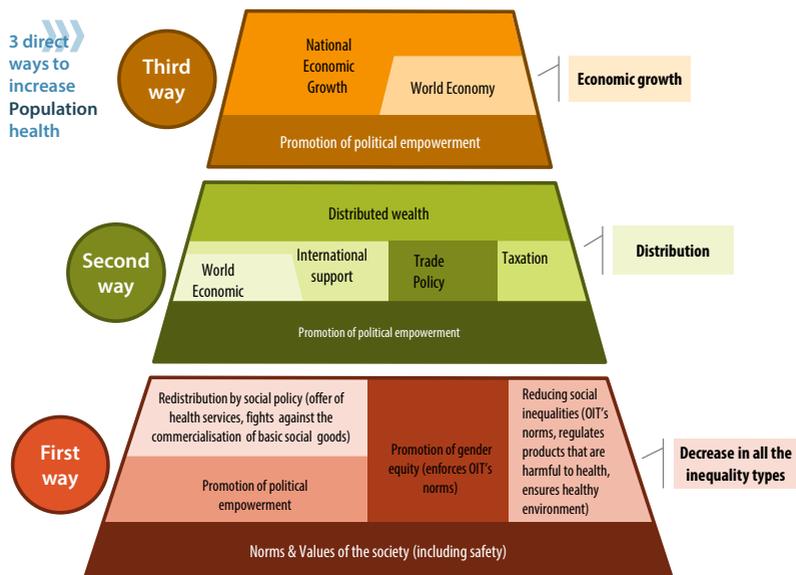


Figure 5: Pyramid of the social determinants of health in LCD, at the nation-scale

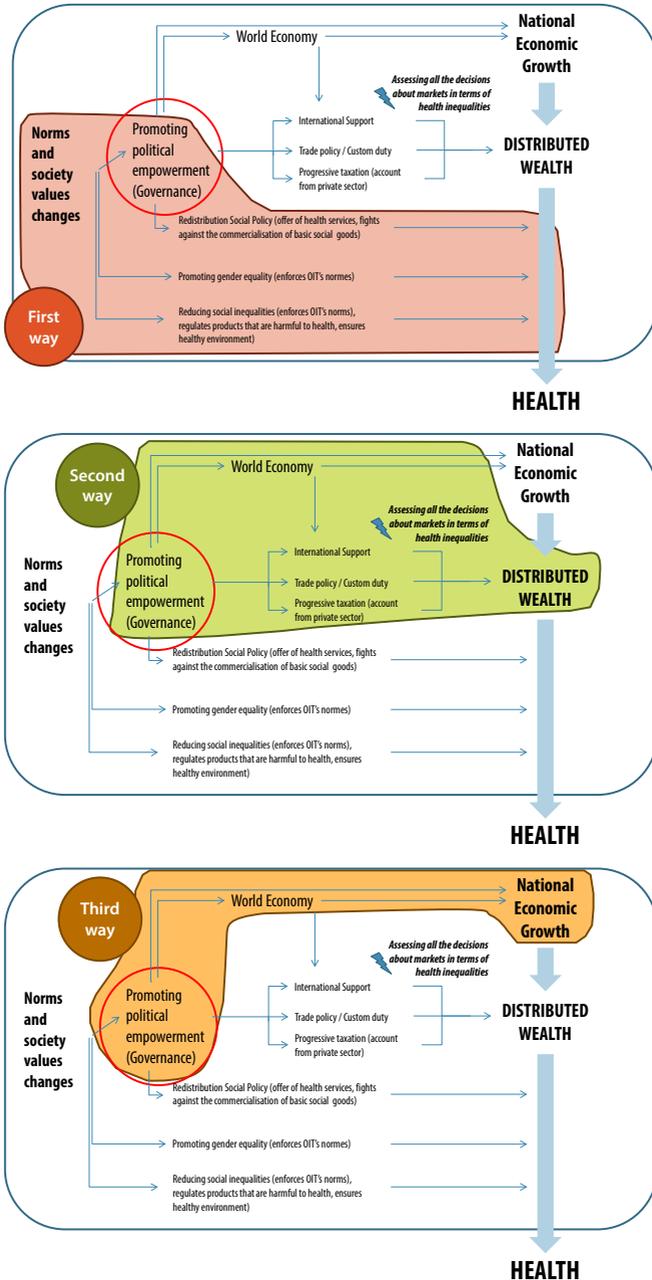


Figure 6: "Promoting political empowerment" is a crossroad of the three paths to improve population health

The figure 5 highlights that "promotion of political empowerment" is one brick belonging to the three elementary pyramids, while this brick does not occupy the same position in the three elementary pyramids. Indeed, as underlying by the figure 6, the "promotion of political empowerment" is a cross road for the different paths towards population health.

At the meso-scale (rural households), we designed two paths towards households health, as displayed in the figure 7. There is no hierarchic order among the two pathways, so the resulting pyramid is made of two equivalent parts, set side by side (figure 8).

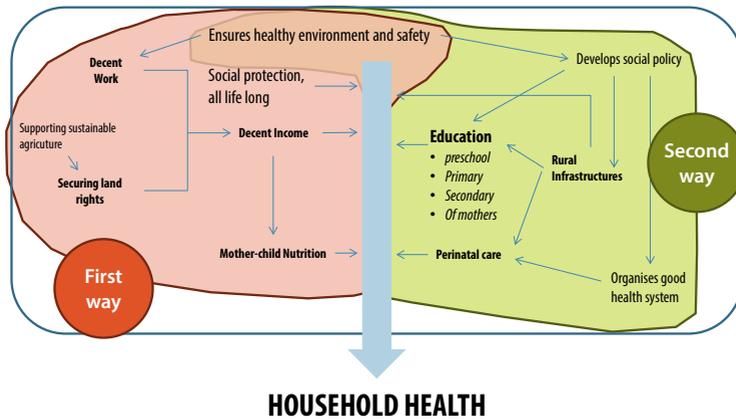


Figure 7: The two paths towards rural household health

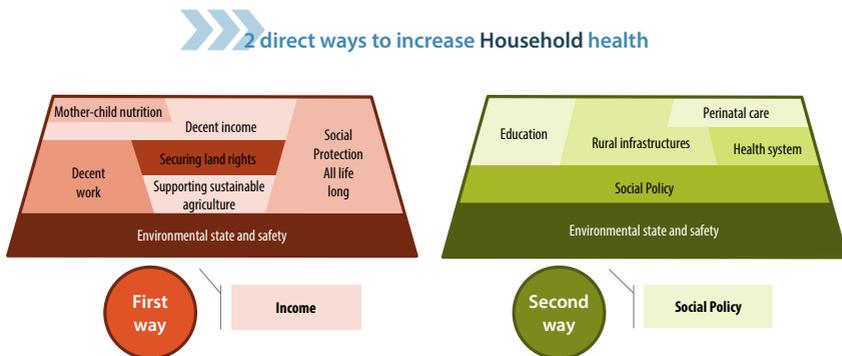


Figure 8: Pyramid of the social determinants of rural household health, in LCD country

It is noticeable that "Ensuring healthy environment and safety" is the root for both pathways towards rural household health. The pyramid shapes highlight the hierarchy among the different brick of each elementary pyramid. For instance, **setting a fair social policy** is more important than **setting fair health system** alone. If necessary (for instance to perform scoring) it is possible to allocate one given weight to each brick of the pyramids.

1.4 Weighting the pyramids

First, we are describing the rules to get "weighting of the pyramids" (§ 1.4.1), then we are presenting possible results for the macro-scale (§ 1.4.2) and for the meso-scale (§ 1.4.3).

1.4.1 Rules to "weight the pyramids"

We decided to set **some rules** in order to weight the bricks inside the pyramids. We have arbitrarily decided to allocate the same number of points to each elementary pyramid. Indeed, each elementary pyramid describes a path towards health, and we do not know the hierarchy (if any) among the elementary pyramids.

- The total number of points by elementary pyramid is arbitrarily set to 10.
- The more a brick is down in the pyramid, the more its own weight is high. Indeed, we consider that the lowest bricks are the basic, the fundamental ones. Any action upon one basic brick is prone to cause larger social impacts than the impacts caused by the equivalent action upon one higher brick. To account for this preponderance allocated to basic bricks,

X+1 being the level immediately superior to X

X-1 being the level immediately inferior to X

The total number of points at one level X of the pyramid is k, with:
"total of the points at the level X+1 < k < total of the points at the level X-1"

- The weight of one brick alone increases in proportion with the number of relationships the brick is involved in. The number of relationships is indicated by the height of the brick (the number of levels covered by the brick).

Following these rules, we can suggest weights for each brick. Examples are provided in the next two paragraphs.

1.4.2 Suggestion of weights for the pyramid at macro-scale

In order to weight each brick, we start from 10 points to be split into all the bricks of the elementary pyramid. First, we determine the number of levels in the elementary pyramid. Here, the bottom pyramid handles three levels, the middle one handles four levels, and the upper one three levels.

Then, for the elementary pyramid at the bottom (for instance) we divide 10 points between three levels, taking care that the number of point by level is decreasing as we are climbing the levels. We decided to keep whole numbers (as far as possible), and so we distribute the 10 points as follows:

- **5 points** (among 10) at the lowest level,
- **3 points** (among 10) at the following upper level,
- **2 points** (among 10) at the following upper level again.

Then, the **5 points** allocated at the lowest level are the weight of the brick "Norms and values of the society".

The **3 points** must be divided into the 3 bricks: "Promotion of political empowerment" (1 point), the bottom of the brick "Promotion of gender equity" (1 point) and the bottom of the brick "Reducing social inequalities" (1 point).

The **2 points** must be divided into the 3 bricks: "Redistribution by social policy" (2/3 point), the top of the brick "Promotion of gender equity" (2/3 point) and the top of the brick "Reducing social inequalities" (2/3 point).

By adding the points gained at the bottom and at the top of each brick, we get the figure 9, and so on for the other elementary pyramids.

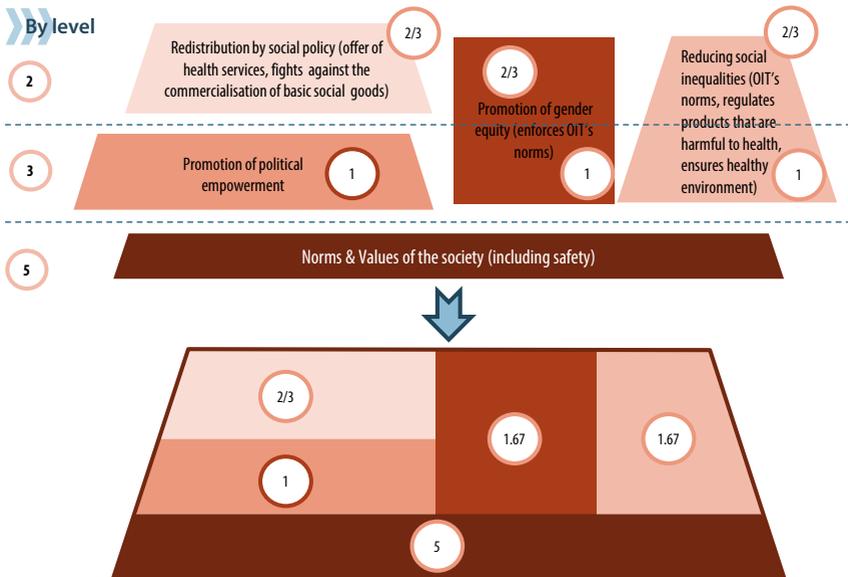


Figure 9: Example explaining the weighting process for one elementary pyramid

For the macro-scale, the resulting full picture is displayed in figure 10.

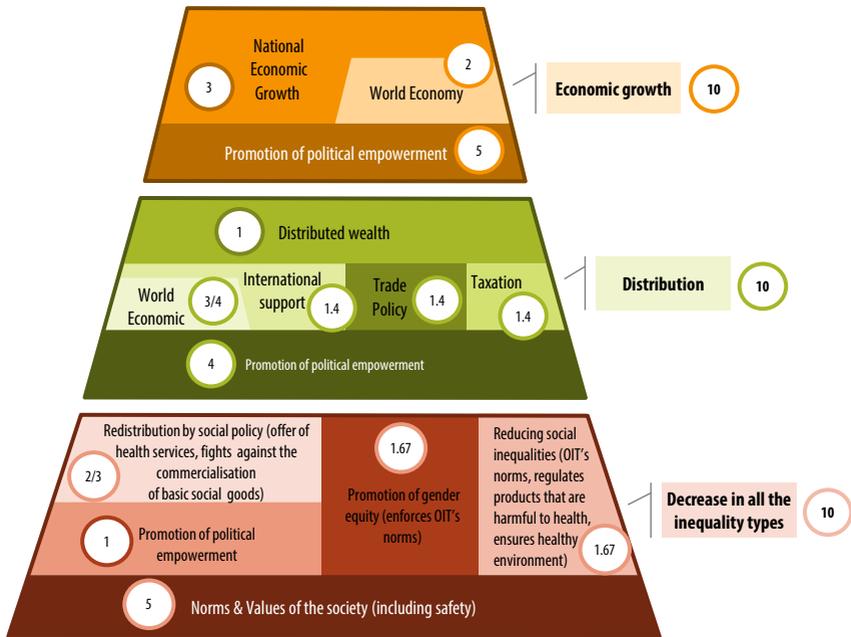


Figure 10: Example of weighting for the bricks of the pyramid of social determinants of health at macro-scale, for LDC country

1.4.3 Suggestion of weights for the pyramid at meso-scale

With the same rules and hypotheses, we can suggest the weighting of bricks at the meso-scale (rural households), as displayed in the figure 11.

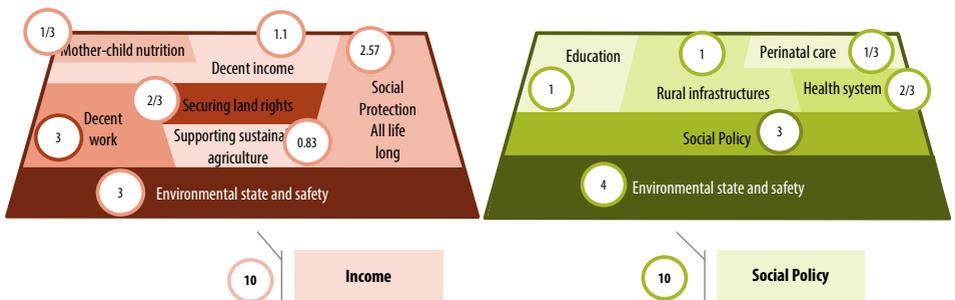


Figure 11: Example of weighting at the meso-scale

Of course, other systems to weight the bricks of the pyramids are possible and welcome. The ones presented above are the simplest to represent the hierarchic order among bricks translated from the Commission of Social Determinants of Health's work.

1.5 Filling in the pyramids

The pyramids can be useful for research or for implementing case study.

1.5.1 Setting a diagnostic about one given situation

The first usage is **setting a diagnostic about a given value chain** (example in the figure 12), in general for gate-to-gate parts of the whole life-cycle. In this case, **the reference state is the situation where the value chain would not exist**. For instance, the data may be collected within sustainability reports of the central company driving the value chain. The work to be done is searching for **information about the present state**, for all the topics of interest in the pyramids.

The outputs highlight the bricks for which no information has been found, and the bricks displaying many different actions. When the brick is empty, it is important to sort out the cases where there is nothing (no action), from the cases where we simply do not know it.

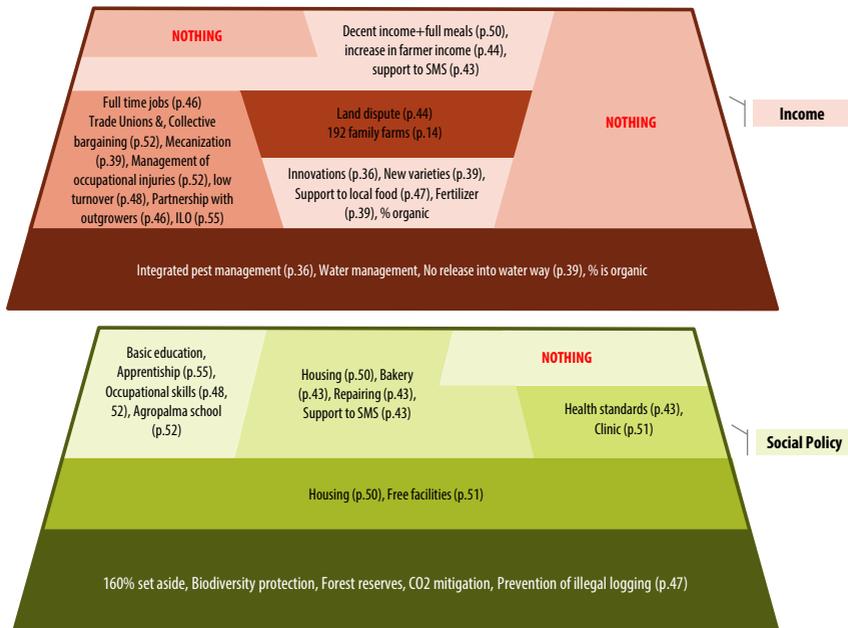


Figure 12: An example of diagnostic by meso-scale pyramid, filled in from sustainability report

We can compare different diagnostics, and we may score the bricks (cf. § 1.4). Nevertheless, for comparing diagnostics of two different value chains (of the same product), even if we fill in the same bricks and if they are ranked in the same order, we must be aware that **we likely do not use the same features** of the situation (for instance, to fill in the brick "rural infrastructure" in one case we focus on "roads maintenance", while we focus on "sewage" in the second case). So comparison of pyramids between different sites remains at risk of misunderstanding.

1.5.2 Assessing one project/one change

The second usage is **assessing a project** which affects (or will affect) the value chain, regarding at least one part of the life-cycle. The change can be assessed by anticipation, or after the change occurs. The reference state is either the situation before the project/change to occur, or another state of the situation (for instance an alternative project which might be implemented instead). The work to be done is searching for **information about changes** for all the topics of interest in the pyramids. In this case too, about empty brick, we must sort out the cases where there is (will be) no change, from the cases where we do not get knowledge about it.

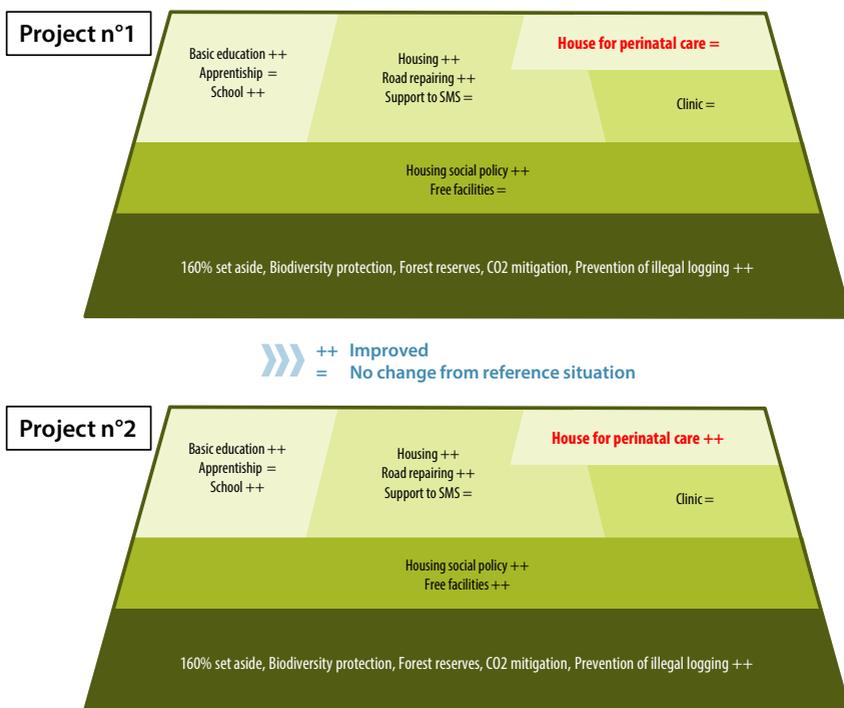


Figure 13: Two elementary pyramids filled with the same features, for two projects affecting the same value chain

Moreover, we can compare different projects, and we may score the bricks (cf. § 1.4). Nevertheless, for comparing projects regarding the same value chain, we must fill in the same bricks and ranked in the same order, and we must **use the same features** of the situation. If these conditions are fulfilled, the comparisons are meaningful and may be relevant for policy-making (whatever scoring or not). The figure 13 presents a comparison between two projects regarding the same value chain.

2. Workshop 2: using the pyramids

This second section describes the workshop 2.

2.1 Differences between the workshop and real-life practice

When starting the workshop, we addressed differences between one real case-study, and what we can achieve during the workshop.

In real-life practice, the team in charge:

- sets the project;
- collects general information about the context (e.g. country features, laws, history of the case, evolution, social stakes etc.);
- seeks to find specific information about the project, as far as possible;
- organizes and picks up interviews from relevant actors;
- by iterations with the pyramids, the team tries to fill in the pyramids' bricks with all the relevant information collected.

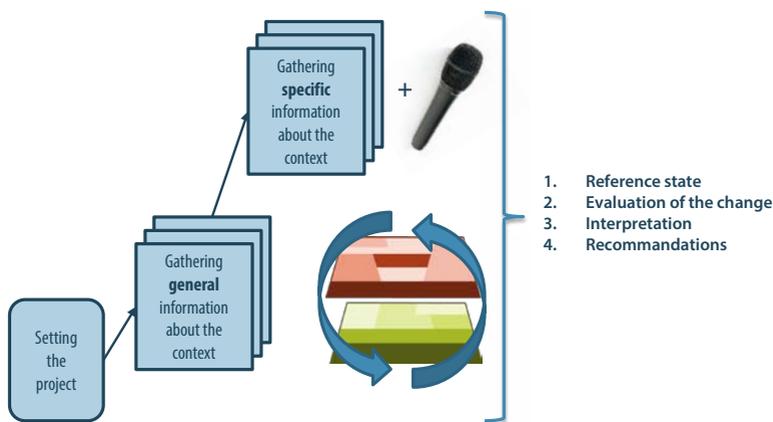


Figure 14: Steps when implementing a real case-study

The objectives are to know and to describe the reference state, to evaluate the change, to interpret the impacts of the change, and to provide recommendations. The figure 14 schematizes the real-life practices.

In workshop practice, the team in charge makes something different.

It is not possible to address all the real-life practices during the workshop time frame. We describe the part of the real case-study we can perform during the researcher school, in the figure 15.

In order to implement the workshop, the facilitators of the researcher school provide:

- the design of the project;
- two documents gathering general information about the context;
- the "Agropalma Sustainability Report 2013", to cope with specific information;
- the results of supposed interviews of actors.

The tasks devoted to the participants are:

- setting the reference state,
- evaluating the impacts of the planned change,
- providing interpretation and recommendations.

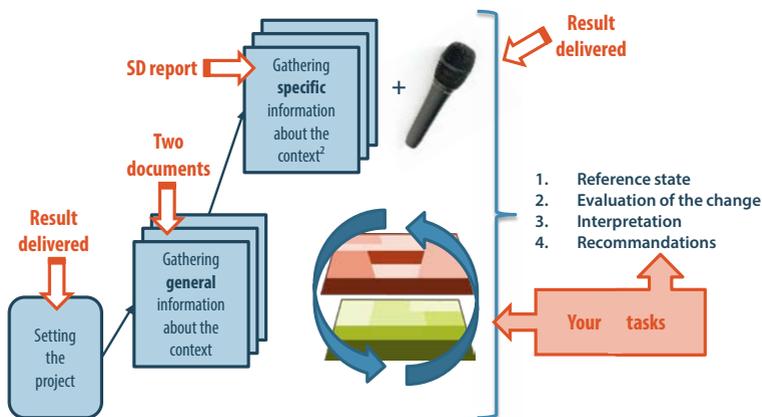


Figure 15: Part of the case-study practice we can deal with at the researcher school

2.2 Presentation of the case study

The project under scrutiny is that a large company producing palm oil in Brazil is willing to increase the surface of cultivation of palm, which will be cultivated in the same conditions as the current ones. Nevertheless, new varieties of palm will be devoted to internal usage only, and not to exportations. The documents about the context are the "Palm oil" chapter from the Yearbook 2015 Cyclope (2016), For whom tolls

the bell? (Cyclope 2016), and the published paper: Drouvot C. M., Drouvot H. Perluss P. (2014) Greenhouse Gas Reduction through Social inclusion in Brazil, International Journal of Sustainable Development, Volume 17, Issue 1. The specific document is the Agropolma Sustainability Report 2013.

The results of the supposed interviews are: "There is less inhabitants and services in the new area, and rights of native peoples might be threatened. The new plantation takes the risk of attracting migrant workers from neighbour regions."

Warning! The situation has been imagined and does not reflect any project from the Agropolma Company itself. Of course, the aim of the workshop is not criticizing a real project, but about performing together an exercise using the pyramids.

Here (figure 16) are the pyramids at the meso-scale, filling in by the facilitators of the workshop, and from the same documents as the participants' ones.

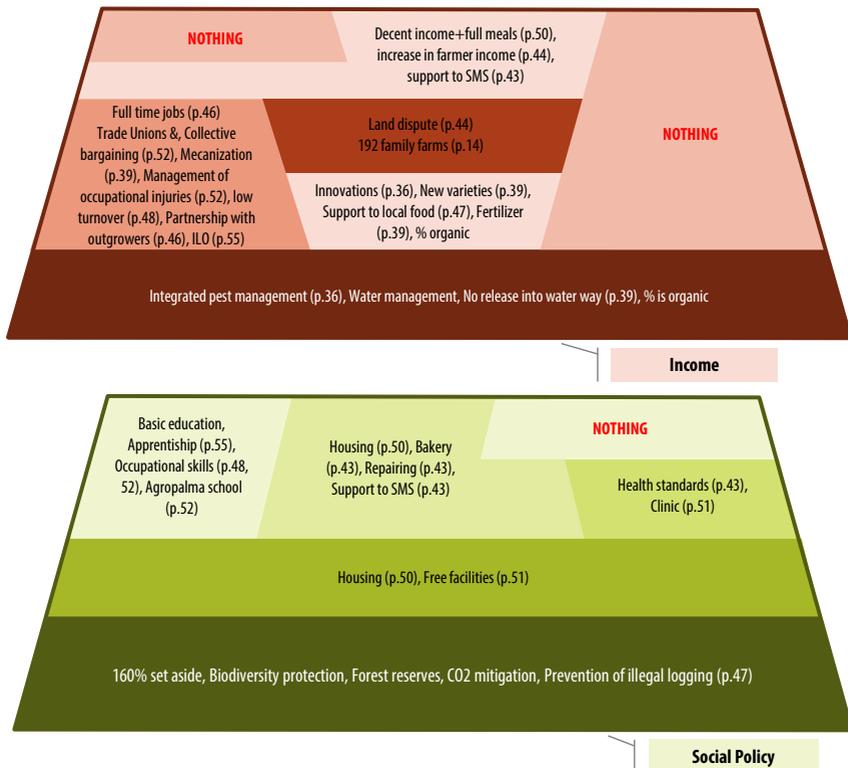


Figure 16: Reference state used in the workshop
(the numbers are the pages of the Sustainability report devoted to the corresponding topic)

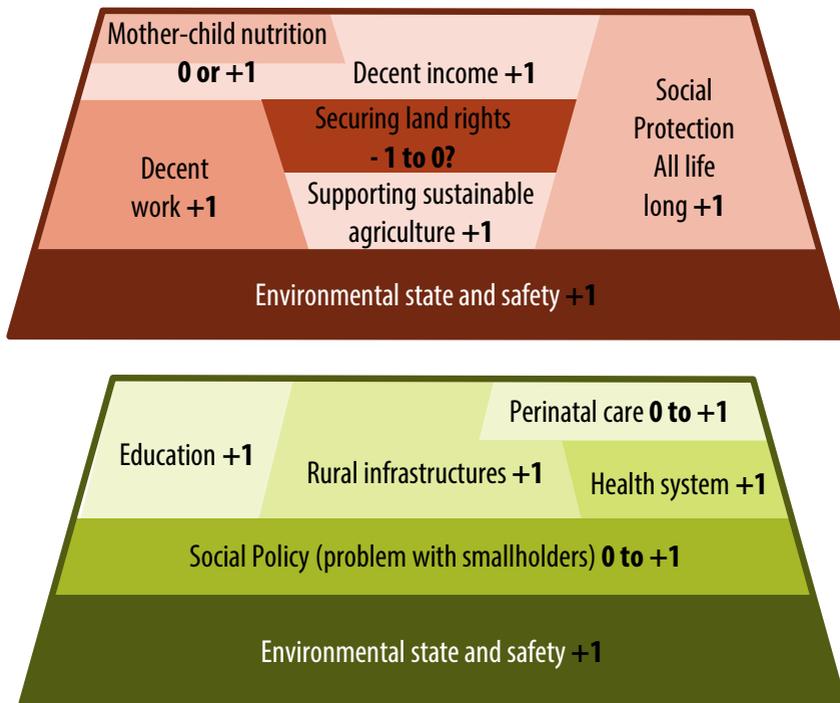


Figure 17: Possible scoring of the change in the workshop

The figure 16 represents the reference state, while the figure 17 displays the scoring of the change.

As it is obvious from this picture, in some cases, it is difficult to choose between 0 and 1, or -1 and 0. It means that interpretation is difficult because of lack of knowledge, or because of contradictory insights.

2.3 Practical organization of the workshop

The participants were divided into four groups, located in different places. Each group received the same instructions about time and tasks (see figure 18).

A calculator (excel sheet, see figure 19) was available for the participants, to get immediate results from the scoring of bricks, and to help performing several simulations.

Workshop 2: time organisation

- 1) First slot: 1h30**
 - Task: understanding and using the documents
 - Expected results: filled pyramids with
 - the reference state
 - the scores of the project in the different bricks

- 2) Second slot: 15 mn** (with the calculator)
 - Scoring the pyramids
 - Discussing
 - Interpretation

- 3) Third slot: 10 mn each group**

Restitution:

 - Reference state
 - Scoring of the change
 - Interpretation
 - Recommendations

Figure 18: Time organization during the workshop

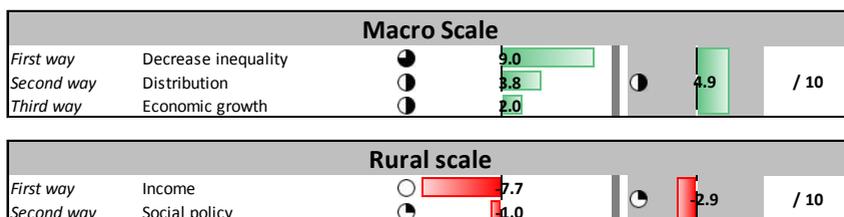


Figure 19: Scoring calculator for the pyramids

2.4 Outputs from the workshop

In terms of time

Many discussions were held within each group. So, not all the groups achieved the work of scoring the change. One group performed the assessment of the reference state only. In general, time devoted to the exercise was not enough.

In terms of filling in the pyramid

All the groups used the bricks of the pyramid to put rough information (mainly taken from the sustainability report) and to gather it in a meaningful way. The different groups found the same information and allocated it to the same brick.

In terms of interpretation

Nevertheless, the interpretation of the information was diverse, depending on the group, and depending on how they have deepened the topic. Some group decided not to take for granted the data provided by the sustainability report, and to fine-tune their interpretation thanks to other opinions (often contrary to the report views). One group deemed that the sustainability report was not detailed enough.

In terms of scoring

When the groups performed scoring, it was different from one group to another, because of the different interpretations attributed to the same information.

Conclusion

The pyramids are ways of implementing the new social metric, which is "human health" of the general population, and of the rural households. They only reflect the works of the Commission on Social Determinants of Health. This commission has been set up by the World Health Organization to propose new approach of public health by social determinants, rather than by the sanitary ones. When filled in from case studies, the pyramids gather information either about the diagnostic of one life-cycle (then, comparisons between cases are delicate), or about the analysis of changes. This latter case, when comparing projects regarding the same value chain, is relevant. As displayed in this chapter, it is possible to weight the different bricks. Nevertheless, when the information reported in one given brick alone is contradictory, the comparison of situations is very delicate.

The exercise highlights the issue of completion of information. During the workshop, few documents are provided (because of time frame). In real-life practice, it is mandatory to gather as many documents and sources as possible, and to cross many sources of information. Doing so, the team can achieve the "completion" of the case (it means that any new source of information would not provide new insights). When completion and crossing of data are achieved, the disparity of interpretations decreases, even if there is always room for the subjectivity of researchers.

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10 The Preston pathway

Wealth and health

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To sum up

In this chapter, we present a pathway linking economic activity and population health state, usable in Social Life Cycle Assessment to assess a social impact. From the general idea, we present the statistic relationship, named the Preston relationship, and the arguments to use it as a pathway to calculate a social impact. We notify how to implement this relation with social LCA perspective. Then we discuss strengths and weaknesses of this pathway.

Outlook

1. General idea
2. Preston relationship
3. From macro (econometrics) to micro (social LCA)
4. The limitations

1. General idea

Changes in health status are very important experiences for people. Even if human health is multifactorial, there are strong empirical and historical evidences suggesting that increased economic activity leads to improvements in the health of population.

Based on the preliminary works of Norris (2006) and Hutchins and Sutherland (2008), the general idea is:

- if there is a **positive effect** of growing economic activity on population health in a given country,
- **if one sector** (gathering farms, workshops or companies) contributes to this growing economic activity,
- then we suggest that the functioning of this sector, generating local added value, could **contribute to health improvement** for population.

Provided that some conditions are fulfilled, it is possible to explain and predict past and future effects on the health of a given population, by studying long-term changes in economic activity of such a sector.

2. The Preston relationship

2.1 The Preston curve and the variables involved

The relationship between health and wealth has been first proposed by Preston in 1975, linking life expectancy at birth (LEX) with real per capita income (GDP) at a given time. He studied this relationship thanks to a cross-section analysis for the first decade of the nineteenth century, the thirties and the sixties.

The proxy for health is Life expectancy at birth (LEX), because it has been demonstrated that there is a strong correlation between LEX and healthy life expectancy meaning the number of years that may be lived in good health, based on data from 192 countries collected in 2002 (Canning, 2010).

Wealth is estimated thanks to the GDP/capita because it is not possible to calculate the overall individual income. GDP is expressed in "Purchasing Power Parity" in order to compare countries.

The basic empirical relationship may be expressed by the following equation:

$$\ln LEX_i = \alpha + \beta \ln (\text{GDP per capita}_i) + \varepsilon_i$$

Constant
Coefficient of regression
Error term

As illustrated by figure 1, countries with a low GDP/capita have low life expectancy, whereas countries with a high GDP/capita have high life expectancy. Nevertheless many questions are still pending.

2.2 Are the good variables here and is it the right direction?

The effect of income on health is open to question such as "Is income really important to improve health?". It has been demonstrated that variables such as women education, institutional and political systems, clean water and sanitation, or religious background have a role to play in the improvement of health (Filmer and Pritchett, 1999; Pritchett and Viarengo, 2010), but income still remains a major variable. Actually, from a historical perspective, it has been demonstrated that before 1870, LEX was similar among all countries at around 40 years old (Bloom and Canning, 2000). Since

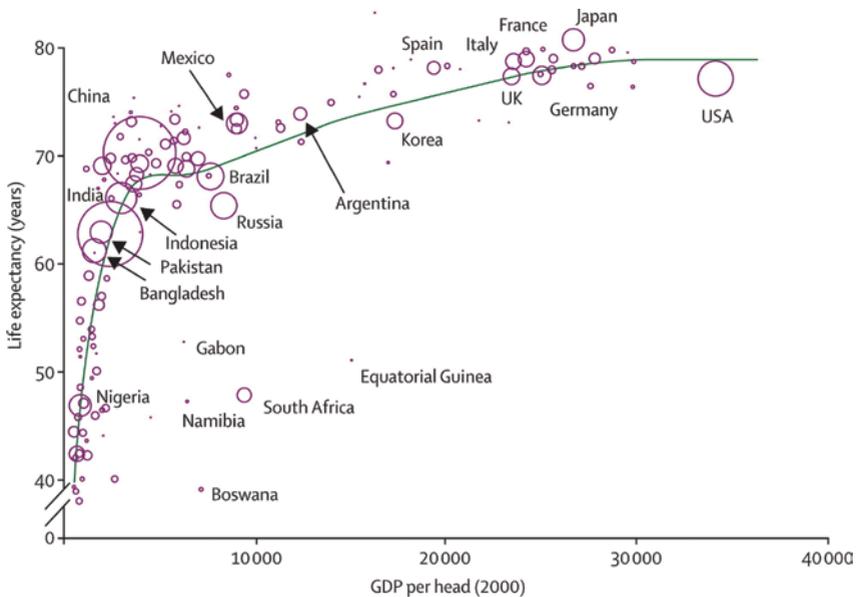


Figure 1: The Preston curve for 2004 (from Deaton, 2004)

then, LEX has increased quickly in rich countries, whereas it has taken more time for poor countries. Significant improvements began after 1930 only.

Regarding the concave aspect of the curve, Deaton (2007) provides a dynamic reading of it: *"On the left of the graph, among the poorest countries, small changes in income are associated with large increases in life expectancy. [...] Among the rich countries, on the right of the graph [...], increases in income are associated with smaller, but still positive, increases in life expectancy."*

Even if figure 1 might be interpreted as: "there is an impact of income on health", the reverse relationship might be valid too. For example, healthier workers may have a better productivity, or healthier children can attend school and improve their cognitive abilities. This reverse effect exists but it is not so important compared to the other relation from income to health. All the studies which have tried to take into account this reverse effect led to strengthen the Preston relationship!

2.3 Is the relationship valid?

Some authors question the validity of the relationship, because they face some "counter-examples", like Russia, China, side by side with Costa Rica and Tunisia (countries that did not experienced the same economic growth but have similar LEX).

For example, in 1970, a little Tunisian girl had a LEX of 55 years, whereas the Chinese girl's LEX was 63 years. Since then, economic growth in China has been high (about 8% per year) contrary to that of Tunisia (about 3% per year). In 2010 the LEX in Tunisia was 76 years, whereas it was 75 years in China.

These results might be explained by the statistical methods in use (see figure 2), since most of the studies used **cross-section analysis**, focusing on a group of countries at one point in time or different points in time but taken separately. This approach does not provide a dynamic analysis of individual behaviours. It does not give a representation of the trajectory of the country.

We performed our own calculations using a different statistic method with **panel data**, merging **cross-section** and **time series analysis**. We analysed a group of 146 countries during 60 periods, from 1950 to 2009. This method allowed us to consider the trajectory of each country along time and the potential heterogeneity between countries. Thanks to the size of the sample (about 8 760 data), uncertainties were very low.

Considering the first statistic methods (cross section analysis), R^2 was about 0.80, differing slightly depending on the studies. It is very high!

In our case, R^2 is about 0.68. It is still very high, meaning that the relationship is strong for a group of countries and for one country alone over time!

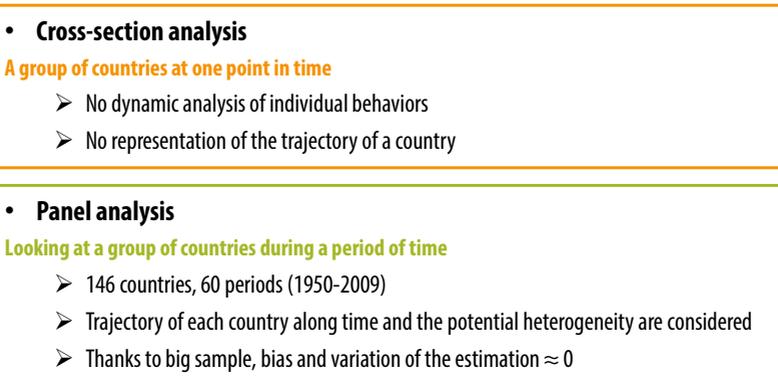


Figure 2: Comparing the analysis methods

2.4 Can we predict an impact?

The idea of social LCA is to predict social impacts due to a change in the system. We wonder if the Preston relationship can be useful to predict an impact, that is to say: if there is a variation of income, is LEX affected?

Some authors answer "no in general" because even if there is a strong correlation between the level of national income and the level of average LEX, there is no correlation between economic growth (variation in national income) and immediate variation in health.

One explanation might be related to the non-linear aspect of the relationship, and to the time lag to observe an effect in the overall population. It is not immediate.

Thanks to a co-integration analysis, we found that there is causality between changes in income and changes in health, but it is very low, due to the time-lag. Thanks to an **impulse response analysis**, we found that this time lag is about four years.

In line with these results, some authors say "yes it is possible to predict an impact on LEX, but only for poor countries and if the economic activity is long enough". As an illustration, Angus Deaton, the Nobel Prize in 2015 for his work related to income poverty and well-being, wrote: "Income poverty and health poverty are positively correlated, and those who suffer from material deprivations are also those who suffer from health deprivations" (Deaton, 2007).

In addition, Easterly (1999), dealing with impacts of economic growth upon quality of life, demonstrated that one of the important parameters to consider, is the duration and the regularity of the growth.

3. From macro (econometrics) to micro (social LCA): how to use Preston in social LCA?

Using the Preston pathway in social LCA is tricky, because it implies to downscale the macro-scale relationship (at national level) to the micro-scale (the company level) (see figure 3).

Indeed, the idea is to attribute one part of the variation of LEX to the economic growth of a given sector or company, that is to say to identify the causes of the health effects to the added value generated by a growing sector.

It is a similar approach as the one about "global warming", which is a global effect but related to micro processes.

Of course, the downscaling operation is possible only if some conditions are met.

3.1 The conditions of use

In order to support this downscaling, we suggested that four conditions have to be met before implementing the pathway:

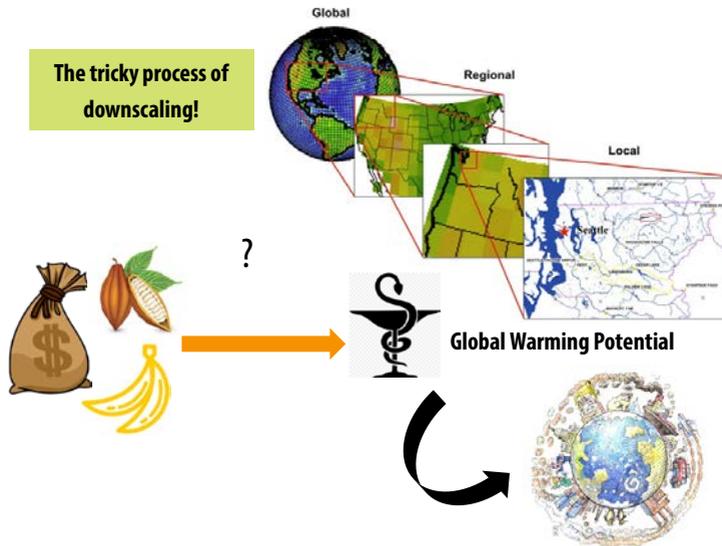


Figure 3: Downscaling process in environmental and social LCA

- the sector under scrutiny (part of the product chain) has to be located into a country where the initial GDP is less than 10 000 \$/capita;
- the duration of the activity has to be long enough and regular to observe a significant statistic change. Thanks to an impulse response function we calculated that at minimum four years are necessary to observe an impact of income on LEX;
- the system under scrutiny needs to have a relevant weight into the national economy (more than 1% of the GDP) and/or a strong influence (e.g. lobbying);
- a correlated condition is the distribution among the population to insure that the value added is not captured abroad or by few persons. Wages and local expenditures have to represent more than 60% of the value added created.

As usual, absolute results have no meaning. It is necessary to interpret results in comparison and for the same provided service.

3.2 The steps of the implementation

We make the hypothesis that there is a change in the volume of production in country A during ten years. The different steps of the calculation are gathered in the figure 4.

It will certainly cause a change in the added value generated, whose only a part will stay inside the country, affecting the national GDP through the repartition between

the different sectors of the economy. Thanks to I/O tables and technical coefficients, it is possible to calculate the repartition among economic sectors and the effects on national economy. Gains or losses in life expectancy are calculated applying the Preston relationship in variation.

Hypothesis

Change in the volume of production in country A during 10 years

1. Change in the value added generated
 - **National vs. Abroad value added**
2. Change in national GDP
 - **Repartition between sectors of the economy (I/O tables, technical coefficients)**
3. Change in life expectancy
 - **Implementation of Preston relationship**

Results expressed in days or years won/lost for the national population

Figure 4: The different steps for using the Preston pathway

4. The limitations

As a conclusion, the panel-based relationship may be used under appropriate conditions to explain or to predict the change in potential LEX generated by a change in economic activity. The resulting Preston pathway is an attempt to contribute to a framework for social LCA, consistent with the LCA philosophy developed thus far in environmental sciences. However, some issues deserve to be discussed more deeply, and some others have not yet been addressed.

One source of uncertainty comes from the lack of precision of some data sources of international figures. It would have been preferable to use real income and real health levels (but we do not know them) in order to take into account informal income or unearned income for example, which are very important aspects in developing countries.

Conditions of use are very important and can be improved or adapted according to the context. For example, it is not necessary to calculate precisely the repartition of local added-value through wages if most of the activity is handled by poor smallholders.

Life Cycle Assessment is based on the concept of potential impact, so it is misleading to interpret estimated LEX in itself. It is useful only **in a comparative perspective** between two value chains or two sectors, providing the same service.

Finally, it is absolutely necessary to consider this impact pathway as a **part of a multi criteria framework** including other pathways at the same scale, such as the pathway developed by Bocoum et al. (2015), and including pathways from other scales, in particular to highlight potential impact transfer.

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11 The Wilkinson pathway

Income inequalities and health

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To sum up

Following the approach developed in environmental LCA, we propose to build formalized relationships based on cause-consequence logic, in order to predict potential socioeconomic impacts under certain conditions. The Wilkinson pathway assesses the potential effects of a given change in the "production step" of the life cycle, upon infant mortality, through growth of income inequalities.

Outlook

1. Origin and justification
2. Functioning of the pathway and required data
3. Pros and cons of the method
4. Example of application
5. Conditions and precautions of use

Conclusions

1. Origin and justification

To assess and compare social impacts of life cycles, there are several alternatives. It is possible to ask experts (Sironen et al., 2013) or different groups of actors, for their opinion regarding the likely social impacts of different scenarios. Another possibility is to gather information from actors immersed in the life cycle, or who have just experienced the changes. We can ask them about how they feel and what they attribute to the life cycle. However, if the goal is to implement a generic and flexible approach that is fairly able to compare different scenarios in different contexts, then the solution is elsewhere.

Following the approach developed in environmental LCA, we propose to build formalized relationships based on cause-consequence logic, in order to predict potential socioeconomic impacts under certain conditions. The literature on social LCA (i.e. Parent et al., 2010) calls this approach the "impact pathway" approach.

The Wilkinson pathway (figure 1), like the Preston pathway developed by Feschet et al. (2012), is an example of what a generic cause-consequence relationship can be in social LCA. Named after Richard Wilkinson – a British social epidemiologist who worked extensively on the relationship between wealth inequalities and health – it assesses the potential effects of a change in the "production step" of the life cycle on infant mortality.

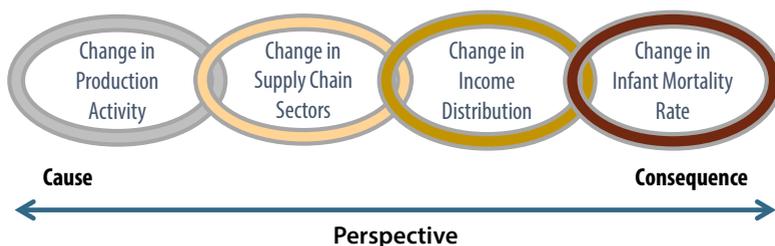


Figure 1: Illustration of the Wilkinson pathway

For decades, wealth inequalities – within and between several regions of the world – have been increasing (Genevey et al., 2013; Picketty, 2013), expanding social problems in the society. One issue that has recently been under scrutiny concerns the damages caused to population health through various materialistic and psychosocial mechanisms (Biggs et al. 2010; Yang et al., 2012; Qi, 2012).

What are the immediate and fundamental socioeconomic drivers of health problems and how different economic activities increase or decrease them, is mainly a concern of policy makers at different levels (province, district, region, country, etc.). It is also – or can be a concern – of big organizations such as multinational companies.

As a life cycle impact assessment tool, the Wilkinson pathway facilitates decision making through the comparison of different scenarios. It becomes perfectly relevant when a government or a big company has to choose between two investment scenarios.

2. Functioning of the pathway and required data

The Wilkinson pathway draws upon Input-Output tables (IOT), key sectorial indicators such as labour productivity and average wages, as well as econometrically tested relations, to predict the effects of a production activity on population health. The figure 2 depicts the whole process.

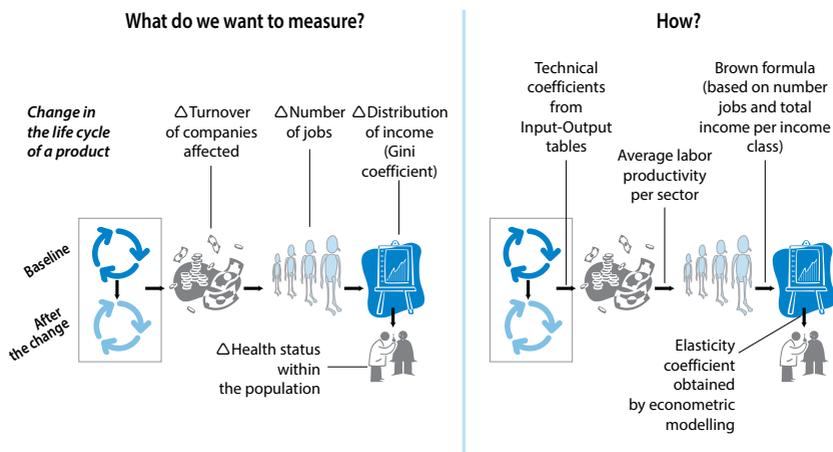


Figure 2: Process of the Wilkinson pathway (source: Bocoum et al., 2014, page 138)

2.1. Effects of a production variation on turnovers and number of jobs in the supply sectors

An IOT is a snapshot of the monetary economic flows between different sectors or subsectors of the economy. The ratios between one sector's consumptions from the other sectors and its total production, also called "technical coefficients", are used to calculate the indirect economic effects of a change in one sector on the supply sectors, in terms of turnover variations.

Concretely, the turnover variations in the supply sectors are obtained by multiplying the amount of the change under scrutiny by the technical coefficient corresponding to each sector.

Considering all else equal, the turnover variations will induce a variation in the number of wage earners. An estimation of the number of jobs created or destroyed is obtained by dividing the turnover variations by each sector's average labour productivity.

These indirect variations (turnover and number of jobs) should be added to the variations within the company in which the production variation occurs.

2.2. Global effects on income inequality

Income inequality is measured through the Gini coefficient, which sizes up the degree of income concentration within the population. Usually, the Gini coefficient is calculated thanks to the following formula:

$$G = 1 - \sum_{i=1}^n (X_i - X_{i-1}) (Y_i + Y_{i+1})$$

Where X represents the cumulative percentages of the population, Y the cumulative percentages of the overall income and n is the number of income classes.

The above-mentioned variations of the number of jobs and their distribution within different income classes are used to calculate the ex-post income inequality index, which can thereafter be compared to the initial one, in order to quantify the variation.

2.3. Global impact on population health

The variation of income inequality is related to the variation of population health status (infant mortality rate in our case), by using the elasticity coefficients obtained from former econometric analyses. An elasticity coefficient represents the percentage of variation of one variable resulting from a one percent variation of another variable.

Given the differences between developing countries and developed countries (described in Wilkinson, 1996)¹, one elasticity coefficient has been calculated for each type of country. **We found:**

- (1) an elasticity of 1 with a time lag of 14 years for OECD² countries,**
- (2) and an elasticity of 0.5 with a time lag of 16 years for the other countries.**
(Bocoum et al., 2015)

These effects are however never directly observed, since it is assumed that all other factors remain constant, which never happens in reality. We actually estimated the relationship for a constant Gross Domestic Product (GDP) per capita, which itself is highly correlated with other determinants of the population health status (education, public health services, number of physicians, etc.).

Finally, the time lags represent the delay between the moment a shock occurs and the moment when the consequences are observed. The rather long time lags that have been measured are consistent with the above-mentioned complex mechanisms through which income inequality creates health problems.

3. Pros and cons of the method

The table 1 sums up the advantages and the drawbacks of the methods used to elaborate the Wilkinson pathway.

¹ Income inequality is supposed to affect population health more in developed countries than in developing countries. In less developed countries, what matters more is people average income.

² Organisation for Economic Cooperation and Development.

	Input-Output analysis to assess how supply chain sectors are interconnected	Econometric modelling to assess the inequality-health relationship
Pros	<ul style="list-style-type: none"> In the absence of actual data on the activities of companies and their suppliers, IOT data remain the most relevant. Technical coefficients are easily calculable wherever IOT are available. 	<ul style="list-style-type: none"> Dynamic models that have been performed, are relevant to show causality. The results are used to predict potential impacts of a variation in income inequality, on infant mortality (under the assumption that all else remains equal).
Cons	<ul style="list-style-type: none"> Using directly the technical coefficients inferred from IOT supposes constant returns to scale (i.e. the amount of inputs required for the production of one extra unit of a product, is constant). Any change in price or technology of production also affects the relationship between production factor and total production. 	Average relationships between income inequality and infant mortality (after controlling for variations of GDP) are used. This is a bit simplistic, but wherever a better assessment of such relationship exists, one can use it instead.

Table 1: Pros & cons of the method

4. Example of application

We consider the case of a big company in the food, beverage and tobacco sector which has an annual turnover of 1 billion euros. The company is intending to outsource its activities from country A to country B. Its decision depends on several factors, among which the potential socioeconomic consequences on population.

We assume the following background information (table 2). To simplify, the economy of each country consists of nine main sectors. The technical coefficients characterizing the relationships between the sectors, as well as the productivity ratios and average wages, vary across the two countries.

The table 3 shows the distribution of the workforce across different salary classes, before any change. The planned change is that the company leaves country A, in favour of country B.

From the equation described in § 2.2, the table 3 allows us calculating the value G_0 of the Gini coefficient (**before change**). The economic consequences of the change modify the repartition of the workforce across the different salary classes. From this new repartition, we can calculate the new value G_1 of the Gini coefficient (**after change**).

	Country A (OECD member)			Country B (non-OECD member)		
	Tech. Coef.	Apparent productivity ratio	Average net monthly wage	Tech. Coef.	Apparent productivity ratio	Average net monthly wage
Agriculture, forestry, fishing	30	65 000	1 500	35	80 000	500
Manufacture of food, beverage, and tobacco	10	60 000	1 600	5	70 000	600
Manufacture of pulp, paper, printing and publishing	3	70 000	1 800	5	75 000	650
Manufacture of rubber and plastics	3	68 000	1 600	5	70 000	800
Supply of electricity, gas and water	3	156 000	2 600	7	200 000	1 050
Wholesale and retail sales	8	65 000	2 600	5	100 000	1 050
Transport and storage	2	65 000	1 600	5	68 000	600
Finance and insurance	2	140 000	7 500	4	200 000	3 500
Other service activities	5	100 000	2 600	1	98 000	1 050

Table 2: Extract of IOT tables for country A and for country B

Monthly wage	Workforce (millions)	
	Country A	Country B
0	3.00	3.00
[500 ; 1 500]	5.00	7.00
[1 500 ; 2 500]	4.00	2.00
[2 500 ; 5 500]	0.75	0.75
[5 500 ; 10 000]	0.20	0.15
[10 000 ; 100 000]	0.05	0.01
Total	13.00	12.91

Table 3: Workforce distribution across different salary classes, before change

Using these background data and applying the methods and calculations presented in the previous section, the following results – summarized by the figure 3 – are obtained.

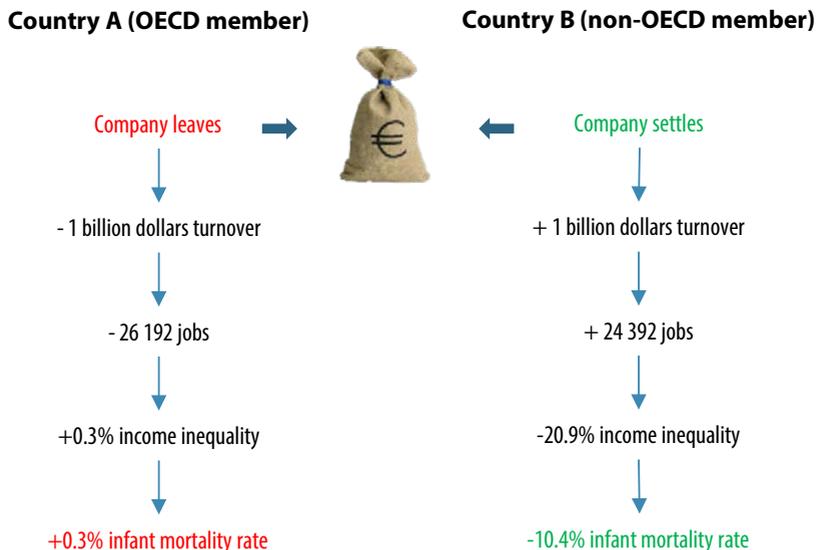


Figure 3: Synthesis of the consequences of the change

The fact that the company leaves Country A leads to negative effects in this country A. All else being equal, 26 192 people find themselves unemployed, leading in this specific case to a potential increase of 0.3%, both in income inequality and in infant mortality rate (after time lag).

On the other hand, the country B in which the company set-up, enjoys several advantages. All else being equal, 24 392 new jobs are created, reducing unemployment, as well as decreasing income inequality by 20.9%, and infant mortality rate by 10.4% (after time lag).

Even though the health impacts on population are probably not the only decisive factor for the company, the results of such a comparison between the two countries will certainly help in its decision making process.

5. Conditions and precautions of use

Overall, the Wilkinson pathway could be applied to assess and compare marginal impacts of different scenarios of production, even though these impacts can be very low at the scale of the entire population. However, it is foremost useful for the impact assessment of activities that have a significant economic weight.

The conditions of use of the pathway mainly depend on the availability of data, such as Input-Output tables and context-relevant information on the income-health relationship.

Depending on the availability of Input-Output tables, this type of assessment is possible at either national or regional level. The relationships (1) and (2) between income inequality and infant mortality are valuable at national level only. They deliver the value of the Gini coefficient approximately expected after controlling for average GDP per capita. Nevertheless, the extent to which GDP per capita captures the effects of other health determinants may vary across countries. Further research is in progress to quantify income inequality-health relationship at the regional level.

The more Input-Output tables are disaggregated and income inequality-health relationships are context specific, the more the impacts assessed are specific. However, since the goal is not to analyse impacts in absolute terms but to compare alternatives using the same methods and tools, the lack of extreme precision is not really an issue. What in contrast is extremely valuable while using the impact pathway approach, **is the capacity to build generic impact assessment methods**. The generic method can therefore be handled easily, while providing fairly accurate information for comparisons. Otherwise, one would have to undertake time-consuming and pricey studies each time a decision has to be made!

The Wilkinson pathway cannot in any way be a unique tool of decision making, since it is designed to measure certain effects only. Production activities have other positive and negative socioeconomic consequences, which can add to the effects assessed by the Wilkinson pathway. That is why it is important to develop other pathways that deal with other relevant issues for our societies.

To conclude, we underline that calculations of an impact pathway can be tedious manually, especially when dealing with actual data. Hopefully, the impact assessment process can be facilitated by software of data management including automatic functions. For example, with the Excel® spreadsheets we started building an impact calculator based on a simplified economy including only few sectors. This is another story...

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12 The Siegrist pathway

Work conditions and health Anticipating psychosocial factors effects in the agro-food sector

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To sum up

People at work face a variety of organizational constraints (night work, atypical work schedules, etc.) and psychological constraints (control and pace of work), which can cause damages to health. The purpose of the Siegrist Pathway is to explain the cause-effect mechanisms between work conditions and health, to allow us anticipating damage to health of workers (involved in the life cycle) caused by poor working conditions.

Outlook

Introduction

1. State of the art in human and social sciences and theoretical framework in business administration science
2. Methodology
3. Results
4. Implementation in social LCA
5. Limits and conclusions in social LCA

References

Sitography

Introduction

People at work face a variety of risks due to chemicals, physical factors, unfavourable ergonomic conditions, and numerous psychosocial factors (Concha-Barrientos et al., 2004). Over the past 30 years, chemical risks have been widely discussed and regulated, and physical constraints have been declining in many trades, due to mechanization and automation of tasks. However, organizational constraints (night

work, atypical work schedules, isolated work, temporary work, subcontracting, etc.) and psychological constraints (control and pace of work, style of management, internal violence at work) tend to increase. These constraints are likely to generate Psychosocial Risks Factors (PRF) that are sources of illness at work and, at the same time, can reduce well-being at work.

PRF are defined as "mental, physical and social health risks arising from conditions of employment and organizational and relational factors that may interact with mental functioning" (Dares, 2014). The best known PRF are: stress, burnout, bullying and violence at work. PRF, in turn, can lead to pathologies such as depression, psychosomatic illness, sleep problems, as well as musculoskeletal disorders, cardiovascular diseases, and occupational accidents (Ministry of Labour, 2016). In terms of costs, PRF and illness in workplace are important economic issues for business performance. Symptoms of ill health among employees would lead to increased absenteeism at work, health care costs and legal proceedings, and would decrease productivity (Danna and Griffin, 1999).

Preventing damage to health due to working conditions has become one of the objectives of EU and of every member State interested to improve health at work. To go to the source to reduce these problems, we need to establish the causes. The causes are often due to working conditions.

The purpose of the Siegrist Pathway (SP) (figure 1) is to explain the cause-effect mechanisms, to allow us anticipating damage to health of workers (involved in the life cycle) caused by poor working conditions. To date, these working conditions are not dealt with by social LCA (S-LCA). We take into account poor working conditions, and also positive working conditions able to buffer the negative impacts of poor working conditions.

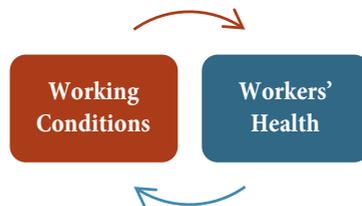


Figure 1: The Siegrist Pathway

To trace the cause-effect chains, it is mandatory to analyse theories which question about working conditions, PRF and health at work. Indeed they provide new explanations for phenomena that have been misunderstood to date, and they are essential for identifying intervention targets and guiding the development of intervention measures (Siegrist and Dragano, 2008).

In the next paragraphs, we illustrate the qualitative methodology carried out in business administration science (§ 2), the results of its application (§ 3), the application

in the social LCA context (§ 4) and we conclude with the limits and future perspectives about the Siegrist pathway (§ 5). First of all, we present the actual state of the art in human and social sciences literature, and the theoretical framework adopted (§ 1).

1. State of the art in human and social sciences and theoretical framework in business administration science

Although many models exist in literature and in different disciplines, it is the so-called psychological approach that has developed the greatest number of contributions about workplace illness. These models explain the relationship between working conditions and work-related stress.

In particular, three different currents stand out (they are summarized in table 1):

	Interactional Theories	Transactional Theories	Resources Theories
Scope	Consider the causal mechanism of an individual's interactions with his/her environment.	Examine the active efforts of the individual to cope with his/her experiences of stress, through such processes as cognitive appraisal.	Psychological stress occurs: when individual's resources are threatened with loss, when individual's resources are lost, and when individuals fail to gain resources following investment of other resources.
Authors	Karasek et Theorell (1979), French et al. (1982)	Lazarus (1984), Siegrist (1996)	Hobfoll (1989, 2001), Demerouti et al. (2001)

Table 1: Most important theories about working conditions and PRF

Among transactional theories, we find the famous "Effort-Reward Imbalance Model" (ERI) (figure 2) originally formulated by Siegrist and colleagues (Siegrist, 1996). The ERI model has received considerable attention in occupational health research, merely due to its predictive power for adverse health and well-being outcomes (cf. van Vegchel et al., 2005). The ERI Model stems from medical sociology and emphasizes both the effort and the reward structure of work (Marmot et al., 2006).

According to the ERI Model, work-related benefits depend upon a reciprocal relationship between efforts and rewards at work. Efforts represent job demands and/or obligations that are imposed on the employee, such as time pressure and working overtime. Occupational rewards distributed by the employer (and by society at large) consist of money, esteem, and job security/career opportunities. More specifically, the ERI Model claims that work characterized by both high efforts and low rewards represents a reciprocity deficit between high "costs" and low "gains", which could elicit negative emotions in exposed employees.

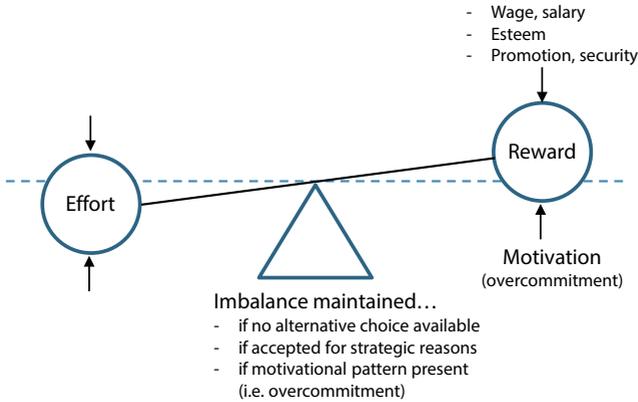


Figure 2: The ERI Model, from Siegrist (1996)

Because it was the first model to explain the imbalance, we have called our pathway after the name of the researcher who developed it.

However, even if this model represents a first attempt, it is not complete. In fact, there are other "rewards" that can be offered to employees. Furthermore, our scope is to understand all poor working conditions, and this model focus only on defined "efforts".

Finally, we decided to focus on the "Job Demands/Resources model" (JD/R) (Demerouti et al., 2001) because it is more capable to take into account many aspects of the workplace. Indeed, the JD-R incorporates a wide range of working conditions into the analyses of organizations and work conditions. Furthermore, instead of focusing only on negative outcome variables (e.g. burnout, ill health, and repetitive strain) the JD-R model includes both negative and positive indicators and outcomes of employees' well-being. The JD-R model can be summarized with a short list of assumptions/premises and is outlined in figure 3.

Whereas every occupation may have its own specific risk factors associated with job stress, these factors can be classified in two general categories: job demands and job resources.

- **Job demands** (figure 4): physical, psychological, social, or organizational aspects of the job, that require sustained physical and/or psychological efforts or skills. Therefore, they are associated with certain physiological and/or psychological costs. Examples are emotional demands, physical demands, and role conflict.
- **Job resources** (figure 5): physical, psychological, social, or organizational aspects of the job that are either functional in achieving work goals; or reduce job demands and the associated physiological and psychological cost; or stimulate personal growth, learning, and development. Examples are: possibilities for learning and development, social support from supervisor, and job control.

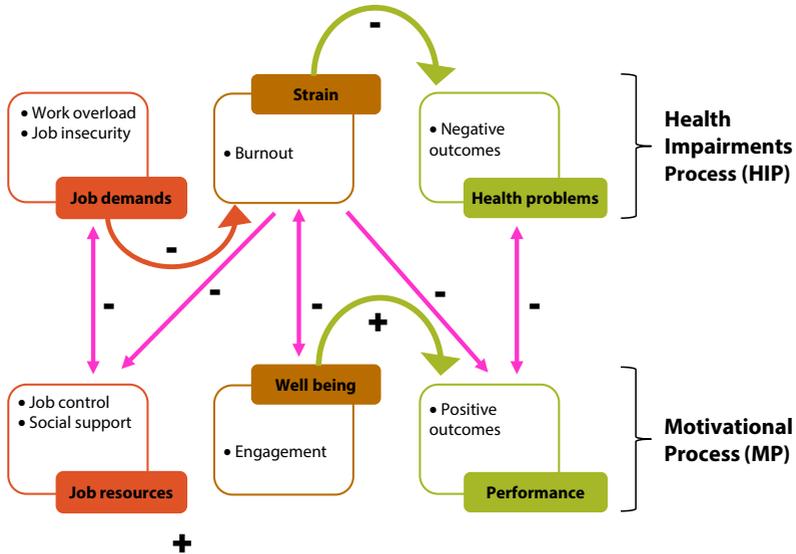


Figure 3: JD-R model, by Schaufeli and Bakker, 2004

Emotional demands:

Are you confronted at your work with situations or events that affect you personally?

Physical demands:

At your work, do you have to lift or move heavy loads?

Role conflict:

How often do you get into arguments with team members at work?

Figure 4: Examples of Job Demands

Possibilities for learning and development:

Social support from supervisor:

My supervisor is helpful in getting the job done

Job control:

Do you have freedom in carrying out your work activities?

Figure 5: Examples of Job Resources

Furthermore, two different underlying psychological processes play a role in the development of job strain and motivation. The first one is the **health impairment process**. Through this process, poorly designed jobs or chronic job demands exhaust employees' mental and physical resources. In turn, this might lead to the depletion of energy and to health problems. The second is the **motivational process**. Through this process, job resources exert their motivating potential and lead to high work engagement, low cynicism, and excellent performance.

The J-DR model was chosen as theoretical framework for the reasons detailed above. How this model has been adapted will be explained in the next section.

2. Methodology

According to our purpose, a case study was implemented in the agro-food industry. The case study was realized in the wine sector, at the French wine group V. This group was born in 2012 after a merger of different companies. The group V. manages two industrial sites (T. and U.) which have the same functions: bottling and selling wine, alcohol-free wine, and fruit juices. Since the group merged, each production site has maintained its own company culture. For example, there are differences regarding weekly working hours, holiday awards, participation rights, or wages. If we find dissimilarities regarding resources, they will not be imputable to the productive systems, because they are identical on the two sites.

For this case study, the qualitative methodology was built in three different steps (figure 6), which are detailed in the following subsections.

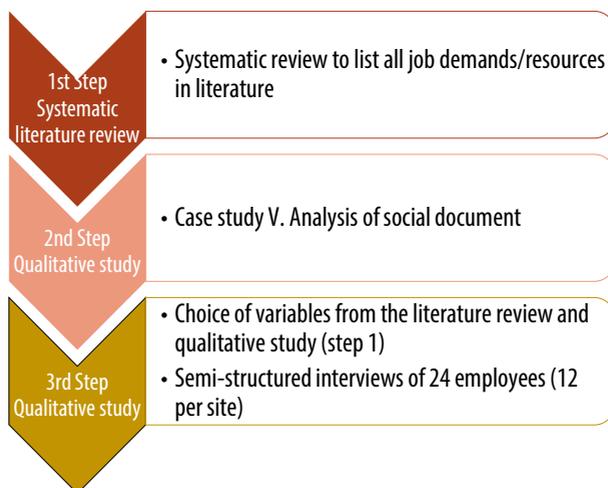


Figure 6: The three steps of the methodology

2.1 Literature review about empirical applications of J-DR model

We conducted a systematic literature review of the empirical studies about the JD-R model, because we wanted to list comprehensively job demands and job resources. We performed the review according to the guidelines of Kitchenam (2007).

All documents (192) were analysed to assess their relevance, whose 169 were selected. From this analysis, we designed a "coding grid" for any document or discourse dealing with resources.

2.2 Analysis of social documents of V.

As mentioned above, we carried out an analysis of the "social documents" of the group V. to find human resources management practices that are supposed to create resources according to the literature. The aim of the analysis was to compare the "resources" obtained by the review of the literature with the resources highlighted in the communication of the group, and further, with the resources deemed important by employees. Several meetings with the head of human resources management of the group V. allowed us to have access to the following social documents, dated from 2011 to 2015:

- social report,
- activity reports,
- single document (document unique) on risk prevention,
- proceedings of joint meetings (EC, CHSCT),
- group newsletter.

The documents were collected at the group level for the social reports, the activity reports and the newsletter, and at the site level for the single document and the proceedings of joint meetings. We analysed the social documents using the coding grid developed thanks to literature review.

2.3 Semi-structured interviews

The last phase was the accomplishment of twenty-four semi-structured interviews. The objective was to classify (from the most important to the less important) job resources, according to feelings of workers. The interviews were carried out in the two industrial sites U. and T. to collect job demands and job resources as workers think of them. We decided to conduct twelve semi-directive interviews per site. We chose semi-structured interviews because they allow the subject to be dealt with by relatively open questions, suggested by a preliminary study on the empirical applications of the JD-R model.

Respondents had the most varied profiles as possible (age, gender, and position) and agreed to be interviewed at the request of the group's human resources manager. The interviews were conducted by two researchers with note-taking and recording.

Subsequently, interviews were completely transcribed. The survey was conducted during the period March to June 2016 (16 interviews). The last interviews were conducted in February 2017.

For each interview, we reported the coding for each resource cited and the number of times the resource was cited. We have divided the resources quoted between the resources already acquired (the employee considers that he/she already got them) and the wished resources (the employee does not have the resource, but he/she wishes to get it). In turn, the resources already acquired can either be quoted spontaneously by the employee, or in response to the direct request of the researcher. It is the same for wished resources. This categorization allows us to distinguish the resources perceived as such by the employees and that they considered important in order to reduce job demands. Indeed, we assumed that resources (acquired or wished) which are the more frequently spontaneously quoted by employees (as offsetting poor job conditions) are the most important resources for them. For this reason, they have more potential to buffer the effect of job demands.

3. Results

This section summarizes the results from literature review (§ 3.1), social documents (§ 3.2) and interviews (§ 3.3).

3.1 Results from literature review

Resource citation rates suggest that – from the perspective of the authors – the resources that deserve to be studied (and therefore the most important ones) would be "superior support", "autonomy at work", "support for colleagues", "challenging work", "professional development" and "learning opportunities". Furthermore, no study exists in the agro-food sector.

3.2 Results from social document analysis

Resources highlighted by the documentary analysis are summarized in table 2. The table shows that the resources communicated by the group V. are for the most part in line with those of the literature. But there are other resources not studied yet, to our knowledge, as "Early-retirement arrangements", "Knowledge transfer", and "Active ageing policies". Are they considered important by the workers also?

3.3 Results from interviews

In group V., the interviews analysis shows that resources considered most important to offset negative effects of poor working conditions, are the same whatever the site and whatever the gender.

Work resources	Company resources	Development resources
Availability of tools	Communication	Career development
Reward and fair pay		Learning opportunities
Job security		Early-retirement arrangements
		Knowledge transfer
		Active ageing policies

Table 2: Resources highlighted from "social documents" analysis

These resources are spontaneously quoted in more than half of interviews. In group V, the important resources are: "tasks variety", "good social climate", "supervisor support", "autonomy at work", and "tools availability". From literature also, these resources are acknowledged as efficient to offset negative effects of poor working conditions.

The following section highlights how these results can be used in the construction of the Siegrist pathway.

4. Implementation in social LCA

First, we must set our hypothesis:

- i) We suggest that the five important resources presented above would be the same in all the activity sectors. In the literature, nothing refutes this pretension. So, until other contradictory studies to be made, we consider this hypothesis as being true.
- ii) We set the hypothesis that the five important resources – when present all together – offset the harmful effects of poor working conditions.
- iii) We set the linked hypothesis that, when they are not balanced by the availability of the five resources, poor working conditions entail pathogenic outputs for employees (see table 3).
- iv) We set the hypothesis that the five important resources are not independent from one another. The principal relationships are depicted in the figure 7.

To build tools for practitioners, we rely on the Demerouti et al. (2001) model, so we call "demands" the potentially harmful working conditions, and "resources" what can offset the harmful effects from the demands. To predict health impacts because of poor working conditions, we handle the matrix whose extract is presented in table 3. Indeed, a previous study (master thesis in sociology of health by Camille Gasnier) has collected relationships between negative PRF and occupational health states. Thanks to a literature review, she built a matrix which relates PRF to the probability a specific disease to occur (table 3). For example, to be subjected to "high job demands" and "low job autonomy" multiply by 1.64 the probability of developing musculoskeletal problems.

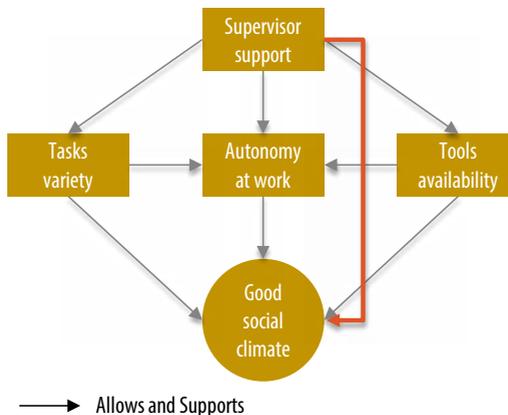


Figure 7: Diagram depicting relationships between the five important resources

	Musculo skeletal disorders	Mental health troubles	Cardiovascular diseases	Cancers
High demand / low control (Karasek)	x 1.64 (Koehoorn, 2006)	x 4.7 (depression) (Tsutsumi, 2001)	x 3.55 (blue collars) (Johnson, 1988) x 1.03 (white collars) (Johnson, 1988)	Negative effect (Légeron, 2003)
Effort/reward imbalance (Siegrist)	Negative effect (Roquelaure, 2006)	x 4.1 (depression) (Tsutsumi, 2001)	x 6.15 (Siegrist, 1996)	
Flexible jobs (fixed-term contracts)		13.7% to 24.6% (depression) (Santin, 2010)	Negative effect (Siegrist, 1996)	x 2 (long unemployment period) (Légeron, 2003)
Flexible work (shift work)	Negative effect (Roquelaure, 2006)	x 2.43 (fatigue) (De Raeve, 2007) x 6.08 (night work more than 4 years → depression) (Bara, 2009)	Negative effect (night work) (Härma, 2006)	x 1.50 (night work → cancer) (Messing, 2000)
Long working hours (>11 h/ days)		x 2.43 (depression) (Virtanen, 2012)	x 3 (infarctus) (Härma, 2003)	

Table 3: Extract of the Matrix gathering relationships between RPS and occupational health (from Gasnier et al., 2013)

When it comes to make diagnosis and to deliver advices about workers health because of working conditions, practitioners face two situations: either the working conditions already exist (§ 4.1) or the working conditions are planned only (§ 4.2). In both cases, we are proposing solutions below to help practitioners to make diagnosis without long and tedious interviews of many workers. Nevertheless, the rapid appraisal tools below are not accurate enough when detailed surveys are needed.

The conditions for use of the Siegrist pathway are the following. It can be implemented in the parts of the life cycle where we can study/plan at least one work organization for at least one hundred employees.

4.1 Already existing working conditions

The Siegrist pathway can be used as a diagnostic tool for one given situation, or can provide a diagnostic about the likely consequences of one past given change. Meeting one relevant expert (e.g. one intermediary manager) is helpful to set the diagnostic.

- When it comes to diagnose one present situation, the practitioner must collect the demands, ticking the ones which are well known psychosocial risks factors (PRF) (examples table 3). He/she has to collect also the availability of the five important resources. From the figure 7, we advise to focus on "good social climate". The cause is not because it is the most important among the five (indeed, we are not able to suggest hierarchy among them). But we think that when the social climate at work is good, it means that the other four resources are available enough. Moreover, the quality of the social climate is quite easy to handle, thanks to figures like rate of absenteeism (social climate of plant A is good if the rate is inferior to the average of the sector of A) and the rate of legal proceedings (social climate is good if law suits are rare). After data collect, practitioners face three cases:
 - **no PRF are present:** the work organization is OK;
 - **PRF are present, but the social climate is good:** the work organization is OK, it does not negatively affect health of workers;
 - **PRF are present and the social climate is defective:** the work organization is defective, and does impair workers' health. It is possible to quantify the impairment thanks to the relationships between PRF and health (table 3).
- When it comes to assess the social impacts of one given past change upon the workers' health, the best practice would be making diagnostic of the working conditions, before and after the change. All else equal, the differences between before and after can be attributed to the change. So the social impacts of the change can be:
 - **nothing**, if the change adds no RPS and no new resources;
 - **favorable**, if the change adds no RPS, but adds new resources, and especially some among the five important ones;

- **unfavorable**, if the change adds RPS and if the resulting social climate is defective. In this case, it is possible to quantify the impairment on workers' health thanks to the relationships between RPS and health (table 3).

4.2 Planed working conditions

It may occur that the change under scrutiny did not occur yet. Either the work place does not exist yet, or the workplace exists but the planed change has not been implemented yet.

- The most difficult situation for planners occurs when the work place does not exist yet, because assessing demands and resources of the work cannot be done directly. The solution is discussing with designers of the future workplace. Then, the objective is wondering if the future demands will entail potential RPS (e.g. long working hours, etc.). If these poor conditions are evitable, it is meaningful to replace them by better work conditions, as soon as possible. Nevertheless, it occurs that some organizations (e.g. hospital, emergency services) cannot avoid certain poor work conditions (e.g. night work, shift work, etc.).

It is less easy to detect the availability of future resources. Nevertheless, some features of the future work conditions – like "tasks variety" and "autonomy at work" – can be assessed from the description of future tasks. Moreover, if there are sound reflections among managers about the real "tools availability", and the "supervisor support", it is more likely that these resources will be mobilized in the future situation.

Then, three cases are at stake:

- **no potential RPS** among the future work demands: it is likely that the future work organization will not be harmful for workers;
 - **potential RPS** among the future work demands, and **no projection of resources creation**: the likelihood of impairment of workers' health is high! It can be quantified from table 3 (example);
 - **potential RPS** among the future work demands, but **projection of resources creation** among the five important resources. It is likely that there is no danger for workers' health.
- Sometimes the workplace still exists, but the change under scrutiny has not been implemented yet. The practitioner faces therefore a case mixing features of several previously presented situations. The goal of the diagnostic is improving the current situation in terms of workers' health, as far as possible. In terms of assessment, the goal is comparing the impacts of different scenarios about work organization. The practitioner must collect data about:
 - the current work demands. Are there potential RPS?

- the future work demands can be deducted from planned work organization. Are they likely prone to generate RPS?
- the current work resources. What about the five ones?
- the future likely new resources, or the development of the present work resources. What about the five ones?

The different possible combinations of the present and future demands and resources, shape table 4.

This table must be read horizontally. For instance, we read that if there are RPS in the present situation, without availability of the five resources (5R), and if the change in work organization introduces new RPS without creating new resources, so the workers' health is at risk, and the future situation will be impairment, in comparison with the present one. For all the cases where the diagnostic is "danger", it is possible to quantify the risks for occupational health, thanks to the matrix (table 3). The calculations might

Present situation			RPS and Resources (5R) changes			
RPS presence	5R presence	Comments about present situation	New RPS created?	New 5 Resources created?	Result	Comments about the new situation/ present one
Yes	Yes	Ok, offsetting	Yes	Yes	ok	offsetting
				No	Ok	impairment
			No	Yes	Ok	improvement
				No	OK	stable
	No	Danger!	Yes	Yes	ok	improvement
				No	Danger!	impairment
			No	Yes	ok	improvement
				No	Danger!	stable
No	Yes	Ok, organizational slack	Yes	Yes	ok	offsetting
				No	ok	impairment
			No	Yes	ok	improvement
				No	ok	stable
	No	Ok, no issue	Yes	Yes	ok	offsetting
				No	Danger!	impairment
			No	Yes	ok	improvement
				No	ok	stable

Table 4: Combinations of the different possibilities regarding demands and resources, in present and future situations

be useful to compare two (or more) planned work organizations, both being identified as dangerous.

The limits will be detailed in the next section.

5. Limits and conclusions in social LCA

The limits of the tool can be summarized in the following assumptions.

First of all, the first limit is the lack of studies for all the sectors. This pathway was developed and tested in the agro-food sector, but we do not know yet if the important resources are the same in other sectors. To capture job demands and resources in other sectors, one should always go to feelings (experienced) of workers. Future research should focus on this issue. In the absence of new knowledge about other sectors, the transfer of relationships from one context to another is a temporary solution.

The impossibility to assess the extent of the compensations between job demands and resources is the second limit. At this moment, we do not know to what extent the important job resources buffer job demands. We only know that interviewed employees consider that the effect of these job resources buffers the effect of job demands. The pathway cannot easily and quickly assess the intensity of job demands and resources. Assessing intensity would claim for extra-survey about workers representations, on the ground.

To conclude, the Siegrist pathway is suitable for diagnostic about present work organization. It is useful also to compare two or more possible work organizations, in order to choose the less pathogenic for the organizations of the life cycle.

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Sitography

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13 The Wesseling pathway

The assessment of farmworkers exposure to pesticides

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Denis Lœillet, *CIRAD, UR GECCO, Univ Montpellier (France)*

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To sum up

The objective of this chapter is presenting the so-called "Wesseling pathway". It consists of relevant data and relationships to calculate comparatively the "human cost of pesticides" for agricultural workers. It is based on expert knowledge.

Outlook

1. Some constraints of the assessment of pesticides health risk
2. Links between cropping systems, pesticides and human health
3. Current methods to discriminate cropping systems thanks to assessment of pesticides impact
4. The Wesseling pathway focus on the exposure level

Conclusions

1. Some constraints of the assessment of pesticides health risk

Assessing the magnitude of health risks from pesticide exposures in the workplace is of the utmost interest. Nevertheless, it is difficult to do for many reasons. Exposures are usually intermittent and pesticide metabolites have a short half-life. Nonetheless, available scientific evidence strongly suggests that pesticides cause cancer and other health damages in both people who use the pesticides directly and people who are exposed because of applications made by others. The problem may well be more extreme in developing countries because regulatory controls are weaker or non-existent, and because safe methods of handling pesticides and safety practices are often lacking.

In this chapter, we explain the reasons for developing a decision support tool to help decision makers. The tool's objective is to classify by anticipation different cropping systems, regarding their impact on farmworkers health. The generic tool would be applicable on the agricultural phase of the life cycle of any agricultural product. To date, we developed only one specific tool for banana plantations. For simplification sake, here we expose results about operators' (workers directly using pesticides) health only.

2. Links between cropping systems, pesticides and Human Health

Damages to operators' health caused by pesticides use are modulated and influenced by many different factors, which can be roughly depicted by the figure 1. To comply with country or market regulations, or because of new company policies (e.g. due to environmental/social labels) or cost reduction, variations can occur in the chain leading to damaging operator's health (figure 1).

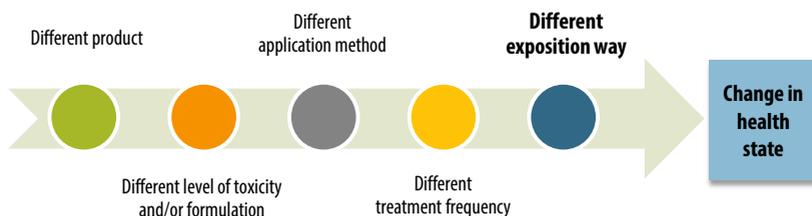


Figure 1: The change in damage to operator's health because of pesticides can have many causes

Consequently, the damage caused by pesticides to one operator's health can be modulated by:

- different levels of toxicity;
- different formulations, which may change the way of exposure (e.g. if one switch from liquid to powder, the exposure can evolve from a principal dermal exposure to a principal inhaling exposure);
- different application methods (when changing from aerial to terrestrial application, the level of exposure changes too);
- different treatment frequency. The more the treatment is frequent, the more the operator is liable to be exposed;
- different changes of exposure way (for instance from inhaling exposure to dermal exposure, with different quantities);
- etc.

The modulating factors are not independent. For instance, changing the product will consequently likely change the product formulation, which would lead to modification of the application technique, which entails a variation of level and exposure way.

If methods are able to discriminate cropping systems according to these different criteria, they are able to account for damage to operator's health because of pesticides.

3. Current methods to discriminate cropping systems thanks to assessment of pesticides impact

There are different current evaluation methods liable to contribute to the purpose of anticipating health state. A literature analysis highlights that they can be sorted out between two principal groups:

- Environmental-Life Cycle Impact Assessment (E-LCIA) methods,
- Risk Assessment (RA) methods.

3.1 E-LCIA methods

To date, E-LCIA methods are not designed to address health damages to certain target populations. In general, the target experiencing health damage in an "average human being". E-LCIA methods focus on the quantity of toxic substance emitted in different "environmental compartments" (like air, ground water, etc.).

E-LCIA methods are able to discriminate between different cropping systems relying on differences (table 1) in:

- **dose and treatment frequency**, because the total quantity of pesticide in use is taken into account in the inventory data of E-LCIA, as being the unitary dose per treatment x the number of treatments per year;
- **pesticide toxicity**, when the pesticide is present in the ELCA databases.

The advantage of E-LCIA methods is that they do not need other data than the ones in use to assess other environmental impacts.

Regarding the assessment of human cost of pesticides for operators' health, there are many drawbacks of E-LCA methods:

- in general, there is little consensus on the calculation of the impact "Human Health" in E-LCA. Especially the calculation of toxicity is challenging. The UseTox 1.0 method has tried to build a consensus;
- these methods have a limited validity for all regions that cannot be defined as well-developed temperate regions (Goedkoop et al. 2009, 5). Indeed, these methods are developed in Europe for the Europe itself, inasmuch they use European

Considered	Not considered
Dose	Dermal exposure
Treatments frequency	Tropical pathosystem
Pesticide toxicity (if the product is present in databases) !!	Application technique variation
	Cultivation system variation

Table 1: Synthesis of issues considered or not considered in E-LCIA

normalisation values (Goedkoop and Spriensma 2001; Guinée et al. 2002; Hauschild and Potting 2005);

- in the E-LCIA method, the main exposure way is inhalation, while the field exposure studies have shown that in the workplace, the main route of exposure is dermal exposure (Inserm 2013);
- E-LCIA does not consider the effects of the variation in the application technique.

Consequently, it is a necessity to search for another method allowing to quantify the "human cost of pesticides" for operators.

3.2 Risk Assessment

In Risk Assessment, distinction is made between acute and chronic toxicity. They are not evaluated with the same methods, given their radically different nature.

- In general, the assessment criteria for chronic toxicity are carcinogenicity, genotoxicity, endocrinal perturbation, reproduction perturbation and development perturbation.
- In general, the assessment criteria for acute toxicity are: DL₅₀ oral (mg/kg), DL₅₀ dermal (mg/kg), CL₅₀ inhalation (mg/l), dermal irritation, ocular irritation, sensitization.

In Risk Assessment, known chronic and acute toxicity of the substance may be combined in the same calculation (e.g. in figure 2) with other criteria. The result of the mathematical formula (figure 2) is a figure, which stands for the value of the impact of the active substance (IRSA active substance).

IRSA active substance = IRTas x FPF x FCP x FPa

IRTas = [acute toxicity + (chronic toxicity x persistence factor)]²

FPF = weighting factor on formulation of commercial product

FCP = weighting factor on dose applied

FPa = adjustment factor on application technique

Figure 2: Example of Equation for Risk assessment

The value of the impact for the product in use (e.g. pesticide) is the total of the different active substances included in the formulation.

$$IRSA_{product} = \sum IRSA_{as}$$

To highlight the factors influencing the results from Risk Assessment, we take the example of the equation developed by Mghirbi et al. (2015) to assess the Health Risk Indicator for Operators (*Indicateur de Risque Santé Appicateur, IRSA*). In this approach, changes in formulation, dose and application techniques, entail changes in the result of the equation. Indeed:

- if the product applied changes, then all parts of the equation will change;
- if the application technique changes while keeping the same product, consequently it will change the adjustment factor FP_a , and possibly the applied dose (which modifies the value for FCP);
- if only the formulation is different, it will change FP_f at least;
- if there is variation of the cultivation system, and if we assume it entails a variation of application techniques or formulation or products, we turn back to the cases above.

Theoretically, the IRSA equation is able to assess the variations of impacts between different pesticides. Nevertheless, the construction of the equation can be criticized from different points of view.

- 1) First of all, by squaring the factor (IRT_a s) standing for toxicity, IRSA equation gives primacy to substance toxicity. Moreover, the other terms of the equation are only weighting or adjustment factors. The equation therefore addresses health impacts through mainly toxicity of the substance. Nevertheless, on the practical side, there is some evidence that workers behave differently regarding the toxicity of the pesticide at hand. They lower their level of exposure when they think that the pesticide is very toxic, and they increase their level of exposure when they deem the pesticide not to be dangerous. So, toxicity cannot be the unique principal factor taken into account when assessing health risks for workers.
- 2) Chronic toxicity assessment is more difficult and inaccurate than acute toxicity assessment. There may be an underestimation of the chronic toxicity (if you are not aware of the disease/risk, you do not care/there is no prevention).
- 3) Regarding the weighting factor to account for the formulation issue (FP_f) it is not clear how to calculate it. It is based on Samuel et al. (2012). At page 5 of the report there is a table (table 4) stating that the more severe exposition route is the inhalation one, despite in the field of pesticides, the worst way of exposure is dermal contact.

- 4) Analysing the adjustment factor on application technique (FPa), we deem that it is insufficient to take application technique into account only through an adjustment factor. Indeed, we know that many bad practices occur because of certain application techniques. This factor would deserve more accurate details.

In general, the model was created keeping the idea in mind that toxicity is the more important factor to evaluate.

Whatever the case, in the field of pesticides, **the real exposure is the major subject to investigate** (and consequently the application technique).

3.3 Synthesis

Regarding the damages caused by pesticides use to operators' health, Risk Assessment focus to different level of toxicity and/or different formulations, while E-LCIA focus on the assessment of different quantities of spread pesticides.

We therefore seek to complement these approaches by the Wesseling pathway, whose aim is to assess the **change in the operator's exposure way**, due to changes in the previously mentioned variables.

The figure 3 provides a synthetic picture of the principal factors highlighted by the three methods.

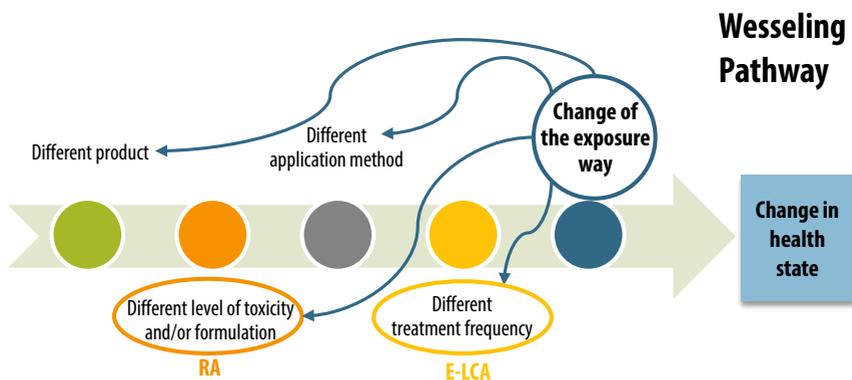


Figure 3: Different methods address different factors

4. The Wesseling pathway focus on the exposure level

Since the current methods do not allow to consider the actual practices on the ground, we propose a model that considers practices and which is usable to anticipate future impacts.

We took as object of study the **case of banana farmed to exportation**. Banana is the most commercialized fruit in the world. Moreover, the economies of several developing countries are dependent from this crop.

We based our work on experts (of banana plantations) elicitation. Indeed, to date, it is the only one way to account for the real practices on the ground. Expert elicitation refers to a systematic approach to synthesize subjective judgments of experts about one issue, when there is uncertainty due to insufficient data, or when such data are unattainable because of physical constraints or lack of resources.

We applied expert elicitation through a Delphi expert consensus method. The collected interviews testimony that – under some particular working conditions (e.g. heat and humidity) – the exposure risk becomes very high, because the use of personal protective equipment (PPE) is thwarted by the working conditions.

4.1 Knowledge trees

From the interviews, we designed knowledge trees. The aim was creating several cause/effect chains (one is represented by the figure 4) relating each cropping action that entails use of chemicals (mainly pesticides and fertilizers) to the potential health damage caused by acute toxicity.

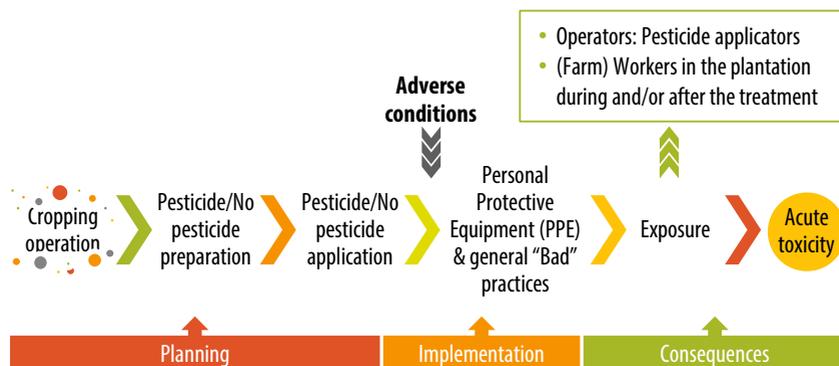


Figure 4: Generic drawing of one cause-effect relationship between one cropping operation and the potential health damage caused by acute toxicity

Exposure can occur through the preparation and application techniques of chemicals (e.g. pesticides), or during the cleaning step.

Thanks to the experts' interviews, we were able to relate the different situations with application techniques, and workers behaviours concerning PPE when they practice pesticide application. All these practices impact on the health of three populations at least: operators, farmworkers working in the plantation during the treatment, and farmworkers entering the field after the treatment.

4.2 "Human cost of pesticides" equations

For one cropping action

Starting from the knowledge trees, we built "human cost" equations for the three farmworkers' population affected. **The main contribution of experts is providing the w_j (degree of operators exposure) terms for diverse conditions.** The general equation allowing to calculate the average human cost of pesticides for operators **for one cropping action** is depicted as below:

$$\text{Human cost}_{\text{operators}} \text{ for one action} = \left(\sum_{j=1}^3 k_j N_j w_j \frac{1}{\text{AOEL}_j} \right)$$

with:

- j means one among three tasks: preparation, application or cleaning;
- k_j represents the number of operators involved in this task;
- N_j denotes the number of times the task is repeated, under the same conditions, on the perimeter of the space-time computation;
- **w_j reflects the degree of operator exposure, and is found out in the knowledge trees based on a specific task at a specific point of the production system, and for certain conditions;**
- $1/\text{AOEL}_j$ stands for the toxicity of the product used in the task j .

For several cropping actions

The calculation of pesticide human cost can be achieved following temporal and spatial aggregations of several "costs of one cropping action":

- for the entire lifespan of a plantation (5-30 years);
- for the cycle corresponding to a single crop (9 months to 12 months in routine);
- for all transactions for a year on a routine plantation (about 52 crops per year);
- by parcel, per hectare, or per any area of the plantation.

Interpretation of the results of pesticide human cost calculations should be done only by comparing at least two scenarios implemented with the same temporal and spatial scales. Indeed, the result of a calculation alone is meaningless in the absolute.

4.3 Usage of equations for social LCA

The method is useful to compare different cultivation systems for the same crop, or to compare systems for different crops.

Given two cropping systems (1 and 2) for the same crop, and that could be implemented in the same place (e.g. convenient soil and climatic conditions), we can calculate their respective "human cost". Here, the cropping system 1 is the currently implemented one. It is our baseline system.

$$\begin{array}{ccc} \text{Cropping system}_1 & & \text{Cropping system}_2 \\ \downarrow & & \downarrow \\ \text{Human cost}_1 & - & \text{Human cost}_2 \\ & = & \\ & \pm \text{ impact} & \end{array}$$

The difference between the two "human costs" (human cost 2 – human cost 1) provides the health impact of the change when replacing the cropping system 1 (the baseline) by the cropping system 2.

For instance, if the change is caused by change in the variety of the crop (which entails many consequences in terms of cropping system), the difference (human cost 2 – human cost 1) is the change in human cost caused by the change in the variety.

Conclusions

To conclude, the **strengths of the method** are that it is based on the real (and sometimes "bad") practices implemented in the plantations. All necessary data can be simply gathered. Moreover, the collect of data concerning the quantity of pesticide to which workers are exposed (which is especially difficult to capture) is not mandatory. The wj factor stemming from experts elicitation already takes this information into account.

Nevertheless, the Wesseling pathway is a simplified model of reality.

The Wesseling pathway is currently implemented for banana, but could be adapted to other agricultural products also.

We named this pathway from the name of Dr. Catherina Wesseling (see Wesseling et al. 1993) who spent her life to investigate health damage because of pesticides, with special attention paid to workers in banana plantation in Costa Rica.

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14 Asking questions and combining various sources of knowledge

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To sum up

This chapter briefly discusses weaknesses of usual social LCA studies, to underpin the interest to perform comprehensive and fair study of the context. Yet, it turns back to the "capacities" framework, for displaying all the results gained from the survey to the backers.

Outlook

Introduction

1. Feedbacks on the weaknesses of LCA studies
2. The analysis of the context
3. Information and actors
4. The framework of capacities articulated in a multiple capital model (MCM)
5. Others articulations in the multiple capital model (MCM)

Conclusion

Introduction

The CEP (Centre d'Etudes de Projets) is an association of researchers and teachers specialized in economic assessment. Since 1986, the CEP has developed and tested many assessment protocols to improve economic assessment knowledge. Since 2010, the CEP has worked on the testing of the "multiple capitals model" and on "capacities" assessment.

In this chapter, we stand for one analyst, in charge of the social LCA study. Very often, the issue at stake is comparing the social consequences of the business-as-usual scenario, with the social consequences of implementing a change, in the same context.

1. Feedbacks on the weaknesses of LCA studies

The feedbacks about social LCA (studies, reviews, research programs) help us to identify the potential weaknesses of social LCA studies:

- poor explanations of the objectives,
- forgetting or excluding bodies in the stakeholders' board,
- inadequate definition of the perimeter,
- inadequate definition of the functional unit,
- incomplete description of the "filière".

To avoid the problems and their harmful consequences on the results of the survey, we need to perform a real analysis of the context.

2. The analysis of the context

The analyst must perform analysis of the context. The goals of context analysis are answering the four questions:

- Who are the real stakeholders?
- What is the scope of the filière?
- What are the other scopes we must take into account?
- What is the functional unit ?
- So what do we really study?

Who are the real stakeholders?

Most of the time, one thinks that the stakeholders are identified before the start of the survey. The stakeholders would be all the organizations who have designed the project! Unfortunately, it is not the case. The real stakeholders are all the actors standing for all the organizations and people affected by – or who are affecting – the project. So, there are many groups of actors performing the same function in the system (e.g. suppliers, state administration, etc.). As it is not possible to ask for all the actors, the analyst selects actors standing for stakeholders. He/she tries to find at least one actor representing each group of stakeholders.

The analyst must answer all these questions with all the actors concerned, directly and indirectly, about the project under scrutiny:

- Who orders the study?
- Who defines the goals?
- Who are the actors concerned by the activity studied?
- Who defines which stakeholders are taken into consideration?

What is the scope of the filière?

This step of the social LCA assessment needs to gather all the free data available to describe the **material exchanges** between the actors concerned by the product or the service under scrutiny.

The second step is to identify the **economic and financial flows** associated with technical flows.

The result of the analysis is the chart of the filière (an example is provided figure 1). It is very important to define the cut-off criteria to design the perimeter. We can consider that all the actors marginally affected by the project (for example, for less than 3% of their businesses) are outside the perimeter. But all the actors who adapt their strategy depending on the project, even marginally, must be set inside the perimeter.

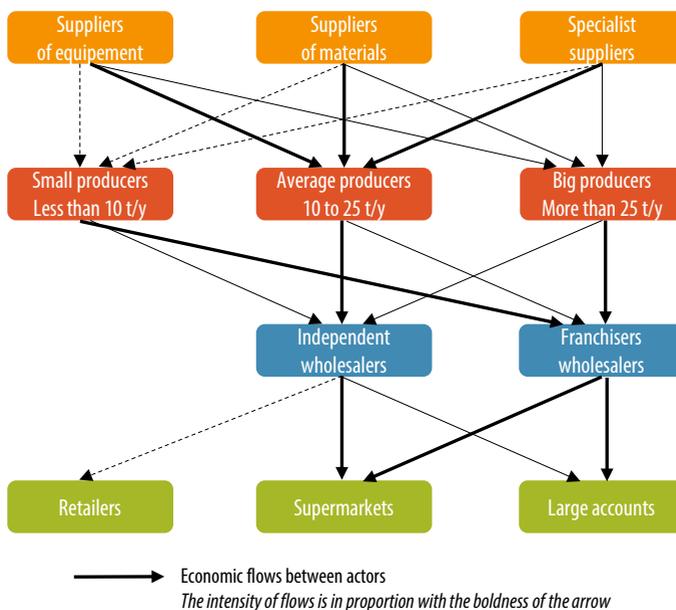


Figure 1: Example of flow chart of the filière (source: Gillet & Loeillet, 2013, page 121)

What are the other scopes we must take into account?

To perform a social LCA study, the analyst has to handle the scope of the project appreciated thanks to three concepts:

- the filière,
- the life cycle of the product,
- the value chain of the activity.

To take into account the social and economic effects and impacts of the project under scrutiny, we also need to define and cross other perimeters:

- the perimeter of social effects and impacts,
- the perimeter of economic effects and impacts,
- the perimeter of environmental effects and impacts,
- the political scope,
- the administrative perimeter, etc.

The scope finally chosen results from these comparative approaches.

What is the functional unit?

Very often, one "functional unit" is chosen a priori. The analyst checks the relevance and the consistency of the functional unit choice, before starting works. Taking into consideration the whole system (along the filière), he/she asks:

- How many co-products are produced with the main product/service?
- Is the business model based on the functional unit, or on the co-products, or both?
- Is the functional unit a product or a portion of a product ?

Depending on the answers, the analyst can recommend to the backers changes about the chosen functional unit.

We cannot perform social LCA study without data provided by the stakeholders.

"No economic information, no social LCA".

The two levers of power are information and money.

3. Information and actors

Before meeting stakeholders, the analyst collects public information and free/open data. The figure 2 sums up the main sources of external information.

The results of the first data treatment help the analyst to prepare one first short questionnaire. The analyst will meet all the actors involved in the project, to fill in this questionnaire.

The meetings give the opportunity to present the survey, its objectives and means. First meetings help us to test the potential participation, implication, commitment and undertaking of each actor. It is also the mean to test their potential perplexity or trouble.

The comprehensive questionnaire focuses on the project, the employees and the organizations directly involved. It is designed on the basis of the results of the first questionnaire.

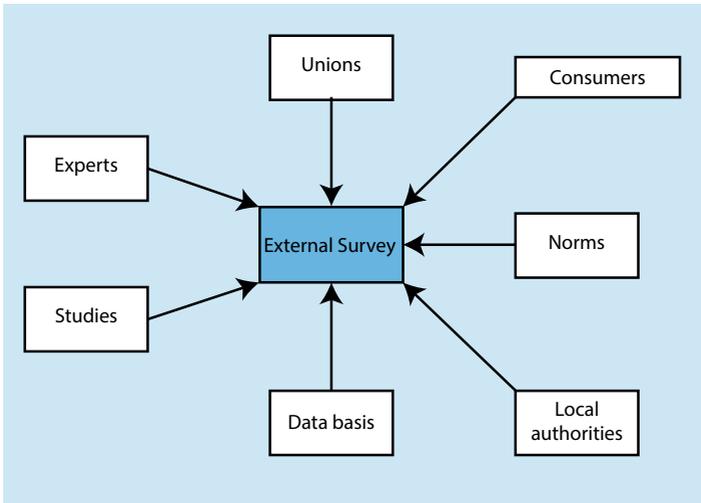


Figure 2: Main sources of external information (source: Garrabé & Feschet, 2013, page 98)

In the next section, we handle the issue of the final analysis of results, in order to prepare restitution to backers.

4. The framework of capacities articulated in a multiple capital model (MCM)

What is the principle of the "Multiple Capitals Model"?

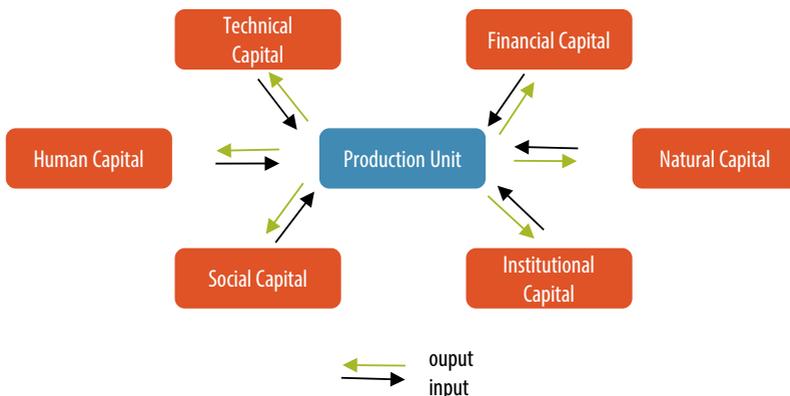


Figure 3: Contribution of Capitals to one "production unit" (source: Feschet & Garrabé, 2011)

We consider that a production unit does not use two inputs (labour + capital) only, but potentially six inputs (figure 3 and table 1):

- Natural capital,
- Technical capital,
- Financial capital,
- Human capital,
- Social capital,
- Institutional capital.

The Capabilities model, which addresses individual "functioning", may be articulated with the MCM, which is a model for development, as depicted by the figure 4.

Capital	Definition	Contains (for example)
Natural	All stocks and flows of natural resources.	Soil, surface water, ground water, air, landscape, biodiversity (wildlife & flora), natural environments...
Technical	All physical stocks and flows used directly and indirectly for production.	Companies, infrastructures, information, market, public administration, induced effects...
Financial	All monetary stocks and flows used to finance directly and indirectly a specific activity.	Grant, equity, investment, credit...
Human	Labor and all factors linked to working conditions.	Training, working conditions, health, security, parity (men/women)...
Social	All the consequences (for society) of links developed by people and / or organizations for a specific activity.	Justice, participation, confidence / trust, social integration, social networks...
Institutional	All the consequences (for society) of laws, rules, norms and labels used or developed for a specific activity	Property / ownership, competition, contracts / agreements, social disputes, norms / labels...

Table 1: Definitions and examples of the six types of Capitals

The framework of capacities

Michel Garrabé and Pauline Feschet have proposed an extension of the capabilities concept developed by Amartya Sen to all capitals. The capability concept by Sen is based on the human capital alone. To underpin the difference with Sen's works, we do not speak about "capabilities" but we use the term of "capacities". To implement the capacity approach in a specific context, we must identify and assess:

- endowments,
- use function,
- functioning achievements.

These elements must be assessed in two situations: if the project is implemented, and if the project is not implemented (business-as-usual). The differences highlight the effects/impacts of the project in this context.

Sub-capital items might be chosen by the stakeholders, experts or by both. But the analyst must notify the conditions to make the choice, at the beginning of the survey.

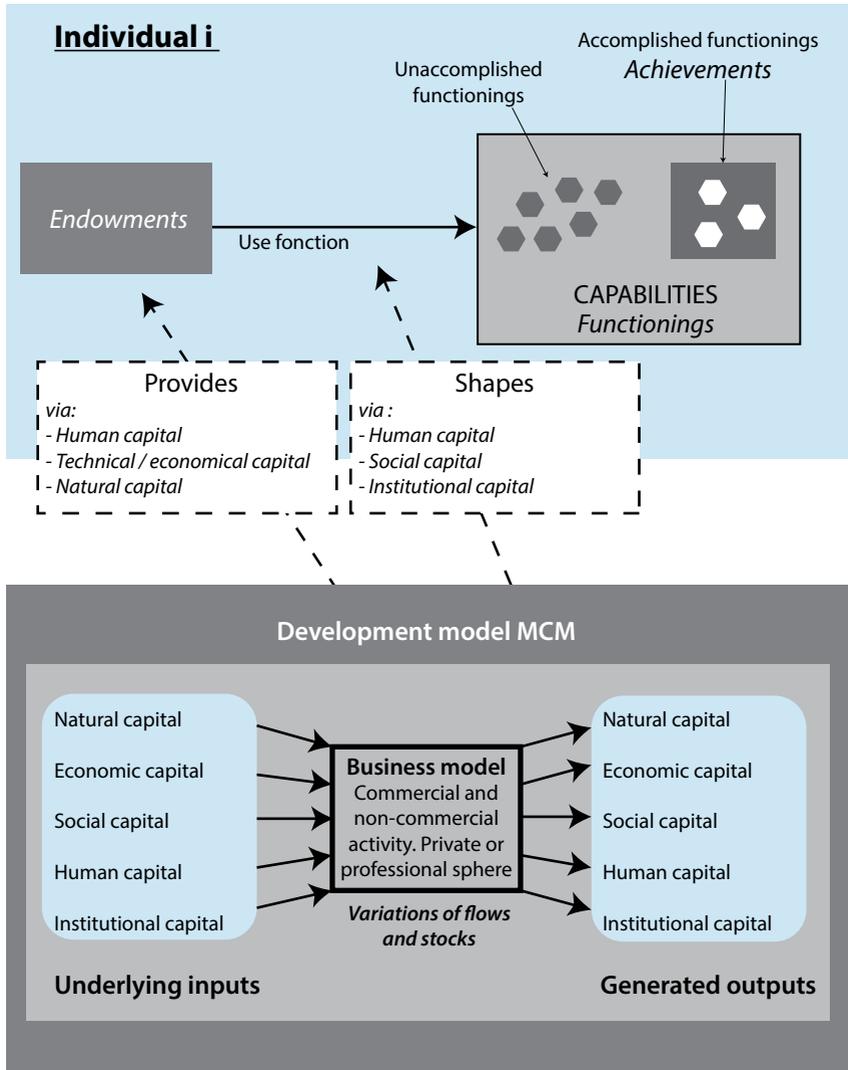


Figure 4: Articulations between the Capabilities and the MCM (source: Feschet & Garrabé, 2013, page 82)

When one implements both E-LCA and social-LCA, one can use the E-LCA items to define some parts of the "natural capital".

The capacities assessment implementation needs to respect, step by step, all the phases:

- identification of classes and subclasses capital,
- identification of potential capacity effects classes,
- identification of potential capacity effects conditions indicators,
- identification and collection of internal information,
- identification and collection of external information,
- diagnosis of effects of **potential capacity variations**,
- estimated **variations of potential capacity effects** (effective or potential capacity marginal effects),
- change analysis of potential capacity effects to real capacity effects.

The most difficult point is to identify "potential capacity" variations. Then, the analyst will measure potential or effective capacity marginal effects. The assessment must screen the direct cause and effect link due to the project. Very often, a given effect alone results from many causes. So, we are not able to isolate the contribution of each cause on the given effect.

5. Others articulations in the multiple capital model (MCM)

For many stakeholders (especially private bodies), talking about **social effects and impacts** is often taboo. Nevertheless, assessing social effects and impacts is still possible thanks to "classical" economic approaches.

For example, a usual way to discuss about working conditions or decent wages is to calculate and to analyse the added value generated and distributed along the value chain. Without questioning the stakeholders about social criteria, you can assess the effects of the project on:

- wages, typology positions, and you can identify the typology of employees (men, women, and children), etc.,
- social contributions or social actions,
- local taxes,
- local investments, potential benefits (EBITDA analysis).

To overcome social taboos of the filière, the analyst must also listen to many and various employees of the value chain concerned by the project.

At the end of 1990's, the CEP developed a specific methodology assessing incomes and employment effects of projects at meso-economic scale. This tool fits well in the

assessment of changes with a filière approach. The figure 5 displays the different steps of the assessment tool.

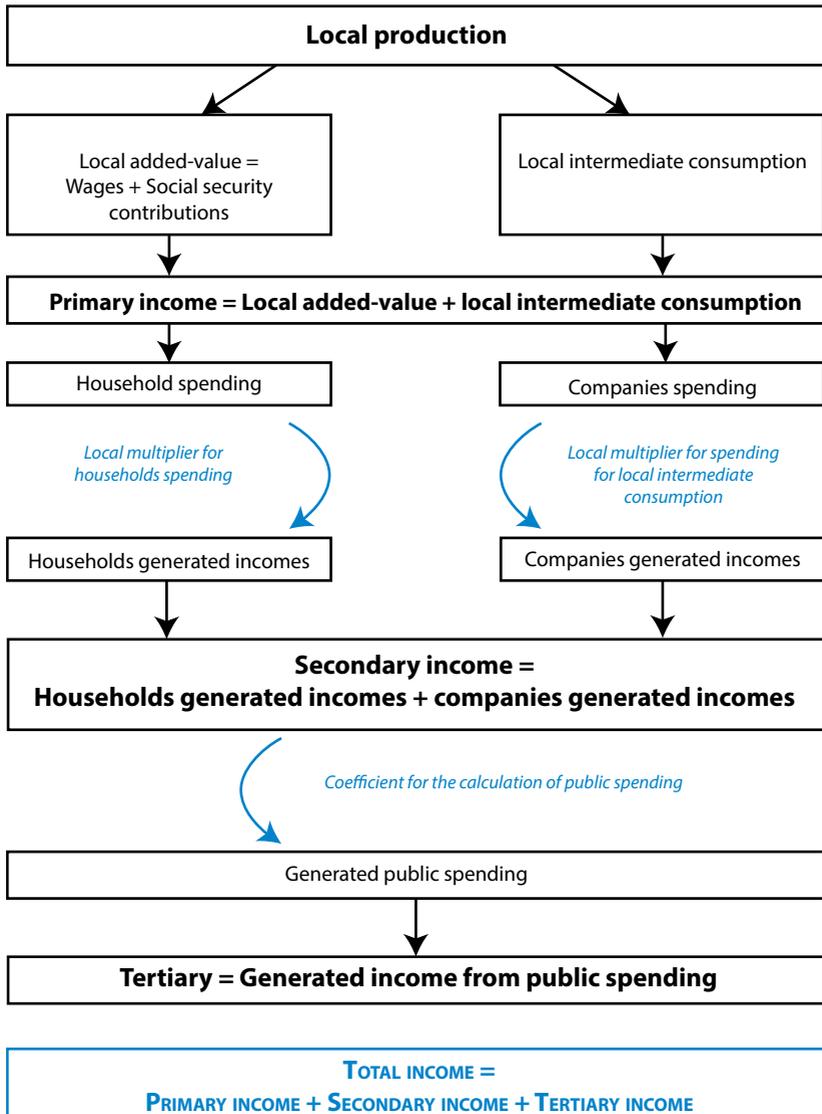


Figure 5: Method of regional multipliers of supply and demand (source: Gillet & Loeillet, 2013, page 132)

The capacities model is a specific business perception of sustainable development. A cost benefit analysis is welcome to complement this approach.

At the end of the analysis, a specific retreatment allows understanding how each actor consumes and creates different capitals (stocks and flows), all along the filière, during the product's life cycle (figure 6).

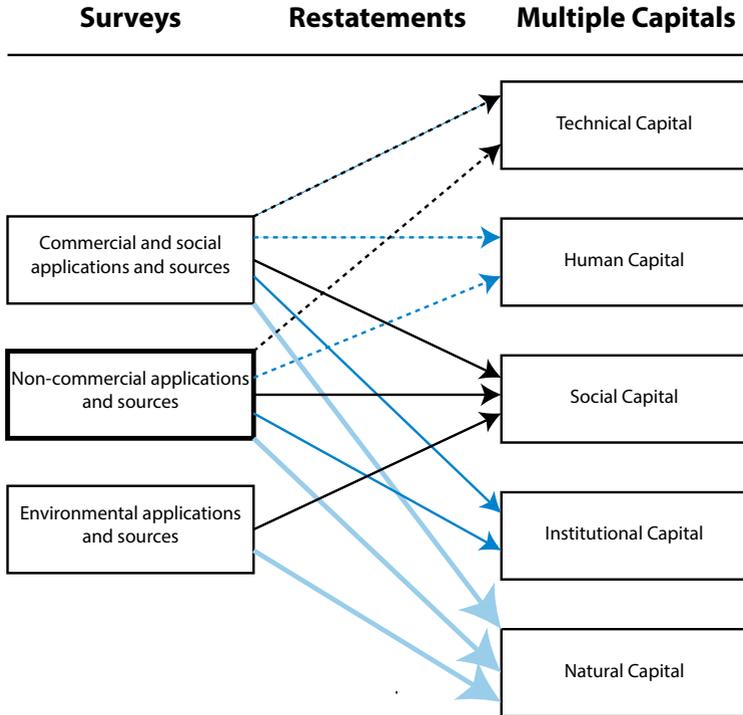


Figure 6: Restatement of the data reported by surveys in the capital accounts
(source: Gillet & Loeillet, 2013, page 134)

Conclusion

"MCM with capacities approach" and "MCM and classical economic approaches" are solutions to assess social effects and impacts in a specific context, and at micro- or meso-economic level. Carrying social LCA study requires large amount of information that stakeholders can help us to gather. The quality of social LCA survey depends on the quality of information. Taking into account the point of view of all the actors involved in the project is of the utmost importance.

In conclusion, an interactive approach with the real stakeholders allows us:

- to structure and to clarify the decision-making process,
- to facilitate the access to data and resources,
- to ensure greater acceptance of results by all the actors involved in the project.

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15 Mobilizing stakeholders to anticipate impacts

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To sum up

From the literature review performed by Mathé (2014), we explain the objectives of implementing participatory methods in the framework of social LCA studies. We focus on the "Principles, Impacts, Indicators" method, and briefly present three case studies.

Outlook

Introduction

1. The objectives of participatory approaches in LCA
2. Principles, Impacts, indicators (PII): a five-steps participatory approach
3. Case studies
4. Advantages, limits and perspectives of participatory approaches in social LCA

Conclusions

Introduction

From the literature review performed by Mathé (2014) emerged different fields of theoretical research concerning the nature and the integration of stakeholders in social LCA.

First, involving stakeholders meets the necessity of addressing sustainability issues, which are complex and context-related. Moreover, complexity has to be considered also in the context of firm paradigm evolution. In recent years, the firm has extended its boundaries, and consequently, has extended the range of actors to be considered.

Another sphere of interest is the stakeholder engagement to balance the incomplete information and incomplete knowledge provided by research.

Evolution of the evaluation paradigm

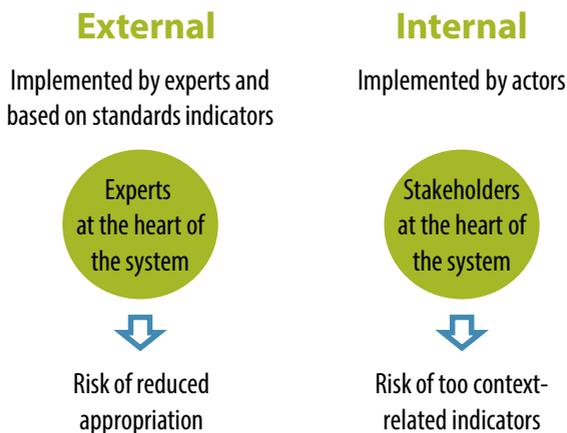


Figure 1: Comparison of external and internal evaluation

In addition, there is also an evolution of the **evaluation paradigm**. At first, the assessment was implemented by experts and based on standards indicators (**external evaluation**). In more recent years, **internal evaluation** has been promoted to encourage the involvement of affected stakeholders. The figure 1 highlights the main differences between both kinds of evaluation.

1. The objectives of participatory approaches in LCA

Usually, the objective of implementing participatory approaches is to **develop democratic practices**:

- by promoting expression and communication by interest groups,
- by considering all the interests,
- by building consensus to facilitate the implementation of sustainable development (Dalal Clayton and Bass 2002).

The quality of the participatory arrangements and the quality of the organization determine the quality of the results (Rowe and Frewer 2000). The quality of the participatory arrangements influences the credibility of the procedures, through the representativeness and the transparency of the process, and through independence of the participants.

Here, the quality of the organization is understood as:

- free access to resources for stakeholders,
- clear definition of roles,
- adequate structure and clarity of the decision-making process,
- cost effectiveness.

Moreover, the **choice of stakeholders** is crucial, especially in order to avoid technocratic participation (Rosenström and Kyllönen 2007).

In Life Cycle Thinking (LCT) stakeholders can be sorted into four groups, as depicted in the figure 2:

- 1) LCA method users,
- 2) LCA result users,
- 3) victims or beneficiaries of impacts,
- 4) actors in the definition of either the types of relevant impacts or – more generally – of the LCA methodology.

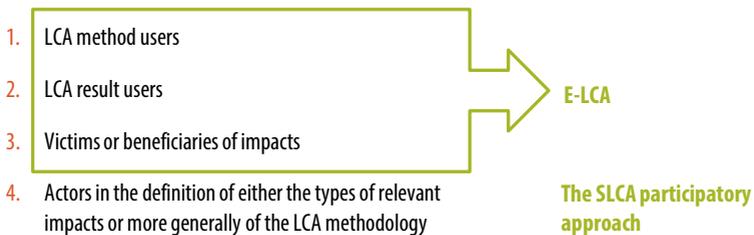


Figure 2: Different groups of stakeholders in Life Cycle Thinking

The first three groups are typical of Environmental-Life Cycle Assessment (E-LCA), while the group 4 of stakeholders is the **core target of the social LCA participatory approach**. More accurately, it requires the stakeholders' participation in the evaluation scheme development (definition of principles, of the nature of impacts to be assessed and of the indicators). This involvement has multiple functions.

2. Principles, impacts, indicators (PII): a five-steps participatory approach

In this chapter, we present the participatory approach implemented in our researches. The figure 3 sums up the five-step participatory approach used to select social

principles, impacts, and indicators, in order to contribute to social LCA development. We start from one process we want to study.

Step 1: it is the step of the selection of stakeholders, presenting the three following features:

- they have an impact on the process or they are impacted by the process (it is close to current LCA approaches, insofar as the stakeholders affected by the production process are considered);
- they have legitimacy to be involved in the process (that implies the search of representatives of interest groups);
- when stakeholders are all together, the range of opinions is complete (that integrates the diversity of social representations in order to incorporate different interests and values).

Step 2: it is the step for collecting data and reviewing the literature on social aspects. Data collection is based on interviews with stakeholders about their representations of the social aspects of the activity concerned. The data are analysed to reveal the social principles and impacts which are the most significant for stakeholders. The method is original as it integrates a bottom-up approach through the interviews, with a top-down approach that complements the interviews results, thanks to significant principles emerging from international conventions and literature on well-being.

Step 3: in the third step, the bottom-up and the top-down approaches are consolidated by a working group gathering social LCA practitioners from different disciplines (socioeconomics, agronomy, ecology) which enabled an "exhaustive" list of social principles and impacts to be developed. The literature review and the consolidation are also undertaken at indicator level.

Step 4: during the fourth step, the list of social principles and impacts is discussed within stakeholder focus groups, so that it could be adapted to the studied context.

Step 5: the fifth step comprises two parts:

- a literature review of social indicators and databases provides a list of existing and available data;
- the literature review allows the researchers to choose indicators according to selected impacts.

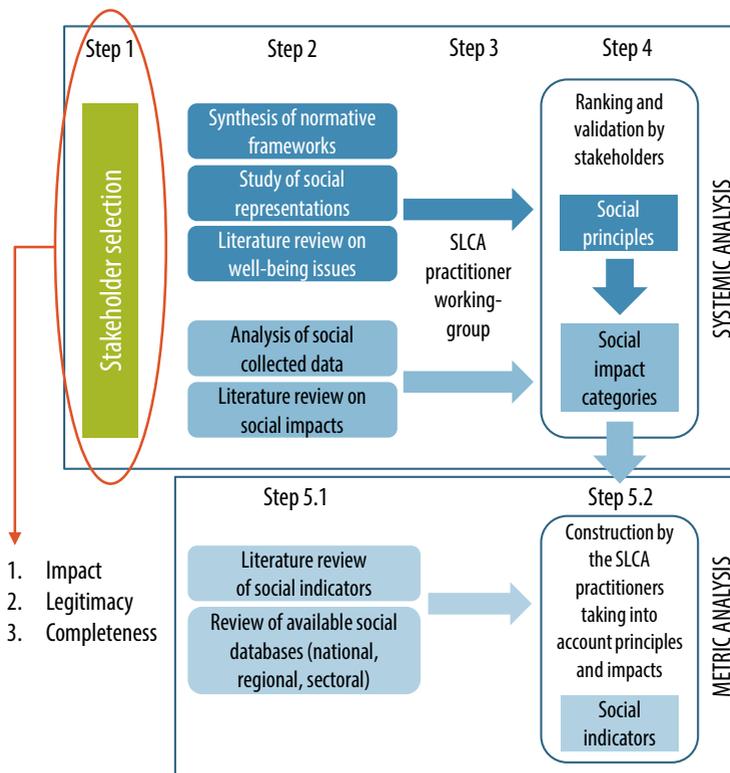


Figure 3: Sum up of the PII method for stakeholders participation

3. Case studies

Here we are presenting the results of three case studies, which (more or less) apply the PII method within social LCA studies.

3.1 Palm oil biodiesel in Jambi Province of Indonesia

The case study implemented by Manik et al. (2013) aims to investigate the social implications of the existence of the value chain of palm oil biodiesel, via a case study using a life cycle assessment framework, in Jambi Province of Indonesia.

In the inventory phase, Manik et al. (2013) made a survey among experts and decision makers to define the relevant social sustainability criteria. Experts and stakeholders were involved also in weighting and gauging phases. The whole design of the method is depicted in figure 4.

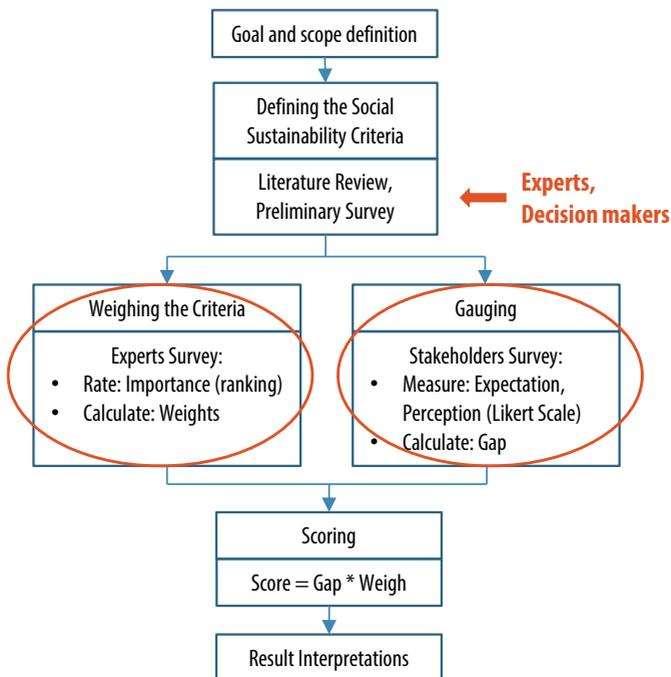


Figure 4: Design of the method for the case study "Palm oil biodiesel in Jambi Province of Indonesia" (source: Manik et al., 2013)

3.2 Clementine farming in Southern Italy

This research addresses the issue of the impacts of migrant workers' presence in the South of Italy (they are mainly involved in citrus fruits value chains).

The present study outlines a methodology that combines social LCA with two research tools. The first is the focus group, adopted from qualitative research. The second is the Analytic Hierarchy Process (AHP), adopted from operational research, which belongs to the framework of Multicriteria Decision Analysis (MCDA). These have been used to make the social LCA more locally relevant and to legitimate the chosen criteria. The table 1 sums up the structure of the categories of impacts, and some other data.

Three different methods were adopted:

- 1) focus groups with local experts to define categories, impacts and indicators;
- 2) data gathering through interviewed and semi-structured questionnaires;
- 3) AHP (Analytic Hierarchy Process) by interviewing a sample of the three stakeholders groups, in order to weigh each category.

Stake holders	Categories	Criteria	Indicators	Sources and data significance	Unit of Measurement
Workers	Equal opportunities	Discrimination between Italians and foreigners	Retribution inequality	Our elaboration on primary source	Quant: % retribution imbalance
		Discrimination between men and women	Retribution inequality	Our elaboration on primary source	Quant: % retribution imbalance
Local community	Use of immaterial resources and technologies	Use of information technologies	Percentage of farms using information technologies	Our elaboration on primary source	Quant: (% farms)
		Use of internet access	Percentage of farms with internet access	Our elaboration on primary source	Quant: (% farms)
		Use of local competences	Percentage of farms using local knowledge: customised tools, machines, softwares	Our elaboration on primary source	Quant: (% farms)
	Area reputation	Reputation of local area linked to the quality of products	Percentage of farms producing Clementine PGI of Calabria	Our elaboration on primary source	Quant: % (ha clem PGI/tot ha clem)
Society	Impact to economic development	Estimated Employment Impact	Estimated Permanent work	Our elaboration on primary source	Quant: n./ha
			Estimated Temporary work	Our elaboration on primary source	Quant: n./ha
			Estimated Stability work index	Our elaboration on primary source	Quant: non-dimensional
		Estimated evasion of contribution payments	Working needs imbalance	Our elaboration on primary source	Quant: days/ha

Table 1: Groups of stakeholders, impacts categories, criteria and indicators in the Clementine farming case in South Italy (source: De Luca et al. 2015)

3.3 Sugar industry in South Africa

The case study implemented by Nemarumane and Mbohwa (2015) aims to assess social and socio-economic impacts of the existence of the South African sugar industry.

In this study, the authors simply used questionnaires to gather data, as depicted in the table 2 below.

Characterization	Growers and millers	Technique used to gather data
Health and safety	<ul style="list-style-type: none"> Exposure to physical hazards Protective equipment available 	Questionnaire, interview and field research
Wages	<ul style="list-style-type: none"> Satisfaction of wages and commission Availability of wage-related incentives Basic expenditure of wages 	Questionnaire, historical comparative data, interview
Gender equality	<ul style="list-style-type: none"> The ratio of men to women in the workplace Treatment of men to women in the workplace Favoritism in company policies based on gender 	Questionnaire
Social LCA methodology	Applications and approach	Historical comparative data

Table 2: Nature of impacts, criteria and techniques used to gather data in the sugar industry case in South Africa (source: Nemarumane and Mbohwa, 2015)

4. Advantages, limits and perspectives of participatory approach in social LCA

Here are the main advantages of involving all the stakeholders in participatory approach in social LCA:

- It increases the legitimacy of the assessment, which becomes more adherent to reality (Iofrida et al. 2014; Mathé 2014).
- It adapts indicators to the context, far more than when they are developed by experts (Mendoza and Prabhu 2000).
- It guarantees a final set of indicators of better quality (Rosenström and Kyllönen 2007) and which reflect stakeholders' values (Mendoza and Prabhu 2000).
- It improves democratic representation and promotes empowerment and learning opportunities for communities (Fraser et al. 2006) while encouraging partnerships (Mendoza and Prabhu 2000).

- It incorporates preference of different interest groups or stakeholders (De Luca et al. 2015).
- It promotes social learning processes and mutual feedback (Sala et al. 2013).
- It creates new knowledge and legitimates research activities (De Luca et al. 2015).
- Finally, it adapts the lists of normative categories through the collective ranking of them.

Limits of participatory approach in social LCA

- Participatory approach is time and resources consuming.
- Using the participatory approach, we obtain a context-related study, which raises comparability problems. Indeed, it is likely not possible to compare two surveys gained from different locations. Nevertheless, one solution may be the adaptation of the PII. The principles must be sufficiently generic to allow comparisons to be made at their level.
- There is the possibility that relevant categories are not mentioned by stakeholders, and consequently, not considered in the study.
- The personal interviewee experience/perception of impacts affects the study outputs.

Conclusions

As a conclusion, using participation for selecting indicators raises different issues. Indeed, what to do when some changes are deemed socially favourable by one category of stakeholder, and unfavourable by another? How to deal with impacts which are deemed favourable at one given scale, and not at another scale? More generally, how to deal with changes which entail a positive impact in one domain (e.g. children health) and unfavourable impacts in another domain?

Whatever future works, introducing participatory methods in social LCA is still a challenge. It claims for new methods in collective decision making.

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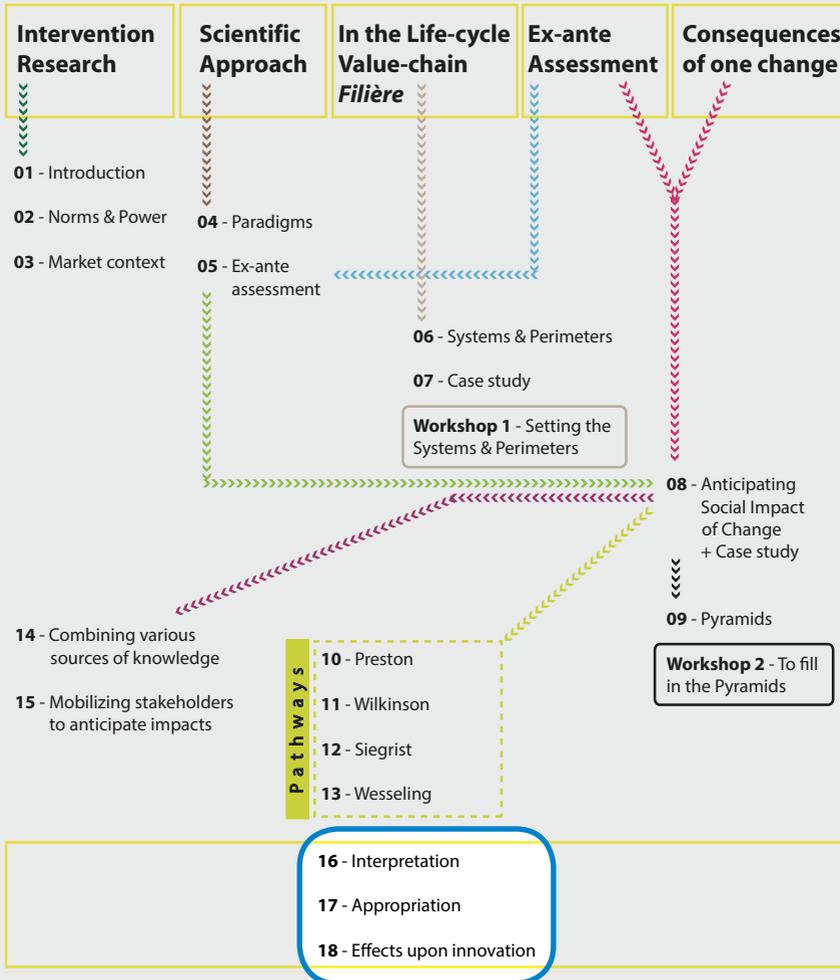
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Matrix of the researcher school's contents



Part 5

Interpretation, appropriation and innovation

16 Interpretation of results

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To sum up

This chapter discusses the interpretation issue. The interpretation is the process by which one gives meaning to the results obtained thanks to the social LCA study. While wrapping up the different methods to anticipate effects/impacts, we highlight that the interpretation process must be planned from the start. We deepen the idea that social LCA studies accompany decision making, especially thanks to the process of reversing pathways. The results are often used to rank scenarios.

Outlook

1. What do we want to avoid?
2. The interpretation step is planned from the start
3. Reversing pathways

Conclusions

Those who want to optimize interpretation with acute exactitude are victims of "hybris". We must keep modesty when delivering interpretation, as stressed by Edgar Morin (1980):

"We might understand that the true optimization is always complex, risky, involving disorders and conflicts, and that its enemy is the pseudo-rationalisation which pretends to remove conflict, disorder, competition, risk."

1. What do we want to avoid?

The social LCA research program avoids two usual pitfalls found in most social LCA literature (§ 1.1) displaying a list of criteria without providing sound guidelines for interpretation, and (§ 1.2) using benchmarks on each criterion, instead of using an homogeneous reference state (reference scenario) for the whole.

1.1 The pitfall of "the list"

Very often in the social LCA literature, the results are displayed like a list of criteria taking some value attributed by the study (see table 1). This is really unfortunate, so what?

In our opinion, it is mandatory to plan the interpretation step from the start. It is a pity and loss of time to perform a (long and expensive) social LCA study without including (at least) the guidelines to make the interpretation!

Scenarios	Gross Values of the criteria for scenarios 1 to 4			
	1	2	3	4
Global cost	500	20	20	900
Diff in jobs creation	100	25	150	610
Diff in jobs losses	20	0	0	400
Diff in LEX for country population	4 days	2 days	4 days	10 days
Decrease in infant mortality rate country population	1.2%	0.7%	0.1%	0.0%
Increase in health for region population	12 days	10 days	60 days	5 days
Diff in work conditions for workers (days of LEX more)	60 days	3 days	55 days	78 days
...				

Table 1: Example of list of criteria representing the results of one social LCA study

1.2 The pitfall of benchmarks by criterion

More often, in social LCA literature, the interpretation is planned for all the criteria, but **one by one**. Some authors (e.g. Brent & Labuschagne, 2006) use different sources of reference criteria for the different criteria to be interpreted. It is understandable and tempting for researchers to draw "legitimate" references from several international regulations (like ILO conventions and so). Sometimes, authors make efforts to draw references from one coherent regulations framework (Dreyer et al. 2010).

Often, several impact categories are at stake. It is the case when implementing study inspired by the Guidelines UNEP/SETAC, 2009. Then, the interpretation is often performed by comparing the values of the criteria to "performance reference points" (PRP) which are "*acknowledged social standards, norms or practices used as thresholds to distinguish, among the observed practices or behaviours, those that are socially responsible from those that are minimally expected from the organization*" (Revéret et al., 2015).

Unfortunately, depending on the situation, the researchers' practices may **become traps**, for two reasons:

- In the developed world, the international regulations (e.g. about labour rights) are quite consensual. But when implementing the PRP stemming from international regulations in developing countries, we impose occidental models on another value system (Zolo, 2006). More seriously, there is no space for local specific social progress, because the only one social progress acknowledged by the PRP is compelled by the indicators coming from Occident. For instance, I bear witness of one research project searching for "gender parity" at work, despite the very local progress would be removing women from the plant, because work is too hard. It is impossible to make all the necessary improvements at the same time. Imposing occidental criteria may hamper local progress.
- The second trap is valuable for developing and developed countries alike, and is the following. By choosing PRP from different origins, one describes a scenario of the perfect company, or a scenario of the perfect value chain. Nevertheless... maybe this perfection does not exist in the sector, or is not desirable (not compelling enough, not relevant) in the sector. Even when fine-tuning the interpretation framework to the specific sector¹ (as for farming), we have no mean to know if the different criteria are consistent together, so if the perfect company/value chain described as such is a valuable goal or not.

The way to overcome these pitfalls is interpreting the values of criteria **by comparing consistent scenarios**, and not by comparing one by one small bricks (criteria) belonging to several scenarios. The most irrefutable scenario is the state before any change to occur. Another is the "business-as-usual" state (what if things go on without implementing the change?).

2. The interpretation step is planned from the start

The interpretation step must be planned from the start. In this paragraph, we wrap up each of the four methods designed to perform ex-ante assessment, in order to focus on its specific interpretation step. We are highlighting the advantages of using pyramids, which is a specific tool for ranking the nature of the impacts according to their importance for health.

2.1 Asking people

When asking people (so-called "participatory methods"), the protocol often includes different tasks for the people involved in the study. They have not only to select, but also to **weigh** the social impacts categories, and sometimes to weigh the

¹ It is the case of the RISE project for farming, from Bern University, where authors are aware of the limitations of designing general criteria for "sustainable farms".

indicators themselves. It is legitimate the task of weighting to be the exclusivity of the stakeholders.

Often, the social LCA study delivers both figures and qualitative insights. The importance to be attributed to each one has already been designed by the process of weighting. So, results can be displayed to stakeholders or to backers, by ranking the criteria from the most (heavy weight) to the least (light weight) important one. Table 2 (stemming from table 1) displays an example of ranked results after weighting. Ranking the criteria BEFORE performing the survey (so before anyone can see the figures), will provide fairer interpretation.

Scenarios	Weight/100	Gross Values of the criteria for scenarios			
		1	2	3	4
Diff in jobs creation	22	100	25	150	610
Decrease in infant mortality rate country population	20	1.2%	0.7%	0.1%	0.0%
Increase in health for region population	18	12 days	10 days	60 days	5 days
Diff in jobs losses	12	20	0	0	400
Diff in LEX for country population	12	4 days	2 days	4 days	10 days
Diff in work conditions for workers (days of LEX more)	10	60 days	3 days	55 days	78 days
Global cost	6	500	20	20	900

Table 2: Example of ranking of criteria (from table 1)

As the table 2 makes it clear, displaying ranked criteria does not achieve the process of interpretation. Indeed, it is important also to make interpretation of the value given to each criteria in itself: Is it a neutral value? Is it a "favorable" value, is it a "bad" value? Of course, the interpretation of the values is performed against a clear reference state (for instance, the "business as usual" situation). Of course, **the reference state must be the same for all the criteria!**

We suggest providing interpretation of each value by **translating it** along the following simple scale:

- +1: means that the value of the criteria is an improvement compared to the reference situation;
- 0: means that the value of the criteria is neutral in comparison to the reference situation;
- 1: means that the value of the criteria is spoilage compared to the reference situation.

Of course, many other scalings are possible and welcome, provided the same scale is implemented to all the criteria. The table 3 (stemming from table 2) displays an example of ranking and translation of criteria.

Scenarios	Weight/100	Gross Values of the criteria for scenarios			
		1	2	3	4
Diff in jobs creation	22	0	-1	+1	+1
Decrease in infant mortality rate country population	20	+1	+1	+1	0
Increase in health for region population	18	+1	0	+1	-1
Diff in jobs losses	12	0	+1	+1	-1
Diff in LEX for country population	12	0	-1	0	+1
Diff in work conditions for workers (days of LEX more)	10	+1	-1	+1	+1
Global cost	6	0	+1	+1	-1

Table 3: Example of ranking and translation (along the scale -1;0;+1) of criteria (from table 2)

Nevertheless, the decisions to be taken and the actions to be implemented are the realm of policy-makers, and not the domain of researchers. At the contrary of ranking, **aggregation of results** must be avoided, as it is not clear and transparent process. We suggest that people are clever enough to account for many criteria, provided that they are ranked.

2.2 Finding relationships from past

Each "relationship from past" allows calculating the figures for different scenarios to be compared. As stressed several times, the absolute value of the figures provided by the calculation is meaningless, because of the multiple biases linked to the modelling, "equation making" and calculation process. Nevertheless, differences between different scenarios calculated by the same method are relevant, because the different calculations are suffering from the same bias. So interpretation about one "relationship from past" alone implemented to several scenarios, is sound.

For some pathways, many criteria are involved, like in the figure 1. In this case, the rules for interpretation are included in the pathway design.

Usually, decision-makers need insights about a range of social impacts regarding several scenarios. The interpretation of the figures delivered by the relationships from the past takes into account several other criteria (like in the previous case § 2.1). Among the criteria, some have been got by calculations and some others by interviews or by

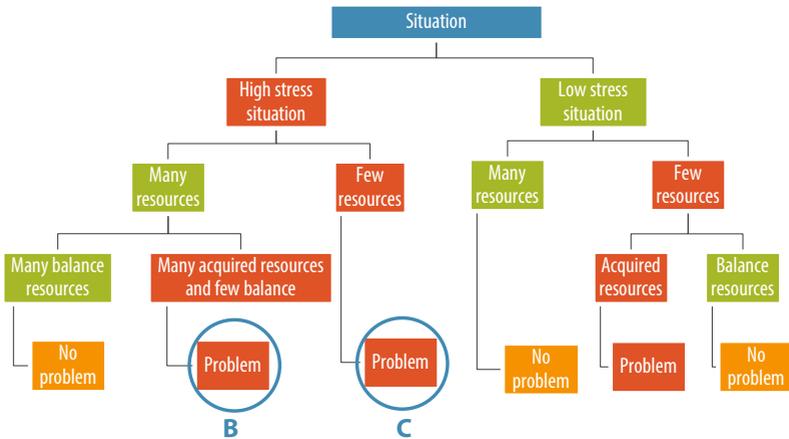


Figure 1: Decision tree for identification of work situations at risk (source: Federica Silveri PhD thesis)

other means than calculations. It is important not to allocate more importance to the criteria whose level is shown by figures (like the ones calculated by relationships from the past) than to the criteria based on narrative.

Another usage of past relationships will be discussed in the paragraph 3.2 (reversing the pathways).

2.3 Using ELCA models

When using ELCA models to assess consequences of the change upon "human health" in general, the value given by the ELCA model to the criteria "human health" is devoted to be considered in the ELCA study as a whole.

From our experience, practitioners of ELCA consider that the calculation of the criteria "human health" is jeopardized by "many uncertainties" (sic). So, they tend to disregard the criteria "human health" within global interpretation.

2.4 Crossing all the sources

When practitioners cross all the sources to gain clear picture of the situation, the interpretation step focus on:

- answering specific questions from the backers;
- attracting the attention of backers on the outstanding impacts, and on impacts outside from the range of consequences that were normally expected.

The table 4 depicts an example.

Technical Capital		Institutional Capital	
Building	Consumption	Building	Consumption
Construction of new public roads Maintenance of one more school building	Increased use in public infrastructures in the region P. (roads and cargo port)	Creation of new norm about the blue-collar work in the banana industry in the country X	Removing of the old standards about the blue-collar work in the banana industry in the country X
Financial Capital		Natural Capital	
Building	Consumption	Building	Consumption
Cash generation of additional working capital	Liquidation of provisions from the account devoted to fund investments	Set up a new sanctuary to protect biodiversity in the reserve N	Land utilisation, air use, water withdrawal, in the reserve N
Human Capital		Social Capital	
Building	Consumption	Building	Consumption
New hires of 500 workers New social contributions are paid Introduction of new training courses	Dismissal of 30 old employees	Stimulation of the local socio-economic fabric Increased access to local services for the population (hospital)	Increased conflicting sectoral interest for water with local farmers Increased dependency to cultivation of banana

Table 4: Mapping of capitals consumption and building, for the project: adding one new banana organic value chain to the current non-organic value chain, in the country X
(source: Gillet C. & Loeillet D. chapter 6, page 135, in social LCAs socio-economic effects in value chains)

2.5 Ranking the social determinants of health

When it comes to interpretation, the determinants of health defined by the Commission for Social Determinants of Health (WHO, 2009) and presented in the chapter 9, are of the utmost interest... because they are already hierarchized. Moreover, the pyramids highlight the diverse links between the social determinants.

Earlier (see chapter 09), we have given an example of attribution of weights to the different social determinants, from simple rules. Figure 2 is an example of "rating" for the social determinants of health at macro-scale.

Independently from rating, the interpretation scale (-1; 0 ; +1) presented above (§ 2.1) maybe implemented to the findings from pyramids too.

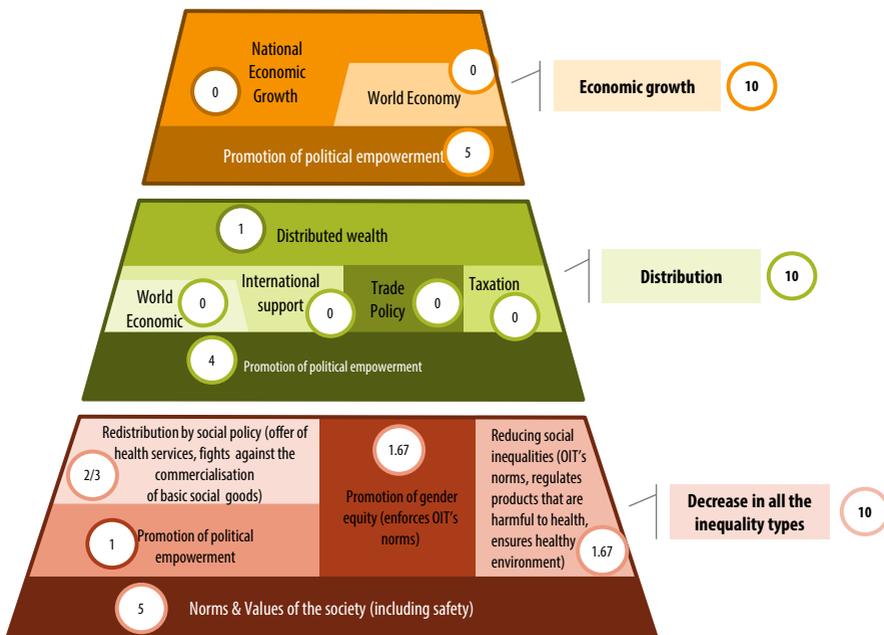


Figure 2: Example of rating for the social determinants of health, at macro-scale, for the change X

3. Reversing pathways

Pathways (§ 2.2) are attractive for decision-making because they offer the possibility to "reverse the pathway". Indeed, the causality between variables (and not only the correlation) has been demonstrated. For instance, (see chapter 10) growth of the wealth generated by increase in production increases the average life expectancy of the population, if some conditions are met.

Moreover, by introducing nuances linked to the conditions for use, we got quite sound knowledge of "how it works". So, such a pathway provides decision-makers with **levers to modify the situation**, if unsatisfactory. The example depicted by the table 5 identifies the different potential causes of stress (for workers) in the B and C scenarios.

Scenario	High demand / low control	Effort reward imbalance	Flexible jobs	Flexible work	Long working hours
B	x	x			x
C	x		x	x	

Table 5: Identification of the specific causes of stress involved in the B and C scenarios

Investigation can deepen the case (as proposed in the example of the table 6), in order to prevent health problems by fine-tuning work organization.

The anticipation of impacts by pathways is the only one which provides such levers to improve action. Indeed, elaborating sound pathways includes understanding the cause-effect relationships, despite it is not necessary when "asking people" for instance.

Scenario	Effort reward imbalance	Flexible jobs	Flexible work	Long working hours	Health issues
B	X			X	
Detailed issues	Negative effect (Roquelaure, 2006)			/	Musculo-skeletal disorders
	X 4.1 depression (Tsutsumi, 2001)			2.43 (Virtanen, 2012)	Mental health troubles
	X 6.15 (Siegrist, 1996)			X 3 (Härma, 2003)	Cardiovascular diseases
	/			/	Cancers
C		X	X		
Detailed issues		/			Musculo-skeletal disorders
		13.7 to 24.6 depression (Santin, 2010)	2.43 fatigue (de Raeve, 2007) 6.08 (night work more than 4 years = depression) (Bara, 2009)		Mental health troubles
		Negative effect (Siegrist, 1996)	Negative effect (night work) (Härma, 2006)		Cardiovascular diseases
		Long unemployment period (Légeron, 2003)	X 1.50 night work = cancer (Messing, 2000)		Cancers

Table 6: Identification of the detailed health issues caused by the stress factors in scenarios B and C (source: from Gasnier et al., 2013)

Conclusions

In usual practices of social LCA, interpretation of results can meet two pitfalls. The first is that obtained outputs are a list of unranked criteria, the second is that the interpretation of each criterion is performed one by one, against one benchmark

criterion, without consistency among benchmark criteria. We therefore insist on the **necessity to interpret the scenario** under scrutiny **in comparison to another consistent scenario** (for instance, the scenario of the state before the change).

Whatever the choice of a method for anticipating impacts, the interpretation rules must be fixed from the start. Choosing one method entails choosing a framework for interpretation at the same time. In a nutshell:

- If asking people, people select and weigh the indicators. We can interpret indicators by simple scaling, according to deterioration (-1), stability (0), or improvement (+1) of the situation because of the change.
- If using relationships from past, you gain partial results to be involved in another frame.
- If using ELCA models, the "human health" output is liable to be agglomerate with other ELCA indicators.
- If crossing all the sources, the interpretation highlights the striking topics, and answers the questions asked by backers.
- If ranking the social determinants of health, the indicators are already ranked (weighted) in the pyramids. Interpretation of each criterion follows the same rules as for "asking people".

Beyond interpretation alone, knowledge gained from the building of pathways allows us to suggest actions for improving the diagnosed situation.

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17 Utilization of results

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To sum up

This chapter deals with the relationship between the outputs obtained from the social LCA study and the very decision taken by the decision-maker.

Outlook

Introduction

1. The different interfaces between policy-making and science, from Hoppe (2005)
2. Using the Hoppe's model

Conclusions

Introduction

Indeed, the use of new knowledge in policy-making is not straightforward, as illustrated by the figure 1!

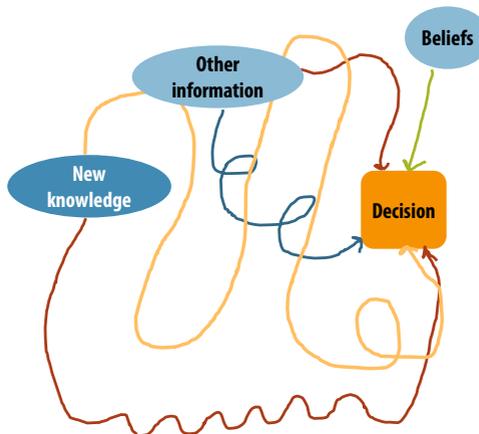


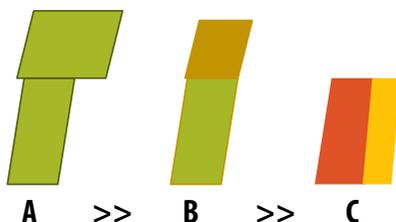
Figure 1: Schema of use of new knowledge by decision-makers

Researchers agree upon three propositions (Wittrock, 1982):

- The very concept of knowledge utilization is very complex. It encompasses from perception of some policy-relevant information to the actual implementation.
- Social research is only one part among many types of information and beliefs, taken into account for decision-making.
- Social research does have an impact other than that serving as a basis for a well-defined planning process.

To explore the different contexts of utilization of the outputs by policy-making, we are taking an example:

- The outputs of one given social LCA study provide a classification of three scenarios in terms of "social impacts" where A is much better than B, and B is much better than C.



What will the decision-makers choose?

In general, decision-makers **do not** take decision directly reflecting the raw outputs from the LCA study¹ only. The way decision-makers consider the outputs mainly depends on the relative role (interface) of policy-making and science at stake in the situation.

To improve our knowledge about this issue, we adapt the work by Robert Hoppe (2005) regarding interfaces between scientists and policy-makers. In this presentation, the decision-makers of the social LCA study stand for the policy-makers from the Hoppe's works.

1. The different interfaces between policy-making and science, from Hoppe (2005)

Robert Hoppe (2005) presented six possible situations.

The six situations are six different interfaces between policy-making and science, and can be described **according to two axis**.

¹ This is the same whatever the tool (environmental LCA or others).

The first axis (figure 2) is inspired by Habermas, as interpreted by Outhwaite (1996) about the primacy of mastering and authority. Are the policy-makers dominant, or are the scientists dominant?

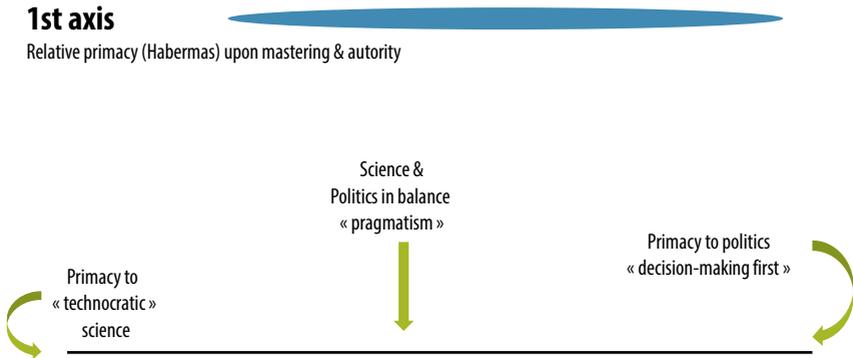


Figure 2: The first axis of the diagram by Hoppe (2005)

If scientists are the masters, the situation gives primacy to science (left end of the axis). If decision-makers are the masters, the situation gives primacy to politics (right end of the axis). Nevertheless, another situation is possible, when science and politics are in balance (middle of the axis).

The second axis (figure 3) is inspired by the work of Wittrock (1991) about the divergence or convergence of functional logics (rules of decision depending on the function occupied by the person).

2nd axis

Divergence or convergence of functional logics (Wittrock ,1991)

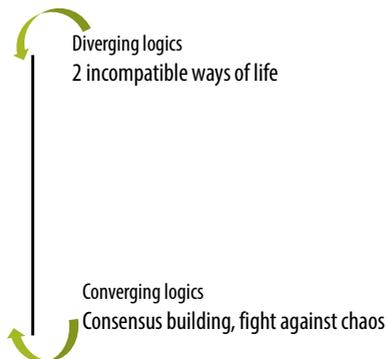


Figure 3: The second axis of the diagram by Hoppe (2005)

If the function of the decision-makers entails rules (logics) which are not compatible with the logics linked with the scientists function, the situation is "diverging logics" (at the top of the axis). If both functional logics are more or less similar, the situation is "converging logics" (at the bottom of the axis).

By crossing the two axis, Robert Hoppe designs four squares (figure 4) to account for different possible interfaces between decision-makers and scientists.

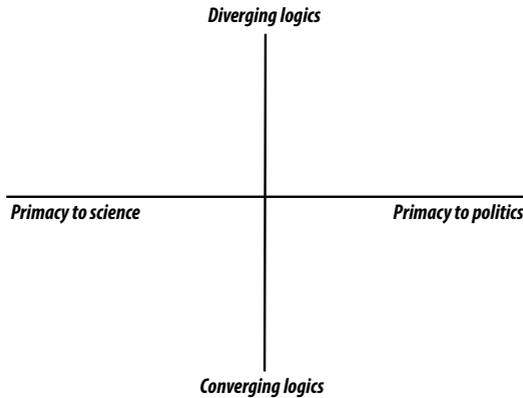


Figure 4: The four squares by Hoppe (2005)

Hoppe proposed to give names to the four squares (depicting four different situations) of the picture above. The names are: "enlightenment", "bureaucratic", "technocracy" and "engineering" (figure 5).

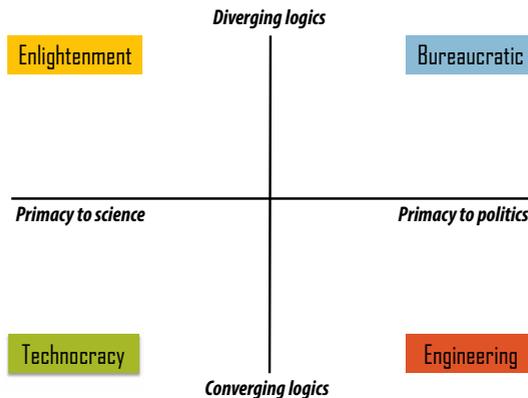


Figure 5: The name of the four squares

2. Using the Hoppe's model

Turning back to the A, B, C scenarios... the choice of decision-makers will depend on the situation they are placed in, regarding interface between science and policy, despite they are not aware of this influence. Indeed...

In the "Enlightenment model" of interface between science and policy, scientists and policy-makers believe that science is leading to the progressive progress of knowledge towards the truth. New knowledge spreads towards policy-makers. The functional logics are diverging. Both scientists and policy-makers believe that science is enlightening policy, by opening the eyes of policy-makers on "the" truth.



Thus, the scenario A is "the good solution". Science is free to calculate results and to aggregate them as they like. Scientists are not responsible for the use of their results. The policy-makers' decision follows the advice provided by science. **They implement A.**

A

In the "Bureaucratic model", functional logics are diverging between science and policy. Policy becomes "administration". The focus of the decision is on the means implemented, and not on the purpose of the action.

*In parallel with the social LCA study, an administrative process is on the ride, which **has decided earlier to implement scenario D.***



D

The "Technocracy model" is a-politics. "Good policy is spoiled by politics" is the adage of the Technocracy model. Policy-makers and scientists believe that the social functions of science and policy-making are the same. Scientific knowledge has colonized the administrative and politic world, as such as decision-makers have scientific culture. In the radical version, scientists themselves replace policy-makers!



*There is one best solution. The policy maker decision follows advice provided by scientists because they believe in science. **They implement A.***

A

Idea of mobilizing society knowledge at the service of the State, is at the basis of **the Engineering model**. Policy-makers commit scientists (seen like engineers) to detailed research projects. Scientists-engineers implement current knowledge corpus to local issues for local solutions.



From the start, policy-makers want the scientists to highlight by figures **that B is the best solution** (it is possible to make it by setting certain hypothesis).

B

The previous four situations are very contrasted. Robert Hoppes (2005) assumes that other mitigated situations may occur, and must be drawn closer to the centre of the picture (figure 6). The names of these intermediate situations are: "Advocacy" when logics are more diverging than converging, and "Learning" when logics are more converging than diverging.

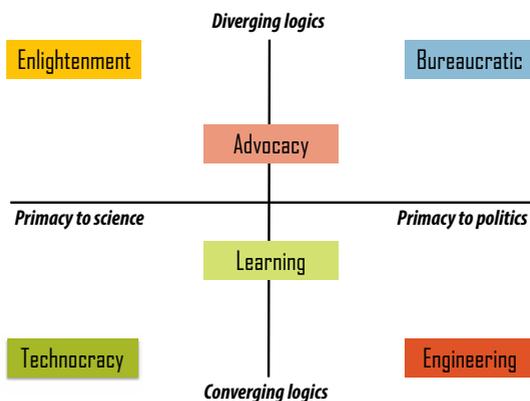


Figure 6: Extreme and intermediate logics

Here again, the very decision will be influenced by the results of the social LCA study and by the model of interface between policy-makers and scientists.

In the "Advocacy model", there is a dialogue between scientists and policy-makers, but their social functions are more diverging than converging. Science takes part in the battle of the political arena to define what public interest is. Science brings one plea among the other pleas carried by other actors making lobbying.



A bis

Policy-maker will more or less take into account the scientific plea. Maybe they will implement A, because the lobbyists for A are better than the lobbyists for other solutions, but in general **they implement A bis**.

In the "Learning model", there is no "one best solution". The focus is on the approach, the "goal is in walking the way". All the actors are involved in social learning through social debate. The approach and the solution provided by scientists are delivered to stakeholders as one component of the issue at hand.



E

*In general, stakeholders decide **to implement another scenario (E)** than those submitted, because they have learnt new ideas by doing. The scientific study comparing A, B and C helps them to learn and to build E.*

Thus, the six different types of interfaces entail different choices. The schema (figure 7) depicts a sum-up of the six approaches and of the role of scientific results in each case.

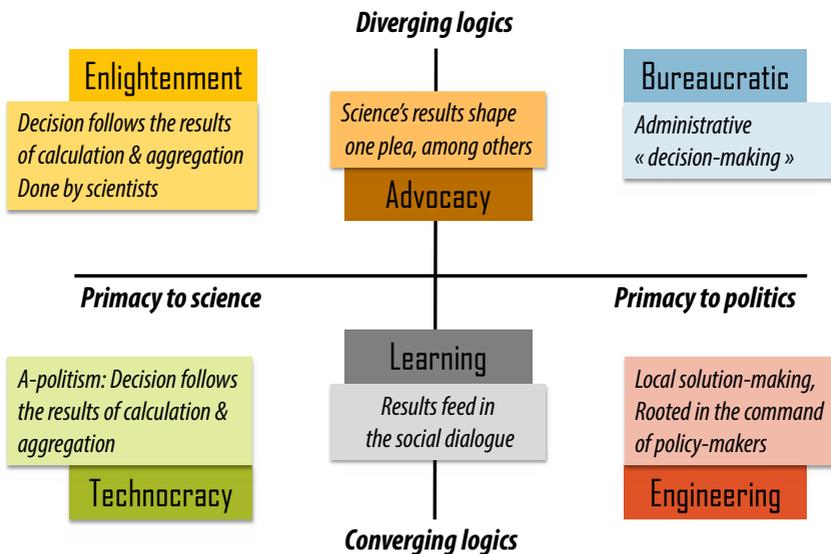


Figure 7: Sum-up of the six approaches by Hoppe (2005)

Conclusions

These considerations could discouraged researchers to carry sound assessment work. Nevertheless, it is not useless to perform assessment, because the outputs – and especially the process – are taken into account in the final decision. Nevertheless, we

must not believe that the effective decision will simply follow the indications provided by scientists. It would be a naïve belief!

If we admit that we live in the "technical democracy" described by Callon, Lascoumes and Barthe (2001), then methods like social LCA must be considered as **learning tools** first. Their principal role is accompanying actors (Helweg and Mila I Canal, 2014), who learn all the way.

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18 Effects of social LCA on innovation

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To sum up

The aim of this chapter is to explore and to discuss the links between the implementation of ecological/social norms and innovations, at the company level. Results from the literature shows that the norms lead effectively to different types of innovations, but the reason of this process is likely a little bit different from the expectations.

Outlook

Introduction

1. What are the effects of ecological norms on innovation?
2. What are the effects of social norms on innovation?
3. Discussion

Conclusions

Introduction

The introduction of eco-conception, for example, leads to changes in management procedures to reduce social and environmental risks. Intuitively, it seems logical that caring after environmental issues leads to environmental innovations, and that paying attention to social issues... entails social innovation. So, this chapter discusses the introduction of "ecological norms" and "social norms" in the company as drivers for innovation (figure 1). Bringing the new norm (A) in the company influences a group (orange star) whose role is choosing among different possible innovations (pink heart, yellow star, green moon). Because of the norm (A), the group selects a solution (here, the green moon) which is the more compatible with the norm (A).

Nevertheless, the direction of the relationship is not obvious. According to Wagner (2008), it should not be concluded that eco-labelling or other types of similar activities has a clear direction of causality towards increased innovation. Often, eco-labelling comes after the first product innovation, but this knowledge may lead to continue

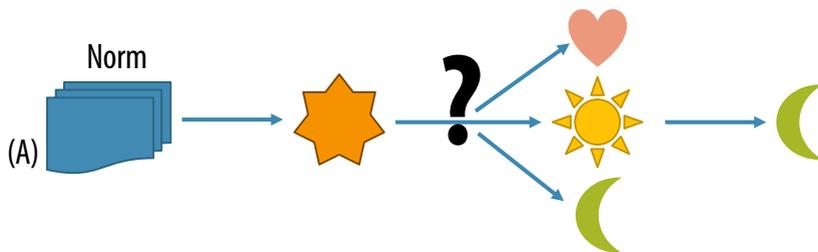


Figure 1: The theoretical process leading from introduction of new norm to innovation

the exercise for the creation of new "green" products. A virtuous circle between innovation and environmental standard is then engaged.

The ecological norms are more or less based on "life cycle" approach. For the social norms, we limited the research to Corporate Social Responsibility (CSR) norms, due to the lack of study based on the link between Social life cycle assessment (S-LCA) and innovations.

Innovation is a generic term, encompassing more specific "product innovation", "process innovation", "organizational innovation" among other terms. Product innovations are the introduction of a new, redesigned or substantially improved good or service. Process innovation means that only the way of crafting, elaborating, processing the main product or service is new. We use the term "organizational innovation" when the general organization of the company is new, without affecting the processing of the main product/service itself.

The next sections will present findings from a literature review, in order to display the effects of ecological (§ 1) and social (§ 2) norms introduction. The results discussion (§ 3) and the general conclusions will follow.

1. What are the effects of ecological norms on innovation?

First, what are the ecological norms, linked to Environmental life cycle assessment (E-LCA), that have been introduced in companies? We answer this question in the § 1.1. Evidences will be discussed in the § 1.2 about case studies, and in the § 1.3 for statistical effects demonstrating the link between presence of ecological norms and innovation. Because of the scarce available literature out of Europe, the cases and results are set in European countries only.

1.1 What are the ecological norms introduced in companies?

Sometimes, ELCA following the norm ISO 14040 (2006) is directly used in companies for specific environmental analysis. But in general, companies adopt the Environmental Management System (EMS) more broadly. EMS is *"a system and database which integrates procedures and processes for training of personnel, monitoring, summarizing, and reporting of specialized environmental performance information to internal and external stakeholders of a firm."* (Sroufe, 2003). EMS explains the best ways for increasing environmentally friendly practices. Meanwhile, companies can freely join the EMAS (Eco-Management and Audit Scheme) which is a voluntary environmental management instrument developed in 1993 by the European Commission. EMAS also helps organizations to assess, manage and continuously improve their environmental performance. Since late 1999, some particularly exposed sectors (considered more pollutants than others) are subject to the European directive "on integrated prevention and pollution control" (IPCC), which forces them to calculate the environmental impacts of their activities, on the entire life cycle of their products (Azapagic, 1999).

1.2 Evidences from case studies

The analysis of the literature shows that a small number of studies consider the existence of an EMS or EMAS registration, sometimes separately from LCA practices.

The link between ecological standards and innovation is obvious as soon as the organization involves eco-design (it is a new product design process, in order to reduce environmental damage related to their existence and their functioning). Indeed, the eco-design approach includes sessions of creativity, supported for example by the "wheel of eco-design strategy" (Brézet, 1997). Cluzel (2012) describes the phenomenon at Alstom Grid. The company first performs a LCA study of several scenarios that cover the operating variability of the industrial system (here, electrical conversion substations used in the primary aluminium industry). The LCA study highlights the most harmful processes for ecology. Gathered during a creativity session, the experts generate ideas of solution, thanks to their varied disciplinary origins.

The practice of LCA exerts a particularly powerful leverage in the early phase of creation (Hellweg and Mila I Canal, 2014). For example, an E-LCA study demonstrated that major ecological damage caused by washing clothes comes from the high temperature of the water. The innovation was therefore to convince the washing powder manufacturers, washing machine manufacturers and users, to design machines operating at "low temperature".

1.3 Statistical effects of ecological norms on innovation

To know if the precedent effects are general, we collected different surveys. The table 1 reflects results from four surveys.

Authors	Case studies	Ecological norms	Innovations	Results
Ziegler et al., 2004	588 German companies with more than 50 employees, representing 11 manufacturing sectors in 2003 telephone survey	waste management	products	positively correlated (Rehfeld et al., 2007)
		LCA for design	product and process	positively correlated
		EMS certified or ISO 14001	product and process	low correlation
		EMAS	product and process	no correlation
Wagner, 2008	data from the European barometer of the business environment (9 countries), e-mail survey	consumer information, market research of 'green' products, eco-labelling	products	positively correlated
		EMS	process	positively correlated
		EMS	products	no correlation
Wagner, 2008	134 German companies in 2006/2007, telephone survey	consumer information, market research of 'green' products, eco-labelling	products	positively correlated
		EMS	product and process	low correlation
		EMAS	product and process	no correlation
Rennings et al., 2005, 2006	1 227 telephone interviews with firms in the EMAS system	EMS	Product and organisation	correlated

Table 1: Statistical effects of ecological norms on innovation

The surveys suggest that targeted actions (e. g. waste management, markets research for green products, etc.) that accompany the introduction of ecological standard, are more often associated with the existence of environmental innovations, that mere membership in a device certification (which requires no specific actions).

Moreover, the standards imposed by law, as the European environmental directives, have the reputation to stimulate creativity of entire sectors. Similarly, Hellweg and Mila I Canals (2014) find that Environmental Product Declarations (based on E-LCA) have become an effective mechanism to share data. This sharing encourages the industry to innovate, by mimetic behaviour with other certified firms (and supposedly innovative).

2. What are the effects of social norms on innovation?

Empirical studies about the relationship between social life cycle practices and innovation in company are missing. On the other hand, the effect of introduction of CSR on innovation has been studied, although in few cases. CSR plays an important role within the management literature, and has become the dominant tool for assessing the social issues in the community "life cycle" (Macombe & Falque, 2013). The question is always the same: do social norms lead to social innovations?

The table 2 shows the authors' opinion about this topic.

Authors	Affirmation
McWilliams and Siegel (2000)	CSR boosts product innovations and innovations in business organization.
Stigson (2002)	A growing number of companies are adopting CSR in order to stimulate innovation.
Asongu (2007)	The implementation of CSR standard at DuPont caused innovations for the company and society.
Bocquet and Mothe (2009)	SMEs are making radical innovations based on CSR (7 case studies in Rhône-Alpes).
Rapport OCDE, 2010 cited by Bocquet et al. (2011)	Social concerns are increasingly vectors of innovation.

Table 2: Different visions on the link between CSR and innovation effects

Depending on the case under scrutiny, or on their own experience, the authors generally argue in favour of a positive link between the practice of CSR and the generation of innovations in the company. Table 2 summarizes some evidences. Other authors argue for a positive reciprocal influence between CSR and innovations. MacGregor and Fontdrona (2008) argue that there is a virtuous circle between CSR and innovations (of which CSR is both a driving force and a consequence) (figure 2). This is true even if the result does not have a clearly social logic, because it is embodied in the establishment of a productive process that is more socially responsible.

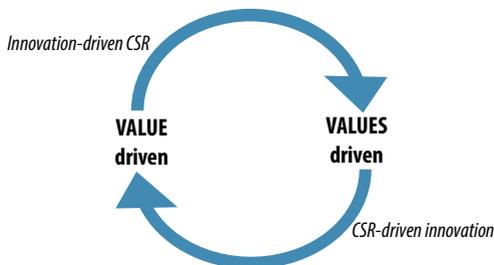


Figure 2: The virtuous circle between innovation and CSR (source : MacGregor et Fontdrona, 2008)

Contrary to previous opinions, Bocquet et al. (2011) argue that the adoption of CSR practices is not always synonym of innovation. Gallego-Álvarez et al. (2011) even argue that the influence of CSR on innovation is negative! Adhering to CSR practices entails increased costs. In addition, breaking innovations are based on discoveries. The most important discoveries occur at random, without being able to know whether or not CSR practices (when present) have facilitated their emergence (Gallego-Álvarez et al., 2011).

3. Discussion

The discussion is built on three questions:

- Is the reputation of environmental standards (through eco-design in particular), which is to promote product innovation, justified? (§ 3.1)
- Concerning ecological norms, are products generated greener? (§ 3.2)
- Do social norms lead to social innovation? (§ 3.3)

3.1 Is the reputation of environmental standards justified?

In the company, the introduction of an environmental standard seems to positively influence innovation. However, some studies suggest that this effect does not perform as intended. A priori, one would imagine that the awareness of the potential for improvement would stimulate creativity in the service of the invention of greener products. The process can be repeated as long as it is possible to obtain an ecological improvement. This phenomenon certainly exists. However, we make the assumption that the introduction of these standards lead to innovation by an indirect phenomenon first.

This phenomenon is **strengthening the teamwork** (figure 3). Twelve case studies show that EMS acts as a coordinating mechanism that enhances teamwork (Avadikyan et al. 2001).

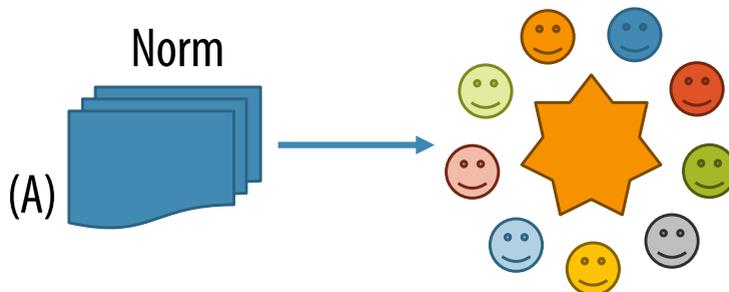


Figure 3: Bringing the new norm (B) in the company strengthens the teamwork

From literature, we know the importance of development of creative solutions by people with different experiences and intellectual formations (Price, 1996). Yet it is impossible to carry out an E-LCA without fetching data outside the boundaries of the enterprise. So, the potential to innovate of the team built from members of partners organizations, is particularly high (Price, 1996). The probability of generating innovations is therefore very strong. Teamwork generates richer innovations, because they take into account the product system rather than the single final product.

3.2 Concerning ecological norms, are generated products greener?

In a German survey, Ziegler et al. (2004) highlight that the standard management system ISO 9001 (which has no ecological specificity) is **as effective for ecological creativity than EMS** (which is supposed to bring focus on ecological issues)! Ecological creativity seems independent of the orientation – ecological or not – of the introduced standard. Yet the introduction of an ISO management standard (whatever it is) modifies explicitly the expectations of the management towards the employees in charge of the realization. When the introduction of the norm is perceived as a new possibility of being useful, the members of the organization concerned receive a major push to improve.

3.3 Do Social norms lead to social innovation?

In the company, the introduction of social standards often aims at repairing or building the company's public image (Laufer, 2003). There is often a gap between what the company "says" and reality. This behaviour undermines the credibility of CSR (Laufer, 2003). In addition, the resources invested in the company to innovate are very important, while the practices for the reduction of social negative impacts are modest (Gallego-Alvarez et al., 2011).

Despite these shortcomings and excesses, it is likely that CSR standards induce some creativity in the organization, but more limited than for environmental standards. However, the underlying mechanisms of their positive effect on innovation are probably the same. Wagner (2008) writes that **it is not the certification itself that causes innovation, but the effective implementation** within the organizational devices. In the same way, we believe that this is not the standard that produces innovation, but the conditions for its effective implementation. Instead of the expected ordered process leading from new norm to innovation (as depicted in figure 1), it is likely that the real process looks like the "happy disorder" depicted in the figure 4.

3.4. The features of norms which cause innovation

Standards based on environmental "life cycle" approach and CSR standards share three common characteristics, that we deem important from the perspective of innovation.

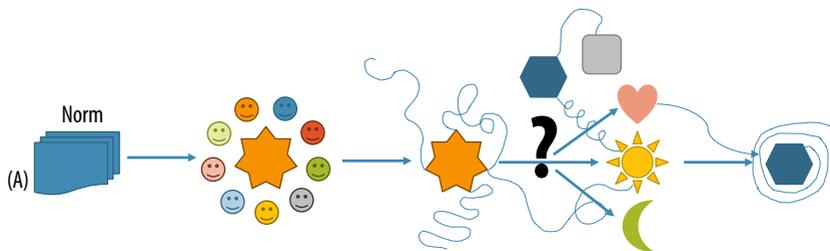


Figure 4: The "happy disorder" generating innovation

First, incorporating standards in the company *de facto* create new teams. As mentioned above, this is a great field to generate all kinds of innovations.

Next, the implementation of the standards promotes the vision of an organization connected to the world. Yet one of the sources of inspiration for innovation is confronting realities from elsewhere (Kaufman et al., 2010).

Finally, appropriation of the tools stems from manipulating them, and leads to experiment. Companies adapt E-LCA tool to their own needs (Rex and Baumann, 2008). It is the same for CSR (UNEP-SETAC, 2009). The manipulation encourages companies' innovations.

We think that the three characteristics explain the real effect of the introduction of these standards on innovation.

Conclusions

The aim of this chapter was to highlight the links between the implementation of ecological/social norms and innovations, at the company level.

The adoption of environmental standards stimulating innovation of products and processes seems a well-supported idea, especially when it comes to practices (waste management, conducting LCA studies, etc.) mobilizing employees. It seems that social norms based on CSR stimulate innovation, or at least accompany it. However, the effects on innovation have likely other causes than those imagined first. The introduction of norms reinforces teamwork (inside the organization and outside), promotes linkages of the organization with the outside world, and generates ownership by the employees. This phenomenon seems to be more pronounced for E-LCA standards than for CSR.

Results from the literature show that the norms lead effectively to different types of innovations, but the motivation of this process is likely a little bit different from the expectations.

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Conclusion

19 Conclusion – Directions for future research in social LCA

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Here we are at the conclusion of five days of discussions and exercises of the March 2016 "researcher school". In the first section, we sum up the messages from the different chapters of the book, and we provide a few references to get right to the heart of the topic, when available. In the second section, we highlight the main topics which generated discussions during the researcher school. In the third section, we turn back to the research program to be implemented in the future of the social LCA of pathways or type 2 social LCA (referred to here as "social LCA").

1. Summary of the chapters

In the previous chapters, we have tried to gather all the modest knowledge gained by our team about the components and articulation of the social LCA method, since 2008.

The first chapter presents the notions which characterize our method. The research program belongs to the "intervention research" domain, bearing a scientific approach, with the **purpose of performing ex-ante assessment of the social consequences of changes** (even if the method may equally be used to analyze past changes). We underline that we are not seeking to determine the "social performances" of the companies involved in the life cycle. On the contrary, we are seeking out the social consequences (effects and impacts) caused by the existence of the life cycle (in comparison to the case where it did not exist) or by changes in the life cycle.

The certifications, conventions, social standards, norms and the like do not stem from scratch (Reverdy, 2005). As an example, Chapter 2 "Norms and power" deals with the creation of the norm ISO 45 001. The text explains that the new norm is an avatar of the British referential OHSAS 18 001, and illustrates power games. The active members involved in the commission for building the norm are only management consultants, members of standardization bodies, assessors, QSE managers (Quality, Safety and Environment managers, managing risks in firms) and members of occupational risk prevention and insurance organizations. Actually, workers' organizations – albeit they are the most affected by the standard – are not present.

Chapter 3 describes the market context pushing for fair assessment of the social consequences of decisions. Large companies, and especially transnational ones, are carefully looked after by watchdogs (NGOs, state services etc.). Companies are becoming aware of the need to be fully accountable for all the negative impacts generated by their value chain (Spence and Bourlakis, 2009). But crises are still numerous, and large world companies acknowledge that they do not know the social functioning of their value chain (which is actually a complex network). The proliferation of labels does not help, because it fails to protect against bad practices. This chapter presents several solutions in terms of environmentally friendly practices, and identifies the different needs for social assessment tools.

Any scientific work is rooted in epistemological positions. Chapter 4 is devoted to describing the paradigms usually implemented in social LCA works, from the origins of the domain to the present day (Iofrida, 2016). Chapter 5 "Science and ex-ante assessment" discusses the specific epistemic positions chosen to build the research program in social LCA. This method aims at providing knowledge promoting coordination of the actors, and fine-tuning the social side of projects. It is not aimed at monitoring suppliers or workers, covering the responsibility of the central firm or preventing competitors from entering the field.

After reminders about the importance of framing, Chapter 6 "Systems and perimeters" highlights the originality of the selection process of the affected actors. The chapter turns back to the concepts of "5 forces" model, value chain, *filière*, strategic arena and net value, before depicting the "systematic competitive model of the product system" (Lagarde and Macombe, 2012). This model allows us to identify all the value chains likely to be affected by the change under scrutiny. It concludes with discussion of the proposed cut-off criteria for setting the boundaries.

In Chapter 7, one first case study ("Territorial bio-refinery" scenario for breeding and processing the mealworm *Tenebrio molitor*...) illustrates how to set the perimeter in practice. The same chapter reports on workshop 1, where participants managed to design the perimeter for another insect case study, known as "Brown chemistry scenario" (and processing the fly *Hermetia illucens*).

Chapter 8 sums up the different means of building methods anticipating the social impacts (mainly impacts on health) of planned changes in value chains: i) the most intuitive method is asking interested parties, but this must be done soundly; ii) social LCA rests also on finding relationships from the past, retesting them, and discovering their conditions for use. The pathways obtained address one specific target population (e.g. workers of the value chain), at one specific scale (e.g. plantations, industrial facilities...) only; iii) when implementing a social LCA study, one cross-references all the sources of information (including documents, interviews, pathways calculations etc.) to anticipate likely consequences of the change.

Chapter 9 presents the "pyramids" built from our translation of the relationships between social determinants and health, as depicted by the members of the "Commission for social determinants of health" (WHO, 2009). The same chapter

sets out a short report about workshop 2, where participants managed to fill in the pyramids, by implementing an imagined case study based on a Brazilian palm oil company. The major advantage of pyramids relies on the hierarchy set among the different impacts, for both macro-scale and meso-scale impacts.

Chapter 10 presents the "Preston pathway" (a general relationship on a macro-scale) and its conditions for use, developed during a PhD work (Feschet et al., 2012). It links the added value generated by the change in the value chain and the progress (after a certain delay) of the average life expectancy of the general population of the country where this change is occurring, provided certain conditions are met.

The "Wilkinson pathway" is a general relationship on a macro-scale also, presented in Chapter 11. Built thanks to post-doctoral mobility (Bocoum et al., 2015), the pathway makes the link between change in the value chain, change in wealth distribution among the population (calculated thanks to Gini coefficient) and change in infant mortality in the population (after a certain delay).

Chapters 12 and 13 are devoted to meso-scale matrix-pathways. Rooted in a PhD work about conditions influencing worker health, the "Siegrist pathway" is a tool for diagnosis of resources and stresses of work, and for anticipating therefore the likely occupational morbidity of workers, depending on work organization. Stemming from another PhD work, the "Wesseling pathway" addresses the human cost of using pesticides in intensive agriculture. This cost is mainly paid by the workers of the agricultural part of the value chains, who are frequently exposed to pesticides.

Combining various sources of knowledge (Chapter 14) to capture the nature and value of anticipated social impacts is a good compromise, bringing together several methods. Chapter 14 reminds us the necessity of sound analysis of the case context, and displays the different possible sources of information. Using the framework of capacities (Garabé and Feschet, 2013) may provide a relevant pattern for presenting results to decision makers, to backers of the study, or to any stakeholder.

When it comes to anticipating social consequences of one given change on the ground, very often, the consultant asks stakeholders to imagine the nature of the impacts to be assessed. Nevertheless, to get sound outputs, it is worthwhile to set a fair process of interaction with stakeholders. Chapter 15 addresses the tricky topic of interacting with stakeholders of the value chain (Mathé, 2014). It describes principles for sound participation (with the PII method), and displays several field practice examples.

Chapter 16 deals with the interpretation of results, which must be planned from the start. It depends on the chosen method. The chapter highlights the advantages of the pyramids, because they display a hierarchy of social impacts according to the resulting health (both public health and health of rural households) in developing countries.

To prevent future disappointment, it is worth knowing how the decisions informed by scientific works are actually taken, in the real world. Chapter 17 discusses the different

options (from Hoppe, 2005). Social LCA must therefore be considered as providing learning tools, rather than direct decision-making tools.

Introducing environmental or social norms inside an organization is likely to generate innovations. Chapter 18 has searched through the literature on this subject. Actually, the very effect of norms on innovation likely relies on three phenomena: i) strengthening of team work; ii) opening the mental boundaries of the company, thanks to life cycle thinking; iii) manipulating and appropriating tools to cope with the new norms. Details are provided in (Silveri and Macombe, 2017).

2. Main topics addressed

During the researcher school, several scientific issues have been discussed with specific accuracy. In this section, we turn back to the issues of "setting a fair perimeter", "functional unit and linearity", "uncertainties", "use of pathways" and "role of participation". We try to report on the discussions, and to underline the solutions borne by our team for social LCA.

2.1 Setting a fair perimeter

In environmental LCA (ELCA), it is worth making a distinction between foreground and background processes. Indeed, it is neither possible nor reasonable to study all the processes with the same accuracy. Foreground processes will be studied with great details, while background processes will not. For instance, to study the environmental footprint of the "production" step of the life cycle, we can often use national data as background processes, and primary local data (collected for the purpose of the study) as foreground processes. For social LCA also, is it worth making a distinction between background and foreground processes? We shall show that there is no equivalent of these concepts in social LCA.

In ELCA, practitioners often report that they assess "products" or "services". Of course, they do not assess products or services – which are inert things. Actually, they assess the environmental consequences of the existence of such a scenario to deliver the product or service. If one needs to answer a question like "what is the preferential ecological scenario to provide customers with the service X? Is it scenario 1, scenario 2 or scenario 3?", we need to make a comparison between the outputs of the scenarios 1, 2 and 3. Then, we encounter two alternatives.

- If the scenarios likely introduce marginal changes in the strategic arena of the value chain underpinning the life cycle, we can perform "comparison of products", using attributional ELCA only.
- If the scenarios likely introduce important changes in the strategic arena of the value chain underpinning the life cycle, the change likely makes other actors move

(besides those involved in the value chain under scrutiny). It is therefore meaningful to perform what is called "consequential ELCA".

In social LCA, we deal with the level of organizations (including unitary processes), and not with the level of unit processes. We look at the organizations obviously linked by the value chain of the product/service under scrutiny first, but we cannot stop at this point. Indeed, we consider that social change is seldom "marginal". We guess that the initial change entails other changes affecting other organizations outside the main (first studied) value chain. Thus, **we always perform the equivalent of "consequential ELCA", in the terms of ELCA**. But in general, instead of using economic modelling (this would be a possibility) we prefer to use "strategic modelling".

Thanks to experts in the domain, we try to anticipate the significant moves of the organizations involved, in response to the change under scrutiny. Then we account for these moves, to anticipate their social consequences. The process has been described in (Lagarde and Macombe, 2012). Thus, setting a fair perimeter in social LCA implies that the perimeter will include all the organizations really affected by the change, inside and outside the main life cycle.

2.2 Functional unit and linearity

For years, **ELCA** practitioners have been used to handling the "functional unit", which is the atom of life cycle analysis! Indeed, it is the smallest part of the problem. By definition, the functional unit is the service rendered by the existence of one defined quantity of product/service, with defined qualities (e.g. the service rendered by one kg of Golden apples at maturity). Of course, for the sake of simplification, the functional unit takes into account one service only.

Among many advantages, the first one is as follows: the studied change affects one functional unit, so is considered as marginal, in industrial mass production cases. In other words, removing or adding one functional unit would not affect the structure of the life cycle itself. That is why we can perform "attributional" ELCA to determine the materials and energy flows consumed and released by the processing of one functional unit. **It is assumed that the case corresponds to mass production.**

Also, the concept of functional unit allows comparison of different life cycles providing the same functional unit. A given functional unit can be provided by different scenarios in the same value chain (Golden value chain stemming from technical itineraries A and B), and even by scenarios affecting different value chains (Golden value chain versus Reinette value chain). **It is therefore assumed that certain products are equivalent to each other** (they render all the same services), because they are equivalent on the basis of the functional unit alone (which considers one single service).

The third advantage lies in the possibility to extrapolate the environmental damage caused by processing one functional unit, to the environmental damage caused by thousands of functional units. As it is done by a simple application of the rule of three,

it means that the function behind the relation (between number of functional units and magnitude of damages) is linear. **It is therefore assumed that the relationship between functional units and magnitude of impacts is linear.**

Clearly, it is impossible to start from the same three assumptions in social LCA, and especially when implemented in agro-food systems, because i) In general, practical cases still correspond to mass production, but not always: everyone will recall attempts of social assessments studies for small value chains or even for artisanal products; ii) Very often, agro food systems deliver several main functions at the same time (e.g. income for the farmer, food and status for consumer...). As a consequence, the products/services delivered by different value chains are not equivalent in terms of social effects; iii) at least, we do not know even a single case where the relationship between units and social impacts would be always linear. To address these concerns, what to do? We will take an example, for sake of clarity.

In social LCA, we assume that we must answer the question: what are the social impacts of implementing the scenario A, instead of implementing the scenario B (which can be the present situation). For instance, we must determine the social impacts caused by the change from the present state B (no cows) to scenario A, which would produce 10 t of cow milk per year. Figure 1 depicts this example. B represents the situation of a deprived region with modest agriculture (without cows) in one developing country. A represents the scenario where the region is producing 10 t of cow milk per year, self-consumed. The corresponding impacts of changing from B to A are called: Δ LEX (variation of the LEX expectancy); Δ IMR (variation of the infant mortality rate); Δ Lit (variation of literacy); Δ Gini (variation of income inequalities) and Δ WD (variation of incidence of diseases caused by polluted water).



Figure 1: Representation of the impacts of the change between B and A

Thus, the question about functional unit and linearity becomes here: "**what can I say about scenario C, producing 20 t¹ of cow milk per year ?**". The focal point is that the relationship between number of tons of milk and magnitude of social impacts is

¹ Just as a matter of comment, we underline that the number of t delivered by the scenario is only one aspect of the scenario. This aspect is highlighted in ELCA, because quantities of damages are supposed to be in proportion with quantity of produced goods. But it is not the case in social LCA.

not linear, in general. Nevertheless, **for one given impact pathway, between certain thresholds**, real relationship may be approximated by linearity (for 20 t of milk, the social impact "variation of income inequality" may be double that for 10 t of milk), or by constant function (for 20 t of milk, the social impact "variation of literacy" has the same magnitude as for 10 t of milk).

C stands for the scenario where the region would produce 20 t of cow milk, and the corresponding impacts are similar. Figure 2 depicts the impacts of the change from B to C, in comparison with the impacts of the change from B to A.

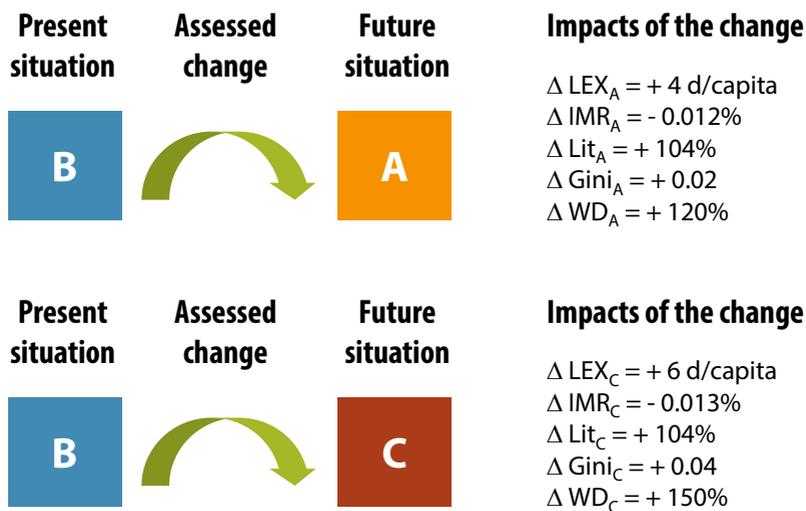


Figure 2: Representation of the impacts of the change between B and C, in comparison with the impacts of the change between B and A

In practice, thresholds can take several forms. They can be accounted for by setting conditions for use of the pathway. For instance, when we set the condition for use "set in poor country" about the Preston relationship, it means that for countries above the threshold of \$10 000 per capita per year, the function between extra added-value and progress in life expectancy is not linear. Another way of accounting for the thresholds is using "matrix pathways". The matrix pathway accounts for irregularities in the relationships between one variable (e.g. resources available at work) and impacts (e.g. health impairments). In the matrix, each box means that thresholds are met.

As a conclusion, the "functional unit" can be defined in social LCA and ELCA alike. It can be the same², which can be useful for presenting results to policy makers. But the possibility of extrapolating magnitude of impacts through the number of functional units is not the same. Each pathway has its own rules in this matter (extrapolation of the magnitude of the impact to the number of functional units). Defining the functional unit is less useful in social LCA than in ELCA. In social LCA, the focal issue is defining scenarios.

2.3 Uncertainties

When performing social LCA study, we are sure to deliver results tainted by many biases. For instance, when calculating the social impacts in terms of change in life expectancy, we do not think that the result is meaningful in itself. Indeed, even if econometric results are given with the conventional error deviation, there are many other causes of bias (is the modelling perfect? Are the data fair? etc.). Nevertheless, two scenarios will be prone to the same bias. This assumption is sound **only if the two scenarios are set in the same context**. Indeed, if scenario 1 is set in context 1, and if scenario 2 is set in context 2, then the differences observed in the outputs cannot be attributed to the difference alone between scenario 1 and scenario 2. The unknown influence of contexts 1 and 2 are causes of an unknown part of this difference.

The only reasonable way to soundly attribute the actual outputs to the change itself alone, is to make a comparison between two scenarios set in the same context, with the same baseline. Other considerations about uncertainties in social LCA are given in the paper (Macombe, Loeillet and Gillet, 2016).

2.4 Use of pathways

Can a pathway like the Preston pathway be used to assess one product? For which kind of decision maker are the pathways made?

Of course, the pathways do not assess the "product". Each pathway contributes to assess one specific social effect/impact caused by changes in the product value chain. In fact, each pathway is designed on one given specific scale, and affects a specific target population (which experiences the impact). Moreover, one given pathway addresses mainly specific categories of decision makers only. Table 1 sets out the pathways already scientifically built, and their main features.

All these pathways refer to issues which are identified among the most important from the "social determinants of health" (WHO, 1999).

² In general, the functional unit is set by the ELCA study. The social LCA study involving the same real system can adopt the same functional unit... but cannot draw the same conclusions about extrapolation of quantities.

Name	Scale for the pathway	Specific target population	Main categories of interested decision makers	What to do?
Preston	Nation, group of nations, large region	The general population	Government, national agency, European Commission, social planner etc.	To compare large scale projects generating different added values.
Wilkinson	Nation, group of nations, large region	The general population	Government, national agency, European Commission, social planner etc.	To compare large scale projects generating new repartitions of income in the population
Wilkinson region	Region with administrative autonomy	General population of these regions	Government, national agency, European Commission, social planner, regional administrations etc.	To compare projects generating different repartitions of income in the regional population
Siegrist	Plant, plantation, workshop, organization	Workers in the life cycle	Central firm of the value chain, trade unions, other organizations involved in issues of well-being at work	To choose work organization improving well-being at work.
Wesseling	Plantation	Workers in the agricultural steps of the life cycle	Plantation (cropping head), Central firm of the value chain, trade unions, other organizations involved in issues of well-being at work	To design new crop systems lowering the risk of exposure to pesticides for agricultural workers.

Table 1: Pathways developed in the research program in social LCA

2.5 Role of participation

When handling a case study, one can feel quite "deprived". Indeed, the available pathways are few, and many other issues (than the ones addressed by established pathways) are likely at stake. When it is easy to locate the affected stakeholders, it is intuitive to think: "I am asking people what they feel about the consequences of this change". For sure, the target populations are privileged informants. But it is not so simple for several reasons.

As depicted in Chapter 8, using participative methods to capture future impacts rests on several assumptions. Sometimes, they cannot be met. Either no-one knows what will happen if the change occurs (then, we must use prospective methods with a

variety of experts). Or someone knows... but does not want to tell because it would be dangerous for him/her, or because he/she want to keep information for his/her own usage. More often, it is really difficult to find the relevant stakeholders: either because who will be affected is unclear, or because the most affected people are hidden. Frequently, the interaction can be difficult, because the topic is too "hot", or too sensitive...or, conversely, when no-one is interested in it. As emphasized earlier, we assume that it is worth implementing participatory methods when the study aims at appropriation first.

For all these reasons, when it comes to **social assessment only**, we suggest to gather information from all the possible sources (statistic data, papers, reports, experts, available stakeholders...) without investing time and energy in setting and implementing sound protocols for participation. Nevertheless, we cannot help thinking that – maybe – we miss some important social impact by processing as such. That is the reason why we advise **focusing on the sentinel populations**. The sentinel populations are the most marginalized and deprived people among the stakeholders (Botta and Bousquet, 2017). If the effects of the change are neutral or favorable for them, it is likely that the change will be globally favorable for the society as a whole. Indeed, reducing inequalities (whatever their nature) within a population can be seen as a social good.

We will conclude this second section by presenting the possibilities of social LCA. In the majority of cases, it is possible to answer questions of decision makers as such "what are the main social impacts of changing this agro-food value chain from this situation to this other situation?" The answer will be given in qualitative terms for some impacts, and in quantitative terms for others. The decision makers often have the legitimate expectation to obtain knowledge about environmental and social impacts of single scenario. Some from the potential environmental impacts will be highlighted by ELCA (by consequential ELCA, or at least by comparative ELCA). The main potential social impacts will be depicted and/or calculated by social LCA. Both ELCA and social LCA will use the same functional unit, but above all, will use the same scenario of change.

3. Future research program

The remaining task is huge! As highlighted during the researcher school, the quest for pathways is not completed. For instance, even if the "Wilkinson region pathway" has been built for Québec (Canada), it has not been demonstrated in other regions yet. Other pathways depicted in the pyramids (links between the value chain functioning and education and health, or infrastructures and health...) must be established³. Any help is welcome!

³ By "establishing a pathway" we mean demonstrating the nature of the relationship, its scale and limits, its formal shape (if any) and its conditions for use (including thresholds).

In the same vein, it would seem important to set the equivalent of the pyramids for intermediate and for developed countries also (Wilkinson & Marmot, 2003; Wilkinson & Pickett, 2009). Thanks to some authors (Rostila et al., 2012) we have obtained sound clues that social goods are effective in offsetting the health impairment effects of income inequalities, in developed countries. Likewise, new case studies are welcome to test new findings. Implementing the whole method in easy-to-use software is another medium-term objective.

On top of the social LCA method itself, we assume that it is time to think about alternatives to certifications, standards, norms... concerning agro-food value chains. We expect that environmental and social LCA will be helpful in the new panorama which is emerging.

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0 A historical outlook for understanding the enduring reluctance of some people about objectivated quality

Petri Felix-Melastic

Lobbyists of all kinds will soon fight each other in Brussels about the ongoing project for the directive "Quality first". You may joke or worry about it, or you may treat this with the same importance as you would about the correct quantity of cellulosis that is required in a diaper, the fact is that France will not speak with a unique voice, nor even with a harmonious polyphony. By the fact, even in the U.K., pro tradition voices often cover the steady tune of market evolution. Indeed, local producers in the European countries maintain diverse folklore alive, and significant and historical companies may play songs of the same repertoire when it suits them.

French networks of giantmarkets and virtualmarkets are the one who speak louder against the directive. Some regional food companies have brandished the same banners and claim that neither their brands nor the history of their products should be forgotten.

As for worldwide-class agrofood corporations, they have their gentle and canny way. They let anyone who is willing to hear them know that defending producer brands, in the ultraconnected world of today, is, well, less meaningful... Nowadays, every single product can be traced and localized. Marketing and net-publicity experts know how to attach quality and hedonic information to each product. Corporations need not maintain caravans of aging brands, and need not invest fortunes in launching new ones. With today fast audiocultural translation technologies from Transient© and YuHang©, publicity can seamlessly be deployed at high speeds on the goodiescans of consumers worldwide. It can still reach the old ubiconsumax that you may find in certain remote areas of southern countries.

Already, on each product, a logolabel identifies the company that is responsible of quality information. The referencing framework has been adopted worldwide. The

quality guarantor is today more important to the client than the company who sells the product. The logolabel carries a certificate. The goodiescan does the rest. Every citizen is aware that the true job of a retailer, whether a giantmarket or a mini-shop one, is to welcome the client, tactfully arouse emotions that are appropriate for immediate or differed buying, and, at last, deliver right and straight away.

It is rather obvious that the French cultural specificities about production and sales do not weigh very much on the European and worldwide debate of today. Consumers of our regions have other concerns. Nevertheless, we have considered in this survey that information with cultural bias was not unuseful if it could help to gain a historical perspective on the evolution of brands and consumer landmarks.

In this spirit, we have questioned a few academic experts in the department of history of cultural and sales traits in Paris-Dolphin University.

When things moved from producer to consumer

Says professor Léo Dupartre, in the 1970s, France supported the installation of what was called then "*grandes surfaces*" (superstores). The political objective was to allow many people to access a wide range of products for an affordable price. This social and consumerist policy was in line with urban policies to dynamise and structure the growth of big towns' peripheries. The young researcher Maxou Parnassius wittily jokes about what appears today as a paradox : the movement of creating «superstores» was favouring the retailer as a prominent and powerful intermediate between producers and consumers, yet, at least at the beginning, the producer brands got in fact reinforced.

Markets naturally drove to an economic rationalisation of domestic supply. Types of products were standardised, yet each brand advertised to the consumer about the link it had, still, with the producer. The consumerist optimism of the time, based on an ideal of equality with regards to consumer access to well identified food goods, eased the grouping of food industries that were now able to have their products on the shelves of many superstores in a country. Then, internationalisation of brands which at the time only concerned few brands really took off. It is hard to acknowledge today that consumption was at the time based on product names that had more to do with cultural connivance between producer and consumer than with the intrinsic qualities of the goods.

Maxou Parnassius has dived with delight in the commercial archives of the time, merely those from magazines, that were printed then, and from tv ads. He had great fun while reading the multiple names. He deduced from these that brands were meant to set up enjoyment and connivance between consumer and producer.

From the so-called "crisis" to social and ecological rationalisation

During what was called then "the crisis", which started with the economic turmoil around oil in the 70s' and steadily set up itself from the 80s' on, the superstores began their emancipation, with discourses advocating about social progress.

In fact, they had undertaken to display on their shelves, besides products with producer brands, some products sold under their own brand. The prices of those products were attractive when compared to the "traditional" products. Off course, when it became obvious that the so-called "crisis" was on the contrary a systemic trouble, that was in the 90s' and 2000s', the phenomenon extended. Besides "basic and economical" products with sober or grim packaging, retailers started to develop lines of products that were more and more sophisticated and with attractive packaging. So, in a progressive way, the system converged to a sort of influence equilibrium, within the shelves (it was then customary to browse those while driving a caddie), between products stamped with "producer brands" and products stamped with the "retailer brand". Maxou Parnassius is ironic again when he tells about the lines of "local and regional goods" that were proposed by retailers that had become companies with a European dimension. As a matter of fact, before governments intervened to clarify things, there was a lot of confusion between the local culture marketing signal and the more prosaic notion of geolocalised origin. When you compare with today's situation, which is far more objective, one may say that the Protected Geographical Indication (PGI), which was grounded on a well specified typicity, was indeed a significant step towards the better.

With the raise of concern about sustainable development – a notion it is today hard to believe that yesterday citizens could hope they had not to bother with – it was only natural that public authorities created the market conditions that would signal the scarcity of resources and the recycling costs to the consumer. The high officials of the European Union had trained themselves and worked out carbon markets, linked to greenhouse gas emissions, down to consumer level. In giving an economical reality to these carbon markets, without creating a local and dissimulated protectionism, they had achieved a political feat. International associations for environmental protection, and later on, those associations involved in social and economical equity issues, were pioneers. They brought forward the idea that the quality of a product was not plainly intrinsic. Quality also had to qualify the impact of production, and, in fact, of the whole product life-cycle, on our lives and our planet. These associations were trained to the now established concepts of sustainable development, and they had succeeded in creating a market based on values and rhetoric. What was left to do was only to formulate the scientific and politic bases that are required for a durable economical organisation. Concomitantly, multiple theories about corporate social and environmental responsibility were elaborated. Nevertheless, it took a long time before this emerging and global cultural awareness gave birth to actual and significant political actions by governments and before evolutions in international economical policies could be observed. In fact, change came thanks to major food

companies, which, because of their multinational dimension, were able to catalyse negotiations between states, academic institutions and associations of activists. These negotiations allowed for a renewed acknowledgement of the respective roles of producers, consumers, and sales, more in line with the 21st century modernity.

International economical actors on the move

With the kind pressure of a few majors, some ten years ago, the WTO set up one hundred research centres dedicated to the design of quality labels and made possible the financing of a strong international network of analysts, computer scientists and mathematicians. Pragmatic WTO required that each centre would hire linguists and cultural agents, beside researchers from the environment and social sciences. Let there indeed be no mistake: with today's labels, the point is not only, as it was at the beginning of this century, to ensure consumer quality of a product. The point is also, and this is a driving force for both consumers and labelling societies, to coordinate resource sharing at world level, including appropriate use of arable lands. WTO keeps a watch on the globe so that there are enough societies having a critical size and that a proper market of concepts is maintained. Production methods should evolve as a consequence.

Off course, when it comes to onerous goods, or the ones that are most emblematic to national cultures and economics, objectivated quality is to be promoted with pragmatism. Then, the implementation plan of the directive does not enforce the primacy of logolabels on car manufacturer brands until 2045. *Chi va piano, va sano.*

Supplement

Outline of presentation (acting performance)

- Talk by Petri Felix, consultant
- Testimony by Mrs Mechu, a woman anxious about sustainability of her home made food
- Interactions with Mrs Mechu by Mrs Taylor, fond of kitchen robots, and Mr Ferrari who is for smart fridges and more generally smart data management in the kitchen.

This article was originally distributed as a copy of section « Values & Economy » in the Swish journal (issue January 2027). The slogan of the Swish journal is « The journal that goes beyond applied and meta humanities ». Attached to the article is a short outline of the presentation involving a testimony by several consumers of the time. Petri Felix-Melastic is a pseudonym for speculative, and often tentatively humorous, work in writing and in acting by Olivier Naud.

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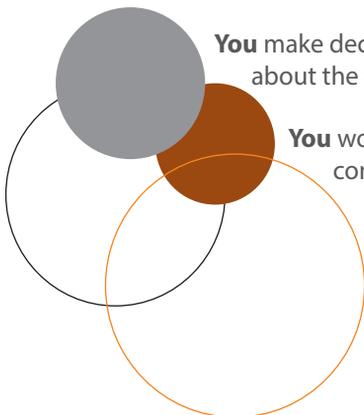
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You make decisions about the future of industrial sectors.

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 idea of this Research Training Course arose from the need to take stock of the research programme on social impact assessment (rather than performance), known as “Social LCA of pathways.” The aim is to give new impetus to this programme.

It addressed the issues of epistemological positions, founding theories, research objects definition, system boundaries, proximities/differences with environmental LCA, conceptual models indicating the nature of impacts, consideration of participation, calculation of impacts, and implementation on the ground.

This book is compiled from the presentations and discussions held during the researcher school.



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