Social issues in classical and social LCA: from identification of overlaps to an integrated framework

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1. Context and scope

In order to come to an overall Life Cycle Sustainability Assessment (LCSA), it has been stated many times that classical (environmental) Life Cycle Assessment (LCA) should be extended with economic and social impact assessment like Life Cycle Costing (LCC) and Social Life Cycle Assessment (SLCA). This methodological framework reflects the concept of sustainable development as defined in the Johannesburg World Summit on Sustainable Development (UN, 2002). Indeed, according to this definition the sustainability principle should integrate the three pillars of economy, environment and society, also referred as 3P approach: people, planet and prosperity. LCA has first emerged as a tool for environmental management, based on the compilation of physical exchanges in between the natural environment and the human/industrial environment (energy and materials) and the assessment of the environmental impacts directly attributable to a system throughout its life cycle.

The importance of understanding social aspects of supply chains and their cost and benefits for human societies have been increasingly recognized. SLCA and LCC methodologies are aimed at addressing these aspects, complementing the information provided by LCA on the environmental aspects. However, it is questionable whether LCA assesses the environmental impacts only, as stated in the ISO definition (ISO 14044, 2006), or if it already includes socio-economic aspects. This is particularly evident in the impact assessment of natural resources, based on the assumption that decreased availability of resources will damage human systems. Beyond scarcity, the security of supply of mineral raw materials has become a high-priority theme in the political agenda of many countries, especially those highly dependent on imports. The need of taking into account in LCA economic and geopolitical aspects that can reduce resource availability has been acknowledged (Schneider et al., 2011, Mancini et al. in press), and is debated if they should be accounted in LCA or in SLCA (Mancini et al., 2013).

Establishing clear domains between LCA and SLCA implies the definition of what we want to protect or promote using one methodology or the other. Traditionally, the three Areas of Protection (AoP) in environmental LCA are Human Health, Natural environment and Natural resources (EC - European Commission, 2011), but the inclusion of the AoP "Human Dignity and well-being" was proposed by Dreyer et al. (2006) to supplement the existing ones through SLCA. The Prosuite proposal for an integrated sustainability assessment framework to be used in LCA includes five impact categories: Human Health, Social Well-being, Prosperity, Natural Environment and Exhaustible Resources, broadening the scope of LCA to the three pillars of sustainability.

Impacts on human health due to physical exchanges in between the ecosphere and technosphere are typically accounted for in environmental LCA, in terms of Disability-adjusted life year (DALY) or quality-adjusted life-year (QALY). Human health is also accounted for in SLCA, but typically taking into account impacts on different stakeholders, often caused by socio-economic conditions, e.g. labor conditions. This suggests that there may be an overlap between Social and Environmental LCA: both target to quantify impacts on humans caused by a production and consumption cycle. At a second glance, the identification of this 'overlap' might be a source of rethinking social impacts; indeed, both environmental LCA and SLCA envisage the same AoP "Humans" (health, dignity, well-being) but starting from other causes. In this sense, further analysis might result in recognizing some complementarity instead of overlap.

Given the above picture, this paper aims at contributing to the scientific discussion on the scope and field of domain of LCA, in relation with the SLCA and LCC. This is done through: i) an analysis of the overlaps of contents among existing areas of protection ii) the proposal of a framework for the AoP 'Humans' based on the application of cause-effect mechanisms and the integration of bio-physical accounting with economic accounting in the assessment of production and consumption systems.

2. Analysis of the Areas of Protection and proposal of an integrated framework

While the AoP natural environment (also defined as "ecosystem quality" in the UNEP classification (UNEP/SETAC Life Cycle Initiative, 2011)) has a pure environmental focus, the inclusion of natural resources and human health in the environmental assessment is less straightforward. Natural resources, in particular, are at the edge of natural and anthropogenic systems, as they are extracted from the natural environment to feed the economic production systems. The impacts due to resource extraction and use are very different and depend on the life-cycle stage. At the cradle (i.e. before the resource use), resources extraction can negatively affect the functioning of ecosystems, therefore negatively impacting the natural environment. Moreover, availability issues can rise, especially for the non-renewable resources. The risk of resource depletion, and its future consequences on human wellbeing, is currently accounted in LCA

through the resource depletion impact category. Even though this issue is commonly included within the environmental assessment, the consequences of limited resource availability are likely to affect the human societies primarily. Resource scarcity can also result as a consequence of temporary disruptions in the supply chain. This aspect is closely related to the concept of "resource criticality", and regards the risk of supply of raw materials due to geo-political reasons. In the criticality assessment socio-economic aspects like, e.g. governance of the producing countries, market concentration and import dependency are taken into account (EC - European Commission, 2014; Graedel et al., 2012). Resource criticality, even though not included in the mainstream practice, is starting to be considered in the (environmental) LC impact assessment methods. Despite of its socio-economic nature, the integration of this aspect in LCA appears to be much more feasible than in SLCA, due to the accounting in physical units and the compilation of mass flows inventory that is commonly practiced in LCA (Mancini et al., 2014). Other social aspects linked to resource supply chain can be captured in SLCA and they refer to, e.g., labor conditions, human rights violations and sharing benefits from resources extraction with local populations. These aspects are considered in this methodology also because they need the involvement of different stakeholder categories and the magnitude of the impact is expressed in terms of risk and working hours.

Human health is accounted in environmental LCA with the aim of quantifying the changes in both mortality and morbidity that are associated with goods or services and caused by various types of environmental stressors induced by 'elementary flows' at the ecosphere/technosphere interphase. According to Dreyer et al. (2006) SLCA should embrace a broader understanding of the human life, and not be limited to the life expectancy. Health is one of the three prerequisites for protecting human life, together with dignity (i.e. to live a decent life and enjoy respect and social membership) and basic needs fulfillment (i.e. the access to food, water, clothes, medical care, etc). Therefore, the AoP human health in LCA can be considered a sub-set of the wider area AoP 'Humans', including Human Health, Human Dignity and Well-being, the latter two more addressed in SLCA.

This brief analysis highlights that, in spite of the formal definition of environmental LCA, the methodology does not account environmental impacts only; the metrics used in the assessment (physical, economic, etc), seems to be the main criteria for the inclusion of an aspect in a methodology or in the other, rather than the nature of the impact itself. Some aspects like natural resources, however, are multifaceted and need a more holistic assessment.

3. Proposal for an integrated framework to cover social issues in (S)LCA

Classical environmental LCA is based on a life cycle inventory, i.e. listing all resources extracted from and emissions released into the environment. This physical exchange

between the environment and the human-industrial sphere is the starting point of so-called cause-and-effect chains that impact AoPs: the natural environment, natural resources and human health. However, human health and other impacts on humans are not only affected by this cause-and-effect chain that is initiated at the ecosphere/technosphere interphase. Indeed, Humans as a broadly defined AoP can be threatened by other causes within the human-industrial environment or technosphere.

So if one aims at a holistic analysis of impacts on Humans as AoP due to the life cycle of a product (including resource extraction, processing, design, manufacturing, retail, distribution, use, collection and re-use/recycling/energy recovery/disposal), we may propose two types of cause-and-effect chains that impact the AoP Humans. First, there is the cause-and-effect chain typically considered in environmental LCA, see Figure 1 at left hand side: it starts from flows in between the ecosphere and technosphere. After their inventory, they are translated into impacts on the classical AoPs. With respect to Humans, the considered health effects can be local, short term, global and/or long term.

Secondly, the aforementioned set of life cycle stages of a product does not only result in physical ecosphere/technosphere exchanges, but also in a number of economic exchanges within the human-industrial sphere that impact humans as well, see Figure 1 right hand side. Over the life cycle, we identify two basic economic exchanges that can be identified as a starting point of a cause-and-effect chain and that are situated within the technosphere. First, there is the exchange "labor for income", to be situated in the production phases: humans receive money in turn for their labor. This first exchange can be the starting point of a first set of cause-and-effect chains that impact humans. On one hand the labor conditions can cause several effects on humans as typically recognized in social LCA (child labor, excessive working hours …). On the other hand this exchange provides income so that the employee or employer receives income he can spend to meet his needs. This latter impact is a positive impact; positive impacts are rarely considered in a cause-and-effect context in LCA.

A second economic exchange is "expenditure for products and services": humans spend money to acquire products and services. This exchange is clearly at the use phase in the life cycle. Again, the exchange can be seen as the starting point of two kinds of cause-and-effect chains. First it results in exposure to products and services that may impact health or even safety of humans when they are not properly manufactured. Second and maybe more importantly: the acquisition of products and services helps in meeting needs of people, hence in a positive impact.

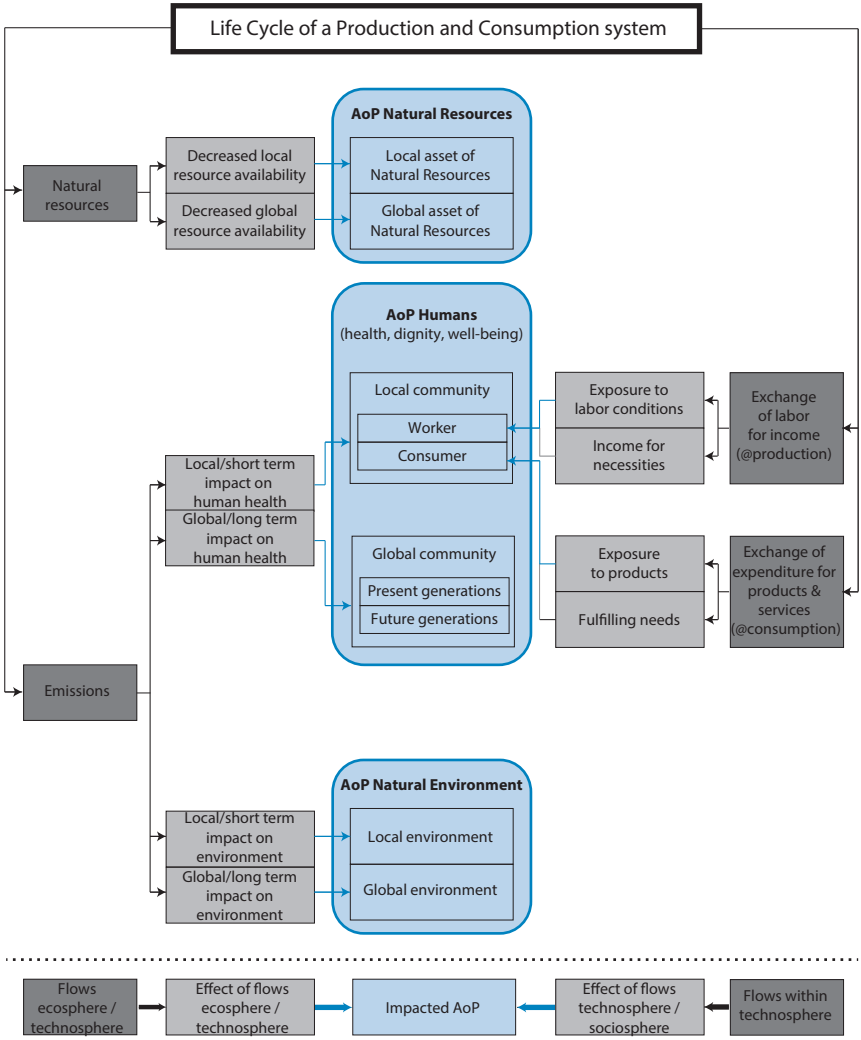

Figure 1: Proposal for an integrated framework to assess impacts on Humans in (S)LCA as AoP next to other AoPs as a result of a production and consumption system (top), through effects as a result of two types of causes: (1) elementary flows as in classical environmental LCA (elementary flows in between ecosphere and technosphere) (left hand side); (2) economic flows within the technosphere (right hand side). Arrows represent negative impacts but positive ones (effect of income for necessities and fulfilling needs) as well.

In summary, the life cycle of a product results into both physical exchanges in between the ecosphere and the technosphere, and in economic exchanges within the technosphere. These exchanges result in four types of negative effects on the AoP Humans (health, dignity, well-being):

- Local/short term impacts on humans caused by emissions (impacts mainly on health)
- Global/long term impact on humans caused by emissions (impacts mainly on health)
- Impacts on humans caused by exposure to labor conditions (impacts mainly on health, safety, well-being)
- Impacts on humans caused by exposure to products (impacts mainly on health and safety)

Secondly, there are also positive impacts as a result of a product's life cycle to be recognized :

- Income for necessities for humans as a result of the labor offered into the product's life cycle (at production)
- Meeting of needs for humans as a result of the consumption of the product's use phase (at use)

4. Conclusions and perspectives

Social issues are part of both classical (environmental) LCA and SLCA. The aforementioned sections revealed that both aim at quantification of impacts on Humans as AoP, but typically as a result of other causes, ending in the conclusion that both frameworks are rather complementary, although with some overlapping. A holistic analysis of cause and effects chains that impact Humans as AoP have been proposed. This may be ground to a better integration of social and environmental LCA. A next step may be a quantification of impacts of both physical and economic nature in a similar way, ideally on the basis of a same unit. In a first phase, at least negative impacts may be considered. Basically, there is the possibility of the quantification of labor conditions in terms of QALYs (instead of risk hour equivalents) (Weidema, 2006). Even positive impacts have been approached in a similar way, e.g. the QALY concept is typically used in health economics to assess the benefit of the intake of medicines as product (Whitehead and Ali, 2010).

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