TOWARDS AN OVERALL FRAMEWORK TO ASSESS THE SUSTAINABILITY OF THE USE OF NATURAL RESOURCES

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Abstract

Over the years, the sustainable supply of natural resources for the global economy has drawn increasing political interest. The efficient use of resources is a fundamental issue for sustainability assessment, entailing and affecting environmental, economic and social aspects. It is not surprising that they hold a central role in many different sustainability assessment frameworks. In conventional life cycle assessment (LCA), natural resources are considered as one area of protection (AoP). It is well recognized that the typical approach of this AoP starts from the provisioning function of resources, but natural resources however are also dealt with in totally different frameworks. If one starts from an ecological point of view, provisioning services is only one role natural resources fulfill next to regulating, cultural and supporting functions, all captured by the Ecosystems Services framework.

The access to certain resources is a further issue of concern for policy. The identification of the so-called Critical Raw Materials for EU took into account their economic importance for specific sectors and supply risk, the latter being focused on concentration of supply from producing countries showing poor governance and low environmental standards, in turn mitigated by substitutability and recyclability of the materials.

Further on, there is no doubt that resource exploitation and use may affect several social aspects (e.g. working conditions) as can be identified by the Social Hotspot Database, and that emissions generated along their use in supply chains (from extraction to manufacturing, use and end of life) might affect human health and natural ecosystems, other two areas of protection in conventional LCA.

This presentation proposes an integration of the aforementioned frameworks aiming at depicting an overall framework to assess the sustainability of the use of natural resources.

Keywords

Natural resources, area of protection, critical raw materials, ecosystem services

1. THE FLOW OF NATURAL RESOURCES AS A FRAME

Natural resources play a key role in fulfilling functions to meet the needs of humans. It is of utmost importance to use natural resources in a sustainable way. At the cradle, we can differentiate resources, such as: land area, sea area, flow resources (solar irradiation, water, wind and tidal currents), water, metal ores, minerals, fossil resources, nuclear ores and atmosphere/air (1). It must be said that natural resources are quite broadly defined here: they

are the source not only for materials with mainly a material function (e.g. ores as natural resource for copper as a mineral commodity), but also for materials that can have both a material and energy application (e.g. fossil oil as natural resource for manufacturing chemicals and for producing diesel) and even for energy functions only (e.g. wind currents as a natural resource to produce wind power electricity as primary energy carrier).

Natural resources are extracted from nature by the primary production sector, which makes use of growing, harvesting, mining and/or refining as key operations. Primary production sectors include biomass producing sectors (agriculture, forestry and fisheries), the mining sector, and the renewable energy production sector. After primary production, natural resources can be named as raw materials or primary energy carriers, depending on their further applications. Raw materials will have in the end mainly material functions (e.g. refined metal), whereas primary energy carriers (e.g. natural gas) will be mainly used as utility for heating, cooling, pressurizing etc. Primary energy carrier forms are basically the first type of energy carrier that is made available to human activities.

After the primary production, the processed natural resources are used as raw material or primary energy carriers into manufacturing, i.e. incorporation of the natural resource into a final product. It must be said that the manufacturing sector can also rely on recovered or recycled energy and materials embodied in waste streams and by-product streams, substituting and saving raw materials and primary energy carriers derived from virgin natural resources.

Finally, natural resources embodied into the end product go into their application, i.e. in the product at disposal of the consumer/user. At the end of their application, the so-called end-of-life, the natural resources embodied into the product might be a source of materials or energy; alternatively they may give rise to emissions into the environment.

This life cycle of natural resources affects many sustainability issues as it interacts with all key areas of sustainability: the planet, the people and the economy. A proper sustainability assessment framework could enforce a sustainable management of natural resources as this can become a key constraint if we are aware of the limited availability of some natural resources and the increasing demand caused by a growing world population.

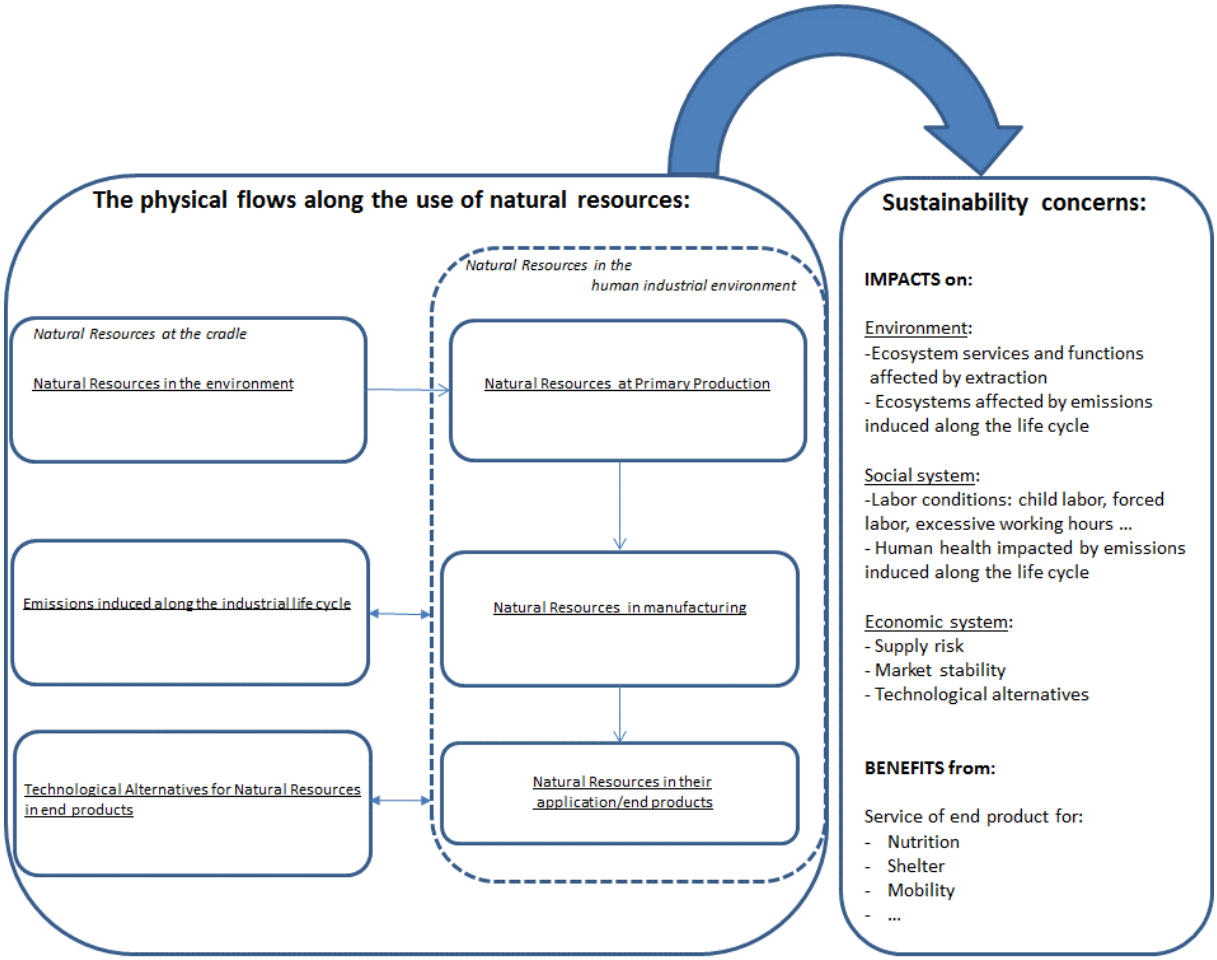
2. SUSTAINABILITY CONCERNS ALONG THE LIFE CYCLE OF NATURAL RESOURCES

If we like to develop a framework for the sustainable management of natural resources, there is the prerequisite to identify the issues of concern for sustainability when natural resources are extracted, and further processed, used and disposed as raw materials, energy carriers, intermediates and final products. Given this complexity and the complexity of sustainability, a way to structure the identification of sustainability concerns may follow the natural resources along their life cycle. This is represented in Figure 1.

For natural resources in the natural environment at the cradle, we can identify their role in ensuring adequate ecosystem structure while interacting with biotic systems for providing ecosystem functions and services for life support. From an economic point of view, the capacity of suppliers to meet demand maximizing benefits from mineral natural resources to present and future generations is to be considered.

At the primary production stage, sustainability issues include concerns for social and ethical aspects such as labor conditions (child, forced, excessive working hours). In addition, the role of resources that can play a role in conflicts, the so-called conflict minerals, may need attention.

Figure 1. Physical flows along the use of natural resources



Further on, when the processed natural resources are available as commodities and primary energy carriers for manufacturing, economic concerns arise: market stability (volatility) and supply risk, induced by geopolitical supply constraints and the lack of technological alternatives.

Finally the natural resources embedded into final products reach their application, where finally the benefits of the products are identified as they contribute to human wellbeing in provisioning of food, shelter, transport …

Along the entire chain, one should be aware of physical flows that are interlinked with this supply chain. Indeed, throughout the life cycle emissions are generated that may impact both the ecosystems and the human health through cause-and-effect chains assessed through LCA.

3. TOWARDS AN INTEGRATED SUSTAINABILITY ASSESSMENT FRAMEWORK FOR THE USE OF NATURAL RESOURCES

The aforementioned concerns are quite diverse in their nature, location and time throughout the use of the natural resources. Some particular sustainability assessment frameworks heavily concentrate on specific concerns, e.g. life cycle assessment is a well elaborated quantitative framework that is able to characterize the impact of emissions onto ecosystem quality and human health along the full life cycle. The ecosystem services framework looks to the broader role of natural resources in an overall perspective, i.e. not only from a provisioning point of view, but also the role of natural resources in habitats, in regulation and in cultural functions (2). Other framework focus on social issues, e.g. social life cycle assessment concentrates on labor conditions, whereas other policy documents (3) look at the role of resources and materials in conflict zones. Policy makers are also concerned about the security of supply because geopolitical strategies and the application of protectionist measures (e.g. trade barriers, quota on exports etc.) can affect the market mechanisms, increase the price volatility and threat the supply of resources. Other vulnerabilities that can be considered as factors of risk of supply are lack of substitutes or recovered materials. The latter issues are typically analyzed in a criticality assessment framework (4).

Bringing a consistent, coherent and mutually exclusive set of properly defined sustainability areas of concern is quite challenging, as most existing frameworks typically focus on a limited subset of sustainability concerns and where sometimes an overlap can be identified, e.g. human health is both an issue in environmental LCA and social LCA. Nevertheless, as these specific frameworks have reached a certain level of maturity, it is useful to search for an integrative approach, which is an essential next step if humans and their policy makers strive for an integrated sustainability assessment for the use of natural resources.

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