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Life cycle assessment-based consumption footprint indicators to address environmental and social Sustainable Development Goals and their interplay

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A. Abstract

1. The Consumption Footprint is a Life Cycle Assessment (LCA)-based set of indicators that quantifies the environmental impacts of the production and consumption patterns of EU and EU countries. Hence, the indicators primarily address the SDG12. However, the methodological framework is flexible to allow application at different geographical scales. The indicator fills the gap on missing official statistics on the environmental impacts of the consumption patterns of countries, and can be used as well to address social impacts. Mapping the environmental and social LCA indicators assessed by Consumption Footprint with the 17 SDGs, there is a broad thematic coverage. Moreover, for the environmental dimension, the Consumption footprint indicators are linked with the estimates on the Planetary Boundaries, allowing the assessment of the level of sustainability of production and consumption.

B. Keywords

Consumption footprint, SDG12, life cycle assessment, planetary boundaries

C. Introduction

2. The Sustainable Development Goals (SDGs) require a set of indicators to monitor their achievement. However, the indicators considered so far employ traditional metrics that limit the proper assessment of trade-offs and interplay between goals and targets. For example, the SDG12 has a set of indicators addressing the impacts of resource consumption and different environmental impacts of each resource, while lacking to cover spill-over effects (Schmidt-Traub et al., 2017). With the aim of achieving higher degrees of sustainability in consumption and production patterns, it is upmost to consider the impacts associated to trade, as highlighted also in the European Green Deal (EC, 2019). The use of indicators that focus only on the domestic performance can lead to partial conclusions on the evolution along time of sustainability performances. For example, while the EU domestic footprint decreases over time showing an absolute decoupling of the environmental impacts from the economic growth, the EU consumption footprint is increasing, due to the inclusion of the impacts of trade (Sanyé Mengual & Sala, 2023).

3. When assessing the sustainability of production and consumption systems, Life Cycle Assessment (LCA) (ISO, 2006a, 2006b) may play a significant role as method to assess the impacts along the entire supply chain. Indeed, LCA has been increasingly integrated in EU policies during the last decades (Sala et al., 2021). LCA is a systematic and comprehensive quantitative method to assess the environmental impacts due to resource use and emissions to the environment along the life cycle of products. As well, LCA allows assessing the environmental impacts due a large number of environmental pressures (i.e., resource use, emissions to the environment), adopting a relatively limited set of impact indicators. Therefore, such approach enables to identify potential trade-offs among life cycle stages and among environmental impacts, as well as to identify hotspots along the supply chains and possible burden shifting.

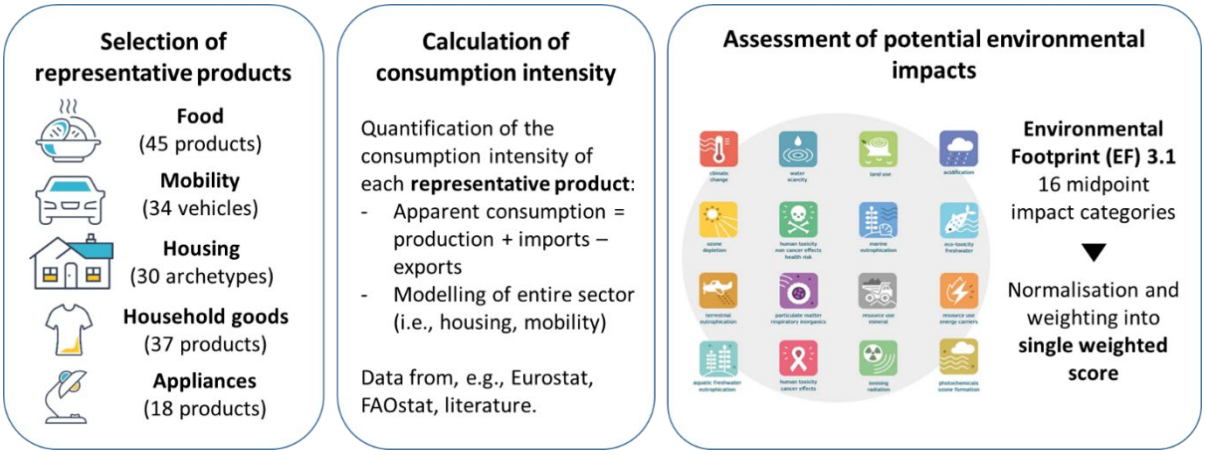
4. Given the lack of current official statistics of consumption footprint at country level, there is the need for model-based indicators that quantify the impacts of consumption patterns considering not only domestic impacts but also those embedded in trade. For this purpose, the European Commission – Joint Research Centre developed the Consumption Footprint, a set of LCA-based indicators to quantify the impacts of production and consumption patterns in the EU. This paper introduces the indicators and explores the link to the SDGs framework.

D. The Consumption Footprint: an indicator to assess impacts due to consumption

5. The Consumption Footprint (Figure 1) is a set of 16 LCA-based indicators to quantify the environmental impacts of an average EU citizen, thereby considering also the environmental impacts embedded in imported goods (Sanyé Mengual & Sala, 2023). This is a full bottom-up model based on the consumption of goods in five areas (food, mobility, housing, household goods, and appliances), which represent the most impacting areas of consumption according to available studies. For each area of consumption, a "Basket of representative Products" (BoP) has been defined including the collection of consumption intensity data and the assessment of the environmental impacts of the life cycle of each representative product through LCA. Currently, the Consumption Footprint includes a total of 164 representative products and the same modelling principles are considered for all products1. To evaluate environmental impacts, the Environmental Footprint method (EC, 2021) is employed including 16 different environmental impact categories or as a single score.

[1] Specific publications are available by area of consumption: food (Castellani et al., 2017a); mobility (Castellani et al., 2017b); housing (Baldassarri et al., 2017); appliances (Reale et al., 2019); and household goods (Castellani et al., 2019b).

Figure 1
Overview of the Consumption Footprint structure (from Sanyé Mengual & Sala, 2023)



6. The Consumption Footprint can support policy making through different uses, including:

- **Identifying environmental hotspots**, at a high level of the granularity (from identifying environmental issues with the highest relevance, to evaluating the most relevant aspects along the life cycle of a product).
- **Monitoring** the evolution of impacts associated with changes in production and consumption patterns. This may be strategic for monitoring e.g. how much EU is decoupling environmental impacts from economic growth (Sanye-Mengual et al., 2019), the benefits of transition towards circular economy, the ability of EU to remain within planetary boundaries (Sala et al., 2020) The Consumption Footprint is a headline indicator of the 8th Environment Action Programme (European Parliament and Council, 2022) and the Circular Economy monitoring (EC, 2020) frameworks.
- **Setting a baseline against which testing policy options and scenarios**: the modularity of the indicators can formulate scenarios affecting not only lifestyles but all the stages along the supply-chain (from raw material extraction to end of life) as well as technological changes in the life cycle of products. For example, the 1st Zero Pollution Outlook included the Consumption Footprint Outlook (EC-JRC, 2022).
- **Evaluating lifestyles and consumption patterns**, which can be compared to EU and Member State average lifestyles. Citizens can assess the impacts of their patterns through the web-based Consumer Footprint Calculator (Sala et al., 2022).
- **Identifying transboundary and spillovers effects**, since the indicators could unveil the trade footprint, namely the magnitude of impacts embodied in imported goods (Sanyé-Mengual & Sala, 2021).

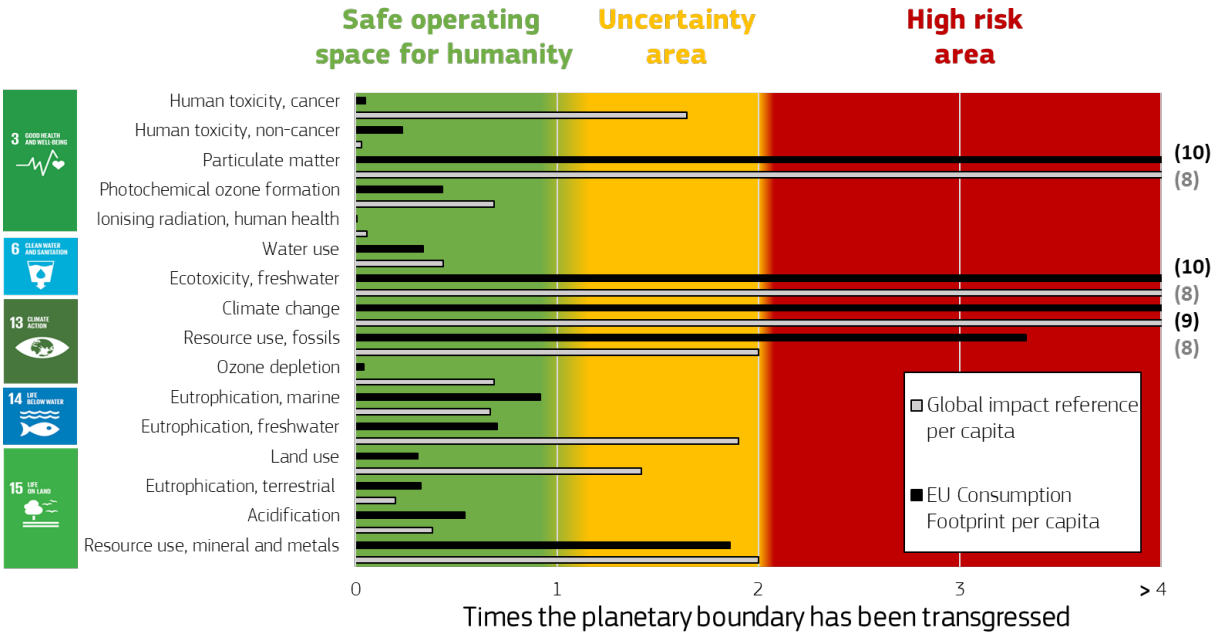
E. Linking environmental impacts with the SDGs framework

7. The Consumption Footprint was originally designed to evaluate progress related to the SDGs (especially SDG12 on responsible consumption and production). The Environmental Footprint method provides a broad coverage of environmental aspects, from climate change to toxicity, and can be mapped to many SDGs and targets of the framework (Sanye-Mengual and Sala, 2022). The indicator can be used to monitor trends along time of the overall impacts in relation to SDG12 and can as well

evaluate how the different impact categories related to other SDGs (3, 6, 13, 14, and 15) contribute to the overall impact.

8. An added value of the Consumption Footprint is the potential linkage between SDGs and the Planetary Boundaries (PBs) framework (Rockstrom et al., 2009; Steffen et al., 2015). The PBs have been operationalized to be used with the Environmental Footprint method, thereby allowing to understand how the most critical environmental issues are related to the different SDGs. For example, current impacts in the high-risk area due to EU consumption patterns are associated to SDGs 3, 6 and 13 (Figure 2).

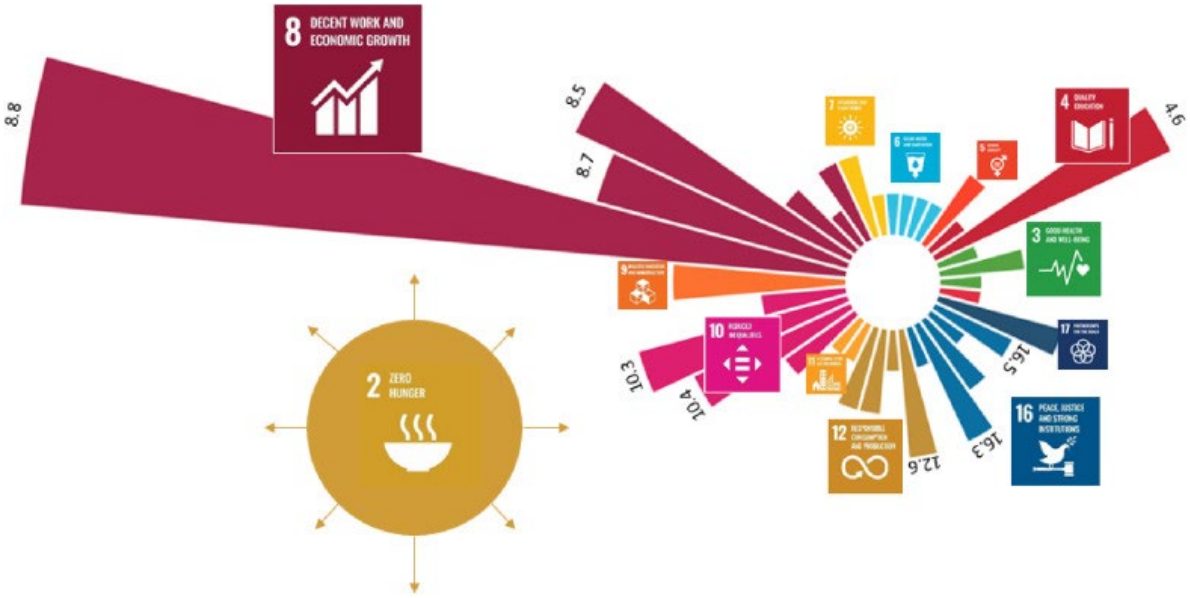
Figure 2
Linking the SDGs with the Planetary Boundaries through the Environmental Footprint set of impact categories: assessment of the Consumption Footprint per capita (2018) (adapted from Sanyé-Mengual & Sala, 2023)



F. Linking social impacts with SDGs framework

9. The Consumption Footprint model can be employed also to evaluate the social impacts of consumption patterns through social LCA methods. An analysis of the social footprint of EU food consumption was performed for 2015 (Mancini et al., 2023). The study was the first attempt to map existing indicators of social footprint in LCA (PSILCA database) with the SDGs framework at target level. Thirteen SDGs were covered by the PSILCA indicators, highlighting the relevance of SDG 8, while SDG2 was considered to be addressed horizontally being the assessment focused on sustainable food systems (Figure 3).

Figure 3
Mapping of social footprint indicators with SDGs framework at goal and target level (from Mancini et al., 2023)



G. Conclusions and outlook

10. The Consumption Footprint model enables the assessment of the entire supply-chain to go beyond the common scope of official statistics, i.e., having mainly a territorial perspective. Towards the achievement of global sustainability goals, a footprint approach considering the entire supply-chain and a consumption perspective is key. Considering the impacts embedded in imported goods allows considering as scope the overall 'responsibility' of consumption patterns of countries. While the Consumption Footprint was designed targeting the assessment of SDG12, combining the assessment of the environmental and social footprints of EU consumption from an LCA perspective can provide information related to the broad scope of the SDG framework. With the PBs framework providing an absolute sustainability approach to the assessment of macro-economic systems, the opportunity of linking the SDGs with the PBs framework allows to evaluate the contribution to global sustainability beyond the assessment of trends. Future developments might explore the potential link with the social dimension of the Doughnuts Economics, which defines minimum criteria for well-being.

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