Ying Xuea, Yazeed M. Aleissaa, Bhavik R. Bakshia

aWilliam G. Lowrie Department of Chemical and Biomolecular Engineering,

The Ohio State University, Columbus, OH 43210, United States

Bakshi.2@osu.edu

Abstract

Mot

**Citations appear as:** Y. Xue, Y. M. Aleissa, and B. R. Bakshi, 2022, TITLE

**Keywords**: Safe and Just Space, Multi-scale sustainability assessment, supply chain design

References

Y. M. Aleissa, and B. R. Bakshi, 2022, Meeting National Food-Energy-Water Needs in an Environmentally Safe and Socially Just Manner, Submitted.

Y. Xue, and B. R. Bakshi, 2022, Metrics for a nature-positive world: A multiscale approach for absolute environmental sustainability assessment. Science of The Total Environment, 846, 157373.

B. R. Bakshi (editor), Engineering and Ecosystems: Seeking Synergies for a Nature-Positive World. in preparation. Springer, 2022.

‘Nature positive by 2030’, ‘Net zero CO2 by 2050’, etc. have been widely accepted as global goals. To achieve these goals, impact of human shouldn’t exceed nature’s carrying capacity. Assessments methods, sustainability metrics have been developed for guiding decision makings and system designs. Life cycle assessment (LCA) is a well-recognized method for quantifying environmental impacts over a product’s life cycle. However conventional LCA only focuses on quantifying the impact of emissions and resource use nature's ability to mitigate emissions or provide resources.

Absolute environmental sustainability (AES) incorporate the role of nature into assessment. The multiscale framework Techno-ecological synergy based on ecosystem services determines absolute environmental sustainability precisely at any spatial scale []. Instead of directly downscales planetary boundary which most AES research do, TES encourages nature restoration, brings in high geographical resolution which motivates precise assessment and design. An open-source web-based software for TES is developed. Similar as life cycle inventory data, the ecological data inventory is constructed including carbon sequestration data over US at current stage.

This approach can be used in sustainability analysis, process, and supply chain designs. We demonstrate this through the design of bio-based Polylactic acid (PLA) supply chain. To achieve the ‘Nature positive’ goal, this supply chain is designed considering economic, social (safe and just) and environmental (nature’s carrying capacity) simultaneously and integrated with LCA.

Anders Bjorn, Manuele Margni, Pierre-Olivier Roy, Cecile Bulle, and Michael Zwicky Hauschild. A proposal to measure absolute environmental sustainability in life cycle assessment. Ecological Indicators, 63:1-13, 2016.

outline:

~~Short coming of traditional LCA.~~

~~Only conisder the emissions of the process.~~

They do no conisder ecological and social aspects

The way to solve this is nature positive, and just decisions

We propose an approach to identify the safe and just space that will guide engineering decisions and designs.

Quantifiying the ecologically safe space . (Ying’s Work, approach and tool)

Quantifiying the just space is achieved by (Yaz’s Work) quanitifying the minimum need from ecosystems to meet the dmenad of local populations in terms of food energy and water. These need can be phyiscally quantified and connected to the supply of ecosystems through the necessary emissions of energy generation and food production in the study area.

This approach can be used in sustainabaility analysis, process, and supply chain designs. We demonstrate this through the design of bio-based Polylactic acid (PLA) supplychain.

(Wrtie about the expected outcome of example)