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Setting the Common Ground: A Generic Framework for Material Flow Analysis of Complex Systems

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Abstract: Circular economy is currently characterized by various definitions, measurement approaches, and critical analyses thereof coexisting alongside each other. Whether the concept eventually prevails or collapses will depend to some extent on our success in harmonizing assessment methods among public, scientific, and private institutions, as well as across different materials and scales. Therefore, in this article, we present a generic material flow analysis framework that might serve as a common basis for circularity assessment, and test it by means of three case studies. It proved impossible to eliminate all subjective assumptions when transforming a real complex system into the generic framework, especially regarding the definition of by-products. However, by introducing subsystems it is at least possible to make such assumptions transparent. Therefore, adequate comparability across regions, materials, and scales is provided. Moreover, the generic system allows for coupled analysis of multiple materials simultaneously so that interactions between them can be studied, as well and a deeper insight into overall sustainability of the system can be gained.

Keywords: resource interaction; circularity indicators; socioeconomic cycles; material flow analysis; assessment framework; by-products; cyclical use rate; phosphorus; nitrogen