Life Cycle Assessment for Brownfield Management Decision-Making

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Decision-oriented environmental evaluation of urban contaminated sites (brownfields) has mostly been limited to identifying and quantifying hazard and risk, and interventions have been focused on compliance and/or risk management. This approach was proven necessary to ensure human and ecological health on the local scale (primary impacts). However, impacts associated with the actual implementation of brownfield management strategies (secondary impacts), such as resource consumption and pollutant emissions, are rarely considered in decision-making, even though methods and data for their evaluation are available. Also, impacts related to changes in land occupation and urban planning (tertiary impacts), such as reduction of urban sprawl pressure, are usually presumed without verification. Since trade-offs between these three types of impacts characterize the selection of brownfield management options, a need for integrating them has been identified. A quantitative LCA was used for this purpose. This evaluation focuses on reliability and validity aspects of integrating disparate environmental impacts by LCA methods, and this for different applications.

A case study is used, for which distinct LCA models were developed for three environmental decision-making contexts: (1) formulation of implementation strategies in 'dig & haul' remediation projects; (2) choice between brownfield management options for a specific site; and (3) public policy development concerning environmentally sustainable brownfield management. Application dependence of modelling choices, data quality goals, system boundaries, and their impact on overall confidence in results, are considered. The three aforementioned scenarios are evaluated using different types of inventory and environmental data but processed using the same evaluation framework. For primary impacts, high quality site-specific data originating from the physico-chemical characterization is used to consider contaminant flows in the inventory and then develop low-uncertainty site-specific characterization factors for spatially differentiated LCIA methods. Secondary impacts are evaluated using usual LCA data sources for all remediation activities as well as for long-term landfilled contaminant fate. LCI data for tertiary impacts rely on scenario development using urban development data and transport models. The product system, stakeholder involvement procedure, LCA methodology and confidence assessment approach are presented.