IMPACT ASSESSMENT OF URBAN SCENARIOS - AN OVERVIEW

Valentino Tascione*, Raffaella Taddeo*, Alberto Simboli *, Andrea Raggi*
*DEPARTMENT OF ECONOMIC STUDIES - University "G. d'Annunzio" - V.le Pindaro 42, 65127 Pescara, Italy
E-mail contact: v.tascione@unich.it, r.taddeo@unich.it, a.simboli@unich.it;, a.raggi@unich.it

Introduction

To measure the potential environmental performances of a complex system it is necessary to start from a baseline scenario, defined as the situation in which the system is currently, and compare it with and at least one future scenario [1] in which improvement solutions are implemented. At present, the main methodologies for representing and quantifying the flows of anthropic systems are essentially Material Flow Analysis (MFA) and Life Cycle Assessment (LCA) [2; 3]. Their potential remains partly unexplored in the case of urban contexts [4]. Urban Metabolism (UM) has gradually affirmed as the Industrial Ecology approach focused on urban contexts [5]; it traditionally stops at the quantification of mass or energy flows through MFA-based tools (Fig.1). The integration of UM and LCA approaches is able to develop an integrated multi-scale framework for environmental impact assessment also in a UM perspective. In the last years, efforts have been made in this direction; this article, moving from a literature overview, seeks to highlight the most significant ones.

Methods

The authors defined a combined search for the two key-concepts of UM and LCA and refined the results obtained through a qualitative analysis. Sources were retrieved from the Scopus database.

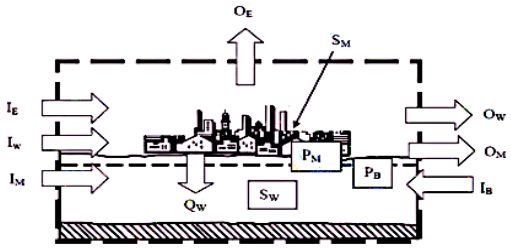

Fig. 1 *Material and energy flows within urban areas: input flows (I), output flows (O), internal flows (Q), storage (S), production (P) of biomass (B), minerals (M), water (W) and energy (E) (Kennedy et al. 2007)*

Results

Mahmoud et al. (2009)	Baynes and Wiedmann (2012)	Goldstein at al. (2013)	Tseng and Chiueh (2015),	Junqua et al. (2016)
Use scenarios to plan *long-term decisions* and *short-term decisions* that have long-term effects. They highlight two types of scenarios found in literature: *exploratory* and *anticipatory* scenarios. The former is related to the extrapolation of trends from the past, projections, and patterns. The latter, that is closer to our UM scenarios, is related to desired or feared different visions - policy-responsive scenarios - of the future that may be achievable or avoidable if certain events or actions take place (e.g. decision-maker policies). [6]	Consider three categories of direct or indirect material and energy flows accounting in the urban context: the *consumption-based accounting* (CBA), the *metabolism-based accounting* (MBA) and the *complex systems approach*. They suggest different kind of tools to assess the environmental sustainability for the CBA and MBA, such as *extended input–output analysis* (IOA) and, more recently, *hybrid input–output life-cycle analysis* (IO-LCA). They point out that to simulate future scenarios dynamic cause-effect relationships needs to be described, and that IO-LCA is better to assess existing scenarios. They also recognize that complex systems include features such as system interactions, feedbacks, network relationships and agency. The disadvantage of such contexts is uncertainty. [7]	Applied a *hybrid model approach integrating UM and LCA* to five global cities. The results of this study show that the UM-LCA helps to identify which parts of the city's supply chain have the higher environmental impact and it can be successfully applied to cities for which the data exists. However, according to the authors, UM-LCA is methodologically immature.[8]	Proposed a study, regarding food waste, in which the analysis of UM is integrated to the LCA method (the so-called UM 2.0) to evaluate 4 different scenarios with different technologies of food waste treatment. Data was collected from the literature, statistics and databases. The authors state that applying simultaneously UM and LCA can provide information on the environmental impacts, as well as about the interactions of flows inside the black box, i.e. the interaction between components. [9]	Propose two valid tools for the assessment of the different options of land planning of a territory: *Eurostat Material Flow Accounts* and *Territorial LCA*. The authors state that these tools are able to propose scenarios integrating global initiatives of circular economy, regulations changes and local action as industrial ecology. They highlight the role of *consequential LCA* in territories with strong interactions between many activities. [10]

Discussion/Conclusions

The results obtained highlight that the joint use of UM and LCA may: i) improve the understanding of how cities consume resources and discharge waste by incorporating flows beyond city geopolitical boundaries; ii) provide a framework for connecting urban flows with resource depletion, human health damage, and ecosystem quality damages; iii) provide rigorous understanding of infrastructure role (e.g. for utilities, water, and wastes management). However, as also recognized by Chester et al [11], the full achievement of these goals implies to reconsider the boundaries of the urban system intended as a residential system, because it predominantly focuses on use and consumption activities and this limits the perspective characterizing life-cycle-based methodologies, which should also include the extraction, production, and end of life stages.

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