Editorial

WM&R

Waste Management & Research
2018, Vol. 36(8) 661–662

DOI: 10.1177/0734242X18793339
journals.sagepub.com/home/wmr
SAGE

Urban metabolism as a key method to assess sustainability of cities

Cities are centres for social and economic development and thus engines to develop urban sustainability. The main issues involved in urban sustainability are buildings, energy, food, green areas and landscape, mobility, urban planning, atmospheric emissions, water and solid waste. Unlike other systems, the complexity of cities makes them difficult to be analysed comprehensively. Currently about 50% of the world's inhabitants live in cities and this is expected to rise up to 80% by 2050. Urban areas are responsible for 75% of the consumption of the planet's energy and resources as well as 80% of global CO_2 emissions. Moreover, cities grow more rapidly than their capacity to cope with environmental pollution and dwindling resources, among other problems making themselves increasingly evident. According to several authors, an urban metabolism disorder is the fundamental reason for these problems and directly affects a city's potential for sustainable development.

In 1883, Karl Marx introduced the concept of urban metabolism as the study of material and energy flows, arising from urban socioeconomic activities and technical and socioeconomic processes over a particular period. Nowadays, urban metabolism can be considered as an extended analogy of biological metabolic processes. On the basis of this analogy, urban metabolism has become a useful method to assess the flows of energy and materials within the urban system, providing key information on its sustainability and the seriousness of urban, social, community and domestic problems from a global scale down to the local level. Additionally, an urban metabolism focus allows for data collection on an urban system's material recycling, waste management and the features of its infrastructure. Standard environmental effects of urban metabolism are described through four types of flows: economic, material, processes and energy. Economic and process flows refer only to interactions between different aspects of urban metabolism, while material and energy flows could describe effects on the environment. Many cities have been examined with this focus, though the various studies carried out have provided no consensus as to the assessment methodology to be employed in analysing sustainability. Material flow analysis (MFA) and energy analysis are the most widely used methodologies in urban metabolism studies.

MFA is an analytical tool based on conservation of mass and it evaluates the inputs, consumption and outputs of material throughout the whole life cycle within an urban system. Unfortunately, MFA uses one unified weight unit for different categories of material, which ignores the diversity of society, economic structure and environmental conditions. Owing to a lack of environmental assessment to facilitate the evaluation of the effects on the interaction between flows and the environment, other methodologies have been used, particularly carbon and ecological footprints, as well as input–output, network and life cycle assessment (LCA). These methods offer different and complementary advantages for urban metabolism environmental assessment. However, substantial variation exists between studies, complicating comparison and exchange of data between them. Despite this, the number of published scientific articles on urban metabolism increased exponentially in recent years, thanks to the integration of emerging technologies, particularly MFA and LCA. The latter subject has increasingly been included in urban metabolism studies, with coverage rising from 8% of published articles in 2008 to approximately 40% in 2018.

The two methodologies have been combined simply in urban metabolism studies, given that any material flow can be considered a 'flow reference' in a LCA. Therefore, material and energy flows entering the urban system can be modelled through a LCA and emissions (liquid, solid and gaseous) from the system into the environment (domestic processed output) can become impacts through classification factors. Methodological problems are heretofore unlikely, as most of the literature focuses on creating a measure to allow comparisons of cities and on the quality and uncertainty of data. In the former case, some investigators suggest developing basic principles for the use of a functional equivalent on which to compare, while for the latter, having more transparent information for modelling environmental effects is key. This is difficult if the representativeness and variety of data in urban metabolism studies remains largely undiscussed or unmeasured, and more so when data uncertainty has been neither analysed nor calculated. Several authors have postulated the need to establish a unified and standardised multilevel category system to support the creation of consistent inventory databases. To this end, where LCA plays a key role in facilitating improvement in urban metabolism studies, data analysis in its interpretative phase and calculating data uncertainty are now part of the discussion.

Results obtained through both methodologies can enable improvement in the certainty and understanding of the environmental impacts associated with the metabolism of a city. In this sense, MFA allows the evaluation in terms of productivity, efficiency and intensity of resources use, while through LCA it is possible to evaluate different impact categories (climate change, eutrophication, acidification, among others) and determine the uncertainty of the results. Specifically, quantifying the environmental impact of waste flow is not only affected by the processes occurring within the city, but also those tied to systems for extraction, production and transport of the materials and energy the city consumes. This can help in defining and prioritising urban sustainability strategies, especially for environmental policy and legislation proposals.

Finally, the analyses of policies, renewable energy, greenhouse gas and solid waste reduction, among other environmental aspects, are crucial and compulsory to improving sustainability. Thus, on the basis of the above information, urban metabolism is a key tool in the assessment and advancement of urban sustainability. Together with other data-analysis methods and environmental assessment, this tool provides a clear and scientifically consistent structure for sustainable short- and long-term urban planning, essential to evolving toward more sustainable consumption and production patterns in cities.

Waste Management & Research serves as a forum for exchanging research expertise and scientific ideas supporting the development and application of urban metabolism to assess cities sustainability. To this end, *WM&R* invites researchers to submit manuscripts that focus on this topic for catalysing the discussion regarding sustainability of urban areas.

Edmundo Muñoz
Center for Sustainability Research,
Universidad Andres Bello, Santiago, Chile

Rodrigo Navia
Department of Chemical Engineering,
Universidad de La Frontera, Temuco, Chile
Email: rodrigo.navia@ufrontera.cl