Available online at www.sciencedirect.com

ScienceDirect

Procedia Environmental Sciences 38 (2017) 635 – 642

Procedia Environmental Sciences

International Conference on Sustainable Synergies from Buildings to the Urban Scale, SBE16

The Environmental Footprint of Cities: Insights in the steps forward to a new Methodological Approach

Nadia Mirabella[a,*], Karen Allacker[a]

[a]*Division of Architectural Engineering, Department of Architecture - Faculty of Engineering Science KU Leuven, Kasteelpark Arenberg 1, 3001 Leuven, Belgium*

Abstract

Cities are complex entities which are constantly evolving, they are responsible for the largest share of most environmental impacts, but provide also major opportunities for improvement. Nevertheless, holistic methodologies to evaluate the environmental footprint of cities are still lacking at the urban scale level. Currently, carbon footprint and water footprint are the most used methods to evaluate the environmental performance of cities, despite their limited scope. The Urban Metabolism (UM) concept allows making an inventory of the flows into and out of the city, but it does not allow to interpret these flows in terms of environmental impacts. Life cycle assessment (LCA) provides this capability, but it is not yet feasible at urban scale. A first attempt to fuse the two approaches was made, but this proposal considers only four environmental indicators.

It is clear that none of these methods can represent the whole environmental picture. Providing a new methodology adapt to urban context and extending the list of environmental impact categories is of paramount relevance to move towards a comprehensive and reliable environmental assessment able to guide cities on a sustainable transition path.

For this reason, the main aims of this contribution are to give a comprehensive and critical insight in the most valuable and current available methods and tools able to assess the environmental burdens of cities, and at the same time trace the steps forward to propose a new methodology that could be capable to overcome the current gaps. This paper presents the first part of a broader research project which aims at developing a hybrid top-down and bottom-up approach to identify the contribution of the main flows at the macro-scale level, but also the main hotspots on the micro-scale level and the potential improvements.

Peer-review under responsibility of the organizing committee of SBE16.

Keywords: City environmental footprint; Urban sustainability; Urban Metabolism; Life Cycle Assessment

* Corresponding author. Tel.: + 32 163 73 427
E-mail address: nadia.mirabella@kuleuven.be,

Peer-review under responsibility of the organizing committee of SBE16.

doi:10.1016/j.proenv.2017.03.143

Nomenclature

LCA	Life cycle Assessment
UM	Urban Metabolism
City EF	City Environmental Footprint
OEF	Organization Environmental Footprint
LCT	Life Cycle Thinking
GHGs	Greenhouse Gases

1. Introduction

1.1. Definition of "city": not an easy task

Starting from the roots of the research subject, it is very important providing a proper definition of the"city". This is usually a crucial point to define, not as much from the semantic point of view, but rather from a technical one, as it involves the definition of system boundaries for the object investigated.

A unique definition of "city" is not yet available, and it is slightly possible to shape it according to the methodologies applied and the goals. Indeed, there are many definitions of a city. The term city can refer to an administrative unit or a certain population density or more generally to the perceptions of an urban way of life and specific cultural or social features, as well as places of economic and exchange activities [1]. Furthermore, the intrinsic uniqueness of each city represents a great challenge to manage, understand and quantify in a proper and robust way its environmental impacts. Hence, so far, the most promising definition could be the one that takes into account not only the administrative boundaries, but also the specific context in which the selected urban system is located. Further considerations are provided and discussed in section 3.

1.2. A complex, but promising entity

Cities are complex entities which are constantly evolving, key player in the evolution of human population. The urban population has constantly increased in the last decades at an unprecedented rate that it is not yet stopped and, on the contrary, it is forecast to increase. In 2050 two-third of the human beings are expected to be "urban", i.e. 6.3 billion people according to the projections [2]. In Europe this share is already visible, and our continent is the most urbanized in the world [1]. As cities concentrate most of the world's economic activities, current urban environmental pressures on planet Earth are high, and they could become even higher if current patterns of consumption will continue at this rate. Considering the great density of people and energies concentrated in the urban contexts, the potential of cities to be drivers of change is similarly high. Decoupling population growth, i.e. potentially leading to a further potential increasing consumptions and wastes, and environmental pressures is crucial to avoid the overexploitation of the planet with irreparable consequences. That will be possible if cities will become really "smarter" and resilient, taking into account the multiple aspects in which city prosper with a holistic approach towards both environmental and economic issues. In order to act efficiently and avoid the risk of burden shifting, it is urgent setting methodological approaches able to gain insight the most important ingoing and outgoing flows and the related environmental impacts on a macro-scale level and the analysis of the parameters influencing them in depth on a micro-scale level. It is clear then that the evaluation and reduction of carbon dioxide emissions should not be the only metrics assessed in the future.

1.3. Context and state-of-art of city footprinting

Although holistic methodologies to evaluate the environmental footprint of cities are necessary, these are still lacking at the urban scale level. Indeed, few metrics exist to evaluate and improve the sustainability of cities. Currently, considering the rising awareness related to climate change and water scarcity, carbon footprint and water footprint are the most used methods to evaluate the environmental performance of cities, despite their limited scope. One of the most widely applied metric to gain insight in the material and energy flows to and from cities is the Urban Metabolism (UM) model that uses a top-down approach, such as Material and Energy Flow Analysis (MEFA) and input/output (I/O) analysis. UM clearly has it strengths as it makes an inventory of the flows into and