



Flows, system boundaries and the politics of urban metabolism: Waste management in Mexico City and Santiago de Chile



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ABSTRACT

In this paper we examine two central concepts of urban metabolism ('system boundaries' and 'flows'), and explore how to approach them as a means to politicise urban metabolism research. We present empirical findings from two case studies of waste management, in Mexico City and Santiago de Chile, looking at: the materiality of waste flows, the actors involved in them, and how waste flows relate to issues of environmental justice. We argue that urban metabolism, as a methodology to understand urban sustainability, has the potential to produce knowledge to trigger urban transformations, and to analyse the social, political and environmental aspects of waste management in urban areas.

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1. Introduction

Urban metabolism is a framework that takes material flows as the unit of analysis to describe patterns of natural resources transformation in cities. Urban metabolism analyses have been used in the field of Industrial Ecology to identify pathways to improve the sustainability of these flows. Yet, because of its emphasis on the environmental efficiency of the urban system as a whole, urban metabolism has not effectively engaged with the institutional and political contexts which shape and are influenced by urban material flows. Calls for a 'politicisation' of urban metabolism have ensued (Newell and Cousins, 2014; Delgado Ramos, 2014), building on a rich debate about the politics of urban metabolism (Heynen et al., 2006; Heynen, 2013; Keil, 2005).

Beyond its instrumental use in eco-efficiency studies, urban metabolism enables deep analyses of the politics of urban ecologies (Castán Broto et al., 2012). Particularly, political geographers have shown that urban metabolism ideas make explicit how politics are embedded in specific forms of material circulation in capitalist economies and the production of new types of urban inequality (Swyngedouw, 2006; Keil, 2005). There is thus a growing interest in the potential of urban metabolism methods of urban

analysis to facilitate just transitions to urban sustainability (Swilling and Annecke, 2012). However, engaging with these questions requires a refinement of urban metabolism's approaches. Analysing the principles and assumptions of knowledge production (their *doxa*) is a means to critically expose the political work of knowledge legitimisation and its governance consequences (Castán Broto, 2013). We suggest that can be done by revisiting two of its central analytical concepts: system boundaries and flows. While system boundaries relate to the delimitation of the problem of study in Industrial Ecology, the concept of flow relates to the ontological assumptions that underpin the conceptions of the city that are mobilised in urban metabolism analyses.

This is evident in the management of urban waste flows. Waste is an object which is conceptualised either as disposable or reusable, through the assignation of meaning as part of its active integration in society (Moore, 2012). From the health impacts of waste management, to the way it supports the interests of diverse actors from waste pickers to global businesses, urban waste flows are embedded in multi-layered systems of governance (Hoorneweg and Bhada-Tata, 2012). The political dimensions of resource flows become explicit in specific contexts: we focus on the cases of Mexico City and Santiago de Chile, to develop a comparative analysis of the influence of urbanisation patterns and local politics on the configuration of waste flows. Urban metabolism serves here as a framework to relate material circulation to the role of different actors in waste collection, revealing context-specific patterns of

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injustice. The comparative analysis suggests that urban metabolism can be appropriated as a method for progressive analyses of environmental injustices as long as its fundamental assumptions are put under critical scrutiny.

2. Understanding the city of resource flows

Urban metabolism is an analytical framework that studies urban material flows; that is, the processes of consumption and transformation of materials in the urban system. An Industrial Ecology approach to urban metabolism follows a functionalist perspective to quantify environmental flows through the urban system in order to manage the city's overall consumption and waste (see for instance: Barles, 2009; Kennedy et al., 2007; Wolman, 1965). Material Flow Analysis (MFA) measures the input and output of materials being consumed and disposed by an administrative region (Brunner and Rechberger, 2004) and Life Cycle Assessment (LCA) tracks materials through their industrial lifecycle (Goldstein et al., 2013). These methods have been used to produce strong accounts of urban material flows (Alfonso Piña and Pardo Martínez, 2013; Kennedy et al., 2011; Rosado et al., 2014), their climate impacts (Delgado Ramos et al., 2012), the resource cycle (Forkes, 2007; Villarroel Walker and Beck, 2012), and the relationship between a city and its hinterland (Barles, 2009). Urban metabolism has been used to study waste flows in both Mexico City (Delgado Ramos et al., 2012) and Santiago de Chile (Wackernagel, 1998), using city-wide data and per capita averages. These studies consider solid waste as a significant flow linked to unsustainable patterns of land use, energy consumption and land/air/water pollution; however, the methods used to produce these quantitative accounts are based on specific assumptions about the urban system, the material flows, and how these can be represented. We argue here that questioning these assumptions is a way to politicize the urban metabolism framework. To do so, we build on a body of literature, often grouped under the umbrella term 'Urban Political Ecology' (UPE), which relates urban metabolism to the production of environmental injustices in the city, as resource flows are embedded in processes of material accumulation (Cook and Swyngedouw, 2012; Heynen et al., 2006). Methodologies like Material Flows Analysis have the potential to reveal material politics as they unfold in urban areas, but only if its fundamental assumptions are put under scrutiny.

The first assumption is one of *system boundaries*: within Industrial Ecology, urban metabolism research focuses on the city as the object of study and frames it as a homogenous, static entity. Once the system boundaries are set around the city, it becomes impossible to look at what happens within, outside or beyond the urban system: material flows become an indistinct "black matter" that veils the specific modes in which the flows circulate and inequalities are embedded in these flows. However, material flows cannot always be studied by looking at the city scale alone: looking at the case of water flows in Mumbai, McFarlane (2013, p. 499) argues that "addressing [...] metabolic inequalities requires more than addressing water alone": this means looking at processes that affect water use, such as housing, water saving practices or agricultural policy. Likewise, it is necessary to look beyond the city scale, within homes, municipal offices, corporate practices, or irrigation pipes (McFarlane, 2013, pp. 498–499). Recognising that natural resources flows are not just material, but are entangled with spatial, social and political practices, which are embedded in a particular place, is a first step towards politicizing urban metabolism research. In order to do so, it is necessary to challenge the conceptualisation of the city as a "black-box", looking instead at processes of urbanisation in the flows are produced and circulated, regardless of their scale.

The second assumption relates to how *flows* are conceptualised. In an Industrial Ecology framework, flows are conceptualised as items that can be isolated in space and time, in order to be quantified. However, framing flows in this way *de facto* restrains which flows can be included in the research: some flows cannot be quantified (for instance, because there is no data readily available about them, or because they evolve very rapidly and thus cannot be estimated for a specific point in time), and thus tend to not be included in Industrial Ecology research. On the other hand, not all the interesting data about material flows is of a quantitative nature. Flows also matter because of the people who interact with the material, which practices these flows enable, and how they distribute power in a context of capitalist globalisation. As such, waste workers, their daily lives, values, and working conditions should be an essential aspect of a waste metabolism analysis. Thus, we propose a conceptualisation of waste flows as dynamic, not always -or not fully- quantifiable, and as related to other components of the urban system, such as society, workers, productive activities, and governance.

Material Flow Analysis is approached not as a rigid framework but rather as a data-gathering tool through which different actors can be engaged in producing narratives about resources flows in their city; the overall objective being to build a political analysis of material flows that is pluralistic and addresses issues of environmental justice (see Guibrunet and Castán Broto (in press) for theoretical background, and Demaria and Schindler (2015) for an empirical example).

3. Debates around urban waste management in the Latin American context

The management of domestic solid waste has implications for all aspects of urban sustainability (UN-Habitat, 2010). In cities where waste collection rates are low, improving the waste management system is first and foremost a public health imperative. Additionally, waste that is not processed properly has negative environmental impacts (such as greenhouse gas emissions or production of toxic by-products). Waste management poses, on the one hand, an economic challenge for local authorities (being one of the highest expenditures of municipalities in low-income countries) and on the other hand, provides livelihoods for the urban poor (up to five percent of urban dwellers in low-income countries). This has both positive economic and social impacts: socially, it provides a livelihood to marginalised urban dwellers (who have no other access to work, because of low education levels, drug addiction, age...). Economically, it provides the basis for a thriving local economy (Ezeah et al., 2013; Hoornweg and Bhada-Tata, 2012; Le Courtois, 2012).

The local governance system (political, legal and administrative frameworks) shapes how waste management services are run (UN-Habitat, 2010). For example, waste management systems are shaped by social and institutional relations including: political interests and clientelism, public administration changes and their timeframes, financial pressures and funding sources, public opinion, relationship between stakeholders (such as existing collaboration, or ongoing conflicts), and the governance capacity of local authorities (Ali et al., 1999; Bhuiyan, 2010; Castillo Berthier, 2003; Ezeah et al., 2013; Schindler and Kishore, 2015; Sembiring and Nitivattananon, 2010). Looking at the case of Mexico, Castillo Berthier (2003) highlights how relations of patronage ('clientelism') and the rule of local leaders or 'caciques' play a defining role in waste management services. Caciquism is a way of making informal politics where an autocratic leader mediates negotiations between civil servants and informal groups. For example, informal waste handlers' right to work in certain areas of the city (for

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