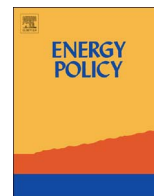




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# Between theory and quantification: An integrated analysis of metabolic patterns of informal urban settlements

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## HIGHLIGHTS

- The policy challenges of fast changing informal urban settlements are assessed.
- Metabolic patterns are used to assess and compare different typologies of slums.
- Semantically open representations are used to capture the complexity of slums.

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## ABSTRACT

As informal urban settlements grow in size and population across the developing world, the issue of how to design and implement effective policies to provide for the needs and the aspirations of dwellers becomes ever more pressing. This paper addresses the challenge of how to characterise in quantitative terms the complex and fast-changing phenomenon of informal urban settlements without falling into oversimplification and a narrow focus on the material deficits of informal settlements. Energy policies are taken as an example to illustrate the shortcomings of oversimplification in producing policy relevant information. We adopt a semantically open representation of informal settlements that can capture the diversity of adaptive strategies used by different settlement typologies, based on the societal metabolism approach. Results show that as settlements grow in size and complexity, they remain economically and politically marginalised and fail to integrate into the city. We argue that in the case of energy policy, the analysis must go beyond the definition of problems such as access to energy at the level of the individual, and focus on a multi-scale assessment including the household and community levels studying the capacity of the household to increase its energy throughput through exosomatic devices and infrastructure.

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## 1. Introduction

Informal urban settlements are a major challenge for governance all around the world. In 2001, it was estimated that about 32% of the world's urban population lived in informal settlements and about 43% of the urban population in the developing regions lived in informal settlements (UN-Habitat, 2003). The challenge posed by informal settlements is that they are complex, show wide variations within and between countries, and change at a very fast pace (ibid). This challenge has been met with a proliferation of very sophisticated scholarly work on the conceptualisation of informal settlements.

A myriad of definitions and terms are used to refer to informal

urban settlements (Nuisl and Heinrichs, 2013; Taubenböck and Kraff, 2014). The term *slum*, coined in the 1820s, was used to refer to the working class accommodation built around factories during the Industrial Revolution (Hardoy and Satterthwaite, 1986) and was up taken in the 1960s to refer to inner-city settlements with infrastructural and service deficits (Eckstein, 1990); in the 1970s the term *squatter settlement* was introduced to refer to illegal housing developments (Hardoy and Satterthwaite, 1986); and *shantytown* designated settlements that developed in the outskirts of cities (Eckstein, 1990).

On the other hand, quantitative descriptions of informal settlements are limited to measurable characteristics. Table 1 reports a few examples of the definitions of informal settlements used by the Brazilian (IBGE, 2014) and South African (Pernegger and Godehart, 2007) governments and by the United Nations (UN-HABITAT, 2003). Quantitative descriptions remain very tied to the spatial and physical aspects of these settlements, and are thus

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**Table 1**  
Official definitions of informal settlements.

Institution	Definition	Characteristics
Brazilian Institute of Geography and Statistics	Subnormal agglomerate	51 or more housing units, characterised by absence of legal tenure and either or both of: (i) Substandard urbanisation, such as narrow and irregular streets, house plots of different size and shapes, and buildings not authorised by public administration; (ii) Lack of essential public services. (IBGE, 2014)
Statistics South Africa	Township	Residential areas that during Apartheid were reserved for non-whites (Africans, Coloureds and Indians), characterised by low-income housing estates and not fully functional neighbourhoods. (Pernegger and Godehart, 2007)
United Nations	Slum	Sites with one or more of the following characteristics: (i) Inadequate access to safe water; (ii) Inadequate access to sanitation and other infra-structure; (iii) Poor structural quality of housing; (iv) Overcrowding; (v) Insecure residential status. (UN-Habitat, 2003)

unable to deal with questions of social inequality, informality, power struggles and political interests that play a pivotal role in the establishment and development of informal systems. As a consequence, the evidence used to inform policy in the case of informal settlements does not keep up with the theoretical developments in the field.

Roy (2005) raises a harsh criticism to the use of formal representations based on location, quality of housing, lack of planning or land titles, etc. because it reduces the focus to the physical characteristics of informal settlements, rather than to the institutional causes of marginalisation, discrimination and systematic exclusion of part of the population, which is forced to look for alternatives in informality. This is the case of the Enkanini settlement, one of the case studies considered in this paper, which was the target of an upgrading programme providing rooftop solar panels to selected dwellers. The programme led to increased tensions and conflict within the community for its failure to consider the political implications of technical interventions. The dwellers of Enkanini have vandalised the shack of the solar panel service provider (Kovacic et al., 2016), showing that the upgrading programme was not perceived as beneficial.

The reduction of the slum phenomenon to a matter of physical characteristics leads to the formulation of policies that are unable to control the expansion of informal settlements and may deepen marginalisation. The eradication of informal settlements does not solve the emergence of informality, it merely leads to the relocation of dwellers to new settlements (Hardoy and Satterthwaite, 1986). For example, the *Favela-Bairro* programme of the municipality of Rio de Janeiro, Brazil, aimed at transforming informal settlements (*favela*) into formal neighbourhoods (*bairro*), focused on limiting the horizontal growth of *favelas* (occupied land), disregarding vertical growth (the construction of multi-storey buildings) and densification (the construction of new buildings inside the settlement) (Vial and Cavallieri, 2009). The formal tenure and social security requirements have led to the marginalisation of the previously integrated work force living in informal settlements (Eckstein, 1990), or to what Lawson (2012) calls adverse integration, whereby informal dwellers are incorporated into existing structures that are needed to maintain middle class privilege.

We argue that the mismatch between the theoretical understanding of informal settlements and the simplifications used by statistical offices to measure and monitor these settlements creates an unnecessary duality between theory and quantitative analysis, which leaves policy in a conundrum. The policies designed to improve living standards in informal settlements are

based on over simplified descriptions (Tipple, 2015), fail to alleviate poverty and to engage meaningfully with informality (Eckstein, 1990), and often worsen social inequalities (Roy, 2005). As a consequence, policies have been limited to (i) the initial attempts at eradication of informal settlements (AlSaiyyad, 2004; Pamuk and Cavallieri, 1998), and (ii) upgrading – a strategy that has not evolved since the 1980s (AlSaiyyad, 2004; Hardoy and Satterthwaite, 1986; Roy, 2005).

This paper addresses the gap between theoretical conceptualisations and quantitative representations of informal settlements by developing a semantically open accounting method capable of dealing multiple epistemologies and retaining some of the complexity linked with the social, ethical, legal and other dimensions of the slum phenomenon. The goal of the paper is twofold: (i) developing a methodology that can be used to articulate a plurality of epistemologies and create a dialogue between quantification and theory; and (ii) assessing the contribution of this methodology in relation to energy policy in the context of informal settlements.

The paper is organised as follows: Section 2 introduces the theoretical approach of societal metabolism used to characterise informal settlements through semantically open categories; Section 3 presents the data and methodology used to define typologies of settlements. In Section 4, we report the results of the methodology application to the two case study settlements considered (one in Brazil and one in South Africa), and explain how the methodological approach makes it possible to account for the multi-dimensional nature of informal settlements and for the differences between settlements. Section 5 concludes and indicates the policy relevance of the analysis.

## 2. Background

Informal settlements are dynamic and fast-changing systems. As reported for the case of Enkanini – the first case study presented: an informal settlement on the outskirts of Stellenbosch, South Africa – the population doubled in a span of just 3 years (Kovacic et al., 2016). This change implies the generation of significant differences both in the population size and demographic structure. This dynamism aggravates the challenge of lack of data on informal settlements, making any survey carried out rapidly out-dated.

A precise quantification of physical characteristics of informal settlements presupposes a closed definition of what constitutes an informal settlement and sets an expectation about what should be

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