



## Probing uncertainty levels of electrification in informal urban settlements: A case from South Africa



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### ABSTRACT

This paper assesses the different levels of uncertainty that affect the analysis of informal urban settlements and the implementation of upgrading policies, with a specific focus on electrification. The rapid growth of informal settlements in the cities of the Global South poses serious challenges to the management of energy systems, particularly when it comes to the electricity grid. Informal urban settlements are characterized by the lack of urban planning and low or absent provision of public services. Exponential population growth increases the complexity of urban planning. An inadequate understanding of uncertainty can undermine the effectiveness of informal settlement upgrading and deepen social inequalities. Based on the case study of the Enkanini settlement in Stellenbosch, South Africa, this paper probes three levels of uncertainty: (i) methodological uncertainty associated with the challenge of estimating energy demand and demographic changes, (ii) technical uncertainty associated with the expansion of the electric grid and securing revenues, and (iii) epistemological uncertainty associated with the definition of the relevant problems and pertinent solutions for informal settlements. The paper highlights how the focus of technical uncertainty displaces the debate on the socio-political challenges of informal settlement upgrading.

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### 1. Introduction

The challenge of electrification (Cities Alliance, 2013; Department of Energy, 2011; UNHABITAT, 2014) and upgrading (Abbott, 2002; Bradlow, Bolnick, & Shearing, 2011; Tipple, 2015) of informal urban settlements is attracting increasing attention in the African context. The upgrading hype is occurring despite the long standing criticism of upgrading policies for their narrow focus on physical infrastructure and space (Hardoy & Satterthwaite, 1986; Roy, 2005), and the failure of upgrading programmes in eradicating poverty and controlling the growth of informal settlements

both in the Global North and in the Global South (Hardoy & Satterthwaite, 1986; Pamuk & Cavallieri, 1998). Informal settlements upgrading focuses on the infrastructural deficits, spatial characteristics and physical living conditions of dwellers, which assume that informal settlements migrants fail to adapt to the city (Abrams, 1964). More complex views of informal settlements recognise them as suppliers of labour to the city (Tipple, 2015), integrated into the socio-economic organisation of cities (Hardoy & Satterthwaite, 1986), where informality is employed as an instrument of social control, economic exploitation, political repression, social stigmatisation and exclusion (AlSayyad, 2004; Roy, 2005).

The most commonly cited problems concerning the electrification of informal urban settlements are: (i) technical issues associated with grid expansion and service provision in low density areas (Department of Energy, 2011; Sustainable Energy Africa, 2014a), (ii) the impact on the load profile and difficulty in estimating energy

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demand in illegal settlements (Gaunt et al., 2012; Madlener & Sunak, 2011), and (iii) securing revenues for utility providers from informal settlement dwellers (Borchers, Euston-Brown, & Ndlovu, 2015; Sustainable Energy Africa, 2014b). We argue that the issues listed above stem from the reduction of uncertainty to technical issues and the failure to address the uncertainty linked to the challenge of meeting unplanned and fast changing energy demand with fixed infrastructure, and to the inadequate institutional arrangements in dealing with complex multi-dimensional issues and the underlying political challenges.

The objective of this paper is to assess how uncertainty affects the analysis of energy demand in townships and which types of uncertainty are taken into account, and which are ignored, by energy policies and upgrading strategies. Several levels of uncertainty (Maxim & van der Sluijs, 2011; Wynne, 1992) can be associated with the challenges of electrification of informal settlements. These include methodological uncertainty, technical uncertainty, and epistemological uncertainty. The paper shows how upgrading policies focus almost exclusively on technical uncertainty to the detriment of a better understanding of the challenges of representing (methodological uncertainty) and defining (epistemological uncertainty) informal settlements, leading to a purported depoliticisation of upgrading policies and deepening of social inequalities. The analysis aims to demonstrate how uncertainties associated with the representation and definition of informal settlements are pivotal to the formulation of policies.

This paper considers the case study of Enkanini, an informal settlement on the outskirts of the town of Stellenbosch, South Africa. The settlement was created in 2006, when the backyard dwellers of the neighbouring Kayamandi township occupied the adjacent land. The occupation was initially negotiated with the municipality and later continued in spite of the resistance posed by the municipality (Keller, 2012). The name of the settlement, Enkanini or “taken by force,” refers to the unauthorised occupation of land through which the settlement was created. The provision of public services is limited to 70 public toilets and 32 water taps (Community Organisation Resource Centre, 2012). Electricity, waste collection services, and medical services are not provided.

The Enkanini settlement has been the target of an incremental upgrading project endorsed by the Municipality of Stellenbosch and funded by the Bill and Melinda Gates Foundation, aimed at providing rooftop solar panels to shack dwellers (iShack Project, 2012). However, the solar panels are only partially able to meet energy demand, and paraffin and gas are still widely used. Moreover, the upgrading project has not solved the tensions between the municipality and Enkanini’s dwellers in relation to the official recognition of the settlement. The case study is indicative of how technical, methodological and epistemological uncertainty affects the understanding of informal settlement dwellers needs, as well as the governance of energy provision.

The paper is structured as follows. Section 2 introduces the Quantitative Story-Telling approach used to analyse complex and fast changing systems such as informal settlements. Section 3 details the data and methods used in the case study. Section 4 presents the results of the application of Quantitative Story-Telling to the assessment of the different levels of uncertainty identified for the case of the Enkanini settlement. Section 5 highlights the limitations of technical solutions in dealing with uncertainty and socio-political challenges, and points at the insights that can be gained through the analysis of complexity.

## 2. Approach

This paper uses the Quantitative Story-Telling approach (Saltelli & Giampietro, 2015) to assess the technical, methodological and

epistemological uncertainty associated with energy provision in informal urban areas. Quantitative Story-Telling addresses the challenge of dealing with multiple non-equivalent definitions of complex issues, or what Rittel and Webber (1973) have named *wicked problems* in the context of planning. Problems are defined as wicked when the problem framing that is used affects the proposed solution. Roy (2005) provides a variety of examples of how different definitions of urban informality lead to the formulation of different policies towards informal settlements, which can only partially address the challenges of these settlements.

Quantitative Story-Telling makes the link between problem framing and quantification explicit, referring to the theoretical framework of hierarchy theory. Hierarchy theory is a branch of complexity theory, which focuses on the role of the observer in the analysis of complex systems (Ahl & Allen, 1996; Allen & Starr, 1982). According to hierarchy theory, quantification is not seen as an objective representation of a given issue, but rather as the result of a series of pre-analytical choices used in framing the problem. Quantitative Story-Telling is an operationalization of hierarchy theory. We speak of story-telling in order to highlight the role of the analyst, not just as a neutral observer of self-evident phenomena, but as an active agent in the definition of what should be observed and how. Different epistemologies are analysed through quantification in order to address the following questions: what insights are gained through each problem framing? What types of uncertainty are taken into account by each problem framing? What types of uncertainty are ignored, or deliberately hidden, by the choice of problem framing?

Quantitative Story-Telling utilises quantitative information in a heuristic way in order to assess the quality of the scientific information used for policy, as opposed to using more data, larger models or more precise quantification to reduce uncertainty. The use of quantification as a means to compare different story-tellings, highlights the ambiguity and subjectivity associated with the quantification. The analysis of uncertainty (presented in the following section) draws attention to the means through which quantification is used to formalise the choice of a given scale of analysis and level of observation (Kovacic & Giampietro, 2015). This approach is particularly useful when dealing with fast changing, dynamic and complex systems.

For example, there is much uncertainty in population estimates. Population estimates cannot be precise owing to the daily occurrence of births and deaths, and migration. For this reason, the population of a country for a given year can only be an estimate of the order of magnitude. Additionally, in the case of informal settlements, large portions of the population are not officially registered (UNHABITAT, 2003) and there is a high level of mobility. Population estimates are very important for policy, as they are necessary to plan for energy demand and supply, food requirements, health and education expenditures, *et cetera*. However, any quantification below the hundreds, or thousands in some cases, is spurious (Saltelli, Guimaraes Pereira, van der Sluijs, & Funtowicz, 2013). What is relevant for policy is the order of magnitude (for example a country of 45 million people, a city of 1.8 million people, a town of 200 thousand people), rather than a precise quantification.

Precise quantification cannot be achieved in the context of uncertainty (Saltelli & Funtowicz, 2014). However, it is possible to observe patterns by combining approximate assessments of the size of the system with benchmarks used to characterize relevant characteristics of the system – for example, the level of consumption per capita, wage levels. It is then possible to analyse general trends and the possible clash against external constraints and/or the emergence of internal constraints. Instead of trying to tame complexity through quantification, Quantitative Story-Telling

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