# The morphology of the Arrival City - A global categorization based on literature surveys and remotely sensed data

H. Taubenböck*, N.J. Kraff, M. Wurm

*German Aerospace Center (DLR), German Remote Sensing Data Center (DFD), Oberpfaffenhofen, Germany*

## ARTICLE INFO

## ABSTRACT

When we think about living environments of the urban poor, slums might be the most immediate association. These slums evoke a more or less stereotype impression of built environments: complex, high dense alignments of small makeshift or run-down shelters. However, this perceived characteristic morphology is neither globally homogeneous nor is this perception covering morphologic appearances of urban poverty in a comprehensive way. This research provides an empirical baseline study of existing morphologies, their similarities and differences across the globe. To do so, we conceptually approach urban poverty as places which provide relatively cheap living spaces serving as possible access to the city, to its society and to its functions – so called Arrival Cities. Based on a systematic literature survey we select a sample of 44 Arrival Cities across the globe. Using very high resolution optical satellite data in combination with street view images and field work we derive level of detail-1 3D-building models for all study areas. We measure the spatial structure of these settlements by the spatial pattern (by three features – building density, building orientation and heterogeneity of the pattern) and the morphology of individual buildings (by two features – building size and height). We develop a morphologic settlement type index based on all five features allowing categorization of Arrival Cities. We find a large morphologic variety for built environments of the urban poor, from slum and slum-like structures to formal and planned structures. This variability is found on all continents, within countries and even within a single city. At the same time detected categories (such as slums) are found to have very similar physical features across the globe.

## 1. Introduction

"*We did not see a mountain full of houses, but rather a house the size of a mountain*" (UTT, 2016). This statement captures the overwhelming impression one gets of informal land occupation capitalizing every inch of urban space in cities across the globe. Organic, amorphous, complex, and dense seas of makeshift shelters have significantly different physical appearances than formal, planned parts in cities (e.g. Fig. 1). With it, the built environment can be an expression of inequality in cities, and socio-economic disparities even become visible from space (e.g. Davis, 2007; Sliuzas, Mboup, & de Sherbinin, 2008). While a first superficial observation may suggest forms of living at the lower end of urban societies feature great similarities in terms of their physical appearance, (informal) processes such as illegal land occupation do not always shape such distinct and demarcating building morphologies and patterns for this social group (Saunders, 2010; Vaz & Berenstein, 2004).

Settlements of the urban poor are by no means a homogeneous physical phenomenon (e.g. Schneider-Sliwa & Bhatt, 2008; Taubenböck

& Kraff, 2015). Nevertheless, most studies describing the physical appearance of such areas are of qualitative nature observing e.g. high building densities or organic patterns as characteristic (e.g. Davis, 2007; Glaeser, 2010); however, relatively little systematic quantitative, spatial research exists about their explicit physical appearance (Hofmann, 2001; Kuffer, Pfeffer & Sliuzas, 2016), not to mention a systematic inventory of morphologic types across the globe.

In this paper, we aim at reducing these knowledge gaps about settlements of the urban poor by an empirical baseline study taking stock of physical building types and determining structural patterns across the globe. Avoiding terminological imprecision and related conceptual restrictions of terms such as 'slum' or 'informal settlement', we base this study on the term '*Arrival City*' (introduced by Saunders, 2010). The term conceptually integrates all places which provide comparably cheap living spaces serving as possible access to the city, to its society and to its functions for rural-urban migrants as well as for the existing urban poor; this conceptual umbrella allows a broader perspective on the specific places and their built morphologies.

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* Corresponding author.
*E-mail address:* hannes.taubenboeck@dlr.de (H. Taubenböck).
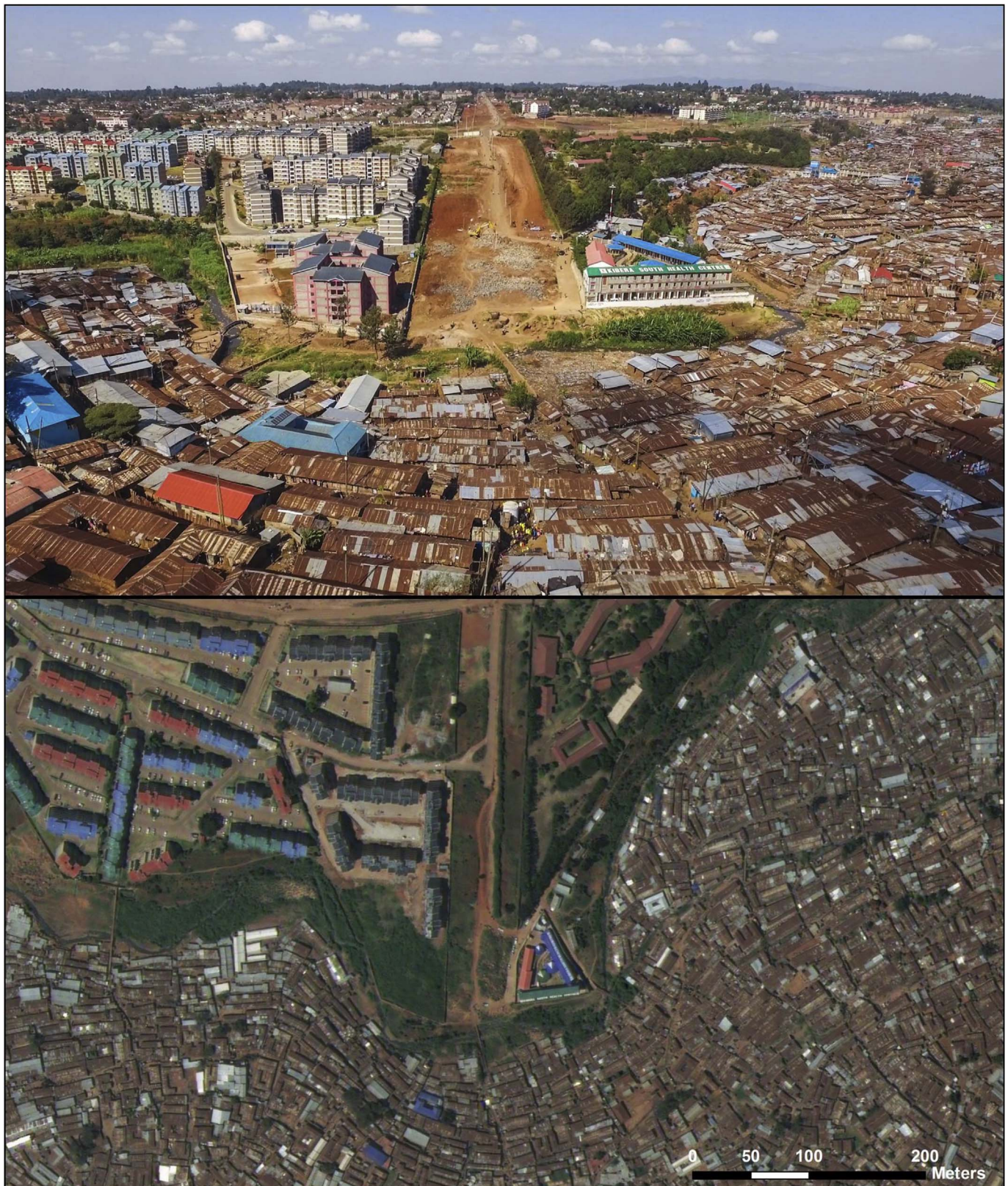
**Fig. 1.** The morphologic appearances of informal versus formal settlements for the example of Kibera, Nairobi; Top: Photography of Kibera: © Johnny Miller/Thomson Reuters Foundation; Bottom: High resolution optical satellite imagery © Google Earth.

Arrival Cities show a large variety of built forms. Earth observation (EO) data are the crucial data source to consistently capture built environments. However, due to conceptual imprecision of the target class, due to challenges for image classifications algorithms in these complex environments and due to unavailability or high costs of appropriate EO-data, spatial data on the level of individual buildings (level of detail-1 (LoD-1)) for the neglected parts of cities are mostly inconsistent, generalized or simply inexistent. The purposeful development of