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## Mapping Transitional Urban Forms From Afar

Ana Ricchiardi<sup>1</sup>

<sup>1</sup> “Transitional Morphologies” Joint Research Unit member, Department of Architecture and Design, Politecnico di Torino, Italy

### Abstract

*Lack of data often complicates research on urbanization processes in developing regions. What is more, carrying out research without the possibility of doing fieldwork has become a challenge to face during the 2020's pandemic. The presented study argues for mapping and urban morphology as potential research methods to explore complex urban environments from remote. Available online resources with maps and satellite imagery can potentially be used as a source of up-to-date geographic information to map settlements and their developmental dynamics from afar. Advances in geographic information systems and satellite imagery provide tools and images to analyze cities' changing morphology. This study proposes a methodology for the mapping and systematic observation of urban forms at different scales. The paper presents an ongoing mapping project to test the methodology in 4 different cities in the context of Sub Saharan Africa, where rapid urbanization has created complex interactions between formal and informal morphologies in recent years. An analytical approach and deductive observation of satellite images help define the areas used to exemplify the urbanization phenomena. The mapping operation is carried out with the remotely collected open-source information. The samples selected are observed in different scales (territorial scale, urban scale, and block scale) and different time frames. This study uses the morphology of a city as a descriptive language that frames the recognized phenomena. In the developed maps, the fact that mapping is not just a matter of establishing facts, but can be a means of constructing spatial knowledge, is put to the test. As this is still an evolving study, the chosen cases are exploratory and may not represent the wide range of informal-formal relations and dynamics, however the opportunity to see the overwhelming changes from a spatial and morphological point of view opens up opportunities for reflections about urbanisations and ways of studying it.*

**Keyword:** mapping, developing regions, informal settlements, remote sensing

### Introduction

The management of urban settlements represents a complicated task for cities' officials, and it is a crucial aspect of the development of a nation. A large part of developing regions is still characterized by rapid urban growth. Due to fast population growth and the volume of younger populations, these regions have more significant challenges to overcome in the coming years (UN Habitat, 2018). Hence, it is of extreme importance for the future of these regions that the decision-making policies are guided by up to date data (White & Engelen, 2000). Urbanization in developing regions has presented vast informal urban settlements. These

settlements have been neglected by formal planning processes, and their management has been constrained by a shortage of information on the settlements and their morphology. Recently, new approaches and technologies have been implemented to create more comprehensive spatial data structures of these settlements and resources such as open-source software and the volunteered geographic information have modified the way researchers and professionals interact with data on marginalized settlements.

The increasing availability of spatial surveying, data processing, and visualization tools has led to the propagation of diverse types of maps that assess situations from afar. Geographic Information System (GIS) allows digital technologies to unveil complex spatial datasets (Tomlinson, 2013) and available online interfaces with maps and satellite imagery provide potential geographic data to analyze cities' changing morphology.

This paper looks at available open geospatial data sources and proposes a methodology for the mapping and systematic observations of urban forms at different scales. The paper presents an ongoing mapping project to test the methodology in four different cities in the context of Sub Saharan Africa. Preliminary results of the test and the comparative analysis of the selected samples are presented ahead.

## **Background**

Urban morphology deals with the knowledge of the logic of urban form (Oliveira, 2016). It involves looking at physical characteristics, structure, relations, and transformations of urban elements and their components. Cartography and mapping are tools to describe these physical and spatial characters. In this sense, mapping is the mechanism by which the dynamics and the logic of the city can be revealed, and it has the potential to be a framework for structuring direct and indirect observations. (Pinzon, 2009). Maps embody spatial knowledge that words or numbers can not replace; and intellectual exchange in planning relies on communication with maps in all formats (Dovey et al, 2018). In this sense, mapping represents a valuable instrument to fuse information and visualize it for understating complex conditions (Abrams and Hall, 2006). The use of geospatial data to decipher the logic of the city and produce maps has rapidly increased in the last decades. The application of such data has influenced the way research is carried out and how it is applied by planners and practitioners.

Open-source datasets containing satellite imagery and geographic information can be used for monitoring urban and environmental events. In particular, the spatial visualization of data can guide strategies of interventions for planning (Fremouw et al., 2020). While traditional satellite and field data analysis continues to be widely used, open-source data has become an essential innovation in the field.

## **Transitional urban forms in Sub-Saharan Africa**

The accelerated speed of urban growth in Sub Saharan African cities has increased demand for housing, infrastructure and services. The lack of data on urban settlements in the region has made it difficult for policy-makers to make prospective allocation and management decisions (Ayanlade 2007). In this sense, urbanization processes in the last decades in the continent have been signed by two scenarios: the first one refers to the continuous growth of informal settlements. The second one refers to the phenomena of private investments that have appeared in the last 20 years. This study sees the co-evolving morphologies coming from these two scenarios as morphologies in continuous '*transition*' (Ricchiardi, 2020b). The term "*transitional*" has been used to describe elements in a state of change or in a state of becoming (Trisciuglio et al., 2021), and it is used as a term to highlight and embrace the dynamic nature of cities. This dynamicity has been confirmed in morphological terms with observations of urban permutations. Typomorphologists such as Muratori, Caniggia, and morphological geographers like Conzen have observed the characters and the evolution of urban form through repetitions that create patterns (Moudon, 1997). Seeing the urbanization processes with this transitional perspective highlights how diverse and fluid morphologies are in urban contexts.

### **Morphological characters of informality**

Until recently, the study of informality represented an overlooked aspect of analysis in morphological terms (Fabricius, 2008; Duarte, 2009; Kamalipour, 2016; MCarney & Krishnamurthy, 2018). However, an increasing interest in the morphological characters of informal settlements has appeared in the last years, and a continuously growing body of literature is interested in understanding the form of informal settlements (Dovey & King, 2011; Carracedo, 2015; Dovey & Kamalipour, 2018; Kamalipour & Iranmanesh, 2021; Dovey et al., 2020). While there are significant variations in density and building types between informal settlements, some morphological uniformity has been recognized: small building increments, narrow lanes, and irregular access networks (Dovey et al., 2020).

The availability of remote sensing data has contributed to the development of ways to detect and monitor the expansion of informal settlements. Maps of these settlements are important for several reasons, probably one of the most crucial being that governments may not be made responsible for the provision of infrastructure and services if it does not exist on a map. On the importance of having spatial data on informality, some authors have pleaded the need for a repository of spatial information about informal settlements (Kuffer et al., 2020; Samper et al., 2020).

A growing interest in informal settlements' morphological traits has also appeared in the Urban Morphology community in recent years. ISUF interventions on the topic have included studies dealing with informal morphologies. The researches have included strategies of intervention (Branko et al. 2020), taxonomic studies (Veneraldi and Mottelson, 2020), urban dynamics (Migliorisi, 2020; Assreuy et al., 2020; Mottelson, 2020 ) morphological public-private spaces (Borges, 2020), and mapping exercises and methodologies

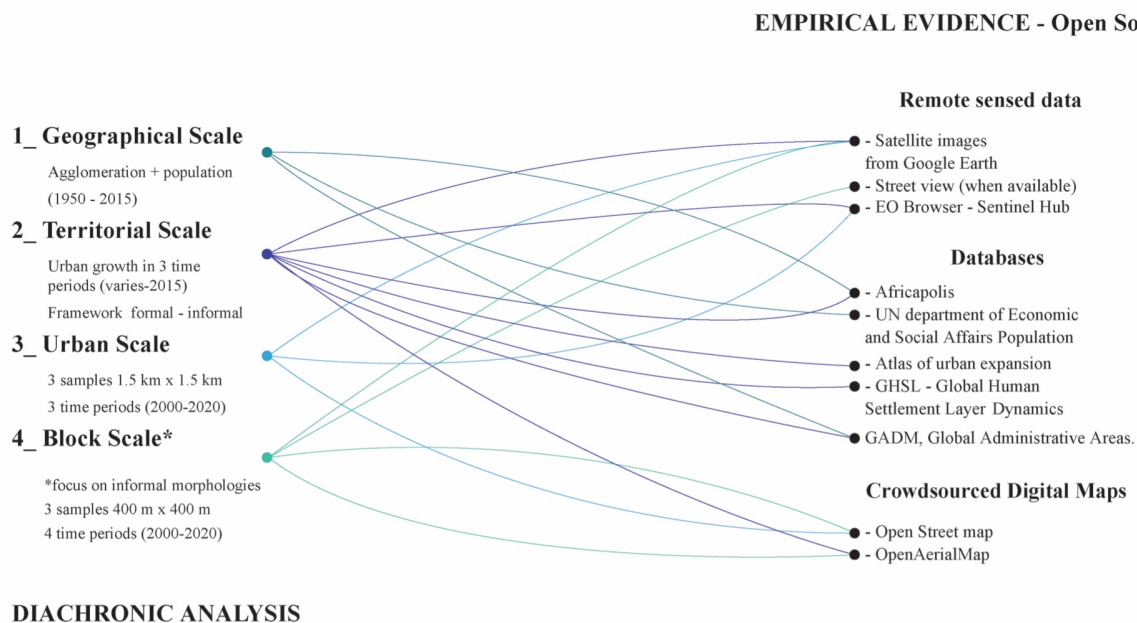
(Iovene et al., 2017, Ricciardi, 2020a, 2020b). What is more, the last issue of the journal *Urban morphology* (25.1) features an article on the social processes that drive the development of the morphology of an informal settlement in Caracas (Vigiola, 2021). This article represents the first one using "informal settlement" as a keyword in the journal (Keyword index, retrieved June, 2021 [http://www.urbanform.org/online\\_public/keyword\\_index.shtml](http://www.urbanform.org/online_public/keyword_index.shtml)). This paper intends to contribute to the growing discussion on the topic and highlight an ongoing mapping study.

## Methodology

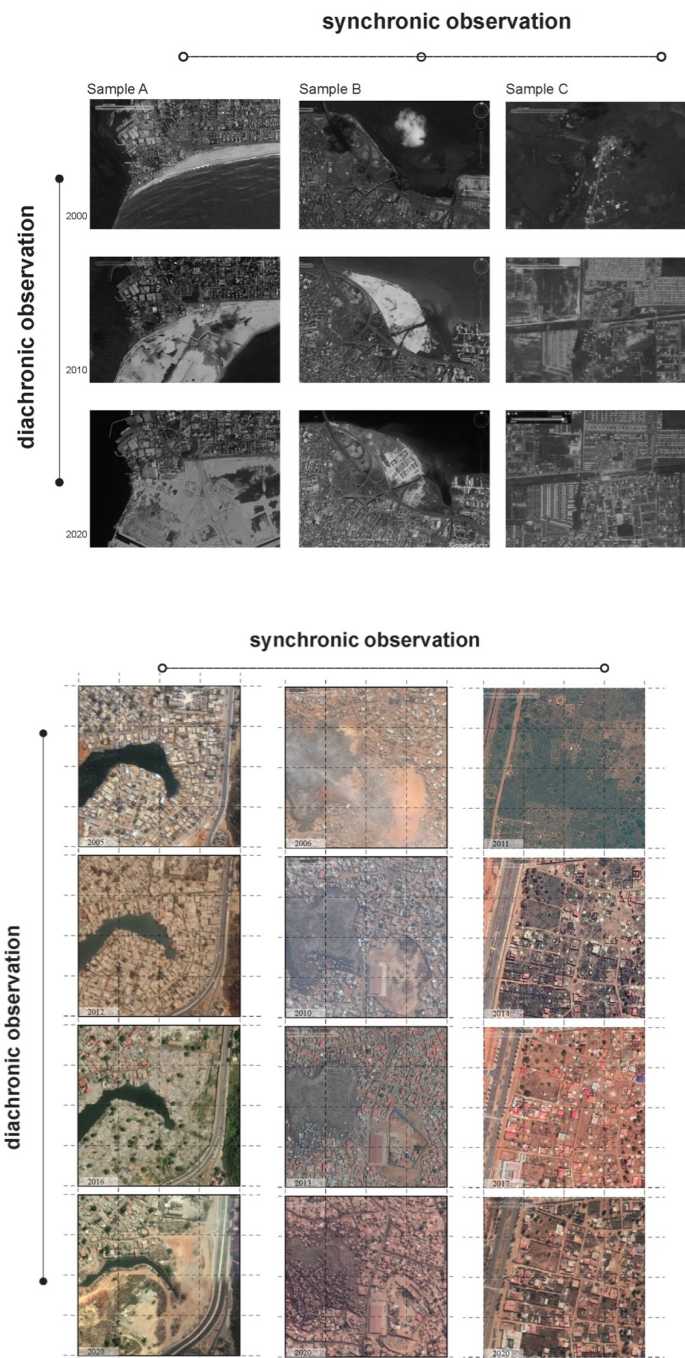
The study's methodology employs a mapping operation and comparative analysis of morphological enclaves from highly populated cities in the Sub-Saharan area and those where informal settlements are projected to grow the most in the coming years (UNHabitat, 2008). A specific emphasis was put on developing a method that could be applied in different contexts, and one where conclusions could be drawn based on observed patterns. In terms of data availability, the case of the African continent is interesting for the heterogeneity of available open-source resources according to location and scale of analysis. Figure 1. summarizes the general proposed methodology for the observation of the morphologies. The methodology was projected in five incremental steps.

1. The first step pointed to assessing the availability of empirical evidence coming from three different open sources. The first one refers to Open Remote Sensed data (Satellite images and street views). The second one refers to databases, the main database for information on urbanization in Africa is Africapolis. This is a database produced by the OECD Sahel and West Africa Club, compiles geospatial data on cities and urban dynamics in the continent. (<https://www.africapolis.org/home>); other databases include the datasets of the UN, department of economic and social affairs, the Global Administrative Areas (GADM), a vectorial database of country administrative areas (<https://gadm.org>), and the Atlas of Urban Expansion. This database collects and analyses data on the urban expansion of 200 cities. (<http://www.atlasofurbanexpansion.org>). The third resource refers to open mapping resources like OpenStreetMap (OSM) and Map Data (Google). These resources are used simultaneously and as base information for the mapping operation in different scales.
2. The second step refers to the definition of observable scales. Diachronic analysis is proposed in four different scales for the mapping operation. The scales of analysis proposed include geographical scale, territorial scale, urban scale, and block scale. The methodology points for a general overview of samples to be observed and compared in a diachronic manner and in a synchronic one, *within* the cities and *across* cities. (Figure 2)
3. The third step implies the definition of variables to observe in the samples collected for the urban and block scale. Three samples are selected at an urban scale, and they are observed in different

- time frames. The selected samples come from areas where urban form variations can be observed clearly. For the morphological analysis at the urban scale, variables of analysis were defined as 1. Streets and their arrangement, and 2. Formal – Informal Morphologies and open spaces in them.
- The fourth step looks at three samples of each case study at an identical block scale to observe informal morphologies recognized in the urban scale. For each sample, a multilayered database that includes: building footprint, access network, and boundaries is created using up to four aerial photographs of different intervals (ranging from 2000 - 2020).
  - The last step of the methodology points to make a comparative gesture at different levels with the maps created.



*Figure 1. General diagram of the proposed methodology for the mapping operation*



**Figure 2.** Examples of Synchronic and diachronic observation. Top: Samples taken from Lagos for urban scale mapping operation. Bottom: Samples taken from Luanda for block scale mapping operation

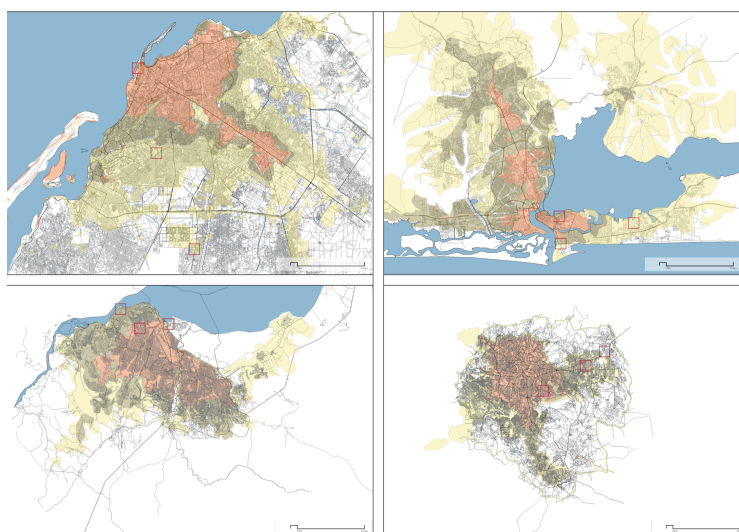
## Results and Discussions

This paper presented the proposed methodology to be tested in four cities from fast-growing countries in Sub Saharan Africa, intending to have at least one case study from each major region. The chosen case studies illustrate processes of urbanization that involve recent developments and informal ones. The selected cases

include Luanda, Angola (Southern Africa); Lagos, Nigeria (West Africa); Kinshasa, Democratic Republic of Congo (Central Africa) and Addis Ababa, Ethiopia (East Africa). The results presented ahead are preliminary.

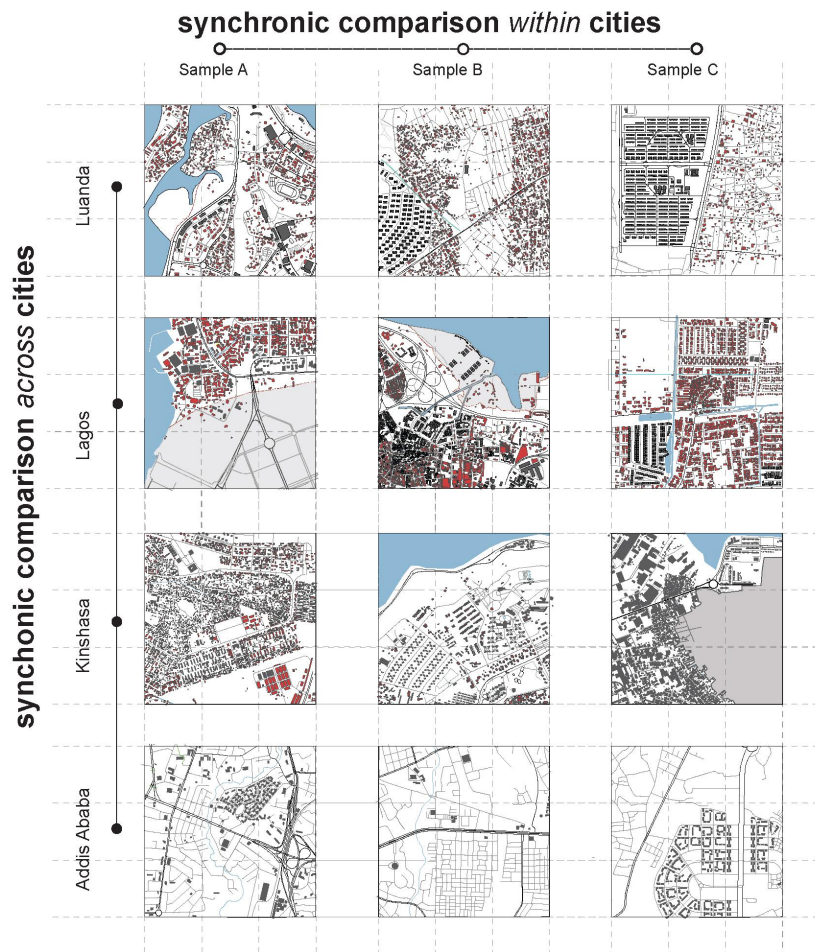
The assessment of the available open data varied in each case. In general terms, vectorial data on administrative areas, main and secondary roads and contextual water elements were available. As for morphological data on buildings, vector information depends highly on the OSM database; as expected, available information on formal morphologies was more complete than informal areas.

The mapping operation conducted for the four case studies showed results in different scales. The overwhelming statistics of population data are translated into agglomerations and located in a geographical map at a geographical scale. All the cases present highly populated agglomerations and growing urbanization rates. At a territorial scale, information on city growth is taken to illustrate how the cities have grown in three different periods (1990, 2000, 2010). A selection of the three enclaves to be observed at an urban scale illustrates samples developed in different periods. At the urban scale, the samples are decomposed into layers depending on the variables defined. In this scale, streets and their arrangements represent the most stable elements of the urban fabric. At a block scale, a manual mapping method of visual interpretation of satellite images in different time frames was carried out, and a multilayered map of the observed variables was created; this method has been used before as a way to decipher characters of urban morphogenesis (Dovey et al. 2020). In the maps at block scale, signs of reclaimed land, demolitions and relocations are visible. The mapping operation provided the chance to develop numerous maps in diverse scales; the next steps of the work foresees a synchronic comparative gesture within and across the cities (Figure 4) with the aim to recognize permutations or patterns in the mapped samples. With the comparative gesture, an important realization about how diversified and fluid the observed settlements are can be made.



**Figure 3.** Mapping operation of the 4 case studies at territorial level.





**Figure 4.** Mapping operation of the 4 case studies at urban level. Synchronic observation of samples within and across cities

## Conclusions

The illustrated study advocates for the use of the morphology of a city as a consistent descriptive language for the built environment and as tools that facilitate rigorous comparison. The speed of urbanization in developing regions brings important challenges for the future. An absence of data on those urbanization processes might make it hard for cities to develop sustainably. Finding ways of observing and understanding the dynamics of urbanization processes to then consider these dynamics in future interventions and developments is a big challenge the planning realm faces. The chance to see overwhelming urban changes from a morphological point of view opens opportunities for new reflections. Mapping and Urban morphology represent potential research methods and allow the systematic observation of complex urban environments remotely. As this is an ongoing mapping project that aims to frame the spatial character of transitional morphologies, the paper highlights only partial results. In the long run, the methodology could potentially help to create an Atlas of samples that may bring a better understanding of the ways in which the morphological singularities work.

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