

# SES

Social Inclusion and Energy Management  
for Informal Urban Settlements

## CASE STUDY OVERALL ASSESSMENT AND MAPPING OF INFORMAL SETTLEMENT IN MEKELLE CITY

Daniel S. Negese



Funded by the  
Erasmus+ Programme  
of the European Union



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## ABSTRACT

In the context of Ethiopia like in many sub-Saharan countries, informal settlement is the major contributor of housing provision. This could get as high as 40% of the housing provision in major Ethiopian cities. However, due to multiple technical and political reasons there is a lack of structured study and up-to-date information regarding the extent and existence of informal settlements, and it is always doubtful. Mekelle, the second largest city and capital city of Tigray region, regards itself 'informal settlement free' unlike most cities in Ethiopia. However, on the contrary, different socioeconomic studies show the extent of poverty and unemployment to be as high as 27% and 38% respectively (MU household survey 2016). This sparked interesting question in our research team "where and how do the urban poor

live in the city?". This case study has pursued the investigation of ontology and extent of informal settlements in Mekelle city and its vicinity using **visual interpretation** of aerial **photography through GIS** analysis, triangulated by interview and discussion with stakeholder NGO, local government offices, and community representatives about the topic.

Despite Mekelle city's official claims, the case study finds 13.25 % area of informal settlement (Urban village types) in the city's administrative area. ♦

**Key words:**

Informal settlements, mapping, visual interpretation, Aerial photograph, community participation.

“Settlement maps are X-rays that allow us to diagnose a settlement's condition.”

CARIE PENABAD

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## INTRODUCTION AND BACKGROUND

Ethiopia is the second most populous country in Sub-Saharan Africa with an estimated population of about 100+ million. And it is considered to be the least urbanized nation in the world, with less than 20% of its population living in urban areas (according Central Statistics Agency, 2012, estimation for 2017). Mekelle, as second biggest city in Ethiopia, is experiencing the highest urbanization rate along with all other major cities in the nation with an average of 5% annual growth rate (Mekelle structural Plan Project report 2014). Such high rate of urbanization with weak land management, exacerbated by absence of inclusive housing policies and less preparedness of the city to accommodate the influx of population, creates a challenge in the urbanization process in Mekelle. As a result, urban sprawl and informal settlements are inevitable phenomena from such an urbanization process. However, the government bodies fail to recognize these consequences of unmanaged urbanization, since they are considered as failure of the city administration.

Due to the above-mentioned reason, the situation of informal settlements and their spatial distribution in Mekelle is almost absent in almost all reports and documents from the city administration, and the occurrence of illegal settlements is considered as an indicator of failure of city administrations.

In Mekelle, the major city of Tigray region, the level of urban poverty and lack of affordable housing is an inexorable phenomenon. However, there is no quantified citywide data regarding the situation and the occurrence of informal settlement has been observed mostly along the periphery.

On the other side, some inconsistent reports show, in 2011 1338 housing units were deemed illegal by the regional government and had been demolished at Gefih Gereb. Despite this fact, in the same year, 1820 informal settlers who were considered to purchase land prior to 2010 through different mechanisms were legalized based on data gathered from satellite image from Google earth (SES-Mekelle city profile 2016).

**Figure 1**  
Gefih Gerb (2011) evicted informal settlement, Mekelle  
(Source: Google earth image)



Adding to that, the 2014 city administration report showed 827 units were recorded illegal and most of them were demolished. The report has also pointed out that there is a severe occurrence of illegal settlement at the city periphery. Despite of the city administration's harsh measures and controls, illegal or informal settlements in these outskirts areas are still inevitable because of the lack and exclusiveness of formal housing provision by the city administration.

To understand and recognize the existence and extent of informal settlements is not only viable for decision and policy makers but also its settlers right in order to be integrated to the government development plan as rightful citizens. When these informal settlements, that are literally off the radar (map) are documented and studied, you begin to not only understand them but get a much bigger picture of the problem and sustainable way to overcome it. Thus, the case study will focus on conducting a preliminary assessment and mapping of informal settlements in Mekelle city. It will mainly focus on identifying types and the physical nature of informal settlement in Mekelle city, the housing typology and existing infrastructure in the informal settlements. ♦

## PROBLEM STATEMENT

On the contrary to the fact that Mekelle has the highest percentage amounting to 27% of population under the poverty line (1 USD PD) (according to 2016 CSA); during the preparation of Mekelle city profile by the SES University of Mekelle team, there was literally no official document or academic research conducted which speaks about the informal housing sector in Mekelle.

It is obvious Mekelle's urban poor (with daily income below one USD) cannot afford any of the formal housing scheme provided in the city. However, **this case study research is hypothesizing that these parts of the community are settled informally in less visible and poorly controlled areas of the city.**

Despite this fact, the informal settlement residents succeeded to hide themselves from most of the official documents and maps of Mekelle city administration. And the documents fail to recognize the very existence of this part of the community.

This contradiction of report and failure to recognize the excluded part of the community has resulted from two possible reasons:

1. Lack of technical skills to identify and study the existence and extent of informal settlements; with a high interval of census and mapping (Cadaster, structural plan and base map) of usually more than ten years, the local administration and the community often face difficulty on understanding the socio spatial information about their locality.
2. Lack of interest to recognize these excluded areas, because the city administration considers informal settlers as outlaws and their areas are also thought to be sign of failure for the local administration. As a result, they don't want to recognize that part of the city.

The above-mentioned issues left us with multiple questions: Where exactly do Mekelle's urban poor live? Why is the local city administration failing to recognize spatially and socially excluded (informal settlers)? How can we assess the existence and extent of informal settlement in Mekelle city? ♦

## METHODOLOGY

The case study research will focus on the methodological approach to examine the existence and extent of informal settlements in Mekelle. This will be done by employing multiple mapping techniques as a tool to map and study the morphology of Mekelle city, and triangulate it with the non-spatial assessment form the community residents and the City's Administration office. ♦



## OBJEKTIVE AND SIGNIFICANCE

### Objective of the study

The objective of this case study research is to assess and study the existence and extent of informal settlement in Mekelle by employing multiple mapping techniques and to use it as baseline information or contextual background for multiple design and urban design courses. This case study will help students, researchers and staff members to exercise on identifying informal settlements using aerial photographs, satellite images and UAV drone images, analyzing and studying urban context, urban morphology and settlements, in architecture and urban design programs in Ethiopian higher institutions. Specific study objectives and learning outcomes are the following points:

1. Study the existence and type of informal settlements and their extent in Mekelle city
2. Exploring the mapping and informal settlement identification techniques
3. Using participatory mapping to incorporate the communities' side to triangulate and verify assessed information.
4. Assessing and analyzing the contextual situation of informal settlements: contextual understanding of informal settlements. ♦

### Significance of the study

The study will assess and record the real-time situation regarding informal settlements and urban context of Mekelle by utilizing cost effective aerial photographs and UAV drone images. Creating knowledge and evidence-based data for the community, local administrations, higher education students, researchers, academics and policy makers. Consequently, affecting the architecture and urban design curriculum in the way it can give emphasis to excluded, marginalized informal settlements in their academic and future practicing endeavors.

- The case study will be a baseline research to informal settlement, slum and housing related researches and any academic related activity.
- This case study research will provide exemplary way of using aerial photographs and UAV drone images to analyze the urban context and settlements in urban areas.

Urban context analysis and mapping; in Integrated design II (4th year Architecture BSc. Program); can be revised in a way that mapping techniques can be used for better understanding and interpretation of different types of settlements and housing. ♦

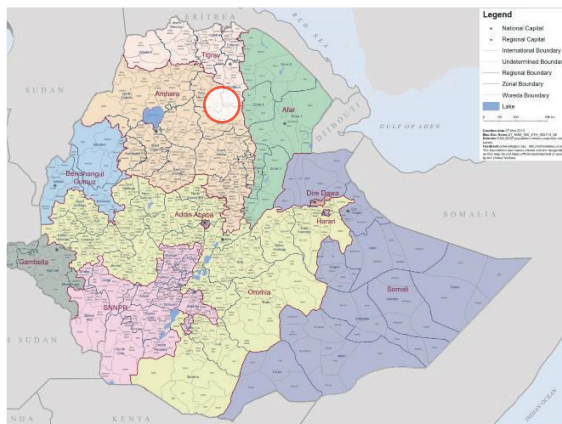
## THE SCOPES AND STUDY AREA

The scope of the study will be settlements in Mekelle city and its annexed new urban villages. Since the city administration has history of evicting informal settlements as soon as the administration is aware of their existence, most

of informal settlers prefer to reside along the peripheral villages where there are less regulatory plans and organic organization where they can blend in easily (to avoid visibility from the city administration).

**Figure 2**

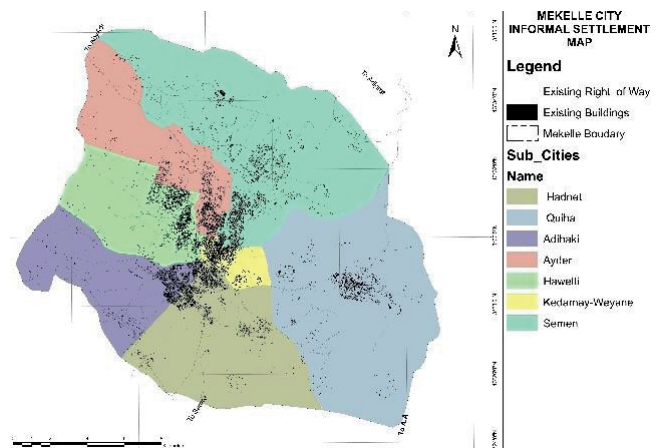
Location of Mekelle in Ethiopia  
(Source: UN OCHA)



Mekelle, the capital city of the Tigray region, is located in the northern Ethiopian high lands at 784 km drive north of the national capital city, Addis Ababa. Geographically, it is located between 130 24'30" to 130 36' 52" Latitude and 39 0 25'30" to 390 38'33" Longitude. It has an average altitude of 2200 meters above sea level with a mean minimum, mean maximum and mean average monthly temperature of 8.7, 26.8 and 17.6° C, respectively. The amount of rainfall is variable in Mekelle; it is on average about 600 mm, and more than 70% of it falls between July and August, followed by long dry season.

**Figure 3**

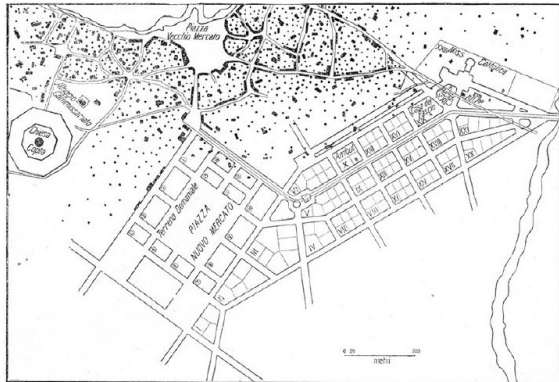
Mekelle city administrative map  
(Source: Author)



Mekelle had an estimated total population of 215,546 (CSA, 2007). It was founded as a national capital during Emperor Atse Yohannes the 4th era in the nineteenth century and subsequent years. As a regional city of Tigray, it has been developed as political, economic, and cultural center characterized by its spontaneous growth. Since the time of Italian occupation there were attempts to introduce city planning based on modern principles at that time. 1937, the Italians prepared the first ever drawn city plan (grid organization) which guided inner settlements from then on. The morphology of Mekelle city has took its character and kept it through all political, social and economic changes over last century.

**Figure 4**

Piano Regolatore of Mekelle by Italians, 1937,  
 from Gli Annali dell’Africa Italiana, Numero 4, 1939  
 (Source: Rumi Okazaki 2011)



**Figure 5**

Aerial photograph of Mekelle by Italians, during Italian occupation  
 somewhere in the late 1930s,  
 (Source: Rumi Okazaki 2011)

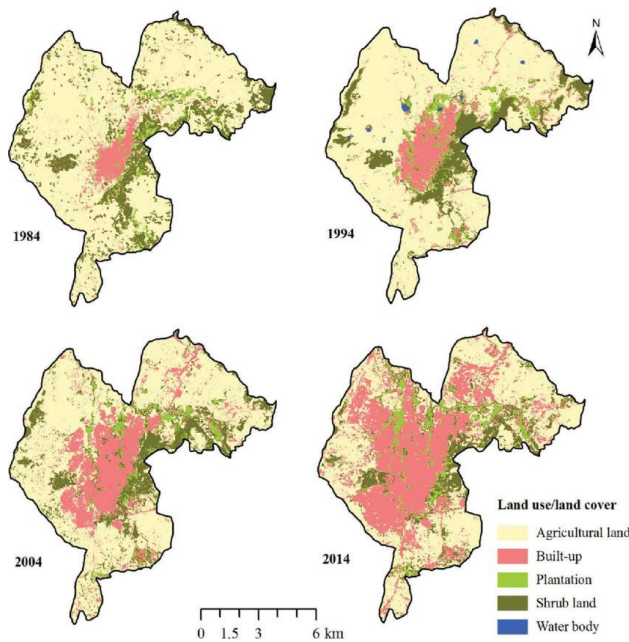


Mekelle has been one of the fastest growing cities in Ethiopia next to Addis Ababa in terms of human settlement, industrial and institutional establishment. At present, the city has a built-up area of 3500 hectares. As the prime city in northern Ethiopia and regional capital of Tigray, the city has experienced very high urbanization and influx of rural-urban

migration. Such rapid urbanization and influx of migration coupled with the lack of timely, efficient and proper planning exacerbate the gap between what the city can provide and the needs of its residents in all aspects. Housing and municipality infrastructure are among the basic services the city is lacking severely. ♦

**Figure 6**

Evolution of Land use of Mekelle city from 1984-2014: Ayele A. Fenta (2017)



## INFORMAL SETTLEMENT

Generally, the terms 'informal' and 'slum' area are considered problematic and negative words and defined in terms of a lack. A slum variously lacks space, durability, water and sanitation. Informality implies a squatter that lacks land tenure and formal control over planning, design and construction. However, there are different definitions and they have different meanings and interpretations around the world. Its meaning spans from inner city slums, authorized or unauthorized squatters pirate urbanizations, non-planned settlements, etc. (Davids, 2006). Usually, the difference in meaning and interpretation raises from multiple sociopolitical and economical contexts of specific cities and places. In Mekelle's context, the definition coincides with (Alim M. Sulaiman S. 2006) definition of informal settlements, as residential housing units built on planned and unplanned areas without formal approval from the concerned body.

Over one billion people now live in 'squatter', 'slum' or 'informal' housing settlements globally, a population that is projected to grow to 1.4 billion by 2020 (UN- Habitat, 2006). Informal settlements have been the most inescapable single form of new urban development over the past half century, and provides housing around a quarter of the global urban population (UN-Habitat, 2006).

In line with that, informal settlement and informal economy covers a considerable part of the global south cities' economy.

Though there is a considerable difference in the very definition of informal settlement among states and even sometimes city administrations within a state,

rare official documents generalize informal settlements in Ethiopia as **unauthorized and unplanned neighborhoods without tenure security** where a mix of lower middle and low-income families live in congested or irregular dispersed environment depending on their age of formation.

While it is easy to regard such settlements as unsustainable, they are the way in which one in every four people in cities sustains him or herself and they are the fastest growing form of urban development. Any idea that such populations are marginal to the cities they occupy has long been disproven (Perlman, 1976) and most developing cities are economically unsustainable without them. Many such settlements have developed over time into well-serviced neighborhoods - no longer 'slums' and with varying levels of tenure and formality. 'Neighborhoods like 'Ed'a Abune' Aregawi and 'May liham' (parts of old settlements in Mekelle) present such situations. Yet, the tendency to see such settlements as a problem to be fixed or erased has led to a situation where they are often relatively invisible within the urban spectacle and largely unstudied in urban morphology and image.

However, despite of their absence (invisibility) from official documents of the city administration, these settlements are characterized by single story house types that follow the traditional way of construction (less scientific) and usage of locally available and as cheap as possible materials. The settlement follows a compact or disperse layout depending on the location usually with an organic urban fabric. The overall spatial feature can be categorized in to two: informality at the fringe with dispersed settlements and informality in the inner city with very dense settlement.

### Characteristics of informal houses

Mekelle is a radially organized and shaped city and it is characterized by a mono-centric urban and administrative structure with middle and low-income families settling along invisible urban villages in a pattern of low density and low-rise urbanizations, mostly in single story informal housing areas, causing sprawl, informal settlement and land underutilization (Lupala, 2002). The underlying reasons why informal settlements exist are poverty, population growth, urbanization, land scarcity and environmental hazards. In informal settlements, most of the houses have been built by the families who occupy them. Infrastructure and services are lacking, and the house materials are of a temporary nature (Napier M., 2005).

### Informal settlements in Mekelle city

At this exploratory phase, the SES Mekelle University team has a rough range of categories of informal settlements in Mekelle city. For the study purpose, they are categorized in four major groups. (SES UoM team, 2017)

### Urban Villages

These are basically rural settlements except that they are currently under urban administration. These settlements have haphazard and sparse morphology. Most of them don't have basic municipal amenities. They are the dominant informal settlement in the city.

### Squatter Settlements

These are settlers on publicly owned open spaces or vacant lands. They are public land sub-divisions usually in peri-urban areas.

### “Unauthorized Colonies”

These are illegal private land sub-divisions in peri-urban and urban areas, usually from farmers. The process of forming such colonies happens either before the transfer of the land to urban administration or afterwards within urban villages. In terms of tenure security, ownership is relatively better acknowledged in the former than the latter case.

### Semi-formal

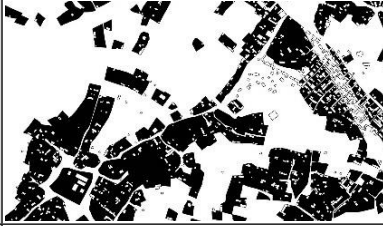





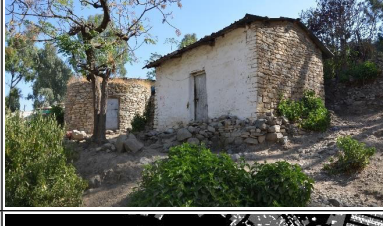





These are varieties of informality cases but with high tenure security and with no or little deprivation with regard to the provision of municipal amenities. The following cases are considered under this category.

- **Formally acquired private lands:** having structures built without construction permit or against building standards/codes. Such activities are usually treated with penalties.
- **Formal-gone-informal or due to recent urban planning activities:** Sometime in the near future, they are expected to be relocated elsewhere with a minimally allocated size of property and compensation money.
- **Heading-informal:** acknowledged as formal but at risk of informalization in by future planning. They are located near marginal locations, rivers, mountains etc. They may be relocated elsewhere with a minimally allocated size of property and compensation money.
- **“ownership in limbo”:** These are cases of informal transactions of formal properties due to bureaucracies in ownership transfer. The plot and housing are identified as formal by government, but ground realities are different. The buyers take a calculated risk to obtain the property before they are able to transfer it legally.
- **Not Serviced “Formal” settlements:** leased and privately owned, but they are not serviced with social and physical infrastructures. They are mainly located in the sub-urban areas of the city. They basically do not have any sort of risk with regard to tenure security.

OVERALL ASSESSMENT AND MAPPING OF INFORMAL SETTLEMENT IN MEKELLE CITY  
**INFORMAL SETTLEMENT**

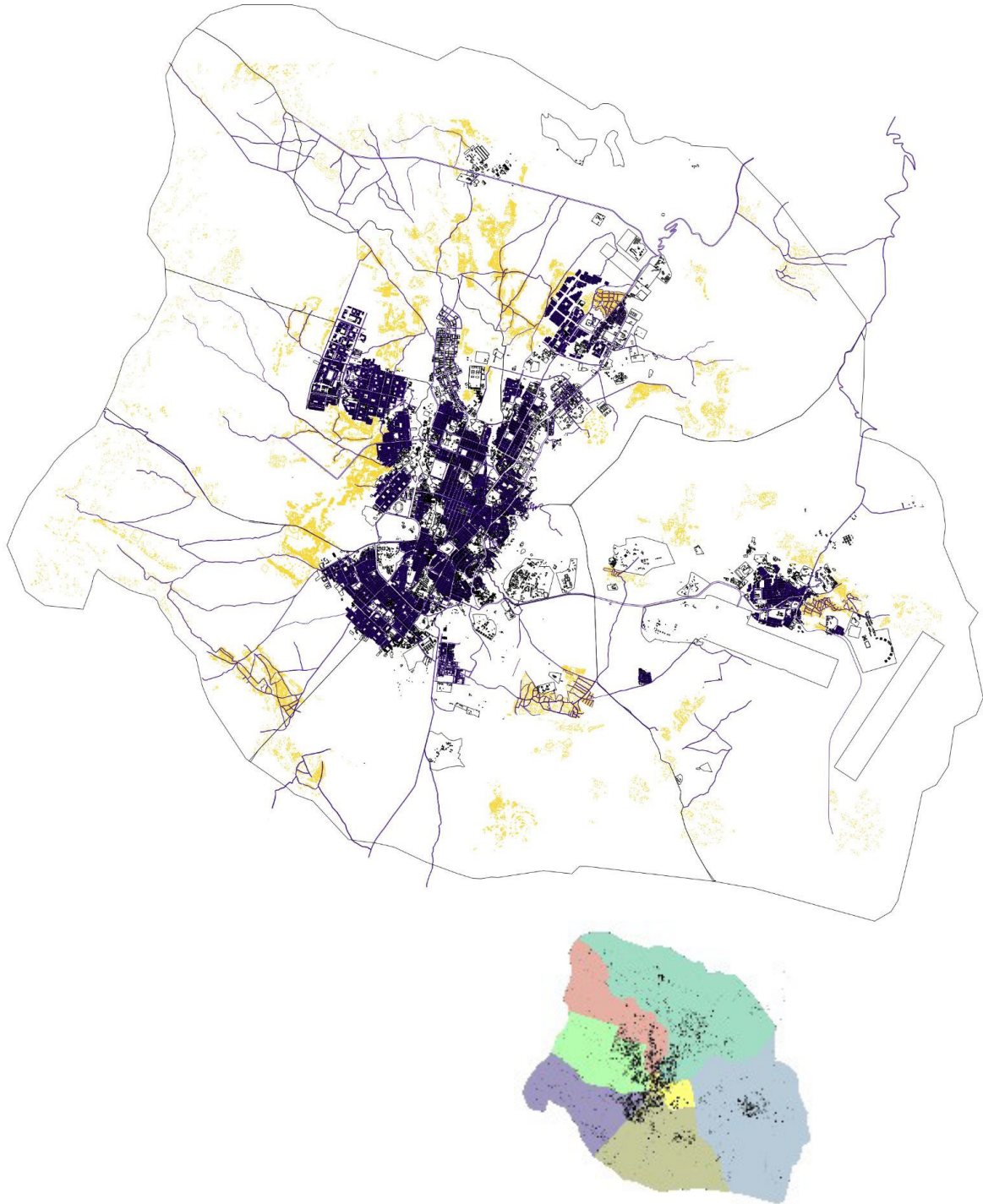
**Table 1**

Characteristics of informal and formal settlements

| FEATURES  | INFORMAL SETTLEMENTS  |   | FORMAL (PLANNED) SETTLEMENTS  |  |
|---|---|---|---|--|
| <b>Size</b>   | Small building sizes<br>Irregular parcel and orientation  |    | Generally larger building sized   |    |
| <b>Density</b>                                      | Inconsistent density<br>Lack of defined open and public spaces  |   | Low - Moderate density areas<br>Provision of public open spaces and green areas                   |   |
| <b>Pattern</b>                                      | Organic layout Ever-changing layout<br>Heterogenous and scattered layout                                |  | Regular layout pattern  |  |
| <b>Site Characteristics</b>                         | Inaccessible and/or hazardous location  |  | Formal development with grid organization, easy to access and infrastructure provision            |  |
| <b>Road Network</b><br><b>Infrastructure layout</b> | Organic road layout, with inconsistent widths and materials.<br>Half hazardous infrastructure provision |  | Geometric, grid road layout with proper width and order.<br>Readable pattern for road connections |  |
| <b>Building material &amp; character</b>            | Deteriorated<br>Temporary nature  |  | Permanent structures with proper construction materials,<br>Well designed and constructed         |  |

**Figure 7**

Informal settlements at the outskirts of Mekelle (Source: Author)



### **Informal settlement in the eyes of Mekelle city Administration**

Due to multiple sociopolitical and economical contexts (yet to be investigated), the regional government of Tigray and the city administration of Mekelle has a low tolerance to any kind of informal settlement. At some level, the city administration wants to build an image of an informal settlement free city regardless of its cost and inconvenience it might cause to its low middle- and low- income residents. These intentions have been seen as they were evicting multiple informal settlements around the peripheral districts of Mekelle.

The informal settlements in Mekelle representing slightly less than 15% area of the city have developed without any kind of recognition of existence. Strategically, the informal settlement usually tries to create a sense of ordered layout and blend along with formal planned urban fabric. Peripheral rural villages and less administrated areas of the city and its neighboring villages were preferred informal settlement areas. The major factors for the people to settle were need, availability and temporal invisibility. From aerial photographs, satellite images and drone footages, it is easy to notice that formal areas in the formal city are well described in contrast to informal areas, where neighborhoods appear as empty spaces (right side of fig. 8).

However, we lack information about Informal settlements, specifically their scale, location, extent, boundaries, populations, buildings and enterprises. Consequently, holistic strategies that focus on understanding the local role of slums, the needs of their inhabitants, as well as their geography and spatial dynamics are required (Pugh, C. 2000).

At present, many local governments do not fully “acknowledge the existence of slums and informal settlements”, as available “data is often ad hoc and not connected to integrate city-wide monitoring and evaluation processes” (UN-Habitat 2015). In Mekelle as well, different government bodies failed

**Figure 8**

Google satellite image of Mekelle city



to acknowledge this phenomenon, due to a lack of interest and capacity to see it. However, in order to develop pro-poor policies and accommodate the marginalized part of the city’s community, innovative methods are required to enhance our understanding of the spatial and chronological dynamics of informal settlement towards the creation of knowledge regarding causes of informal settlements and their nature (Slums from Space, Kuffer, M, 2016). Such understanding can form a basis for socioeconomic data integration and offer essential information for devising and implementing customized approaches of integrating the informal settlement in all aspects of the city’s development.



Figure 9 and 10 show forceful eviction as it happened to thousands of informal settlers. Regardless of their specific cases, this has been source of friction between the people and city administration lately. And this kind of forceful eviction happened due to lack of proper study and identification of settlements prior to resident's investment and build their livelihoods without being seen by the city.

Generally, remote sensing has transformed the real-time analysis of spatial information, and it is taking a critical part on understanding "space-time dynamics" and overall evolution and transformation of settlements (Patino, J.E. 2013). In addition to that, remote sensing can easily facilitate analysis of morphology in relation to none spatial features (Taubenbock, H. et al. 2009). Accordingly, in many sub-Saharan cities with unfavorable technical, political and geographical situations, Remote sensing is a highly important tool to study spatial and nonspatial phenomenon over time. Remote sensing is capable of mapping the number of informal settlements and slums in highly hazardous and incontinent areas or the normal environmental conditions without (Netzband, M. et al. 2009). This can be used to empower communities and

in support of pro- poor policy formulation. It is important to combine such spatial information with community-driven mapping to understand local needs (Joshi, P. et al. 2002).

#### **Tools of Mapping of informal settlement and slum areas**

Informality has been defined in diverse ranges from country to country and there is no unified binding definition for what is informality on a global scale (Risbud, N. 2002). Usually, this causes different understandings and representations in geo- spatial recording and visual interpretation of informal settlements. Thus, it is important to get consensus on the contextual definition prior to start mapping. This can be done by overlapping/ triangulating the information from determinant stakeholders (Community and Municipality and local administrators).

The information about the change in landscape and morphology can be obtained by visiting sites on the ground and/ or extracting it from remotely sensed data. The power of the maps vs. the power of the informal settlements. "Scientists master the world, but only if the world comes to them in a form of two dimensional, superposable, combinable inscriptions" (Latour, 1999).

**Figure 9**

Dingur (February 2019) evicted informal settlement, Mekelle



**Figure 10**

Romanat (July 2019) evicted informal settlement, Mekelle



## METHOD OF ANALYSIS

The topic of informality and slum is rarely discussed and we assume local administrators and community representatives will have difficulty in understanding qualitative and quantitative information in regard to informal settlement. Therefore, the methodology is designed to triangulate spatial data with structured interviews of knowledgeable people, local level administrators, municipality officials, Tigray Bureau of Urban Development (TBUD) and members of neighborhood communities. To do so we have designed three step methodology.

The first step is a visual analysis and interpretation of high-resolution aerial photos of Mekelle City from 2014. This leads to a categorization on object (housing unit) level, settlement level and neighborhood level of informal settlements.

This photo analysis is followed by (Second step) focus group discussions and structured interviews with representatives and residents of informal set-

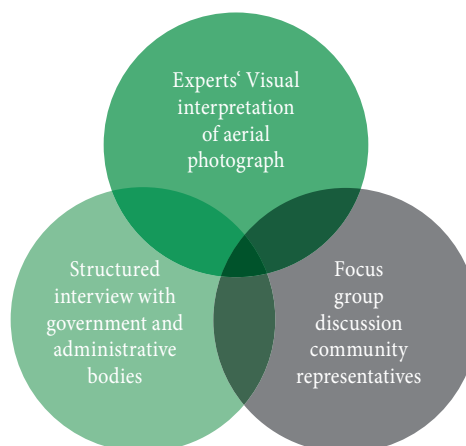
tlements (during local stakeholder meetings). Here the community representatives have been selected randomly with a fair distribution of gender and economic situation.

And finally, (third step) confirmation of both data from visual interpretation and the discussion with communities with municipalities data in regard to the settlements.

During the discussion and interviews with the members of a neighborhood community, knowledgeable people, local level administrators, municipality officials and Tigray bureau of urban development TBUD are present, as a first step of verifying the existence of informal settlements in the city, and the understanding of city and sub city managers in regard to the definition of informality in their context. Consequently, Structured Interviews and discussions with local administrators and experts of all the seven sub cities were conducted.

**Figure 11**

Case study methodology diagram



## SUMMARY

### **Summarized points of the discussions and Structured interviews with government and local administrative bodies**

The questions and their reply were,

1. The **definition of informal settlement** according to the office's practice, what the criteria to designate any settlement formal or informal are
  - All respondent from all local city administration replied, "any house and settlement which are not incorporated in the city's Masterplan are deemed informal."
2. The **existence of spatial data** of their vicinity and how often they update it; and the means the office uses to get the spatial data.
  - They have base map and a master plan prepared by private consultants; and they update the spatial data manually by adding surveys of new developments.
3. **Communities' participation** in developing their locality's map, and the right and level of access to spatial information.
  - Neither the community in informal settlement nor the formal settlers participated in mapping of their neighborhood.
4. The **existence of informal settlement** in their local administrative area, to what extent and where they are located.
  - All of the interviewees confirm the existence of informal settlement in the form of urban villages in their sub-cities. However, there is no statistics and further study on the type of informality and socio-economic aspects.

### 5. The **causes of informal settlements?**

- Annexation of rural villages caused by rapid urban expansion, and delay of formal plan preparation to incorporate it to a city's master plan.

### 6. **Future of informal settlements** in their administrative area.

- De facto informal settlements will be compensated for their farmland & residence. However, illegal informal settlements will be evicted as soon as they are discovered.

### **Visual interpretation of aerial photographs**

After the first informative discussion with municipalities about the location of informal settlements, **high resolution aerial photographs** were used to study the spatial characteristics of the settlement and delineate the area.

Visual interpretation of informal settlements is based on certain characteristics cited from literature review and structured interviews with local administrators.

### **Morphological analysis of informal settlements**

In the context of Mekelle, informal settlements are easily recognizable from their morphological characteristics:

- Small building sizes
- Organic layout, irregularity of parcel shapes and orientation
- Inconsistent density, heterogeneous and scattered layout
- Undefined open and public spaces & ever-changing layout
- Inaccessible and hazardous location

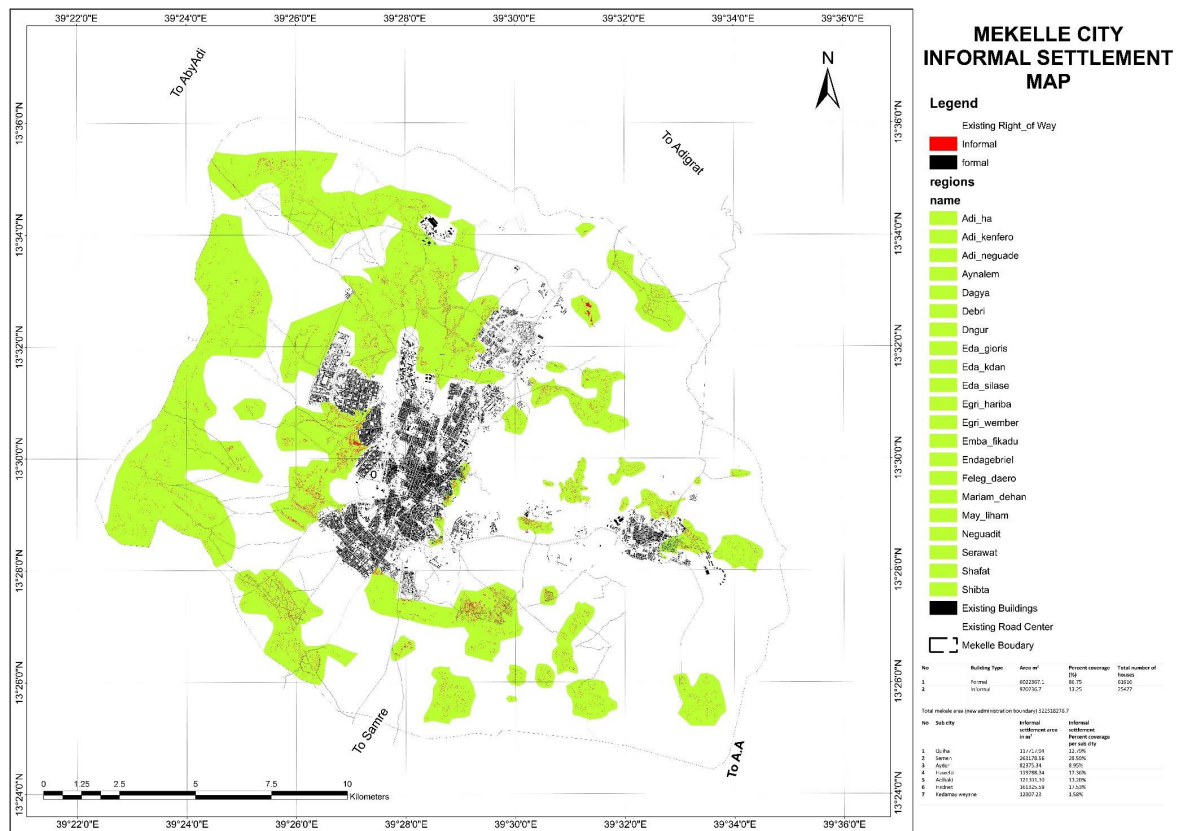


# CONCLUSION

On the contrary to the claim of the city administrations official documents, informal settlements do exist in Mekelle regardless of the history of harsh measures (evictions) by the administration. The extent of informal settlement is increasing as the city is engulfing urban villages without proper preparation on how to integrate the peripheral settlements. In addition to that, the existing challenges of affordable housing

coupled with political and economic instability of east Africa is exacerbating the extent of informal settlement in Mekelle city. As you can see from the map in figure 14, in general, slightly above thirteen percent of the settlement areas in Mekelle are informal settlements. Considering the previous actions of the municipality, if the administration remained consciously unaware, they will face eviction.

**Figure 14**  
 Overall map of Informal Settlement areas in Mekelle city



## REFERENCES

- Aik W.**, Anger A., Reis G. Slum health; Diseases of neglected populations. *BMC International Health and Human Rights*. 2007;7:2 available from: URL: <http://www.biomedcentral.com/1472-698X/7/2>
- Alim M.**, Sulaiman S. The causes and Consequences of the Informal Settlements in Zanzibar Tanzania. October 8 – 13, 2006.
- Davis, M.**, (2006), *Planets of Slums*. London, Verso.
- Kuffer, M.**, Pfeffer, K & Sliuzas, RV 2016, 'Slums from space: 15 years of slum mapping using remote sensing', *Remote sensing*, vol. 8, no. 6, 455, pp. -. <https://doi.org/10.3390/rs8060455>
- Latour, B.** (1999). *Pandora's Hope: Essays on the Reality of Science Studies*. Cambridge MA: Harvard University Press
- Lupala, J.** (2002) Urban types in rapidly urbanizing cities - Analysis of formal and informal settlements in Dar es Salaam, Tanzania. Doctoral Thesis submitted to the Department of Infrastructure, Royal Institute of Technology, Stockholm
- Napier M.** Informal settlement integration, the environment and sustainable livelihoods in sub-Saharan Africa. March 2005. Available from: URL: [www.grif.umontreal.ca/pages/i-rec%20papers/napie](http://www.grif.umontreal.ca/pages/i-rec%20papers/napie).
- Netzband, M.**; Rahman, A. Physical characterisation of deprivation in cities: How can remote sensing help to profile poverty (slum dwellers) in the megacity of Delhi/India? In Proceedings of the IEEE Joint Urban Remote Sensing Event, Shanghai, China, 20–22 May 2009; pp. 1–5.
- Okazaki, R** 2011, 'Deterioration of Heritage by Informal Urbanization in Mekelle, Ethiopia', *Journal of Asian Architecture and Building Engineering*, vol. 10, no. 2, pp. 343-350. <https://doi.org/10.3130/jaabe.10.343>
- Pugh, C.** Squatter settlements: Their sustainability, architectural contributions, and socio-economic roles. *Cities* 2000, 17, 325–337.
- Patino, J.E.**; Duque, J.C. A review of regional science applications of satellite remote sensing in urban settings. *Comput. Environ. Urban Syst.* 2013, 37, 1–17.
- Patel, S.**; Baptist, C. Editorial: Documenting by the undocumented. *Environ. Urban.* 2012, 24, 3–12.
- Perlman, J. E.** (1976). *The myth of marginality: Urban poverty and politics in Rio de Janeiro*. Berkeley, CA: University of California Press.
- Joshi, P.**; Sen, S.; Hobson, J. Experiences with surveying and mapping Pune and Sangli slums on a geographical information system (GIS). *Environ. Urban.* 2002, 14, 225–240.
- Risbud, N.** Policies for tenure security in Delhi. In *Holding Their Ground-Secure Land Tenure for the Urban Poor in Developing Countries*; Durand-Lasserve, A., Royston, R., Eds.; Earthscan: London, UK, 2002; pp. 59–74.
- Taubenbock, H.**; Wurm, M.; Setiadi, N.; Gebert, N.; Roth, A.; Strunz, G.; Birkmann, J.; Dech, S. Integrating remote sensing and social science. In *Proceedings of the IEEE Joint Urban Remote Sensing Event, Shanghai, China, 20–22 May 2009*.
- UN-Habitat**, (2006) *THE STATE OF THE WORLD'S CITIES REPORT 2006/2007: 30 Years of Shaping the Habitat Agenda*. Nairobi, United Nations Human Settlements Programme: [https://sustainabledevelopment.un.org/content/documents/11292101\\_alt.pdf](https://sustainabledevelopment.un.org/content/documents/11292101_alt.pdf)
- Ayele A. F.**, Hiroshi Y., Nigussie H., Ashebir S. B. Zelalem H., Mewcha A. G. Getchew M., (2017) The dynamics of urban expansion and land use/land cover changes using remote sensing and spatial metrics: the case of Mekelle City of northern Ethiopia; *International Journal of Remote Sensing* 38:17, pages 4107-4107. <https://doi.org/10.1080/01431161.2017.1317936>