

**GEOSPATIAL TECHNOLOGY BASED ANALYSIS OF SQUATTER
SETTLEMENT EXTENT: A CASE OF DIRE DAWA CITY,
ETHIOPIA**



Taju Kedir Hussien

A Thesis Submitted to

The Department of Geomatics Engineering

School of Civil Engineering and Architecture

Presented in Partial Fulfilment of the Requirement for the Degree of Master's
of Science in Geoinformatics Engineering

Office of Graduate Studies

Adama Science and Technology University

August, 2021

Adama, Ethiopia

**GEPSPATIAL TECHNOLOGY BASED ANALYSIS OF SQUATTER
SETTLEMENT EXTENT: A CASE OF DIRE DAWA CITY,
ETHIOPIA**

Taju Kedir Hussein ID: PGR/19377/12

Advisor: GetachewB/Meskel (PhD)

Co-Advisor: KeredinTemam (PhD)

A Thesis Submitted to
The Department of Geomatics Engineering
School of Civil Engineering and Architecture
Presented in Partial Fulfilment of the Requirement for the Degree of Master's
of Science in Geoinformatics Engineering

Office of Graduate Studies
Adama Science and Technology University

August, 2021
Adama, Ethiopia

APPROVAL SHEET

We, the Advisors the thesis entitled “Assessment of Squatter Settlement Extent by Using Geospatial Technology: A Case of Dire Dawa City, Ethiopia” and Developed by Taju Kedir Hussein hereby certify that the recommendation and suggestion made by the board of examiners are appropriately incorporated into a final version of thesis.

Major Advisor	Signature	Date
Co-advisor	Signature	Date

We, the undersigned, Members of Board of Examiners of the thesis by Taju Kedir Hussein have read and evaluated the thesis entitled “Assessment of Squatter Settlement Extent by Using Geospatial Technology: A Case of Dire Dawa City, Ethiopia” and examined the candidate during open defense. These is, therefore to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Geo-informatics.

Chairperson	Signature	Date
Internal Examiner	Signature	Date
External Examiner	Signature	Date

Finally, approval and acceptance of the thesis is contingent upon submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

Department Head	Signature	Date
School Dean	Signature	Date
Office of Postgraduate Studies, Dean	Signature	Date

DECLARATION

I hereby declare that this Master thesis entitled “Assessment of Squatter Settlement Extent by Using Geospatial Technology: A Case of Dire Dawa City, Ethiopia” is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

Taju Kedir Hussein

Name of Student

Signature

Date

RECOMMENDATION

We, advisor of this Thesis, hereby certify that I have read the revised version of the thesis entitled “Assessment of Squatter Settlement Extent by Using Geospatial Technology: A Case of Dire Dawa City, Ethiopia” prepared under our guidance by Taju Kedir Hussein submitted in partial fulfillment of the requirement degree of Master’s of Science in Geoinformatics Engineering. Therefore, we recommend the submission of revised version of the thesis to the department following the applicable procedures.

Getachew B/meskel(PhD)

Major Advisor

Signature

Date

Keredin Temam(PhD)

Co-advisor

Signature

Date

ACKNOWLEDGEMENT

Firstly, I would like to thanks the almighty Allah for giving me strength, courage, health, and patience throughout this all long journey and especially throughout compilation of this thesis. Next my deep thanks goes to both Dire Dawa University and Adama Science and Technology University for granting me this master's program and help me for rising me one education level again. In addition I want to extend my sincere Gratitude to the department of Geomatics for allow me to do my thesis on this topic and also for assigning both Major advisor and Co-advisor for my thesis work.

In the bottom of my heart I would like to thanks all my course instructors Roba Gemechu (PhD), Tilahun Erduno(PhD), Getachew B/meskel(PhD) for their productive, unforgettable and experience they delivered to me.

My special thanks also goes to both may Major advisor Getachew B/meskel(PhD) and co-advisor KeredinTemam(PhD). Without their guidance, this work would be impossible to complete. Their fruitful and constructive effort throughout this study period would not be forgotten.

I also sent my overwhelming thankful for Dire Dawa Municipality officials, and all municipality workers for providing me the necessary data and for their supportive well coming my questionnaires and interviews, similarly my big respect goes to every individuals who were participated during my social data collection as respondents.

Finally yet very importantly, I want to deliver my lovely gratitude to my wife Saredo Ahmed and to my sweet son Egunma Taju for your love, patience, encouragement and support during my study time.

TABLE OF CONTENTS

Table of Contents	
APPROVAL SHEET	iii
DECLARATION	iv
RECOMMENDATION	v
ACKNOWLEDGEMENT	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF ACRONYMS	xi
ABSTRACT	xii
CHAPTER 1: INTRODUCTION	1
1.1. Background of the Study	1
1.2. Statement of the Problem	4
1.3. Objective of study.....	6
1.3.1. General objective	6
1.4. Research Questions	6
1.5. Significance	6
1.6. Scope of the Study.....	7
1.7. Thesis Structure	8
CHAPTER 2: LITERATURE REVIEW	9
2.1. Land	9
2.2. Structural plan and its implementation	9
2.3. Urbanization and squatter settlements	10
2.4. Factors contributing for Informal Housing development	11
2.5. Urban Policies and Planning for Squatter Settlements	11
2.6. Squatter settlement	11
2.7. The emergence of squatter settlements in Ethiopia	13
2.7.1. Squatter settlements in Dire Dawa City	14
2.8. Types of squatter settlements	14
2.8.1. Squatter settlement situated on government lands	15
2.8.2. Squatter settlement along Roadside and under big public wall.....	15
2.8.3. Squatter settlements on indigenous land.	16

2.9. Land information and land information management system	17
2.9.1. Land information	17
2.10. Land information management system	18
2.10.1. Existing Land Information System in Ethiopia	20
2.11. Urban Land management.....	20
2.12. Regularization.....	21
2.13. The need for GIS-based land information systems	22
2.13.1. Benefits of GIS-based cadastral information systems	23
2.14. Remote sensing and urban land	25
2.15. Empirical Review	26
CHAPTER 3: MATERIALS AND METHODS	28
3.1. Description of the study area	28
3.2. Data Sources	29
3.3. Used material and software's	31
3.4. Methods of Data Analysis	31
3.5. Social data collection methods and analysis.....	32
3.1. Socio-economic characteristics of squatter settlers site in Dire Dawa city	33
3.1.1. Sampling Methods	33
3.2. Spatial data collection methods and analysis	34
CHAPTER 4: RESULT AND DISCUSSION	39
4.1. Results	39
4.1.1. Social data analysis results	39
4.2. Discussion.....	54
5. CONCLUSION AND RECOMMENDATION.....	57
5.1 Conclusion	57
5.2 Recommendation	58
6. REFERENCE	59
APPENDIX	63

LIST OF TABLES

Table Number and Title	Page
Table 3.1 Materials and data used	30
Table 3.2 Used Software and GPS	31
Table 3.3 Socio-economic characteristics of settlers.....	33
Table 4.1 Society representative data analysis results.....	39
Table 4.2 confusion matrix table of classified map of 2020	46
Table 4.3 change detection table 2010-2020	47
Table 4.4 Overall change detection in hectare and percentage	48
Table 4.5 Criteria for Discriminating squatter from formal settlement.....	53

LIST OF FIGURES

Figure Number and Titles	page
Figure 2.1 squatter settlement under Muslim cemetery	16
Figure 2.2 land information elements.....	19
Figure 2.3 Geo-Spatial technology integration.....	25
Figure 3.1 Study area location map	28
Figure 3.2 Schematic Workflow chart.....	35
Figure 4.1 respondent response results in graph	40
Figure 4.2 Land use land cover map of 2010	43
Figure 4.3 land use land cover map of 2015	44
Figure 4.4 Land use land cover map of 2020	45
Figure 4.5 Land use land cover map of 2010-2020	49
Figure 4.6 Area coverage of squatter settlement in Dire Dawa 2007.....	50
Figure 4.7 Bargele area newly occupied informal settlement	51
Figure 4.8 Mermersa area illegally grabbed parcel	51
Figure 4.9 Overlay of structural plan with settlement type	52
Figure 4.10 Classified squatter settlement map 2020.....	54

LIST OF ACRONYMS

CAAP.....	Cities Alliance Action Plan
CSA.....	Central Statistics Agency
E.C.....	Ethiopian Calendar
GIS.....	Geographic Information System
GPS.....	Global Positioning System
LIMS.....	Land Information Management System
LIS.....	Land Information system
LULC.....	Land Use Land Cover
LULCC.....	Land Use Land Cover Change
MDGs.....	Millennium Development Goal
ORAAMP.....	Office of For the Revision of Addis Ababa Master Plan
PCA.....	Principal Component Analysis
PCC.....	Post-Classification Comparison
SDI.....	Spatial data Infrastructure
SECR.....	State of Ethiopian City Report
TS.....	Total Samples
UN ECE.....	United Nations Economic Commission for Europe
UN STAT.....	United Nations Statistical Division
USGS.....	United States Geological Survey
TCS.....	Total Correctly Classified Samples
ETB.....	Ethiopian Birr
ERDAS.....	Earth Resource Data Analysis System

ABSTRACT

The widespread growth of slums or squatter urban settlements has become a central policy issue in the last two decades. Currently, urban squatter Landholdings have become a source of social, political, and economic problems in parts of Ethiopian cities. Dire Dawa city also has similar characteristics as another city of our country on squatter settlement.. analyzing the extent of squatter settlement conditions in Dire Dawa city by using Geospatial technology is main objective of this thesis whereas analyzing land use land cover trend of study area from 2010 to 2020, identifying major causes of squatter settlement in study area and others are specific objective of this study. To achieve the main and specific objective of the study socio-spatial mixed approach that comprises social and spatial analysis techniques was used. The social data analysis results point out that weak governance, population growth, political crisis, and others as the major causes of squatter settlement in study area while spatial data analysis results reveals the declined and risen of land cover to one another; the overall change detection during study time was show that continued increment of built up with 30.1% between 2010-2020, and radical declination of other classes in this ten years. Designing the appropriate and workable policy and regulation for land management purposes in addition to that revising of rigid articles from existing land policy and regulation should be important. Improving the capacity of the municipality with well-trained manpower with recent equipment, software and service delivery is another essential point put as recommendation for this study.

KEYWORDS: *Squatter settlement, Geospatial technology, Change Detection, Dire Dawa,*

CHAPTER 1: INTRODUCTION

1.1. Background of the Study

Squatter settlements, widespread in urban Africa, Latin America, and South and Southeast Asia, are a characteristic feature of contemporary urbanization. Also known as shantytowns, slums, favelas in Brazil, and bustees in South Asia (DeSoto, 2000). With the overall number of people residing in informal settlements globally estimated to be increasing by 10 per cent each year. Squatter land settlement is usually referred to residential areas where a group of housing units have been constructed on land to which the occupants have no legal claim, or which they occupy illegally (Daniel, 2006). They are characterized mostly by the low quality houses and inadequate infrastructure and social services. It can be also explained as occupying land illegally and conduct unplanned housing constructions that does not meet with the current master plan and building regulation policy of the city.

Nowadays we are faced with the significant growing trend of the urban population. Rapid population growth is increasing the number of people to land relationships particularly in urban areas; many parts of the world are experiencing unprecedented pressure for urban land. To meet the need for housing of these increased populations, many new buildings need to be constructed every year (Khalili M, 2015). Constructing a new building requires the municipality's permission. However, unfortunately, some of the constructors do not get building permission which ends in non-rigid buildings. Furthermore, some of the permitted buildings commit building infractions that are against the rules of construction. (Mwangi, 2007)

informal settlement dilemma encompasses high rate of urban expansion, structural and economic unsustainability, lacking services and facilities and infrastructure, social disorder, land invasion and illegally construction, not considering the formal urban legislations, and etc. and has become as the most challenging problems of the developing countries over the last century. as the result of over population and high urbanization, the governments' facilities and strategies are incapable of responding to the overgrowing demands of the population.

A combination of social, economic, legal, and administrative parameters leads, in several countries, to the stage of unplanned development and the creation of a considerable number of squatter buildings (Charalabos I, 2007). These squatter urban land grabs are used either for permanent living house construction residence or for the purpose of making money

mechanism, which is another illegal action in context of our country's constitution which clearly prohibits land selling activities. The causes of such squatting activities are population growth, inefficient land provision, the high cost of urban living standards, and illegal land grabbing by urban speculators. Migration is one reason for population growth; Squatter settlements in the city could cause environmental deterioration, social distress, economic destruction (fire), and urban violence (Alemie, 2015)

A distinguishing feature of the urban growth in developing countries has been the growth of squatter settlements (Daniel, 2006), in addition to that he explains Squatter Settlements are as residential areas of the urban poor more often in the cities of the developing world. Squatter settlements are found on public, private, or customary land accessed by invasion or developed against planning, building, and ownership regulations (Abbott, 2000). Persistent urban issues detected as uncontrolled and unplanned urban growth, changes in family patterns, a growing number of urban residents living in slums and squatter settlements, in addition to the challenge of providing urban services for all (UN-Habitat., 2003).

The squatter landholding is characterized by a lack of basic social services and infrastructure facilities. (Inostroza L, 2017) Suggests that Squatter urban settlement has four common dimensions of informality: lack of formal legal titles, irregular urban structure development, lack of essential public services, and the occurrence on public land. classifies Squatter Settlements as those settlements of; which occur due to unauthorized invasion and development of public and private land, are through a subdivision that is not registered officially or subdivisions that do not conform to planning regulations, are built without permits from the local authorities. Squatter Settlements are therefore unauthorized residential areas and are within areas covered by customary tenure which have been made part of the city through Cities expansion.

There are various synonyms term used for squatter settlement, such as slum, squatter settlement, unplanned towns, and shanty town (Abunyewah M, 2018). As Daniel Lirebo suggests in Ethiopian context squatter settlements are known as “Chereka Bet”. The term Chereka bet in its Literal Translation means “house of the moon” implying the illegal construction of houses overnight using moon light, thus, they are defined as a settlement built on land occupied or used without the consent of the city council and without having any construction permit grantee by the city council (Daniel, 2006).

Currently, urban squatter Landholdings have become a source of social, political, and economic problems in parts of Ethiopian cities (Hailu, 2019) Squatter settlement in Ethiopia covers houses that are built on government, communal, or privately held land against the will of the holder and/or without having a development authorization (building permit)(Ambaye, 2011). Recently Squatter Landholdings are rapidly growing in all urban areas of Ethiopia. For example, squatter settlements have been expanding at an alarming rate in the expansion areas of Addis Ababa (Daniel, 2006). For instance, from 1984 to 1994 such settlements had been growing by 15.7% and the figure rose to about 30% in 2001 (ORAAMP, 2001), and in Adama city, the largest part of the city, especially in the expansion area of the city, are occupied by unplanned squatter landholdings (Hailu, 2019) the living condition of squatter land holders are also complex in that area of which, lack of infrastructure is a visible problem.

Dire Dawa city also has similar characteristics as another city of our country on squatter settlement, Squatter landholders occupied the land without any evidence and without construction permit by force, violating the law and without considering the land use zoning and planning. The occupied land may, according to the plan, be reserved for public purpose activities such as infrastructure, greenery, factories, industrial, and other different urban public activities. But the possessors held the land for residential purposes in many places of the city, and hence such illegal occupancy of lands might not be used for the intending purpose according to the city plan.

The government has to applied balance penalties in case of detection of squatter constructions, the owners may be charged with high penalties; also such properties cannot be transferred or mortgaged, while there is always a risk of creating an squatter market (Charalabos I, 2007). The measures taken by urban land administration authorities vary from countries to countries, but the demolished structures were soon replaced by new ones. This shows that the city administration has attempted to mitigate the expansion of squatter landholdings by formulating various strategies. But this alone cannot solve the problem; a Sound update of land-use planning according to changing needs, and a series of other fiscal and social measures are also necessary.

The visible alarming expansion of squatter settlement problems, critical risks with relation to revenue loss of city administration and as country level because of squatter settlement, particularly in relation to the increasing Lack of urban development plan implementation

produced by squatter settlement and land use land cover changes are among few motivations behind this study. Therefore, the poor performance of structure plan (LDPs) implementation, in case of controlling squatter settlement expansions, can be a threat to the achievement of the City's urban re/development objectives. As to the researcher's knowledge and review there is no available documented case study on the assessment of squatter settlement expansion extent challenges in DDC. Hence, the researcher has intended to go through the study, to fill the gap in this regard, and to assess causes of squatter settlement in Dire Dawa city.

Therefore Sound updates of land-use planning according to changing needs, and a series of other fiscal and social measures are also crucial for the management of squatter settlement. Classic administrative control procedures are proved inefficient, especially when public administration suffers from a lack of employees, bureaucracy, and increased responsibilities. In this regard, this paper aims to offer a fresh overview of the current problems of urban informality in the Dire Dawa city while exploring the potential capability of Geo-spatial technology related to the management of squatter land occupation activity in the study area.

1.2. Statement of the Problem

The human race continues to increase and the global population is estimated to grow from the current 7billion to 9billion by 2040 (Enemark Stig, 2009). Population growth is directly associated with an increase in pressure on land and the environment. The effect of the pressure on land and other natural resources is that communities develop a need to own land exclusively. In developing countries, due to rapid growth of squatter landholdings, today the total number of people lived in squatter settlement worldwide are estimated to be 924 million (Hailu, 2019).

A major problem nowadays in most urban areas in developing countries is the presence of squatter settlements (Okongo, 2019) and even an increase of it from time to time by an alarming rate, hence these squatter landholdings have huge negative implications on the development of one country it should have to be managed through systematic records of land information and up-to-date land cadaster system. Currently one of the perplexing problems confronting many of the developing nations is the illegal occupation of urban land (Abagissa, 2019).

The widespread growth of slums or squatter urban settlements has become a central policy issue in the last two decades, especially in developing countries (Vicente Sandoval, 2016).

Ethiopia Even if the government launches many initiatives which include urban land development policies and urban good governance in many concerned sectors; public provision of service land and housing is considered inefficient and ineffective(Ayele, 2019). There is no coordinating mechanism to regulate and protect the squatter land occupation activities with having full land information and updated data. Currently, urban squatter Landholdings have become a source of social, political, and economic problems in parts of our country. Starting from a few years ago there's an alarming rate in an increasing illegal urban land grabbing in almost all of the cities in our country Ethiopia.

Mulugeta and Yalew (2004) States the major problems of land delivery in urban centers of Ethiopia as Lack of resources, widespread corruption and illicit practices, administrative and technical bottlenecks, supply of land not cope up with demand which creates squatter land market; and squatter and delivery. In our country, the demand for urban land increases, but there are restrictions and the majority of the people cannot access it from the state for different urban purposes. These lead people to occupy land illegally by violating the laws. In other cases, people illegally purchase land from squatter urban land occupier itself because of low prices, due to this and other reason squatter landholdings grow in Dire Dawa city from time to time.

The State of Ethiopian cities report(SECR, 2015), reveals that the “Regarding the proportion of planned city extensions, out of the total extension of built-up areas, the data acquired from city administrations reveal that most of them have been experiencing significant squatter expansion In Dessie, for example, of the total expansion of 7.7ha in 2013, 6.5ha was informal. The same is true for Adama which had a formal expansion of 60ha in 2013. According to data furnished by the city administrations covered by this report, Dire Dawa has the largest coverage of squatter settlement 1770.7ha. Dilla, Adama, Shashemane, and Jimma are among the cities that have large areas covered under squatter settlements. On the other hand, Axum (0.13ha), Debre Markos (1.0ha), and Assosa (1.5ha) have reported the existence of a smaller amount of land under squatter settlements”

Dire Dawa is also one of the city, which characterized by huge illegal urban land grabs taken place in different parts of the city. government failed to respond to the housing needs of the urban poor either through providing government houses or urban land, it leads to the formulation of squatter slums and illegal land occupation (Van dar molen, 2014). The expansion of squatter settlements in Dire Dawa becomes a major problems recently. There are rapid squatter settlement expansions across many parts of Dire Dawa city. this study

focuses on analysis of squatter settlements expansion throughout the city's and land use land cover change during study period.

In Dire Dawa city demolishing the squatter buildings is a daily action measured by city administration every year based on the law formulated in 2004 E.C on squatter settlements which is occupied and built after 2003 E.C. As per law allowed the actions but the demolished structures were soon replaced by new ones and it's normal in the city demolishing ones squatter house for several time before it was regularized. Regularizing squatter landholdings even may encourage others also to do so; this shows that the city administration has attempted to mitigate the expansion of squatter landholdings by formulating various strategies. When the city has taken the action there may rise conflict between individual squatter settlers and security forces and a lot of damage can cause including injury on people in addition to material properties damages.

To solve the illegal urban landholding problem demolition of squatter buildings are not the final solution, before that having reliable information especially urban land-related, the creation of an up-to-date and efficient Cadastre and registration are crucial impediment to alleviate these problems with reasonable Geospatial technology.

1.3. Objective of study

1.3.1. General objective

The main objective of this study is to analyze the extent of squatter settlement conditions with its main causes and change Detection trends in Dire Dawa city,

1.3.2. Specific Objective

1. To identify the major factors that contributing to the expansion of squatter settlements in Dire Dawa city
2. To analyze the land use landcover change trend from 2010 to 2020
- 3.To Map the hotspot site area of the city for squatter settlements.

1.4. Research Questions

1. What are the main possible causes or factors that contribute to the increment of illegal urban land grabs in Dire Dawa city?
2. Where is the hotspot site for illegal settlements in Dire Dawa city?
3. what is the trend of land use land cover looks like in the study area?

1.5. Significance

Management sector(Land Municipality):Before this study there was no detailed investigation had been conducted for this study area, the output or findings this study will be

served as a basis to give more detailed information about illegal urban land status in the city, and about the complexity of the problem which is not clearly stated before. hence this study tries to point out the status of squatter settlement conditions across Dire Dawa city and hotspot area for squatter settlement it can be better references for municipality planners and policy makers. The results of the study will be used as an indication for Dire Dawa land municipality and Dire Daw city administration for planning and prepare to overcome the problem related to illegal urban land occupation and illegal constructions.

Further Researcher: this study uses socio-spatial mixed approaches for identification of the main causes for squatter settlement expansion and land use land cover change detection. So it is better reference for further study on squatter settlement issue by adding another geospatial technology and web based Cadastre for early detection of newly built and newly occupied land parcels to concerned body for further identification as formal or informal settlements.

For local community: if the planners and policy maker use this study as reference the community will be benefited because the revenue of the city will be increase by by protecting the informal land occupation, and also by keeping land market on stable manner with fair prices of rental house for the community. For provision of affordable land for urban society and successful implementation of master plan of the city.

1.6. Scope of the Study

The scope of this study will be limited to Dire Dawa city which not included all villages under city administration, which is characterized as the base with illegal construction as same to many different cities in Ethiopia. This study will focus on assessment of Squatter Settlement extent through Geospatial technology for accessing the extent of land occupation informality in the study area and mapping out the area which needs special attention for future urban land through analysis of the data, which collected from different sources.

1.7. Thesis Structure

The overall structure of the thesis can be divided into four major parts/chapters. These parts are, Chapter one: introduces the background of the study(introduces the proposed topic), statement of the problem, objectives of the study, research questions, significance of the study, and delimitations and limitations of the study. Chapter two deals with literature review including both conceptual and empirical framework which includes previous studies related to this study, whereas Chapter three has a closer look at the materials and methods. This chapter gives an overview of the description of the study area, materials used, data analysis methods, and conceptual framework of the study and finally, Chapter four is discussed the thesis result and discussion for future studies based on the result of the study.

CHAPTER 2: LITERATURE REVIEW

This chapter demonstrates both theoretical and empirical frameworks. A Comprehensive Review of urban squatter settlements, Types of urban squatter settlements, Emergence of squatter settlements in Ethiopia, on the roadside squatter housing in Dire Dawa, land information management and land management system, And also exploring and reviewing literature review related to this topic through empirical overview. This and other sub-topics were the main interest reviewed parts of this chapters.

2.1. Land

Without land, life on earth cannot be sustained and therefore it's the ultimate resource. Land is a critical resource for the economic, social, and cultural development of a country. The land is both a physical commodity and an abstract concept in that rights to own or use it are as much a part of the land as the objects rooted in its soil (UN ECE, 1996). In developing countries where the poor people are the majority, the land is the primary means of generating a livelihood and the main vehicle for investing, accumulating wealth, and transferring it between generations. Therefore proper management of land, by securing rights to the land goes a long way in increasing the net wealth of the poor (Mwangi G. , 2001). Secure tenure also encourages long-term investments on land and creates incentives for sustainable development. The land parcel is the basic unit for access, control, and making land-use decisions.

2.2. Structural plan and its implementation

Urban planning, as one of the most important tools of urban management, guides the socio-economic and physical development of an urban area (MWUD, 2006). In other words, it is an activity carried out in a planning center to meet the socio-economic and spatial development needs of a given urban population. Thus, without the guidance of urban planning no development effort can be realized in an urban center. In Ethiopia, the term urban planning can be commonly viewed as an essential element that is meant to regulate and guide the proliferation of unplanned urban centers to bring about balanced and integrated national, regional and local development (MWUD, 2006). Planning as the art of guiding the spatial growth of the town formulating buildings and planned environments to meet the various needs of the urban population in terms of social, economic, cultural, and recreational perspectives, and to provide healthy conditions for all inhabitants to live, to work and to play or relax, thus bringing about the social and economic well-being for the majority (Hiraskar, 1998). A structure plan is a legally binding plan along with its explanatory texts formulated

and drawn at the level of an entire urban boundary that sets out the basic requirements regarding physical development the fulfillment of which could produce a coherent urban development in social, economic and spatial spheres (Zewdu, 2015).

Nowadays, the government of Ethiopia is providing support for the preparation and implementation of urban plans for urban centers. Actually, all of the urban areas need plans to guide their developments. however, a lot of major Challenges and Constraints in case of implementation of Local Development Plan (LDP) in Dire Dawa city's. these are lack of sufficient resources, lack of civic participation, lack of well-defined improvement policies ,lack of coordination and lack of concern for socio-economic issues, Unclear Institutional Hierarchy, and Changing Policies.

2.3. Urbanization and squatter settlements

Urbanization can be expressed as the physical growth of urban areas and its population due to natural increase and migration (Manoranjana, 2020). The rapid growth of population together with lack of capacity to accommodate the people will lead to high concentration of population in cities or towns with insufficient infrastructure and services. This has resulted in the creation of polluted environment, slum formation, proliferation of squatter settlements and poverty. It is said that planning is not without failure; and failure usually stems from problems.

Informal urbanization refers to informal, unregulated, and spontaneous processes of urbanization especially in the cities of Global South and is the resulting effect of marginalization of social groups, poverty, and inequality (Mohanty, 2019). Informal urbanization emerges because of inability of cities to absorb growth within formal urban framework due to absence of serviced land and affordable housing, inadequate urban planning regulations, and exclusion of low-income populations from formal urbanization (Mohanty, 2019). Informal urbanization process includes both poor rural migrants who build their home through gradual processes of informal land occupation and consolidation and developer who subdivides land without complying with urban regulations (Roy, 2005).

2.4. Factors contributing for Informal Housing development

Ethiopia is the second most populous and the fifth least urbanised country in Africa. At present, 21% of Ethiopia's 112 million residents live in urban areas (23.5 million people). According to the national definition.⁵ Although significantly below the sub-Saharan average of 40.4%, Ethiopia's urban population is expected to grow considerably over the next few decades (CSA, 2005). The main Factors of urbanisation are:

Economic growth: Ethiopia's average annual gross domestic product (GDP) growth rate was 10.4% between 2004 and 2018.

Administration and planning: The reclassification of rural villages into towns accounted for approximately 33% of growth in the total urban population as of 2012, while the expansion of existing urban areas into nearby settlements accounted for 3%.

2.5. Urban Policies and Planning for Squatter Settlements

Slums are often portrayed as institutional failures in housing policy, housing finance, public utilities, local governance, and secure tenure (Sietchiping, 2005). Sietchiping (2005), discussed the governmental responses and policies toward slums under three approaches such as centralized control of housing, neo-liberal approach, and the preventive approach. Laissez-faire attitudes, Site and service programs, Slum upgrading, Enabling strategies and security tenure, Cities Without Slums action plan. urban development strategies have been adopted for squatter settlements that range from denial, tolerance, formalization, demolition, eviction, and displacement. It has been argued that poverty and inequality cannot be simply eradicated through demolition or eviction. There was an increasing focus on providing basic urban services, secure tenure, and the needs of the dwellers and the communities (UN-Habitat., 2003).

2.6. Squatter settlement

Squatter settlements are areas where groups of housing units have been constructed on land that the occupants have no legal claim to, or occupy illegally. They are unplanned settlements and areas where housing is not in compliance with current planning (UNSTAT, 2005). A description of squatter settlements has been defined by many different authors and scholars at different times, about what they are and their characteristics. The global organization UN-habitat categorizes squatter settlements into squatter and illegal land development settlements, land has been occupied without the owner's permission and occupation is legal but unauthorized land development is occurred respectively (Lamba, 2005).

Terminology

Slum: is contiguous settlements where inhabitants are characterized by insecure residential status, inadequate access to safe water, inadequate access to sanitation and other basic infrastructure, poor structural quality of housing, and overcrowding (UN-Habitat., 2003).

Squatter settlement: is settlement is defined as a low residential area, which has developed without legal right to the land or permission from the concerned authorities to build; as a result of their illegal status, infrastructure and services are usually inadequate (UN-Habitat., 2003).

Informal settlement: is unauthorized, unplanned, uncontrolled, marginal, or spontaneous settlement and a resulting effect of spontaneous informal urbanization (Manoranjana, 2020).

Illegal Settlement: is where initial occupation is illegal but where unauthorized land developments have occurred (e.g change of land use that breach zoning plans, building extensions without building permits, subdivisions without regard to services and infrastructure etc).

Change of land use that violate zoning plans, building reshape and renewal without building permits, subdivisions without regard to services and infrastructure are among illegal development settlement activities. As the cases of our country constitution also defined squatter landholding as Possession held without the authorization of the appropriate body or occupied the land without the permission of the government. Proclamation 721/ 2011 Article 6(4). An official sometimes says illegal possession. People also call the building erected on these possessions “*yecherakabetoch*” implying the illegal construction of houses overnight.

Various expressions have been used in literature to refer to squatter settlements. These include spontaneous, squatter landholding settlements, unplanned, marginal, and squatter settlements. Some literature has used the terms slums and squatter settlements interchangeably. Other similar definitions are provided in many policy documents; for example, the Cities Alliance Action Plan (CAAP) describes slums as follows: Slums are neglected parts of cities where housing and living conditions are appallingly poor. Slums range from high-density, squalid central city tenements to spontaneous squatter settlements without legal recognition or rights, sprawling at the edge of cities” (Hailu, 2019).

The rise of the urban poor is caused by the high migration rate from rural to urban areas in search of job opportunities and better living conditions and natural population growth. The migration process is termed urbanization. Thus, poverty in the cities has been attributed to

rapid urbanization. In most developing countries, poor economic performance caused by both internal and external factors has led to the growth of squatter settlements parallel to the formal one. Squatter settlements provide cheap accommodation and economic opportunities for a large part of the population that means these settlements respond both to housing needs and the search for economic activities.

According to the existing legal framework, “squatter settlement” in our country is characterized by: exists/ occupation of land without authorized body permission, has any kind of excess or violation against the urban plan, is in violation of any valid urban and spatial rule, regulation and policy regardless of the existence of a building permit. Illegal settlements are lack of social services and infrastructures, few they are; inadequate access to safe water, Inadequate access to sanitation and other infrastructure, lack of public service provider infrastructures like school, worship areas, and government offices, Poor structural quality of housing, overcrowding and, Insecure residential status, scarcity of road access, mostly unplanned and generally very dense to each other.

2.7. The emergence of squatter settlements in Ethiopia

Various studies have shown that the magnitude of Squatter settlements indifferent countries is considerable and huge today. They have become the fastest-growing type of human settlements in developing countries. Their growth is closely linked to the rapid urbanization that has been taking place in most developing countries over the past three decades. In most cases, it seems therefore that, the absolute quality of land is rarely a problem. The breakdown is in the system of delivering land to the urban poor, which makes it legally accessible often aggravates the problem on one hand. On the other hand, in former socialist countries where there is no land market the origin of illegal statements is not due to market rather than government failure and public inefficiency in land management.

There is no sufficient written document that indicates that when squatter settlements emerged. However, squatting in Ethiopian cities and towns has come recently, predominantly after the downfall of the imperial era. So no one has a right to construct his house on privately owned land. The construction of a residential house on public land without the consent of any concerned body increased greatly after the fall of the Derg Regime.

For instance in Ethiopia, following the nationalization of the land by the socialist regime in 1975, urban land become under the stewardship of different city authorities. Regarding rural land, peasant associations were established all over the country and they were given the responsibility of administering land in their jurisdiction. Thus, monopoly power by the

government and the multiple management of land by different authorities created a loophole for many illegal activities including the emergency of Squatter settlement.

2.7.1. Squatter settlements in Dire Dawa City

The government of Ethiopia recognizes the right of citizens to decent housing and commits itself to implement international conventions and agreements, such as MDGs and the habitat Agenda. But the implementation is not as per law and international convention, there is insufficient capacity, technology, and finance to provide the right to citizens to decent housing as per convention. This leads the situation to increase squatter settlements in different cities in Ethiopia. Under UN-habitat Regional and Technical Cooperation Division report in 2008 reveals that backlog of 24,000 houses, and expected needs to grow annually by 2 900 houses increasing the problem related to settlement informality in the Dire Dawa city with the high rate. Therefore this huge gap between demand and supply increases squatter settlements and more than 200 000 people are living in slums or sub-standard housing.

Squatter settlements typically lack regulation and subsequent user rights, rendering residents with little formal protection against developers. As a result, residents are complaining of not being properly compensated for development activities affecting their homes, and developers are complaining of delays in the acquisition of land. Lack of formal access and a huge demand for housing has made squatter settlements a main growth area in the city. An estimated 182 000 people live in sub-standard housing, of which at least half-lives in simple mud-houses or shacks. Many of these are located in hills and floodplains, rendering a significant proportion of the inhabitants vulnerable to natural hazards such as landslides and floods(UN-habitat, 2008) and also which is against the master plan of the city. The municipality is responsible for making regulations, setting of standards, adaptation, coordination, management of land and housing development, housing administration, support, and capacity building. Cognizant of this critical problem the federal government of Ethiopia and the Dire Dawa administration has put housing development and provision on top of the list of priorities.

2.8. Types of squatter settlements

We can categorize squatter settlements seen around Dire Dawa city into Squatter settlements situated on government lands, squatter settlements along the Roadside, and squatter settlements on indigenous land.

2.8.1. Squatter settlement situated on government lands

These settlements are the settlement that settled or try to settle on the land that is belonged to the government or public land, in many Kebele in Dire Dawa city there are few open space lands for different purposes such as for Greenery, common public services areas like Water tap reservoirs, military camp, and youth football fields and others. Examples of such squatter settlements which illegal landholders try to settled on before few years were; water tap reservoir compound around locally called “Toni” area which was not well-bounded, military camp around locally “Ganda Tesfa” area in Kebele 02, and other many more squatter settlement activities on public land situated in different Kebeles. In addition to these, there very huge squatter settlements are there around buffer protected areas alongside “Dachatu”, and other rivers

2.8.2. Squatter settlement along Roadside and under big public wall

Types of squatter settlements which occurred alongside the road edge and open space near the big wall, permanently this land proposed on the city master plan as road feature and pedestrians. But Dire Dawa city is characterized by squatter settlements alongside the road and under big wall housing which is unique from other area types of squatter settlements. Specifically, this type of squatter settlement has been practicing since ten to fifteen years ago in Dire Dawa city particularly in 08 and 09 kebeles. Surprisingly settlers who have been living for many years have house numbers, most of them have to tap water, and electricity service as well. The proposed road around this area is almost all in all changed to settlement and out of the service of the road.

These types of squatter settlers were not paid any annual taxes for the government; this action by itself harms City development and also the development of the country. In 1998 E.C Dire Dawa city was attacked by a very devastating flood which taken away a lot of city dwellers lives. Many of these dead citizens were squatter settlers who settled around the protected riverside area, in addition to that in this year(2021) also around nine people lives have been passed away due to collapsing of big wall and buildings on squatter settlers houses near to it because of heavy rainfalls.



Figure 2.1 squatter settlement under Muslim cemetery

The above image shows the squatter settlements near the big wall of the Muslim funeral area in kebele 07 and kebele 08 borders. Many families are living here in one household and if the flood damage can cause the damage on human lives can be very dangerous, not only that but also the existence of this protected Muslims funeral will be in doubt hence illegal grabs of this land can cause at any time.

2.8.3. Squatter settlements on indigenous land.

Hence the city's northern and eastern parts were bounded by farm lands; each farm has individual indigenous land owners. After the city's sprawl reached their land, the land owners framers are partitioned their lands into aloft of small parcels and transfer them to many individuals with less money in an squatter way. This can bring many people's to participate in these illegal actions at the same time and can cause insecure stability in the land management sector as well for the city peace and security, because of the city's priority measurement action they can take will be demolishing squatter infrastructures with peace keeping security which can lead to dangerous conflicts.

2.9. Land information and land information management system

2.9.1. Land information

Information may be defined as the combination of human and technical resources with a set of organizing procedures, which procedures in support managerial requirements (Dale P. , 1988). Policy makers, civilians, planners, land administrators, and all others are need for land information and make significant use of spatial data on day by day basis (Dale D. , 1988). In both, the private and public sectors having land information is the most prime thing for decision making, the quality of this information is directly related to its values and effectiveness of decision making where it uses.

Land Information Systems may comprise spatial and non-spatial/attributive data (survey plans and registry records). Both these spatial data (such as parcel boundary and other cadastral objects) and non-spatial data (such as records of rights, responsibilities or/and restrictions in land and/or attachments to the land) are stored, maintained, and accessed in the database environment. Spatial cadastral data is acquired through cadastral surveying methods which are concerned with geometrical data of each land parcel. The results of cadastral surveys are isolated plans of a parcel or a subdivision.

Existing LIS in many developing countries particularly in Ethiopia nearly most of them based on maps and records on paper formats having no cartographic standards with quite outdated information. A land information system usually includes a database containing spatially referenced cadastral data (objects), and additionally, it consists of a set of procedures and techniques for systematic collection, updating, processing, and distribution of cadastral data. This restricts their operational usefulness in extracting precise information on land parcels, ownership, and taxation as well as planning development activities. While there are a variety of disciplines in which GIS and ICT are being applied. Land information system is organized by combining cadastral and topographic data. Cadastre, land administration and land management are the basis for building adequate land information policies.

Land information describes attribute, spatial and temporal information about land objects, land property rights/obligations. Attribute information may refer to personal information legality or the rights and responsibility they hold. Spatial information refers to geographical information about land objects e.g.area (size), boundary coordinate, elevation, land use land cover, etc. Temporal information includes the duration rights in land, seasonal changes permitted in land use, spatial changes over time, etc. land information may produce through

the form of papers, images, Digital Models, Written documents, etc. The provision of land information is the responsibility of the land management organizations, land information is also used in land administration levels during land transfer and dispute resolution on land-related and others (Lamba, 2005).

2.10. Land information management system

Land information is a public good and it needs to be properly managed just like other resources (Lamba, 2005). LIMS as strategies is concerned with the effective management of the land information resource to achieve specific objectives and to improve decision making. Information management involves the management of information from single or multiple sources and sharing of that information to single or further stakeholders who have a right to this information. These objectives may include the improvement in cadastral coverage, data content, data reliability, and data access, integration of data, etc.

Land and property datasets develop ever larger as populations increase and the need for land information in support of development becomes ever more urgent. To supply both administrators and data users with accurate and up-to-date information about the land, more quick and resourceful systems must be developed for data collection, update, and sharing and improved surveying techniques, database management systems. The base of a land information system is a uniform referencing system that could facilitate linking the different types of data within the system and with other land-related datasets. The most important thing in land information management is the quantity of the data that can be handled, the speed with which these data can be processed, and how the data can be manipulated and analyzed (Dale M. , 1990).

There are many types of data that are used in GIS/LIS operations for cadastral applications. Some of them contain legal or fiscal cadastral information which may consist of parcel data, land ownership data (such as a mortgage, lease, and easements) large scale topographic data, land use data, etc. and related data such as utilities, population, land values, etc (Muller, 1988).

A Land Information Management System (LIMS) in the context of Land Administration Systems consists of several broad dimensions, firstly an institutional element, which includes a corporate structure in terms of policies, legal framework, etc. Secondly, it consists of a set of organizing procedures, which structure the relationship among the functional components, and thirdly, a technological dimension that includes hardware and software. Fourthly, it includes a platform or a resource-base, on which data are stored and from which meaningful land information can be produced, analyzed, and disseminated. Finally, it includes an explicit, implicit, policy towards users, transparency, information dissemination, etc.

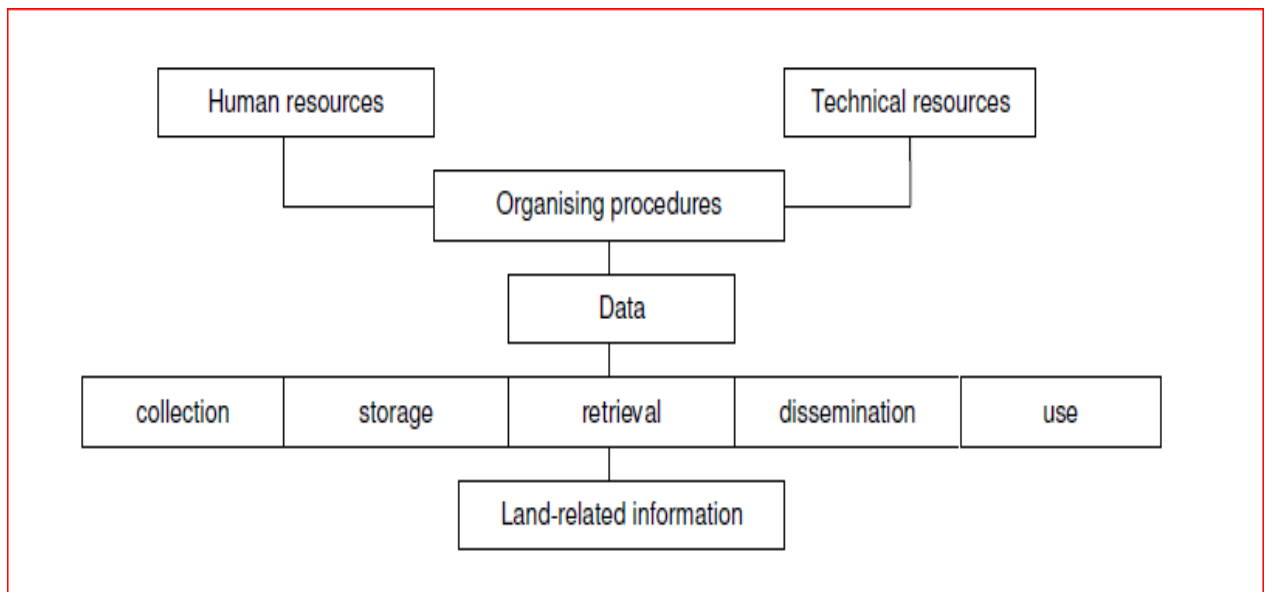


Figure 2.2 land information elements

Land information system elements

From (Dale P. , 1988)

Computerized LIS has several advantages few of them are: less storage of data due to physical compaction of data, easier and quicker access and manipulation of data, easier analysis using georeferencing tools, data integration, and data sharing between networks between distributed databases. A land information system can be determined by user satisfaction (responsiveness to information needs by its users, system accessibility and availability, etc), data (efficiency of data capture, maintenance, and process, quality of data protection, data completeness, currency, consistency, and accuracy, etc), spatial data infrastructure (SDI) (level data conversion, standardization of database structure and contents).

Making decisions for rational, sustainable land use is becoming increasingly difficult as land pressure and the competition for land worth increase. The information and knowledge required for these decisions should be based on comprehensive and quantified assessments

of potentials and development possibilities of the land resources, taking into account the biophysical, environmental, socio-economic factors, as well as the space and time dimensions of sustained land use. The outputs from such assessments are required by a growing variety of clients: land-use planners, ecologists, environmentalists, economists, researchers, politicians, agriculture extensionists, and land users (Sombroek, 1998). Generally, the process of land administration wants complete, accurate, and reliable information about the ownership, use, and value of existing land and its resources. Cadaster's play the 'book-keeping' role for this information within the wider land administration and land management systems (Tesfay, 2009)

2.10.1. Existing Land Information System in Ethiopia

Population density has increased in all major towns of Ethiopia. These major towns are capital cities of regional states (Abraham, 2019). Other cities are not capital cities of a region, however, due to business and other reasons; their population is as large as the capital city of the respective regional state. As a result, urban house construction and its correspondent infrastructure enlargement are major apparatus on the usage of urban land in Ethiopia. Hence, urban house construction is pressing the available lands for rapid urbanization of Ethiopia; land in urban areas is an essential resource for every development activity.

As modern administration applying a spatial database system, therefore, is mandatory. Most of the time, land administration responsibilities are dealt with land delivering and transferring, building permits, land tenure administration, and documentation. However, most municipalities are challenging in the administration of the land which is severely lacking consistent and automated land record systems which in turn result in a lack of transparency to the citizen. This potentially leads to corruption and squatter settlement (Abraham, 2019).

2.11. Urban Land management

The land is central to the political, social, and economic situation of any country, thus therefore proper land governance benefits the broader public governance (Burns, 2008). To manage land in society, adequate information is required on the location, size and use of land to be managed. Therefore sustainable development requires comprehensive information on the environmental conditions in combination with other land and property-related data (Mwangi, 2007) Management is an umbrella concept that involves different processes including defining appropriate regulations, procedures, and technology to attempt to achieve certain overarching goals (Purdon, 2003).

Land management is the process of defining land policies, laws, and appropriate technologies and applying them to the resources to put them into good effects (Enmark, 2005). Land management is also a process of managing the use and development of land resources in a sustainable way (Mwangi, 2007). Land resources are used for a variety of purposes that interact and may compete with one another and therefore a need to plan and manage all uses in an integrated way. The use of land resources focuses on both environmental and economic perspectives.

Land management may involve the following; property conveyance, including decisions on mortgage and investment; property assessment and valuation; development and management of utilities. To manage land in society, adequate information is required on the location, size, and use of land to be managed. (Ministry of Urban Development, 2015) Stated that to achieve millennium development goal and to help the country to join middle-income countries the issuance of the urban land development and management policy and ensuring the existence of effective, efficient, transparent, and reliable urban land development and management service delivery system over urban areas is a must. Therefore sustainable development requires comprehensive information on the environmental conditions in combination with other land and property-related data.

2.12. Regularization

As the house of peoples representative formulated new land-related law, the proclamation is restricted any type of land occupation unless through lease holding only. “Proclamation No 721/2011 Article 5 proclaims that Land Possession and Permission other than Lease Holding is prohibited.” sub-article 3 under article 5 of the proclamation stated, “that no region or city administration may permit or transfer urban land in a manner contrary to the provision of this proclamation”. The prohibition is strict that no person is even allowed to enclose and use any plot of land adjacent to his lawful possession without the permission of the appropriate body.

As land policy proclaimed as Dire Dawa city administration level based on the proclamation of lease holding 721/2011; stated that the land that occupied before 2003 only be regularized following the required process and legal way. The regularized plots shall be administrated by lease holding. But this only cannot stop and minimize the squatter settlement in the city, as the documented information the author received from the city urban land municipality department of regulatory shows illegal land occupation activity was even rising. Only in less than one years times, more than 20000 parcels were occupied informally. As city urban land management

municipality experts said regularization but itself has a positive impact on the continuation of squatter landholding because many people believe that if they occupy land parcels today the same proclamation may also be proclaimed to include their lands also one day. Based on these future wishes many land parcels are occupied in several parts of the city. Proclamation 721/2011 explains that any kind of building that was built after 2003 without the permission of officials must be demolished.

2.13. The need for GIS-based land information systems

A Geographic Information System (GIS) is the central element in the configuration of a LIS. GIS'S utility derives from a capacity for dynamic functionality based on the following three main qualities: The physical computing capacity to manipulate data, including overlay join, desegregate. The related capacity to query the data by formulating hypotheses for testing assumptions, defining potential relationships, and developing theoretical constructs; The capacity to relate two-dimensional and three-dimensional location of earth features, including atmosphere, lithosphere/hydrosphere/ecosphere, along with dynamic (spacetime) four-dimensional processes, such as represented by functional operations of systems of natural resources appraisal, planning, management and monitoring (Sombroek J. A.)

Geographic Information Systems (GIS), computerized Land Information Systems (LIS) have emerged as powerful tools in the management and analysis of a large amount of basic data and information, statistical, spatial, and temporal, needed to generate in a flexible, versatile, and integrated manner, information products in the form of maps as well as tabular and textual reports for land use decisions. In recent years FAO has been developing GIS/LIS systems in linkage with its agro-ecological zoning (AEZ) and similar models, applying these to tackle issues of land, food, and people at global, national, and sub-national levels. So far the applications have addressed mainly issues linking land use outputs with other development goals in such areas as food production, food self-sufficiency, cash crop requirements, population supporting capacity, taking into account soil fertility constraints soil salinity, soil erosion risks, and land degradation hazards. While good progress has been made in developing GIS/LIS-based tools for land resources planning, management, and monitoring at different scales, practical difficulties are encountered in making these technologies accessible to the casual user of GIS/LIS in most developing countries.

There are problems with lack of data and poor data quality; there are difficulties in training and support for such advanced systems. GIS/LIS is a multidisciplinary undertaking that integrates databases from various kinds and sources, models for data analysis, decision-

support tools, computer hard and software, and the human resources and institutional framework to operate the system. The development of these and related applications involve the analysis and interpretation of large quantities of biophysical and socio-economic data, statistical, spatial and temporal, to produce the diverse kinds of information products required in the form of images, maps, and both tabular and textual reports for decision-making at various application scales. Up-to-date computing tools of spatial analysis allowing easy access to data and information and their manipulation are necessary to produce these (Sombroek J. A.)

In a GIS, data are maintained in a digital form. As such data are in a form more physically compact when comparing to a paper map, tabulations, or other conventional types. Large quantities of data can also be maintained and retrieved at greater speeds and lower cost-per-unit when computer-based systems are used. This ability to perform complex spatial analysis rapidly provides a quantitative as well as the qualitative advantage of Geographic Information Systems over any other methods of handling land-related data (Victor Akujuru and Adebajo Durojaiye).

2.13.1. Benefits of GIS-based cadastral information systems

The benefits of GIS-Oriented cadastral information systems are immense (Victor Akujuru and Adebajo Durojaiye). UIS can be considered as an implementation of GIS in urban extent. It is an effective tool for local authorities concerning manage urban relevant data and well-qualified service offers. Many geospatial data can be examined at the same time in UIS. However, land parcel-based information is very significant within this entire management task.

From land taxation to environmental works in urban areas, cadastral documents are the main references that are always needed for meaningful decision-making. Because cadastre is a methodically arranged public inventory of data concerning properties within an area, up-to-date cadastral data should be available at any time. If such data is in a digital form then it could be more valuable for a UIS application. So, local authorities want to establish their cadastral data infrastructure in the initial stage of their UIS study. However, there are important issues in realizing it with respect to cadastral maps, data quality, institutional and legal perspective.

Certainty and security of ownership: Accurate compilation of land records enhances formal identification and recognition of the ownership of the land and other rights that exist in the land thereby leading to social cohesion. Also, existing defects in any title to land can

be cured by the judicious use of the appropriate powers. In the rural areas, where farmers have an incentive to take greater care of the land and to invest their capital on it, GIS-based cadastral information systems will ensure greater productivity.

Reduction in land disputes: Disputes concerning land ownership and boundary definition often give rise to expensive litigation. Settlement of such disputes should be integral part of the process of adjudication, which will eventually lead to greater productivity, reduce court costs, and money wasted in litigations.

Improved conveyance: The cost and delay in transferring property rights can be substantially reduced through this operation of computerized land registration systems. Duplication of efforts, for instance in the repeated investigation of old titles can be avoided, thus saving costs.

Security of credits: The land titles are often used as security against a loan. The combination of a sound title with the ability to raise long-term credit can give rise to a substantial increase in productivity from the land.

Monitoring of land market: A GIS-based cadastral information system can be used to monitor and if necessary to control land transactions and ownership.

Support for land taxation: Many states of the federation have some form of land assessment and derive revenue from charges made on the land; this system will enhance greater efficiency in tax collection and the consequential greater rate of recovery of tax.

Management of state land: In Ethiopia, the state is the major landowner. The development of computerized cadastral systems and the subsequent creation of cadastral maps in a systematic manner will benefit the states greatly in the administration of their land. Leading to improved revenue collection from the land that it leases. More so, the public acquisition of land through a compulsory purchase before re-development can be expedited.

Improvement in physical planning: GIS-based cadastral systems can be used to support physical planning in both rural and urban areas. In some states, many development programs have failed or been unnecessarily expensive because of a lack of knowledge of existing land rights. The system will equally provide the basis for restraining certain uses of the land, monitoring encroachment on the right of ways, etc.

Facilitating of land reform: Land redistribution, land consolidation, and land assembly for development and re-development can be expedited through the ready availability of information on individuals who currently own things.

2.14. Remote sensing and urban land

New technologies such as Lidar, remote sensing satellites, Google Earth, and others are enabled to capture and compile new indicators for understanding land governance. Geospatial information which is the result of these technologies is important to capture and explicit location knowledge (de By, 2013) of surface artifacts. Tools such as Geographic Information system (GIS) including spatial analysis and remote sensed aerial or satellite imagery are prime examples of sources of spatial information (Alemie, 2015). Remote sensing data sources such as high-resolution images provide detailed data about specific surface features. Especially in urban areas, these imageries depicts individual buildings in the slum (squatter settlements), roads and pattern of features (sluizas, 2010).

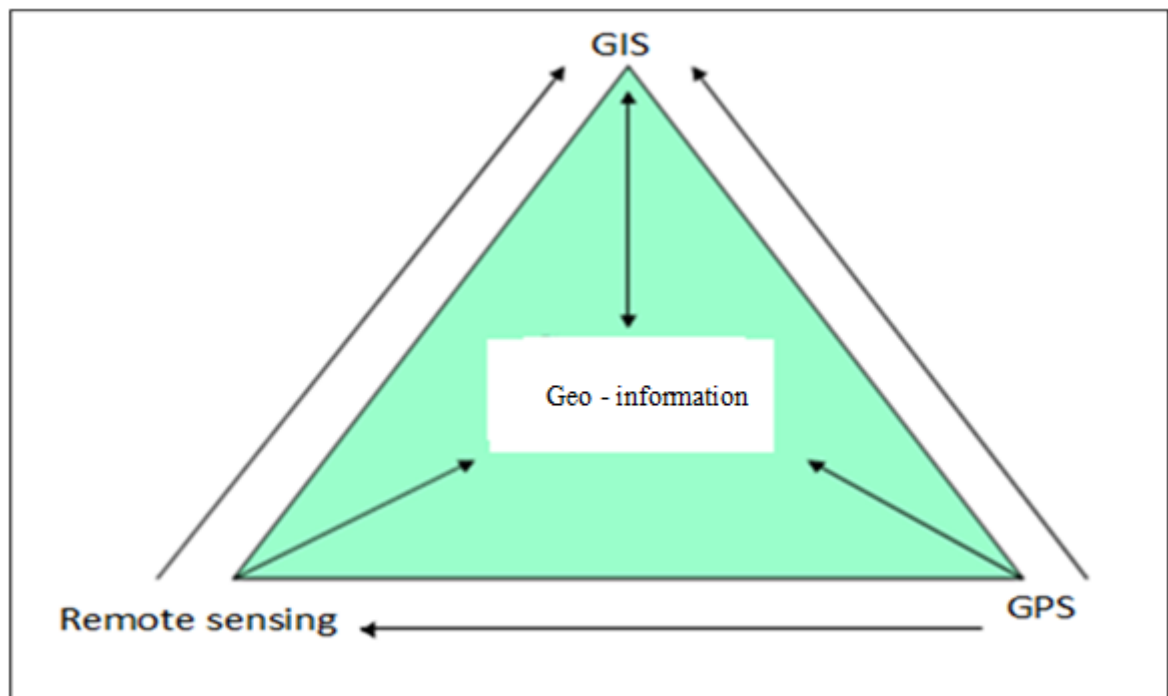


Figure 2.3 Geo-Spatial technology integration

Source: from teaching materials of integrated systems in geomatics course.

Remote Sensing technology is a modern technology applied in improving cadastral information. It uses Electro Magnetic Energy (EME) as source energy record data which is the false-color composite format. The satellite carries sensors with different specifications that can continuously monitor the earth and acquire data beyond the visible region of the human eye. Sensor eye is kept on board satellite in space which records and sends the data to the ground receiving station on the repetitive cover basis.

Remote sensors record data of the environment through reflectance values resulting from electromagnetic radiation, as an exception case sensors only record the human-made and natural artifacts. These artifact features are derived from government policies, organizational capabilities, land management, and land tenure characteristics. However, none of these are reflected from electromagnetic radiation that gets recorded in the tenure system. These problems are tackled by social data analysis which evaluating the performance of organization capabilities, policies, and others. These could lead us to understand squatter settlement causes in combining with spatial data analysis. Similar works are used the same mechanism by different researchers at different times (Cowen, 1988) as shows that indicators for remotely sensed data through analysis of plots sizes, nature of roads, pattern, and density of buildings.

Particularly for squatter settlement, remotely sensed data have a high value. In a similar context, attribute information not eagerly available this is because squatter settlements are highly dynamic (Hofmann, 2008). Squatter settlement records are excluded from the government national census (Owen, 2010) and spatial cadastre also. Remote sensing can fill this gap (Alemie, 2015). But before it applies directly, the criteria for differentiating squatter settlements from formal settlements and resolution of remote sensing images should be defined. The criteria that the researcher used particularly for this research were tabulated in the next chapter.

2.15. Empirical Review

Binns's describes the benefits of land as "man's most valuable resource, the foundation of all forms of human activity" and he also that we obtain the food we eat from it, the shelter we need, and the place to work (Binns, 1953). Daniel weldegebriel Ambaye suggests on Governance is about making decisions and service delivery to be transparent, equitable, and efficient. In the context of urban land, this relates directly to land and housing access. A lack of access leads to squatter settlement (Ambaye, 2011), and also he demonstrates that the uses of mixed-method are the preferred way for squatter settlement studies hence causes are easily understood from social data analysis, and the effects on the spatial dimensions are easily identified and mapped by Geo-spatial technologies from spatial data analysis.

Daniel Lirebo also suggests this when he explained when land delivery to the society is so poor the formation of squatter settlement is a remedy for the citizens. He concludes about land delivery and Addis Ababa's squatter settlements as, "The present regulations, building standards, land delivery system; procedures to obtain housing finance from institutions

coupled with lack of institutional capacity hampered the accessibility of formal housing. Thus, squatter housing is the only remedy for their survival. Squatter settlements in the expansion areas of Addis Ababa are concerned, it is very difficult to conclude whether they are “poverty-driven or not”. This is because some of these settlements do not have a sign of poverty (rather they are good housing, have a large compound and full services) while others are suffering from a lack of services, are highly crowded, and located in environmentally sensitive areas (Daniel, 2006)

Hailu Geletu suggests on squatter settlements Regularization as create expectation, “all squatter landholdings will be legalized. This expectation further enhances squatter developments especially on public lands and this again created land speculators to buy parcels (illegal building) in the expectation of that the area will be legalized sometime in the future”. Lambaby his part conclude this on squatter settlement regularizations and land transactions, “access and delivery of land and shelter are not equitable, land allocation procedures and financial arrangements are not transparent. Yet squatter land tenure systems are still widely accepted in urban residents, because of the transaction costs in these systems are still lower than those of formal even these imperfections” (Lamba, 2005).

SECR 2015 suggests this on the necessity of modern technology on the urban squatter management firms, “Improvement of housing condition requires adopting innovative housing construction technologies that take into account durability, affordability and sustainability issues”.

CHAPTER 3: MATERIALS AND METHODS

This section presents the description of the study area, the research design/research methods to be used, and sources of data, data collection, and data analysis techniques.

3.1. Description of the study area

Dire Dawa, is a city in eastern Ethiopia, was established in 1902 as a relative lowland with an elevation of 1200 m above sea level. Dire Dawa City, located 515 km from Addis Ababa, 55 km from Harar, and 313 km from Port Djibouti, with a latitude and longitude of 9°36'N 41°52'E and 9.600°N 41.867°E Coordinates respectively. The city's economy has not recovered to date (UN-Habitat, 2013; CSA, 2017). With this economic slump, growth has been more organic and dense; unplanned (informal) settlements can be seen scattered throughout the city.

The administration is bordered by the Shinile Zone of the Somali National Regional State on the northwest and northeast, and by the eastern Hararge Region of the Oromia National Regional State on the south, southeast, and east. The Provisional Administration is estimated to have a total land area of 128,802 hectares of land of which 97.73% covers the rural area, and the remaining 2.27% accounts for the land area used by the region's main urban center:

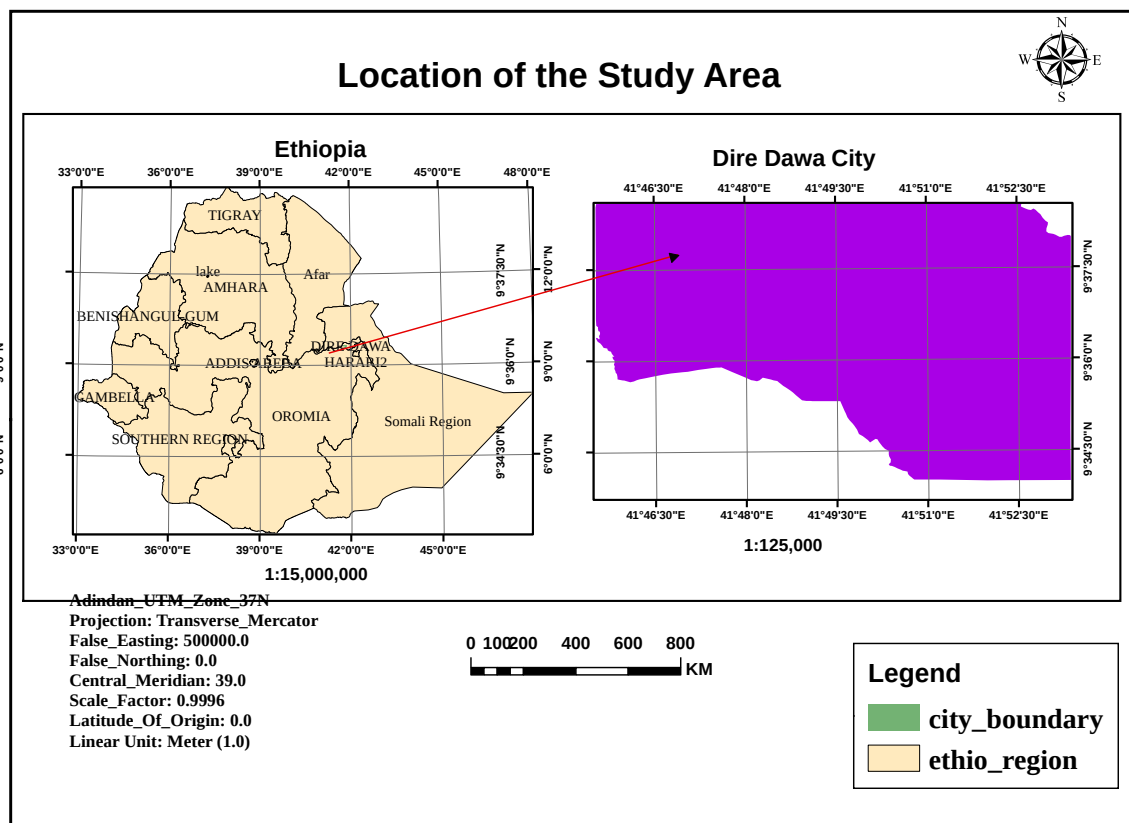


Figure 3.1 Study area location map

Population

Dire Dawa is one of the biggest towns in Ethiopia. The Central Statistical Agency (CSA) records an increased population number which is 212,029 in 2007. Also, this population number will be projected towards 374,175 in the year 2020 with an average growth rate of 4.2%.

Climate

The climatic condition of the Provisional region seems to be greatly influenced by its topography, which lies between 950 – 1250 mean sea level, and which is characterized by a warm and dry climate with a relatively low level of precipitation. The mean annual temperature of the Provisional Administration is about 25.4⁰C. The average maximum temperature of the Administration is 31.4⁰C, while its average minimum temperature is about 18.2⁰C

Demography

Censuses record that Oromo is the greatest percentage of the city, based on the number who speak the Oromo languages. Based on CSA data oromo accounts for about (45%) of the total population of city's, Somali (35%), Amhara (13%), Gurage (3%), and Harari (1%). The religion with the most believers in Dire Dawa is Muslim with 70.8%, 25.71% are Orthodox, 2.81% Protestant, and 0.43% Catholic.

3.2. Data Sources

A variety of data sources dealing with different data types include both primary and secondary data. The primary data which is coordinate data was collected from the field in squatter settlement site Garmin handheld GPS, interviews and questionnaire is another data which was collected from different kebeles of the city with different social classes with educational background level and different occupations, experts from the land municipality and different sectors. The secondary data source was obtained from the city municipality which involves an aerial photograph of the city 2020 with 0.5m resolution used to assist field observation data in training the images during classification, structural plan of Dire Dawa city, and up to July 2020 Regularized parcels from Dire Dawa city land municipality, Landsat 4 images of 2010, Sentinel images of 2015 and 2020 with 10m resolution from earth explorer of United States Geological Survey (USGS) were used to detect the LULCC, which all of the images cloud cover were less than 10% to keep low downs the seasonal variations.

Used materials are listed and tabulated as follows.

Table 3.1 Materials and data used

Used Data		Purpose	Sources
1	Aerial photo of Dire Dawa city	For extraction of land uses And also for digitization purpose	From city municipality
2	Rectified Google Earth Image	To get updated information that may not exist on an aerial photograph, and for georeferencing aerial photo	Google Earth Explorer
3	GCP coordinate	From aerial photo and from field for image classification and validation	From Field Survey
5	Sentinel image of 2010, 2015 & 2020	For LULC classification	From USGS

3.2.1. Field Data Collection

In this research as the researcher explained before, both primary and secondary data were used to make sure that the objectives of the study are met. Yet important information and data are gathered from the field were collected socially and spatially. Primary data was gathered through questionnaires, interviews, Discussions with different society classes and experts, and the major purpose of this task was to identify the main causes of squatter settlement and main factors to its. Ground Control points were collected with handheld GPS.

3.3. Used material and software's

In this study, different materials and software were used to achieve the objectives of the study.

Table 3.2 Used Software and GPS

Name	Version	Purpose
ArcGIS	10.8	Geo-Database creation and digitization, analysis, and preparation of illegal urban land-grab map
Erda Imagine	2014	For image segmentation and image classification
Equipment to be used		
Hand held Garmin GPS		Collection of geographic coordinates

3.4. Methods of Data Analysis

After collecting the entire relevant primary and secondary data, the next task is to process and analyzing the data. As the title's of this study declared at the beginning this study was used geospatial technology to examine the extent of squatter settlement conditions in Dire Dawa city as the main tools spatial and social data analysis as primary data and secondary data. As (yeager & Steiger, 2013) recommended mixed method that comprises social and spatial analysis techniques to be better understand and to solve social influences on spatial systems is preferred. On the other hand (Pahl-Wostl, 2009) expressed that the need for developing more interdisciplinary approaches to enhance the base and understanding of land governance. In this research, a socio-spatial approach for evaluating squatter urban settlements in land governance was applied. Based on this argument the methodology is composed of two parts social data collection and analysis, and spatial data collection and analysis.

3.5. Social data collection methods and analysis

The social data collection was done through a field survey. A total of 143 questionnaires and two group discussions which were composed of 4 participants each were conducted. The participants were the city's land management and development bureau official, official, and members of squatter settlement regulatory department, residents selected based on purposive sampling method with their understanding about the issues, society representative and elders were selected for group discussion. the participants from the municipality's educational level were from Diploma(10+3) to second-degree holder, and the participants from residents were above grade six with the previous curriculum. Of the participants 121 are male and 22 of them are female, and 86% of participants were married, also 79% of them are house owners with 14% of them are females. Due to its many advantages like low-cost, not time consuming, not confuse for identifying target groups and others purposive or judgmental techniques were used. Based on this 150 respondents were selected first but 7 of them was not interested and were not respond.

Firstly the purpose of the study was explained for all parties; the question was designed and asked as the level of the participant understanding systematically. Different questions in content were prepared for urban land management experts and society representatives alone. Experts and officials were asked to explain the causes for squatter settlement in Dire Dawa city and the Impacts of Regularization on illegal landholding increment firstly. Secondly, they were asked to mention the main challenges in the case of managing landholding illegality in Dire Dawa city and to mention their opinion for the solution. Society representatives were asked the causes of an squatter settlement in the city and which causes highly serious in the study area, and to reason out how the selected cause is played a key role.

The intent was to capture important issues of the causes and effects of poorly performing urban land and other policies and laws, urban land and other actors and their interaction during policy-making and implementation (Alemie, 2015)helped to the specific causes of an squatter settlement in the study area. The overall data collection through questionnaires, interviews, and discussion were designed to distinguish the main cause of the spatial and temporal expansion in the case of Dire Dawa city during social data analysis.

3.1. Socio-economic characteristics of squatter settlers site in Dire Dawa city

Squatter landholder faces many challenges such as; Lack of basic services - housing, water supply, lack of religious places or long distance from them, education center, sanitation, etc. let summarize them as follows in table form.

Table 3.3 Socio-economic characteristics of settlers

Characteristics	Descriptions
Water	No access to tap water around it. They buy the water from formal residents near to them, which is far distancing them and quite expensive, hence the scarcity city of drinking water at city level at all.
Electric light	They have no access to electric power. They buy power from nearby formal residents by 40-50 birr per single bulb, which is too costly.
Health center	No health center nearby them at all, and even this one is too serious for those squatter settlers. An existed health service is kilometers far from them.
Police station and education center	Hence squatter landholders occupy the lands illegally the site was very dense to each other, the was characterized by lack of access to a public service center like road, police station, religious places, education center, and others

3.1.1. Sampling Methods

The purposive non-random sampling technique method was also employed to intentionally identify key informants from government offices, elders who could provide well thoughtful information about the impact and what solution could be as their thoughts. And they were intentionally interviewed to strengthen the results of this thesis and hit the objective of the

study. Purposive or judgmental sampling is a strategy in which particular settings persons or events are selected deliberately to provide important information that cannot be obtained from other choices (Maxwell J. A, 1996). Because of the following main advantages and others, the researcher used this method: low cost, convenient, not time-consuming, ideal for exploratory research design.

3.2. Spatial data collection methods and analysis

Spatial data for this thesis was collected from the urban land management municipality of the city administration including an aerial photo of the city of 2020 with a spatial resolution of 0.5m. Structural plan of the city which includes squatter and formal settlement, kebele and city boundary, land use the land cover of the city also accessed from land management municipality bureau of city plan and development department. The water pipeline distribution data was accessed from the city's liquid and drinks water bureau, and Google earth which was imaged on May 4 in 2020 was used for newly updated on the area. Finally, the sentinel image of 2015 and 2020 was downloaded from USGS with 10m resolution of Red, Green, and Blue colors for image classification tasks.

Handheld GPS was used at the field survey stage, for the collection of ground truth related to squatter settlements which include squatter settlement x, y coordinates, main roads, religious places, schools, clinics, and other points.

The overall schematic charts showed socio-spatial approaches throughout this study was shown below.

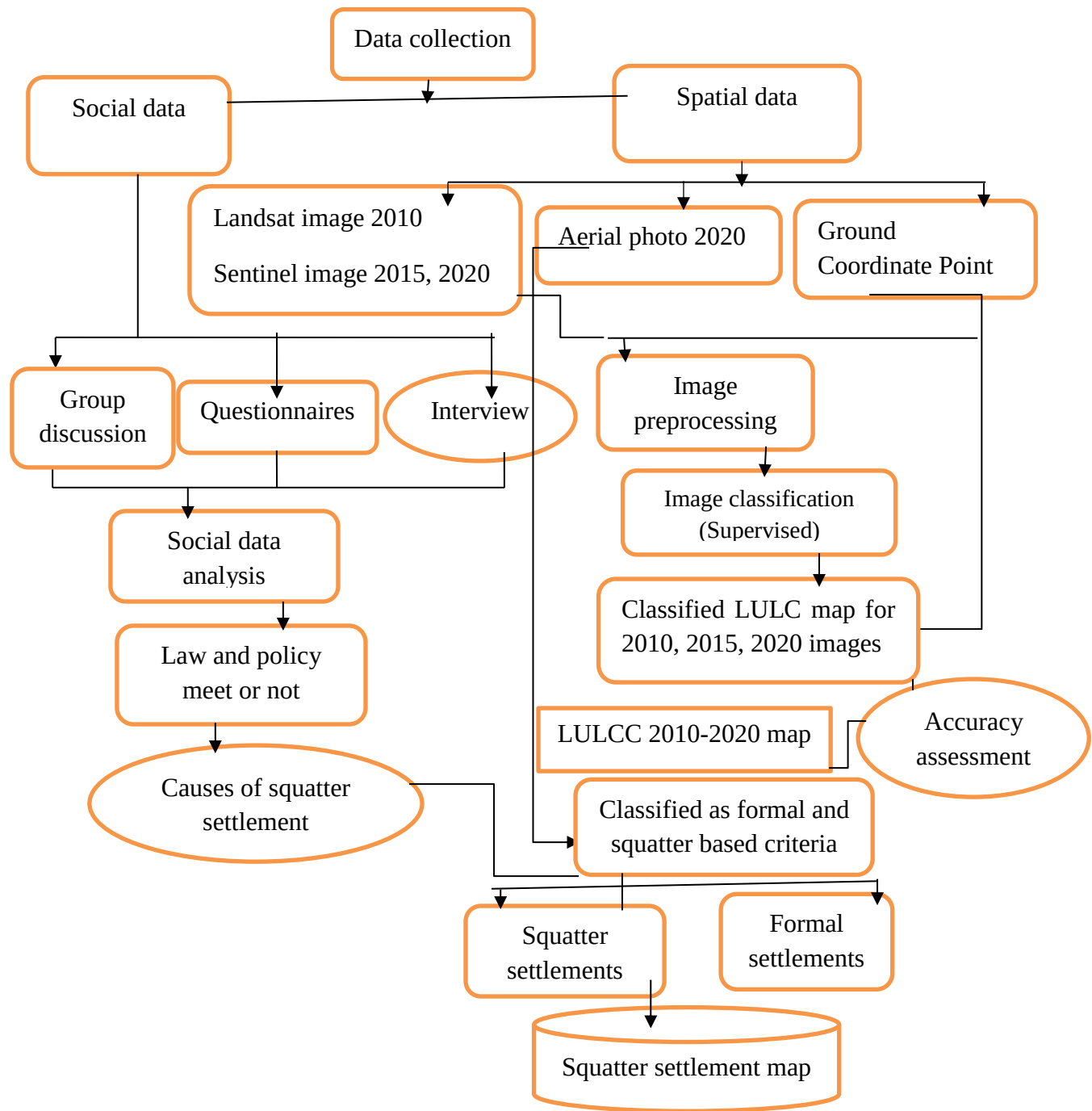


Figure 3.2 Schematic Workflow chart.

3.2.1. Image Classification Methods

Image classification is an important part of remote sensing, image analysis, and pattern recognition. Classification in remote sensing involves grouping/clustering the pixels of an image to a relatively small set of classes, such that pixels in the same class are having similar properties. Image classification is distinguished in two main ways as supervised and unsupervised classifications. Supervised classification is the process of assigning objects of unknown identity to one or more known features using training data. Sentinel image with 10m resolution has been used for this thesis with, 2015, and 2020 years; and were classified by using the ground truth data collected; by supervised classification method. Better results can be achieved in the supervised classification technique by taking more features and samples from the study area. More than fifteen (15) samples were collected from the field for each of five (5) classes.

Two 10m resolution Sentinel images were used to analyze the assessment of squatter settlement extent trends and their patterns in the past 10 (2010-2020) years. Accordingly, the images were classified into different land cover classes which finally ended up in generating three different year land-cover maps of the study area. In the classification method, pixels with maximum likelihood are categorized into the corresponding class. The land cover maps are composed of five major land-cover classes namely; Built-up, Barren-land, Vegetation cover, Farmland, and Temporal/Seasonal river. The built-up area consists of commercial, residential, industrials, road and impervious features and barren land includes open space with no built-up or non-developed area; on the other hand, the area which covered with shrubs trees, cabbages, other eating fruits and big trees are classified under vegetation cover class.

3.2.2. Land use land cover change

The ultimate reasons for studying these change characteristics are to understand land change trends, evaluate and manage the consequences of change. Information about factors that drive squatter urbanization and the rates of it was obtained from multiple multi-temporal images, can provide valuable knowledge about the patterns of urban growth and the probable factors driving the changes. Numerous techniques have been developed and used for change detection to monitor changes in LULC by making use of remotely sensed data for instance image differencing, post-classification comparison (PCC), vegetation index differencing and principle components analysis (PCA) (Lu D, 2004). The change detection method used in this analysis is the post-classification comparison technique; argued with Alphan “in which GIS overlay of two independently produced classified images in Arc-GIS” (Alphan, 2009).

The resulting land cover maps are then visually compared and change areas are simply those areas that are not classified the same at different times. Following this method, maps have been produced to show the newly built-up area between each subsequent year, 2010 to ends of 2020 for the study area and finally built was classified again to Formal and settlement based on (Owen, 2010) discriminating criteria.

Accuracy assessment

Classification accuracy is the most important aspect to assess the reliability and the correctness of classification tasks performed by individuals; it compares the classified image to ground truth data. The accuracy of any classified image is of utmost importance especially if that image is to be used for further analysis since it serves as the certificate of authenticity for any image. Accuracy assessment is particularly important in post-classification change detection analysis where the accuracy of the final change image depends on the accuracy of the independently classified images (Yuan, 1998).

The main purpose of Accuracy assessment is to determine how well the classified image corresponds with what exists on the earth's surface. In this study, the accuracy of the classification results for the years 2010, 2015, and 2020 were assessed using 30 randomly sampled ground truth points, obtained from fieldwork. The most common way to assess the accuracy of your classified image is to create a set of random points from the ground truth data and compare that to the classified data into a confusion matrix

Accuracy assessment formula

$$\text{User's Accuracy} = \frac{\text{Number correctly classified pixels in each category}}{\text{Total number of reference pixels in that category (Total Row)}} * 100$$

$$\text{Producer's Accuracy} = \frac{\text{Number correctly classified pixels in each category}}{\text{Total number of reference pixels in that category (Total Column)}} * 100$$

$$\text{Overall Accuracy} = \frac{\text{Number correctly classified pixels in each category (diagonal)}}{\text{Total Number of a Reference pixel}} * 100$$

$$\text{Kappa coefficient (T)} = \frac{(\text{TS} * \text{TCS} - \sum (\text{Row Total} * \text{Column Total}))}{\text{TS}^2 - \sum (\text{Column Total} * \text{Row Total})}$$

TS= Total Samples, TCS= Total Corrected samples

CHAPTER 4: RESULT AND DISCUSSION

This chapter will present the results of the analysis performed on the images and will also examine the outputs in terms of changes that occurred after applying spatial data analysis and also point out the possible squatter settlement causes at the study area after interpretation of social data analysis

4.1. Results

In this section, the social and spatial data analysis results for Dire Dawa city squatter settlements are presented.

4.1.1. Social data analysis results

Social data collected during the field survey were identified as the cause of squatter settlement in Dire Dawa city, and the data from the group discussions and interviews were used to complement the causes. The results of social data of society representatives and citywide dwellers have been analyzed presented as follows graphically and as table form.

Table 4.1 Society representative data analysis results

Causes of squatter settlements	Responses%				
	V. high	High	low	V.low	No effects
Political crisis	59.2	20.8	10.0	8.6	2.4
Population growth	46.4	24.3	12.5	9.6	8.5
Land lease expensiveness	44.1	33.4	13.5	4.4	3.9
Weak governance	40.3	31.5	20.6	5.4	2
Land value increment	53.7	19.3	15.2	8.7	4.1
Lack of land provision for housing for urban poor	58.1	20.7	18.2	3.1	0
Problem with land policy and regulation	50.5	29.1	14.4	4	2
Too weak law-enforcement with existing policy	48.9	36.6	11.3	3.2	0

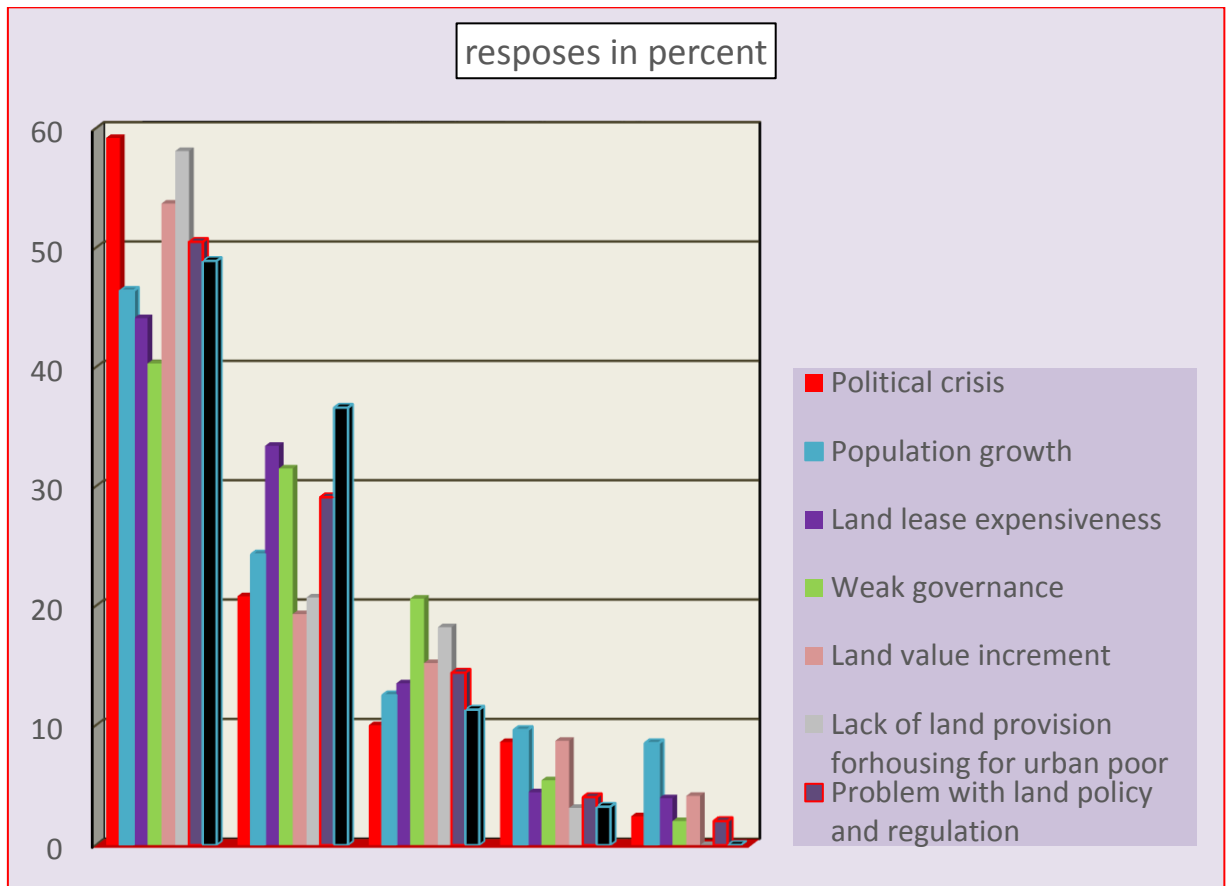


Figure 4.1 respondent response results in graph

The percentage of both responses shows all listed factors raised in society representatives and experts analysis data exhibit high contributions for the spatially expanded of squatter settlements in Dire Dawa city. Based on the social data analysis; the results for cause of squatter settlement in the study originate from different sources; lack of good governance (weak governance), lack of land provision for urban poor society, political crisis, population growth, land lease expensiveness, land market value increment, too weak law enforcement with existing policy, the problem with land policy and regulation are among listed by respondents as the main cause for squatter settlement and was listed alone by society representatives as main causes whereas experts list; as additional causes for squatter settlement by their parts. The detail of social data analyses was here as follows.

Respondents response

As described in the above table 4.1 the 59.2% of society representatives believe that the political transition of 2010E.C have had a **very high** contribution to the expansion of squatter settlement in Dire Dawa City the same as to major cities in the country such as Addis Ababa. According to them hence all administrative bodies and most of the people's focus was on the political transition made during the mentioned year in the country, many people were motivated on land grabbing illegally because of the vacuum created by those political power transition. Respondents claim that the government was too late to take action for such land grab illegality. Around 20% of society also believed that political crisis had played a key role in squatter settlement causes. 58.1% respondents believe that the lack of land provision for urban poor society was lead people to occupy land parcels without confirmation from concerned officials, they added that since they have no enough money to lease the land from land municipality their option is occupying any open space land and built simple house on it.

Population growth and land lease expensiveness was also listed by 46.4% and 44.1% respondents respectively, as opinion population growth in a study from time to time increase rent house prices alarmingly across the city which by its this also the cause for land value increment in Dire Dawa city. Single land parcel lease price is more than 27000 ETB for every individual and this amount of many was too much for urban Ethiopians inversely this opposes constitutions which state every citizen of the country can have his shelters.

Problem with land policy and regulation and Too weak law-enforcement with existing policy pointed out by 50.5% and 48.9% respondents respectively. From a technical point of view, one common reason for the administration's incompetence to control unplanned development is the difficulty to locate quickly, and in time, the under-construction of squatter buildings in a cost-effective way and stop the construction at its beginning or apply a penalty as early as its beginning. land policy and regulation which formulated in 2004E.C stated that any kind of building which built after 2003E.C without any permission from the concerned body should have to be demolished but like 50.5 % expert respondent mentioned there was a huge gap on working with this policy. Overall squatter settlement causes in Dire Dawa are mostly in agreement with (Abbott, 2000) and (Ambaye, 2011)

4.1.2. Spatial data analysis results

The spatial data analysis involves image processing, image classification, land use land cover map preparation for all those 2010, 2015, and 2020, accuracy assessment calculation, and overall change detection area calculation and mapping. Temporal and spatial variations of squatter settlements were analyzed for the Dire Dawa city to determine the extent of unplanned/ squatter landholding over the study period. Percentages of each land-use class, including built-up area, vegetation, barren land, seasonal river, and farmland land for 2010, 2015, and 2020 were analyzed for changes in LULC. Satellite image pre-processing before change detection phenomenon is very important to establish a more direct affiliation between the acquired data and biophysical phenomena (Abd El-Kawya OR, 2011). Due to the problem of the acquisition system, platform movements, remotely sensed data from aircraft or satellites are generally geometrically distorted. The satellite data were imported into ERDAS 2014 software in an image format for geometric correction. After the images were geo-referenced, mosaicked, and subset based on Area of Interest (AOI).

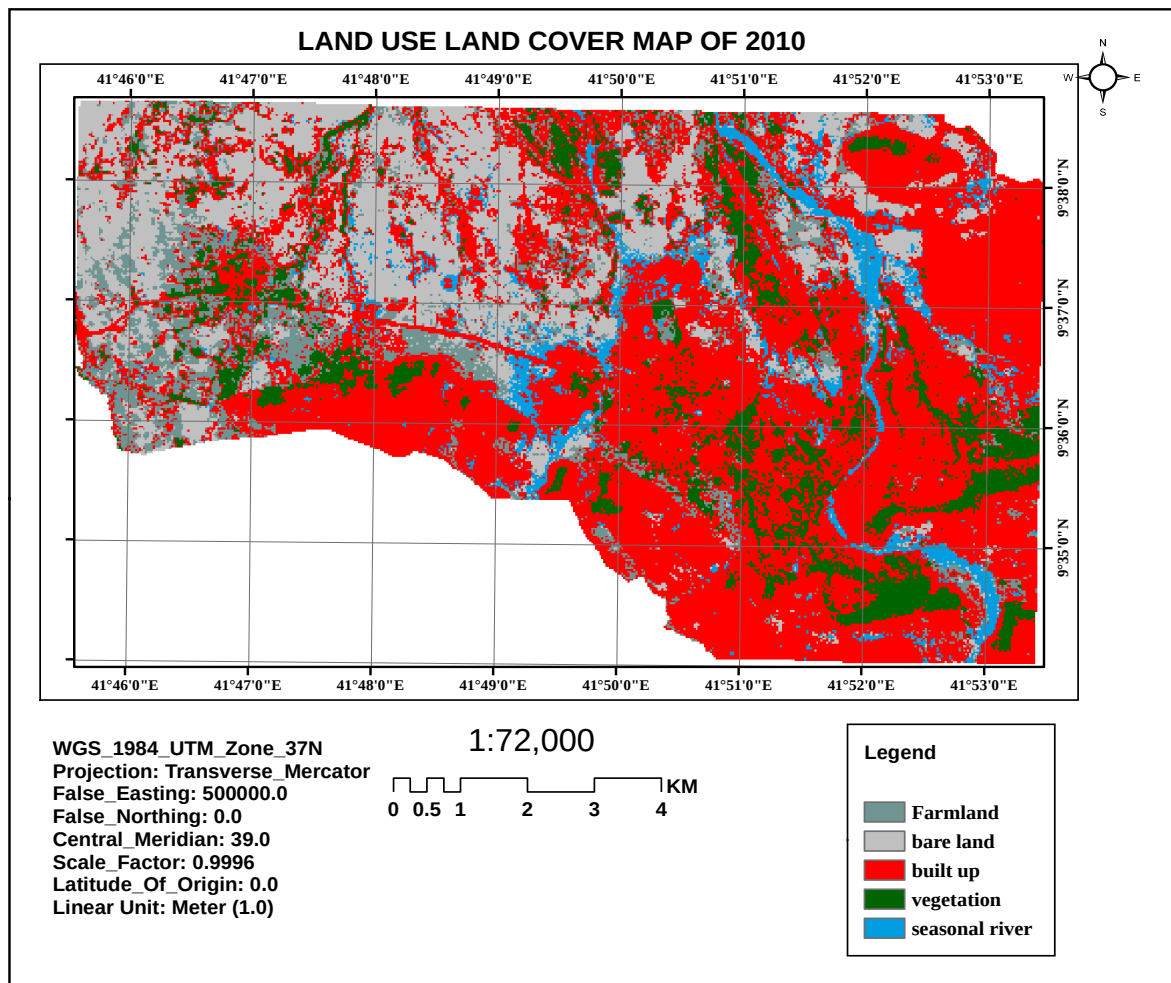


Figure 4.2 Land use land cover map of 2010

Then all the images are classified by the supervised classification method by taking eighteen(18) to thirty(30) signatures for every class for all three images. As we can observe from table 4.5 Bare land was the most dominant class with 3270.2 hectares (34.5) or 34.5% of the city boundary and followed by building up which accounts for 2012.5 hectares from the total area of the city. Farmland, vegetation, and seasonal river class were covered 20.6%, 10.78%, and 5.67 % respectively.

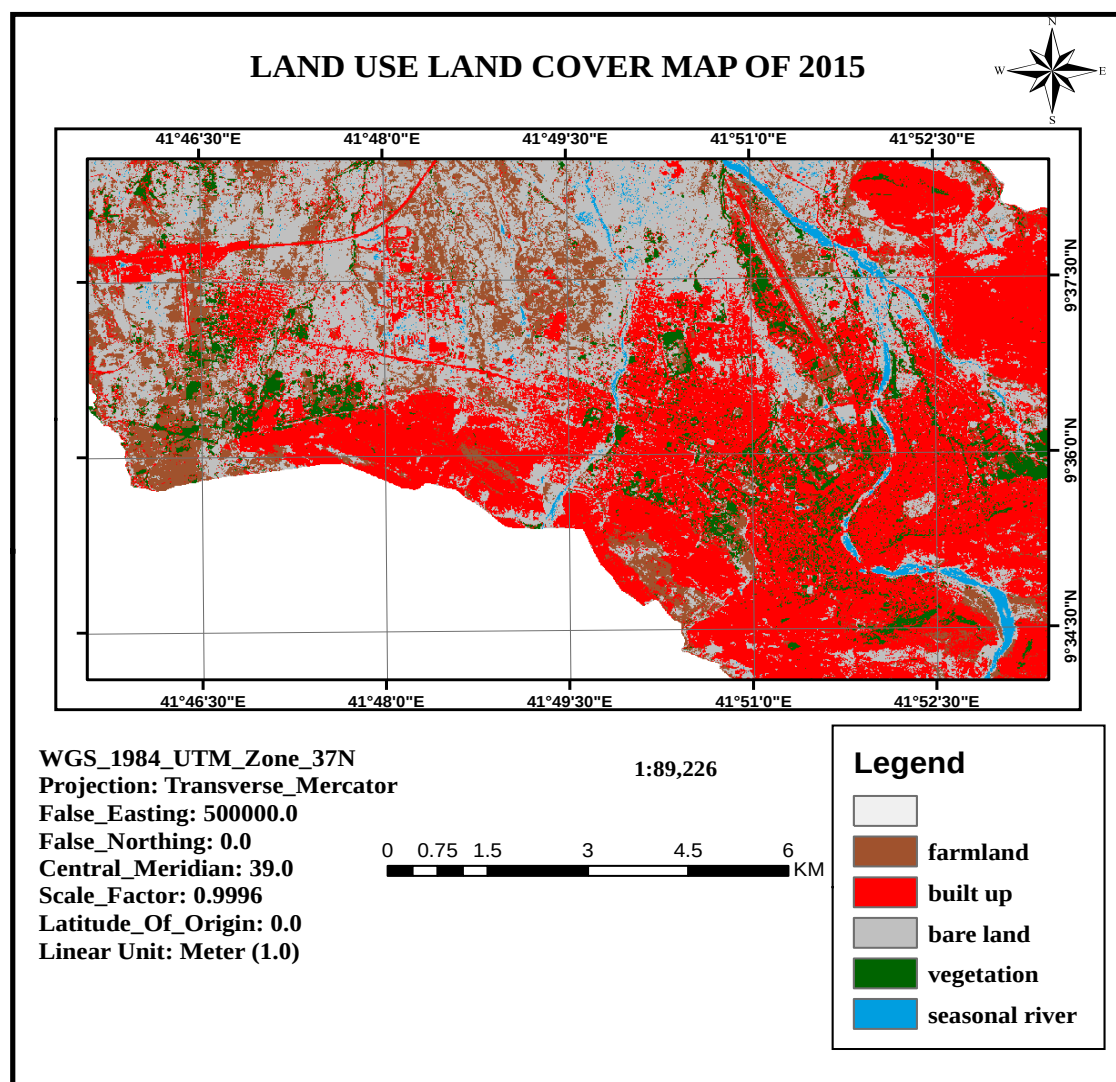


Figure 4.3 land use land cover map of 2015

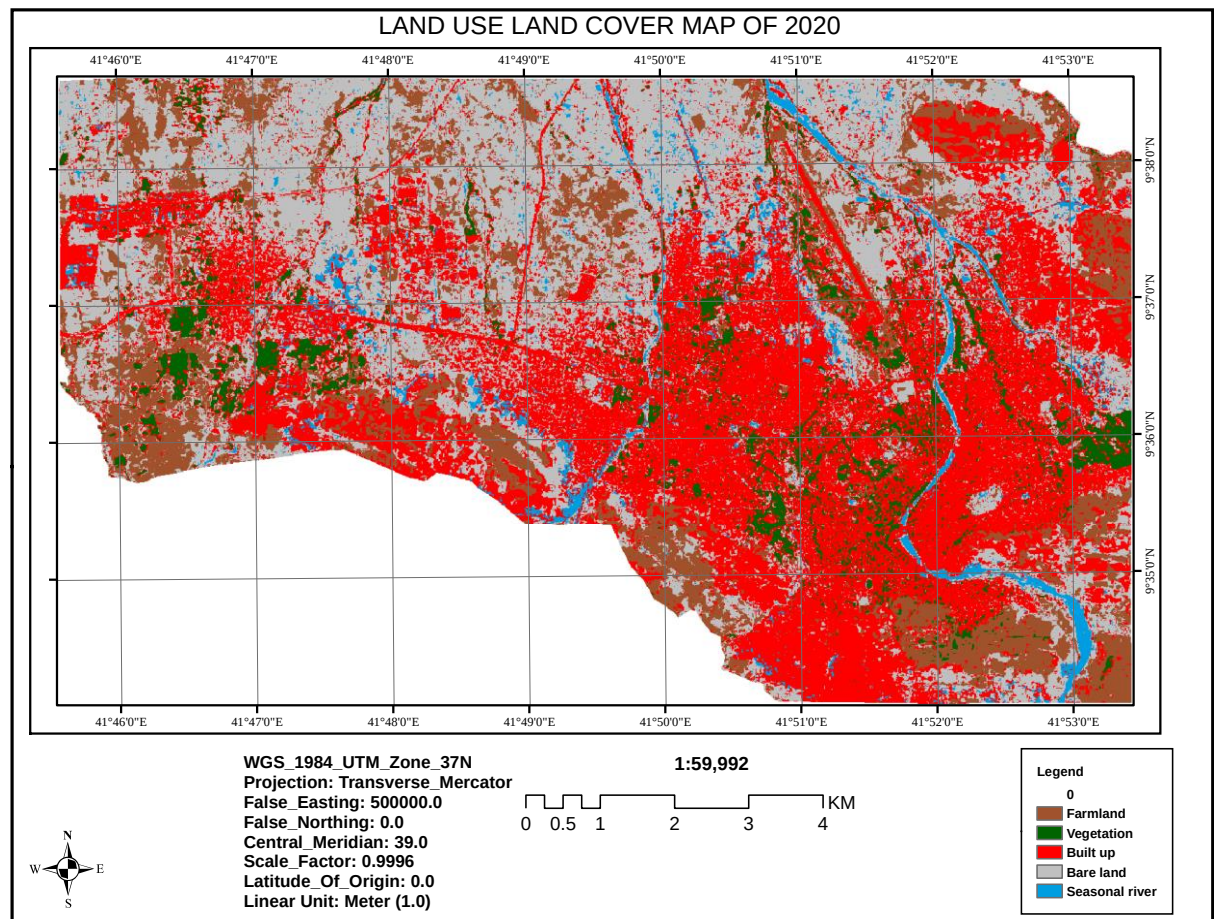


Figure 4.4 Land use land cover map of 2020

4.1.3. Accuracy assessment

Accuracy assessment in this study revealed the overall accuracies of 90%, 87%, and 93% were calculated for 2020, 2015, and 2010 respectively.

Table 4.2 confusion matrix table of classified map of 2020

LULC Name	bare land	built up	farmland	seasonal river	vegetation	Total User
bare land	9	0	0	0	0	9
built up	1	5	0	0	0	6
farmland	1	0	6	0	0	7
seasonal river	1	0	0	3	0	4
vegetation	0	0	0	0	4	4
Total producer	12	5	6	3	4	30

$$\begin{aligned}
 \text{Overall Accuracy} &= \frac{\text{Number correctly classified pixels in each category (diagonal)}}{\text{Total Number of Reference pixel}} * 100 \\
 &= \frac{9+5+6+3+4}{30} * 100\% \\
 &= 90\%
 \end{aligned}$$

$$\begin{aligned}
 \text{Producer's Accuracy} &= \frac{\text{Number correctly classified pixels in each category}}{\text{Total number of reference pixels in that category (Total Column)}} * 100
 \end{aligned}$$

User Accuracy Calculation

$$\text{Bare land} = 9/9 * 100 = 100\%$$

$$\text{Built up} = 5/6 * 100 = 83.33\%$$

$$\text{Farmland} = 6/7 * 100 = 85.71\%$$

$$\text{Seasonal river} = 3/4 * 100 = 75\%$$

$$\text{Vegetation} = 4/4 * 100 = 100\%$$

Producer's Accuracy

$$\text{Bare land} = 9/12 * 100 = 75\%$$

$$\text{Built up} = 5/5 * 100 = 100\%$$

$$\text{Farmland} = 6/6 * 100 = 100\%$$

$$\text{Seasonal river} = 3/3 * 100 = 100\%$$

$$\text{Vegetation} = 4/4 * 100 = 100\%$$

$$\text{Kappa coefficient (T)} = \frac{(TS * TCS - \sum (\text{Row Total} * \text{Column Total}))}{TS^2 - \sum (\text{Column Total} * \text{Row Total})}$$

$$\begin{aligned}
 &= \frac{30 * 27 - \sum (9 * 12 + 5 * 6 + 6 * 7 + 4 * 3 + 4 * 3)}{30^2 - \sum (9 * 12 + 5 * 6 + 6 * 7 + 4 * 3 + 4 * 3)} \\
 &= 0.673
 \end{aligned}$$

Most of the LULC classes have a larger producer's accuracy than overall accuracy except that of bare land. The lower accuracy for these classes can be may due to the similarity of soils with that of farmland and may misclassify under farmland classes. Landsat image resolution and the lack of comprehensive ground truth data. By the same procedure, the researcher calculated accuracy assessment for all classified land use land cover maps for one decade periods with 2010,2015, and 2020 which had found as90%, 87%, and 93% overall classification of them respectively, calculated by using a confusion matrix. Kappa statistics/index was also computed for each classified map to measure the accuracy of the results. The resulting classification of land use/cover maps of them has been 0.673, 0.88, and 0.85 respectively for map 2020, 2015, 2010, this was reasonably good overall accuracy and accepted for the subsequent analysis and change detection.

4.1.4. Change Analysis

After the preparation of land use maps, the changes that occurred during the studied periods in each land cover were detected. Over the study period, land covers in study areas such as bare land, a seasonal river, and vegetation were continuously declined, farmland cover types show an inconstant pattern. The extent of change within the study area of the individual land cover categories in hectares and its percentage changes was tabulated and summarized as followed tables.

Table 4.3 change detection table 2010-2020

	LULC Class	LULC 2020					Total
		bare land	built up	farmland	seasonal river	vegetation	
LULC 2010	bare land	376.20142	281.4339	239.46834	17.244012	87.194785	1001.542406
	built up	1326.9468	2582.332	764.18804	119.047969	189.490109	4982.004892
	farmland	1152.8123	429.596	251.73795	75.627203	32.076356	1941.849797
	seasonal river	219.02207	179.8347	17.002345	104.167323	16.219056	536.245508
	vegetation	192.3193	402.1094	186.33684	9.929749	228.969632	1019.664916
	Total	3267.3019	3875.306	1458.7335	326.016256	553.949938	9481.307519

The results of the image classification showed that the total land area of Dire Dawa city was 9486.23ha in 2020. The percentage area of Barren Area had the largest share in 2010 representing 34.5% (3270.2 ha) of the total LULC categories assigned. This class faced a major shift and it was reduced to only 10.22 % (970. ha) in 2020, Only in this past ten years bare land was decreased by 2300 hectares which are covered 24% from change that occurred during study time. As shown clearly on the table the area coverage of built class increasing alarmingly even tenths times of others land cover classes, Farmland land has been shown the

sign of increment between the years 2015 to 2020 it may because of the increment of the land market and people think to occupy or buy a lot of parcels by cheap price without considering any legality of it for future money made mechanisms.

Seasonal river class was another badly off class, hence this area is restricted for any housing and other activity as per city master plan because of its high vulnerability for flood risk which is common during rainfall season in Dire Dawa city hence it is open space physically many of this class category was occupied by illegal settlers. From its few coverages it was decreased by 390 ha across the city during the study period

Table 4.4 Overall change detection in hectare and percentage

LULC Class	2010		2015		2020		2010-2015		2015-2020		2010-2020	
	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Bare land	3270.2	34.5	2986.3	31.5	970.24	10.22	-283	-2.9	2016.2	-21	-2300	-24
Built up	2012.5	21.2	2870.3	30.3	4876.1	51.34	857.8	9.04	2000	21.08	2857.8	30.1
farmland	1953.1	20.6	1308.2	25.9	1459.7	13.79	-506	5.34	-1151	-12.1	-644.9	-6.8
Seasonal river	537.42	5.67	326.18	3.44	147.28	1.55	-211	-2.2	-178.8	-1.88	-390.0	-4.1
Vegetation	1022.8	10.78	694.89	7.33	554.07	7.95	-327.	-3.5	59.18	0.62	-268.7	-2.8

These change detection results revealed that there was about more than 2857.8 ha or a 30.1% increment of the built-up area from 2010-2020(Table 4.5) above. This value indicated that huge land cover change on the category of built-up surface exerting incredible pressure on other class types, specifically on farmland and bare lands. Expansion of construction sites of residential units, commercial and industrial units, and road networks, and other impervious surfaces all combined led to the continuous expansion of built-up surfaces in the different corners of the city. (Tahir M, 2013) A study on Land uses land cover change was also showed a positive change in the urban area of Mekelle city which coherent with these results.

As mentioned above on social data analysis results and point out by(Zahra Hassan, 2016) urban changes may be associated with population growth as well as industrial development during this period which means it could be the possible cause for built-up expansions, all other class types record negative change over study period which accounts from -2.8 of vegetation's to the unbelievable decrement of barren land by 24%during this time of ten years. The area under vacant land decreased because of the increment of squatter settlement due to different causes such as population growth, lack of appropriate land management, land value increment, and others. A Post-classification comparison of the detected change was carried out to produce change maps by using GIS, to realize the spatial patterns of

change among study years. The overlay of LULC maps was to produce the change map, the overall change map was as seen in fig 4.6 below.

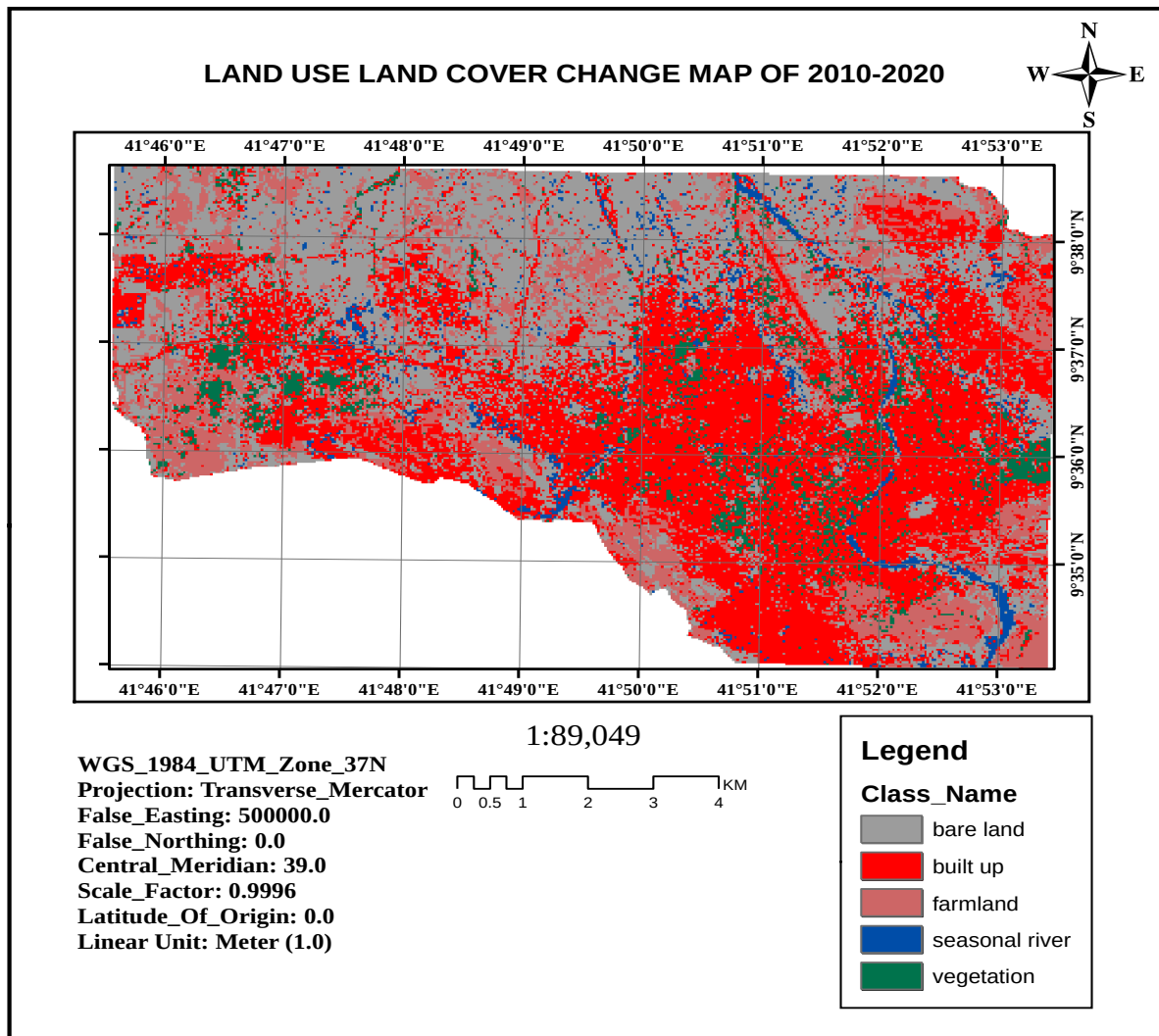


Figure 4.5 Land use land cover map of 2010-2020

The total area of built-in 2007 was 1578.1285 hectares from this 1042ha was an squatter settlement which accounts for more than 66% of built-ups classes and 536.1285ha was a formal settlement which calculated from vector data of figure 4.6 map, by using calculate geometry method as we can observe from this number squatter settlement was nearly two times of formal settlement during that years. The total area coverage of the city was not more than 3534.46 hectares including all types of land cover classes, during this year non-built up classes were 1956.3315ha which is covered 55.35 in percentage.

In 2020 the total area of the city increased to 9486.55ha which is three times more than the total area in 2007. only built up classes in 2020 were exceeded than total area coverage of the city in 2007 which was 3147.42ha this accounts for the increment near to 100% From

this increment in built-up class much amount of it was an squatter settlement as land municipality officials who are head of squatter settlement window director explained during discussion time in an only single year which was 2020 more than 20000 parcels occupied without any permission from concerned government body but society representatives said that they would not agree with only this much number and guess as more than two times of the officials said. Inversely throughout one year, the parcels turned to formal from squatter settlements regularized as per 2004 E.C land policy were not much greater than 1000 parcels, which is too small because of the rigidity of regularization systems.

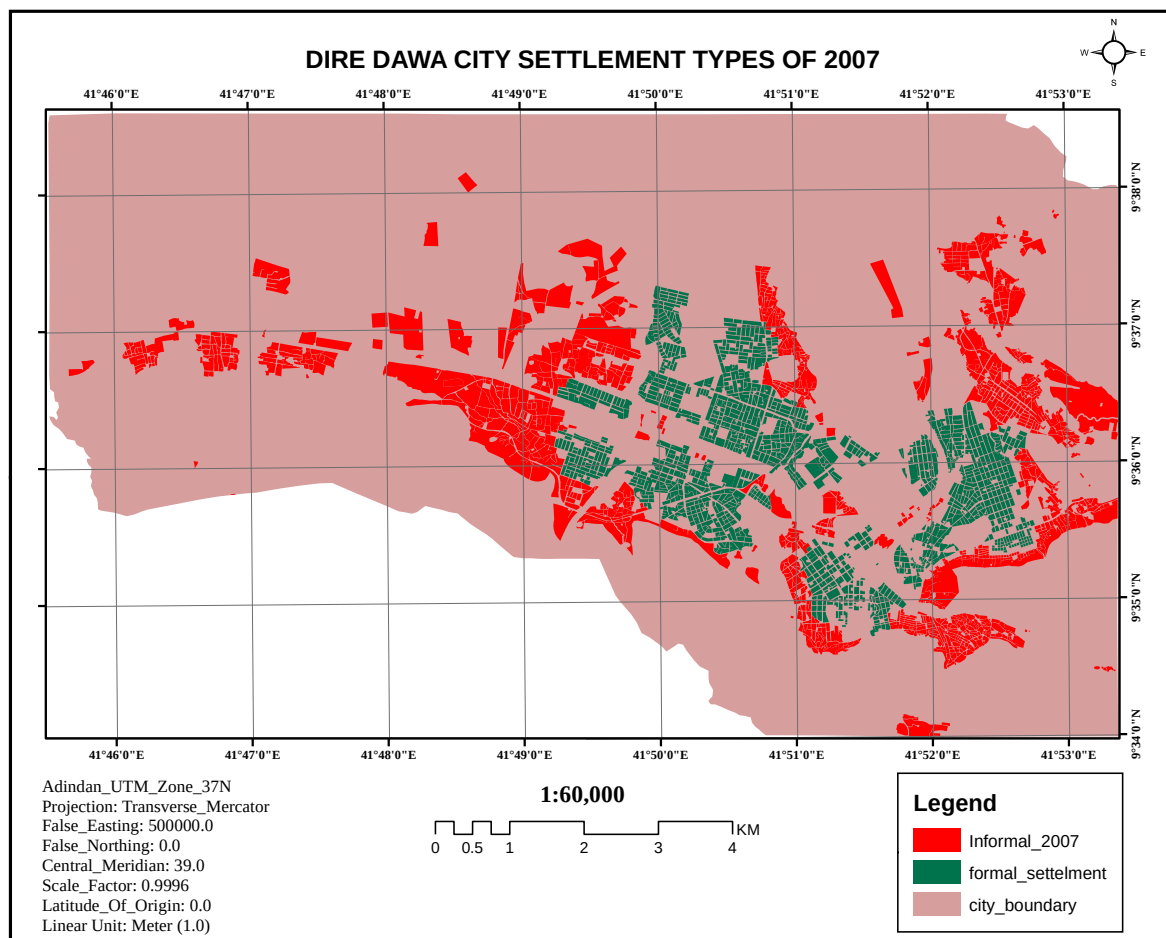


Figure 4.6 Area coverage of squatter settlement in Dire Dawa 2007

There are many criteria for discriminating squatter from formal settlements, which are tabulated below and similar criteria were also used by many researchers such as (Owen, 2010). As previously mentioned different geospatial technology software's and tools were used to fulfill the main and specific task of this study among them; remote sensing, GIS,

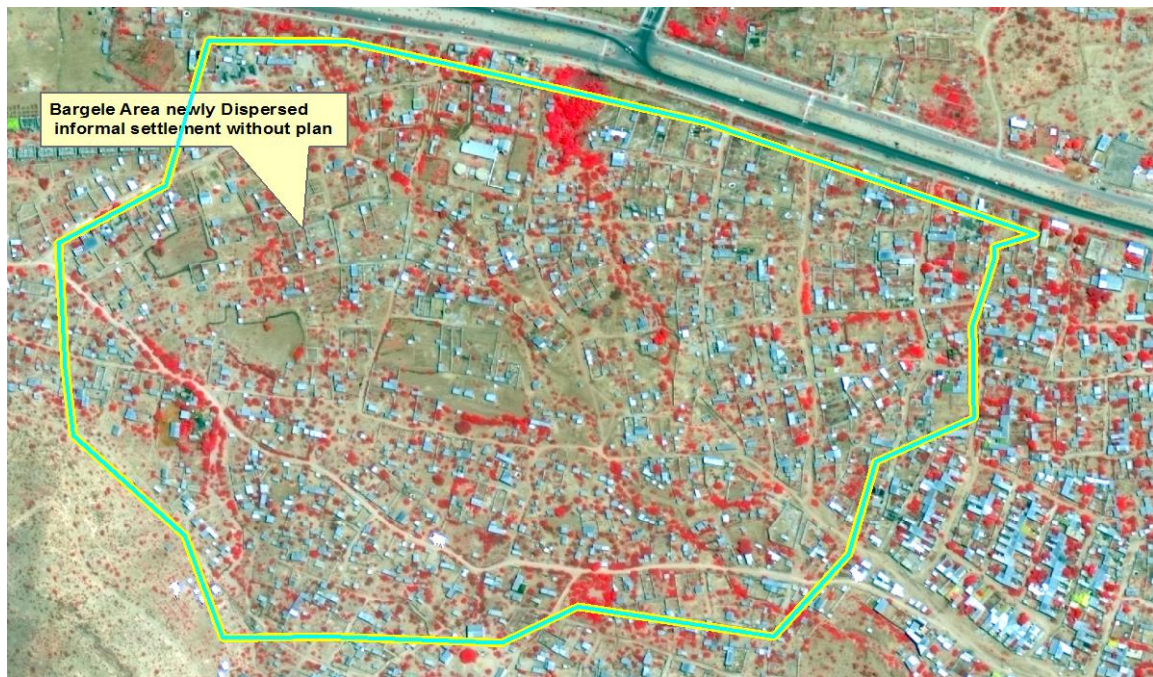


Figure 4.7 Bargele area newly occupied informal settlement

In 02 kebele unplanned and irregular shapes of informal settlements was seen in many corners of kebeles. This kebele(south west direction of Dire Dawa city) will be the most vulnerable site from the city, hence many open space area is under this kebele.

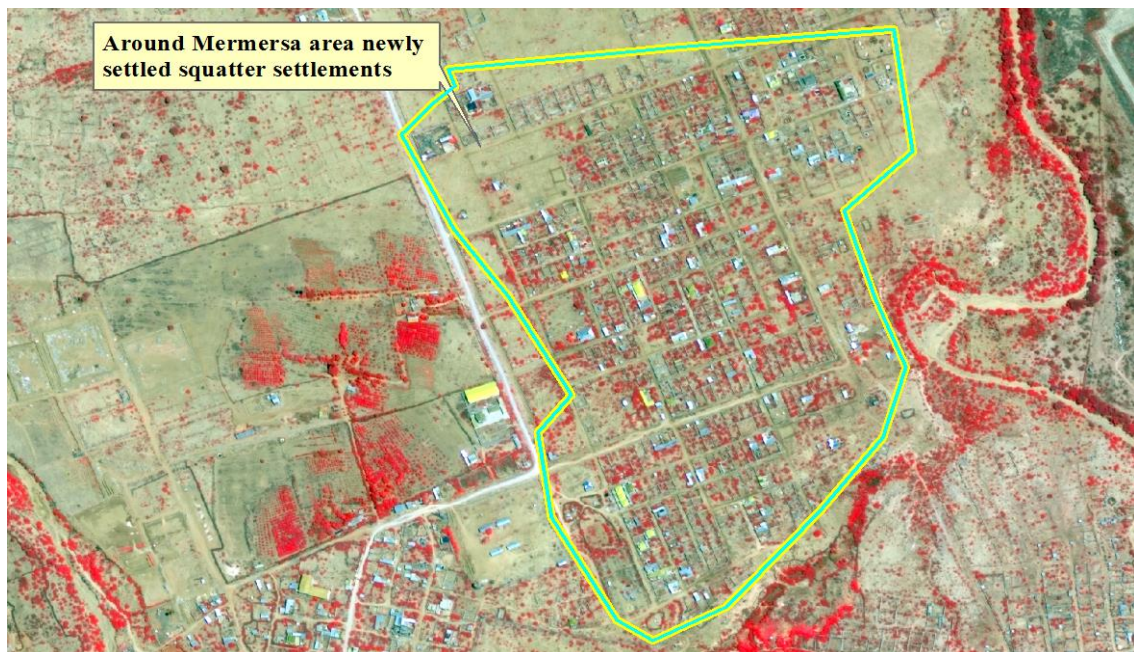


Figure 4.8 Mermersa area illegally grabbed parcel

The following map was produced from GIS overlay map of structural plan, informal settlement and formal settlement map

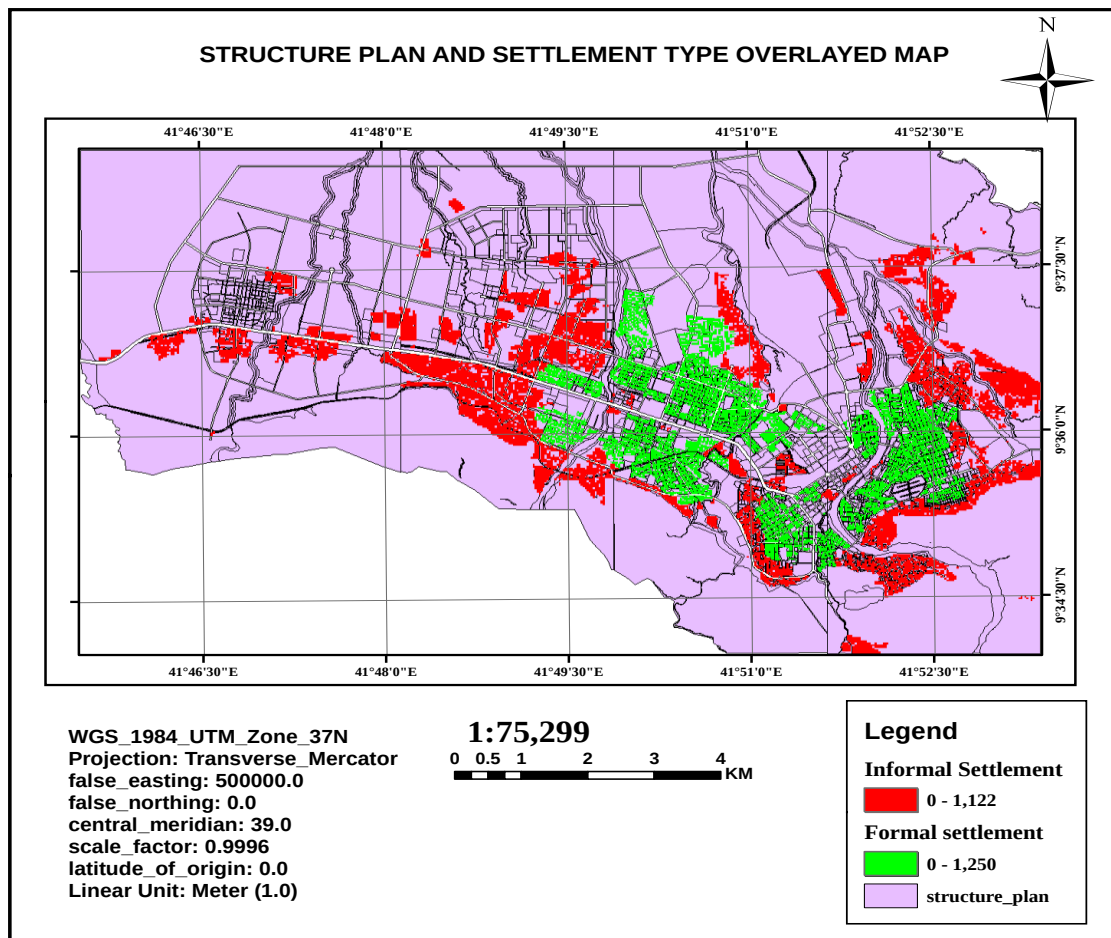


Figure 4.9 Overlay of structural plan with settlement type

Mermersa area was also another critical site for informal settlements which is very vast area was already occupied by informal settlers.

The below criteria were selected as per Owen's, 2010 point out as explained preferred criteria.

Table 4.5 Criteria for Discriminating squatter from formal settlement

Criteria	Description of the criteria in the context in IS	Source
Vegetation	Less vegetation cover	(Hofmann P. J., 2008)
Road type and material	Short lengths, irregular in their shapes, narrow in their widths.	(Owen, 2010)
House size	Small dwelling size	(Neibegall, 2008)
Orientation/pattern	Randomly oriented and simple in shape	
Dense	Crowded to each other, high population density in small house	

From the following squatter settlement map we can conclude that the vulnerable area for squatter landholding activity will be North West and southern direction of the city hence other city corner is surrounded by mountains and less suitable for housing purposes, figure 4.7(above) shows squatter and formal settlement in Dire Dawa city in 2007E.C whereas figure 4.8(below) shows the map prepared from classified images of 2020 into formal and squatter settlements based on discriminating criteria of (Owen, 2010).

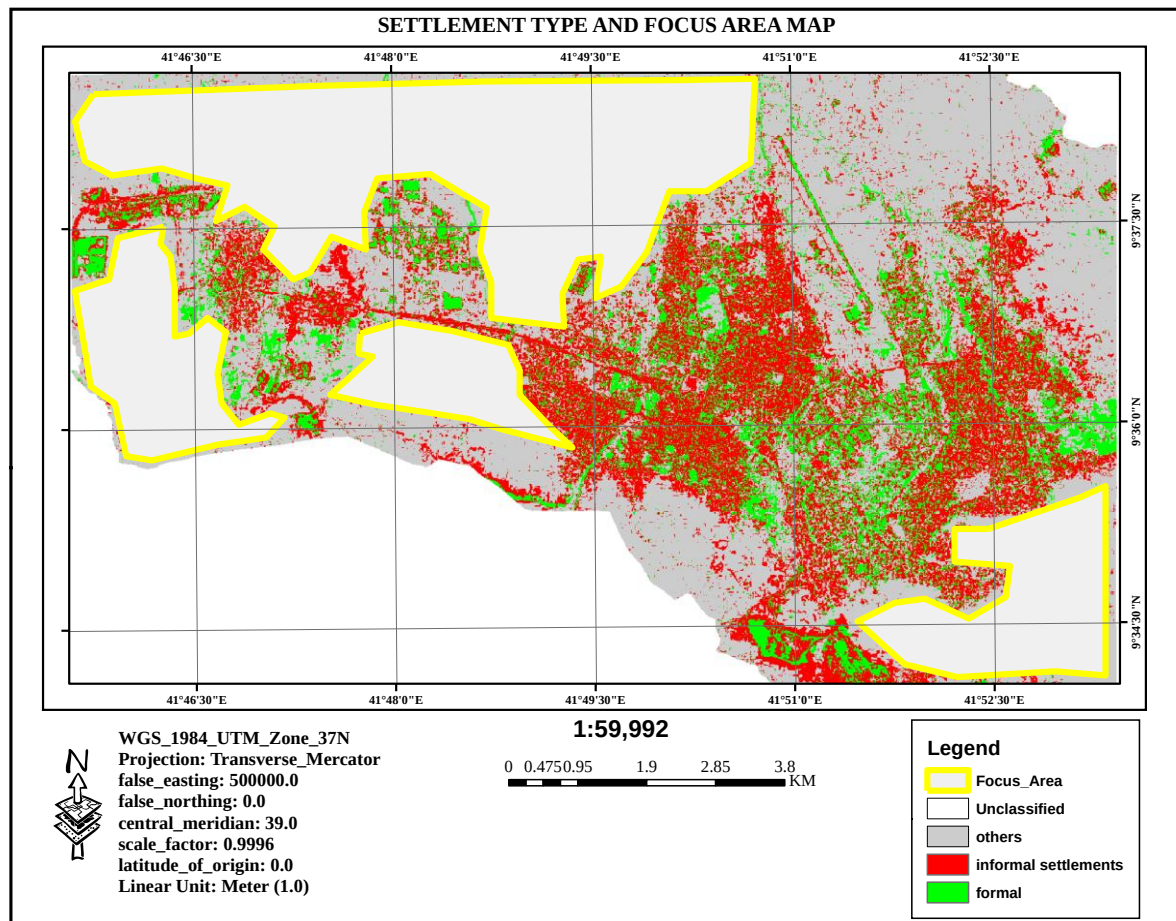


Figure 4.10 Classified squatter settlement map 2020

As clearly depicted on the above Figure 4.10 the most prone site for informal settlement is northwest, northeast and southern direction of the city, which most of the city's open land is located in this direction. Generally most of Kebele 02 and 3-Kilo(southern part of the city) Hugely affected and it needs critical attention. 01 kebele area and mermersa site also another site which needs big attention hence area known by a lot of vacant land and flat from the city.

4.2. Discussion

This section discusses the used methodology, causes for squatter settlement expansions, and their implication on study areas future.

Social data and spatial data integration (Mixed methods)

As discussed under the method section of chapter two mixed-method use prefer studying and understanding of social influences on spatial systems, this mixed-methods used to point out that where the squatter settlement takes place spatially and what is the causes of it socially. Shortly the methodology answered the questions start with where and why related to an squatter settlement in the study area. But the final classification of built-up into formal

settlers and squatter dwellers based on discriminating criteria some limitation was observed, as the density of house can be seen squatter settlement also which is considered as one criterion for the informality of settlements, in addition to the roof similarity for both squatter and formal houses is another challenge.

Causes of squatter settlements

As described earlier under social data analysis results in two types of groups respondent respondents for the question raised for them and point out the main cause for land occupation informally, based both parties explain that lack of good governance or weak governance and lack of affordable land provision for urban poor as the main cause for squatter settlement expansion across the city.

Political crisis

The respondent give the priority above all for political crisis with 59.2% and according to them political transition during 2010 E.C had high contribution for expansion of squatter settlement in Dire Dawa City. An squatter settlement in the urban periphery is a common and serious problem in Ethiopia(Misgana Secho Abebe, 2018). People were motivated by the administration vacuum created following the unstable moment to get land in an informal way. Respondents both in group discussions and questionnaires, claim that the government was taken as one means to divert the attention of people from taking part in the political dispute processes.

Weak governance

Local governances are the main in people to land relationships the effect on of policy's and laws on the spatial system is deperdent on how the local government body react to the implementation of it. The table 4.1 shows that 40.1% of the respondents explained that inefficient local government contribute high role in expansioning squatter settlement in Dire Dawa city. As the respondent explained during discussion the local government is so rigid and incapable incase of identifying and taking action on informal settlement quickly and timely.

Too weak law-enforcement with existing policy

Table 4.1 shows that 48.9% of respondents response that too weak law enforcement with existing law and policy was contributed very significance role that lead to informal settlements. Hence demolishing the informally builtd house after 2003E.C was allowed as per 2004E.C formulated policy but it is so difficult to apply this policy because of huge number squatter in the city now a day.

Lack of land provision for housing for urban poor

The table 4.1 shows that 58.1% of respondents believe that lack of land provision for urban poor plays a vital role for the triggering of squatter settlements in the study area. They also mentioned that because of low income significant number society can't be apply on land provision from government hence they cannot fulfil the prerequisite as per urban land lease said. Their option was going some where on open space area and occupying illegally and built up simple plastic house on it.

The change detection results revealed that the majority of the land class were badly runoff example; seasonal river was reduced by 4.1% from its small content in the study area, many peoples have blindly occupied the seasonal river (locally named Ashewa) without considering its high vulnerability to major flood risks. According to the Dire Dawa city, police commission in this June 2021 around 9 people died because of heavy rains which all of them were resident squatter dwellers. On the other hand, Due to this squatter settlement, the scarce land resource is misused and the government lost revenue from the illegal dwellers. If we calculate only 20000 parcels which known by government officials as it illegally occupied by on year by 27000ETB for as per cost of single land parcels based urban land lease prices; government lost at least 540 million ETB only in a single year in a single city. Beyond that for the city development also this squatter settlement condition is challenging only barren land class decreased by 24% which accounts 2300ha's in only one decade not only that no doubt that most this occupied by individuals without fulfilling any formality which made them owners legally.

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Increasing urbanization and rapid population growth have exaggerated the problem of squatter settlements. An squatter settlement in urban is becoming common daily news in our county in recent years. Particularly in Dire Dawa city, newly emerging squatter settlements can be seen on the roadside, near a big wall (figure 2.1) shows squatter residents who settle under Muslim cemetery wall), on the hillsides and other types are very common. Therefore this study was evaluated the extent of squatter settlement conditions in Dire Dawa city based on mixed methods which include analysis of the cause for squatter settlement socially and spatial data analysis for analyzing of hotspot or most vulnerable site spatially.

The study revealed that various cause factors for informally landholding in the study area which include weak governance, population growth, land market price increment, land lease expensiveness, lack of land affordable for urban poor, the problem with land policy and regulation, and too weak law enforcement with existing policy and regulations were depicted as the main cause for squatter settlement during study time.

Understanding the characteristics, the extent, and pattern of land-use change associated with the squatter settlement is an important supporting tool for decision-making processes. To know the illegal land occupation activity in the study area and to determine the rate of squatter settlement expansion in the study area change detection for different years can be put as an important pre-request. Concerning that this paper was analyzed the LULCC to identify the extent of squatter settlements by using Geospatial technology. Combining both social data analysis results and multi-temporal remote sensing images reveals that there is a fast increase of squatter settlements across the city. The overall change detection results indicated that the built-up area was shows an increasing trend during the past ten years, it increased by more than 800ha between the years of 2010-2020, whereas the other land category showed significant reduction with different amounts.

5.2 Recommendation

Based on the results obtained from socio-spatial data analysis the following recommendations are forwarded

Designing the appropriate and workable policy and regulation for land management purposes in addition to that revising rigid articles from existing land policy and regulation should be important. Improving the capacity of the municipality with well-trained manpower with recent equipment and software and service delivery is another essential point. Beyond that having an updated data regarding every parcel should also be another land municipality target, with strengthening and supporting land registry and GIS-based cadastre development for efficient land management with full parcel-related information.

Special attention should be given to urban poor society despite land lease regulations and the need to update land lease price hence it was restricted the rights of many citizens to have their own houses who cannot fulfill the pre requests. taking measurements of demolishing squatter settlements after 2003E.C as per 2004E.C land policy could cause major destructive against human lives and properties so it shouldn't be applied, moreover increasing the capacity of the land municipality as they can regularizing a lot of parcels per a year in parallel to taken law enforcement action with protecting new land occupation activity illegally.

For further study creating a new Geospatial technology-based Database is a crucial thing hence stopping one policeman (locally Denbaskebari) in every corner of the city is a very difficult task, creating a web-based database for all unregistered and registered parcels are the most important thing, hence this once created its alarming for the concerned body for further detection as legal or illegal.

6. REFERENCE

- Abagissa, J. (2019). Informal settlements in Addis Ababa: Extent, Challenges And Measures taken. *Journal of Public Administration, Finance and Law*, 7.
- Abbott, J. (2000). An integrated spatial information framework for informal settlement upgrading. *International Archives of Photogrammetry and Remote Sensing*, 33.
- Abd El-Kawya OR, R. J. (2011). Change detection for monitoring forest. *Photogrammetric Engineering & Remote Sensing*, 483-494.
- Abraham, K. T. (2019). Building Urban Land Information Management System in PostgreSQL, for the Case of Ethiopia. *Journal of Communication and Computer*, 25-37.
- Abunyewah M, G. T. (2018). Profiling informal settlements. *7th International conference on building resilience*; (pp. 238-242). Bangkok, Thailand: Procedia Eng.
- Alemie, B. K. (2015). *urban cadastres for urban land governance* . twente, netherlands : unpunished .
- Alphan, H. D. (2009). Post-classification comparison of land cover using multitemporal Landsat and ASTER imagery.
- Ambaye, D. W. (2011). Informal Settlement Issues, Spatial Development, Planning and Governance. *FIG Working Week*, (pp. 18-22). Marrakech.
- Ayele, B. (2019). urban informal dwellers access to land for housing and regularization of informal settlements. *ResearchGate* .
- baud, I. K. (2010). Understanding heterogeneity in metropolitan India the added value of remote sensing data for analyzing sub-standard residential areas. *International journal of applied earth observation and Geoinformation*, 359-374.
- Binns, S. B. (1953). Cadastral Survey and Records of Right in Land. *Land Tenure Study* (p. 1). Rome : FAO.
- Burns, T. &. (2008). *Conceptual framework on for governance in land administration* . stockholm, Sweden : FIG.
- Charalabos I, c. p. (2007). Towards a strategy for suburban informal building control through automatic change detection. *Μαπρίον*.
- Cowen, D. &. (1988). Extraction and modeling of urban attributes using remote sensing technology . *national academy press*.
- CSA. (2005). *Central Statistics Agency*. Addis Ababa: CSA.
- Dale, D. (1988). Land Information Management. *Oxford University Press*, 266.
- Dale, M. (1990). An introduction with special reference to cadastral problems in developing countries,. *South African Journal of Geomatics*,.

- Dale, P. &. (1990). An introduction with special reference to cadastral problems in developing countries. *south african journal of Geomatics*.
- Dale, P. (1988). Land Information Management. *Oxford University Press*, 8.
- Daniel, L. (2006, february). UDP-705 Housing in Urban Context. In D. Lirebo, *Informal Settlements in Addis Ababa* (p. 5). Addis ababa: unpublished.
- de By, G. Y. (2013). Digital earth application in the twenty-first century . *international journal of digital earth* , 511-515.
- DeSoto, H. (2000). *The mystery of capital*. Newyork: Basic books.
- Edward, K. (2014). Digital Cadastres Facilitating Land Information Management. *South African Journal of Geomatics*, No 1.
- Enemark Stig, M. R. (2009). Land Governance in Support of the Millennium Development Goals. copenhagen, Denmark : The World Bank and the International federation of surveyors.
- Enmark, S. (2005). Understanding the land management paradigm . *FIG conference on innovative technologies for land administration* . Madison, USA : FIG.
- Hailu, g. a. (2019). *Regularization of urban informal landholding*. Addis ababa.
- Hiraskar, G. (1998). *An Introduction to the Fundamentals of Urban Planning*. Tehran: M. Salmani and A. Reza Yekani Trans.
- Hofmann, P. J. (2008). Detecting informal settlements through Quickbird in Rio De Janeiro using an object based approach. *International Archives of photogrammetry, Remote Sensing and spatial information science* , 531-552.
- Hofmann, P. S. (2008). Detecting informal settlement from Quickbird data in Rio De Janeiro using an object based approaches. *international archives of photogrammetry remote sensing and spatial information science* , 531-552.
- Inostroza L. (2017). informal urban development in Latin American urban peripheries. Spatial assessment in Bogota.
- Khalili M, M. R. (2015). automatic urban illegal building detection using multi-Temporal satellite images and geospatial information system. *Sensors & Models in Remote Sensing & Photogrammetry*. Kish Island, Iran.
- Lamba, O. A. (2005). *Land Tenure management system in informal settlements*. Nairobi.
- Lu D, M. P. (2004). Change detection techniques. *International journal of remote sensing* , 2365-2407.
- Manoranjan, M. (2020). Squatter Settlements and Slums and Sustainable Development. *Springer Nature*, 1-3.

- Maxwell J. A. (1996). *Qualitative Research Design: An Intractive Approach* London.. london: Applied Social Research Methods Series.
- Mikir Kassaw. (2019). Development of Cadastral Information System Using Geographical Information System (GIS). *Journal of Geosciences and Geomatics*, 184-190.
- Ministry of Urban Development, a. (2015). world bank conference on land and poverty. Washington dc: the world bank.
- Misgana Secho Abebe, K. T. (2018). Exploiting temporal-spatial patterns of informal settlements using GIS and remote . *Environmental System Research*, 6-8.
- Mohanty, M. (2019). Challenges of informal urbanization. *Springer Nature*, 1-11.
- Muller, A. (1988, Aug 7-12). Land Information Systems and Taxation of Properties in developing countries. *A pragmatic approach. Presented at world congress III, Computer assisted valuation and land information systems*.
- Mulugeta & Yalew. (2004). Urban Sector Millennium Development Goal Needs Assessment. *Improving lives of slum dwellers*. Addis Ababa, Ethiopia.
- Mwangi, ` . W. (2007). Development of integrated land information management system in Kenya. In G. W.mwangi, *Development of integrated land information management system in Kenya*. Nairobi.
- Mwangi, G. (2001, November 24). Development of integrated land information management system in kenya. Nairobi, Kenya.
- MWUD. (2006). *Manual for Local Development Plans*. Addis Ababa: Birhanina Selam.
- Neibegall, S. &. (2008). Integrative assessment of informal settlement using VHR Remote Sensing data . *Ieeee Industry applications megazine* , 193-205.
- Okongo, T. M. (2019). Development of Web-based cadastre for an Informal settlement in Nairobi . 1.
- ORAAMP. (2001). *Structure Plan: Housing component*., A.A.
- Owen, K. W. (2010). An approach to differentiate informal settlements using spectral, texture, geomorphology, and road accessibility metrics . *applied geography* , 107-118.
- Pahl-Wostl, C. (2009). A conceptual framework for analyzing adaptive regimes. *Global environmental change-human and policy Dimensions*, 354-365.
- purdon. (2003). the nature of ecosystem management . *environ.sci.policy*, 377-388.
- Roy, A. (2005). Urban informality: towards an epistemology. *J Am Plan Assoc*, 147-158.
- SECR. (2015). *State of ethiopian cities report* . addis ababa.
- Sietchiping, R. (2005). Prospective slum policies: conceptualization and implementation of a proposed informal model . *Accessed*, 30.

- sluizas, R. K. (2010). Remote sensing of urban and sub-urban areas . *springer Geosciences* 10.
- Sombroek, W. (1998). *use Geographic information system in land resource appraisal*. Rome, italy: delle Termi di caracalla.
- Tahir M, I. E. (2013). Evaluation of land use/land cover changes in Mekelle City, Ethioppia using remote sensing and GIS. *Compute ecological software* , 9-16.
- Tesfay, A. (2009). Preparation of Coordinate Based Cadastral Map in Rural Ethiopia.
- UN-ECE. (1996). *land administration* .
- UN-habitat. (2008). *dire dawa urban profile*. Nairobi : unon.
- UN-Habitat. (2003). *The challenge of slums: Global report on human settlements*. London: Earthscan Publications.
- UNSTAT. (2005). *environmentalgl/gesform.asp*. Retrieved 05 28, 2021, from <http://unstats.un.org/unsd>.
- Van dar molen, P. (2014). Rapid urbanization and slum upgrading . *survey review* .
- Vicente Sandoval, J. P. (2016). informal settlement, urban development and Disaster risk reduction in Latin America and the caribbean . 1.
- Victor Akujuru and Adebajo Durojaiye. (n.d.). developing a gis-based cadastral information system. *niesv journal*.
- W. G. Sombroek, J. A. (n.d.). *The Use of Geographic Information Systems (GIS) in Land Resources Appraisal*. Rome, Italy.: Via delle Terme di Caracalla.
- yeager, C., & Steiger, T. (2013). Applied Geography in a digital age. *Applied Geography*, 39 1-4.
- Yuan, D. &. (1998). NALC Land Cover Change Detection Pilot Study. *Remote Sensing of Environment*., 166-178.
- Zahra Hassan, R. S. (2016). Dynamics of land use and land cover change (LULCC) using geospatial techniques. *springer plus*, 812.
- Zewdu, T. W. (2015). *An Assessment of Administrative Challenges and Prospects in Implementation of Local Development Plan (LDP) in Dire Dawa*. Addis Ababa : unpublished .

APPENDIX

No	x	y	Land Use Land Cover Class	Place Name/Location
1	811,561.441	1,064,405.168	Built up	DDU registrar building
2	811,777.761	1,063,598.509	Built up	Yigezu Hotel
3	812,547.548	1,063,306.620	Built up	Meskel Square
4	813,427.289	1,063,117.112	Built up	Dire total madeya
5	813,683.936	1,063,820.574	Built up	Airport
6	814,222.099	1,062,765.811	Built up	Millennium park square
7	814,291.817	1,062,650.055	Built up	Rift Valley
8	814,123.806	1,062,733.730	Built up	Triangle Hotel
9	814,399.437	1,062,395.658	Built up	St. George church
10	815,042.111	1,062,324.220	Built up	Mina Mall
11	814,788.057	1,061,850.086	Built up	Sheikh Habib
12	814,326.087	1,061,580.991	Built up	Conel Bridge
13	814,237.948	1,061,662.152	Built up	Ethiopian Airway's Office
14	814,176.035	1,061,801.852	Built up	Dashin Bank
15	814,099.438	1,061,887.578	Built up	Midir Babur square
16	813,884.265	1,061,134.175	Built up	Ras Hotel
17	812,791.137	1,062,375.206	Built up	Art Hospital
18	812,661.359	1,062,443.865	Built up	Bridge cafe
19	812,328.777	1,062,582.375	Built up	Global Bank
20	812,302.186	1,062,539.909	Built up	Dire Mall

21	811,898.564	1,062,463.709	Built up	Bus Station
22	811,651.707	1,062,827.644	Built up	Seido Residents
23	811,136.165	1,063,565.436	Built up	Sebategna Mosque
24	811,418.344	1,063,801.180	Built up	Sabiyan primary hospital
25	808,952.158	1,063,858.727	Built up	Dire Dawa City Municipality building
26	807,922.265	1,064,181.784	Built up	Industry zone Condominium
27	806,349.446	1,064,097.647	Built up	Bargele Mosque
28	805,420.757	1,064,166.703	Built up	Melka secondary school class room
29	804,305.867	1,065,527.061	Built up	Railway station waiting building
30	804,394.502	1,065,646.124	Built up	In front of passenger exit
31	811,651.213	1,064,342.065	Vegetation	Toni Farm
32	811,534.832	1,064,338.311	Vegetation	Toni farm
33	811,549.343	1,063,681.612	Vegetation	Bewana green area
34	810,805.002	1,062,712.838	Vegetation	Papa Recreation
35	810,713.985	1,062,751.996	Vegetation	Vegetation at the left side of papa
36	810,429.293	1,063,177.447	Vegetation	Vegetation around military camp
37	808,902.115	1,063,714.023	Vegetation	Fruitfarm in front of land municipality
38	806,098.584	1,064,329.975	Vegetation	On melka way muslim cemetery
39	814,136.311	1,062,827.006	Vegetation	Greenery in side millennium park
40	816,561.355	1,062,121.228	Vegetation	Genda Gebere vegetation farm

41	816,653.430	1,062,406.185	Vegetation	On melka way muslim cemetery
42	813,130.033	1,061,832.832	Vegetation	Greenery around Depo
43	812,083.432	1,064,006.838	Bare land	Open space of toni
44	813,571.551	1,063,532.797	Bare land	Open space near airport
45	813,345.331	1,063,524.859	Bare land	Open space near airport
46	812,506.600	1,062,551.190	Bare land	At opposite side of Dir Mall
47	811,175.744	1,063,303.932	Bare land	Around Dire Dawa Abattoir
48	811,472.078	1,063,425.640	Bare land	Behind DDU teachers building B
49	811,603.047	1,063,569.838	Bare land	On sebategna meskelegnas road
50	810,015.543	1,063,752.401	Bare land	Kuba camp
51	810,038.033	1,063,301.286	Bare land	On melka way
52	808,652.937	1,063,917.766	Bare land	Behind city municipality building
53	807,666.039	1,063,855.589	Bare land	Bargele around asphalt road
54	807,154.069	1,063,990.527	Farmland	Left side of melka street
56	807,203.017	1,063,930.995	Farmland	Left side of melka street
57	807,064.110	1,063,941.579	Farmland	Left side of melka street
58	806,639.453	1,063,843.683	Farmland	Left side of melka street
59	806,639.453	1,063,851.620	Farmland	Left side of melka street
60	806,131.452	1,063,780.182	Farmland	Left side of melka street
61	806,255.807	1,063,684.932	Farmland	Left side of melka street
62	805,610.222	1,063,806.641	Farmland	Left side of melka street
63	805,827.181	1,063,764.307	Farmland	Left side of melka street
64	804,532.043	1,065,253.915	Farmland	Farmland around railway station

65	805,231.536	1,062,308.435	Seasonal river	Crossing bargele
66	805,459.079	1,063,753.063	Seasonal river	Crossing bargele
67	805,781.871	1,064,456.856	Seasonal river	Crossing bargele
68	806,496.247	1,065,335.274	Seasonal river	Crossing bargele
69	806,856.081	1,066,965.111	Seasonal river	Crossing bargele
70	807,258.249	1,067,298.486	Seasonal river	Crossing bargele
71	811,412.215	1,069,568.616	Seasonal river	Dachatu river which crossing the city
72	812,426.112	1,067,100.929	Seasonal river	Dachatu river which crossing the city
73	812,171.450	1,068,122.884	Seasonal river	Dachatu river which crossing the city
74	815,554.816	1,064,342.642	Seasonal river	Dachatu river which crossing the city
75	814,807.367	1,063,598.500	Seasonal river	Dachatu river which crossing the city
76	814,939.659	1,062,603.003	Seasonal river	Dachatu river which crossing the city
77	814,245.126	1,061,389.225	Seasonal river	Dachatu river which crossing the city