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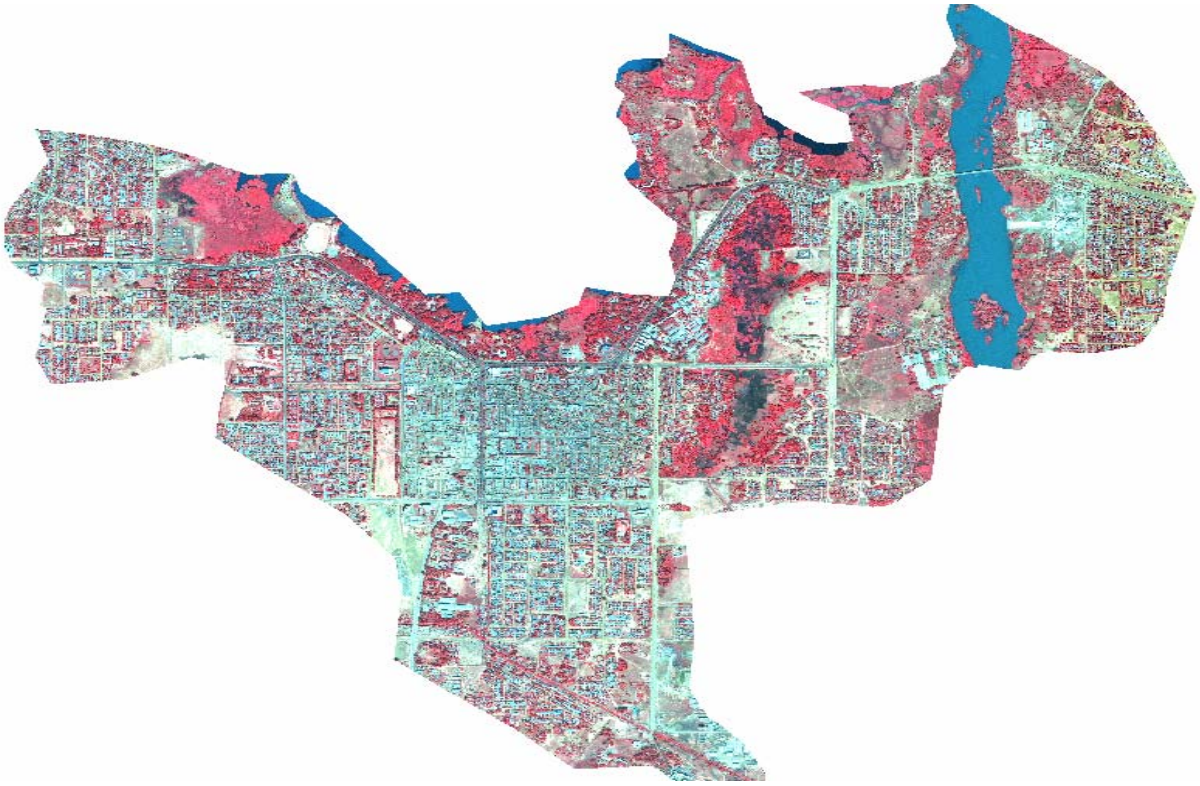
TEMPORAL URBAN GROWTH ANALYSIS AND POTENTIAL SITE IDENTIFICATION FOR A HIGH RISING BUILDINGS IN BAHIR DAR CITY



BY HAIMANOT MEBRATU

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Finally I dedicate this thesis work to my beloved father who passed away before four years and without him I cannot start any kind of formal education at all.

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List of Acronyms

DEM- Digital Elevation model

GIS- Geographic Information System

Ha - Hectare

LULC – Land use land cover

RGB – Red Green Blue

UN-United Nation

CSA – Central Statistical Authority

TM – Thematic Maper

UTM – Universal Transverse Merctator

RS – Remote Sensing

ABSTRACT

The Urbanization level and the land use dynamics of Bahir Dar is assessed in the field of GIS and Remote sensing technology for excellent understanding of the emerging growth pattern using multi temporal dataset. And the results from a study about growth trends of the urban areas in Bahir Dar are described here. The period under consideration is from 1957 to 2005. It should be noted that the internal urban growth is evaluated in a separate manner and in the pre 1957 urban centers of Bahir Dar during 1957- 2005 built up area increases from 13 hectares to 33.68 hectares. In the 1957-1984 expansion areas during 1984-2005 built up area increases from 166 hectares to 210 hectares. In the post 1984 expansion areas 363 hectares of land is used for built up. With regard to the external growth of Bahir Dar two distinctive phenomena is visible from 1957 to 1984 the city expand ten times to its size of 1957 and from 1984 to 2005 again a three times growth from its size of 1984 is observed. In addition to the above urban growth analysis a suitability model for identifying potential developable land for high rising buildings has been carried out. This analysis is based on the physical and social parameters, besides in the present research all the empirical observations, the RS imagery and the GIS analysis have been used. This has been done in an integrated conceptual and operational frame work which adds an indicative bottom up perspective to the understanding of urban growth pattern.

CHAPTER ONE

1 Introduction

Planning is a decision making method that aims at achieving a desired goal with a given resource and time frame. Urban planning should be viewed in this context particularly with the objectives of addressing the prevailing social, economical, physical and environmental problems of the given town.

As population increases, so dose the need for new housing, schooling and transport network. In today's world the need for dwelling is extremely high. And this human necessity results urban growth which is a new dynamic system, consisting of a quantity of projects constructed that are increasing with time from t1 to t2. It is an open system it involves verity of regulation/decision making, investment form higher organization, external investors, inhabitants and managers.

Understanding of land conversion using GIS and RS techniques is necessary for managing those areas of rapid growth .because change in land use transformation affects both human and natural systems.

According to Henok (2005) the majority of Ethiopian towns involved without having plans to guide and facilitate their development, their pattern, density and rate at which built up develops are contemporary debates. The study area is not exceptional in this regard.

Today The Amhara regional capital Bahir Dar is facing urban sprawl problems such as increasing cost of providing public service, loss of productive farm land, loss of Biodiversity and alter ion of hydrological regime.

1.1 Statement of the Problem

Ethiopian city are experiencing an influx of people from rural area on unknown scale, looking for work and a better quality life. because of this rapid growth on the urban-rural fringe, planners and policy maker lack accurate, timely and cost effective urban land use data which is most essential to make decision concerning land resource management.

Urban land is always modified by mans activity and today in the study area with in the last five decays many of agricultural land, rang land, marsh land and forest land are converted in to urban built up area with out considering it's social, economical, physical and environmental impact .

1.2 Background of the study

Bahir Dar, the capital city of Amhara National Regional State is located at the geographical coordinates of 11˚ 38' north latitudes and 37˚ 15' east longitudes. The city has altitude of 1830 meters above sea level and it is characterized by a tropical climate with an average temperature of 29˚C. It is accessible both by airplane and car from different directions. It is one of the most tourist destination points of the country, which is endowed with natural beauty (having the largest lake in the country).i.e. Lake Tana and Blue Nile fall. The ancient churches and monasteries with the long lived religious and historic heritages in the island of the lake are worth visiting for many international and domestic tourists.

The city administration area comprises the city proper three rural kebeles (namely Zenzenema, Addis Alem, and Woramit and three satellite towns/urban centers namely Tis Abay, Meshenti and Zegie.)

1.3 Objectives

1.3.1 General Objectives

The general objectives of this research are to map the temporal urban growth and to identify the potential suitable sites for high rising buildings using suitability models.

1.3.2 Specific Objectives

- To evaluate the internal growth of the city in different time scale
- To Map the external growth of the city
- To identify the potential suitable site for high rising buildings in the city
- To provide provisional recommendations based on the critical findings

1.4 Significant of the study

In many Ethiopian cities a complex interplay of governmental, private, national and international forces have influenced urban growth responding to changes in political and economic drive each city is redefining its rolls and functions. from empirical observation fast growing towns face difficulty to manage urban construction areas this means mapping growth center can directly solve the problems of city planners and this days remote sensing has been recognized as a powerful and effective tools in urban land feature characterization and dynamic change detection it is therefore an efficient way to study the urban area like Bahir Dar city and its extended suburb region And in a very broad manner this study will have the following importance

- It provides information about the urban growth pattern.
- The study will provide guidance to suitable site selection for housing development offices.
- A study will have a provisional recommendation on critical problem of urban expansion

1.5 Data type and source

The reliable data is necessary to fulfill the specified objective of the study. And the study will be based on both primary and secondary data, the nature of these data and their source are shown below.

Table 1.1 Data Types and Sources

Segment	Data type	Data source
Primary data	GPS data collected regarding major urban infrastructure from the filed work	Researcher
	Arial photographs of 1957&1984 on 1 :50000 scale	EMA
	A resent high resolution satellite image (i.e. a quick bird image of 2005)	Bahir Dar university
Secondary data	Topographic map on 1 :50000 scale	EMA
	Sub district boundary	EMA
	Soil map on 1 :250000	Amhara regional investment office
	Different published documents	FUPI
	Ancillary data like population, road, climate etc	CSA and various Amhara regional offices.

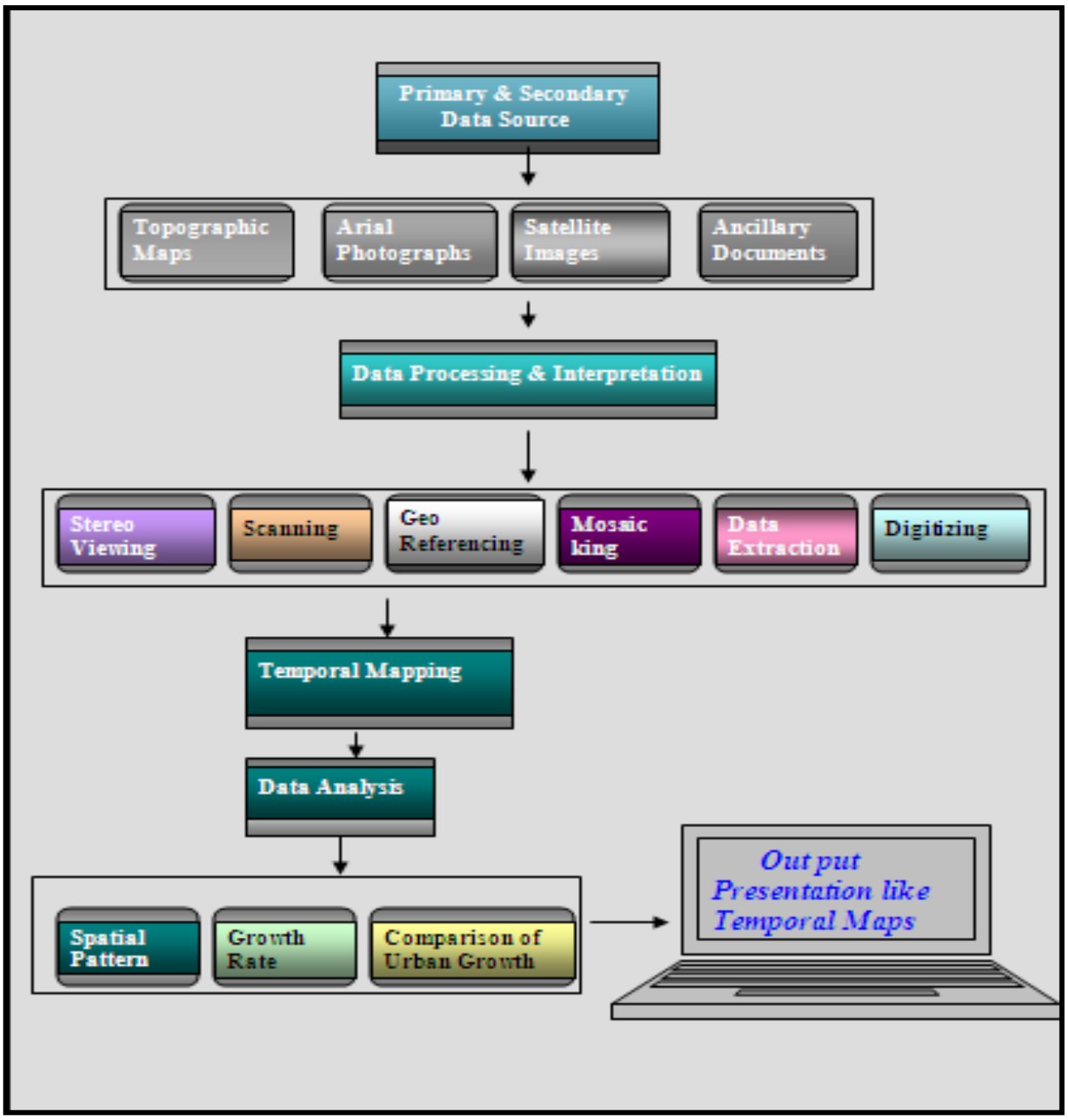
1.6 Methodology

Urban growth involves complex physical, social, economical and ecological processes. As a consequence, the interpretation and evaluation of urban growth based solely on qualitative knowledge is difficult if not impossible.

Method selection is highly dependant on the concepts used as such similar concept can be borrowed from other relevant research areas. In this particular research both qualitative and quantitative method was employed.

The methodology displayed in figure 1 which is based on monitoring temporal urban growth from remotely sensed photographs and images and this methodology consists of several steps such as scanning, digitizing, temporal mapping and evaluation. For selecting a potential site for high rising buildings a GIS land suitability model is used hence GIS is capable of both managing large amount of spatial related information and integrate multiple layer of information. In the study area the urban topography, the flood hazarded areas, accessible areas, urban service intensity areas and soil conditions are evaluated and in addition to this a multi criteria evaluation tool is employed to achieve preferences between options with reference to a set of defined criteria. In figure 2 the general work flow methodology for identifying high rising buildings are indicated.

Figure 1.1 A methodological work flow for urban growth analysis



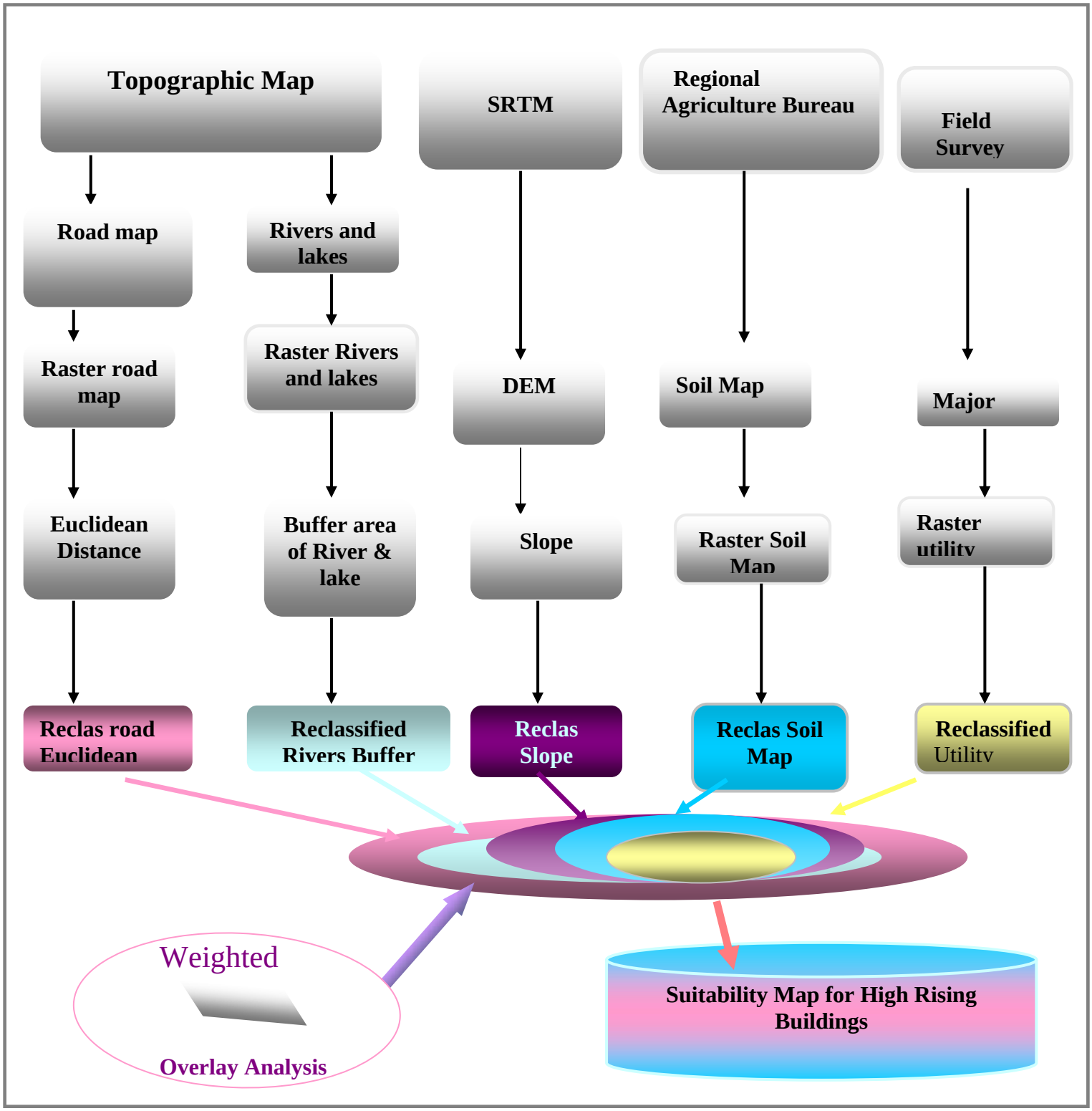


Figure 1.2 A Methodological work flow for site suitability analysis to high rising buildings

1.7 Materials and Equipments Used in the Research

- Different topographic sheets and satellite images
- Data processing facilities and hardware components like scanner, printer etc, software components (ERDAS IMAGINE 8.6,ARC GIS 9.2,IDRISI 32,3DEM)
- Fill data capturing equipments like GPS, photogrammetry equipments like stereoscope and pantographs
- Digital camera

1.8 Limitation of the Study

Despite the fact that Bahir Dar is one of the fastest growing towns in Ethiopia it is rather less studied in comprehensive urban analysis and most of the published literature obtained from varies government offices are old version type and in addition to this for any urban researcher those important document like the existing and the proposed master plan in a digital format are inaccessible both in the regional as well as in the federal urban developmental offices and due to this farther analysis on the proposed developable land use can not be conducted.

CHAPTER TWO

2. Literature Review

2.1 Key Concepts in Urban Studies

2.1.1 New Urbanism

It is an Intellectual movement of architects and planners that opposed to the normative growth pattern by suburban and sprawl and restrictive residential enclaves. Among the principles they advocate are on the one hand, a return to citizen participate in the planning process and on the other the conception of plans that involves the three forms of neighborhood, district and corridor.

New urbanst build up urban space according to neighborhood. The ideal neighborhood they envision is small, a five minute walk from the center to edge. It is diverse, containing a balanced mix of dwelling, work places, shops, parks and civic institutions such as school and churches. Land use in their ideal neighborhood articulates with a system of pedestrian friendly and transit- oriented transportation that offer residents opportunities to walk, drive or take public transit. (Le gates and stout, 2003)

The second component to this vision is the concept of the district. It is a functionally and specialized space that nevertheless supports complementary activities. And the final concept is the corridor it is a connector and separator of neighborhoods and districts. Corridors include natural and man made elements ranging from wildlife trails to rail lines provides entry to districts and neighborhoods. (Le gate and Stour, 2003)

As a planning concept, it is focused on the development of diverse housing forms and close proximity to jobs. Issues such as historic preservation, state streets, green buildings and the renovation of brown-field land are also the focus of new urbanism. (Talen 2005)

2.1.2 The Smart Growth

The concept emerged in 1990s and it addresses three inter-related issues:

- The density of the development
- The separation of land uses and different land uses
- The mobility and transport mod choice(Vereeker etal. 2004)

The features that distinguish smart growth in a community vary from place to place. Smart growth promotes a character of the town center. It is a transit and pedestrian oriented concept and has a greater mix of housing with commercial and retail uses. It also preserves open space and many other environmental amenities.

The principles of Smart Growth are:-

- Take advantage of compact Building Design
- Mix land uses
- Create walk-able neighborhoods
- Develop attractive communities with a strong sense of place
- Preserve open space, farmland, Natural beauty and critical environmental areas (APA, 1999).

2.1.3 Ecological Foot Print

William Rees (1992), a community planner developed the idea of an ecological foot print. This refers to the resources a city population consumes in excess of the carrying capacity of the city it occupies. This is expressed as an 'ecological deficit' per person of the land area needed to support the population. The ecological foot print also draws attention to the' interaction field' beyond the city from which it takes those resources, and over which it distributes.

Nowadays, a city of 10 million may typically need to import at least 6000 tones of food every day to feed its population. (Bedcock, 2002). In calculating the ecological foot print of an urban population, Rees (1992) develops the ecological equivalent of 'carrying capacity.

Ecologists define this as the population of a given species that can be supported indefinitely in a given species without permanently damaging the habitat it depends on estimates are derived of the energy consumed in the process of feeding, housing, transporting and providing an urban population with goods and services .This estimates are summed and converted in to a measure of the land area required per person to sustain this level of resource utilization by un urban residents. (Bedcock, 2002).

2.1.4 Compact City

Compact city concept emerged as a response to the occurrence of urban sprawl in developed cities. The concept was first discussed in the publication of Green paper on urban environment, which aimed at the improvement of the quality of life in relation to urban planning and sustainable development (Vreeker et al 2004), which encouraging urban growth to take place within the existing boundaries of urban areas

The main attributes define the concept of compact city: high densities, mixed uses, and intensification. This implies:

- Conservation of the country side
- Lesser need to travel by car thus reduced fuel emissions.
- Support for public transport
- Better access to services and facilities
- And revitalization and regeneration

Of inner urban area (Burton, 2001 and Jenks and Gerhardt, 2000)

2.1.5 Multifunctional Land use

Multifunctional land use as a concept emerged in the late 1990s (Vreeker et al. 2004). As a planning concept, it promotes a sustainable form of land use by influencing the form of urban development .It endorses most principles of smart growth and compact city, except that it encourages development in higher levels and subterranean levels. In addition it achieves high density and makes it possible to mix different functions .Multifunctional land use (MLU) promotes activities of different users at different time in a mixed land use.

One of the most important facts about MLU is that it concentrates specifically on the creation of synergies between various function. This is one of the principles that make MLU different from smart growth and compact city (Rodenburg, 2006, Vreeker et al 2004).

The principles of Multifunctional Land use are:

- Mix land use and compact building
- Create a range of Housing Opportunities and choices
- Create walk-able neighborhoods
- Increase vertical development (multi store buildings above and sub terrain)
- Provide a Varity of transportation choices

Striating from new urbanism and all the way to multifunctional land use all contain common principles they support: space saving, reduced car mobility and increased vertical development.

2.2 Understanding of Urban Growth

2.2.1 Overview of the Global Urban Population Growth and Development Challenges

A. Global Trends of Urban Population Growth

For the first time in history, rapid population growth and its concentration in cities around the world constitute a crucial element affecting the long term out look for humanity. Despite standing out as centers of civilization and economic activity for eight million, cities never attracted more than ten percent of the global population until the second half of the 19 the century. New, system of cities have become the world's social, economic, cultural and political matrix (UNCHS, 2001)

In 1970 37% of all people lived in urban areas sometime between 2005 and 2010 that percentage is envisaged to reach 50% virtually all the population growth expected at world level During 2000-2030 would concentrate in urban areas 95% of population increase expected during 2000-2030 will be absorbed by the urban areas of the less developed regions whose population will likely rise from approximately 2 billion in 2000 to just under 3.5 billion in 2030 (World urbanization prospects, 2001).

B. Urban Development Challenges

Poverty in the developing world, a phenomenon that has for long been uniquely associated with rural areas, has increasingly become urbanized. Depending on the individual countries and cities, between 40 and 80 percent of urban dwellers in the world is living in poverty, with very little or absolutely no access to shelter, basic urban services and social amenities.

Poverty in cities of the developing world will be characterized by, among, the following features:

- Large and growing backlogs in delivery of basic services to urban residents as demand out strips institutional capacity and financial resources
- The worsening state of access to adequate shelter, resulting in sever over crowding, homelessness and environmental health problems
- Increased vulnerability to environmental health problems, environmental shocks and natural disasters
- Luck of Participation of communities in decision making processes and implementing activities
- Increasing intra-city inequality, manifested in harsh residential segregations and multiplying violence (World urbanization prospects, 2001)

2.2.2 Urban Growth Trend in Africa

Urban growth in Africa is not and has not been "rune away" rather growth both of individual cities and total urban population appears to reflect the effects of demographic and Economic factors. The process is far from mysterious. The driving forces on the contrary are quit apparent further more, the force driving urban growth in Africa are virtually identical to those that drive urbanization elsewhere. Africa is unique because the forces driving urban growth have been stronger than most other places. In particular, these forces include total fertility, demographic shifts, deteriorating Agricultural performance and growth of government. (Becker, 1994)

According to Becker the demographic and Economic model often tend to give very similar projections. The demographic based estimates from the United Nations for Africa 1980 shows the following figures of urban growth for the entire continent.

Table 2.1 Annual African Continent Urban Growth Rate

Urban Growth estimate for Africa	
Urban growth period	Annual urban growth rate in %
1950-60	4.4%
1960-70	4.9%
1970-80	5.0%
1980-90	5.0%
1990-2000	4.6%

Source: Beyond urban bias in Africa P.107. Beck's cherksm. 1994

Africa cities have grown several fold over the last few decades and two clear trends are visible in their growth pattern first, the largest cities have continued to grow in population although by 1980's and 1990's their rates of growth have declined in comparison to spectacular rates of growth during the 1960s their rates of growth during the 1960's and 1970's and the main cause of urban growth were natural increase and rural -urban-migration. Second, in many countries, many or most medium sized cities have been growing more quickly than the largest cities. This may be will be partly a result of the more difficult economic situation facing urban dwellers (UNCHS, 1996).

2.2.3 Urban Growth Trend in Ethiopia

Between 1970 and 1984, there was a rapid growth in both the number of urban area and their population. The number of urban areas with 2000 or more inhabitants increased from 185 in 1970 to 339 in 1994, and the urban population grew from two to four million (Traver, Janes D.1984).

Large increases in the number of urban areas have occurred in all size-classes except in areas with population of 100, 000 or more. The growth in the number of urban areas was dramatic in the small and medium -sized towns with populations under 20,000, which almost doubled in number for every size-class. The most remarkable growth is further demonstrated by the emergence of 10 urban centers of 50,000-99,999 population in 1984 from non in 1970.

There is a sizable difference in population size between the largest city and the second largest city and between the second largest and third largest urban centers. (Traver, James D. 1984)

Table 2.2 Historical Population Estimates of selected Towns: - from the Seventeenth to Twenties Centuries

Town Name	**17th-18th**	**19th**	**1938**	**1965-66**	**1970-71**	**1984**
Addis Ababa	-	40000	300000	443700	683500	1,412,600
Dire Dawa	-	-	20,000	48,800	60,900	98,100
Gonder	80,000	5,000	14,000	35,000	35,300	80,300
Nazareth	-	-	-	26,400	39,200	76,300
Harer	-	35,000	45,000	41,200	44,900	62,200
Bahir Dar	-	14000	-	11,900	22,300	54,900
Awasa	-	-	-	5,500	13,200	36,200

Note -Estimates not available

Source-Urbanization in Africa: a hand book edited by James D.Jerver in 1984.

Despite substantial increases in the number of urban localities and urban population, their distribution patterns by the size- class of localities have remained the same.

Table 2.3 Distribution of number of Towns and population by size - class of Towns: 1970/ 1984

Size class population	Towns	1970 population	% of Population	Towns	1984 Population	% Population
2,000-4,999	109	36,130	15.5	197	611,100	13.8
5,000-9,999	44	295,906	12.7	77	522,296	11.8
10,000-19,999	18	248,934	10.7	39	531,258	20.0
20,000-49,999	12	415,630	17.8	14	398,264	9.0
55,000-99,999	-	-	-	10	668,946	15.2
100,000 +	2	1,014,260	43.3	2	1,687,960	38.2
Total	185	2,337,860	100	339	4,419,824	100

2.2 Descriptive Models and Theories in Urban Growth Analysis

In urban study the key major urban structural models includes

- the concentric- Burgess model
- the sector Homer- Hoyt Model
- the multiple Nuclei Models of Herris and wlmar and
- urban land rent model

The key concepts in each of the above models are described below in brief manner.

2.2.1 Burgess Model - Concentric Zones

Ernest W. Burgess developed a theory of city growth and differentiation in the 1930's based on the work of Robert Park. According to Burgess, the city constantly grew because of population pressures. This, in turn, triggered a dual process of central agglomeration and commercial de-centralization, that is, spatial competition attracted new activities to the center of the city but also repelled on the other activities to the fringe area. As activities themselves located on the fringe, the fringe itself was paused farther out from the city and so on. Thus the area of the city continually grew outwards as activities that lost out in central Business District (CBD) competition were relocated to the shifting periphery. (Got Diner, M.2005)

2.2.2 The Sector Homer- Hoyt Model

Hoyt model of sector conception of space was derived from a study of changes in the land prices with in the city. Hoyt argued that cities were carved up, not by concentric zones, buy by unevenly shaped sectors with in which different economic activities tend to agglomerate. These where produced by competition for locations with in a capitalist market in real estate that translated the functional needs of business in to land prices. Hoyt further argued that manufacturing and retailing, in particular, had the tendency to spin off and away from the center and agglomerate in sectors that expanded outward, while leaving other economic activities behind in a more functionally specialized central business district. (Gottdiener, M.2005)

2.2.3 The Multiple Nuclel Model of Harris and Wlman

Harris and wlman, argued that the spin offs of activities from CBD would take the shape of separate centers rather than sectors radiating from the central core. The smaller centers were conceived as homogeneous urban districts' and they remained organized around CBD of some kind. In their model, unlike Burgess, no regular pattern could be found where spin off district were located in relation to each other.

The entry on the multi-centered Metropolitan Region argues, in contrast to all city-centered approaches, that the separate centers are functionally differentiated and not linked to the large whole. For Harris and wlman the CBD remains an all purpose shorthand concepts for economic concentration with a city. The view of urban space in false multiple centers are spread throughout the metro region and are produced and sustained by regional, national and global model of societal organization. (Budd, Leslie, 2005 PP.84-85).

2.2.4 Theories of Urban Land Use Zones- On the Basis of Urban Bid -Rent Model.

The allocation of urban land use closely parallel that of rural land. Activities that need to minimize transport costs typically cluster in the city center. High land prices reflect this access advantage. Commercial activities located in high rise facilities normally bid the highest prices for such land. Specialty shops and out let with high markup (i.e. Jewelry stores) also easily adapt to expensive real estate. Other activities that might prefer downtown locations can be out bid. As a result, space-extensive industrial use takes up location farther from the city center. (Hartshorn , Truman A, 1980).

A general model of urban land uses along a bid rent curve describes spatial pattern of urban functions the curve slope drown reflecting lower rents per unit of land with increasing distance offices, banks, hotels an d other commercial establishments capture close in locations. Normally government and public- institutions facilitates cluster nearby ware housing and light manufacturing frequently identify with a zone of transition between commercial and residential uses.

The residential curve occupying an intermediate position with increasing distance from the city center, moderate, middle and high-income residential areas appear in succession.

Typically, the higher income family is willing to substitute more land at a greater distance from city center for less accessibility. Relatively large transportation is not important cost factors for the well to do. Manufacturing and distribution facilities are shown in sub urban settings on the graph, probably near radial free ways, or circumferential belt ways. Beyond this zone the land may be predominantly rural with some non farm residential activity.

Chapter Three

3. Description of Study Area

3.1 Location

Bahir Dar City is located in north western Ethiopia. Astronomically it is located at the geographic coordinates of 11^{o} 38' North latitudes and 37^{0} 15' east longitudes. In relative terms, Bahir Dar city is found at the distance of 567 km along Addis Ababa - Debre Markos road and 465 km along Addis -Motta road.

The core city has an estimated area of 16000 hectares. According to the 1996 Master Plan, the boundary of the city stretches up on Yibab Eyesus in the west, Abun Hara Digil in the east (along the lake shore) Igir ber pleatue in the south. Its geographical location favors the city with many and multi faceted opportunities like water resources (lake and river), suitable topography and favorable climate to live and to serve as a political center for the Amhara regional state. For administrative purpose the city classified in to 17 urban Kebeles (local Administration) with the current (2004) restructuring it also incorporates six rural kebeles.

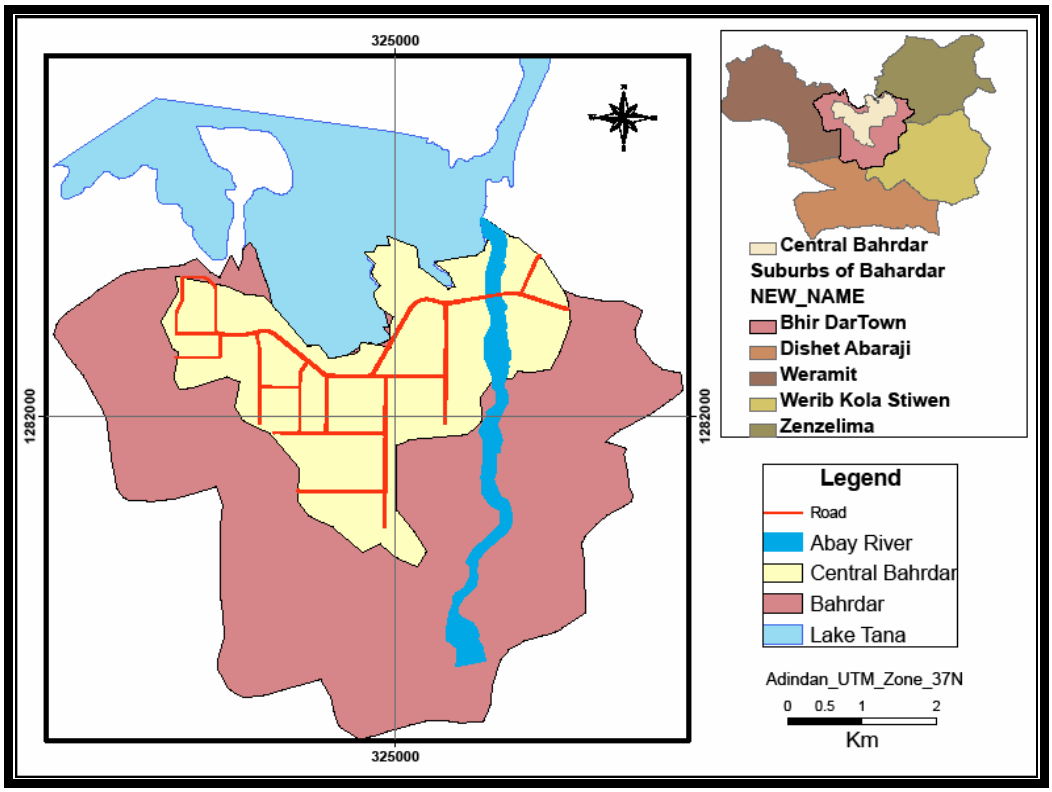


Figure 3.1 Locational Map of the Study Area

3.2 Physiographic

The city stretches over a predominantly flat land with imperceptible slop change. However there are also some dames and bridges with relatively higher elevations that standout in the area, particularly to the north and south of the city and the elevation variation in the area ranges from 1,786 m.a.s.l near the lakeshore to 1,886 m.a.s.l at Bezawit.

The general slop orientation of the town is slightly towards Abay River, which crosses the city proper from North West to south east and serves as the only out let for surface water run off from the town. Although there is no well- defined course of surface water, the direction of drainage in dominantly towards Abay River except for some areas, which drain in to Lake Tana. Because of its extreme flatness, the town has been affected by flood problem. (BMSA, 2001)

3.3 Geology

The rocks exposed in Bahir Dar area mainly include basaltic lava flows (lava outpourings and dames) and related spatter cones. The basaltic lava flows basically comprise periphrastic and aphanites basalts. And the over all exposed thicknesses of the flows vary from few meters to more than 100 meters at Bezawit. They seem to occur as alternate flow layers in some places and are often highly weathered and/ or fractured particularly at depth, as bore hole log date reveals. Generally, the rocks out cropping in Bahir Dar City Administration can be categorized in to three main units based on lithology variation.

These litologic units are:

- Aphetic Basalt
- Vesicular Basalt, And
- Scoria cereous Basalts/ cinder cones

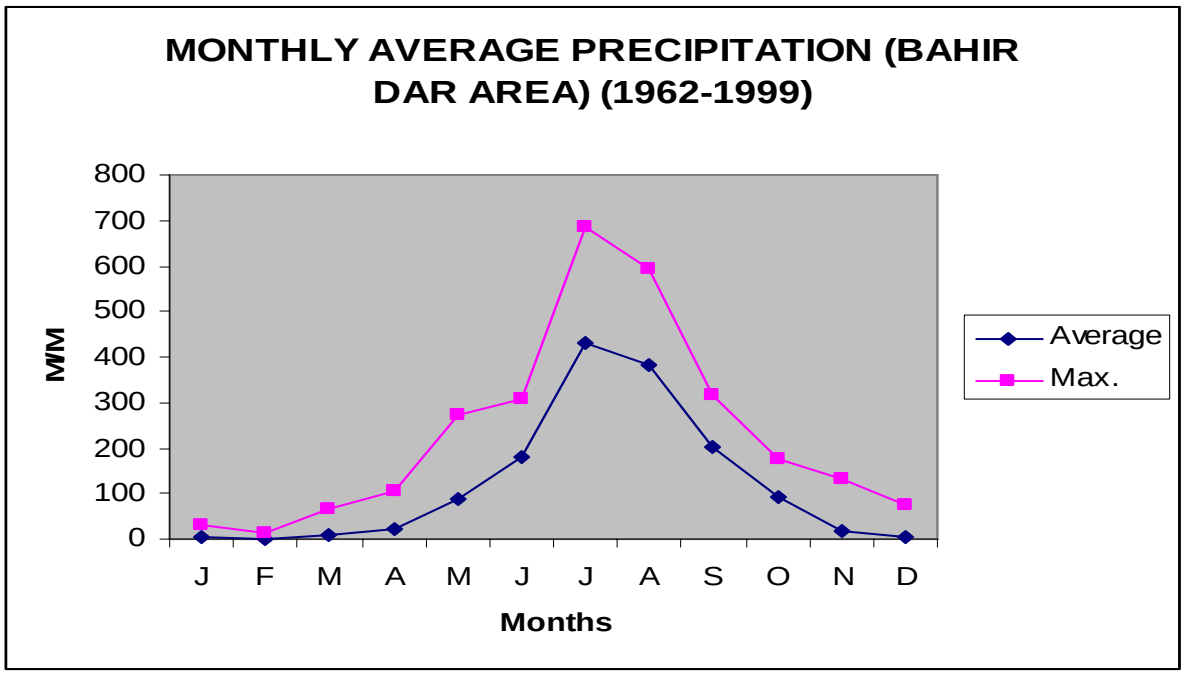
Aphetic Basalt- has a dark color, fine grains and many composes olivine, filed spare mineral and the out crops are found at eastern part of the town .

Vesicular basalt - has light gray color fine to medium grained and it is manly composed of pyroxene, Amphibole, olivine and filed spar the out crops are found in western part of the city along the bank of river Abay and also along the southern shore of the town.

3.1.4 Climate

3.1.4.1 Precipitation

The main annual precipitation depth recorded at Bahir Dar Station in 37 years period from 1962 to 1999 is about 1437 mm. There is a significant seasonal variation in the amount of rain fall. Almost 60.3 % percent of the mean annual rainfall occurs in two raining months of July and August with maximum mean value of more than 432 mm.



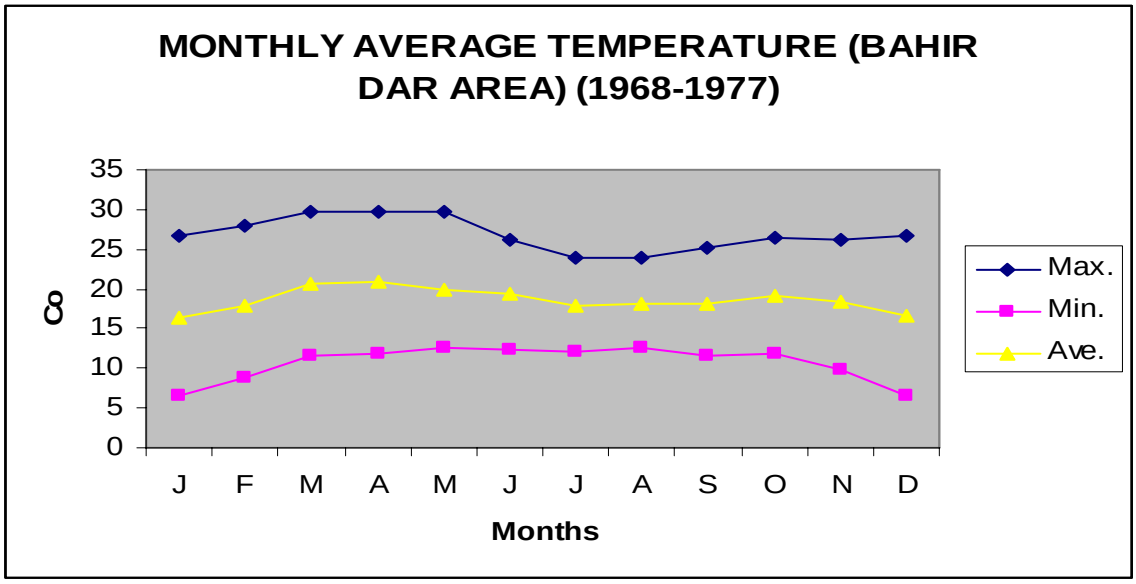
Month	J	F	M	A	M	J	J	A	S	O	N	D
Average	2.8	1.9	7.6	22.9	89.5	180.7	432.2	384.3	200.1	92.6	19.1	2.7
Max.	30	15	67	104	273	306	685	593	314.6	174.4	134	76

Figure 3.2 Monthly average precipitations Bahir Dar

Source: Ethiopia water resource authority land and water studies

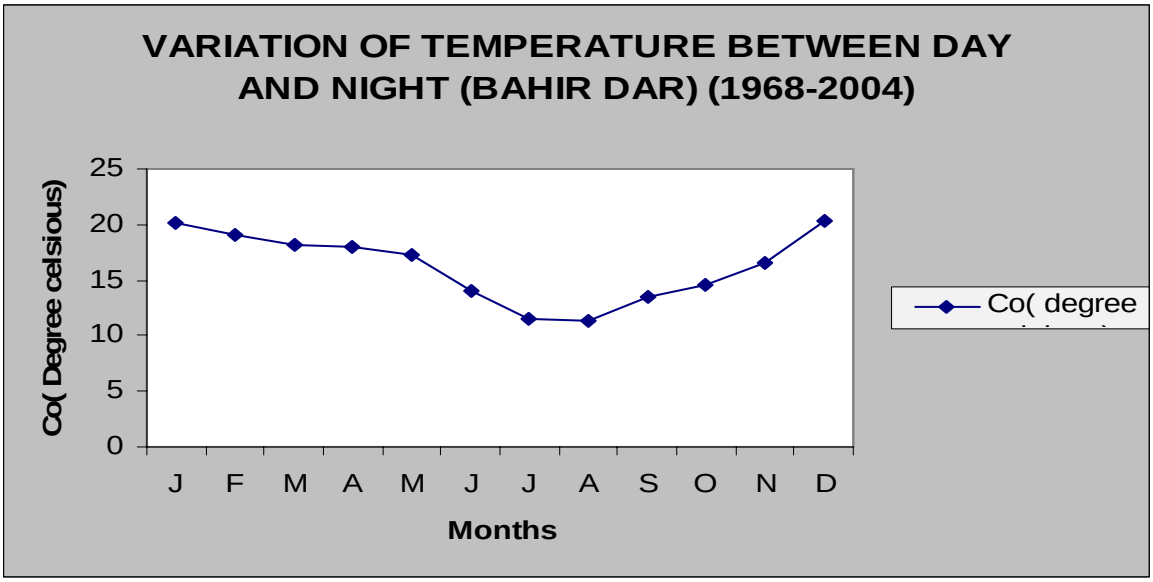
3.1.5 Temperature

The monthly mean maximum and minimum temperature recodes of Bahir Dar in the year between 1961 and 2000 (in the bare blew) indicates that the highest mean monthly maximum temperature occurs in the month of April which is about 29.7^{o} c and the lowest is in the months of July and August which is about 23.3^{o} . While the mean monthly minimum temperature ranges for the lowest from 7.1^{o} in January to the highest 14.2^{o} in the month of May.



month	J	F	M	A	M	J	J	A	S	O	N	D
Max	26.7	28	29.8	29.8	29.8	26.3	23.8	23.9	25.1	26.4	26.3	26.8
Min.	6.6	8.9	11.7	11.8	12.6	12.3	12.2	12.5	11.7	11.9	9.8	6.5

Figure 3.3 Monthly Average Temperature of Bahir Dar



Month	J	F	M	A	M	J	J	A	S	O	N	D
Co	20.1	19.1	18.1	18	17.2	14	11.6	11.4	13.4	14.5	16.5	20.3

Figure 3.4 Variation of Temperature between day and night

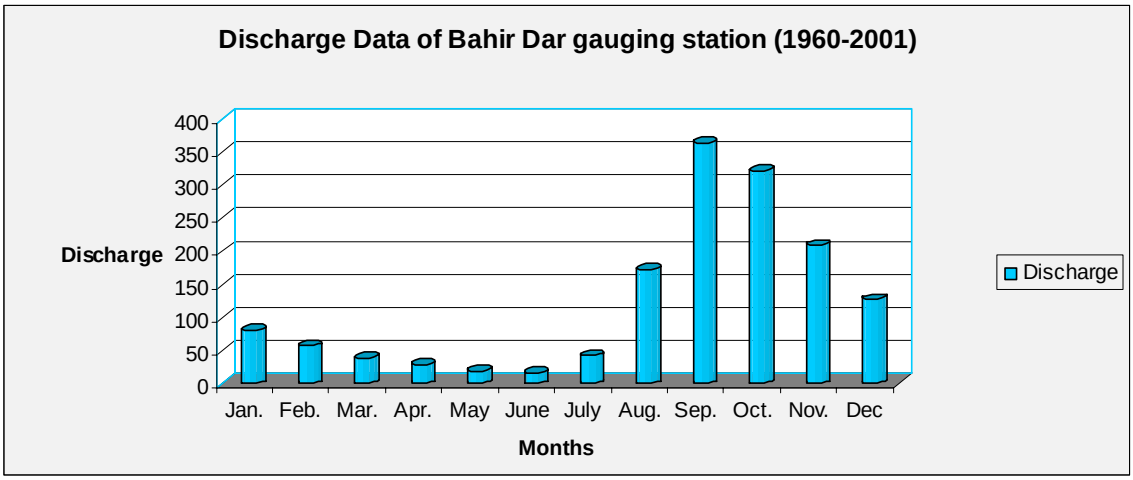
3.1.6 Wind Speed and Directions

The maximum wind speed in Bahir Dar is recorded as 1.8 per second, which is not that much difficult to line and under take any development activities in and around the city. The wind direction of Bahir Dar is towards,

3.1.7 Hydrology

3.1.7.1 Rivers

In the Study Area there is one major international river and one largest highland lake. Respective they are known as river Abbey and Lake Tana. River Abay is flowing on younger volcanic, which dammed of the drainage and formed lake Tana in this section, the river flows in a relatively wide and flat channel, forming a braided pattern as water swilled around the islands and there after it mainly flows in a deep and rugged gorge. The discharge data from 1960 to 2001 at Bahir Dar gauging station indicates the mean annual flow of the river Abay is about 123.07m^3/s.

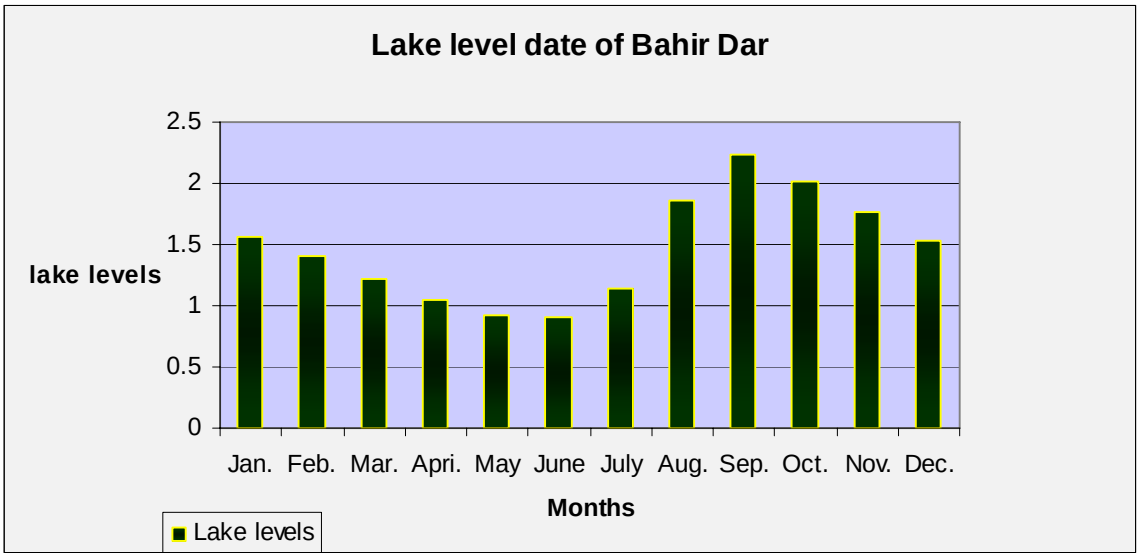


Month	**Jan**	**Feb**	**Ma**	**Apr**	**May**	**June**	**Jul**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec**
Discharge	80.92	57.04	38.08	28.23	18.38	16.92	41.97	172.77	364.24	322.25	208.87	127.17
Mean Annual /123.07/												

Figure 3.5 Discharge data from 1960 to 2001 at Bahir Dar gauging station

3.1.7.2. Lake

Lake Tana which is the source of the Blue Nile covers more than 3000 km^2 of the total drainage area of 15,320 km^2 above the out late Lake Tana stores 29.172*10 $^9m^3$ of water. Seasonal stratification is weak owing to its shallow depth. The lake level data for the last 42 years (1960-2001) at Bahir Dar gauging station is shown in the table below.



Months	Jan.	Feb.	Mar.	April.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Lake levels	1.56	1.41	1.22	1.05	0.92	0.90	1.14	1.86	2.23	2.01	1.76	1.53
Mean Annual /1.53/												

Figure 3.6 Lake level date of Bahir Dar

Source: Ethiopian water Resource Authority land and water studies Agency

3.1.8. Socio Economic Characteristic of the Study Area

3.1.8.1. Population and Demographic Characteristic of Bahir Dar

The first national population and housing census conducted in 1984 puts the population of Bahir Dar city as 54,766. The second national population housing census conducted 10 years latter in 1994 shows that the total population as 94, 235 in the city.

The central Statistical Authority (CSA) in its Annual statistical Abstract of 2004 projects the total population size of 159,796 (Male 82,498 and female 77,295) for the year 2005.

Table 3.1 - Population size of Bahir Dar city

Periods	Population size	Source
1984	54,766	OPHCC
1994	94,235	OPHCC
2005	168,048	A.R.FI.Eco. bureau

Based on the population path of different years it is possible to calculate the growth rate of the city population and to find the population and to find the population growth rate of Bahir Dar the Exponential growth rate formula is used. (The formula can be written as $Pn= Po(1+r)^n$

Where,

R = Growth rate

Pn= Present Population

Po= base Population

n= number of years between base and present population

With this formula the projected population of the town from 2003 to 212 is as follows

Table 3.2 - Projected Population of Bahir Dar (2003-2012)

Year	Projected total Population
2003	153,293
2004	160,851
2005	168,365
2006	176,448
2007	184,913
2008	193,789
2009	203,091
2010	212,839
2011	223,055
2012	233,762

CHAPTER FOUR

4. ANALYSIS AND RESULTS OF THE TEMPORAL URBAN GROWTH

4.1 Data sources for the Temporal Urban Growth Analysis

Remotely sensed imagers are widely recognized primary sources for urban growth monitoring. Before 1970s high resolution satellite images were not commercially available and only aerial photographs were predominantly used. Fortunately the whole study area covered with 1957 and 1987 aerial photographs with 1 : 50,000 table 4 lists the varies dates used for urban growth analysis in Bahir Dar with time span of nearly half a century

Table 4.1 Data sources

Type	Year	Scale /resolution	Coverage	Source
Arial photographs	1957	1 :50000	100%	EMA
Arial photographs	1987	1 :50000	100%	EMA
Arial photographs	1994	1 : 2000	100%	Amhara Regional urban and development bureau
Topographic maps	1987	1 :50000	100%	EMA
Sub district boundary	2005	GIS shape file	100%	Amhara municipality office
Quick bird satellite image	2005	0.61 meter	100%	BahirDar University

4.2 Processing of Aerial Photographs and Images

The mono aerial photographs of different periods were scanned at a resolution of 12000 dpi.As no flight perimeters, ground coordinates (including elevation) or large scale topographic maps of the flight period were available for the 1957 aerial photographs.
The topographic map of 1987 with the scale of 1 : 50,000 is the ideal source for selecting reliable ground control points and used consecutively for rectifying both the three mono aerial photographs and the recent quick bird satellite image.

The scanned aerial photographs have been rectified using some seventeen points systematically chosen and evenly distributed over the images to guarantee enough points in the center and corners of the image.

A second order polynomial model was chosen for the image rectification and resample using nearest neighbor algorism. The root mean square error (RMSE) is strictly limited to 0.5 pixels. The projection system of clerk 1880 North with in zone 37 was selected for the study area.

To identify and recognize major urban features in the aerial photographs the basic visual interpretation parameters like shape, size, and pattern are used. Besides to have the 3D impetrations of the area a pocket stereoscope was frequently used.

4.2 Monitoring of Urban Growth in Old Urban Areas

In digitizing and extracting major urban features the main problem was delineating of the urban boundaries in different time scale for example some sparsely nucleated settlements administratively belonged to neighboring countries even though there are large scales or near to the city area. Therefore the urban area should be clearly defined in geo-space the concept of urban land can be described according to its physical and functional activities.

In physical terms, it relates easier to density or land use urban in functional term means activities therefore it can be argued that the administrative boundary is not an ideal definition as it rarely coincides with the physical extent of urban growth (kevel, 1993) it is more appropriate to apply continuously develop areas for monitoring urban growth. In these particular research emphases was given to monitor the growth of urban areas using

the main physical indicators like built up areas and road network based on the available data sources the study area is further categorized as old, new and recent development areas. As historical records in various office indicates it is in the old development area that the first hospital known as Felge Hiowte hospital was built by the Germen aid and begun its health service activity in 1955 and the first former high school which is known as Tana haik`` was founded in 1956 ,the first Tis Abay hydropower station with the help of Yugoslavian government was founded in 1956 besides the modern commercial center was established at the end of 1950s and this was the major reason in this particular research to begun with the old development site through remote sensing technique.

To evaluate the status of the old development area of Bahir Dar town the 1957 aerial photograph is directly used as base line reference and the same area is sub sited from the aerial photograph of 1987 and 2005 quick bird satellite image. This consecutive input maps are shown below. (Fig 4.1, 4. 2, 4. 3)

Figure 4.1 The Old Urban Area of Bahir Dar town in 1957

Source: Aerial Photograph

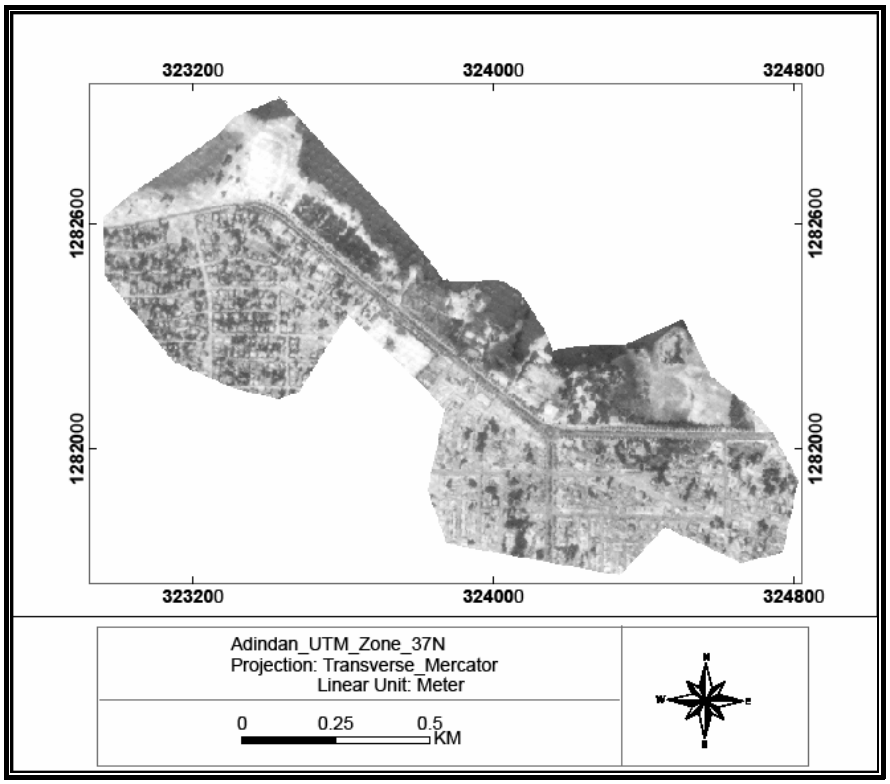


Figure 4.2 The Old Urban Area of Bahir Dar Town in 1984

Source: Aerial Photograph

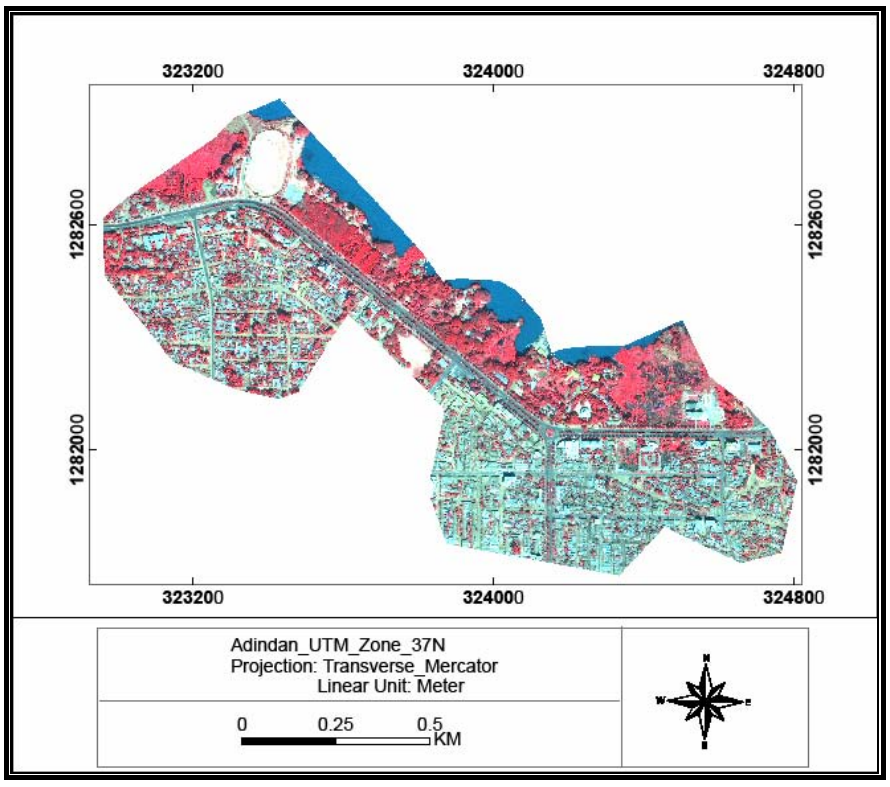


Figure 4.3 The Old Urban Town of Bahir Dar in 2005

Source: Quick Bird satellite image

4.2.1 The Internal Growth of Built up from 1957 to 2005 in the Old Urban Areas

The further analysis could be done basing on the image processing that has been described at the beginning of this chapter. The digitized results of aerial photographs and satellite maps below illustrate the major changes in the old urban areas. In 1957 the old urban area polygon covered a total of 99.44 hectares and during this time the built up coverage was 13.34 hectare and this only accounts 13.4 % of the old urban areas.

In 1987 there was 126.54 % of built up area growth in old urban areas compared with 1957 built up areas and the built up coverage was 30.19 hectares and this accounts 30.36 % of the total old urban areas . Progressively in 2005 the same area consists of 33 .68 hectare built up. The following digitized maps shows the built up growth in three distinctive development periods

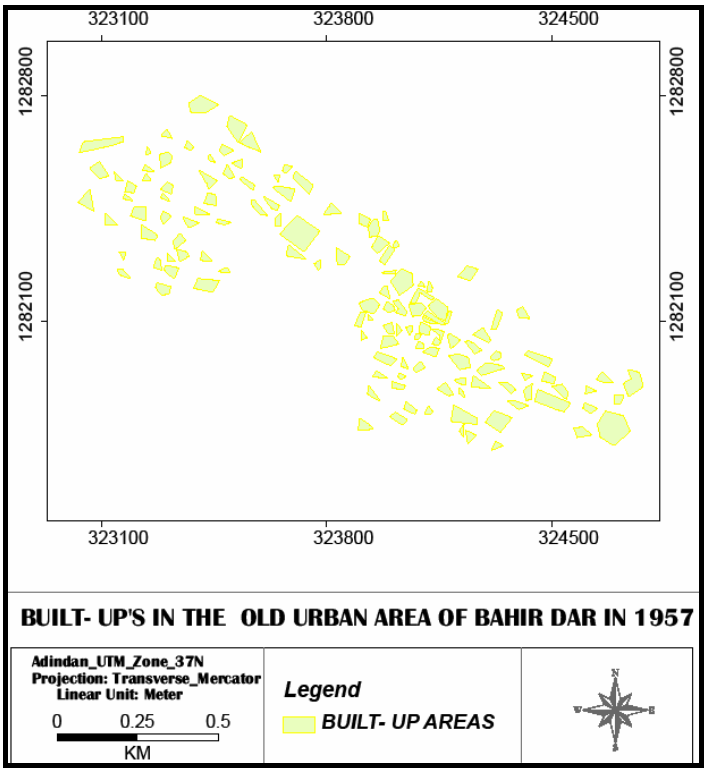


Figure 4.4 Digitized Built ups from the 1957 Aerial Photograph

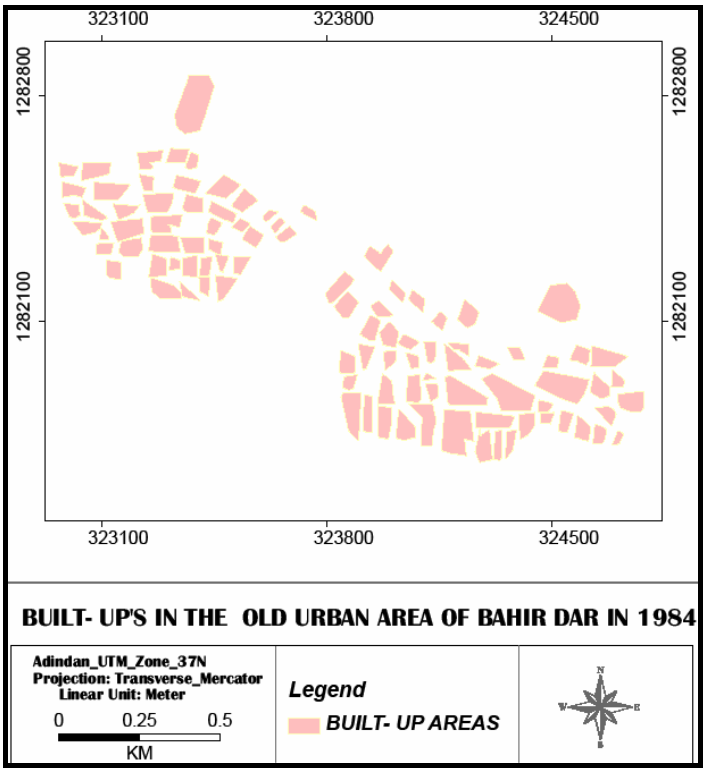


Figure 4.5 Digitized Built ups from the 19984 Aerial Photographs

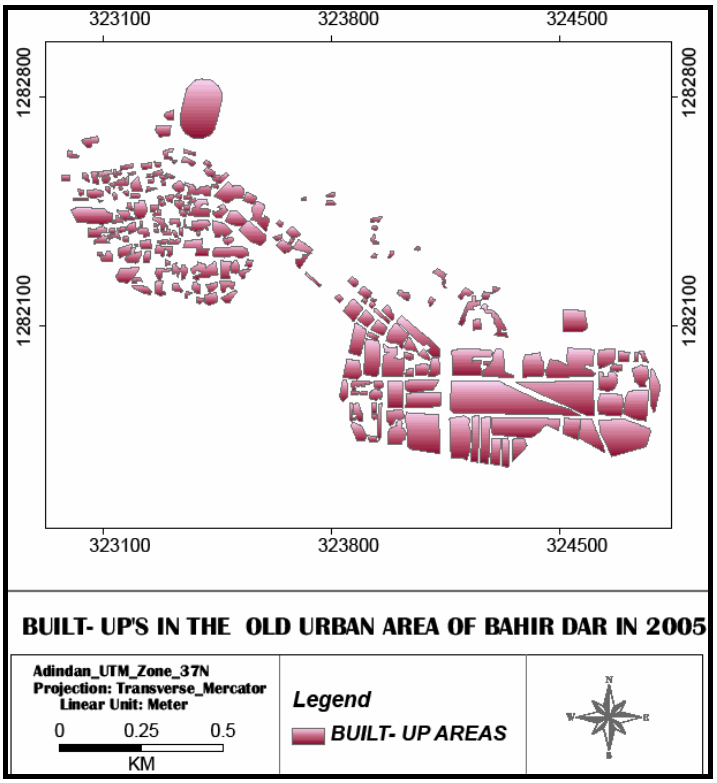


Figure 4. 6 Digitized Built ups r from The 2005 Quick bird Satellite

4.2.2 The Growth of Road Network Coverage in the Old Urban Areas

The road network as one of the major factor shaping the city structure in the old urban area the main road which connects Addis and Gonder pass through the old urban development areas and it is elongated in the east, west direction while all the secondary roads were dominantly laid in the north–south direction. Stereoscopically a poor road quality is also observed among these groups of road. And the total road coverage accounts 11.01% of a total old urban areas and this figure increased and reach 11.06% in 1987 and 12% in, 2005. The map below shows the change in road network coverage in the old urban area of Bahir Dar.

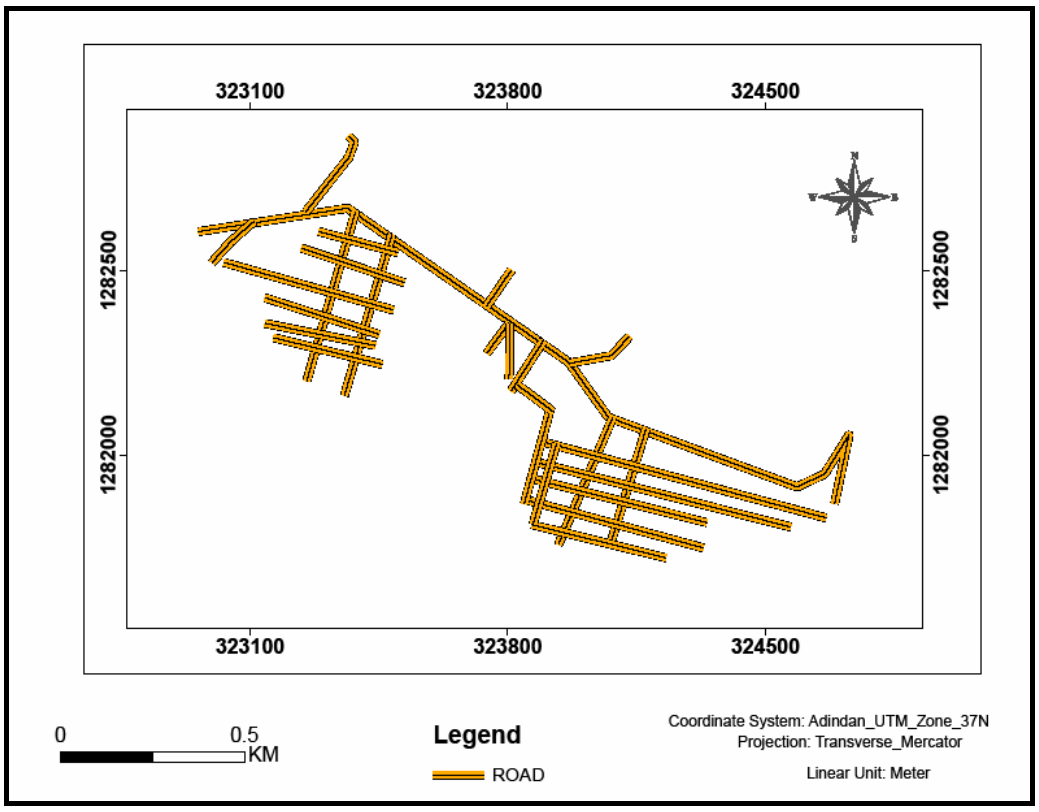


Figure 4.7 The Road Network Map of the old urban Bahir Dar in 1957

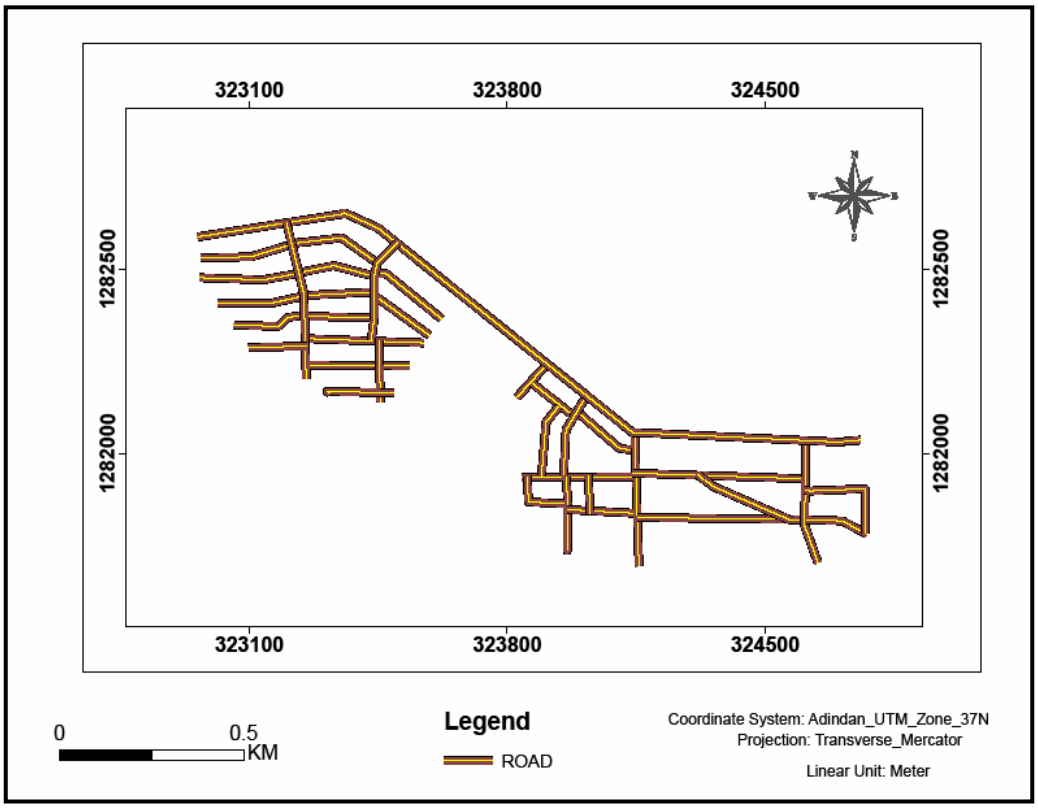


Figure 4.8 The Road Network map of the old urban Bahir Dar in 1984

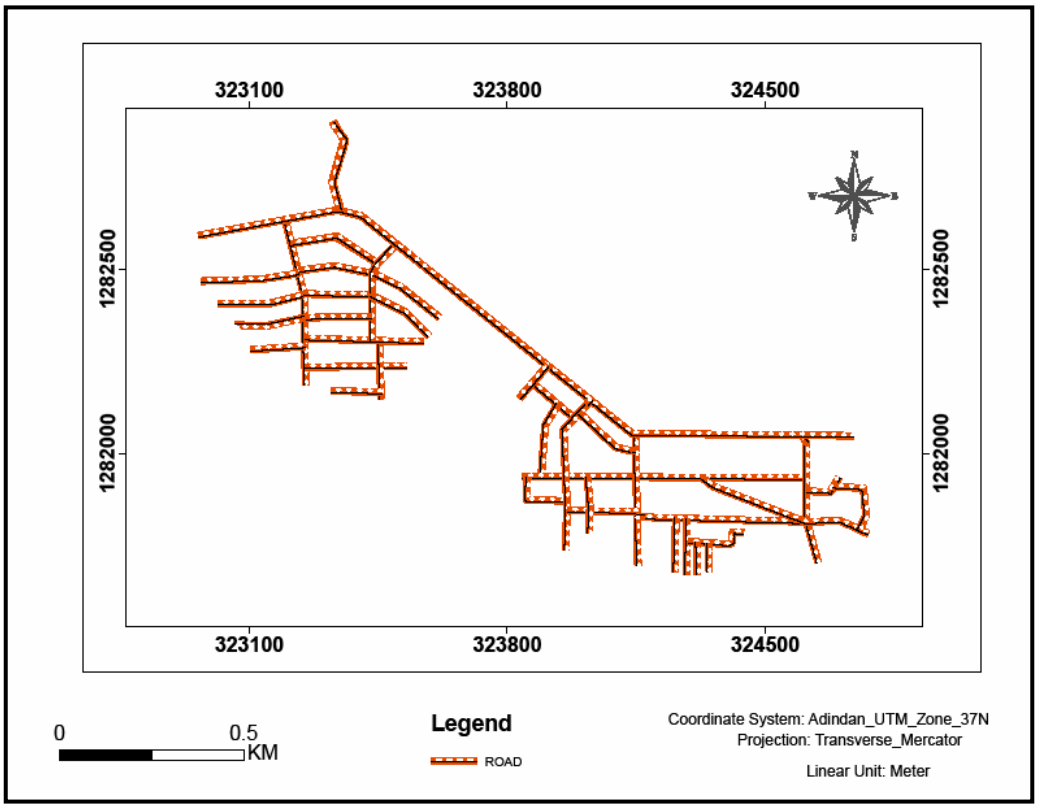


Figure 4.9 The Road Network Map of the old urban Bahir Dar in 2005

The over all road density and road length in kilometer in the old urban area shows insignificant change this can be associated with the growth of built up and population of the area. This quantitative change implies the inefficient utilization of urban geo space. Although this internal growth of roads should be further strengthened through establishing a proper transport policy unfortunately as it is indicated in the master plane document the city dose not have a compressive transport plan that clearly defines the road model networking. With regarding of centers and sub center nods we can generally say the change in the old urban areas with in the last fifty years is extremely low.

From the above digitized results of aerial photographs and satellite maps the major changes in urban built ups, none built ups and roads during the period of 1957 / 2005 are illustrated below from figure 4.10 to 4.12

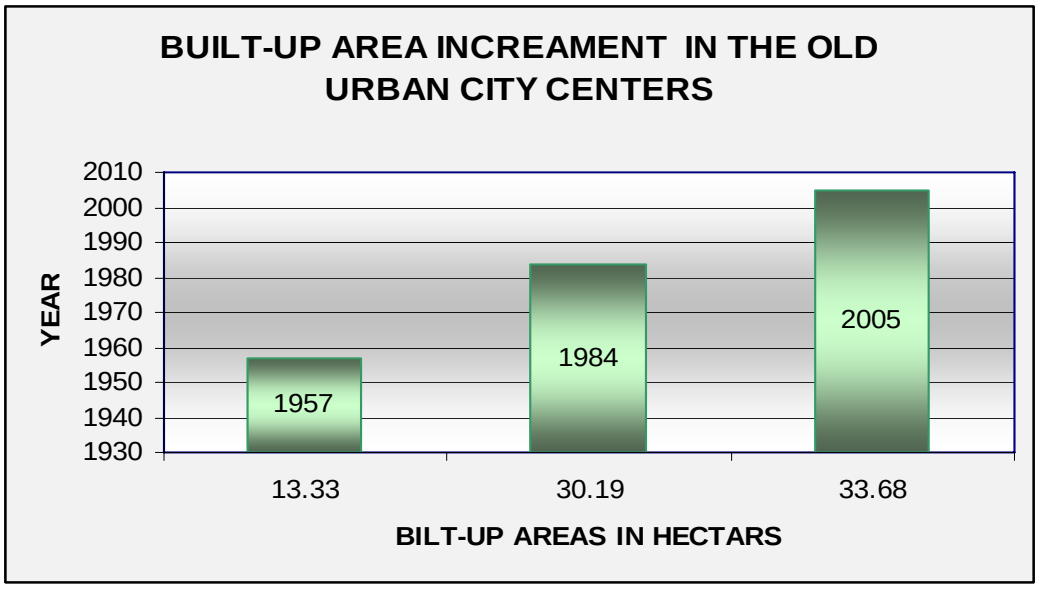


Figure 4.10 Built up area increment in the 1957 urban area of Bahir Dar

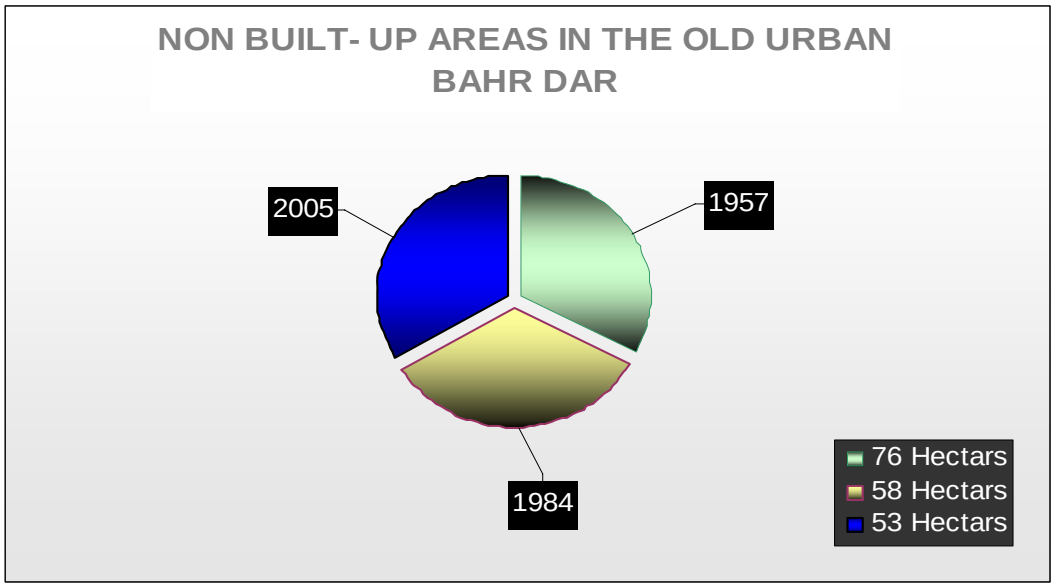


Figure 4.11 None built up areas in the 1957 urban area of Bahir Dar

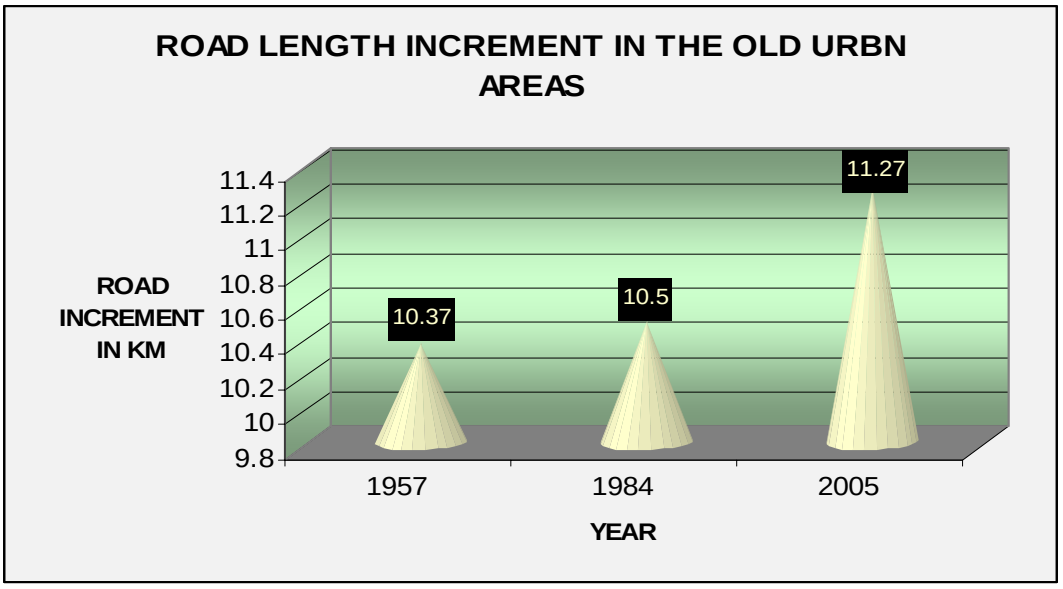


Figure 4.12 The road length changes in the 1957 Urban Area of Bahir Dar

From the above statistical figures one conclude that the land conversion for built ups and roads in the old pre 1957 development area shows a positive growth. The built up area changes from 127% to 153% in 2005 in terms of transportation during 1957 to 1984 the Road length in km changed slightly and only 1% growth is observed. On the other hand the road length in Km grew by 8.7% during 1984 to 2005.

4.3 Monitoring of the Inner Urban Growth of the New Development Area

4.3.1 Major Growth Factors to the New Urban Development Areas

The predominance of flat land escape and plain topography in Bahir Dar crate a promising opportunity and potential to under take various urban development activities besides the presence of the historical and natural tourist attraction site like the churches and monasteries of Zegie peninsula at the south-western side of Lake Tana including ura–kidanmehiret, Azuwan mariam, kibran gebrial and the existence of the national heritage including Tis Abay waterfall and alata bridge which was founded in the 17th century by the Portuguese result in attracting a large number of domestic and international tourists throughout the year, to host the visitors various facilities like hotels, international airports, commercial centers and other physical infrastructures are developed in the new metro pollutant areas.

The other important growth factor is the demographic characteristics of the city. The first national population and housing census conducted in 1984 puts the population Bahir Dar city as 54,766 the second national population and housing census conducted 10 years later in 1994 shows that the population of Bhair Dar as 94,235 and this huge inhabitants in the city requires additional physical infrastructure developments.

The other major growth factor is associated with the change of its political function earlier the city was predominantly serve only as awraga capital later on during the end of derge region the city changes as a provisional administration centers.

To day Bhair Dar is a sit of Amhara Regional State and serves as regional political center as result the city quickly developed into a place of considerable social and economic activities. And the new urban development areas have an agglomerated commercial, residential and industrial building. The city has also a lot of government and private offices, banks, insurance company's, modern shops, medical centers, colleges and universities the present of this facilities has a cumulative effect for further growth and physical development of the city

4.3.2 The Internal Growth of Built Up from 1987–2005 in the New Urban Areas

To weigh the internal growth of the city and to obtain urban changes of the new development site as well as to identify the development axis of the city remote sensing data from 1984 to 2005 was used. To delineate the new development site, the 1987 subdistricte boundaries indicated on Ethiopian mapping topo sheet is directly used as input and all maps used for extracting built ups and roads are shown below.

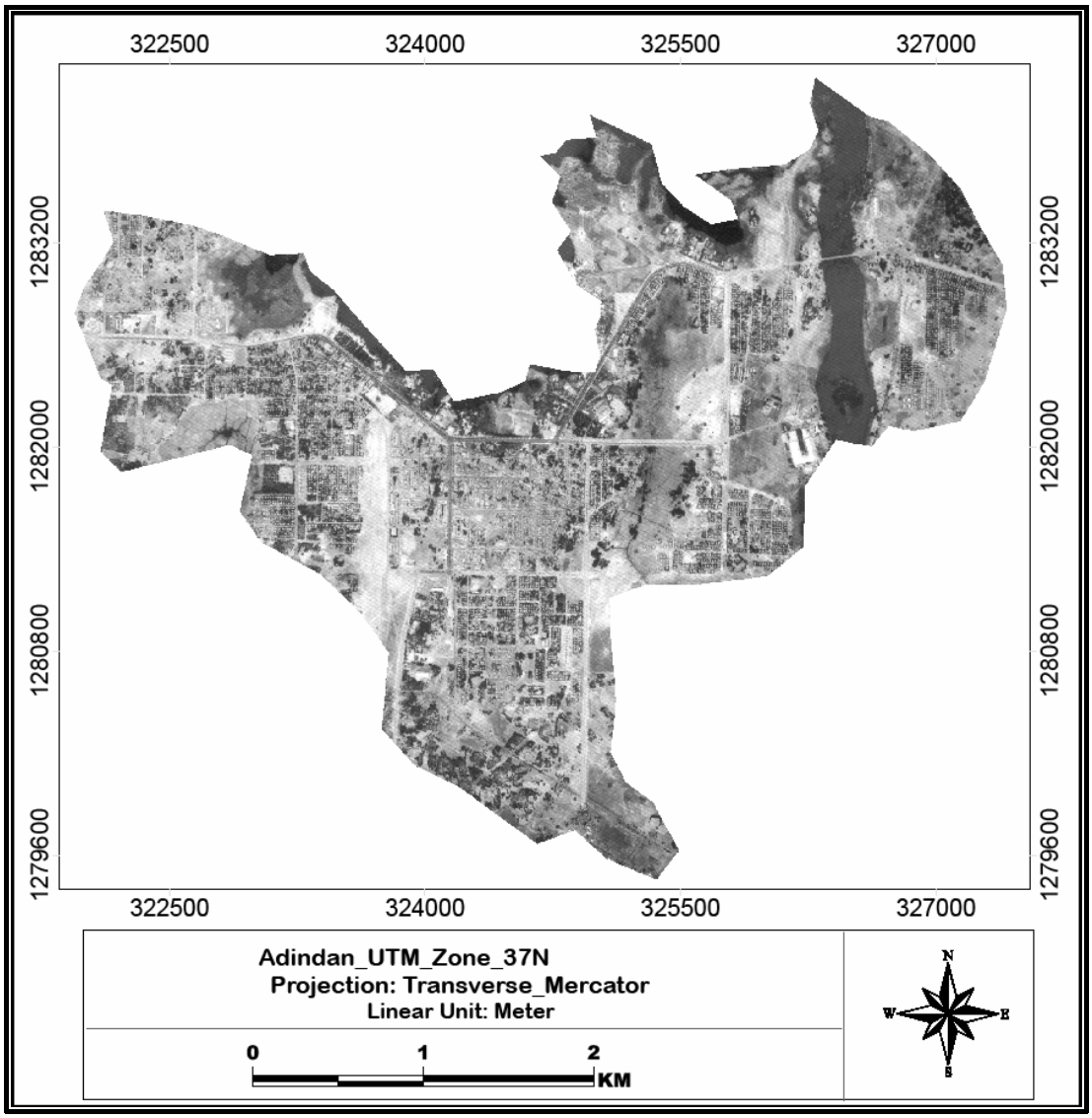


Figure 4.13 The 1984 urban development area of Bahir Dar town
Source: Aerial Photograph

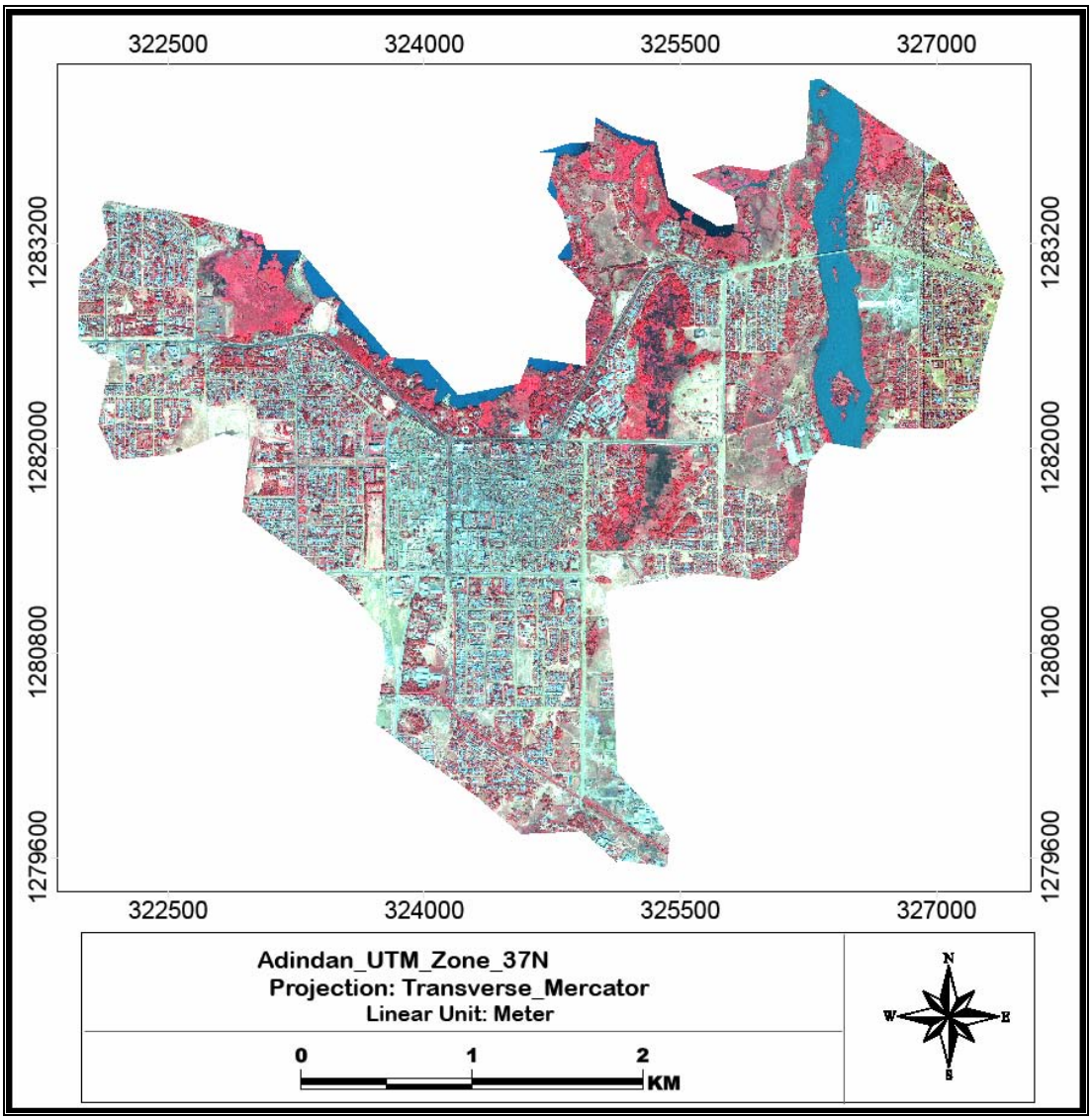


Figure 4.14 The New urban area of Bahir Dar town in the 2005 Quickbird satellite image

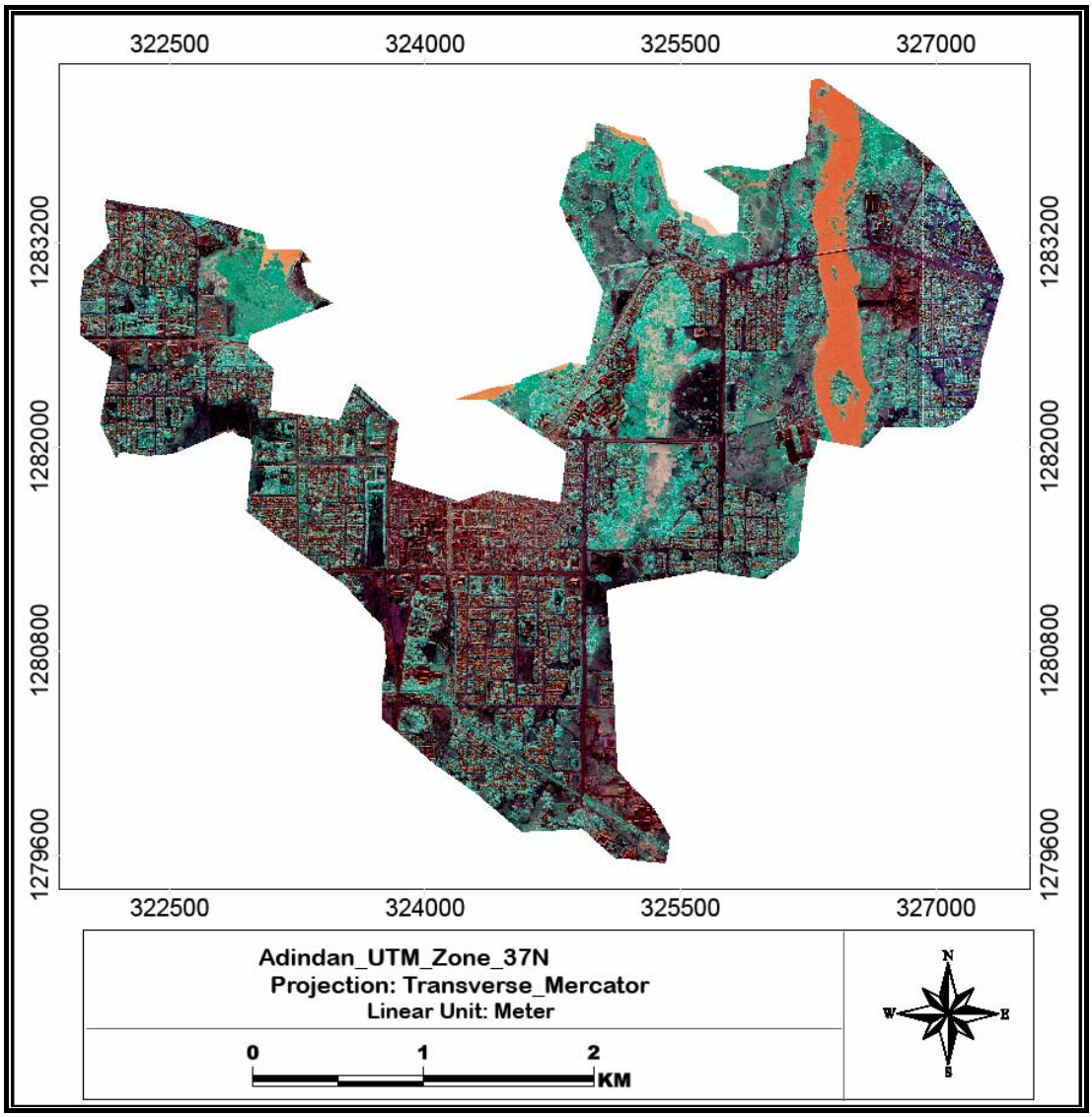


Figure 4.15 The 1957/1984 urban Expansion Area of Bahir Dar in the 2005 Quick Bird Satellite image

Using ArcGIS all built up areas are digitized from the above Aerial Photograph and Satellite images and the built up areas shows an increment from 166.54 hectares to 210.34 hectares for the period 1987 to 2005 and figure 4.16 to figure 4.17 illustrate urban built up growth and change in different period. The largest internal growths were observed during 2005 which represents an increase of 26% over a period of 19 years. The shear of built up areas of the new urban areas was 17% in year 1984 and 22.71 % in year 2005.

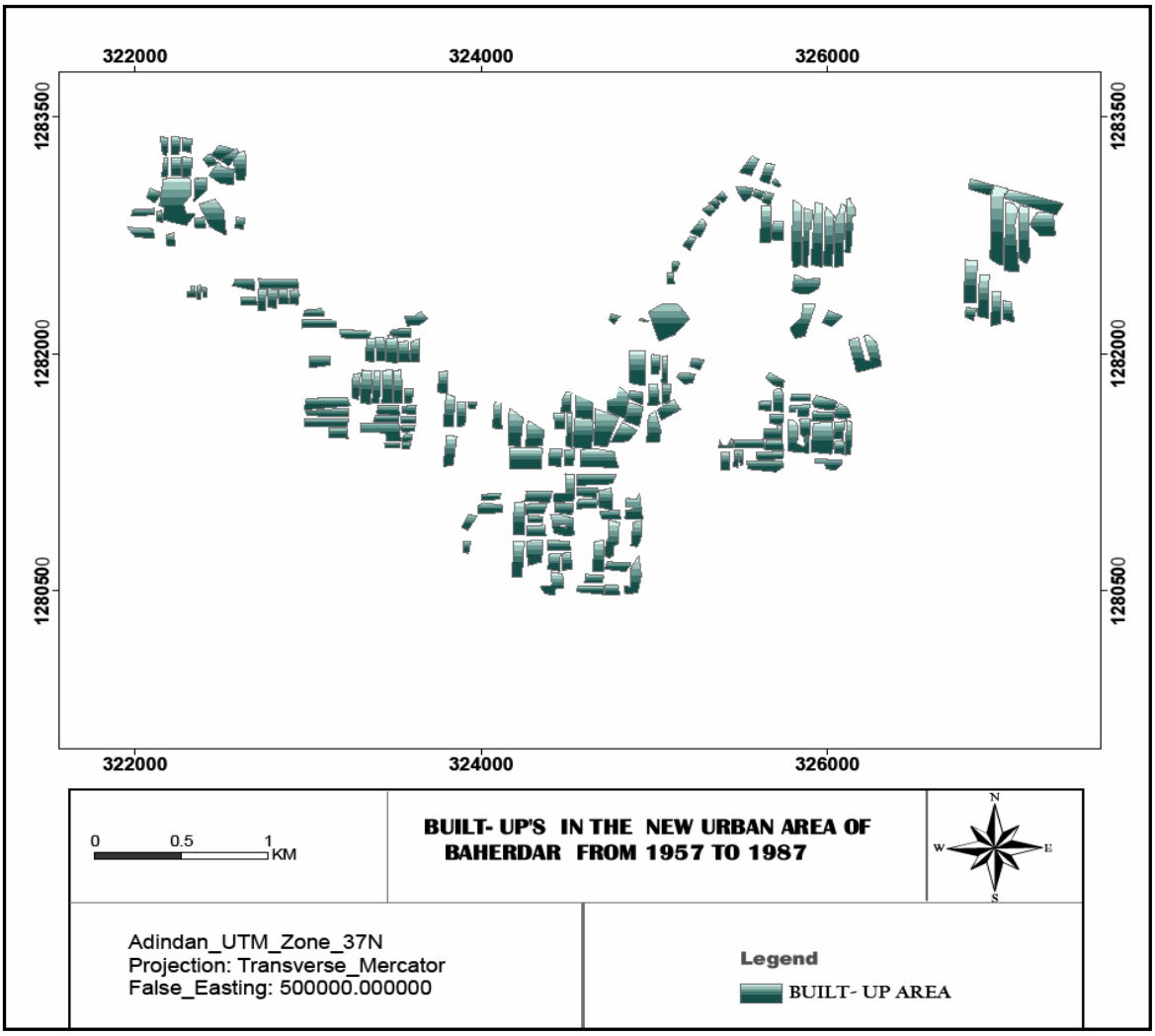


Figure 4.16 Digitized Built ups from the 1957/84 Expansion Areas of Bahir Dar
Source Aerial Photograph of 1984

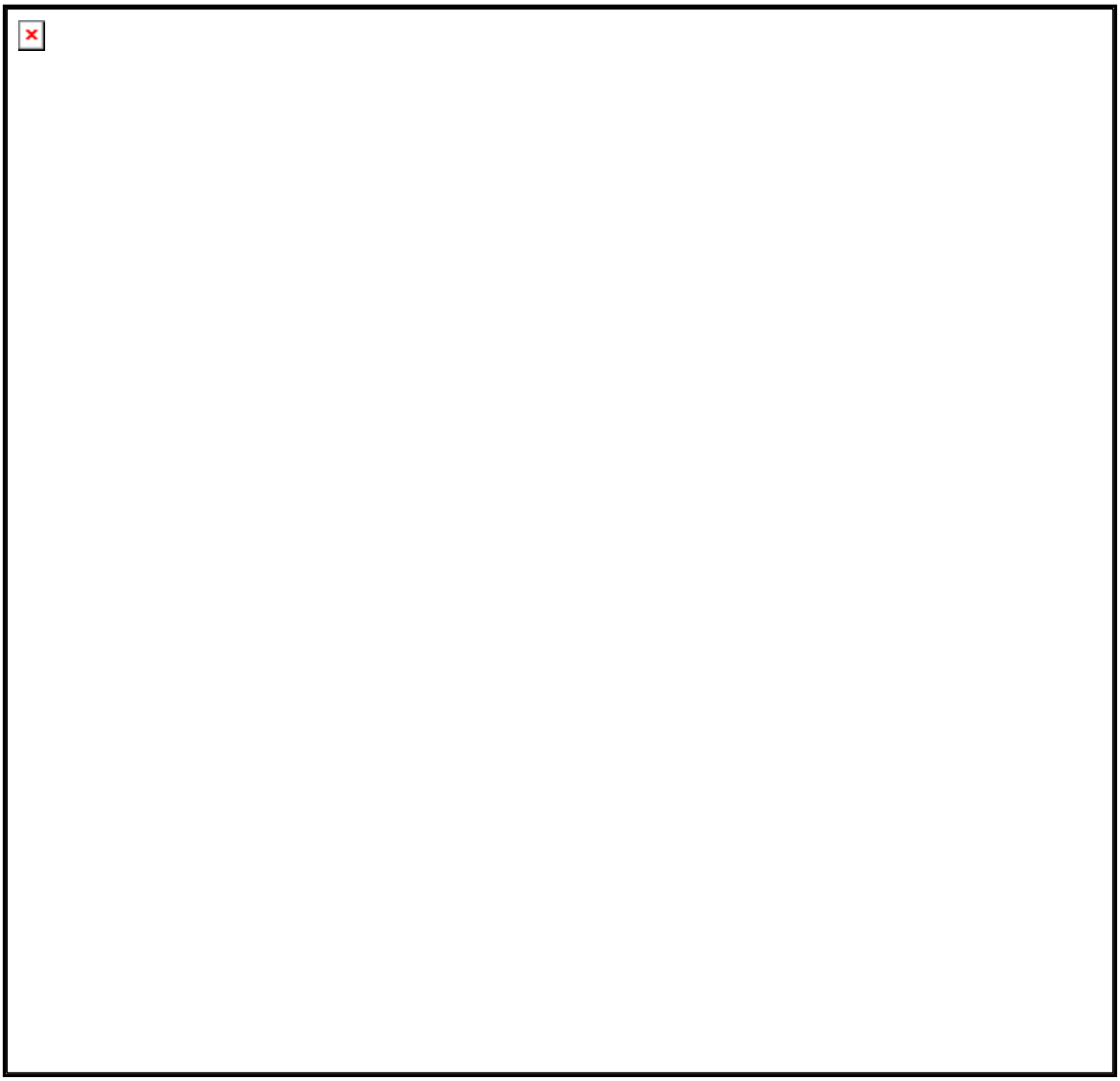


Figure 4. 17 Digitized Built-ups from the 1957/84 Expansion areas in 2005 Quick Bird satellite

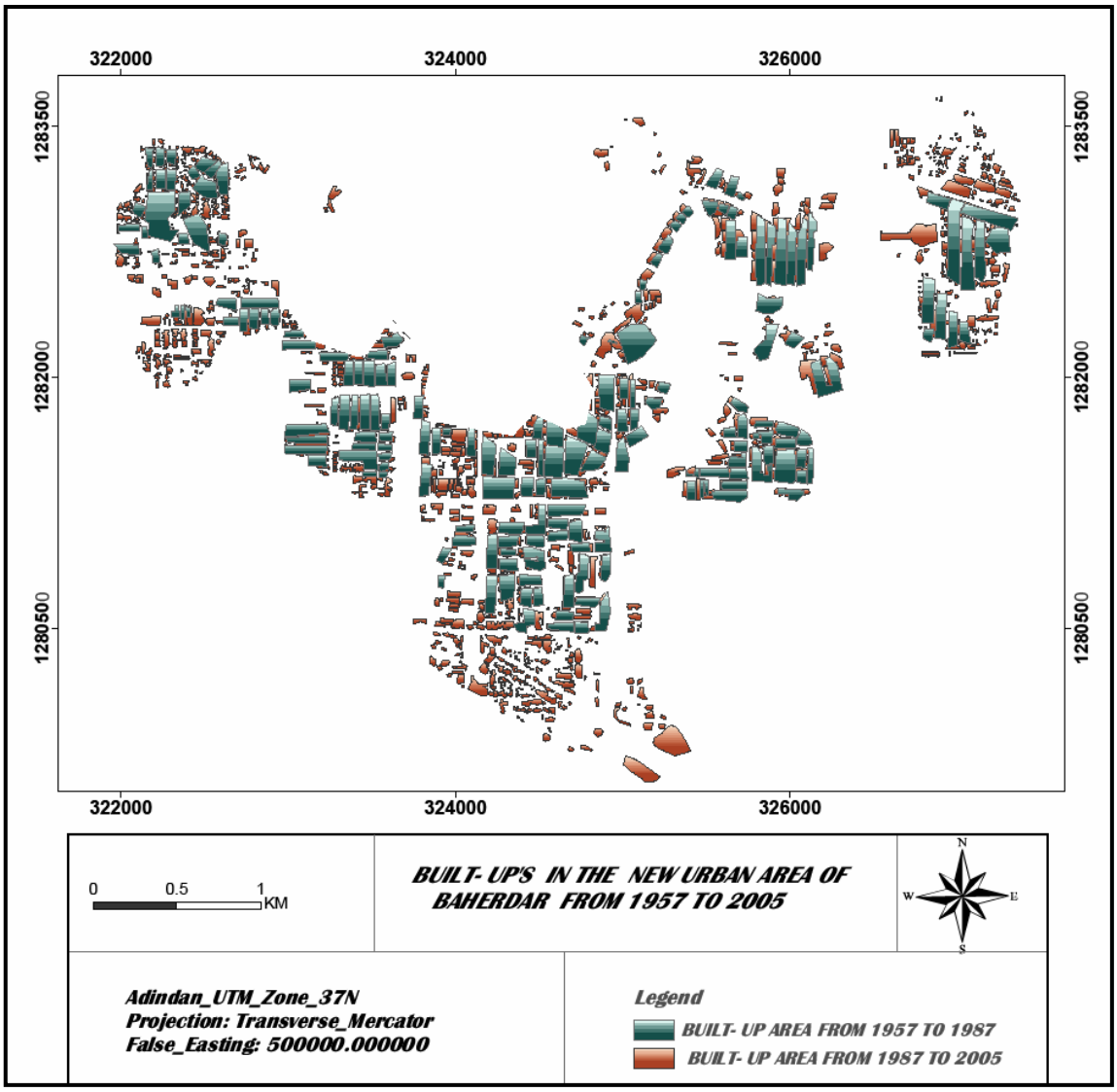


Figure 4.18 Change of built up areas from 1957 to 2005

Digitized from the 2005 Quick Bird satellite

4.3.3 The Growth of Road in New Urban Area

Improvement of road condition of the metro pollutant administration is an over riding issue for the smooth interaction and sustainable development of the urban centers with a multi player impact on the socio economic development of Bahir Dar city. As it is indicated in the table below the total road length grew from 44.414 km to 76.77 km from 1987 to 2005

with in the new urban areas alone and these accounts 9.59 percent of the total new urban areas. The figs below shows the road maps of the new urban areas.

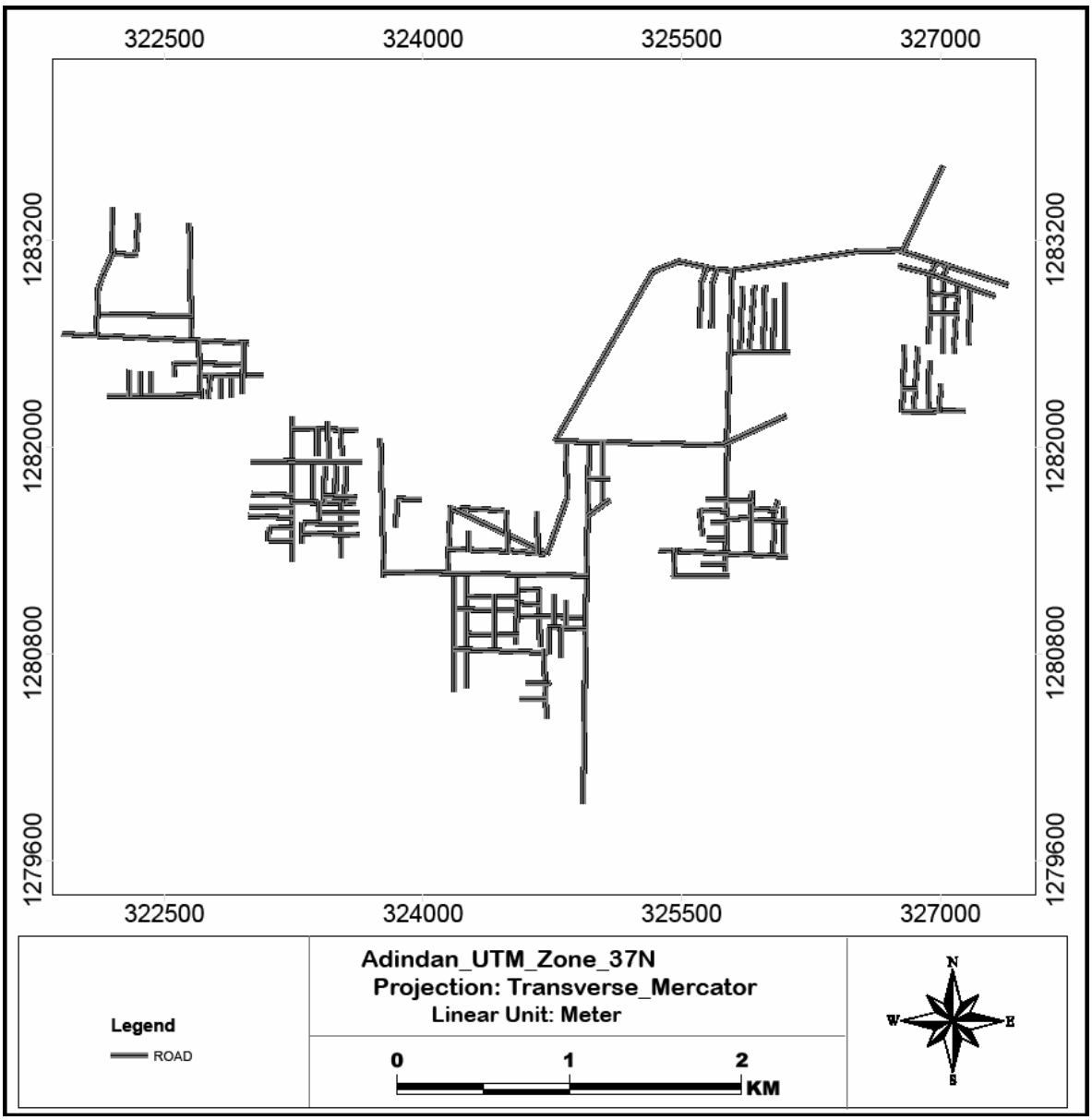


Figure 4.19 Road Net work map of Bahir Dar during the expansion period of 1957/84 [Digitized from the aerial photograph of 1984]

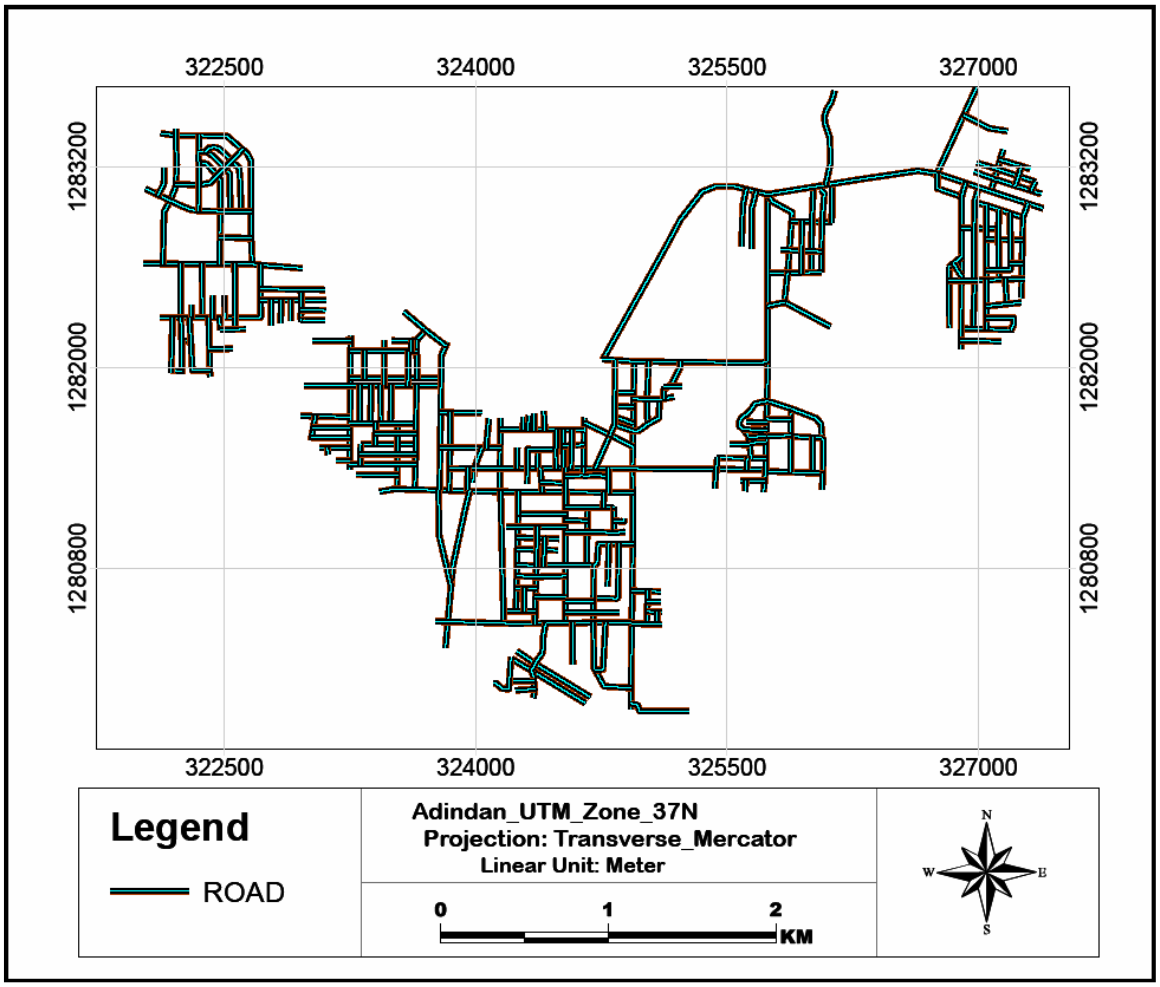


Figure 4.20 Road Net work map of Bahir Dar during the expansion period of 1957/2005 [Digitized from satellite image of 2005].

Result of the above digitized aerial photographs and satellite images of post 1957 urban development features shows remarkable and sizable growth and this change are illustrated in tabular and statistical manner below.

Table 4.1 Area and percentile change of built ups and roads in the new urban Bahir Dar

Period	**1987**	2005
Built up in hectare	166.54	210.34
Percentage of built up change		26%
Non built up area in hectare	670.96	562.2327
Percentage of non built up change		–19%
Road length in km	44.414	76.77
Percentile change of road length in km		42%

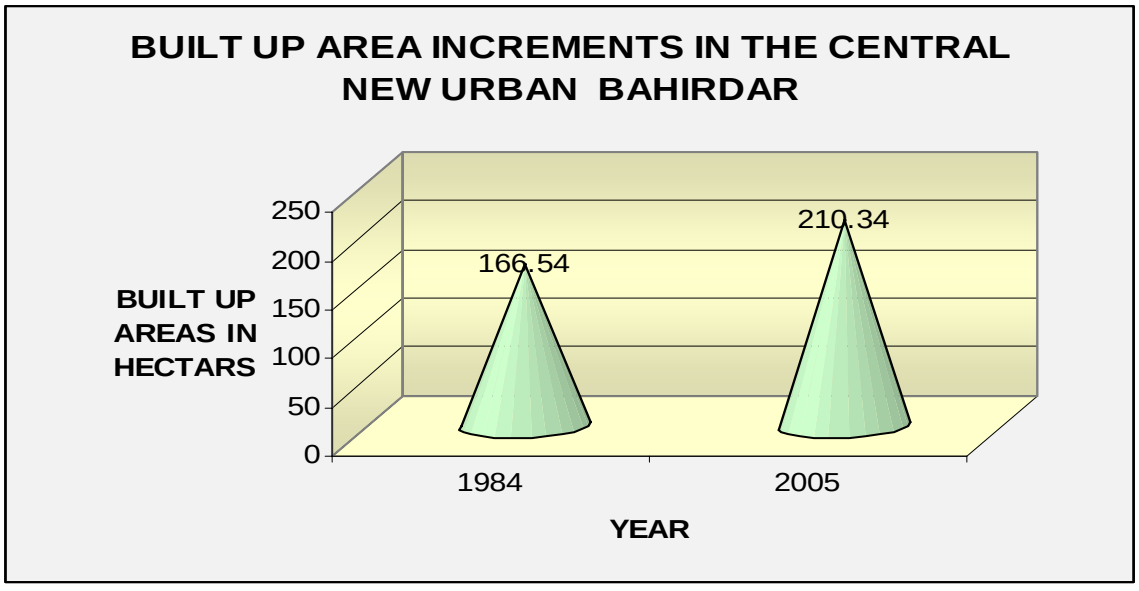


Figure 4.21 Built up area increment from 1984/2005

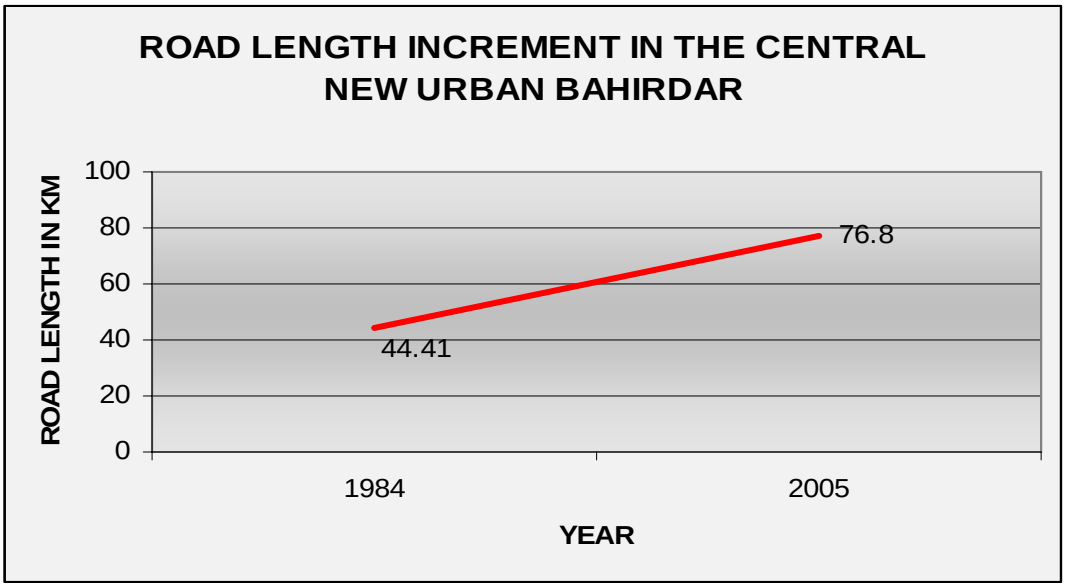


Figure 4.22 The Road network change in the new urban Bahir Dar

4.4 Monitoring of Growth in the Recent Urban Areas

As population increase, urban sprawl is becoming more apparent than ever and increment of in population often lead to increase in urban land development which has a direct influences on rural land conversion. According to the recent development plane, the general profile of the study area stated that the projected total population in the year 2012 would be 2400000. It indicates that the whole area will have to accommodate 80000 additional people.

Almost half of the urban house holds in Bahir Dar are assumed to live in squatter and over crowded slum settlement with little or no access to social services and infrastructure this core slum area in the past where relatively very attractive and enjoyable but now this locality become shanty and they are symbol of chronic poverty drug addiction and prostitution areas as result to day many of the people of this area start to migrate to the near by suburb.

And to evaluate the exclaved 1984 urban development area of Bahir Dar directly the 2005 satellite image is used as an input data set and this are indicated below as figure 23.

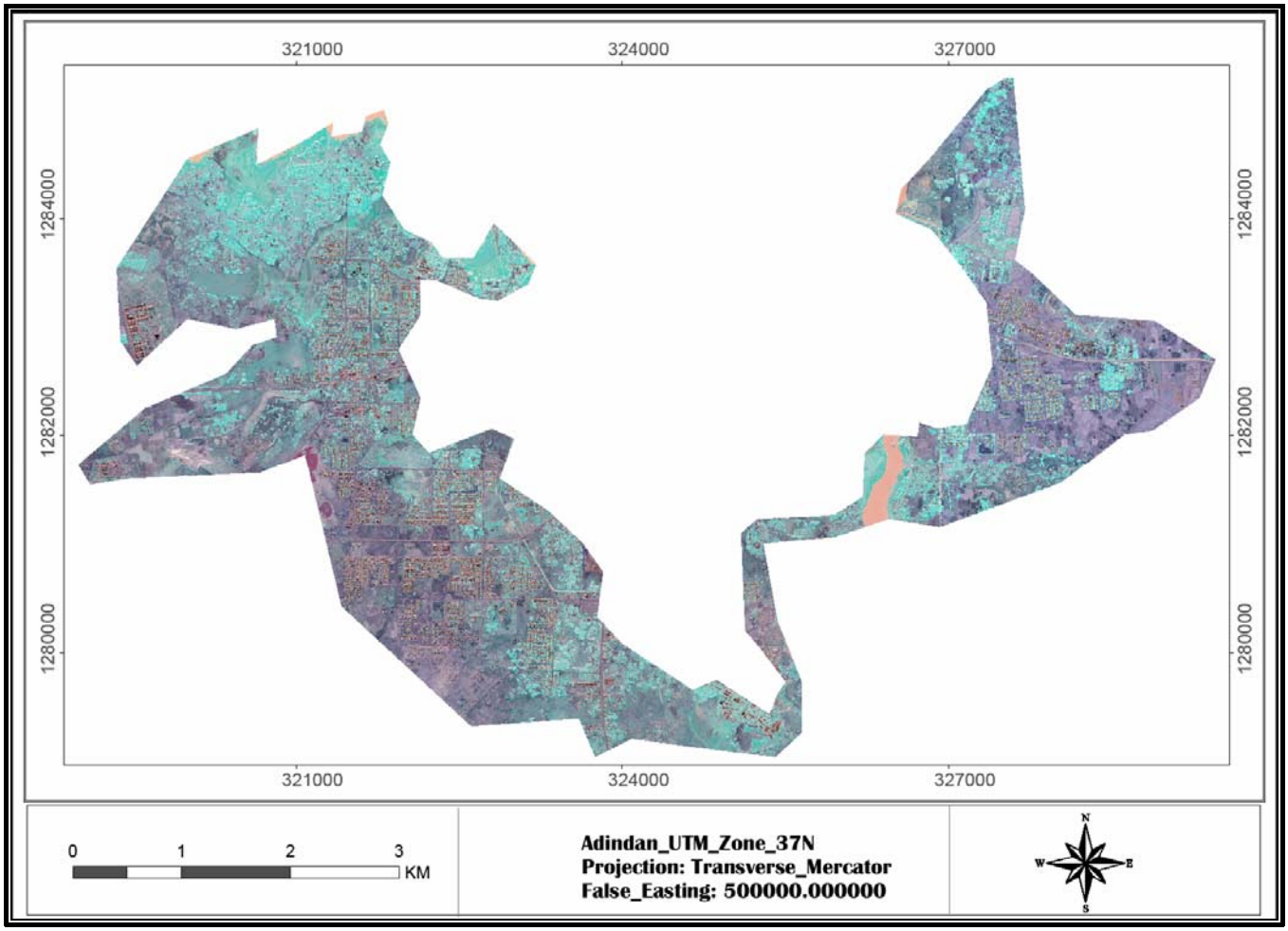


Figure 4 .23 Satellite image of the recent development area of Bahir Dar

To weight the density and the rate at which built up develops in the recent urban area of Bahir Dar the above raster images is digitized in ARC GIS environment and it was found that from 1984 to 2005, 364 new hectare land is used for built up and annually 17.33 hectare land is added for built up .The built up map of the new development area of 2005 are shown below.

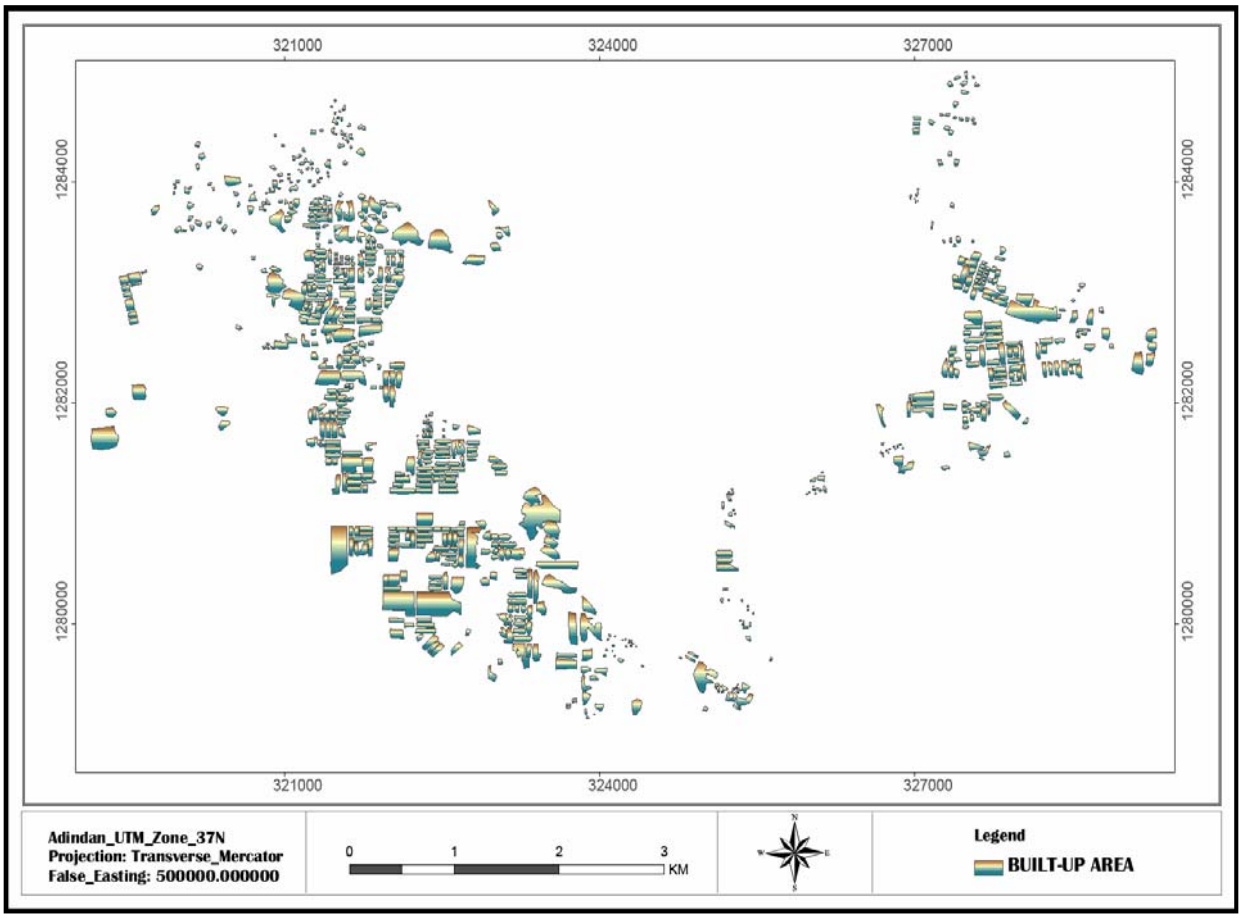


Figure 4.24 The digitized built up map of the recent development areas in 2005.

4.4.1 The Growth of Road Transport Network in the Recent Urban Area

Different research on transport network indicates the existence of strong relation ship between low density and increased transportation cost. Less compact development generate more vehicle miles traveled than more compact development. In the recent urban areas a significant road network growth is observed from 1984 to 2005 alone a total of 81.16 Km road network is added and figure 25 shows the road map of recent development.

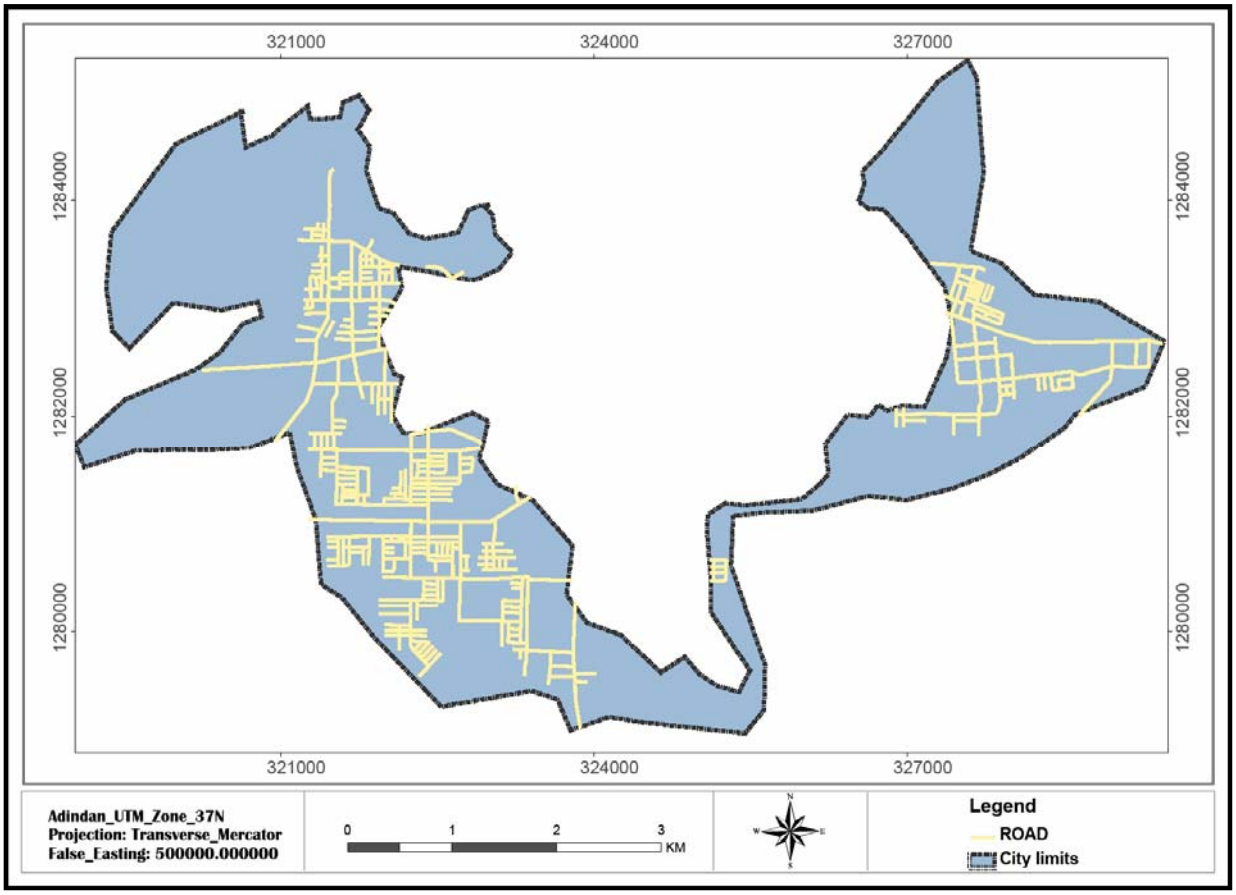


Figure 4.25 The road map of recent development areas of Bahir Dar.

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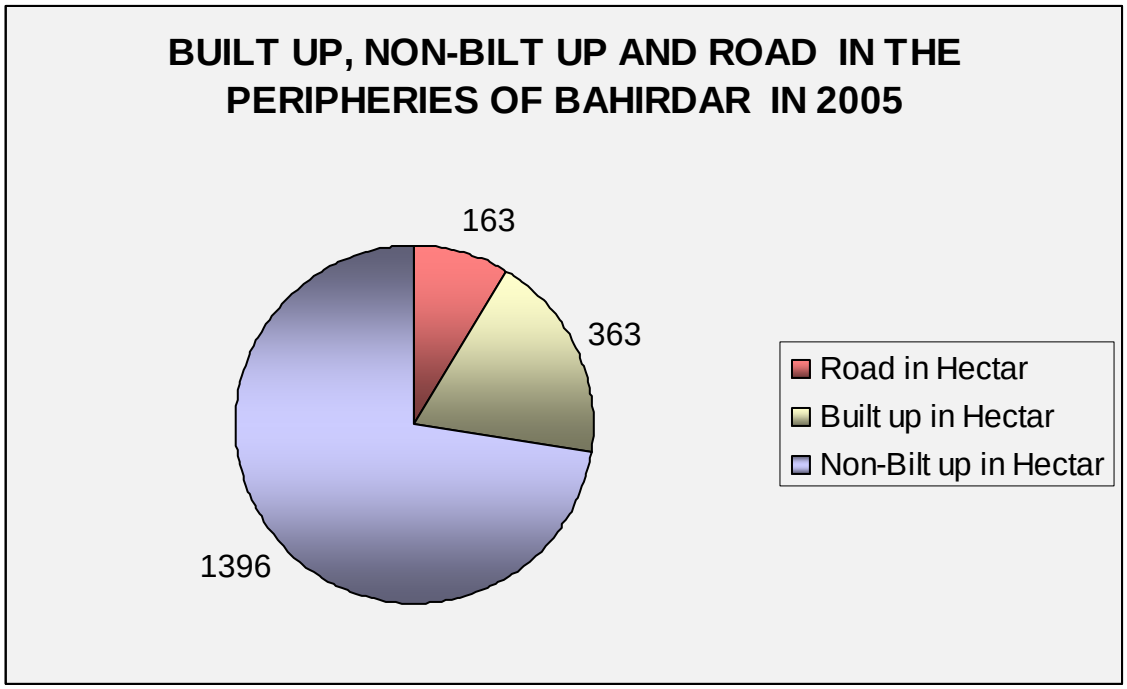

Figure 4.26 The status of land utilization in the recent urban areas.

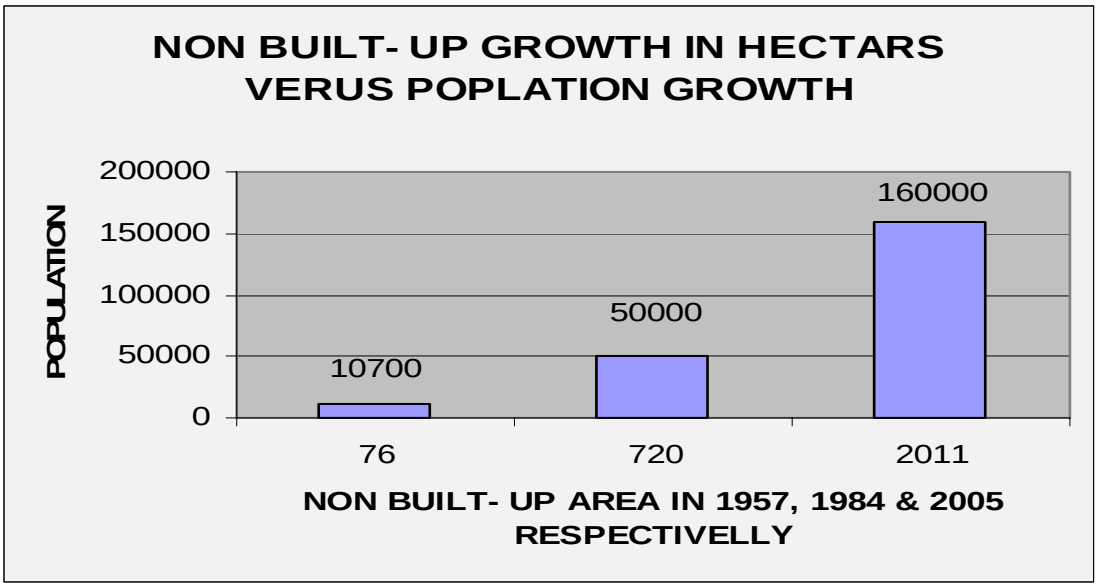

Figure 4. 27 None built up growth versus population growth

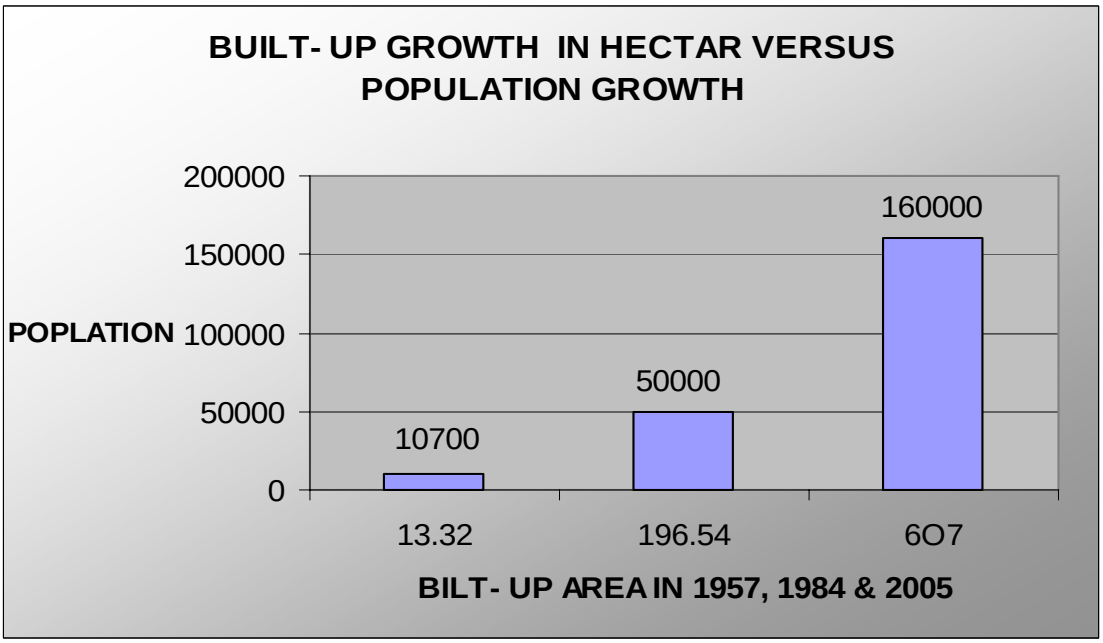

Figure 4.28 Built up growth versus population growth

4.5 The External Growth Bahir Dar in Different Time Scale

Although the concentration of retail, entertainment and business services as a focal point and gathering places for a wider community creates a workable setting and lively streetscape and have a high degree of integrate information. The trained of the out ward growth in Bahir Dar is completely different and findings in this research shows that

- From 1957 to 1984 Bahir Dar experienced a 1000% growth in its urban land size compared with the 1957 habitable areas.
- From 1984 to 2005 the urban land is increased r by 300% from the 1984 physical size.

Fig 29 below shows the change of the city limit from 1957 to 2005

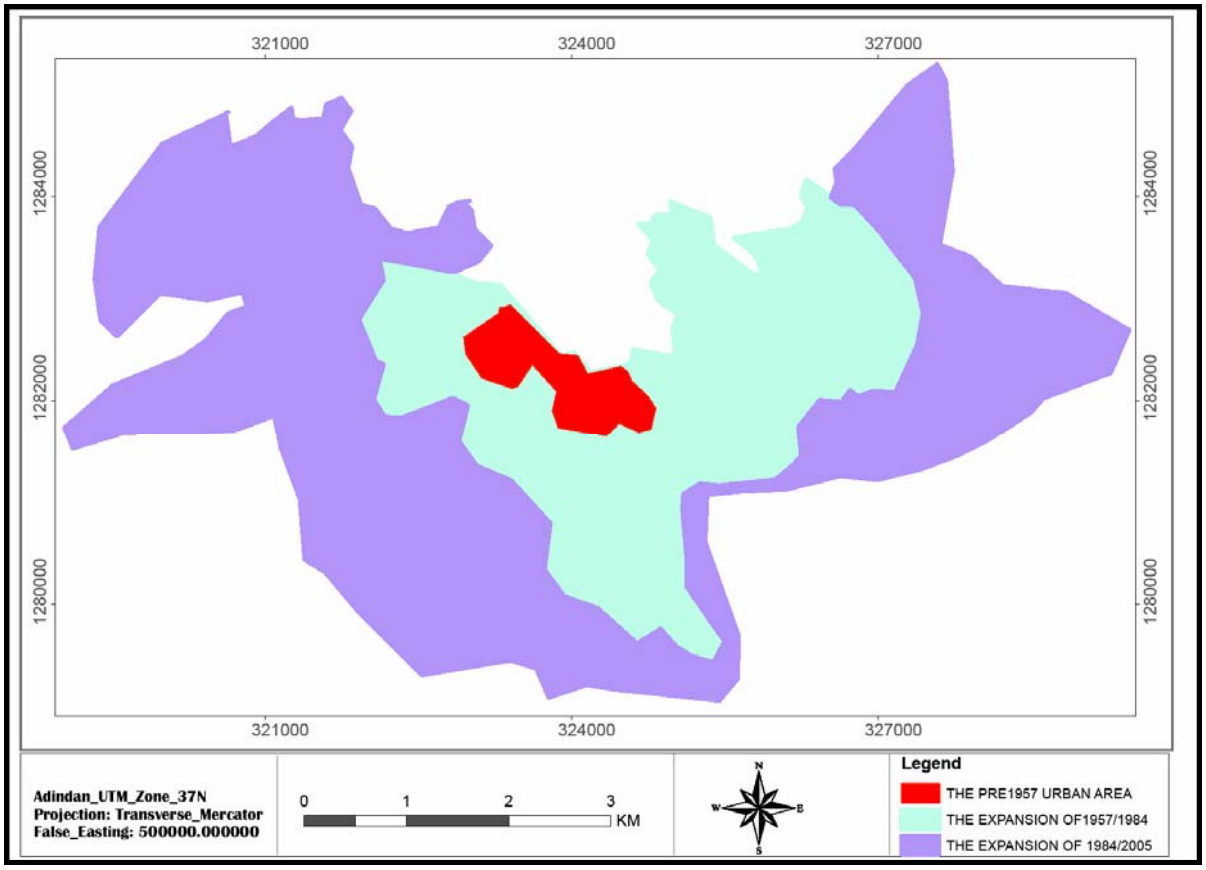

Figure 29 The change of the city limit from 1957 to 2005

4.6 The development Access and Direction of the Recent Urban Growth Areas

Through filtering and sharpening of the edge of physical boundaries of the city from aerial photographs and satellite images a lined measurement was taken using ERDAS soft wear tools and the result shows that in the western direction of Bahir Dar from 1984 to 2005 the city physical limit is extended to 3.1422 km which is the highest and this growth can be associated with the establishment of the new Bahir Dar airport and construction of various office buildings along this direction and the second development axis of the city is in the

eastern direction in which a 2.07 km expansion is observed. The major factor to this growth is the presence of monotones plainly land crossing beyond the Abay River which is relatively suitable for residential construction, the third growth direction is the southern extreme city limit and the difference between 1984 and 2005 physical boundary limit is about 0.37 1k m and this figure is relatively very small and the final growth direction is in north of the city where there is no growth because of Lake Tana become an obstacle to further growth.

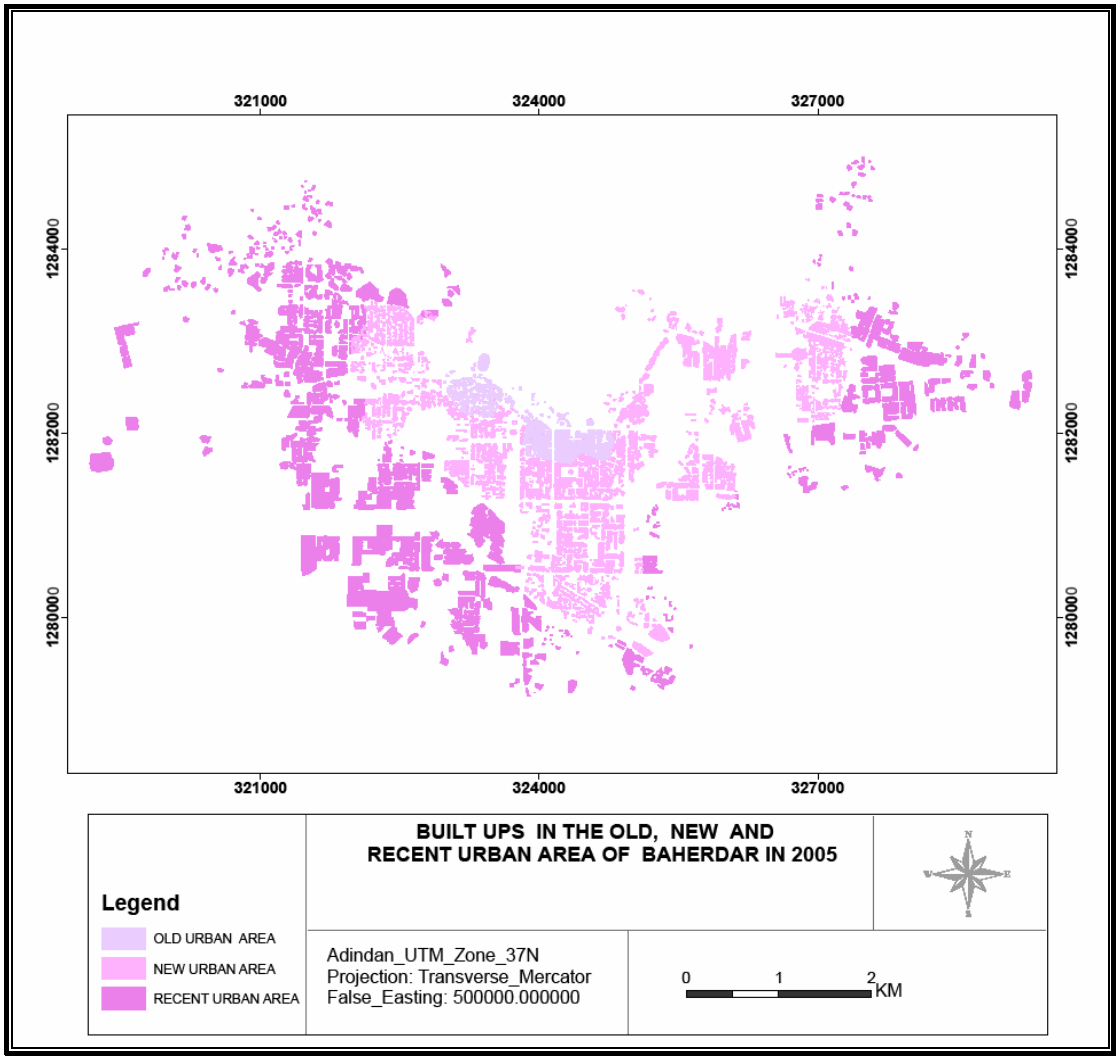

Figure 30 Built up growth direction

CHAPTER FIVE

5 SUITABILITY ANALYSIS FOR SELECTING POTENTIAL SITE OF HIGH-RISING BUILDINGS

5.1 Synoptic of the Chapter

A geo-spatial evaluation for urban land use planning often requires a large amount of information. GIS (geographic information systems) are capable of managing large amount of spatially related information, providing the ability to integrate multiple layer of information and to drive additional information A GIS evaluation for urban land use planning is illustrated for selecting potential site of a high-rising building in the study area and this evaluation incorporates factor such as topography (slope), flood hazards, accessibility, urban service intensity (density) and soil condition. A multi-criterion
Analysis is also performed to evaluate developable land, a suitability of the geo-urban environment for each category, accordingly to measured and weighted factors is developed.

5.2 GIS Based Site Suitability Analysis

The selection of suitable sites is based up on a specific site of local critics. The characteristic of a site (e.g. present land use, slop, water availability, distance to employment, development cost, geology, geomorphology, etc) to assess the overall sustainability a scoring and weighting system is applied to the various aspect of suitability.

Site suitability is the process of understanding existing site qualities and factors which will determine the location of particular activity. The purpose of selecting potential areas for high-rising construction depends up on the relationship of different biophysical & socioeconomic factors like slope, soil; accessibility etc .the analysis may also determine how those factors will fit into the design process to evaluate site suitability (Hofstee and Brusel, 1995).

For any suitability analysis appropriate base data is required (generally the input date set can be satellite date, air photo, topographic maps and different thematic map and filed data)

5.3 Selection of Different Parameter for Suitability:

The following parameters have been considered for the suitability model.

- Flood hazard
- Soil
- road accessibility
- Slope
- Urban service density (infrastructure density)

5.3.1 Food Hazard

The Major River (Abay and Lake Tana banks) including intermittent stream have been digitized from the topographical maps to delineate flood hazard prone areas, various buffer zones have been created by taking different distance values from the river and stream banks as shown in figure 5.1 and figure 5.2

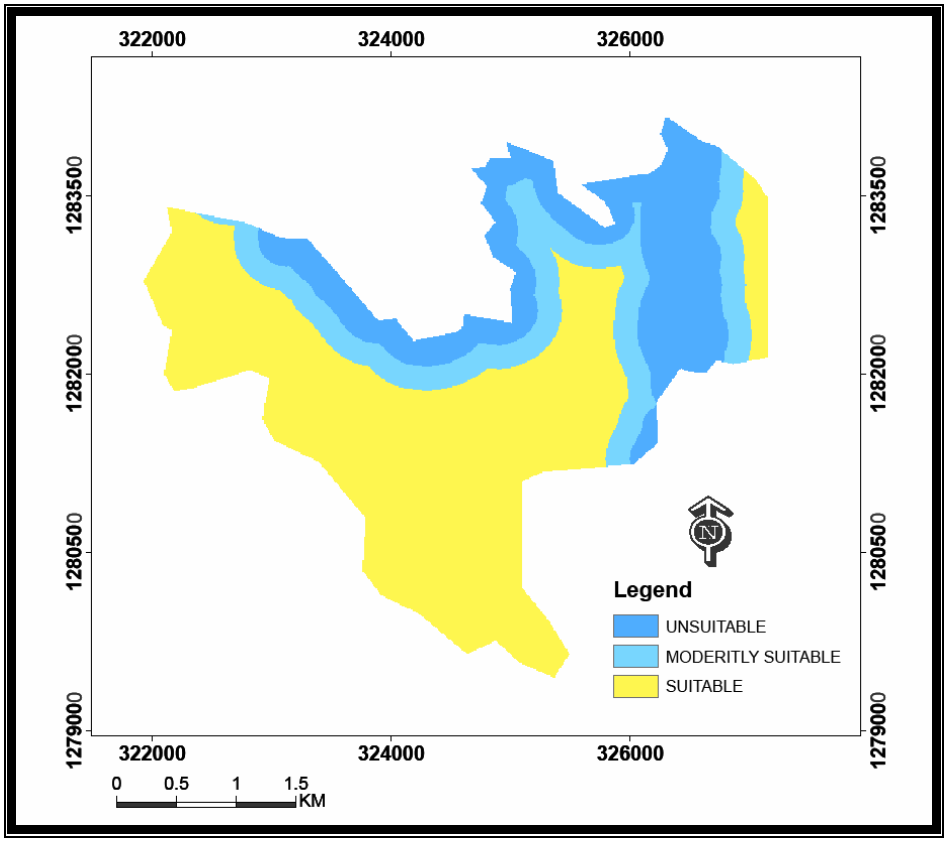

Figure 5.1 The Reclassified River and Lake Area map

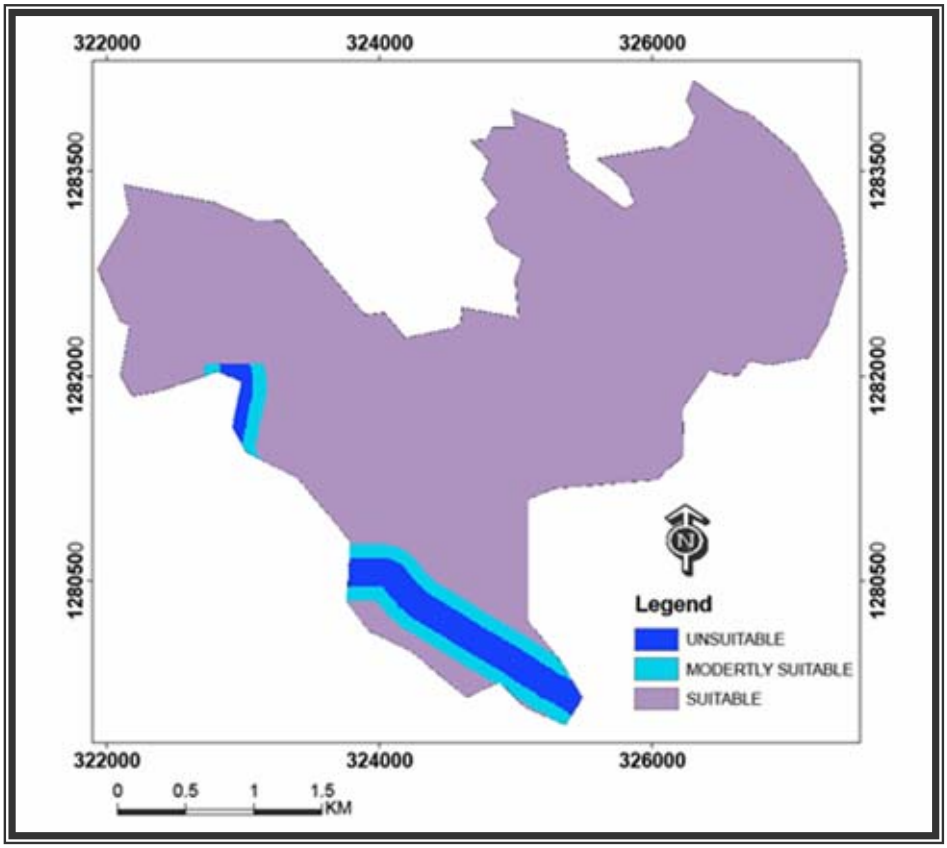

Figure 5.2 The reclassified Stream area map

5.3.2 Road Accessibility

In this study, in order to find out the accessibility of the central Bahirdar, major roads which are connecting to different areas have been digitized from the 2005 Quick bird satellite image. And the Euclidian distance from both side of the road edge is generated this way, the Euclidian distance have been reclassified Fig 5.2 shows the reclassified Euclidian distance for the road accessibility

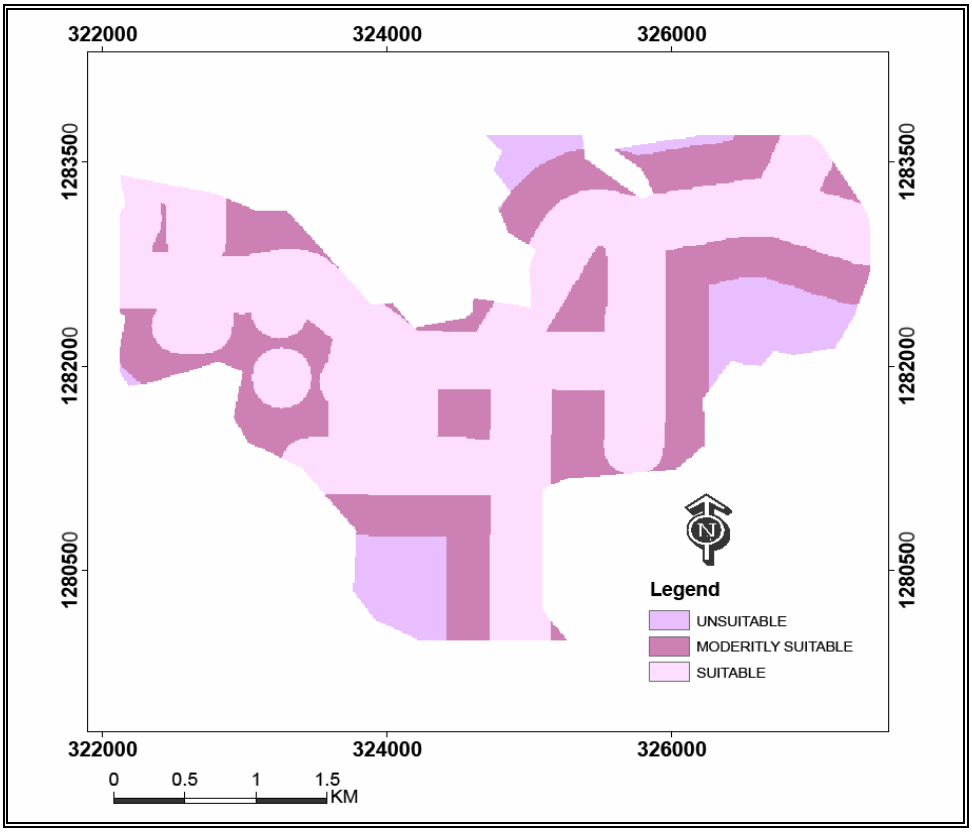

Figure 5.3 The reclassified road map

5.3.3 Slope

When considering land for future development the suitability depends on the slope of topography to great extent. Slope is a significant factor it has economic implication during the establishment of any urban infrastructure usually a gentler grounds is preferable than to the steeper surface. In the study area in order to determine the appropriate slope the UN classification is directly used and to generate the slope map a SRTM is used as an input data set. The reclassified slope is shown in Figure 5.3.

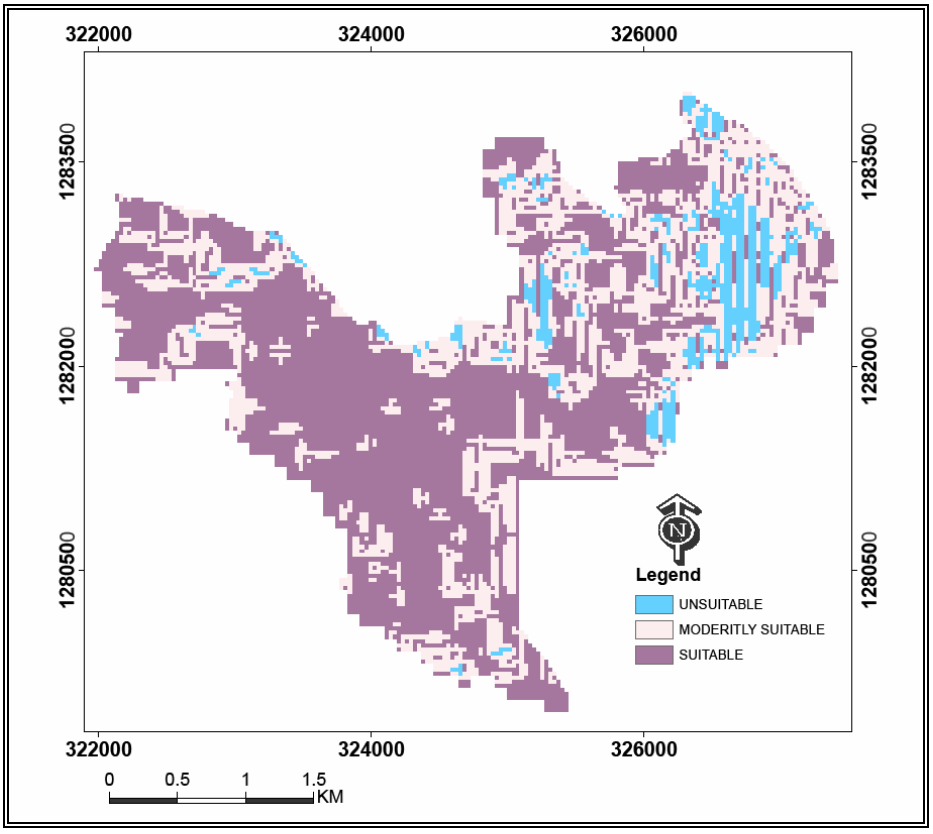

Figure 5.4 The reclassified slope map

5.3.4 Soil

For building constriction in Ethiopia context a black cotton soils is not preferable because of its expansive nature and removing this soil requires unnecessary cost on the construction of buildings. On the other hand areas with red soil type is given priority for any construction sites. For the study area to asses the soil condition a soil map is obtained from the Amhara regional investment office. And using this base map reclassified soil layer is produced. (See in figure 5.4)

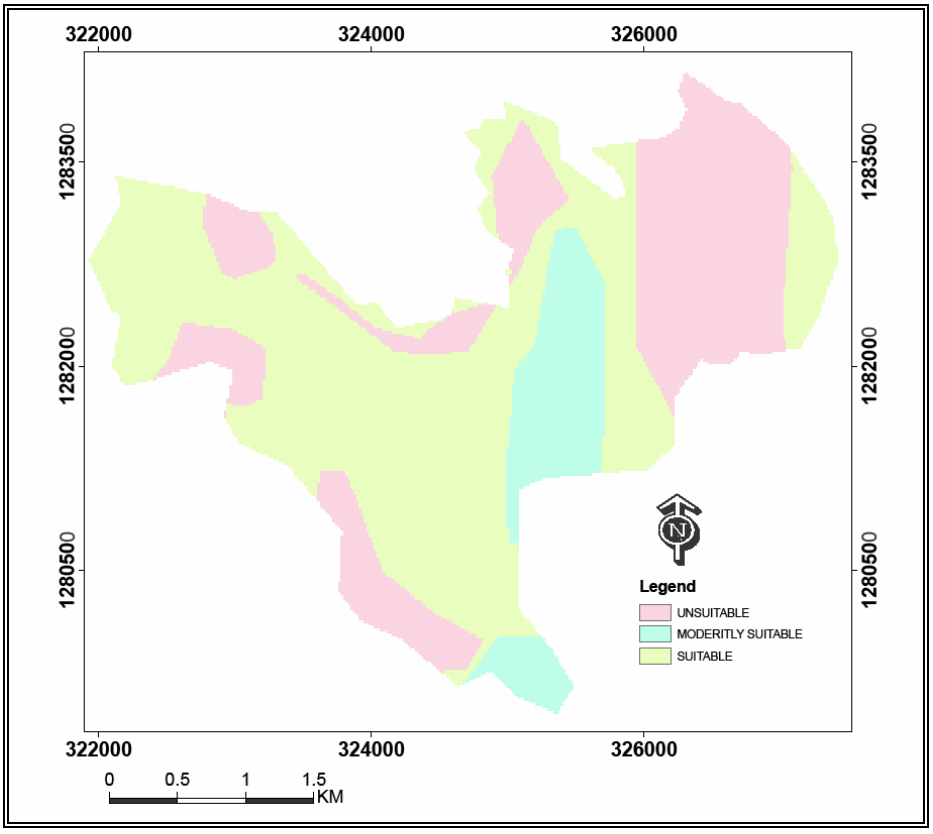

Figure 5.5 The reclassified soil map

5.3.5 Urban Service Density

One has to consider somehow fully functional infrastructure existence whenever new building were taken into service and basically the owner of the high rising complex should not beer a direct responsibility for providing the large majority of this services. In the study area for evaluating the infrastructural density, data on major utility centers are collected on hand held GPS and a point densification map is produced in the arc GIS environment. Fig 5.5 show the reclassified urban serves

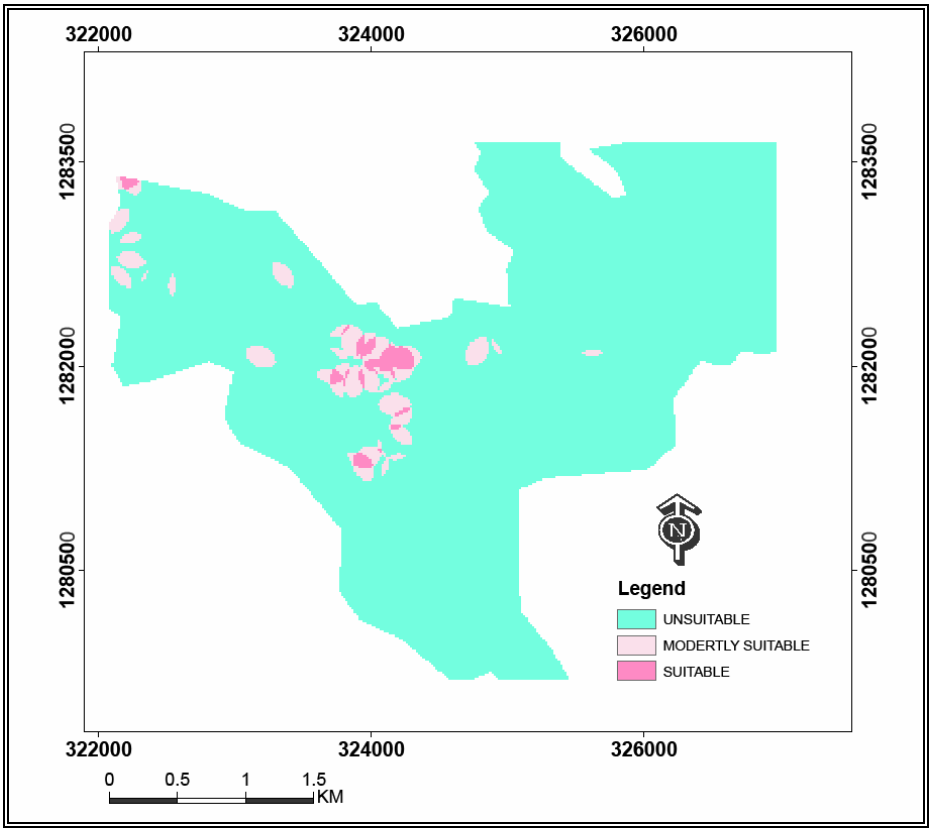

Figure 5.6 The reclassified infrastructural map

5.4 Techniques Employed for Assigning Weight

To define the suitability of an area for constructing of high rising building several criteria need to be considered for this purpose in this paper a multi –criteria evaluation (MCE) method within a geographic information system (GIS) is employed. MCE is the most frequently used when a set of alternatives need to be evaluated on bases of conflicting and in commensurate criteria (Malczewski, 1999) this modeling approach utilizing experts to identify important factor and calculate weights for them through AHP.

AHP (the Analytical Hierarchy Process) enable us to make effective decision on complex issues by simplifying and expanding our natural decision making process. Basically AHP

is a method or breaking down a complex unstructured situation in to its component parts and arranging these parts in to hierarchical order.

In the AHP weights are calculated by taking the principal Eigen vector of squire reciprocal matrix of pair wise comparison between all possible pair of criteria are compared on a nine point continues scale for relative importance in determining the suitability of stated objectives.

In this thesis based on the above specified techniques the criteria weight for the five parameters are determine using IDRISI 32 software. And the following fig shows pair wise comparison matrix and the weights calculated by IDRISI software.

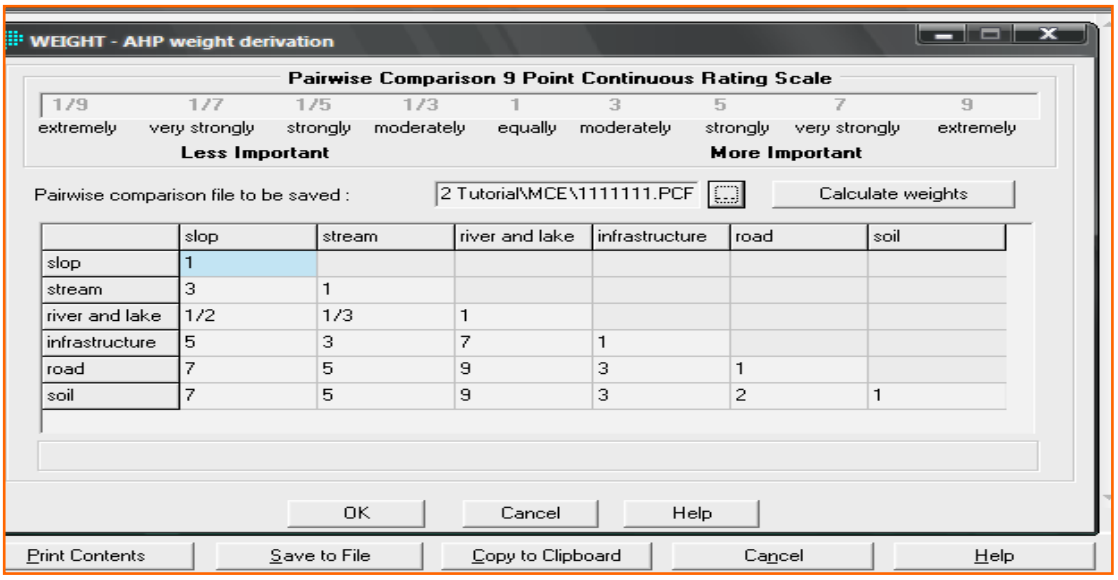

Figure 5.7 Analytical Hierarchal Process weight derivations

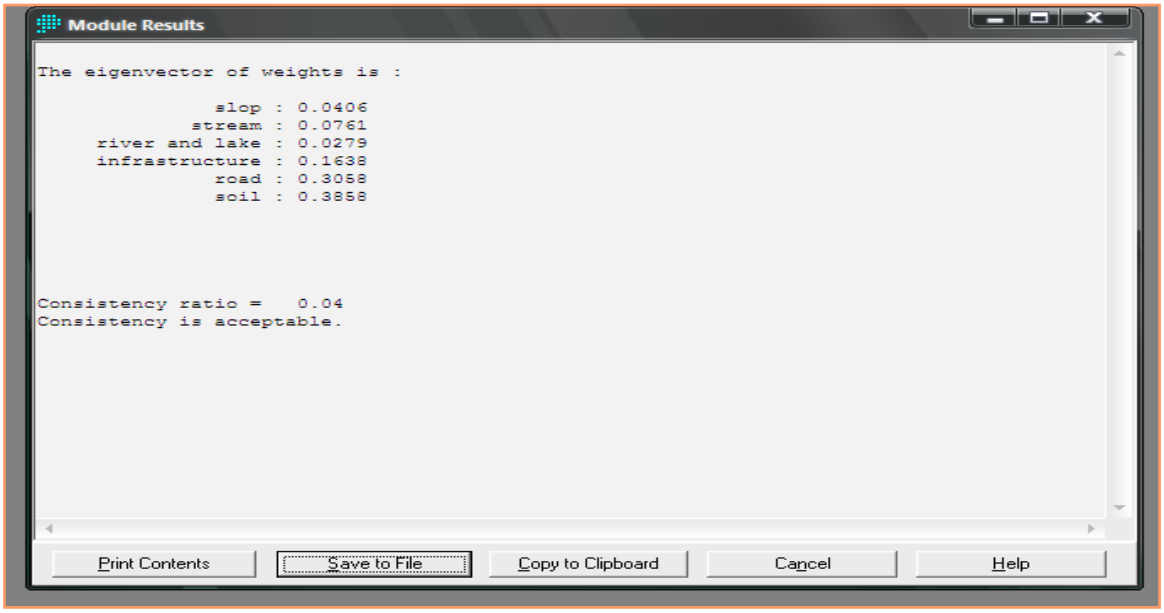

Figure 5.8 The eigenvector Weighted value

5.5 Weighted Over Lay Analysis

For identifying potentially suitable site for high rising buildings overlay analysis has been conducted using model builder. And the figure below shows models and the final suitability map.

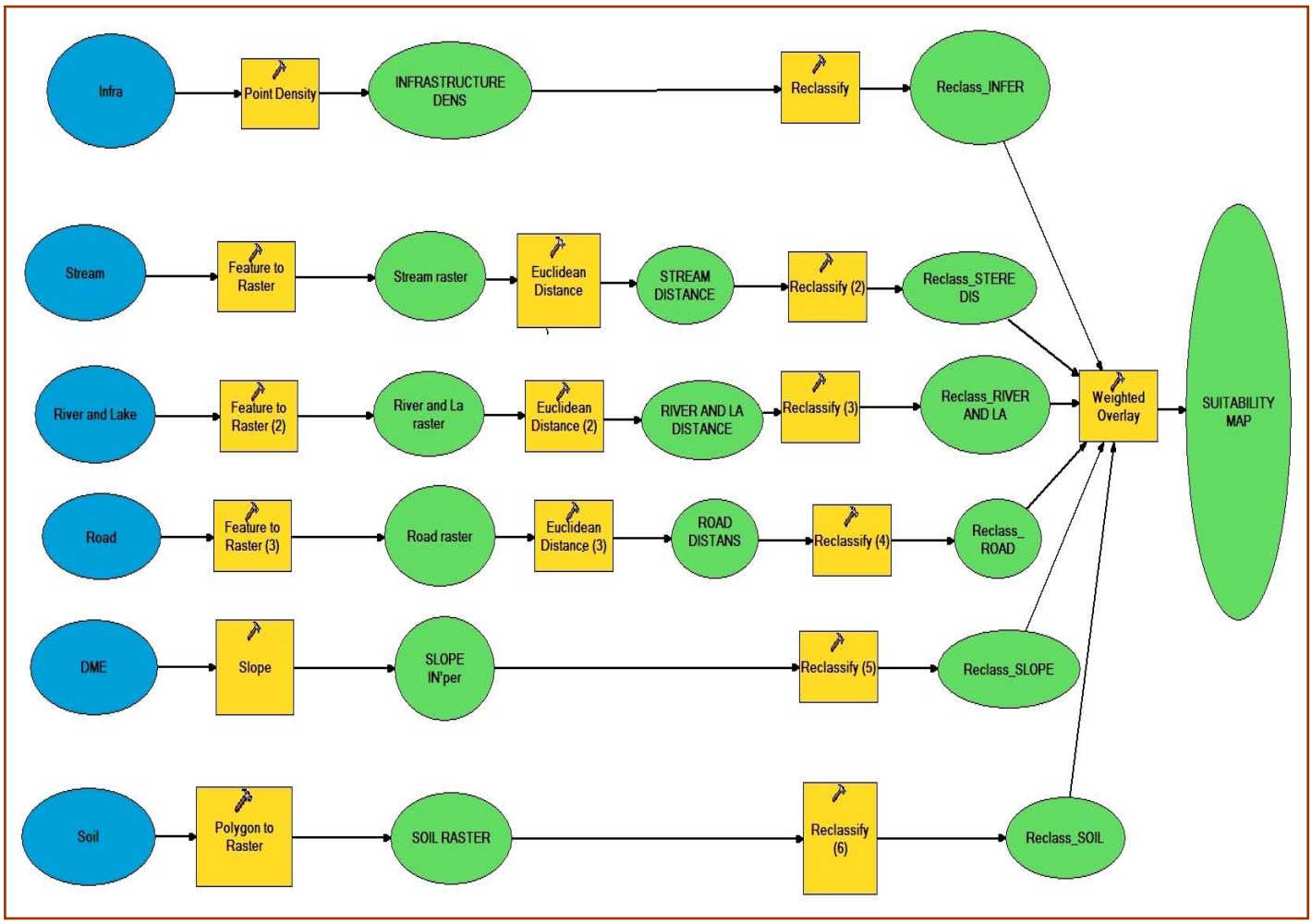

Figure 5.9 Model builders for suitability Analysis

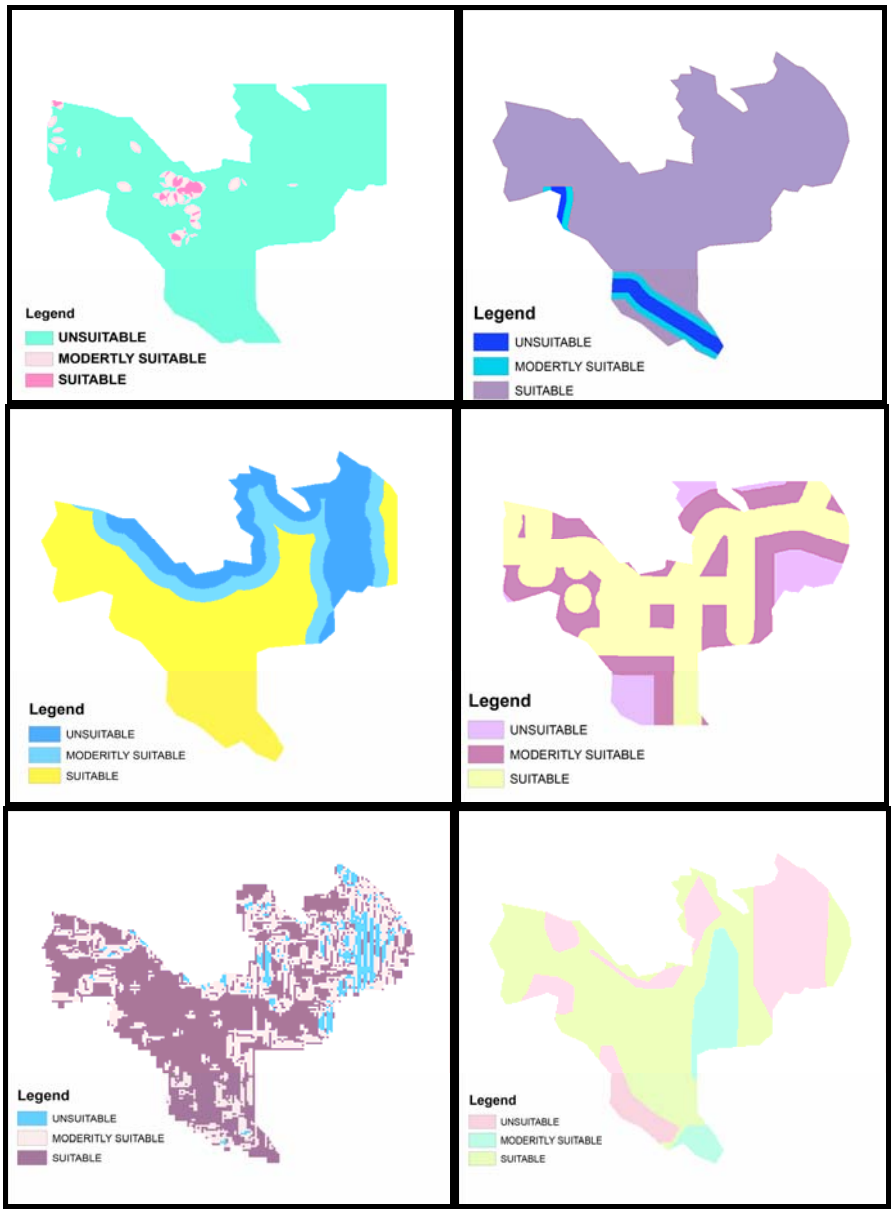

Figure 5.10 Input maps for Weighted Over lay analysis

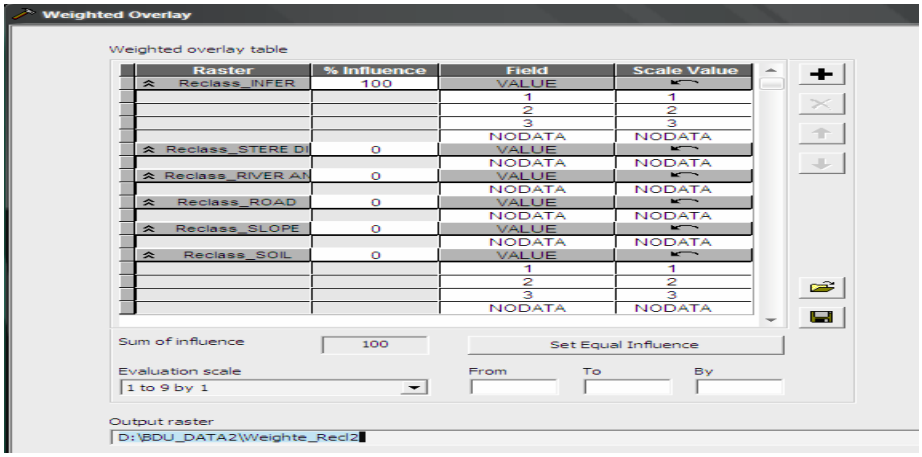

Figure 5.11 The Weighted overlay table

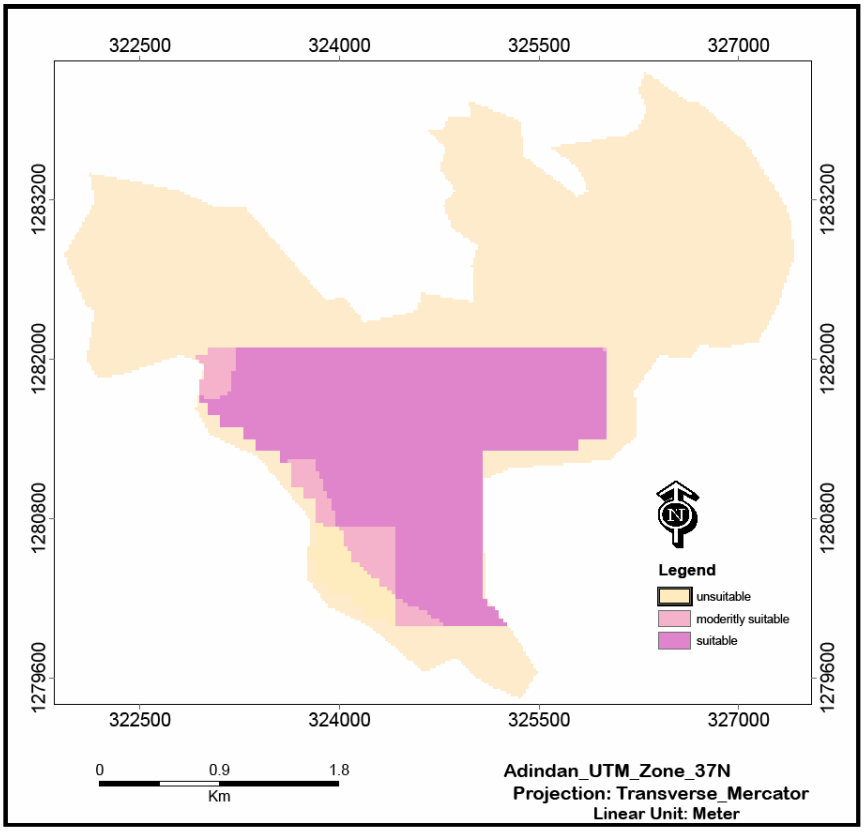

Figure 5.12 the final suitability map.

5.6 Empirical Evaluation of the Suitable Site

Hence the spread of urban areas in a horizontal direction has resulted in the loss of natural forests, the depletion of open grazing lands, and the destruction of agricultural crop fields and a general decline in the spatial extent and connectivity of weight lands and wild life. And in order to overcome all these critical problems identifying potently suitable sites for vertical growth will have paramount importance. Bearing this in mind a suitability map for high rising buildings in central Bahir Dar using ARC GIS model builder is developed and the out put is also assessed visually using the detailed local tourist map and according to this map the selected site at the present moment consists of the largest market areas, the main bus terminals, several pharmacies, educational centers, and commercials banks and many of those luxurious hotels beside all this man made developmental elements ,the areas relative nearness to the lake will be an advantage in regulating the micro tropical climate.

CHAPTER SIX

6. Conclusion and Recommendation

6.1 Conclusion

In resent years cities allover the world have experienced rapid growth because of the rapid increase in world population and irreversible flow of people from rural to urban areas specifically in large African town and cities the rate of population has been constant and now a days many of them are facing unplanned and uncontrolled settlement at densely populated cities and fringes.

To prevent unnecessary horizontal growth urban planner need every detail analysis that are useful in solving urban developmental problems. In this regard the majority of previously sited works on the review of literature are in fever of efficient inner urban geo space, for instance the so-called smart growth which is emerged in 1990s as urban planning concept are fully supporting of taking an advantage of compact building design in central areas to preserve environmental amenities. In similar manner the compact city concept which is also originated as response to the occurrence of urban sprawl are the main advocators of high densities intensification through revitalization and regeneration of inner urban areas (Burton, 2001 and Jenks and Gerhardt, 2000).

Bhair Dar like many of African cities has circumscribed problems and characterized with inefficient utilization of inner urban geo space and unplanned and uncontrolled settlements in urban–rural in fringes. This study tries to evaluate the inner urban space utilization and the external growth of Bahir Dar in different time scale using multi temporal data in remote sensing technique using the aerial photographs of 1957– 1984 and quick bird satellite image of 2005 the internal growth of Bahir Dar both the 1957 development area and the newly added urban area of 1957– 1984 are assessed.

The total area of the city in 1957 is calculated as 99.44 hectares of this only 13 hectare land is used for built up areas and the rest 10.3 and 76 hectare of land respectively used for road space and none built up areas. The same area (the 1957 development area) is subsisted in 1984 aerial photograph and the area used for built up increases to 30.19 hectares, the road space increases to 10.5 hectares while the none built up area decreases to 58 hectares.

Again in 2005 quick bird image the same old urban area (the 1957 development area) is extracted and the area used for built up shows a positive change and reached to 33.69 hectares, the road space increase to 10.5 hectares while none built up area coverage reduced to 53 hectare.

The above calculated out put implies in the old urban Bahir Dar for the last 50 years more than half of the inner urban space remained unused for any kind of urban development. Between the 1957 -1984 expansion areas dramatic changes observed and the built up area increases from 166 hectare to 210 hectare while the road space increases from 88 hectare to 153 hectare. Surprisingly in this expansion areas for the last twenty one years again total of 562 hectare land of none built up areas still exists. In the 1984-2005 expansion areas additional 363.92 hectare land is used for built ups and 44 hectares land is used for road networks.

In terms of spatial extent change Bahir Dar shows a sizable growth during the period of 1957 to 1984 the city experienced more than ten times to its aerial extent of 1957(the total urban land increases from 99 hectare to 1080) .in its second growth cycle from 1984 to 2005 the city again expanded three times from its aerial size of 1984 (the total urban land increased from 1080 hectare to 3022).

Progressively all the above quantitative urban data in different time scale shows the existence of significant external growth in the city of Bahir Dar even if this horizontal growth can result

- Grater capital costs associated with building of new pubic infrastructure
- Grater vehicle miles traveled and consequently higher level of automobile emission.
- Higher rate of conversion of urban land within the fragile environment.

And to solve the impact of horizontal growth from sustainable development perspective this paper attempts to identify the potential vertical development sites with the central Bahir Dar using GIS suitability model, considering soil, slop, major urban infra structure density transport accessibility and flood hazard parameters this suitability results can also

be used to help regional physical planner make better, more informed decision, thus providing more healthy quality of life for the urban settlers.

6.2 Recommendations

Based on the above findings the following provisional recommendations are given

- Filling the existing inner developable urban geo space should be a primary task to the Amhara regional land administration office in order to minimize problems associated with external growth.
- Since transport is a prerequisite for development the coverage of road space both in the old and new central areas should be upgrade in terms of quality and quantity.
- Different efforts have to be exerted to curb population growth rate, which challenges the public service delivery capacity of the city administration.
- Regulation should be clearly stated on land and land related issues around the periphery and in the near by rural area of Bahir Dar.
- Hence urban land is a critical resource an efficient micro and macro land evaluation using multi temporal data through GIS and RS techniques should be conducted on continues base for having an appropriate human imprint on the urban areas.
- Creating a system that performs urban data capturing and handling in a digital format has to be practiced as soon as possible.

6.3 References

APA, A. P.A, 1999. Principles of Smart Growth American Planning Association Press, Chicago.

Bedcock, 2002. Modeling the post-industrial city. Futures 29 (4-5): 313-322

BMSA, 2001 . Unpublished Report.

BUDD, Leslie, 2005. The compact city and social Justice of York . UK.

Burton, E, 2002. Measuring urban Compactness in UK towns and cities. Environment and planning B: Planning and Design, 29 (2): 219-250.

Central Statistical Authority (CSA), 2004. Annual stastical Abstract, Addis Ababa, Ethiopia.

Gottdiener , M. and G. Kephart, 2005. The multinucleated Metropolitan region , Berkeley, University of California.

Hofstee, P and Mr. Brussel,1995. Analysis of suitability for urban Expansion. http.//www.itc.in/ilws.

Henok (2005) Unpublished Report. Harts, Truman, A 1980. The death and life of great city. Black well.

Kevel, D, (1993) .space use optimization journal of environmental management (73-(2):83

Le Gates R and F stout ,2003. The city Reader, 3rd Edition, Rout ledge, UK

Malczewsk, 1999. GIS multi criteria Decision Analysis, New York: John Wiley and sons.

Malczewsk, 2005. GIS based multi criteria decision analysis. A survey of the literature Int. J.Geog. Inform. Sci 20:703-726.

Parr, J.B 1973. Growth poles, Regional Development central place Theory's papers in Regional Science. New York; USA

Richardson, H 1978. Regional and urban Economics, Harsmod work, Penguin.

Rodenburg, CA and Nijramp. P. 2004. Multifunctional land use in city. A Topological over view, Built Environment.

Senks, M and Gerhardt, W, 2000. Urban intensification. The potential of decision support for assessing brown field sites, urban Design international, Northern California, USA.

Talen, E., 2005 .conclusion: The Survival of New urbanization, New urbanism and American planning: The conflict of cultures Routledge, New York.

Traver, James (D) Editor 1984 urbanization in Africa hand book.

Verkeeker, R. 2004. Urban multifunctional land use and Externalities, ERSA Conference. ERSA conference papers, Vienna, Austria.

UNCHS (Habitat) 1996. An urbanizing world: Global Report on Human settlements Oxford University press.

United Nation University Press (1997). The urban challenges in Africa. Growth and management of its large cities

www.un.org/pubs/chronick/2005/ p26.html.

6.4 APPENDIX

Spatial development framework proposed for the city of Bahir Dar by FUPI in 2005

The spatial development framework proposed for the city Bahir Dar defines four major development directions for the coming 10 planning years. These are the three major expansion directions that follow the three major out lets (to *Gonder, Mota, Debre Markos and adjoining area*),and the inner city redevelopment areas. The latter development direction includes in its list the following plans, projects and programs that are partially in action at present such as :-The Action Plan for Lake Shore Development;-The Upgrading projects for *kebeles* 04, 05, 06 and Detail plans and designs for the market area, stadium, and the Martyrdom Monument. The spatial development framework incorporates these action area plans as strategic components since they are prepared based on detail information of their corresponding localities. However the large land holdings that are observed in the city land use; like the plots under the holdings of the radio station in the west, the pot under the a agriculture and rural development office, and the plot under the edible oil factory in the south etc, should be restructured in such away that they could improve, the road pattern, bring efficient land use and even distribution of functions.

Proposals of the previous master plan that could not realize due to different reasons but it is found to be in line with the new spatial development framework are maintained in their previous position while others are reconsidered in view of the role assigned to the location in the new city structure. The existing situation analysis shows that an immense achievement has been registered in reducing the city fragmentation since the implementation of the previous master plan. Hence, this planning issue remains as one of the major concern in the future spatial planning o f the city. The three expansion directions designated b y the spatial development framework is also chosen to further achieve similar results in the future city structure. The emerging active nodes and corridors together with the proposed ones are also expected to play similar role in the city structure while implementing the plan.

I) Residential Area

The situation analysis conducted on the Bahir Dar city has revealed housing as a number one priority issue. Following this BDIDP has formulated different strategies among which the provision appropriate serviced land for housing construction is found to be critical. The Bahir Dar city spatial development framework envisages accommodating all forecasted spatial developments labeled under different categories. All spatial related Forecasting is based up on the population projection, which is the basis to commensurate, all other spatial consumptions during the future planning period of BDIDP. A total area of 1381 ha is allocated for this function. The amount of land allocated is much lager than the exact area that has been required for the purpose, which are about 700 ha. However, the uncertainty we have encountered while selecting suitable land for housing development that has happened due to the marshy and gully nature of the expansion areas, and absence of basic infrastructures together with the distant location of the expansion areas from the existing centre may be minimized through more choices for site selection. The social services that are to develop by the private sector will also take their share out of this area allocated for residential use. (However, it is important to note that as the private social service development depends on the market situation their exact number and location is better addressed by the detail planning at local level).In addition to this the growing interest of Amhara nationals living abroad and elsewhere in the country, to own Residential houses in their national capital have been considered as forth -coming development opportunity. Nevertheless the figure is still exaggerated as numbers of plots that are not included in the existing land use inventory have been delivered to developers while this plan was in the process of preparation. This amount of land is believed to be enough to fulfill the space requirement for residential use in the coming planning years.

ii) Administration

Areas for administration function are reserved in different parts of the city in accordance with their fair distribution in the future city structure. The area reserved for this function is about 81 .4 ha which accounts some 1% of the total built up area. This area includes the existing as well as proposed areas for administration purpose .As the existing prison is located along the Lake Tana shoreline that has been subjected to redevelopment as per the action plan, a new site in the western city edge is proposed for its future relocation. This part of the city is mainly assigned for recreation and agriculture use as other types of functions requiring intensive physical developments in the area are discouraged due to the location of the Bahir Dar international air port in such direction. The newly assigned area for the prison is believed to provide ample space for rehabilitation and correction works.

Its location is believed to be also at a reasonable distance from its pertinent institutions, and well connected to the city with a principal arterial road. The marginal location where the plot for the prison is found is compatible to the character of its function.

iii) Commerce and Trade

The emerging active nodes and the corridors connecting them are further to strengthen their mixed land use character. In addition to the city centre that is active business area the spatial development framework envisages other active nodes to emerge in the expansion areas of the proposed city structure. The location of business in the city structure is supposed to concentrate along and around the junctions of higher hierarchy roads. A total area of 369 ha area is proposed for commerce and trade. But this function can be developed 400 in the areas assigned for residential if the nature of the business identified compatible with the surrounding areas/ environs. Market areas are located at the south west and east of the city in view of the proposed city structure and the distance from the existing city centre. In connection with this, the future active nodes are supposed to emerge around these market places. These market areas may be open before they are eventually covered and used in mixed manner like the one found in the city centre. Two cattle markets are also proposed in the east and south to be operational when the need for relocating the existing one becomes practical. By then the existing cattle market can be used for a city centre function to attract investment.

v) Services The proposed land use plan specifically locates public social services that have to be developed during the planning period of the BDIDP. However, it is also known that the country's social service development policy leaves more space for the private sector. The recent past trend in our cities is a clear demonstration of this fact. However the

Private sector acts on market principles. Therefore the residential area is planned with a contingency so as to accommodate these services on demand basis while detail planning for land supply is made in the future.

Education

Based up on the population projection for the 10 years planning period the area requirement of different services has-been identified. Hence, 10 plots for elementary schools, 6 plots for secondary schools, and a plot for a research institution (on the Nile and its ecology) have been allocated along the riverbank within the city structure. In general, distribution of services in the future land use pattern harmonizes the existing structure with the proposed one.

Health

The future land use proposal of BDIDP reserves plots for one hospital (in the eastern part along the Nile River) and three heath centre s (in the expansion areas). Areas for health are to be attached with *kebele* centers during detail plan preparations. However private health institutions are not specifically allocated on the land use plan as the appearance of these urban functions depends on the market. In the same manner, as the city land budget is allocated with contingency the land administrating body can respond on demand basis for this purpose as well. Plot supply for the function occurs to be preceded by detail planning of the pertinent body.

401

vi) Culture

The situation assessment on the existing worship areas shows the presence of a number of worship places that are fairly distributed in the city structure. Further allocation of plots for this function is to be in compliance with the region's policy on demand basis.

Cemeteries

Additional burial places are proposed on the future land use plan so as to bring a fair distribution of the function on the city structure. They are located at the eastern and western margins of the city structure. Sub divisions among the different religious groups could be executed by the plan implementing body based on the policies and standards in action. The allocation of these sites for cemeteries is also believed to help resolving possible conflicts that may happen while developing the *Dibanqe* hill and its surroundings for other reasonable activities. The existing Muslim cemetery that has been found in the east should be abandoned as its use is growing incompatible with the surrounding activities. However, transforming its land use in to other Muslim functions like *Medeesa* should be encouraged.

vii) Manufacturing and Storage

Taking into account the role of the city in the region and the envisaged fast development in such sectors, 339 ha is proposed for manufacturing and storage functions in all the three development directions of the city. Interventions in the central part of the city resulting in ousting incompatible manufacturing and storages are supposed to take their area share for relocation out of the total area allocated for this function. If the future demand for this

function exceeds the area allocated, the peripheral location of the manufacturing and storage in the city structure is convenient for further expansion.

viii) Transport

The land use proposal maintains the existing bus terminal and envisages further expansion of the service to the Present freight terminal when it is believed to be feasible in the coming planning years .Two freight terminals are allocated in the eastern and southern city peripheries neighboring with manufacturing and storage areas. The locations of the freight terminals are also in line with the major freight flow directions. Terminals for city transport (bus and taxi) are allocated on the plan as vehicle stops/parking so as to provide organized spaces for the purpose. Facilities for the marine transport are to be entertained in accordance with the shoreline development plan or based on further comprehensive transport studies of the city.

ix) Recreation

A total area of 273 ha area is reserved for recreation. This area includes the existing as well as the proposed ones. In addition to the existing recreational areas, 6 additional sport fields and a number of open spaces and parks are proposed for future use. The areas are selected in view of the proposed city structure and topographic nature of specific locations. Neighbor hood level open spaces and play grounds are left for the residential area detail planning That is to precede the land supply. This two-staged plan preparation is believed to provide freedom for more creative and up to date solutions considering all variations occurring due to changes in time. The area required for this type of function is considered while calculating the gross area for residential expansion.

x) Agriculture

Animal husbandry and horticulture are the most commonly observed agricultural activities in the city. This trend is expected to keep on developing in the future too. Therefore wet lands in the city, around and along the water bodies, as well as vacant lands of marginal locations to the city structure are assigned for agriculture use .A total area of 489.5 ha land which is in the vicinity of 8% from the total urban promotion area is designated for general agricultural land use area. Further sub division of the area in to different agricultural functions is left for the plan implementing body.

xi) Forest

A total area of 812 ha area which is 13% of the total built up area is reserved for forest development. The areas assigned under this function are environmentally sensitive. Areas

allocated for this purpose are mostly hills, buffer from the water bodies and hazardous areas. Developing these areas in to parks and/or other compatible functions upon detail assessment and designs is recommendable.

xii) Special function

In addition to the above mentioned land use categories there have been also proposals for special function areas. This function includes in its list all spaces that cannot be categorized under t he above mentioned nine land use types. These areas are water bodies, buffer, and marshy areas that require detail study before assigned for any other uses. This partly relates to the retention pond in the west that will remain marshy before full -scale drainage system is in place. The land use plan proposal has also listed reserved areas under this land use type so as to accommodate the future unforeseen land requests. *Special planning area /Lake shore development area*

The part of Bahir Dar which is interfacing Lake *Tana* is a sensitive area from both environmental a s well as spatial planning perspectives. That is why an action plan to guide the development in the area has been prepared by the Devecon Consulting Architects and Engineers. It is also known that preparations are underway to device plans and strategies for the safeguarding and sustainable development of *Tana*, the success of which has to measure on how this area is considered as a major component of the strategies. Therefore the spatial development framework leaves the detail designs and proposals of the area for the plan in action and forthcoming strategies.

xiii. Proposed road network

The proposed city structure is net worked with four level road types in such away that it will reduce fragmentations of the city morphology. Therefore basic considerations of the previous Mater Plan that are in line with the envisaged city structure are given due attention while determining the city wide road network and geometric standard of the Roads. The spacing and the direction of the roads are determined by the slope so as to drain the run off properly. The proposed road network consist four levels of road types that have been arranged to provide access to every single holding and enable smooth urban traffic flow. Thus, a total of 735 ha area is dedicated for roads, which accounts 11.8% of the total urban area.

No Road type right of way

1 principal arterial 40 m

2 minor arterial 30 m

3 major collector 20 m

4 minor collector 12 -20 m