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LAND SUITABLITY EVALUATION FOR SETTLEMENT USING GEOSPATIAL TECHNOLOGIS. THE CASE OF MIZAN-AMAN TOWN, BENCH SHEKO ZONE, SOUTH WEST ETHIOPIA

BY

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This is to certify that the thesis prepared by Tariku Alemayehu entitled **as LAND SUITABLITY EVALUATION FOR SETTLEMENT using GEOSPACIAL TECNOLOGY**, The case of MIZAN-AMAN TOWN, BENCH SHEKO ZONE, SOUTH WEAST ETHIOPIA is submitted in partial fulfillment of the requirements for the **Degree of Master** of Science in Remote Sensing and GIS compiles with the regulations of the university and meets the accepted standards with respect to originality and quality

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ABSTRACT

Land suitability is a very important task faced by town planners and managers, being to identify the most appropriate spatial pattern for future urban settlement area, based on this, examinations and implication of appropriate land location for urban area development is critical issue in any developing town.

This study demonstrate the use of GEOSPATIAL TECHONOLOGY and numerical Multiple evaluation (MCE) techniques for examine and shows the suitable land for urban settlement area of mizan-aman town. Eight factors were taken into account for criteria evaluation (groundwater, slope, road proximity, urban center proximity, LULC, soil depth, soil texture, river proximity).Weights for each creation are generated by comparing with each other according to their importance .criteria weight was developed by employing GIS based Multi-Criteria Decision Analysis (MCDA) such as Analytical Hierarchy process (AHP) for examining.

The suitability map was obtained from weighted overlay in arc map tool spatial analyst: so that from this suitability map a total area of 4126Hectare it was found that, 230.79 hectare is under highly suitable, 3027.63hectare falls under moderately suitable, 853.95hectare is falls under less suitable, 14.16hectare is falls under unsuitable area.

Generally, from a total the study area 73.63% was under moderately suitable and also south west part of a town Shasheka is highly suitable relative to the other kebeles because 1295ha total area of the kebele 118ha is highly suitable and no area is under unsuitable land form this kebele to urban area expansion so that south west area of the town is more suitable for expansion. The present study allows the local people as well planers for the appropriate plans of land use planning in suitable urban land development and the implication of suitable location for urban growth of town based on international and local factors.

KEY: WORDS. Urban land suitability, Remote sensing, GIS

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Abbreviation and acronyms

AHP	Analytical Hierarchy Process
CSA	Central Static Agency
DEM	Digital Elevation Model
ERDAS	Earth Resource Data Analysis System
ETM	Enhanced Thematic Mapper
FAO	Food and Agricultural Organization
GCP	Ground Control Point
GIS	Geographic Information System
GPS	Global Position System
MCDA	Multi Criteria Decision Analysis
MCE	Multi Criteria Evaluation
MIS	Management Information System
MUDC	Ministry of Urban Development Constrict
MULM	Municipality of urban land management
RS	Remote Sensing
SBRS	Santa Barbara Remote Sensing
SNNPR	South Nation Nationality People
STRM	Shuttle Radar Topographic Mission
UTM	Universal Transvers Mercator
TWI	Topographic wetness index

CHAPTER ONE

1 INTRODUCTION

1.1. Background of the Study

Urban land suitability evaluation for urban growth is considered one of the most important and effective techniques for identifying the best settlement locations. This technique employs different types of criteria and weights (Alexander et al., 2012) Land suitability evaluation involves the selection of suitable locations of development via mapping of the suitability index of a specific area (Joerin et al., 2001).GIS techniques have become a significant tool for controlling and monitoring changes in urban development and their impact on ecosystems (Rosli, 2014). Land suitability based on GIS environments is a process that aims to identify the best locations of development while considering environmental sustainability (Park, 2011). In setting the importance of the criteria used and computing the weights of factors, GIS tools must be integrated with other methods to improve the results of land suitability evaluation. The integration of GIS tools and multi-criteria decision analysis is a powerful approach for evaluating land suitability (Bagheri, 2013). The concept of sustainability generally leads to improved suitability analysis, which is a complex interaction due to various types of factors and criteria that must be considered in the process (Duc, 2006)

In order to determine the most desirable direction for future development, the suitability for various land uses should be carefully examine with the aim of directing to the appropriate sites to establishing appropriate suitability factor to construction of suitability analysis. Suitability analysis techniques integrate three factors area location, development activity and biophysical/environmental process. (Miller et al.,1998). On this concept Land suitability aim identifying the most appropriate spatial pattern of future land use according to specific requirements, preference, and predictor of some activity. The selection of suitable site for specific use must be based on a seat of criteria depending on local norms. Scoring system can be applied to various techniques aspects of suitability to assess the overall suitability for specific urban use (Suraj, 2012)

AHP is one of the significant techniques used in analyzing issues related to spatial nature (Javadian et al., 2011) Identifying the relative weights of the factors used in land suitability analysis is generally difficult. Thus, the use of a technique that has a powerful capability to identify the weights is important. AHP has been integrated with GIS tools to identify the importance of the criteria used and to calculate weights by using a scale of importance and the opinion of experts (Mohammad, 2013).

This study aims to integrate GIS techniques with an Analytical Hierarchy Process (AHP) in order to examine land suitability and its implication to urban planning decision making to mizan-aman town based on both the driving forces of urban growth and the importance of each criterion according to expert opinion, different national and international sources.

1.2. Statement of the Problem

Every municipality, corporation and urban city in the world are facing a problem of managing and preparing suitable urban land for targeted function from complex social and natural interaction of life, which is a natural outcome of daily activities of human. It can never stop, and increase as there is growth in population and living standards of human. Due to lack in management and assessment of suitable urban land cities facing various problems like shortage of infrastructure, a problem to land how to use for desired (targeted) function, facing shortage of pure water accessibility to settlement area and loses economical advantage of land (WDR, 2009). Urban land management problems are one of the major for most developing countries like Ethiopia (Netsanet, 2015) because of its broader impact on socio-economic development and the environment. So for these cases almost all urban settlement areas are not properly selected and they are socially sensitive areas (Abeje and Oritiz, 2014).

As result, the number of population increments, the urban land area is always modified by different human activity and interest of migration so, this activity is reason for horizontal expansion of urban land area increase from time to time, so such case expose agricultural land, rang land, wet land and forest land are converted in to urban land area without considering any factors it’s social, economic, physical and environmental impact. (Haimanot, 2009)

The Municipal urban land management in Mizan-Aman has problems in land use and management. In connection with the preparation of suitable land to each kebele of a town specially based on their classes of suitable. This become a cause of an urban area to unsuitable for its function and a problem to manage urban land area ,implication of suitable land for a town becomes more serious problem from time to time due to complex interaction of processes. (Abeje and Oritiz, 2014).

- Rapid growth of people on the urban rural fringe planners and policy maker in a town lack accurate, appropriate and cost effective urban land use data which is most essential to make decision concerning land resource management
- Not have well-known spatial data which have an association to urban land with degree of suitability classes to expansion
- Creating visualized suitability map for user and decision makers, the integration of MCDA and GIS to solving spatial problems in urban area assessment and planning.

This study intended to fill the existing research gap by geospatial technology with Multi Criteria Evaluation (MCE) through applying land use transfer matrix, methods to Mizan-aman town

1.3. Objectives of the Study

1.3.1. General Objective

To examine the urban land area suitability and its implication in urban
Planning decision making

1.3.2 Specific Objectives

- To identify the best location of urban land to settlement.
- To identify and classify the urban land with degree of suitability of land of a town.

1.4. Research Questions

- Which of urban land area is best location to settlement?
- How can identify and classify the urban land to construct suitable urban land map of Mizan-aman town

1.5. Scope and Limitation of the Study

Spatially, this study marked out Mizan-aman town among four woredas and two administration town of Bench- sheko zones. Conceptually the study was focus on examining suitability expansion and showing suitable land for urban expansions using GEOSPACIAL TECNOLOGY as decisions making tool in the study area. The time for the study was until June 2021.

The depth of assessment were concerned with intensive manipulation of groundwater map, slope map, soil depth map data, preparation of land use/land cover map, road proximity, urban center proximity , soil texture, and river and drainage proximity map, to map each of it and focus on the implication of urban land suitability .

Temporally, this study were focused on the data of 2020 Landsat 8 OLI, 2020ASTER satellite image, master plan and aerial photograph 2010 E.C.

The main limitations of the study were accessibility of internet connection lack of updated geo database from concerning body and the bureaucracy of concerning government organization.

1.6. Significant of the Study

Evaluation of suitability of lands for urban development play fundamental role in regional and urban land use planning .Its major to evaluate the advantage and disadvantage of certain areas for urban development, so as to find out a place which are most suitable for urban development in future.

- Determine the suitability of a specific area for considered use.
- Show important suitable land direction to rapid urban growth and its long term effect, it is becoming increasingly important to monitor and analyze the urban land cover change, as well as to adopt appropriate sustainable land use plans.
- In addition, this is intended to allow urban planners and policy-makers contribute to improved and enhance their competence in decision-making tool into the land management.
- This study produce mainly display most suitable areas for consideration of placement of certain facility, While filtrating out unusable or less desirable sites.
- A study have a provisional recommendation on critical problem of urban land expansion .

1.7. Ethical Consideration

The study was appropriately informed about the purpose of the research and their willing and consent to provide information and data was being secure before requesting data. Regarding the right to privacy of data provide the study was being kept confidential and acknowledge each participant. Any communication with the concerned bodies were accomplish at their voluntary consent without haring and threatening the personal and institutional well- In addition all information obtained from the concerned individuals were being kept confidential

1.8. Validity and Reliability of Data

The study was also incorporate different methods, standards and idea of different article reviews. Web site order helps to obtain reliability and dependable research data. Check the finding before weighted overlay used with GPS point from Google to see accuracy assessment of LULC area and also Garmin 72 GPS, to collect ground truth control points identify existing situation and data of ground water (reservoir) area compare ground water potential map that extracted from DEM.

1.9. Organization of the Study

The study was organized into five chapters. Chapter one introduces and sets out the rational, Objectives, limitation, delimitation and organization of the study. It also gives detailed descriptions of the way the data were captured and processed, the model employed to analyze data and the procedures of their presentation.Chapter two attempts to review related work of other scholar's literature. It provides the conceptual and theoretical frame work for the study. Chapter three tries to introduce the location, major bio physical, socio-economic and demographic attribute of Mizan-aman town with the assumption that this has direct relation with the issue under investigation. Chapter four focuses on results and discussions.Chapter five deals with conclusion and decision implication of the findings.

CHAPTER TWO

2. RELATED LITERATURE REVIEW

2.1. Growth of settlement in urban area

Settlements are part of the environment in protected areas, both in the form of urban and rural areas that function as neighborhood units of residence or residential neighborhoods and places of activities that support per life and livelihood (Tahun 1992)The development of settlements can be interpreted as an increase in the size of the residential environment caused by an increase in the population and an increase in the economy of the community so it will increase the demand for housing needs. The choice of settlement location is essentially through various considerations such as location factors, completeness of facilities and infrastructure, and the environmental conditions of the community literally, morphology means the science of form. In urban contexts, morphology is the study of forms and shapes from neighborhoods. Form means a form that can be observed and is a configuration of several objects, while a shape is a geometric feature or an external form and an outline of an object. The settlement environment becomes an important keyword, because in the science of planning and designing the city it is stated that civilization starts from settling activities.

The complexity in the growth of settlements then forms larger environmental units, namely cities. So the city environment cannot be separated from the neighborhood (Pontoh, 2009). So it can be concluded that the development of a good city must begin with good settlement planning. If settlement growth control can be carried out with certain treatments, the formation of an urban area will run well and meet the principles of sustainable development. The most influential element of city morphology is the road pattern (Pontoh, 2009)

The growth and development of the city can be understood by observing morphological components. Functionally and economically, regional growth is affected by land use, buildings, plots and road networks. Urban areas are formed from a system of activities that are complexly linked by movement networks. The interaction between these two systems, the activity system and the movement system makes urban areas have economic value or property values whose distribution is strongly influenced by natural physical characteristics and the support of the two systems. City growth can be observed geographically assisted by map science (cartography). Using maps, the distribution of natural and artificial physical potential can be easily observed and analyzed. For land use, building density, land size and control and the road network can be mapped and logically explained in relation to each other.

2.2. Urban land suitability

Land is required for various uses in both the urban and rural area of all society. As nation grows in size and aural area becomes urban centered become large metropolitan areas, there is always increased competition as well as demand for land for different purpose. This required adequate planning and control to ensure harmonious development and functional efficiency of this use and settlement. Conceptually the (Battalion ,1971).Gem oral system theory provide appropriate frame work for comparing the mutual interdependence of land use polices, accessibility of suitable land and integrated land use management.

Land suitability refers to the capacity of selected type of land to apply specific use, and the process of suitable land classification involves the evaluation and grouping of particular land areas interims of their suitability for defined use (prankish, 2003:2).Land suitability analysis is thus concerned with evaluation of the fitness of a given tract of land for defined use (Steiner et al., 2000). In the other word, it is a process to determine whether the land resource is suitable for some specific uses. It is also undertaken to determine the suitability level. In order to determine the most desirable direction for future development, the suitability for various land use should be carefully examine with the aim of directing growth to the most appropriate site (Collins et al,.2001).

2.3. Sustainable urban land form

Sustainable development refers to “development that meets the needs of the present without compromising the ability of the future generations to meet their own needs” (WCED, 1987). Due to the problems caused by the rapid urban growth, the current changing urban spatial pattern is a great challenge for sustainable development. A range of reasons related to the sustainable development are brought forward: to preserve important natural habitat and agricultural land; to reduce energy and materials. A sustainable city must “achieve a balance among environmental protection, economic development, and social wellbeing” (Wu, 2010). Urban sustainability consists of minimizing the consumption of resources and land, optimizing urban form to facilitate urban flows, protecting both human health and ecosystem, ensuring equal access to resources and services, and maintaining cultural and social diversity and integrity (Alberti& Susskind, 1996)and(Spiekermann& Wegener,2003). However, developing sustainable cities is a difficult task because cities are the centers of socioeconomic developments, the main sources of major environmental problems, and the living place of nearly half of the world population (Wu, 2008).

The relationship between urban form and sustainability is currently one of the most hotly debated issues in the international environment research. Jenks et al. (1996) pointed out that there is a significant relationship between urban form and sustainable development, although it is not simple and straightforward. The costs and negative environmental impacts of urban sprawl have been widely studied and documented. The particular concerns over urban sprawl is the inefficient utilization of energy (Bhatta, 2010), increasing of infrastructure and public service costs (Buiton, 1994), land use fragmentation and loss of farmland (Nelson, 1990; Tan et al., 2005; Zhang et al., 2007). Urban sprawl is therefore regarded as one of the main challenges in sustainable development and spatial planning Therefore the particular issue in developing a sustainable city is to search for the most suitable urban forms that can help to sustain development, especially for reducing the unnecessary loss of land resources and the consumption of energy. \

In the discipline of urban growth, a new word has emerged compact city to attain the goals of sustainability. The term of compact city was first coined by Dantzig and (Satty 1973) as the alternative planning strategy to the problems linked to disperse city. With the unprecedented and ongoing growth of urban areas globally accompanying by negative impacts, there has been tremendous opportunities to apply this concept in order to achieve the sustainable urban form. Sustainability has been incorporated in urban planning theory through the promotion of a compact policy for urban growth rather than urban sprawl (Arbury, 2005). However, there are inherent difficulties in defining the compact city. Clearly, there is more than just an increase in population density for the compact city (Burton, 2002). It has been proposed that an increase in dwelling density (Godchild, 1994), the advancement of mixed-use development (Williams et al., 1996), and a reaffirmed focus on the nature and quality of development (Elkin et al., 1991) are all important aspects in the compact city theory. The morphology of a city is an important feature in the compact city theory (Jenks et al., 1996). Many researchers believed that compact cities has environmental, social and fiscal advantages and results in energy saving (Burton, 2002); (Frey, 2004; Hillman, 1996; Thomas & Cousins, 1996), thus are an important way to solve problems linked to disperse form and to achieve the sustainable development. (Hillman, 1996) for example, argued that compact city can reduce travel distance, and therefore decreasing emissions of GHG. He also pointed out that urban residents could enjoy lower transport expenditure, less pollution and lower heating costs in compact city.

In addition, the re-use of infrastructure and developed land, a regeneration of existing urban areas and urban vitality can be achieved through the implementation of compact city (Thomas & Cousins, 1996). However, as pointed out by (Burgess, 2000), interests in compact city studies were concentrated on the developed countries, with insufficient studies conducted in the developing countries. With the recognition of its significant impacts in the developing countries, it is important to consider the implementation of compact city policy in developing countries (Jenks, 2000). A heated debate regarding the compact city has dominated the urban planning literature since the middle of 1990s. The realistic experience of cities have shown some problems related to the compact city, such as congestion (Catalán et al., 2008), shortage of open space near to residential areas (Williams et al., 1996). Some researchers argued that dispersed urban form is attractive at an individual level since it satisfies individual preferences, such as more space for per housing unit and quick access to open space, and lower housing prices (Gordon & Richardson, 1997; Baass, 2006). Therefore, how to balance the conflict between compact and dispersed urban form is an important issue for sustainable development.

2.4. Urban Land Use System

This criterion concerns with natural features that may be exposed by the threats imposed because of urban land adjacency. Parameters like river, agricultural potential, bare lands built up areas, forest, urban center, and road, have been taken in to consideration. This criterion is not based on specific directions and may alter according to the study area. From the standpoint of economy, it is better to choose bare lands which can be used after urban land site completion. (Azizand khodakarami, 2013).

2.5. Urban Land Management in Developing Countries

Land represents mosaic that ought to be required to ensure conformity and balance of built environment (Bailey, 1975 &Ratclifs, 1976). However, the general inefficiency associated with the majority of the developing countries ‘land polices ‘and the absence of secure tenure, adequate land management capacity among others, have been cited by (Bernstein,1994). (Hardoy and Satleraite 1989), as serious problems participating existing land crises in these countries. In appropriate instrument and weak institutional structure are among Cavalcade of problems plaguing the commodity, However, the existence of crises in developing countries land market is paradoxical, it not an anathema, judging from the whooping 913,072,64 square kilometer land that lay to be shared among the estimated 140million Nigerians (neglecting the hills, rivers, swamps, and other uninhabitable areas).Nonetheless, the existence of crises in the Nigerian land market could be traced to rapid and uncontrolled migration ,natural increase and urbanization, existing socio-cultural cleavages, lack of secure tuner ,inadequate information, inappropriate and inefficient land polices and instrument weak institutional structure and lack of land management capacity among other factor (Bernstein,1994).

2.6. Urban Land Management in Ethiopia

Most Ethiopia urban centers grapple with informal land market and development a phenomenon prevailing in the most third world countries where, since the 1950s 70—75% of all housing built in developing countries are unplanned or have been developed on land acquired in formally (Farvacqus and Mcauslam, 19920) and the trend does not show any sign of slowing down (Habitat, 2003) and (Davis, 2004). As significant production of urban development occurs outside the official purview of planning while the loop terms benefits of planned settlement are recognized .To these problem urban \town planning acts and reacts on existing slums in a manner that fails to capture and incorporate preventive and productive measure that could reduce the spread of future slum growth and ultimately mitigate the effect of un planned settlement on the majority of urban dwellers in the developing countries (chiping,2005).These is particularly pertinent in the urban fringes where informal subdivision process outpace. Slow formal expropriation process which when they materialize they find the land already occupied informally and there voice calling for regularization or formalization.

2.7. Urbanization and urban land expansion in Ethiopia

Urban development strategy in Ethiopia is largely based on the expropriation of land from the transitional pre-urban areas located immediately beyond municipal/urban boundaries. Before the decision was made to expropriate, land in pre-urban areas was held by local and indigenous landholders and was governed in terms of a rural land-holding arrangement Urban expansion and development in pre-urban areas involve a constant change in land-holding arrangements and in the transfer of land rights to new recipients through lease contracts. Land in pre-urban areas is constantly being transferred from the original pre urban landholders to urban leaseholders through government-controlled expropriation. The rapid rate of urbanization and the resulting high demand of land for urban purposes have resulted in frequent instances of land dispossession and cases of land contestation in pre urban areas. (Achamyeleh,2014).

In addition, mechanisms to convert pre-urban land rights held by local pre-urban landholders/farmers into urban rights are non-existent in this process of urbanization. This proves that local pre-urban landholders do not benefit from the increasing value of land and urban development. Land re-assignment and allocation from pre-urban areas seem skewed in favor of urbanites. The vast majority of local pre-urban landholders, who are poorly educated and used to engage in agricultural activities, seem at great risk of losing their livelihood in the face of urbanization. Thus, the overall process and implementation of urban development has the potential to generate widespread tenure insecurity and land disputes between municipalities and local pre-urban landholders (Achamyeleh, 2014).

2.8. Constrain of land use

Land-use is determined by the human activities on land. (Burley 1961) defined land use by two interrelated phenomena – land cover and land utilization. Land cover describes both the natural and human altered land surface where human actions take place, while human actions determine the land utilization. Both phenomena are important for land-use planning because, on the one hand, human actions are limited by the land cover settings and on the other hand, human activities alter the land cover (Wang and Hofe, 2007). In the modern era, human activities are multiplying rapidly. These activities contribute to rapid urbanization, which has adverse environmental impacts if urban development is not managed sustainably. Land-use planning can play an important role in sustainable development (Lier, 1998; Cao et al., 2012) as well as for sustainable urban development (Shen et al., 2011). A basic proponent for land-use planning is to classify land based on proposed and existing human activities. Growing urbanization demands expansion of urban areas and at the same time alteration of existing land-uses within the urban area. To make such changes in a sustainable manner, land-use planning is a useful tool for administering the potential changes and protecting the land against incompatible changes. According to (FAO, 1996) guidelines, a crucial stage in land-use planning is the suitability analysis, which is a central part of land-use evaluation. From the 1990s, GIS-based Multi criteria Decision Making (MCDM) techniques have become attractive to urban planners for solving spatial planning problems (Phua and Minowa, 2007), like suitability analysis.

GIS-based MCA techniques are generally used for suitability analysis of particular facilities or of a given land use(s); like selecting sites for landfills (S ¸ener et al., 2010), fire safety (Lai et al., 2011), hospitals (Abdullahi et al., 2014; Vahidnia et al., 2009), future camp development (Chow and Sadler 2010); or evaluating land uses (residential, commercial, industrial, educational use etc.) for sustainable urban development (Dai et al., 2001)

2.9. Application of GIS and RS for Suitable Urban Land Selection

2.9.1. Application of GIS

Geographical and political research on urban service delivery has been proliferated during the past two decades (Davies, 1968; Pinch, 1984). Some scholars have investigated the factors which account for higher levels of service in certain neighborhoods (Cingranelli, 1981; Mladenka, 1989) and focused in particular on the role of distributive politics (Miranda &Tunyavong, 1994).

Others have examined patterns of accessibility to certain services and the geographic relationship between service deprivation and area deprivation (Knox, 1978; Pacione, 1989). In order to fulfill these and other needs, man requires access to certain facilities such as market, housing, water supply, electricity and adequate transportation (Aderamo, 2011). Since site selection and suitability process are related to geospatial issues, geographical information system (GIS) allows using data related parameters for suitability analysis. One of the advantages of using GIS in site suitability analysis is the capability of GIS in development of alternative scenarios for urban development. Suitability analysis in a GIS context is a geographic or GIS-based process used to determine the appropriateness of a given area for a particular use.

The basic premise of GIS suitability analysis is that each aspect of the landscape has intrinsic characteristics that are to some degree either suitable or unsuitable for the activities being planned. Suitability is determined through systematic, multi-factor analysis of the different aspects of the problem (Murphy, 2005). The results are often displayed on a map that is used to highlight areas from high to low suitability .suitability analysis is used for site selection, impact studies and land use planning (Edward et al., 2010). Land use planning plays an important role in site development, urban renewal and achievement of sustainable urban development (Wang et al., 2013, 2014).

Suitability analysis is critical for both marketing and merchandising purposes (Dramowicz, 2005). The GIS has different applications in urban health studies (Dom et al., 2012a, 2012b) and can also be used as a decision support tool to allocate health services so that they are geographically accessible for the population that they intend to serve (Phillips et al., 2000, Boulos, Roudsari, & Carson., 2001).

There are various methods used in GIS in evaluating land suitability, for example, Gray more, Wallis, and Richards (2009) produced an index of regional sustainability spatial decision support system; (Saaty 2007) used an analytic network process; and(Mohit and Ali 2006) integrated an analytic hierarchy process with GIS. GIS plays a vital role in planning for many decades of land-use suitability mapping and modeling (Malczewski, 2004 and Malczewski, 2006). The purpose of the current study is to find land suitability for better urban service delivery mechanism of Mizan-aman town. Science site selection and suitability process are related to geospatial issue, geographical information system (GIS) allows using data related parameters for suitable modeling.one of the advantage of using GIS in site suitability analysis is the capability of GIS in development of alternative scenarios for urban development. Suitability analysis in a GIS context is a geographic or GIS based processed used to determine appropriateness of a given area for particular use.

The basic premise of GIS suitability analysis is that each aspect of the land scape has intrinsic character that are some degree either suitable or unsuitable activity benign planned. Suitability is determined through, systematic multifactor analysis for different aspect of the problem (Murphy, 2005).Model in put includes variety physical cultural and economic factor. The result often displayed is on map that is used highlight areas from high to low suitability. A GIS suitability model typically answer equation, where is the best location? Land suitability analysis used for site selection, impact studies and land use planning (Edward et al., 2010). There are various methods used in GIS in evaluating land suitability for example, Gray more, Wails and Richards (2009) produced index of regional suitability spatial decision support system (Satty, 2007)used an analytical network process and (Mohit and Ali, 2006) integrated an analytic hierarchy process (AHP) with GIS ,GIS play a vital role in planning for many decades of land used suitability mapping and modeling (Malczewski, 2004) and MacDill to find land suitability for better urban service delivery mechanism of Mizan- aman administration town in SNNPR of Ethiopia .

2.9.2. Application of remote sensing

According to(Lillesand et al., 2004), RS define as a science or art of obtaining information about on an object, area or phenomenon through the analysis of the data acquired by advices that is not in contact with the object, area or phenomenon under investigation. The multi-update nature of satellite imagery permits monitoring dynamic feature of land scape and thus provides means of to detect major land cover changes and quality the rates of change (Chudmani et al., 2015).

According to(Campell, 1996), remote sensing is the practice of deriving information about the earths land and water surface using image acquired from an overhead perspective, using electromagnetic radiation in one or more region of electromagnetic energy spectrum, reflected or emitted from the earth surface .Its multispectral capability provides appropriate contrast between various natural features where as its repetitive coverage provide information on the dynamic change taking place over the earth surface and natural environment (Adeofun et al., 2011) the role of remote sensing is becoming increasingly frequent in environmental study .At these time, no serious research of the environment performed without advanced image processing and analysis. Moreover, RS can provide digital data as in put for like land use and land cover for GIS.

2.10. Multi-Criteria Decision Analysis (MCDA) for Suitable Land Site Selection

MCDA analysis defend as “decision aid and mathematical tool allowing the comparisons of different alternative or scenario’s according to many criteria often conflict order to guide the decision maker towards a judicious” (Joy, 1996). So land suitability assessment is multiple criteria process. The attribute of land suitability criteria are to be derived from spatial and non-spatial qualitative and quantitative information under divers condition (Chen et al., 2010 a: 175).In land suitability analysis each evaluation criterion is represented by separate map in which a “agree of suitability’’ with respect to that particular criterion is ascribed to each unit of area (Sehgal, 1996, prakash, 2003). These “degree of suitability then need to be rated according to relative importance to contribution made by that particular criterion, achieving the ultimate objective. Different land quality, which can be considered for suitable mapping to present land use /cover ,proximity of transportation network ,ground water depth and quality condition etc. the characteristics of site(e.g. present land use, water availability ,road accessibility, floods hazard etc.) influence its suitability further urban development (sunil,1998 quoted in Jain and subbaiah, 2007). To assess the overall suitability a scoring and weighting system is applied to the various aspects of suitability .Suitable site are found out by adding allayers which are affecting site suitability.

2.11. Criteria for suitable land site selections

In order to select suitable land for urban expansion we have to recognize as our region, suitable land involves an extensive evaluation process in order to identify the optional available suitable land location that must satisfy basic town regulation. In fact, different research has used varying criteria for suitable land location purpose(Kumar and Shaikh,2012) .Even if the criteria is different from country to country the following are most common to locate suitable land for urban expansion.

2.11.1. Slope

Slope map is an important for land site suitability analysis. Slope greater than 30^0 are considered as steep slope which are vulnerable it erosion and not suitable for constricting purpose .slope less than 30^0 is generally suitable for urban development (Malczewski, 2004).

Construction of buildings and development of cities on steep slope terrain has been problematic through the ages. The rapidly expanding urban population is confronted by steep slope areas which have been generally unbuildable, except at very high cost with difficult construction procedures or with environmental destructive and risky squatter settlements. The impact on the environment can be severe from the disturbance of the fragile slopes, particularly when poor soil conditions prevail. Mud slides are a risk with appreciable loss of life and high costs, and in earthquake prone areas the potential for disaster increases. An MIT study has developed an innovative approach for construction on steep slopes, which balances construction on sloped areas with development on the horizontal terrain, maximizing the bearing potential of subsoil conditions.

The concept has three aspects: Structural – It offers high loading conditions, with bearing distribution related to soil capacity. Building design – It uses standard systems and provides centralized single point access, with a building design that respects the soil bearing capacity of the slope. Construction – No despoliation of slopes, no heavy equipment on slopes and uses standard construction methods and equipment. Expansion is facilitated, and allows a continuous means of growth on steep sloped terrain. It is particularly appropriate for multi-story, high density forms, and offers an opportunity to innovate with creative design. The MIT approach is appropriate for single buildings; as well groups of buildings in a new urban paradigm prime, flat land may be preserved, while the steep sloped areas become the dominant development locations. The inherent linear circulation concentrates transportation and encourages and makes feasible high-density routes. More options in city growth and form result from a composite of standard low-rise slope construction with the multi-story designs. Cultural issues are the same as in other high-rise, high-density urban areas. Debates on use of hillsides vs. maintaining their untouched state would arise, but areas with no options for development other than steep slopes suggest the use of an environment-partnering approach.

The recent earthquake in China offers a worthy challenge to build prototypes that explore the concept under actual conditions. The rebuilding in China is ideal: the steep, poor soil terrain, the prevalence of relatively narrow valleys, the immediate need to rehouse large numbers, the propensity to build multi-story buildings, and the interest in mass transit. Use of the innovative approach – which draws on structural, construction, and design strengths – offers a new paradigm for urban development. It is an environmental friendly partner which avoids destruction of the fragile slope terrain while supporting sustainable urban expansion. (Zalewski and Goethert, 1970)

2.11.2. Soil depth and soil texture

Soil depth: From soil depth very deep to deep soils are required for urban development from the foundation point of view as well as providing infrastructural facilities. The cost to be incurred for developing rocky areas is very high and uneconomic (Raghunath.2006).One goal of construction activities in urban areas is to provide material that supports buildings, streets and roads, ball fields, tennis courts, parks, and gardens. Another goal is to use soil and other land resources wisely. Each construction site has different needs from the standpoint of supporting structures to be built and then providing materials for landscaping the site after construction is completed. Some sites are left in their natural condition, but many are leveled, drained, shaped, and compacted. These activities help to overcome the engineering and construction limitations affecting building foundations or concrete slabs for building floors, parking lots, athletic fields, or other uses. Soil or even bedrock must be moved or removed when a construction site is leveled or graded. When bedrock or hardpans are involved, drilling and blasting may be needed to loosen the materials. Large machinery, such as an earthmover is used to move soil material from one place to another on the site (Pouyat, 1991).

Soil texture: Areas with unsuitable foundation materials such as swelling / shrinking soils, compressible soils etc. Pile foundation is required in such soils which is expensive. It is an important aspect with respect to the stability of foundations. Clayey soils increase in volume due to absorption of water and may result in differential settlement of foundations resulting in their failure. Therefore, highly clayey soils are less suitable and sandy soils are more suitable for foundations (Raghunath.2006).Soil materials that are moved from one construction site to another or to a different location on the same site must be compacted if they are to support the weight of buildings. Machinery is used to reduce the number and size of soil pores and increase soil strength. When soils are not compacted or when sites are unstable, project failures occur. Shows house foundation that is unstable. The electric meter was torn from the house as the soil next to the foundation settled. In settling around a house has torn the outside step away from the patio doors. The red line on the foundation is the original level of the patio. Shows damage to a road built on an unstable soil. Soil compaction often occurs in areas where sidewalks were not built along the preferred footpaths. This compaction is unintentionally caused by people after construction is completed .Because of soil sealing at the surface, vegetation cannot grow in compact areas (http:WWW.nrcs.gov/technical/land/urban html**)**

Compaction below the surface may be evidenced by puddles on the surface or trees that are blown over by heavy winds because of shallow root systems. Compaction often is caused by the heavy machinery used by builders and contractors. The use of large machinery to move materials around on a building site when the soil is wet compact surface and subsurface horizons in the soil. These compacted horizons, which are characterized by reduced pore space and increased density, alter soil drainage, root penetration, and even microbial communities on the site. Unintentional soil compaction is a symptom of soil mismanagement and can be a cause of excessive runoff, with or without sedimentation. Compaction occurs when soil particles are packed tightly together as heavy forces (including vehicles, foot traffic, or even glaciers) are applied to wet soils. Compaction is reflected in decreased water infiltration, limited internal water movement, and the inability of plant roots to grow through a restrictive soil layer. After soils are modified and used for urban projects, the landscape must still function as a natural system.

In other words, the soils must still regulate, partition, and filter air and water; sustain biological diversity and productivity; and support structures. This is the challenge. Soils in densely populated urban areas are dramatically different from soils naturally occurring in forests, on rangeland, in agricultural areas, or at the urban fringe. The functions of urban soils often are modified sometimes in a positive way and sometimes in a negative way. Urban soils range from slightly disturbed to completely manmade. Natural soils can occur in urban areas where site preparation has not been extensive. Urban soils present unique challenges to landscape architects, horticulturalists, engineers, and urban planners. (FAO, 1988)

The general types of soil disturbance in urban areas include intentional cutting and filling; vehicular or foot traffic, which can cause compaction; introduction of manufactured soils for raised bed gardens and containerized plantings; and special preparation of sites for parks, gardens athletic fields, and golf courses Large-scale soil disturbance includes leveling through cutting and filling or through grading in certain areas, such as sites for buildings or athletic fields; filling of wet areas or areas that have undesirable soil characteristics (Hollis, 1991)

Disturbed soils differ from soils in natural areas because their horizons have been mixed, destroyed, or removed; natural soil structure has been destroyed; compaction has occurred because of heavy machinery use; water transmission rates have probably been reduced because of soil compaction and loss of soil structure; and runoff and soil erosion rates typically have been increased. (Jenny, 1980)

2.11.3. Ground Water

Ground water is the water that occurs in the saturated zone of earth in various thickness and depth below the ground surface. The ground water source includes springs, infiltration galleries and well. Ground water source is usually influenced by the geological feature of the area. Mizan-aman area is made of the trap serious vacancies over laying the basement rock at depth. Alluvial deposit fills the larger valleys of the adjacent areas while residential soil occurs throughout the area over the gentle to steep slopes. Geology of the area is composed of dominantly by basaltic rock type. The study was made by (Gibbs, 1995) penetrating bore holes which have been penetrated to depth of 100m, revealed that the underground composed the rock of tertiary trap series vacancies (basalt, royalties, and ignimbrites) .

In the geology of environments like Mizan-aman in tertiary volcanic rocks characterize the area ground water could be expected within secondary porosity. $i.e$. Existence of sufficient fracturing and mothering, where fracture zones intercept water course it is believed that deep ground water recharge could be enhanced. However through the area has several streams and receives sufficient rainfall fracturing in the area generally poor. The approach previously and attempted tolerate bore holes skies but the trial did not give satisfactory results the yield from all wells was less than 1 l/s. *(*Gibbs, 1995)

When to data scarce areas, it can encounter lots of problems due to limited data. Digital Elevation Model (DEM) is the digital representations of the topography, and has many applications in various fields. Former researches had been approved that much information concerned to groundwater potential mapping (such as geological features, terrain features, hydrology features, etc.) (Liu, Zhai and Yan, et al., 2015). Can be extract from DEM data. This made using DEM data for groundwater potential mapping is feasible. Extraction methods of the different determining factors like Drainage networks density TWI map, Convergence Index map etc. from DEM were put forward and thematic maps were produced accordingly.

2.11.4. Road Network

The road network is one of the important parameter in identifying the area for urban development as it provides accessibility to different part of a town. The development of transport road network plays an important role in the economic development of a country and, therefore the kilometer-age of paved? Roads existing in a town are often used as an index to assess the extent of its urban development. The proper development of transport road network not only reduces the cost of transportation both in terms of money and time but also helps in the integration of various regions within the town and better understanding of neighboring region at the national and international level. (Aldagheiri, 2004)

Road network plays an important role in urban planning and development as it connects deferent settlements and urban centers .Also important conveying goods and service. In the next study the buffer zone will be crated for road network covering on both sides of the road .The buffer zone falling the nearest distance urban land is highly suitable for urban development. . (Mesfin, 2019).

2.11.5. Land Use/Cover

Land use /land cover are two different but closely interrelated terms. According to (FAO, 1995) land use is described as the function and motive for which land can be harnessed by its inhabitants; it can be explained as the human action tied with the land to get the necessary materials that sustain human life and affecting the land surface in positive and positive ways. Land use pattern and the purpose for which the land can use differ from place to place due to biophysical and socio-cultural factors. Moreover (FAO, 1995) elaborates land use by listing various activities that are conducted on the land surface like grazing, agriculture, urban development, logging, mining and others. On the top of that Mayor and Turner (1994) clearly distinguish between land cover and land use.

Land cover portrays the physical, chemical and biological components of the earth's surface. For instance, grassland, forest, concrete and so forth. On the other hand, land use implies the purpose for a given land type can be best suited. For example, grazing land, recreation and settlement are some of it. However, Land use is related to land cover in many ways and affects it in multi-dimensional ways. A given land use can best used for a single purpose and some land uses can be exploited for multiple functions like forest for fuel wood, recreation, timber and flash and burn agriculture. (Turner et al., 1993), identify the large-scale social components based on their contribution in the process of land cover change into human driving forces, human mitigating forces, and proximate forces of change. Human driving forces are basic societal causes that are very important result of population, technology, socio-cultural and economic arrangements that change the land cover. On the other hand human mitigating forces are used to reverse the adverse impacts of human driving forces like setting up formal and informal regulation mechanisms, a responsible market systems and friendly technological innovations. Mitigating forces can be applied to rehabilitate negative side effects that took place in the past related to land cover change. Proximate causes of change are sociocultural and economic actions which have a direct effect on land cover. They are the immediate land resource allocation strategies that tend to change the original cover land and/or modify the 11 existing land cover types. (Seto, 2002)

According to Encyclopedia of the earth broadly, the term land use and land cover change indicates all kinds of human modification of the land surface. However, Land cover is specifically related with the biophysical cover of land surface including water, vegetation, bare soil and /manmade structures (Ellis and Pontius, 2006). With regard to land cover land use has a bit complicated with various purposes the land is assigned for. Hence, social scientists and land mangers explain the term in a wider sense relating it to socio economic aspects. Others particularly, material science researchers attach the term with various human actions applied on the land, for instance farming, forestry and infrastructures. (Turner et al., 1993) explain land use as both the way in which the biophysical components of the land are used and the burning desire for using it. Moreover, (Lambin et al., 2007) distinguish between land cover and land use in that land cover portrays any observable and visible thing on the land whether it is natural or manmade. On the other hand, land use indicates the practical actions that human beings apply on the land like grazing land for cattle habitable areas. Moreover, Land cover depicts original and introduced vegetation cover, rocks, sand and other surface and human induced structure that are seen on the surface of the earth.

Land use shows a multitude of activities carried by human beings with the motive of setting products and benefits from land resources like soil and vegetation cover (DeBie, et al., 1996). It is a common understanding that land use affects land cover in different ways. Hence, land cover change is the conversion of the land surface for different purposes (Lemlem, 2007). The rapid increase in population size and the booming socio-economic needs create a pressure on land use and land cover. Furthermore, the pressure resulted in unplanned and uncontrolled changes in LULC (Seto, 2002). The LULC conversion are mainly the outcome of improper use of agricultural, urban, range and forest lands that can in turn result harsh environmental problems like land degradation and flooding, etc. different land types do have various land covers for unique purpose. LULC are different but they are closely interdependent features of earth's surface. Land use includes grazing, agriculture, urban development, forestry and mining

2.11.6. Distance from urban center

Suitable lands site for urbanization are not far away from urban center like market, recreation center, different public sectors, health station, schools and so on. The land that we will select for urbanization expects near or average distance for urban center and it is suitable site for Avery part of urban center. In addition to the above factors must be considered when evaluating a site for potential of suitable land to urbanization .some of this these factors includes health public opinion, safety, local geology and economics (Deutsche, 2014). Since center of the town is already well constructed and developed, priority is expected to be given to the peripheries of the town for further development (Suraj *et al.*, 2014).

CHAPTER THREE

3 METHODS AND MATERIALS

3.1 Description of the Study Area

3.1.1 Location of the study area

Mizan-Aman is found in Bench -Sheko zone in the Southern Nations, Nationalities and People's Region (SNNPR) of Ethiopia with a total area of 4126.03 hectares. It is located at 561kilometers of south west direction of Addis Ababa., Mizan-Aman town is geographically located at N $6^{0}55^{'}30''$ to$7^{0}1^{'}30''$ of latitude and $35^{0}30^{'}0''$to $35^{0}36^{'}0''$East of longitude. It has an average elevation of 1478 meters

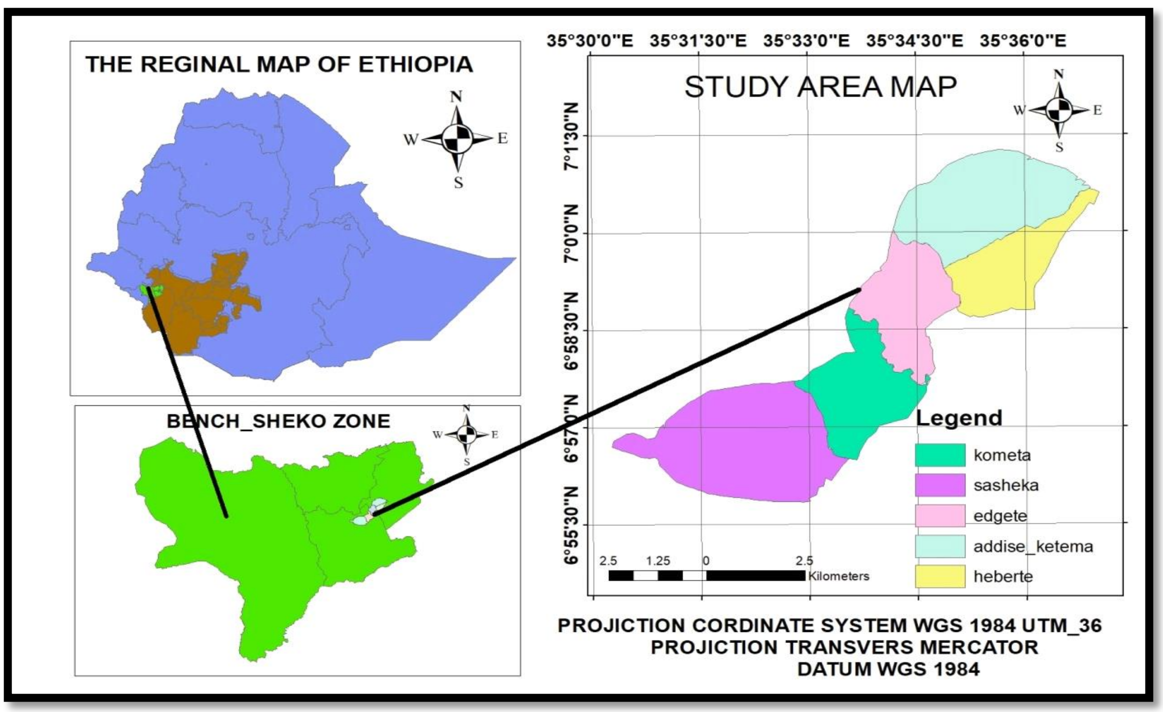

Figure 1 Map of Study Area (source Ethio-GIS and CSA)

3.1.2 Topography

The topography of the Mizana-Aman town is generally undulating with heights ranging between1264 to 1692meter. The relief characteristic of the town is up and down and divers, the settlement area is established on sloppy area and dominated by gorge. The elevation difference ups and down and sloppy nature create the city aggregative impact in physical expansion and social economic development .Generally, the height of the town descends from north east to south west Mizan to aman sub town (Mizan-Aman municipal 2010)..

3.1.3. Population

The population of the town is growing at high rate 3.1%. According to CSA, (2007) Census Report, Mizan-aman administration town had a total population of 60985, of which 31155were males and29830were females. According to the statistical abstract of the Central statistical Agency (CSA) 2019 GC Mizan-aman town has the population of112806As report of CSA (Rif. No 3-16/277anddate august/10/ 2019 GC) to SNNPR .The population of the town expected to grow at the rate of 3.1% per annum.

3.1.4. Climatic Condition

Mizan-Aman Town suited in southwestern part of the country mighty rain due to small portion forest of west and present time the rainfall is become unseasonal and fluctuated due to deforestation and population growth. The mean annual rainfall of the town is 1935mm and the temperature of the town ranges from 15.5^{0}– 37.5ºc and the average temperature of the Town is 23.5oc (SRWUDB, 2009).

3.1.5. Soil

Soil type of town varies from place to place because of variation in, topography, parent material, biological activities and time. The relative humidity of the site reaches 80 to 90%, and the soil is classified as District Nit soil and it is dominated by a loam texture and geologically its rock more of tertiary volcanic rocks. (Gara and Gibi, 2018)

3.2 Materials

3.2.1 Data Collection Tools and Software

The materials and software's that was used in this research including Google earth GPS points, and Garmin 72 GPS tool to collect ground truth control points identify existing situation physical land management in Mizan-aman town .The software's that was used for preparing and analysis of data include, ArcGIS10.3 to perform spatial analysis and suitability modeling, ERDAS imagine 2015 for image preprocessing and classification.

3.2.2. Landsat 8

Although most developed countries have comprehensive land cover information, the relative lack of geospatial data is a serious situation in developing countries, particularly in Ethiopia. In addition to the common advantages of remote sensing images, Landsat8 images with medium spatial resolution and multiple spectral provide an appropriate data source for land cover study because they are free of charge and maximize the possible temporal monitoring period (Patino & Duque, 2013). 2020 the acquisition dates and sensors for the satellite images selected. The cloud free remote sensing images as the primary data source for mapping land cover in the study areas were obtained from the U.S. Geological Survey (USGS). Numerous studies in satellite image based land cover mapping have demonstrated that improved accuracy of the results can be obtained by using more than one date of imagery rather than using single temporal imagery as a basis for classification, because it can increase the potential for spectral differentiation among land cover types (Lillesand, 1994; Lunetta et al., 2006; Oetter et al., 2001). For example, the farmland could represent like the bare soil in some seasons, while in growing seasons, the farmland are spectrally similar to green vegetation because of the crop calendars and phenology. Therefore, besides the images acquired for the study time points, some other images for different seasons were also required to separate farmland from bare soil or vegetation. In order to assess the accuracy of classification results, a set of reference data were necessary, which included topographic maps, high-resolution aerial photography, and Google earth pro.

This study was conducted to investigate the performance of Landsat 8 OLI data and demonstrate its application for land cover classification in Mizan- aman town Ethiopia

3.2.3 Aerial Photography

We are familiar with photographs taken with normal cameras. These photographs provide us a view of the object similar to the way we see them with our own eyes. In other words, we get a horizontal perspective of the objects photographed. For example, a photograph of a part of settlement is providing us a perspective the way it appears to us.

Aerial Photography: Art, science and technology of taking aerial photographs from an air-borne platform. The photographs taken from an aircraft or helicopter using a precision camera are termed aerial photographs. The photographs so obtained have been found to be indispensable tools in the topographical mapping and interpretation of the images of the objects. When we look at it suppose we want to take a ‘bird’s eye view’ of similar features, then we have to place ourselves somewhere in the air. When we do so and look down, we get a very different perspective. This perspective, which we get in aerial photographs, is termed as aerial perspective. Aerial photographs are used in topographical mapping and interpretation. These two different uses have led to the development of photogrammetry and photo/image interpretation as two independent but related sciences.

3.2.4. Sources and Data types

Table 1 Summary of Data and their Source

No	**Types of data**	**Source of data**
1	Slope data	SRTM -- ASTER DEM(2020/21)
2	Road network data	Digitizing from aerial photograph Mizan-aman
3	Urban center	Master plan of Mizan-aman
4	Soil depth and soil texture	FAO
5	Ground water	From DEM data analysis of drainage density, calculating TWI, crating relative relief, lineament density and slope aspect curvature)
6	Riverdrainag network map	Digitizing from aerial photograph of Mizan-aman town
7	Land use	USGS -- Landsat 8(2020/21)

3.3 METHODS

3.3.1 Research Design

This study was based on dominated quantitative cross sectional research design. It relied more on quantitative while concurrently recognizing quantitative procedure (Powell. et al., 2008).

In this case quantitative phase occurs one after the other, with the quantitative or technical phase being given higher priority. The technical phase of this research was associated with land suitability analysis for urban land expansion related with different criteria. The main advantage; it is use of basic research, knowledge and methods for solving an existing problem of this approach has been classified as applied research. It deals with practical problems. Which follows a inductive approach is "down top" or "from specific to general". Depending on the approach and on the specific objective of the research, in the measurement of quantity or amount as well statistical analysis quantitative research would be appropriated. On the basis of data nature used this classified as Cross-sectional Research, the fact that the research undertaken by collecting data on one or more variables from different units at a single point in time.

3.3.2 Image processing

3.3.2.1 Image Pre Processing

In order to use image after acquired from USGS, preprocessing is very important for increasing interpretability of the image.so image preprocessing technique was order by ERDAS image 2015 software applied here. When a sensor detect information from earth surface are summery factor that hinder quality of image .Some of techniques of image processing are geometric correction or rectification or re projection UTM zone 36, radiometric correction by haze removal by true color and gray pixel subtraction was used .Noise removal and image enhancement systematic noisy removal and multistage manipulation was used for increasing readability image.

Pre-processing functions involved that operations required prior to the main data analysis and consisted processes were in this study, geometric correction, radiometric correction and atmospheric corrections to improve the ability to interpret the image components qualitatively and quantitatively. These processes correct the data for sensor irregularities and removing (radiometric corrections) unwanted sensor distortion or atmospheric noise. The correction by ERDS imagines that applied here was the following.

Radiometric Corrections

The reflected electro-magnetic energy are observed by a sensor, due to sun's azimuth and atmospheric conditions the observed energy does not match with the energy emitted from the same object. Therefore, in order to obtain the real irradiance or reflectance, these radiometric distortions must be corrected. A radiometric correction plays a major role in producing error free thematic map for biomass applications; to achieve this objective (Simard et al., 2011) proposed holomorphic calibration technique and heteromorphic calibration techniques to correct radiometry for terrain topography and canopy variations due to reflectivity. It performs better than cosine generation technique but accuracy is low when azimuth slope is considered.

Atmospheric Corrections

Solar radiation is absorbed or scattered by the atmosphere when it is transmitting to the earth. In the same manner the reflected energy from the target is absorbed or scattered by the atmosphere before it reaches a sensor. Sensors receive the reflected radiation from the target and also receive scattered radiation from the target is called path radiance.

3.3.2.2 Image classification

Basically in this study the image was classified using software was ERDS imagine 2015, the first step before classification of the image was makes layer stack of different bands from band1 to band 7 because to give colors different to each properties of LULC but landsat8 has generally 11bands.

This refers to produce automatically classify all pixel of an image in to different land classes or themes (Lellisandet al., 2004) what we used here classification was supervised refers to identify known a priority through a combination of Google map analysis, and personal experience as training site the pixel grouping process specifying numerical descriptors (groups of digital no value) of various lands cover type present in scene to computer algorithm .That is known as priori through a combination of personal experience interpretation of satellite image map .Based on this concept supervise classifications applied to classify the image into four groups they are Agriculture& open area, urban area, Forest and water& wetland area

Supervised Classification

Remote Sensing (RS) associate to the science of identifying different earth surface and features assessment using electromagnetic radiation. Remote Sensing technologies can be used to get spatially variable data for a number of applications. A number of these technologies can supply data to solve problems, and can often be accomplished at a lower comparative cost than many other established methods. It has also been used to supervise land use changes; this has a significant role in urban advance and the purpose of water quality parameters. Remote sensing is very useful for the construction of land use and land cover information which can be useful to resolve the allotment of land uses in the watershed. The evolution in technology of remote sensing has caused it to become one of the most commonly used techniques in the world. Remote sensing is the acquisition of information about an object or phenomenon, without making physical contact with the object. Land cover mapping is important in many scientific and commercial applications involving resource monitoring. Remote sensing provides an effective tool for analysis of land-use and land-cover changes at a regional level. Land use classification of the LANDSAT8 imagery helps to identify and analyze the different regions like water body, farmland, human settlements, vegetation etc.

Supervised categorization can be defined normally as the process of samples of known distinctiveness to classify pixels of unknown identity. Samples of known distinctiveness are those pixels located within training areas. Pixels positioned within these areas term the training samples used to guide the categorization algorithm to assigning specific spectral values to appropriate informational class.

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3.3.3 Data Analysis and Presentation Method

Identification of suitable land for settlements is critical issues of planning. The suitability of the land for urban settlements is not only based on a set of physical parameters but also very much on the economic factors. The cumulative effect of these factors determine the degree of suitability and also helps in further categorizing of the land into different orders of development. The assessment of the physical parameters of the land is possible by analyzing the land use, soil parameters, slope parameters, ground water, road network, and urban center or distance from the existing development etc. and which is much amenable to GIS analysis. As against this, the economic pressures on urban land are very much difficult to be specified and used for evaluation. However the assessment of physical parameters gives an identification of the limitations of the land for urban development. The concept of limitation is derived from the quality of land. For example, if the slope is high the limitation it offers is more than a land which has gentle slopes or a flat terrain. Practically, this would mean that the development of the high slope land would require considerable inputs (finance, manpower, materials, time etc.) and thus may be less suitable as against the flat land where the inputs required are considerably less. The constraints with respect to the terrain characteristics (landform) and their urban suitability are to be assessed. In this particular study eight such important parameters which are most relevant for the area under study and accepted by urban planners, are considered. The parameters are existing land use/land cover, ground water prospects, soil depth, soil texture, land value, proximity to built-up and proximity to road. Also three constraints such as built-up area, water bodies and master plan are also considered in grading the suitable parcels for urban settlement. These eight factors are analyzed in GIS environment using a Weighted Index.

3.3.3.1 Digitizing

Digitizing is the process of interpreting and converting paper map or image data to vector digital data. In manual digitizing you trace the lines or points from the source media. You control a cursor, usually with a mouse or digitizing puck, and sample vertices to define the point, line, or polygonal features you wish to capture. The source media may be hardcopy, e.g., maps taped to a digitizing table, or softcopy, e.g., a digital image or scanned map. ESRI software allows us to digitize using either hardcopy or softcopy sources

The function of GIS converts the base map of the area into digital map to use in GIS environment by applying editor from arc map. It was used to digitized boundaries, road, and streams that exist in the existing in the study area from structural plan.

3.3.3.2 Multi Criteria Decision Making or Analysis (MCDM/A)

The central element of this structure is a decision matrix consisting of a set of columns and rows. The matrix represents the decision outcomes for a set of alternatives and a set of evaluation criteria. The structure of columns consists of levels representing the decision makers, their preferences and evaluation criteria. These elements are organized in a hierarchical structure. The rows of the decision matrix represent decision alternatives. The decision outcomes depend on the set of evaluating alternatives. A criterion is a standard judgment or rule on the basis of which the alternatives decisions are ranked according to their desirability. Criterion is a generic term including the concept of attribute and objectives. Attribute represents the properties of elements of a real world geographical system. More specifically, an attribute is a measurable quantity or quality of geographical entity or a relationship between geographical entities. An attribute is used to measure performance in relation to an objective. An objective is a statement about the desired state of the system under consideration. It indicates the directions of improvement of one or more attributes. Objectives are functionally related to or derived from a set of attributes The state of nature or environment refers to the uncontrollable environmental factors such as weather condition, physical condition, economy etc. Each state is assumed to be independent of other states and immune to manipulation by the decision makers. As such, the states of nature reflect the degree of uncertainty about decision outcomes. Ultimately, the decision problems require that the set of outcomes to be ordered so that the best alternatives can be identified.

This study was used GIS based multi criteria decision analysis (MCDA) approach for evaluating most urban suitable land in the study area .Multi criteria decision making is the process of define as a process of that combine and transforms a different spatial data input in to a result decision output as describe in (Drobne and LISEC, 2009) .MCDA is a set of procedure designed to facilitate decision-making. The basic purpose is to investigate a number of choice possibilities in the right of multiple criteria and conflicting objective. According to research was made MCDM for factor and lastly prioritized each of factor based on weight that was given by AHP calculation. The weight of relative importance of the factor guiding suitable land siting was estimate using pairwise comparisons in AHP. The weight of criteria was given based international urban land suitability management rule and expert opinion evidence to give preauthorize.

In this study all considered criteria were first converted in to raster with the same resolution. Since all criteria cannot have equal degree of importance of each creation in relative to the other area was determined. This was did for the purpose of identifying the influence of each factor relative to the other factor for land suitability to the urban expansion site selection .Weight for the criteria was assigned based on multi criteria evaluation in AHP producer developed by (satty, 1980) using pairwise comparison matrix.Because of this method a power full to rank criterion according to their importance in mitting conflicting objective its ability to detect in consistent judgment using consistency ratio. Based on MICROSOFT EXCEL WORD pairwise technics was developed so those weights for each criterion sum to1.

The selection of suitable sites is based upon specific set of local criteria .the character of a site (e.g. present land used, slope, water availability etc.)influence its suitability for a specific land use type .To assess the overall suitability a scoring and weighting system is applied to various aspect of suitability .site suitability is a process of understanding existing site qualities and factors ,which was determined the location of a particular activity .The purpose of selecting potential areas for residential development depend upon the relationship of different factor ,like location of available sites ,extent of the area ,accessibility, etc. .And site association factor like slope, soil etc. The analysis may also determine how those factors were fitted into the design process to evaluate site suitability (Hofstee and Brussel, 1995).

3.3.3.3 Analytical Hierarchy Process (AHP)

Urban land expansion promotes socioeconomic development and improves quality of life, it is the most powerful and visible anthropogenic force that has caused the fundamental conversion in natural to artificial land cover in the towns around the world (Clarke et al., 1997; Luck & Wu, 2002). As urbanization has occurred, lands making up the natural resource base, such as agriculture, forest and wetlands, have been replaced by urban land (Jantz et al., 2004). Land cover dynamics constitute an important component of the human dimension of global change (Turner et al., 1990). Although urban areas cover a very small percentage of the world's land surface in comparison with other land cover types, their rapid expansion has marked effects on environment and socio-economy, such as loss of natural vegetation, ground water quality, road network and farmland (Tan et al., 2005), decline in biodiversity (Zimmermann et al., 2010), hydrological circle alternation (Barron et al., 2013), etc. Without effective planning, there is no doubt that the pressure for sustainable development was continued to increase (Dewan & Yamagchi, 2009a; Lambin et al., 2001).

AHP is one of a methodological approaches that may be applied to resolve highly complex decision-making problem (saaty, 1980).AHP was proposed in 1970 by ThomaseLsatty in his initial formulation of ,proposed a four steps methodology comparisons method modeling valuation ,prioritized and analysis .At the modeling stage, hierarchy representing relative aspect of the problem (criteria ,subcritical ,attribute and alterative)is constricting .the underling goal or mission is placed at the top of this hierarchy . other relevant aspect (criteria, sub criteria ,and attribute)are placed at the reading level (AltuZarra et,al.2007).The AHP method commonly used in multi criteria decision making exercise was found to be useful method to determine the weight ,in comparisons with other method .The combination of AHP method with GIS in our experiment proves it is a power full combination to apply for land use suitable analysis (Mustffaet,al., 2011) AHP is decision support tool which can be used to solve complex decision problem . It uses a multi - criteria ,sub- criteria and alternative among which the best decision is to be made AHP generate weight for each evaluation criterion according to the decision makers pairwise combination of the criteria .The comparisons is about whether the row creation is equal, or lower importance that column creation and higher the weight the more importance corresponding criterion. The reciprocal value (1/2, 1, 1, 1/2, 1/4, 1/3, 1/4, 1/9) was used when the row criterion is less important than the column creation. AHP also provide measure to determine inconsistency of judgment in which consistency ratio should be less than on.

The main challenge in applying this model is that AHP needs the right experts with the widest knowledge and experience in the fields of suitability analysis and application to judge the factors in terms of their importance and weights .Identifying the relative weights of the factors used in land suitability analysis is generally difficult. Thus, the use of a technique that has a powerful capability to identify the weights was important. AHP is one of the significant techniques used in analyzing issues related to spatial nature.

The selection of suitable area is based upon a specific set of local criteria. To assess the overall suitability a scoring and weighting system is applied to the various aspects of suitability (Town & Pradesh, 2014)

Table 2 weight for each parameter (by Appling AHP)

No	Factors	Weight
1	SD	0.246465
2	SLP	0.220076
3	GW	0.1980055
4	RDN	0.113291
5	LULC	0.059064
6	URC	0.083453
7	ST	0.051921
8	SW	0.027674

SD=soil depth, SLP=slop, GW=ground water, RDN=road network, LULC=land use land cover, URC=urban center, ST=soil texture, SW=surface water (river)

In this part of the research, of previous studies and expert opinions was used to identify the significant factors that influence the determination of appropriate sites for urban growth. All maps were generated based on potential, distance, slop and all criteria affecting the suitability of urban growth .Multi ring buffer distance, reclassification, conversion, and raster calculator are the major GIS tools that were used in this part of the research. For suitability analysis using GIS-AHP, it is important to assign scores to each of the factors based on their suitability for urban growth. To do this, a pairwise comparison matrix using Saaty's nine-level scale for identifying relative weights was used. The calculation of factor weights was applied after the formation of the pairwise comparison matrix. The next step involves the computation of Consistency Ratio (CR), which is used to measure the consistency between the experts' opinions. The acceptable Consistency Ratio (CR) should be $CR < 0.10$, which refers to a reasonable level of consistency in the pairwise comparisons. In contrast, $CR > 0.10$ refers to ratio values that are indicative of inconsistent judgments.

Overlay techniques was done on this study all the criteria was converted into raster tiff data with the same resolution and give suitability status for each criteria by a number 1, most suitable 2, moderately suitable 3, less suitable and 4, not suitable after this process on the arc map tool .

3.3.3.4 Buffering

Proximity river derange network   water sources such as springs, rivers and streams in order to supplying the water needs of plants and livestock is essential and the proximity to rivers was given as200m,400m,800m,and >800m (Lives more Development control plan part A chapter 11,page 7)

Road accessibility in this study in order to search out the accessibility of a town, major road which are conceiting different area to in all side of a place Euclidian distance from the road was created by taking different distance from road to generate road accessibility. The better zone for road accessibility are 200m,400m,600m,and >600m Multi ring buffer zone from a road (Sao,2000)..

Proximity to urban center was an important to determinant the cost of future urban land suitability development depends .That is why proximity to urban center land was assigned higher importance area near located to the urban center on the business accessibility that was why urban center area buffer zone is prepared .The buffer which was near to already urban center area was given higher suitable value and as we go away from urban center the value is decreased .The proximity to urban center area 500m,1000m,1500m, and >1500m . (Miller et al., 1998) and expert information by Appling Euclidian distance approach .

3.3.3.5 Reclassify

Slope Morphological criteria were defined by slope gradient to reflect slope erodible. A digital elevation model (DEM) was prepared employing ArcGIS 3D Analyst on the basis of the study area and classified into four classes based on slope erodible potential. Flat to gentle slopes 1^0—10^0 was identifying as the high suitable areas for expansion location. Weakly undulating plains and slopes of limited erosion potential (10^0—20^0) were identified as moderate suitable. Steep slopes occurring in the hilly relief and characterized by high erodible potential 20^0—35^0 classified as less unsuitable >35^0 not selective. (Mesfin,2019).

3.3.3.6 Weighted Overlay Analysis

Land suitability map for urban expansion has been extracted using weight overlay techniques. Application of GIS and AHP in the process of land suitability analysis is an effective way for urban land suitability assessment .Choosing the suitable land for urbanization means assign such things as land cost ,proximity to existing service ,slope ,and flood frequency (Suresh and Sivasankar 2017).Weighted overlay is tool in spatial analyst tool that overlay several raster data sets using common measurement scale and weight each according to its important .The reclassified raster's were overlay together in order to produce a suitability map identifying suitable land .For the weighted overlay analysis to be successful the raster dataset must be in integer (Rakiat 2016) .

In this research map layers was prepared by buffers and reclassify to determine suitability level .The reclassified map was assigned weight/suitability/and overlaid together. Finally suitable land for urban expansion of study areas was selected.

Weight overlay was processed by all data first converted in to raster data with the same resolution. Each data of the research was given weight as slope 22%,urban center distance 8%,ground water potential 20%,road accessibility 11% ,LULC 6% ,river and drainage distance 3%,soil depth 25% and soil texture 5% after given weight to each then by using a software ARC GIS 10.3 arc toolbox, special analysis tool, weighted overlay process was assign suitable site .(Pathan and Shukla et al., 1991).

(Sokhi and Rashid, 1999) Urban planning is a complex phenomenon expansion

Urban Developments Plan Formulation and Implementation (UDPFI) Guidelines: By Appling AHP (satty, 1980) a matrix was constricted where each criterion is compared with the other criteria, relative to its importance on a scale from 1 to 9. .

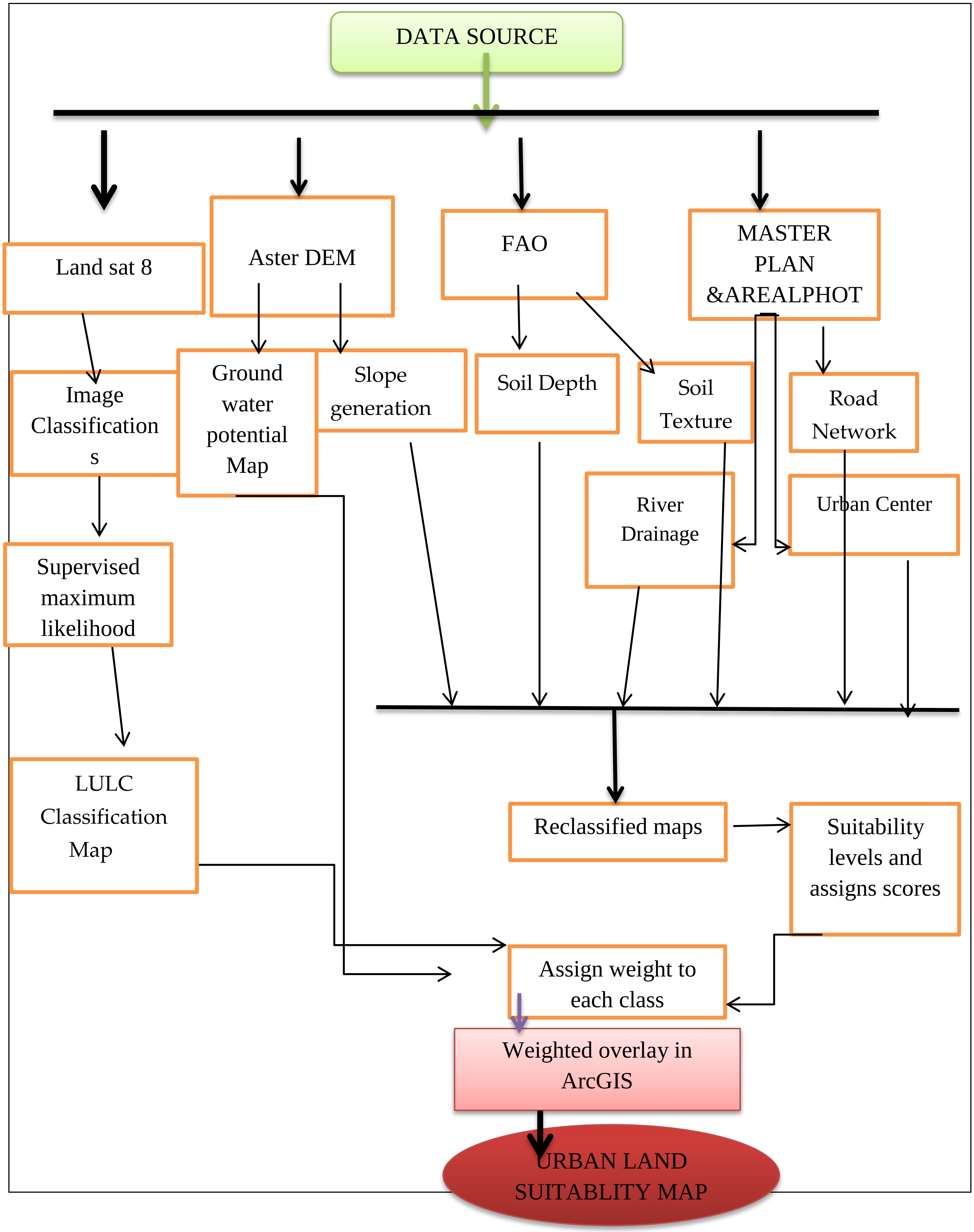


Figure 2 A methodological work flows for urban land suitability analysis

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1. Urban land suitability analysis for the provision of amenities in Mizan-aman town

The identification of suitable land for urban area to settlement is an important fundamental work in urban planning. The physical parameters affecting the suitability of land are discussed below. The cumulative effect of these factors determines the degree of suitability land and also helps in identification of suitable area to settlement. The various factor map layers generated to serve this purpose are; to assessment of suitable land for settlement area ,each evaluation criterion is represented by a separate map in which a degree of suitability with respect to that particular criterion is qualified to each unit of area .These degrees of suitability need to be rated according to relative importance of contribution made by that particular criterion, achieving the ultimate objective .Different land qualities ,which can consider for evaluating suitability for settlement area relate presented; land use land cover, proximity of road network ,groundwater existence ,urban area distance ,soil texture and depth and slope.

4.1.1. Land use / Land cover map

Land use/Land cover map has been prepared by using landsat8 satellite image comparing with aerial photograph, Google earth and random GPS point data from Google earth for accuracy assessment. The land use/cover information help in formulation of policies and programmers for urban development. The main classes which affect planning aspect, such that built up area, agricultural and open land, Forest and water body & wet land are consider here and the area covered under each the classes of LULC is given below.

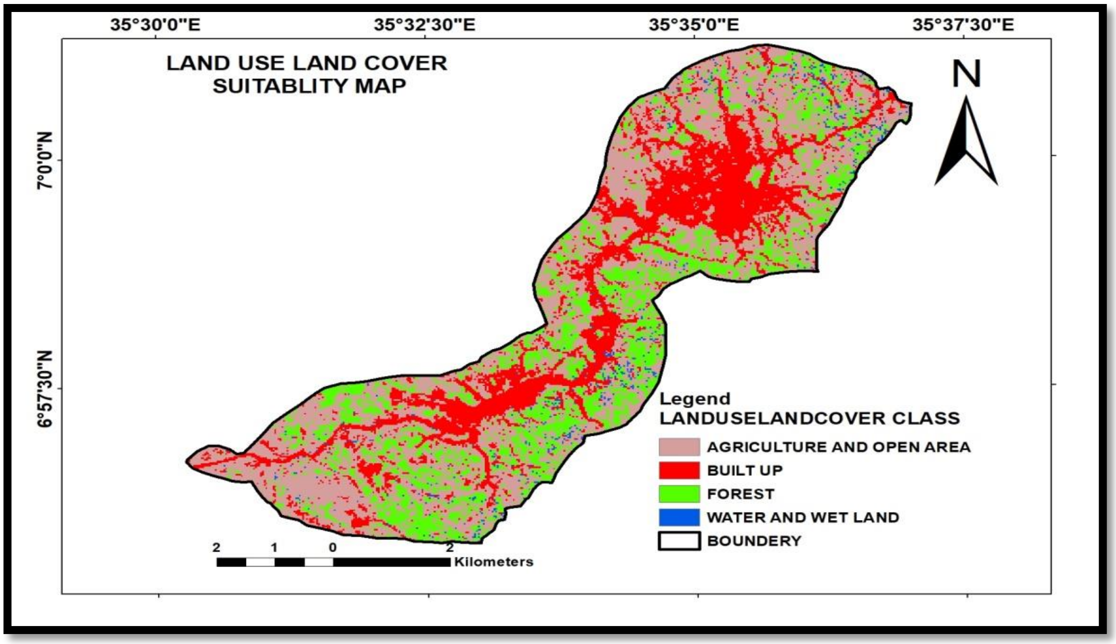


Figure 3 LULC map of the study area

Table 3 Distribution of land use land cover pattern

No	Land use land cover classes	Suitability classes	Area in hectare	Area in percent
1	Agricultural and open area	Highly suitable	2110.96	51.16%
2	Built up area	Moderately suitable	1055.22	25.56%
3	Forest	Less suitable	926.80	22.46%
4	Water body and wet land	Not suitable	32.99	0.799%
	Total		4126.	100%

Information on LULC classes is crucial in locating suitable site for urban development(Kmal,2017) .It may be noted that already built up area is not highly suitable for the future development because once building is constructed ,it remains for minimum 50-75 years .

Likewise, water body and wet land is not suitable for future development for residential and other urban use and also. Rural area and their surrounding pasture lands are called. ”Lai Dora” which is avoided by government in future plans for urban growth .Therefore; these areas are considered suitable for future growth .Thus, open land agriculture land both within and in immediate peripheral areas is the most suitable land for urban development.(Mesfin Girma,2019)

The classification of LULC classes result as follow

Built up Areas

The total area covered by Built-up in the town is about 25.56%. This is the second largest land use category in the town. It includes residential land, formal houses, mixed type residential land use, hotels, recreational centers, governmental bodies, private and governmental industries the road, parks, few informal settlements and other infrastructure of urban areas. The Urban or Built-up category takes precedence over others when the criteria for more than one category are met. For example, residential areas that have sufficient tree cover to meet Forest Land criteria were placed in the Residential category.

Water Body and Wetland area

The water body in the town includes the kosocol river, gacheb river, shonga river and different small rivers and wetland areas which cover (32.99ha) .This water bodies has great potential for the source of drinking water and to make green and smart the town for urban dwellers. This natural gifts plays significant roles, for making green the urban areas, in order to create suitable atmospheric conditions and makes a buffer area .The ecosystem in which the town is situated in general of great recreational values.

Agriculture and open area

Agriculture is the back bone of our economy and the area covered by agricultural activities in Miza-aman town is about (2100.96 ha) the areas different agricultural uses are notable on the town land use. In the pre-urban where the land is under the holding of peasants, crop production is widely practiced. This is however an interim period activity until the land is claimed for urban function development. These areas are mainly out of the town built up boundary. In contrary to this activities like animal husbandry, commercial flower productions and related activities predominantly found within the built up town boundary.

Forest land

Forest Lands have a tree-crown areal density (crown closure percentage) of 10 percent or more, are stocked with trees capable of producing timber or other wood products, and exert an influence on the climate or water regime. Forest land generally can be identified rather easily on high-altitude imagery, although the boundary between it and other categories of land may be difficult to delineate precisely. Lands from which trees have been removed to less than 10 percent crown closure but which have not been developed for other uses also are included. For example, lands on which there are rotation cycles of clear-cutting and block planting are part of forest land. The suitability classes for urban land suitability were 1, agricultural and vacant area 2, urban area 3, forest and water body &wetland area their suitability were respectively 1, 2, 3 and4.

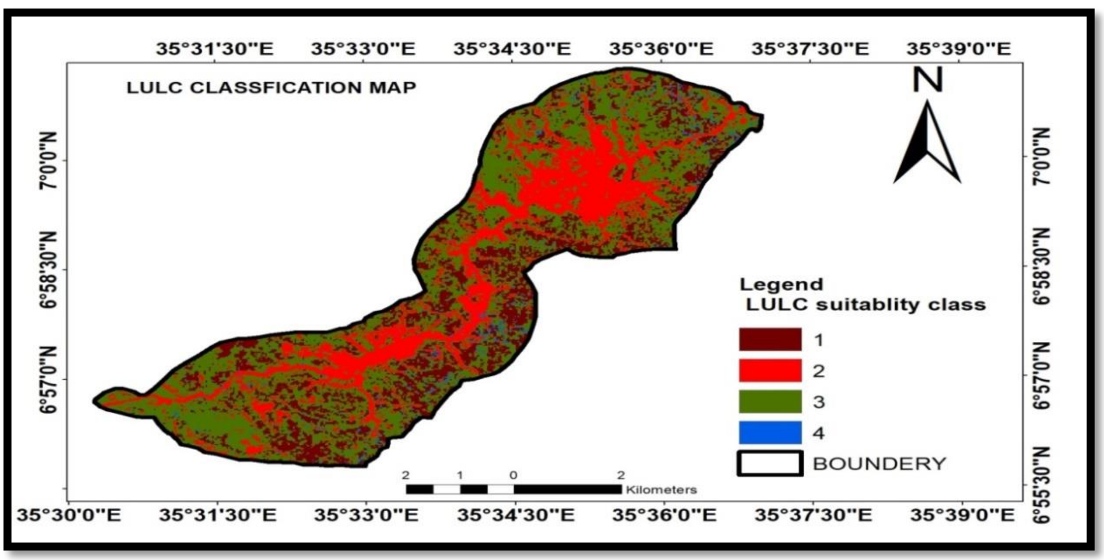
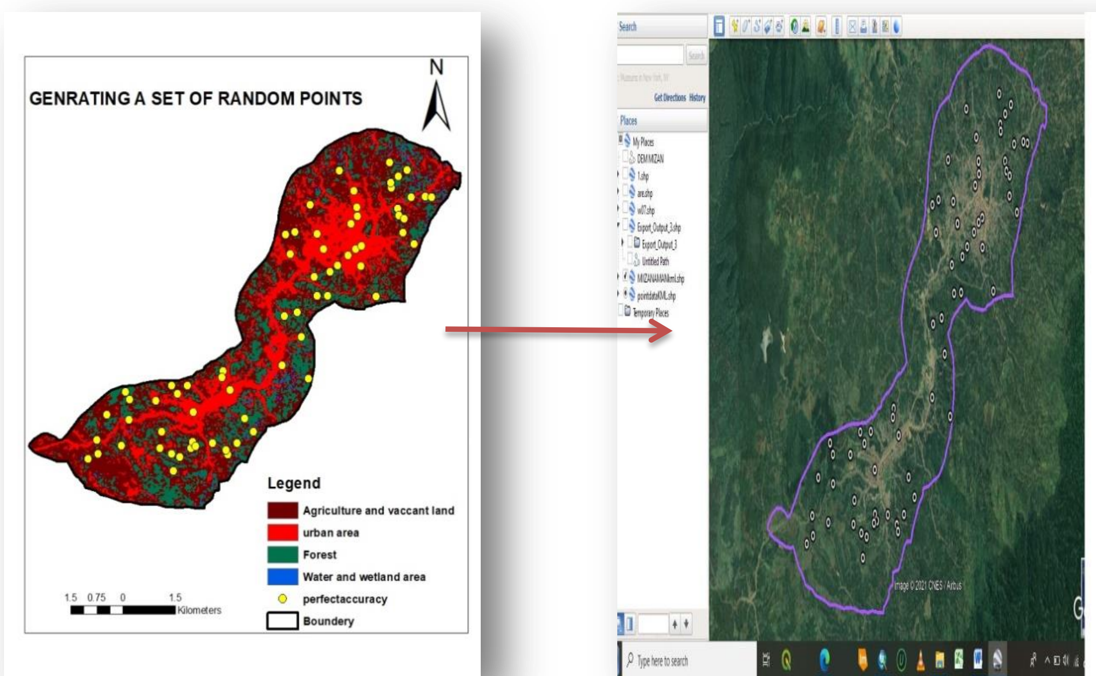


Figure 4 LU/LC suitability class map

4.1.1.1. Results in accuracy assessment in LULC classification

The accuracy assessment of land use land cover classification of Landsat-8 analyzed using ERDASE IMAGIN 2015 by supervised classification scheme was used to classify the images. Under land use and land cover, 70 random Points were generated in Arc GIS and converting random points to KML in order to open in Google Earth. Each random point's value verified from Google Earth for accuracy assessment. Google Earth pro was used to measure of how many ground truth pixels are correctly classified. The result shows that total (overall) accuracy of land use land cover was 88.57% and Kappa (K) is 85% which was acceptable in both accuracy total (overall) and Kappa accuracy.

Google Earth represents a powerful and attractive source of positional data that can be used for investigation and preliminary studies with suitable accuracy and low cost. Since Images from Google Earth with high spatial resolution are free for public and can be used directly in land use land cover mapping in small geographical extend. A study which was conducted by (Abineh and Zubairul, 2015), and the result of accuracy assessment of land use land cover with the help of Google Earth was more than 75% which is acceptable. After image is classified, generating a set of random 70 points was done in Arc Map. Then the value of each random points were identifying from Google Earth image.



A B

Figure 5 Generating random points in Arc Map (A) opening the points in Google Earth (B).

Table 4 . Accuracy assessment of land use land cover: 2020/21.

No	LULC	Agricultural &open land	Built up area	Forest	Water body and wetland	Total	Producer accuracy
1	Agricultural &open land	19	0	1	0	20	
2	Built-up area	1	20	3	0	24	
3	Forest	1	0	17	0	18	
4	Water body and wetland	0	0	2	6	8	
Total		21	20	23	6	70	
User accuracy							

- **Overall accuracy**

The overall classification accuracy = (No. of correct points/total number of)*100

Total (overall) accuracy= (19+17+20+6)/70

Total (overall) accuracy = (62/70)*100

Total (overall) accuracy =88.57%

- **User accuracy**

Agriculture &open land = (19/20)*100 =95%,

Built up area = (20/24)*100=83.33%

Forest= (17/18)*100= 94%

Water& wetland area= (6/8)*100=75%

- **Producer accuracy**

Agriculture &open land = (19/21)*100=90%

Built up area = (20/20)*100= 100%

Forest= (17/23)*100=73.91%

Water &Wetland area = (6/6)*100=100%

- **Kappa coefficient**

K = (70(19+17+20+6)-(20*21+18*23+24*20+8*6))/70^2- (20*21+18*23+24*20+8*6)

K = (70(62)-(420+468+480+48))/4900-(420+468+480+48)

K = (4380-1416)/ **(**4900-1416)

K=2964/3484

K=0.85

K=85%

4.1.2. Slope map

Slope of the town is ranging from 0^0 to 40.76degrees. Slope is a measure of terrain steepness; it is the degree to which land is not horizontal. Slope has an impact on the urban land suitability of an area. A zero slope indicates flat ground while DEM presented in the study area ranging from 1264m—1692m above sea level slope generated from DEM in ArcGIS 10.3 arc tool-surface-slope—re class is called slope. And then the slope map was reclassified to achieve the required urban land slope status (Mesfin, 2019). The slope map was reclassified to suitability classes according to Global urban land expansion status. The slope map clearly indicates that maximum wards of the town have gentle slope of less than 10^0. From this suitability status of Mizan_aman town is, 72.5% of the area is (1^0--10^0) under highly suitable, 24.38% of the area is between $10^0$and 20^0 moderately suitable, 3.02%of the area is between20^0and35^0 less suitable and 0.072% of the area is>35^0 not suitable. Steep slope areas are not advisable for urban expansion

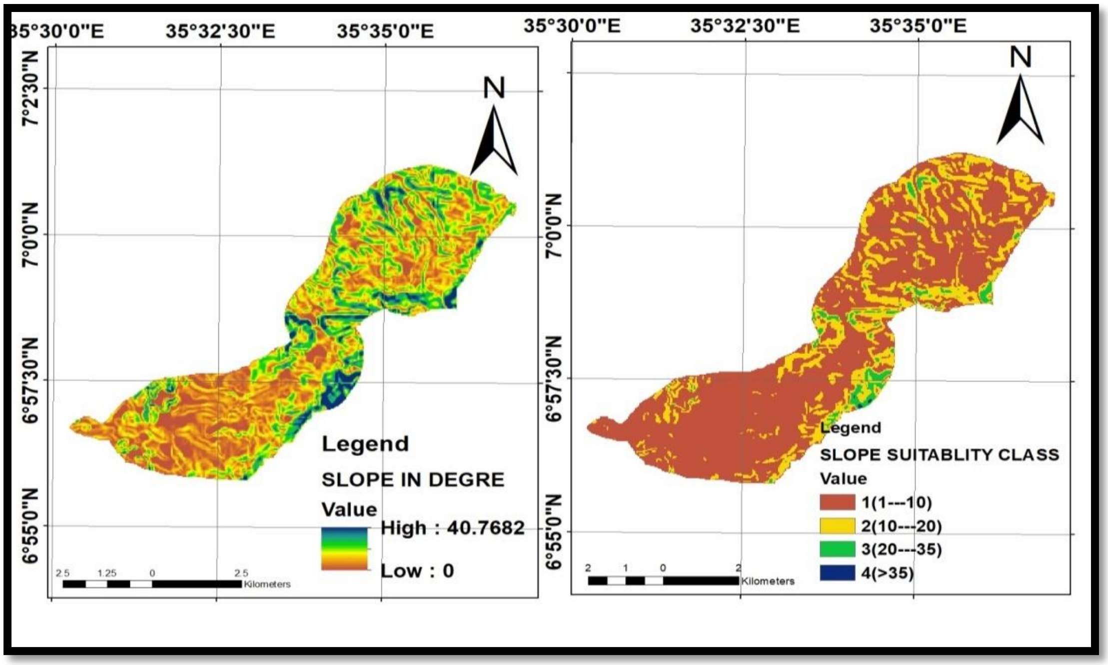


Figure 6 Classification of Slope and Its suitability map to the study area

Table 5 slope of suitability class and its area

Parameter	Classes (4)	Suitability class	Area in hectare	Area in percent
Slope	1^0--10^0	Highly suitable	2293	72.5
	10^0—20^0	Moderately suitable	1005	24.38
	20^0—35^0	Less suitable	125	3.02
	>35^0	Not suitable	3	0.072

4.1.3. Proximity to Road network:

The road network is one of the important parameter in identifying the areas for urban development as it provides linkages between the settlements and different area of the town. The entire area has been classified as major road and minor road. Most of the villages are connected by motorable metalled roads. For the purpose of urban land use suitability analysis, all important roads have been taken from the master plan of town and for accuracy comparing using Google earth image. Buffer zones of 200m, 400m, 600m and >600m on either side of roads by using ARCGIS Euclidian Distance have been generated based on expert opinion and (Mesfin, 2019). (Refer to figure7).

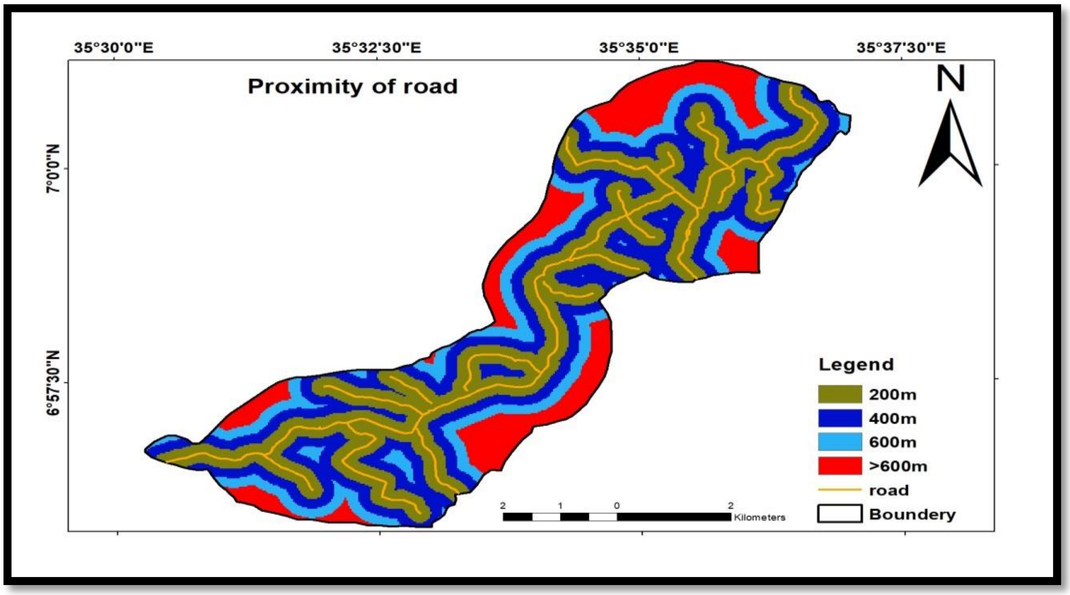


Figure 7 Road buffer zone map

The proximity of roads to expansion areas is considered as an advantage because such roads are used as a source for transportation. Areas lying close to the roads are considered the best and are assigned a class value of 1(highly Suitable)

Table 6 Proximity of road network map and its area (Sao, 2000)

Factor	Distance of the area from a road (m)	Suitability class	Area in hectare	Area in percent (%)
. Proximity to Road network	200	Highly suitable	1608	38.97
	400	Moderately suitable	1169	28.37
	600	Less suitable	613	14.86
	>600	Not suitable	736	17.83

The road was one of the important parameter in identifying the area for urban development as it provide connect to different parts of the town .In this study that found out the accessibility of region major and minor road which was provide connectivity to different area have taken from master plan and comparing from Google earth engine 2020 of Mizan-aman town. Effort had been made here to locate the site nearer to any existing road if possible. In order to find out better accessibility to the existing road ,buffer zones have been created by taking distance 200m,400m,600m,and >600m from the road center to generate road proximity map. The suitability classes of the road is 1,200m buffer is highly suitable area that is (1608ha) 2, 400m buffer is moderately suitable that is (1169ha) 3,600m buffer is less suitable that is (613ha) and 4, >600m buffer is not suitable area (736ha) consider. (Sao, 2000) .This classification of road suitability is as follow Fig.8 below

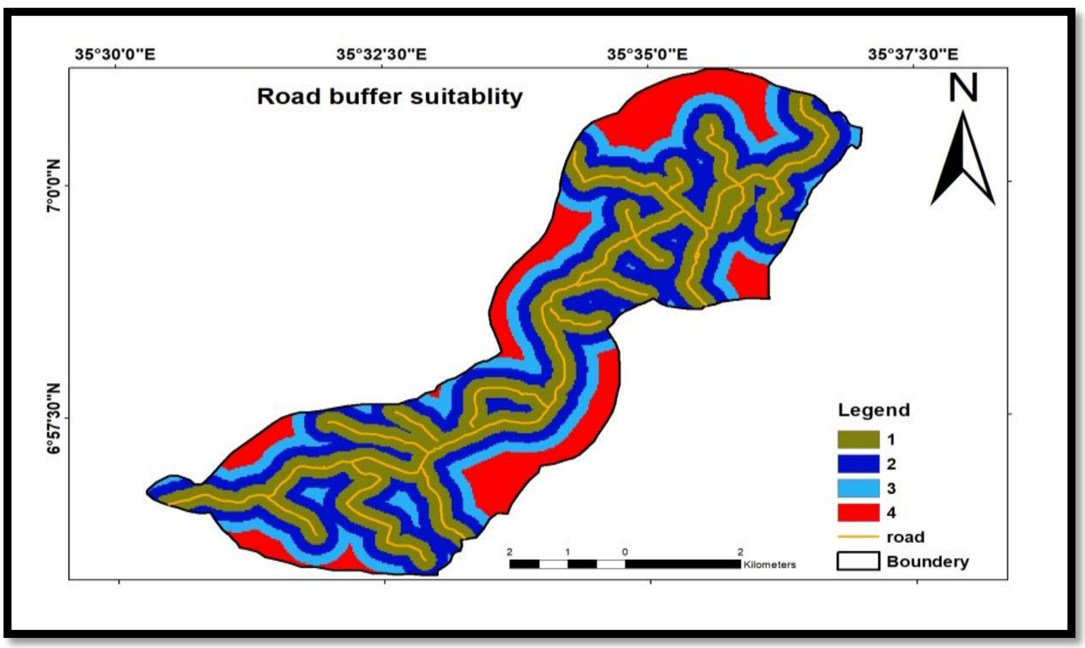


Figure 8 Road buffer suitability class map

4.1.4 **Urban center proximity**

Urban center map is prepared based on Mizan_aman municipal master plan of the town. It is considered due to the reason that the cost of future urban development depends on proximity to the urban centers. That is way proximity to urban built land assigned higher importance than area which located away from the center of a town land on the basis of accessibility to "urban center "land buffer zone were prepared the buffer which nearer already urban center land has been given higher suitable value and as we go away from a urban center the value decrease .proximity to center as shown below.

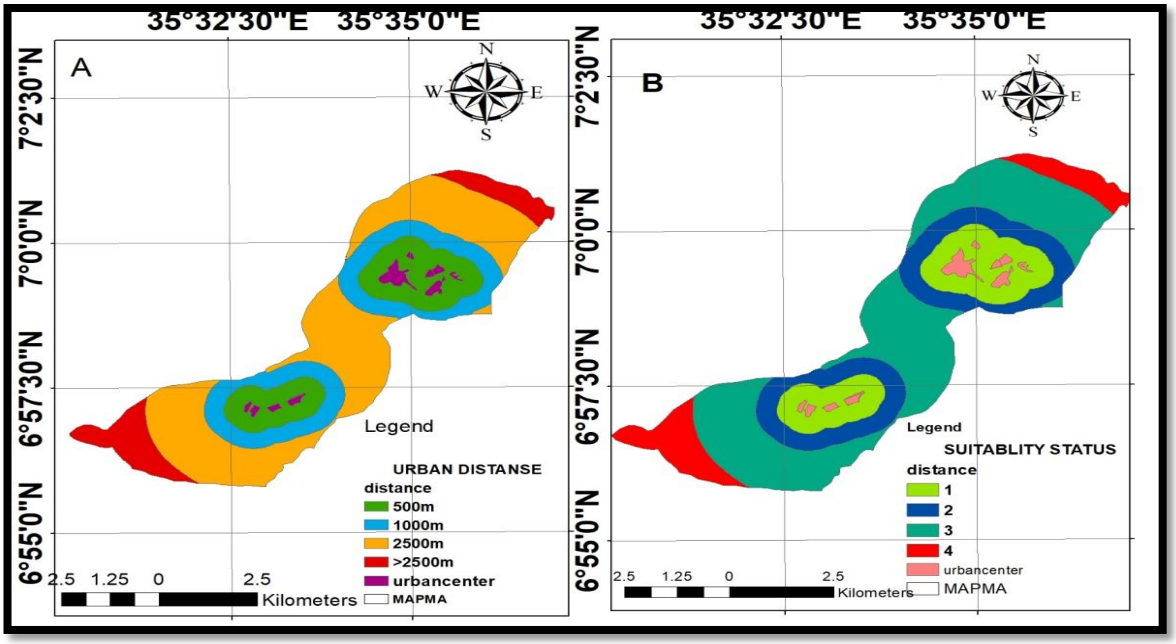


Figure 9 Proximity to Urban Center and Suitability Area map

It is considered due to the reason that the cost of future urban development depends on proximity to the urban center area. The total area of a town was considered in urban development studies center of the town is already well constructed and developed, priority is expected to be given to the peripheries of the town for further development (Suraj *et al.*, 2014). Master plan helps to digitize urban centers. Therefore, areas within 1, (500m buffer area are highly suitable) 2, (1000m buffer area are moderately suitable) 3, (2500m buffer area are less suitable) 4, (>2500m buffer area are not suitable) Proximity to already urban center area was an important determinant of the cost of future urban development depends. Based on this suitability analysis highly suitable for urban center is 1706 he (41.35%) area of total area, 1513he (36.67%) area is under moderately suitable, 744he (18.03%) was less suitable and 163he (3.95%) of a total area was not suitable to urban area development under distance from a center of a town. (Malczewski, 2004)

Table 7 Proximity to urban center suitability class and its area

Parameter	Distance (m)	Suitability class	Area in hectare
. Proximity to urban center or built up area	1--500	Highly suitable	1706
	501--1000	Moderately suitable	1513
	1000--2500	Less suitable	744
	>2500	Not suitable	163

Figure 10 Aerial photography2009 E.C of some part to Urban Center of Mizan- aman Town

4.1.5. Soil depth

Soil types vary from place to place because of variation in, topography, parent material, biological activities and time. The relative humidity of the site reaches 80 to 90%, and the soil is classified as sandy loam and it is dominated by a gravely clay geologically its rock more.

By considering this from classification of soil depth, **1**(deep soil is highly suitable soil for urban area settlement development that is 40.31he area of a town is deep soil). **2**(Moderately deep soil is moderately suitable for urban area expansion development that is 3910.83he area of a town is moderately deep soil).**3**(Shallow soil for this condition between 56cm and 45cm depth this is less suitable for urban area expansion development is 175.42he area of a town is shallow).and no area is not suitable for urban land expansion. (FAO, 1976).in present case land suitability is undertaken for urban development, therefore, land with low fertile soil has been assigned higher value than those with fertile soil for urban development .as already mention that" open area", and" agricultural land "offer the best choice for urban development

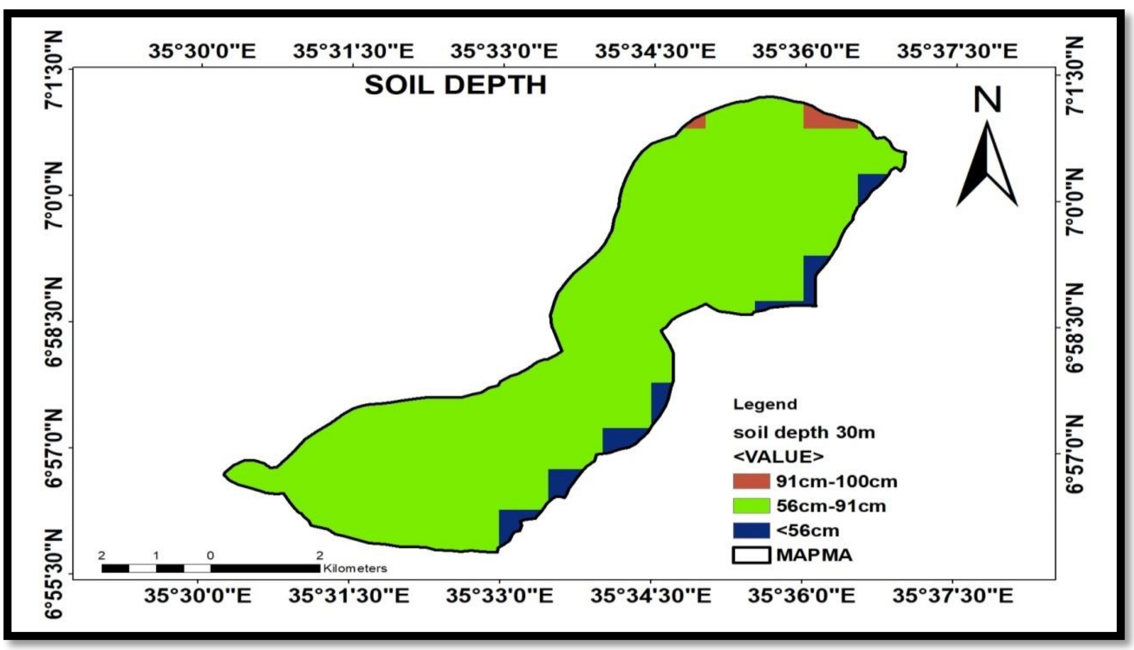


Figure 11 Soil Depth Class map to study area

There for based on this concept Mizan-aman soil is (100cm to 46cm) depth, so this depth categorized in to three classes they are

I, Deep soil which is greater than 90cm

II, moderately deep which is between 90cm and 56cm depth

III, Shallow which is between 56cm and 46cm.deep.

Table 8 Soil depth and suitability class

Soil depth in cm	Suitability classes	Soil Depth class name	Area in percent
>90	1,Highly suitable	Deep soil	0.977%
90 and 56 depth	2,Moderately suitable	Moderately deep	94.76%
56 and 46.deep.	3,Less suitable	Shallow	4.25%

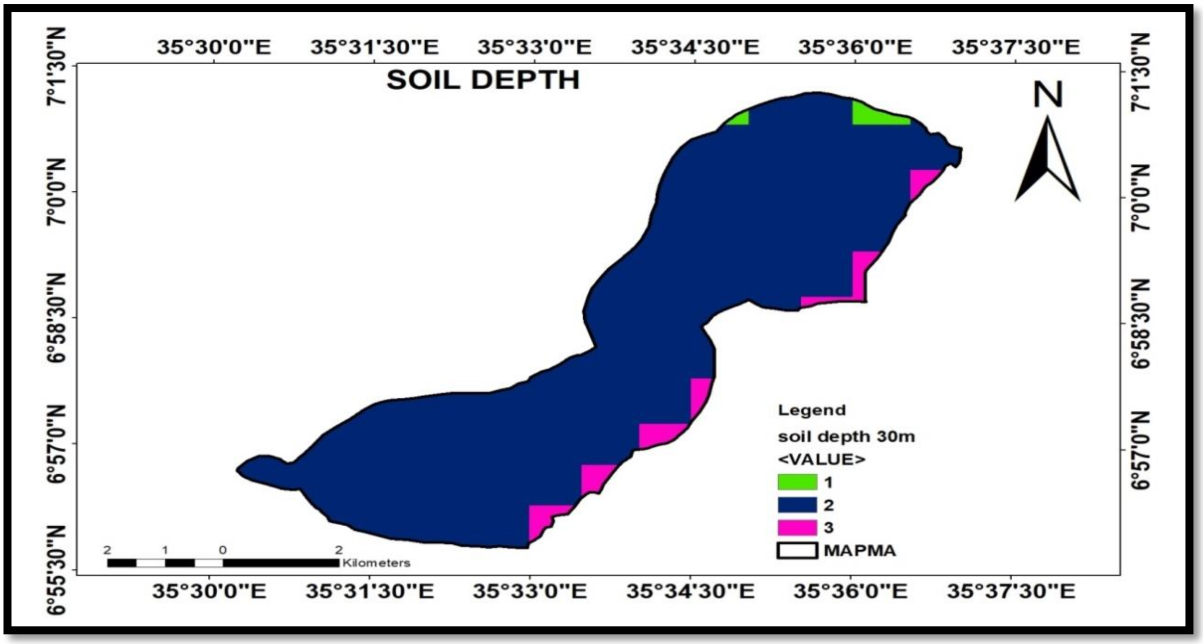


Figure 12 Soil Depth Suitability map

4.1.6. Soil texture

It is an important aspect with respect to the stability of foundations. Clayey soils increase in volume due to absorption of water and may result in differential settlement of foundations resulting in their failure. Therefore, highly clayey soils are less suitable and sandy soils are more suitable for foundations (Raghunath, 2006). The soil map prepared by source FAO and by taking data from Bench-sheko zone Agriculture office is being used for extracting the soil depth and soil texture layers. Each polygon has the information related to the association of soil series. From these soil types, soil depth and soil texture have been separated out and the maps have been prepared separately.

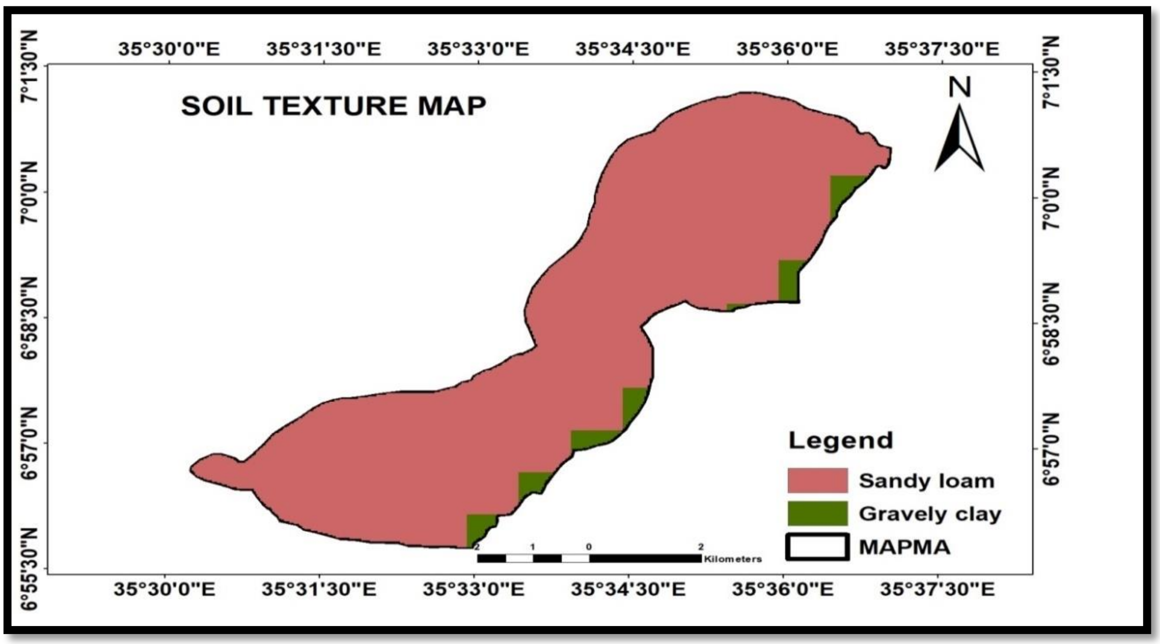


Figure 13 Soil Texture map of the study area

The extent and spatial distribution of soil depth and soil texture play an important role in urban suitability analysis. Soil texture can one of factor for urban land expansion so from a classification of soil texture 1, sandy loam soil that is around 90% of a total soil so 3961.45he area is under highly suitable soil texture for urban land area expansion development and gravely clay is moderately suitable for urban land development that is 165ha is gravely clay soil of a study area. (FAO, 1976

Table 9 Soil texture and suitability class

No	Texture Soil	Suitability class	Area(Ha)
1	Sandy loam	highly suitable	3,961
2	Gravely clay	moderately suitable	165

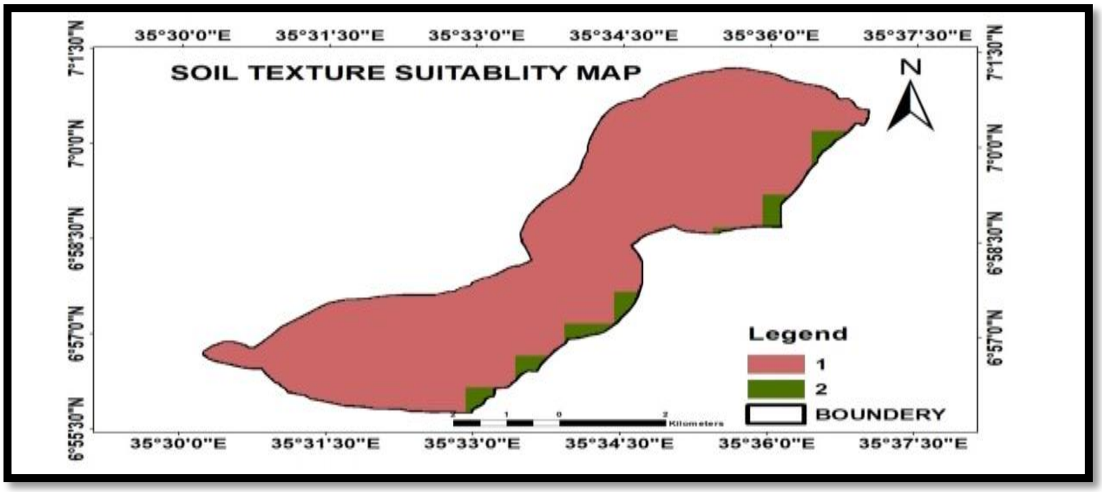


Figure 14 Soil Texture Suitability map of the study area

4.1.7. Ground Water potential

In the geology of environments like Mizan-aman in tertiary volcanic rocks characterize the area ground water could be expected within secondary porosity. $i.e.$ Existence of sufficient fracturing and mothering, where fracture zones intercept water course it is believed that deep ground water recharge could be enhanced. However through the area has several streams and receives sufficient rainfall fracturing in the area generally poor. The approach previously and attempted tolerate bore holes skies but the trial did not give satisfactory results the yield from all wells was less than 1 l/s. (Gibbs, 1995).

The advance of GIS and RS technics has brought a more efficient way for groundwater potential mapping .When data scarce area this technics was encounter loss of issues to the limited data. The groundwater potential is related with many factors, such as geological feature, terrain feature, hydrological feature, etc. Digital elevation Model (DEM)is the digital representation of the topography ,the technological advance provide by GIS and the increasing availability and quality of DEMs have greatly expanded the application of potential DEMs to many application in many fields(Moor and Grayson et al.,1991).Among those factors related to groundwater potential mapping ,most of the information has been proved can be extracted from DEM data ,and this made extracting relevant feature from DEM for ground water potential zone using DEM .Among these extracting factors were lineament density, drainage networks density, topographic wetness index (TWI), relief and convergence index (CI).These were crucial for groundwater potential mapping. These five determining factors were extracted to weighted overlay analysis was carried out by ArcGIS software was applied to obtain the final groundwater potential map (Liu, Zhai and Yan et al., 2015).

Relevant feature from DEM by categorizing 1,Exellint zone 2,Very good 3,Moderate 4,Poor.So that have 181.79he, excellent ,3070.34he, very good ,845.37he moderate and 27.52he, poor respectively .

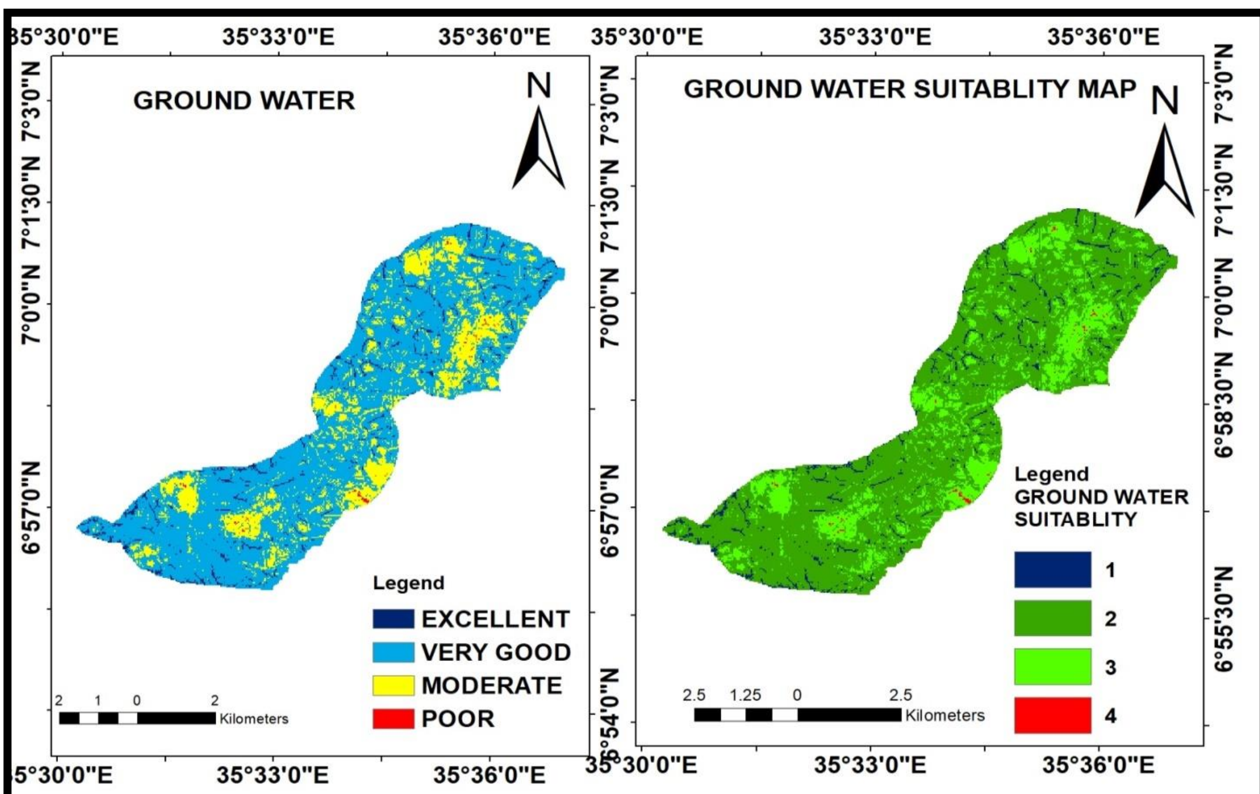


Figure 15 Groundwater Prospect and its Suitability map of the study area

Existing hydro-geo-morphological map being prepared by advance of GIS&RS techniques has brought a more efficient way for ground water potential mapping from DEM extraction of TWI,CI, liniment density ,drainage network density on the basis of geology, geomorphology and structure has been used for extracting ground water prospects map(Lee S, 2011). Hydro-morphologically, the study area has been divided into four zones depending upon the ground water prospects in different geomorphic units. These four zones are 1) Excellent zone, 2) Very good,3) Moderate, 4) Poor.

. **Table 10 Ground water prospect zone area**

No	Ground Water Prospects	Area(Ha)	Area in %
1	Excellent zone	181.79	4.41
2	Very good	3071.34	74.43
3	Moderate	845.37	20.49
4	Poor	27.52	0.67
	Total	4126	100

4.1.8 Proximity to river drainage network

In this study, the rivers have been mapped by recent aerial photograph of the town and comparing with Google earth and master plane of the study area. The area near the river bodies not suitable for settlement because of suspected to flooding. Accordingly, analysis tools were used to prepare multiple polygons around each river within the following distances: 200m, 400m, 800m, and >800m proximity respectively. The proximity map was reclassified into four classes and weights were calculated using data analysis. Accordingly, more weightage was assigned for more suitable areas (200m—400m). Low weightage was given for >200m proximity class this is based on expert opinion.

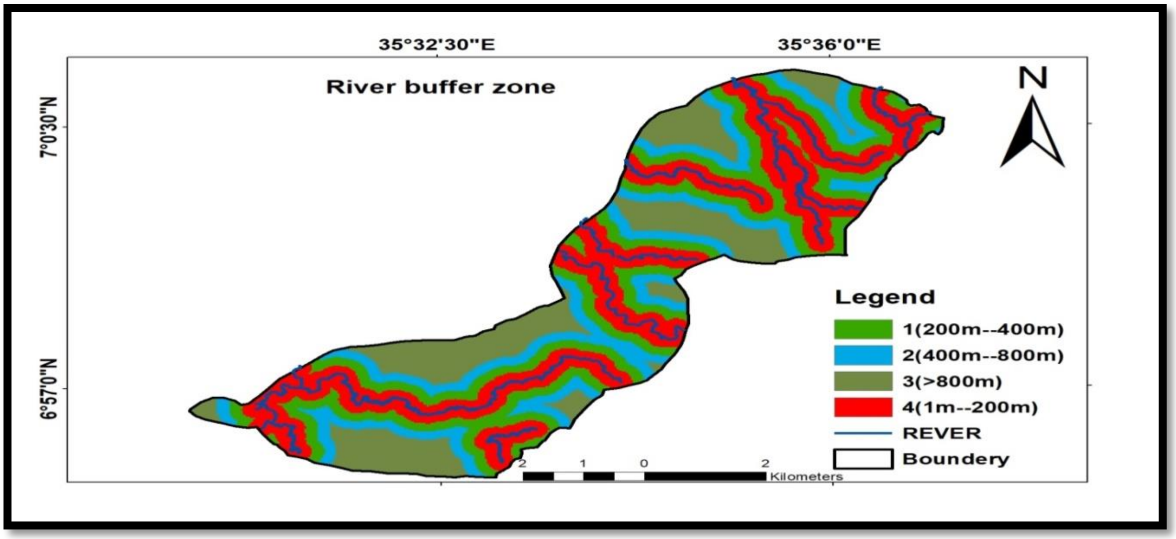


Figure 16 Proximity River drainage map

Proximity Distance to River and drainage each class area of the area

1 Excellent is 200m to400m which has 1005 ha

2 Very good 400m to 800m, this has 728 ha

3 Moderate distance buffer > 800m which have (960ha) and

4, Poor lessen than 200m distance which have 1433ha

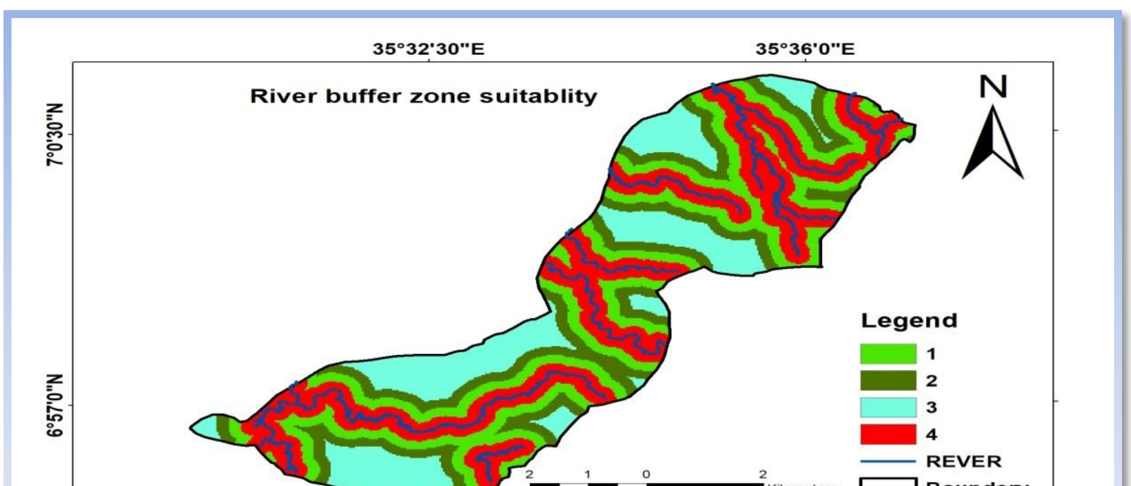


Figure17 proximity river and drainage suitability map the study area

Factor map scale		1(Highly suitable	2(moderately Suitable)	3(Less suitable	4(Not suitable)	Total	Weight
Topography	Slop(degree)	1^0---10^0	10^0---20^0	20^0---35^0	>35^0		22%
	Area(ha)	2993	1006	125	3	4126	
	Area (%)	72.5	24.38	3.02	0.072	100	
	LULC(type)	Agriculture and vacant	Urban area	Forest	Water wetland		6%
	Area(ha)	2110.96	1055.26	926.83	32.99	4126	
	Area (%)	51.16	25.56	22.46	0.799	100	
Soil	Soil depth(cm)	91---100	56---91	<56cm		4126.56	25%
	Area(ha)	40.31	3910.83	175.42			
	Area (%)	4	94	2		100	
	Soil texture(type)	Sandy loam	Gravely clay	--------	______		5%
	Area(ha)	3966.49	159.61	------	____	4126	
	Area (%)	96.13	3.87			100	
River Drainage	River drainage buffer distance(m)	200---400	400--800	>800	<200	4126	3%
	Area(ha)	1433	1005	1204	484		
	Area (%)	34.73	24.35	29.18	11.73	100	
Road	Road buffer distance(m)	200	400	600	>600		11%
	Area(ha)	1608	1169	613	736	4126	
	Area (%)	38.97	28.33	14.86	17.83	100	
Urban center	Urban center buffer(m)	500	1000	2500	>2500		8%
	Area(ha)	1706.5	1514.17	741.34	164.35	4126	
	Area (%)	41.36	36.69	17.96	3.99	100	
Groundwater	Ground water	Excellent	Very good	Moderate	Poor		20%
	Area(ha)	182.18	3070.72	853.75	19.9	4126	
	Area (%)	4.51	74.41	20.60	0.48	100	

Table 11 Environmental requirement rating and influence for urban area

4.2. Weighted Index

One of the classic problems in decision theory or multi-parameter analysis is the determination of the relative importance or weights of each parameter with respect to the other. This is a problem which requires human judgment supplemented by mathematical tools. As all factors of the land cannot be weighted equal for the suitability assessment, it is essential that a weighted method needs to be employed where the relative importance of the parameters defines the weightage. A number of methods are available to deal with such problems.

Saaty's Analytic hierarchy process(AHP) is a most widely accepted method for scaling the weights of parameter by constructing a pairwise comparison matrix of parameters whose entries indicate the strength with which one element dominates over another. The pairwise comparison matrix of parameters results into importance matrix which is based on a scale of important intensities and is generated by a group of experts. The Saaty's scale of importance is presented in. the importance matrices for EIGHIT factors were generated based of Saaty's guidelines mentioned below Table 13.

Table 12 Saaty scale of rating influence of factors

No	Intensity of influence	Definition	Explanation
1	1	Equal importance	Two factors influence equally to objective
2	3	Somewhat more important	Experience and judgment slightly one over the other
3	5	Much more important	Experience and judgment strongly favor one over the other
4	7	Very much more important	Experience and judgment are very strongly to favor one over the other. Its importance is demonstrated in practice
5	9	Absolutely more important	The evidence favoring one over the other is of highest possible validity
6	2,4,6,8	Intermediate values	When compromise is needed

4.3. Ranking, Rating, Development of the pairwise comparison matrix and Weighting Factor Maps

The suitability result in this thesis included four steps: identify site selection constraint and suitability factors, rating and ranking the suitability factors, develop pairwise comparisons matrix, weighing the factors selected and finally implementing the suitability result. Rating, ranking, development of the pairwise comparison matrix, and weighting are the remaining procedures discussed below

4.3.1 Ranking

After multi ring buffer distance calculation, reclassification of the raster layers has been carried out. Reclassification is indirectly refers to putting the suitable values (ranks) in their suitability order. This was done simultaneously during the reclassification process (Meaza 2009) Ranking and specifying the suitability class values have been made based on document analysis and experts comment. The ranking of suitability classes are grouped in to four suitability classes namely high suitable, moderately suitable, less suitable, and not suitable. Accordingly, permanently not suitable areas, area that are rejected from consideration are ordered with suitability rank of 4 while suitability class 1, 2,3 and 4 are ranked as high suitable , moderate suitable , less suitable and not suitable respectively.

Table 13 Ranking System for the Categories of Factors/Parameters

No	Factor	Range values defining			
		1	2	3	4
		Max	Limitation		Min
1	Land use /land cover	agricultural and vacant land	urban area	Forest	water body and wet land
2	Ground Water Prospects	excellent	very good	Moderate	poor
3	Soil Depth	91cm---100cm	56cm---91cm	<56cm	----
4	Soil Texture	Sandy loam	Gravely clay	-----	----
5	Proximity to urban center	500m	1000m	1500m	>2500m
6	Proximity to Road	200m	400m	600m	>600m
7	slope	1^0--10^0	10^0--20^0	20^0--35^0	>35^0
8	River drainage buffer	200m—400m	400m—800m	>800m	<200m

4.3.2. Rating

Once the suitability classes are ranked in order, to the next step was too numerically value a given factor based on extent of strengthen or weakness of influencing a given variable in comparison with the others. Rating is refers to an evaluation, usually expressed in numerical terms, of how suitable a site is supporting a specific land use (Meaza, 2009). Numeric scores to a total of four are assigned to each factor attribute class. Comparisons between classes were based on their level of suitability with respect to the choice of optimal site selection for a urban land expansion. Since environmental factors for each specific study areas are different with others, there is no uniform standard for rating factors. For this thesis however, factors are rated based on the situation of study area, review of literatures and suggestion from experts. For example, a site having a slope over 35^0 degree is assigned a rating of 4 (rejected area) while area with slope steepness between 1^0 and 10^0 degree is rated one (highly suitable) for the location of a urban land expansion site. This is related to cost of construction, transport and accessibility issues.

4.3.3. Development of the pairwise comparison matrix

A pairwise comparison matrix was developed with the support of the main and sub-factors. After the development of the ratio matrix, each main and sub-factor was normalized. Then, the relative weights were calculated for each factor using the pairwise comparison method

Table 14 ANALYTICAL HIERARCHY PROCESS (AHP) DERIVATION

No	SD	SLP	GW	RDN	LULC	URC	ST	SW	Criteria weight
SD	1	2	2	2	4	3	4	9	0.246465
SLP	1/2	1	2	3	3	3	3	7	0.220076
GW	1/2	1/2	1	2	4	3	4	6	0.198055
RDN	1/2	1/3	0.5	1	3	1	3	4	0.113291
LULC	1/4	1/3	1/4	1/3	1	1/2	1	4	0.059064
URC	1/3	1/3	1/3	1	2	1	2	2	0.083453
ST	1/4	1/3	1/4	1/3	1	1/2	1	2	0.051921
SW	1/9	1/7	1/6	1/4	1/4	1/2	1/2	1	0.027674

SD = Soil depth, SLP = slope, GW = Groundwater Prospect, RDN= Road Network, LULC= land use land cover URC=urban center, ST=soil texture, SW-surface water

4.3.3.1. Calculation of Consistency Ratio

The CR is important for identifying whether or not the study's comparisons are consistent. Condition 1: λ_{max} must be equal or greater than the number of factors used. The value of λ_{max} in this study = 8.308, which means that it satisfies this condition. Computation of consistency index (CI) is done using equation (1):

$CI = (\lambda_{max}\_n)/ (n\_1)$……………..1

CI= (8.30-8)/ (8-1) =0.042

CI=0.042

CR=CI/RI………………………….2

CR=0.042/1.41

CR=0.029

CR<0.10 ,

0.029<0.1

Condition 2: Consistency ratio, CR (0.029) <0.10, refers to the reliable level of consistency in the pairwise comparisons. Thus, the CR value meets the requirement of condition 2, indicating that the weights obtained are accepted

4.3.4. Combining and Weighting Factor Maps

In practice, it is usually it depends to give equal importance to each of the criteria being combined. This is because evidence needs to be weighted depending on its relative significance. Hence, each attributes are evaluated according to weighted criteria, resulted in a ranking on a suitability scale (Saaty, 2003). First ranks are given and based on their rank, their rate of influence or weights are determined using the ARCMAP 10.3 software. Finally, the resulted weights are converted in to percentage, which is mostly named as normalized weight. Normalized weight is obtained after dividing the weight of each factor by their total weight. Weight of factors and variables were determined depending on the importance of each 8 factor in comparison with the others in the same factor group as well as between environmental factors.

Table 15 Weight of each parameter

No	Factor	Weight	Weight in Percent (%)
1	Distance to Main Roads and Sub Road	0.113291	11.3=11
2	Land Use /Land Cover	0.059064	5.9=6
3	Slope	0.220076	22
4	Distance to rivers/streams	0.027674	2.7=3
5	Groundwater Prospect	0.198055	19.8=20
6	urban center	0.083453	8.3=8
7	soil texture	0.051921	5.1=5
8	Soil depth	0.246465	24.6=25
	Total	0.999999	100

As a point of departure, in this thesis work, priorities, ranks, rates and weights are given based on reviewing different literatures, personal judgments and including experts' idea. Soil depth, slope, ground water perspective were highly influencing factor for urban land area selection. Due to extent and special distribution of soil depth play an important role in urban land suitability, slope which are vulnerable to erosion and are not suitable for construction purpose. Also Geometrical feature control the distribution of runoff and ground water recharges and the structural of geometrical formation controls the occurrence, movement and quality of ground water the following table describes the details of the ranking, rating and weighting of factors in land suitability assessment in the town of Mizan-aman

4.4. Weighted Overlay Analysis

The Weighted Overlay method uses one of the most commonly used methods for overlay analysis to solve multi-criteria problems such as site selection and models of suitability. The reclassified map was assign weight by AHP based on their suitability factors. Finally, they overlaid together than the most suitable urban development site of the study areas was select

Saaty's Analytical Hierarchy process (AHP) is a most widely accepted method for scaling the weights of parameters by constructing a pair-wise comparison matrix of factors whose entries indicate the strength with which one element dominates over another parameter. The importance matrix can be analyzed by various methods like "Eigen Vector" method as proposed by (Saaty& Giap et al., 2003) has defined Weighted Overlay as a technique use to integrate and combine different factor maps with common measurement scale values to produce one final integrated output. The Weighted overlay Process allows us to set weights for as many different factors as we want to analyze. The weight establishes the relative importance of the factor under consideration. The sum of the weights must equal to 100 percent. Using the Weighted Overlay tool found under spatial analysis tools, the values of each dataset can be weighted and combined at one time (Giap et al., 2003).

So as to fit and overlap different factor maps, however, all inputs in the Weighted Overlay tool must contain discrete, integer values. Land use is already categorized into discrete values; for example open area and agricultural area with a value of one being the highest suitable land use type for an urban land area selection while far away from water body and wetland, are permanently it depends to distance of buffer to be suitable for land expansion site development. Therefore it was simply to adding this datasets directly into the Weighted Overlay tool and assign each cell a new value on the common measurement scale of four. It was now ready to combine the derived datasets and land use to find the most suitable locations. Afterward preparation of maps of all features like road buffer, soil depth, river buffer, slope map, ground water potential map proximity to urban center ,LULC and soil texture were converted to raster files and separate datasets were created using weightage and rank.For different layers having different scores were laid and the scores of each composite class were added. Finally, the suitability map was prepared

4.5. Land Suitability final map for urban land Development of Mizan-aman town

The weighted overlay technique has been used to extract a land suitability map for urban development. As mentioned above, the application of GIS and AHP in the analysis of land suitability is an effective way to assess the suitability of urban land. The assessment is based on a literature review that creates indicators of land use suitability influencing factors. Coverage mapping is a basic method of application in GIS and helps planners to obtain the final suitability map. On the other hand, in the weight value calculation process the attribute scores along with the weights combined by the AHP methods can be used..

The final output has been shown in land suitability map. In figure, 23 as could be seen the study area was divided into four different suitable categories such as

1. Highly suitable
2. Moderate suitable
3. Less suitable
4. Not suitable

After suitability analysis it was found that from the available area 14.16 ha falls under not suitable, 853.95 ha under less suitable, 3027.63 ha under moderately suitable and 230.79 ha under high suitable. The result shows that highly suitable areas for urban development are found in different area of the town.

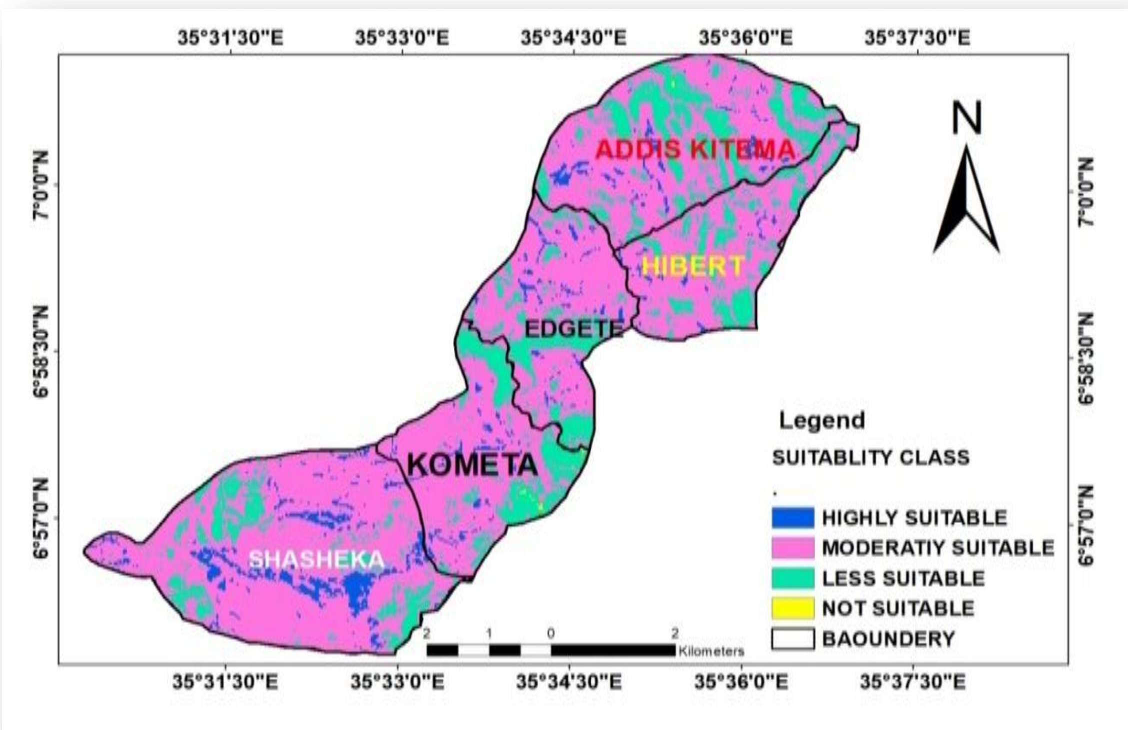


Figure 18Each Kebles Final Land suitability map for urban sprawl of Mizan-aman

From Figure 23, we can observe from the land suitability map of the study area from the above map was generated based on the weights that given for each of eight factors. Considering the above maps, this area which is in yellow is not suitable area to urban development. We can observe these areas as just visible as small points this means area is less than one percent which is considered not suitable in Mizan-aman town for urbanization. The main reason why this was limited area in this map because it is considered as suitable in some maps while not suitable in other maps. These areas which are less than one percent are those areas which are not suitable according to the eight factors. The third class shows the area in green which is less suitable area for urban area development. The second category which is rose is moderately suitable area for urban development it covers most parts of the town. Finally, the first class in blue color shows the areas highly suitable for urbanization or urban land expansion. Absolute values and percentage share of these categories are shown in Table 17.

Table 16 categories of Land suitability for urban sprawl with area percentage and hectare

Suitability Classes for final map	Area (Ha)	Percentage	Remarks
1	230.79	5.59	Highly Suitable
2	3027.63	73.36	Moderately Suitable
3	853.95	20.69	Less Suitable
4	14.16	0.34	Not Suitable

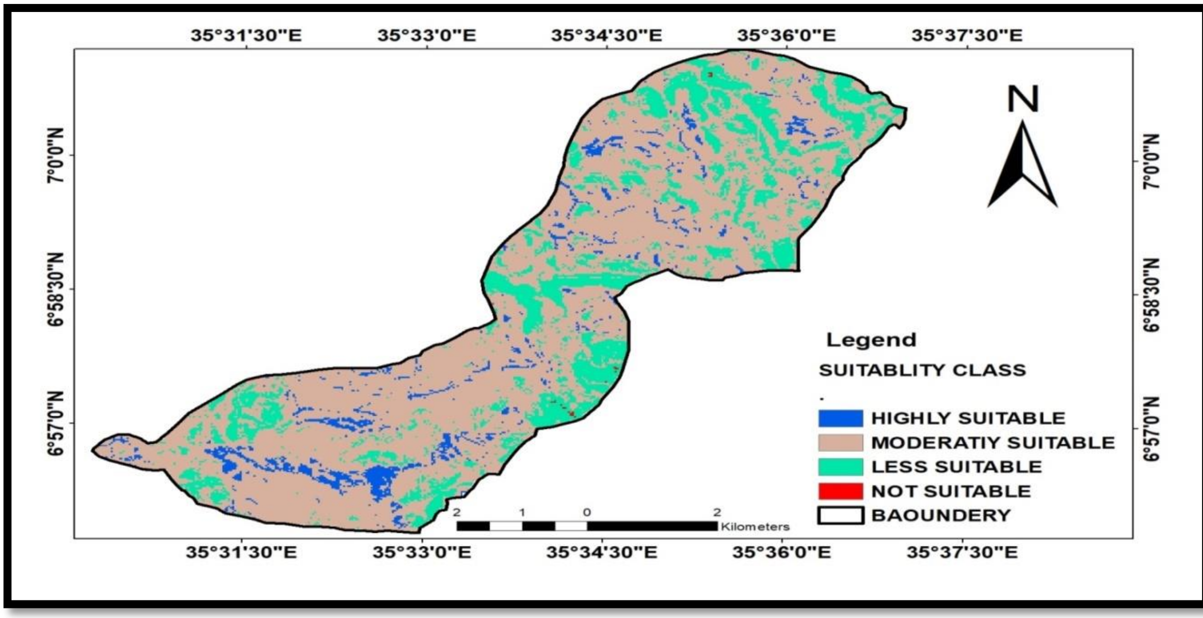


Figure19:Final land suitability map for urban development

Suitablity area of each kebeles of atown

From each kebles of atown shashek keble has 9.11% of the area is hihigly suitable the next kebele that is Adissktema keble has 4.19% of the area of the keble under higily suitable then from the Ediget kebele 3.89% of the area of the kebele is under highly suitable then Kometa keble has 3.60% of total area of the keble under hihily suitable and Hibert kebele has 2.12% of the total area of the kebele under higily suitable area.

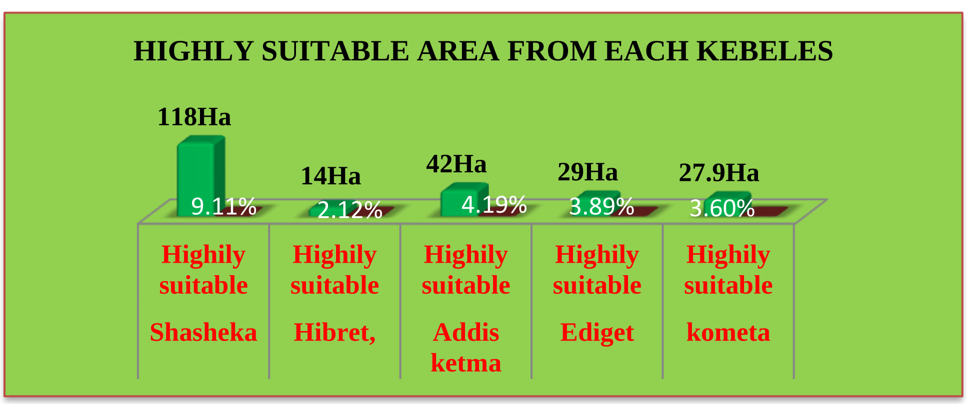


Figure20 Highily suitable area of each kebles

4.6 .Suitability classes' distribution

Total study area is4126.53 ha which categorized into four classes. Figure 25 illustrates the area of every class of land suitability for urban development of Mizan-aman town.

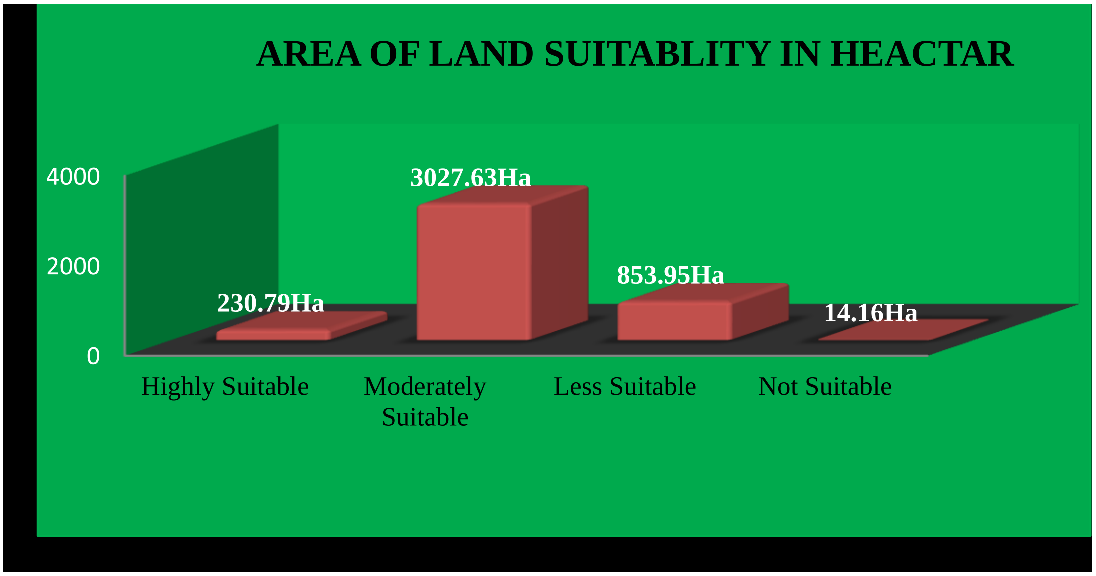


Figure 18 The area of Land suitability classes for urban development of Mizan aman tow

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The thesis examined and showed the suitable land areas for urban settlement and its implication in urban planning decision making by using Geographical Information System (GIS) and remote sensing. This was used to identify the suitable land for urban settlement area. The Weights/ scores were derived from AHP according to the pairwise comparison. The weight of each factor and the result was multiplied as only urban development is considered as suitable.

As per the suitability map, from a total area of a town 73.36% of the area was under moderately suitable land and south west part of town that is SHASHEKA KEBLE has more suitable land for urban sprawl than the rest kebeles because from a total 1295he area of the kebele118 ha is most suitable land area for urban expansion, 1017ha area is moderately suitable and 160ha area is less suitable and no area is under not suitable land for urban land expansion of the kebele.

And the rest kebeles ADISS KTEMA, EDGET, KOMETA, HIBRET, kebeles have suitable area for urbanization or urban land expansion respectively. This study will be helpful for urban planners and urban development authorities to plan development of the town. Generally from a total area of 4126ha of a town 230.79ha is highly suitable 3027.63ha is moderately suitable 853.95ha is less suitable and 14.16ha of a total area is under not suitable.

5.2 Recommendations

Preparing a system that completes urban land data catching and handling in a digital format has to be a professional as soon as possible

The GIS-based AHP for land suitability has proven to facilitate efficiency from the economic point of view as compared to the traditional methods

The outcome of the study will help the local people as well as planners to formulate and implement suitable master plan for development of urban region. Further field investigation needed before the final decision is made.

Urban planning is a complex phenomenon that requires enormous data to support the decision. It is a process of identifying problems and finding solutions using an information system.

Preparation of broad range of criteria is required for performing effective land suitability selecting of appropriate method to handle such wide heterogeneous criteria

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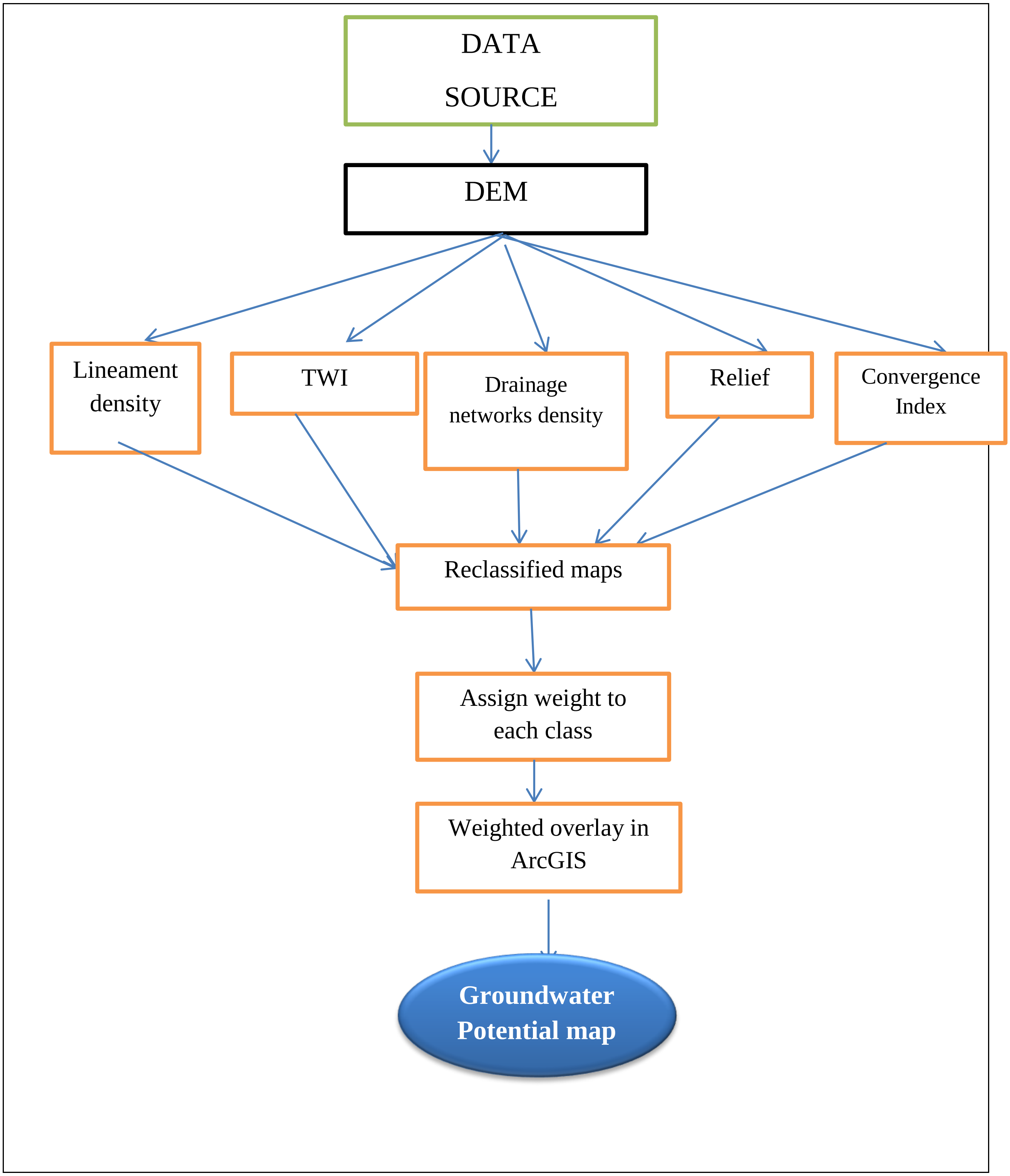
Appendix

A. Extract relevant features from DEM for groundwater potential mapping



B, Ground control point for reservoir

NO	X coordinate	Y coordinate	ELVATON
1	785659.	774907	1417.32
2	786234.47	773329.94	1417.92
3	785649.29	773534.04	1432.56
4	782191.31	769323.13	1336.548

C ,Suitability classes area for each kebele

No	Kebele name	Suitability class	Area in hectare	Area (%)
1	Shasheka	1	118	9.11
		2	1017	78.53
		3	160	12.35
		4	--	
2	Hibret,	1	14	2.12
		2	423.43	74.02
		3	125	23.32
		4	5.41	0.53
3	Addis ketma	1	42	4.19
		2	628	67.27
		3	252	27.88
		4	6	0.65
4	Ediget	1	29	3.89
		2	470	69.76
		3	168	26.20
		4	1	0.15
5	kometa	1	27.9	3.60
		2	489	72.75
		3	148.32	23.35
		4	2	0.30