ANALYSIS OF SUITABLE SITE SELECTION FOR PRIMARY SCHOOL USING GEOSPATIAL TECHNIQUES: A CASE OF BURAYU TOWN

Firomsa Mengistu Bayisa

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

Office of Graduate Studies

Adama Science and Technology University

August, 2021
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Advisor: Getachew B.Meskel (Ph.D.)

Co-Advisor: Gemechu Kaba (MSc.)

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APPROVAL PAGE OF M.Sc. THESIS

We, the advisors of the thesis entitled "Analysis of Suitable Site Selection for Primary School using Geospatial techniques: A Case of Burayu Town, Oromia, Ethiopia" and developed by Firomsa Mengistu, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

Getachew B.Meskel (Ph.D.) ____________________ ____________________

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Gemechu Kaba (MSc.) ____________________ ____________________

Co-advisor Signature Date

We, the undersigned, members of the board of Examiners of the thesis by Firomsa Mengistu have read and evaluated the thesis entitled "Analysis of Suitable Site Selection for Primary School using Geospatial techniques: A Case of Burayu Town, Oromia, Ethiopia" and examined the candidate during the open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Geo-informatics.

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Chairperson Signature Date

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External Examiner Signature Date

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

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Department Head Signature Date

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School Dean Signature Date

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Office of Postgraduate studies, Dean Signature Date

DECLARATION

I hereby declare that this Master Thesis entitled "Analysis of Suitable Site Selection for Primary School using Geospatial techniques: A Case of Burayu Town, Oromia, Ethiopia" is my original work. That is, it has not been submitted for the award of any academic degree, diploma, or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

Firomsa Mengistu Bayisa	______________________	______________________
Name of the Student	Signature	Date

RECOMMENDATION

We, the advisors of this thesis, hereby certify that we have read the revised version of the thesis entitled "Analysis of Suitable Site Selection for Primary School using Geospatial techniques: A Case of Burayu Town, Oromia, Ethiopia." prepared under our guidance by Firomsa Mengistu Bayisa submitted in partial fulfillment of the requirements for the degree of Master's of Science in Geo-informatics. Therefore, we recommend the submission of a revised version of the thesis to the department following the applicable procedures.

Getachew B.Meskel (Ph.D.) ___________________________ ____________________

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Gemechu Kaba (MSc.) _________________________ ____________________

Co-advisor Signature Date

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LIST OF ACRONYMS

UNESCO	UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
PROMOTHEE	PREFERENCE RANKING ORGANIZATION METHOD FOR ENRICHMENT EVALUATION
ELECTRE	ELIMINATION AND CHOICE TRANSLATING REALITY
MCDMA	MULTI-CRITERION DECISION MAKING ANALYSIS
GIS	GEOGRAPHIC INFORMATION SYSTEM
USGS	UNITED STATES GEOLOGICAL SURVEY
DEM	DIGITAL ELEVATION MODEL
RS	REMOTE SENSING
AHP	ANALYTIC HIERARCHY PROCESS
PCM	PAIRWISE COMPARISON MATRIX
WPM	WEIGHTED PRODUCT MODEL
SP	STRUCTURAL PLAN
PM	PRIMARY SCHOOL
M.S.L	MEAN SEA LEVEL
LULC	LAND USE LAND COVER
LUC	LAND USE CLASSIFICATION
KGP	KINDERGARTEN PRIVATE SCHOOL
PrP	PRIVATE PRIMARY SCHOOL
PuSs	PUBLIC SECONDARY SCHOOL
PrSs	PRIVATE SECONDARY SCHOOL

ABSTRACT

Currently, the population growth rate of Burayu town increasing rapidly and this is an increase or expand the need for more infrastructures such as schools, which serve the community. Interestingly, the most important issue which needs unique consideration in the developing town is the selection of an appropriate site for town development or public service facilities. Schools are taken as among the most and basic infrastructural construction in urban and rural to provide educational service. However, currently, the location of the some existing school is not selected using scientific methods by considering the necessary site suitability standards. So that, finding a suitable site that meets the desired qualification is prepared by the selection criteria. Moreover, both methods, Geographical Information System (GIS) and Multi-Criteria Analysis System (MCA) are tools employed to solve such problems. Ten parameters are used for this study. These are land use, existing public primary schools, population density, main road, river, water pond, slope, proximity to emergence services, commercial and religions, industry, and factories are used. The individual thematic maps were produced separately for all parameters. The thematic maps of each parameter are overlaid through the help of AHP and GIS and used by the weighted overlay. Furthermore, according to the allowable standards, one school can serve a 15,000 population but the result indicates that when the distribution of public primary schools is compared with the current population of the town the proportion of the public primary school facility to the population of the town is about 1 to 34,122. This means, existing public primary schools are serving the total population while expected to serve 44 % of the whole population according to the standards. The suitability map of existing schools,34%,54% 18%,50% of kindergarten, public primary schools, private primary schools, and high schools of study area falls under unsuitable area. In detail public primary schools demonstrates that, from eleven public primary schools, six (54.5%) schools are located in the unsuitable area, and four (36.4%) schools are located in the appropriate or suitable location. The composite suitability map produced indicated that 529.50 ha (5.88%) of the total area is the most suitable area, 2150.15(23.90%) is suitable, 4262.30(23.90%) is less suitable and 2055.75(22.85%) is unsuitable. Therefore, the scientific methods of selecting a suitable site successfully developed for new schools to be built in the study area.

***Keyword**: Primary School site selection, weighted overlay, GIS, AHP, and MCDM*

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the study

The school is one of the most essential infrastructural things that serve the community. Recently, there is a rapid increment of population, particularly in developing countries, thus increasing the demand of the community for new schools. Similarly, the number of people moving from rural to urban areas is increasing fast. The fast increase of the urban population creates changes into different social, economic, and environmental such as unplanned sprawl, inadequate housing facilities, and lack of public utility service (Liu, Y, 1998). Currently, the world is facing a rapidly growing population contradictory, not capable of being changed in size of land to survive on, there must be a special means of resolving the challenges of providing services and facilities such as schools and health institutions (Wondwossen, M. and Bedasa, A. 2019). This implies that, when the urban population rapidly increased, the public needs also increased. If governments do not manage by increasing the rate of new public utility it imposes unbalanced public utility service to the community.

Further, about 262 million children and youth are out of school, according to UIS data for the school year ending in 2017. From this much total 24.5% (64) million children of primary school age. At the present day, this number is estimated to reach above 64 million. So that new additional schools are expected to build up across developing counties. Therefore, this is the responsibility of governments to provide the required resource and such installation for the urban area on the safe and proper location.

Likewise, there is a rapidly increasing population in Burayyu town. Burayu town is one of the Oromiya special zones which is surrounding the capital city of Ethiopia, Addis Ababa. The population of the town in the years 2007, 2012, and 2019 were 63,883,152,000 and 375349 respectively (Burayu Town Communication Office, 2019). Burayu town, due to the expansion of the job market and nearness of capital city Addis Abeba, there is large scale in-migration of people from rural to the town, this is played a significant role in the growth of the town population. Interestingly, nowadays from six Kebele in Burayu town only one kebele, Geferssa Burayu carried out 91,314 population which means it's greater than the total population of the town as the year of 2007. This implies how the population of the study area increased rapidly. So that, as of population of the town grows, the demand for various types of public services and facilities increased especially for schools.

Schools are usually funded by profit or nonprofit educational organizations, the public sector, charities, and even religious orders. But no one matter to provide an answer where to locate the new primary schools is an essential question to ask. But, Schools that are located in a strategic and safe area play an important role in improving student's performance and excellence(Bukhari, Z.et al., 2010).So that, to enhance the performance and excellence of students School site selection plays a vital role in school construction and management.

Likewise, concerning government, appropriate school site selection will help to optimize the allocation of educational resource, matches the provision of the educational sector with the social and economic demands of the study area. On other hand, a proper school site will help students to reach school on time without delaying from class. This enhances the quality of education. Because a decline in the quality of education can have a significant negative impact on sustained economic growth (Ladd and Rivera, 2006). From the aspect of investors and operators of schools, building schools on suitable sites be cost-saving on capital strategy. Besides, selecting a suitable site for schools will promote the strategy of the brand, marketing and enhance the competitiveness.

Moreover, several studies employed geospatial techniques and products to address the problem of identifying the best suitable location for building schools and planning educational services ((Abera, 2018; Leykun. G and Abiyu.D (2018); Dadfar, N. (2014)). Most of this research takes to account different parameters to locate schools in the appropriate or suitable site by using scientific methods and allowable standards.

For this study, the researcher aims to evaluate existing public primary schools and identify suitable sites or areas for building for future primary school development across the study area. Therefore, to achieve this purpose the researcher trick GIS fruits and methods with MCDA extension to AHP. Because, currently the application of Multi-Criteria Decision Analysis (MCDA) integrated with GIS and RS techniques having greater value to serve decision-makers and land planners in the education sector(Jayaweera,2016). In addition, these techniques incorporate both quantitative and qualitative standards to enhance the decision maker’s judgment ability in a convincing way and also to choose optimal alternatives by depending upon a scientific approach (Ouma et al., 2011). Similarly, these methods were used by different researchers on suitable site selection such as for school development, agricultural activity, hospitals, solid west disposal, and urban land use management, suitable site selection for dam, hydropower site selection ((J.U.Richard and Chima O. (2016); Pramanic.M (2016); Cheng,Ru.et al.,(2007); S.Karsauliy, (2013); S.R. Soltani and S.M.Monavari (2011); Binh,B.(2008); Lin,S,(2011)).

In general, this study takes to account ten parameters such as Proximity to; Existing schools, Main Road, River, Water pond, Industry, and Factories, Commercial and Religious, Emergence service, Land Use, Slope, and Population Density. After that researcher assigned them various weights according to their importance by depending upon AHP approaches.

1.2. Statement of problem

With the rapidly increasing population of the town, the demand for different types of public services and facilities also increases (Jahan & Oda (2005). The population of Burayu town surprisingly shows growth. Within 27 years the population size has grown from 4,138 in 1984 to more than 375,000 in 2011 (Burayu Town Communication office). The demographic explosion in developing world countries has created massive pressure on resources and public facilities (Ahmed. M and W.Abdel Latif (2007). Still, many more people are immigrating to it from different parts of Ethiopia to make their lives and residence in Burayu (Lencho, 2019). Since the population of an area is increasing, additional social services additional institutions like schools are needed. This implies, like an increment of the population as far as exceeded the expansion of such facilities thereby lead to the deterioration in service of such facilities.

Besides, there is an expansion of new residential site along all direction of the town (Berhanu. K and Dev. N (2020); Degu. B, 2014) Therefore, this indicate the town provide additional schools to fulfill future population demand and to meet the minimum population school ratio as allowable by national standards to enhance educational excellence (CGAAEB, 2018). Figure 1. demonstrate that the population of the town in the year of 1999 was 63,889 within two years difference reached 92,433 with increment rate of 22% at the year of 2001 E.C. And also within three-year difference wich means from 2001 into 2004 the population of the town reached 152,000 with increment rate of 21.50%. Further, within a seven-year difference, the population of the town from 2004 to 2011 reached 3,75349 with an increment rate of 21% and at the year of 2018, estimated to reach 1.4 million. (Figure 1.)

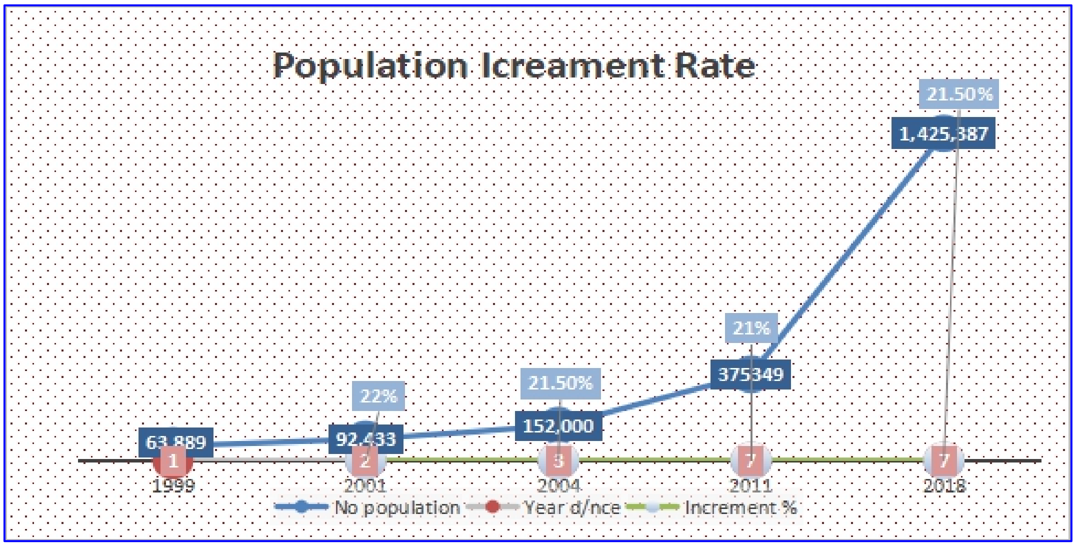

Figure 1: population increment rate of Burayu town.

The research was done by Aschale,(2017)and Bukuhari et. al,(2010) stated that finding a suitable site for school without making scientific analysis and promoted the development of schools in unsuitable areas caused the students to face several problems such as long walking distances, heavy traffic, exposure to sound and air pollution. For instance, distributions of primary schools of the town are not fair when compared with the town's rapid growth population, they are close to some students' residence while far from other students. Therefore, some students facing transportation problems, this, in turn, has made parents worry about their children's safety. So, students` families have been taking their children to school using a different method: some have been renting cars, while some were using their cars and others reach school by walking.

In general, this study intends to select a suitable site for building a new primary school in Burayu town by using Geospatial techniques. Considering different parameters inputs integrated with MCDA and GIS are used. Currently, the Ethiopian Ministry of education has not pointed standards regarding criteria for parameters of this study. However, the national and international standards used by various researchers have been taken for this study. Finally, this research initiates the decision-makers of the study area, to use the method and be producing a good or helpful result or judgment to choose the suitable site for new primary school establishments.

1.3. The objective of this Study

1.3.1. General Objective

The main objective of this research is to identify a suitable site for new primary schools and evaluate the suitability of all existing schools by using Geospatial techniques.

1.3.2. Specific Objective

- To identify a new site for primary schools based on allowable standards.
- To evaluate the suitability location of existing schools.
- To validate the suitability of the existing proposed school land use of the town.

1.4. Research Questions

1. Which sites are more suitable to build new primary schools?
2. How is the suitability of existing schools?
3. How is the suitability of the proposed school land use plan of the town?

1.5. Significance of this Study

The scientific way of selecting a suitable site is increasing the perfectness decision of maker's judgments because the result of this research, based on international and national standards it shows the suitability of current public primary schools sites and indicates suitable areas for future primary school development of Burayu town.

If an investor, profitable, and none profitable organization asking site decision-makers to build primary schools decision-makers easily can address suitable sites from a developed suitability map within effortless. Therefore this research has avoided delaying decision-makers and wasting time during choosing safe primary school sites.

In the aspect of students, the processing of choosing a safe area scientifically means by using Geospatial techniques and Multi-Criteria Decision Method (MCDM) it will improve the way primary schools will be distributed on suitable sites throughout the town. This is very important for students because it will reduce extravagant expenditures exploit to get taxes service to go to schools. Since schools meet the demand of the population of the Burayu town many new primary schools will build up at that students gets schools near to their residence means at mediated the distance of every student from their home to school. This in turn supports families in the economy and improves their way of life. Because in the new suitable primary school site agreeable consideration was given for every selected parameter by the researcher to mediating students' residence. Further, more than of population live hand to mouth life this research will be helpful to them.

It will develop primary school environmental hygiene and safety. Since it has considered the distance between primary schools, main road, industries, and commercial and religious it will reduce the vehicles transportation movement sounds around primary schools then it will reduce pollution of air and different accidents due to vehicles so, health and safety of students will be kept. Because necessary standards considered what distance difference should be between industries etc and primary schools so noise, pollution, and different unworthy things come out from industries. And also workers of industries and factories will not disturb students' attention. Besides students' families will stop worrying and feel safe about children in primary schools.

Generally, the output of this study shall benefit, the investors, students, parents, the town urban planners, and the development office and educational office of the town profitable by showing the appropriate safe location for future primary school development. And also, the research helps as input other researchers who have willing to do further study in Burayu town.

1.6. Scope

This study is limited to the evaluating suitability location of all existing schools and identifies a new suitable site for future public primary schools in Burayu town. One of ten parameters used for this study is limited to proximity to public primary schools. Because it focuses on public primary schools, government school is free of charge. Further, it's difficult to consider them for this study because the existence of private schools is temporary and may be closed at any time depending on the interest of their holders. Only to identify suitability location of existing all private and public schools are included. Nowadays private schools are simply categorized into three by depending on the payment collecting from students, those are; high payable private school, Medium payable private school, and low payable private school. This is a bias for people across the Burayu town due to their unequal income. In general private schools are not commonly established based on population density they only followed the area shall benefit. For this case, existing public primary schools are selected as one influencing parameter, and also the scope of the study is limited to the suitability of all existing schools and select a suitable site for new primary schools by using Geospatial techniques.

1.7. Structure of the Thesis

The finding is structured into five different sections. Chapter one deals with introductions, problem statements, objectives, research questions, significance, Scope of the study. Chapter two reviews the theoretical and empirical literature obtained from various published and unpublished reference materials. Chapter three is about the description of the study area, about the materials and methods of the study. In chapter four the result and discussion of all thematic maps are prepared and the individual maps are overlaid to give the final suitability map of primary school is deeply illustrated. The final title is about the conclusions and recommendations of the research.

CHAPTER TWO

2. LITERATURE REVIEW

This chapter shows different papers, analyzing what was said about optimal site selection and relative research which has been done in different countries.

2.1. Education

Education is the way of facilitating learning, acquisition of knowledge, skills, values, morals, beliefs, and habits (Education, Wikipedia). Since education develops the basic things to increase world economic growth, to transfer information, and to make peace and stability throughout the world it is essential to make difficulties between persons, countries, states, etc easy and peacefully overcome them. Also to develop new technologies, invent things to take the world to another advanced level education have a great role. On the other hand, education transfer skills and value existed in the human mind in a scientific method. Generally, as explained on Wikipedia education is the transfer of knowledge, skill, value, a culture of society, and belief of society at different levels as it is needed at their stage of education.

Education has an extremely good role in the economic and social investment of society and for long-lived development and an energetic building block for weathering and recovering from the crisis (Campaign for Education, 2010). This is why developed countries give great consideration to education. Nowadays, governmental and international nongovernmental organizations are working hard to implement the internationally known motto “education for all” specifically in developing countries (Amnesty International (2012). Globally anybody has the right to get education service to change to reality the United Nations organization is promoting in the economic, social, cultural, educational, and health facilities, etc (United Nation Article 13 of 1966). This indicates that how education is important for the development of the country in multi-direction. This global movement is focused on educational reforms, such as for improving the quality and efficiency of education towards applicable relevance in the students’ lives and efficient problem solving in modern and future society at large(United Nation Article 13 of 1966). However, especially in a developing country, only a few students get the chance to attend school.

Yet above 262 million children and youth are out of school, according to UIS data for the school year ending in 2017. The total includes 64 million children of primary school age, 61 million of lower secondary school age, and 138 million of upper secondary age (UIS;2017). This means in a hundred million children are out of school, this indicates that how the developing countries need additional new schools and capital to facilitate education for all motto specifically among the disadvantaged population. Moreover, this shows how the global learning crisis is how much it's a major condition that makes it difficult to expanding both individual chances and national development (World Bank,2013). And also this is why the world community organization helping developing countries in educational sectors especially UNICEF (United Nations, 2013).

According to different research outline, learning crises is grass rooted problems in Africa. Yet, of all regions, sub-Saharan Africa has the highest rates of education exclusion. This means one in every four in the fifth of children between the ages of about 6 and 11 are out of school, followed by one-third of youth between the ages of about 12 and 14. According to UIS data, almost 60% of youth between the ages of about 15 and 17 are not in school (Education in Africa | UNESCO UIS.,2020) However, when comparing Africa with developed countries, the secret success of their development in all directions is not any other magic thing; it is the way they treat education systems. In those countries, everything of their action towards to education has more attention than any of sector in their countries. So that, restriction of access to education chance and low learning achievement is an alarm bells need attention for African children (Wondwossen, M. and Bedasa, A. (2019).

In Ethiopia, modern education was introduced before counted century. However, the education and training that occurred during these long years had a limited positive impact on the lives of the people and national development (Leta, G.,2018). Because at that time education attempts have not been enabled to solve the problems of farmers and focusing on changing the lives of the overwhelming majority of the people. As one of the African countries, various problems drawn back the economy and education system in the continent. Unfortunately, because of several unanticipated problems such as shortage of teachers, textbooks, inadequate school facilities, politics, environmental conditions, and in adequates attitude, etc that emerged in the early stages of the implementation of the scheme the program failed to achieve the objectives.

Moreover, according to the education history or information of Burayu town, the first formal education was begun in 1963 at a traditional school associated with Ethiopian Orthodox

Church. Lessons were given under tree shades around the premises of the church of Saint Mary, which itself was founded in 1961. Later, an elementary school was opened and began giving classes from grade 1 to 4. Presently, in Burayu town there are above seventy (70) non-governmental primary schools and eleven (11) government primary schools (Burayu Town profile and Education Office).

Generally, for future school development selecting a suitable site in a scientific way and standards is the major task that needs consideration. This study focused on suitable site selection for primary schools through geospatial technology-based on allowable standards. Geospatial technology refers to technologies used to acquire, manipulate, store and visualize geographical information (Allshouse, W.B., et al.,2010). So that, by using this technology mapping suitable site for primary school is achieved. Because, school mapping is an art and science of building a geospatial database with a relational database of educational, demographic, social, and economic information for schools and educational directorates, to support decision-makers and educational planners (Al-Hanbali, no date. page. 2).

However, without considering the suitability of a site for a school building its trouble to bring sustainable development and quality of education. Schools found in the strategic and safe areas are plays an important role to improve the ability and excellence of students. This was why the researcher is highly focused on finding suitable site selection for primary school.

2.2. Significance of selecting suitable sites

Selecting a suitable site for any infrastructure or public service facilities is the key term that needs focus. Previously it was not seen while attention is given to select suitable site selection by following scientific techniques and standards through the help of technology. The land is only selected traditionally, this exposes society to different problems. Currently, due to the development of the Geospatial technology such problem is fixed. According to (Zhou and Wu, 2012), selecting a suitable site have an important advantage in saving capital expenditure, developmental plan, and resource planning. These ideas not only the idea of Zhou and Wu but also Abazari has also supported the idea of selecting a suitable site for any facilities by considering various parameters which have scientific standards that have to be evaluated relative to their importance, to prevent considerable environmental impact and concerning accessibility and fair distribution of the available resource for the society (Abazari et al., 2012).

So that selecting a suitable site is advantageous than roughly building up facilities on it. In general, land planners, decision-makers, and developers used assessed land preliminary input for what they want to construct which means for their project (Beskese et al., 2015).

Recently, different research is showing effects of selecting a site unscientifically or poor site selection which means traditionally leads to failure of infrastructure, and also exposed society the problems related to high traveling costs, lack of transportation access (Bukhari et al., 2010; Jayaweera, 2016). Especially, school facilities accessibility for the society is a very necessary building block on a country's, socioeconomic development(Jayaweera,2016). So, that selecting a suitable site using scientific techniques and standards can irradicate such problems.

2.3. Overview of previous research

Site selection for any particular project is a preliminary task should be carried out within a specific area is subjected to specific terms and condition for this research (Zubaidah, Bukhari, et al, 2012). Various research has been done by different scholars concerning suitable site selection for schools by using Geospatial techniques. Different papers overviewed by a researcher**.**

The research was done by “Narguess Akbary Dadfar, May 2014” on the title of “Suitability analysis of a new high school in the town of Calabasas” has been used six parameters to find the best suitable school location by using GIS and RS techniques. Those parameters are; distance from existing high school; population under 18 years old; land use; proximity to major roads; slope; proximity to the restaurant. This study did not consider the proximity of the new school site to industrials zones. While the California Department of Education states, school sites should not be located in an industrial zone but this study not used the industrial area as a parameter (California, 2018). And also, the researcher has used the proximity of the school to the restaurant as parameters without any supportive reference. On other hand, using age limitation is minimize the reality of the result. This means people above 18 years old can attend primary school how it can exclude population above 18 age from consideration. So that for future development of schools by limiting population data below 18 reduces the reality of the research result. These are the main gaps found in Narguess's research. However, for Burayu Town researcher considered the industrial and factories area as one of the parameters and used standards proximity to commercial and religious places instead of using specifically restaurant as a parameter. Further, populations are not limited by their age all existing populations are considered by a researcher for suitable site selection.

Secondly, the research done by Bukhari and Noordin (2010) under the title of Spatial multi-criteria decision analysis for safe school site selection examined the use of GIS with multi-criteria evaluation and the Analytical Hierarchy Process (AHP) to select primary school site selection planning in Malaysia. According to the researchers' ideas, in Malaysia, land selection for school development was undertaken traditionally. This traditional trend of selecting land for schools are exposed students to contaminated sites which may affect student health. Furthermore, they used parameters such as distance from commercial, distance from the electrical transmission line, distance from the main road and distance from an industrial area, Air Pollution Index (API) reading, distance from the stream, noise level reading, flood plain height, and slope. So that, by using GIS and AHP techniques objective set by these researchers was achieved. But, using population age under 19 as parameters for future new schools is reduce the reality of the research especially in a developing country where those above 19 years old will join schools. On the other hand, if excluding the population under 19 years old for future primary school developments imposes on unbalancing of existing schools service with population service. To fill this gap total population of Burayu town is considered as one parameter.

Thirdly, the finding was done by Talami and Ngig (2015) under the title of “Integration of GIS and Multi-criteria Evaluation for school site selection, in a case study of Belgut Constituency of Kenya. Researchers examined the use of GIS with multi-criteria evaluation and AHP to select primary school selection. They have used twelve parameters to identify a suitable site for primary school location. The total population of the study area was considered rather than excluding population above 18 years old as mentioned in the above previous research gaps. So that, the researcher agreed with the idea of Talami and Ngig because of using the total population of the study area for future primary schools site selection. Using GIS, multicriteria, and AHP techniques both researchers are achieved the set objective. Using this technique for suitable site selection for school has a significant role, so that for this research also this method is selected

Lastly, the research was done by Yared, G., 2018 under the title “Use of Multi-Criteria Decision Analysis Integrated with GIS and Air Pollution Model Inputs for schools site selection". To achieve the desired objective, a researcher is integrated different parameters and used the air pollution model as input of study. Ten parameters were used. But, the population density of an area didn't consider by a researcher as a parameter while the statement of the problem of his study more focused on the rapid growth of the population of an area. To what extent of evidence a researcher has excluded the population of the study area is excluded!. Because new schools site selection is important when two things are identified which related with population. First when the population of the study area is exceedingly increased and need additional school means if there is a shortage of school. Second, if an area is showing rapid population growth and needs a school site for future school development. Both of the ideas are linked to population. So that without considering the population density of the area it may not give any sense.

In general, based on the relevant literature review, all studies on school site suitability analysis have integrated GIS with Multi-criteria Decision Analysis by giving the weight of each parameter through AHP techniques is used in different research.

2.3.1. Application of Geographic Information System (GIS)

For this study, Geographical Information System is the backbone tool used in the research. A Geographic Information System is a system designed to capture, store, manipulate, analyze, manage and present spatial or geographic information or data (Coppin and Bauer, 1996). This designed system as searching the location is urgent. This technology improves organizational integration by enabling them allows to view, interpret, understand and visualize geographical data in many ways that demonstrate relationships, trends, patterns, and producing in the maps and globe. And also, it has power multiplication, which results from the integration of social, economic, agronomic, terrain, climate, environmental, and institutional management and makes data available for managers, scholars/researchers, and scientists alike new and powerful modeling.

So that, it has been argued GIS-based multi-criteria decision analysis can potentially increase collaboration among stakeholders in the decision-making process by providing flexibility that may be used for analysis, comprehension, and reevaluation of a decision problem (Boroushaki and Malczewski, 2010). As K. Sam, and T. Scott (2011) suggested any school site selection it must be accessible to present and future populations and be free of harmful natural and environmental conditions, which threaten the pupils live. And also, GIS has been found as a very good tool in selecting a suitable site for locating facilities such as Landfill site selection (El Baba et al.,2015), wastewater disposal site selection (Aydi et al.,2016, wind farm site selection(Raiarta et al.,2008) and public park selection (Chandio et al.,2011) and location for new schools (Narguess,2014). All these can easily be achieved using GIS spatial data analysis; hence, the objectives of this study will be to evaluate the existing primary schools including their spatial distribution of study area, and proposing a new suitable location for primary schools.

2.3.2. GIS-based Multi-criteria Decision Analysis

The key important term/tool during working to select suitable site selection for any land-linked facilities is understanding multi-criteria decision analysis. This is a preliminary task for a researcher. Multi-criteria decision analysis (MCDA) is a type of technique for structuring and analyzing and evaluating decision alternatives based on multiple attributes and objectives (Voogd, 1983). This approach has been used for analysis by integrating different parameters to give an acceptable solution to the identified problem by depending upon MCDA. Because this MCDA approach can integrate numerous notions of decision problems. (Boroushaki and Malczewski, 2010) stated MCDA very well, "it enhances communication and expedites the process reaching concurrence and determining the most suitable options". This method enables the researcher the most suitable option for a defined problem.

This integration of multi-criteria decision analysis techniques with GIS is a process that delivers, transforms, and integrates geographical data and value judgments (the decision-makers preferences) to evaluate a set of alternatives concerning relevant criteria (Malczewski, 1999). Because the method combines all-important spatial criteria and illustrates the most suitable location for certain land use on a map. Besides the methods is encourages decision-makers/planners or other stakeholders by giving or showing appropriate/suitable areas.

It has been argued that GIS-based multi-criteria decision analysis can potentially increase collaboration among stakeholders in the decision-making process by providing the flexibility that may be used for manipulating analysis, comprehension, and reevaluation of a decision problem (Boroushaki and Malczewski, 2010). Accordingly, various spatial decision problems give increase to the GIS-based multi-criteria decision analysis (GIS-MCDA). The research showed GIS and MCDA can benefit from each other (Malczewski.,1999) because both methods enable the researcher to come over the problem by giving an acceptable solution. Working togetherness of both GIS and MCDA has greater significance than the total power achieved by each working separately This method is why the researcher selected a multi-criteria method to identifying suitable site selection for public primary school.

2.4. Why AHP Method is selected for this paper?

It has been known that the MCDA method has chosen to compare and evaluate different alternatives which may seem difficult without these techniques. However, there are various types of multi-criteria decision analysis methods. Each of these types has its own merits and demerit. So that, the researcher has tried to identify the weakness and hardness of each method to select the best techniques from multi-criteria decision analysis methods. There are different techniques of multi-criteria decision analysis with merit and demerit. A researcher is tried to mention those techniques as follows.

ELETRE; for the first time, this technique was developed and announced by B.Roy in 1960. It is used for alternatives high-rank relations evaluated by using concordance and discordance index. Initially required, acceptable option, identify the criteria the decision-makers preference value & criteria score value, etc (Supraja and Kousalya,2016). The main strength and the weakness of this method, it enables comparison with the option, possible to add alternatives at the end and it isn't able to differentiate the weakness and strength of alternatives & also it seems difficult at a layman level. So that, the researcher is refused this method due to the stated weakness of this technique.

PROMOTHEE; this method is developed by Brans (1982**)**. For this method, the defined option rank may be obtained by depending upon the value of positive & negative high-ranking flow which has been known as net flow. Initial information required in this method is a possible alternative, identified criteria, criteria score value & criteria's weight &, etc (Brans and Vincke,1985; Brans et al.,1986). Advantage; it enables in-comparability between criteria. It can consider uncertainty and fuzzy information. The disadvantage of using this method is it has no method to assign a weight for criteria. So that, for this case the method has been not selected for further process.

WPM; this technique was announced by Triantaphyllou and Mann (1989)**.** This method of evaluating multi-criteria analysis is developed by the theoretical principle of this method is the option will be compared by multiplying the number of ratios one for each decision criterion. To use this method initial information required is an acceptable alternative, defined criteria, weight for criteria & criteria score values. The main importance of this method, it has the capacity town to utilize both single & multi-dimensional problems &, etc. But, it has no method to assign a weight for defined criteria.

AHP; is the method used broadly by a different researcher and developed and announced by Thomas.L.Saaty in the 1960s. This technique is used to break down problems from the hierarchy level and pairwise comparison is applied to each hierarchy level(Saaty, T.L. 1994). Before using this method acceptable alternative, defined criteria, decision maker's linguistic value for pair comparison are required as initial information. It's very easy to use it rather than the others types. It is good to decay large problems into a hierarchy structure and it has pairwise comparison techniques to assign criteria weight. However, the main weakness of this method, consistency may occur due to bias judgment in pairwise comparison which means it doesn't allow criteria in pair to pair or individual

On the whole, the above-listed types of multi-criteria decision analysis are mentioned with brief explanations. Each method is based on the theoretical principle, merit, demerit and primary information which may be needed to perform the task explained very well. All of the listed techniques required preference score, weight value for criteria but all of the above techniques don't assign a relative weight of selected parameters or criteria except the AHP method to obtain the best alternative. So that, this is why the researcher has chosen the AHP method to conduct this research.

2.5. Pairwise Comparison Method

For the first time, this pairwise comparison method was established by Satty (1980) to determining factor weights in the Analytic Hierarchy Process (AHP). This method is widely used by different researchers because it is used to compare different or multi alternative decision methods. Further, the technique involves pairwise comparison to create a ratio matrix. It accepts the pairwise comparisons as an intake/input and delivers the relative weights as output. As Malczewski,1999 stated these weights are determined by making normalizing the eigenvector correlated with the maximum eigenvalue of the reciprocal ratio matrix. This normalization is processed after the matrix of used parameters is made.

Further, the main difference here is in the calculation of the weight, which is achieved using a preference matrix where each criterion is compared to all others in a pairwise comparison. The method is greater reliable and acceptable than other methods. And also the Consistency Ratio (CR) has been computed to check the degree of consistency in the integrated group judgments made by experts (Forman & Selly,2001). This allows for checking and evaluating the weights (again derived by researcher judgment) assigned to the criteria in terms of consistency using the pairwise comparison and calculating the consistency index(Saaty,1997).

Moreover, this method is widely used in the literature of different research to solve problems of this study stated under problem statement of this study area, for example, (Irshad Jamal, 2016) used AHP to map Multi-Criteria GIS Analysis for School Site Selection in Gorno Badakhshan Autonomous Oblast, Tajikistan. This Pairwise was used by Narguess., D., (2014) to identify a suitable location for Secondary School for Calabasas town. And also Yared, G.,2018, pairwise comparison techniques were used to select suitable site selection for school. So, to choose a suitable site for future primary schools development using scientific methods and standards school researcher chose this AHP pairwise comparison technique. So that, on various research this technique was effective for this reason the method is selected by the researcher.

- The steps involved in the pair comparison method

1. Development of a pairwise comparison matrix

This method is used a scale by values from 1- 9 to rate the relative preferences for criteria (Saaty, 1980). Besides, the Eigenvalue which used in AHP lies between 1 and 9. Where, class 1 represents equal preference between two factors and class 9 stands for a factor extremely preferred over the other parameters or alternatives (Eastman,2012.)

Table 1: Preference scale for pairwise comparison

Intensity of Importance	Definition
1	Equal importance
2	Equal to moderate
3	Moderate to importance
4	Moderate to strong importance
5	Strong importance
6	Strong to very strong importance
7	Very strong importance
8	Very to extremely strong importance
9	Extreme importance

2. Computation of the criterion weights

The computation of weights was carried out to know the influence of each parameter by comparing each other. Different researchers have used the AHP method of pair-wise comparison matrix, to assign the weights to each of the considered factors (Haile and Suryabhagavan 2019). This process is pass through three basic steps. First, sum up the values in each column of the matrix, Then each element in the matrix must be divided by its column total (this means the resulting matrix is referred to as the normalized pairwise comparison matrix). Latterly, computation of the average of the elements in each row of the normalized matrix must be made. This includes dividing the sum of normalized scores for each row by the number of criteria. These averages provide an estimate of the relative weights of the criteria being assimilated or compared.

3. Estimation of consistency ratio

Consistency ratio estimation helps to rule/adjudge determine if the comparisons are consistent or not. This consistency ratio (CR) is defined through the mathematical relation equation (Vaidya, 2006). A researcher use standards to identify whether the comparison is consistent or not consistent. The technique uses several steps to get a consistent ratio.

Firstly, define the weighted sum vector by multiplying the weight for the first criterion times the first column of the original pairwise comparison matrix, then multiply the second weight times the second column, the third criterion times the third column of the original matrix, finally, sum these values over the rows.

Secondly, define the consistency vector by dividing the weighted sum vector by the criterion weights determined previously.

Thirdly, calculate for lambda (λ) which is the average value of the consistency vector, and Consistency Index (CI) which provides a measure of departure from consistency and has the formula: CI= (λ - n)/ (n-1) (Forman & Selly,2001). And finally, calculation of the consistency ratio (CR) is defined as follows: CR = CI / RI

Where RI is the random index and depends upon the number of elements being compared (below table 2) and n is the number of parameters. If CR<0.10, the ratio indicates a reasonable level of consistency in the pairwise comparison, however, if CR ≥ 0.10, the values of the ratio indicate inconsistent judgment(Saaty,1980). If the consistency ratio result is rejected means if it is above 0.1 it needs new starting with the expert judgment given for the developed matrix. The below table is demonstrated the constant number given for the Random Index. This is based on the number of parameters used in the AHP method. As an example for this study, the number of used parameters is ten so that the Random Index is 1.49.

Table 2: Random Index

No	1	2	3	4	5	6	7	8	9	10	11
RI	0.0	0.0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

Where n represents the number of parameters used and the RI random index. Source; (Saaty, 1980)

2.6. Decision Rules

To give the decision to compare the primary step is the understanding rule of decision. According to the statement of Starr and Zelany (1977), a decision rule is a procedure that provides making and ordering for alternatives for the parameters. This rule is used to determine how best to order alternatives or to rank alternatives based on desirability or importance. It combined the data and information on choices and decision maker's preferences into an overall assessment of the alternatives.

To the point, the decision rule orders the decision space through one-to-one or a one-to-many relationship of outcomes to decision alternatives. This means that a given course of action (alternative) has a corresponding certain consequence (one-to-one relationship) or uncertain consequences (one-to-many relationship). If factor A is compared to factor B, and factor A is assigned one of the numbers above (1-9), then factor B will be assigned the reciprocal value of A (i.e. 1 / (value for A). As Malczwski 1999 stated, an MCDA problem requires ordering the set of outcomes to determine the decision alternatives yielding these outcomes. So that, for this finding the necessary value has been given.

2.7. Weighted Linear Combination

The approach most commonly used by many researchers for GIS-based decision techniques is a weighted linear combination (WLC) (Hopkins 1977, Tomlin 1990). This enables to make integration of various thematic maps which were developed based on acceptable standards and produced a new map. According to the idea of Hobbs (1980), Eastman et al (1993), and Han and Kim (1988), WLC is a common application to solve land use/ suitability analysis, site selection, and resource evaluation problems. In another way, a weighted linear combination is known as weighting. It's based on the idea of a weighted average in which continuous criteria for each parameter are standardized to a common numeric value and then integrated using a weighted average to produce one composite map. This enables the decision-maker to determine and assigns the weights criteria for used parameters by depending upon the relative importance which means that directly to each attribute map layer.

The sum score for each alternative is the product of importance weight assigned to each attribute multiplied by the scaled value given for that attribute. This is included each alternative and then summing the product's overall attributes. The scores are calculated for all of the choices. The one chosen is that with the highest value from all scores. Moreover, with the weighted linear combination, factors or parameters that are integrated by first applying a weight to each parameter, followed by a summation of the outputs or results to yield a suitability map of Primary school in Burayu town. The formula used for WLC is S = $\sum xjyj$ (Bukhari et al.,2010). Where S is suitability, xj is the weight of factor i, and yj is the criterion score of factor i.

Furthermore, this technique is highly popular mainly due to its ease to use and associated with its implementation in the GIS environment by using map algebra operations and cartographic modeling (Tomlin 1990). According to Massam(1988), the method is intuitive, simple to comprehend, and thus appealing to decision-makers. Because it minimizes or eradicates the illusion that may happen to decision-makers.

Recently, a different study that has been carried out by many researchers concerning Weighted Linear Combination (WLC) model has been applied inaccurately and with unreliable results, because the analysts (decision-makers) either disregarded or lacked a full understanding of these elements. These ideas are supported by Hobbs (1980) and Heywood et al (1995) to provide discussions on some aspects of the incorrect use of the method. To conclude, the researcher has used this Weighted Linear Combination method and generated a suitable location map of Burayu Town for school development.

2.8. Remote Sensing

Recently the use of remote sensing data is increased from time to time for various research purposes. Because the modern use of the term remote sensing has more to do with technical ways of collecting space-born and airborne information. Remote sensing is the capability to gather information without being in direct contact with it (Lillesand and Kiefer, 2000). This gathering land information system without direct contact with the object enables the researcher to get necessary information effortlessly by consuming time. According to Zubair (2006), the earth observation from airborne platforms has 150 years of history, although the majority of the innovation and development has taken place in the recent decade's years. This indicates that how the accuracy of RS data upgraded especially in recent decades. The information is gathered by instruments at the natural level by our naked eyes, or by cameras in another way it means radiometric which measure radiation. As Kern (2011) stated the satellite-based remote sensing provides very necessary information about the earth's surface that can be used in the assessment of the various aspect of atmospheric environment, climatology, meteorology, ecology, agronomy, and environmental protection. So, for this research remote sensing data like sentinel sat image is used for this study to know the current status of land use land cover of Burayu town. Sentinel sat image is available freely at the accuracy of 10 meters.

2.9. Overview of criteria international and national used for school site selection

In the different countries, there is detail well-developed for suitable site selection standards used in the form of school siting guidelines. By depending upon such standards illustrated in their guideline suitable site selection for schools is been undertaken, as an example here its these guidelines; Public schools of North Carolina (2009), Alaska Department of Education (2009), California Department of Education (2009) and Georgia Department of Education (2003), United States Environmental Protection Agency. (2011). *School Siting Guidelines. The* United States Environmental Protection Agency.

In the case of our country Ethiopia, there is a standard for school site selection on Revised Standards for Structure Plan Preparation and Implementation Ethiopia May 2012 and also school site selection criteria prepared by the ministry of education but it's not in detail. However, for this research standards, are taken by reviewing different literature and school guideline. So that, it's important if the experience of those educational departments are taken and implemented by revising or developing a new school site selection guideline with detailed parameters and standards for Ethiopia school site selection.

2.10. The lesson drawn from literature reviews

- Education is an extremely good role in economic and social investment for long-lived development and is an energetic building block for weathering and recovering from the crisis.
- Yet above 262 million children and youth are out of school, according to UIS data for the school year ending in 2017.
- Nowadays, everyone has the right to education has been recognized by some governments and the united nation.
- In Ethiopia, modern education was introduced before counted century. However, the education and training that occurred during these long years had a limited positive impact on the lives of the people and national development.
- According to the education history or information of Burayu town, the first formal education was begun in 1963 at a traditional school associated with Ethiopian Orthodox Church.
- Without considering a suitable site for a school building its trouble to bring sustainable development and quality of education. Schools found in the strategic and safe areas play a crucial role to improve the ability and excellence of students.
- Various research has been done by different scholars concerning suitable site selection for schools by using Geospatial techniques

- Based on the relevant literature review, all studies on school site suitability analysis have integrated GIS with Multi-criteria Decision Analysis by giving the weight of each parameter through AHP techniques.
- A geographic Information System is a system designed to capture, store, manipulate, analyze, manage and present spatial or geographic data (Coppin and Bauer, 1996).
- MCDA; approach has been used for analysis by integrating different parameters to give acceptable solutions to the identified problem by depending upon MCDA.
- Various research shows, GIS and MCDA, can benefit from each other.
- GIS and MCDA combined power of a group of things when they are working together which is greater than the total power achieved by each working separately.
- AHP; this method is used by a different researcher. It can break down problems from the hierarchy level and pairwise comparison applied to each hierarchy level.
- The advantage of using AHP, it is good to decay large problems into a hierarchy structure and it has pairwise comparison techniques to assign criteria weight.
- Pairwise comparison techniques involve pairwise comparison to create a ratio matrix.
- Consistency ratio estimation helps to rule/adjudge determine if the comparisons are consistent or not.
- WLC enables the decision-maker to determine and assigns the weights criteria for used parameters by depending upon the relative importance which means that directly to each attribute map layer.
- Remote sensing is the capability to gather information without being in direct contact with it.

CHAPTER THREE

3. MATERIAL AND METHODOLOGY

3.1. Description of Study Area

The study area of this research will be Burayu town. Burayu is located in Oromia Regional State; it is one of the Oromia Special Zone around Finfine at a distance of 10 km from Addis Ababa. Its astronomical location is 9º02'30''North Latitude and 38º03'30''- 38º41'30'' East Longitude. The town was founded in 1953. Burayu town is one of the reform cities in the region and has a town administration, municipality, and six kebeles. The town has Integrated Development Plan which was prepared in 2008 E.C. Administratively, it is a part of Oromia State that bordering the other Oromia cities in three directions. Sebeta town in the south, Welemera district in the west, Sululta Town in the north, and Addis Ababa city in the east. At most Burayu's landscape seems plateau (flat land) and sub-high. Fourteen degrees centigrade and 1188 mm annual rainfall on average are other seasonal aspects of Burayu town. Source; Burayu Town Municipal Office

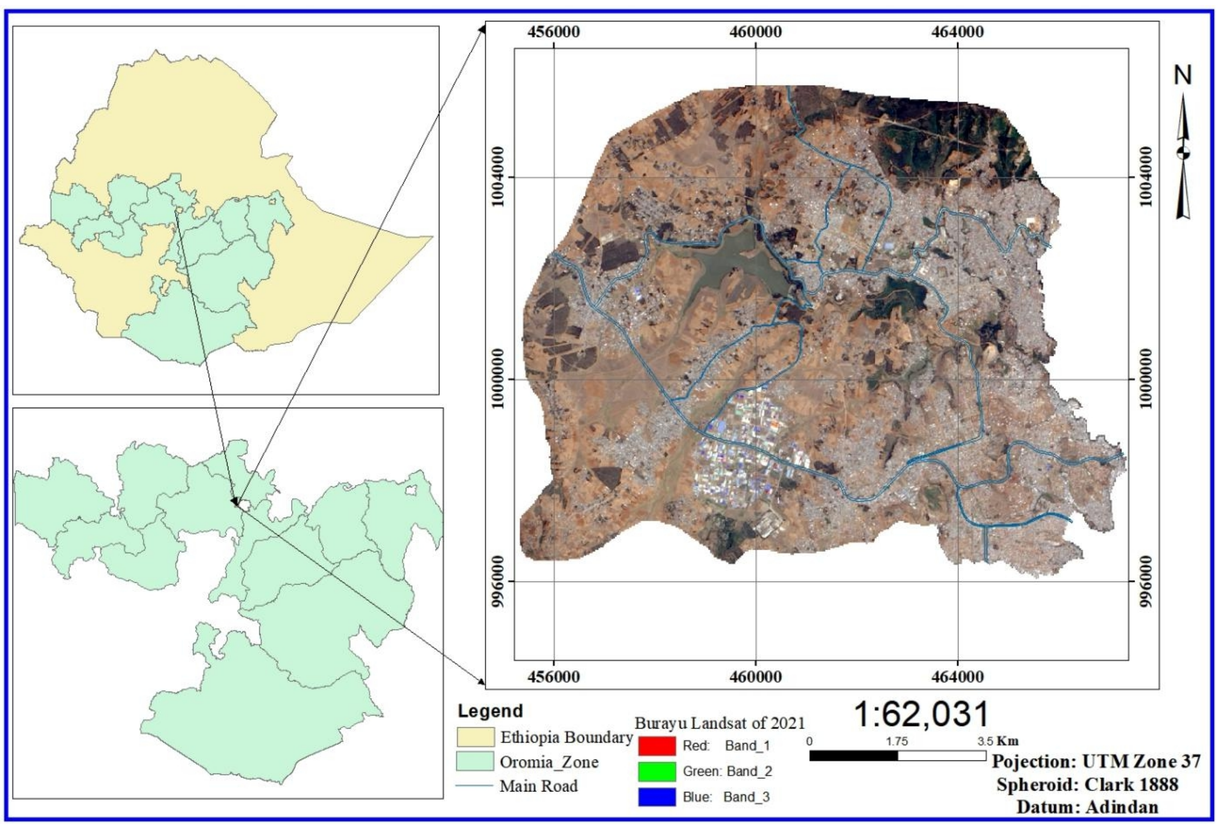

Figure 2: Location map of the study area.

3.1.1. Topography and Drainage

As the town is situated at the southwest foot of Entoto Ridge, most of the existing built-up areas of the town lie on rugged terrain (land profile with steep slopes, deep streams or river valleys with steep gradients, deep river/stream banks, gullies, and ridges) with limited flatlands.

On the other hand, most of the proposed expansion areas are characterized by gentle slopes and undulated plains (northwest) with limited steep slopes and deep gorges (South) along Burayu and Tinishu Akaki Rivers, Altitude of the Town in the north range from 2600 meters above sea level (M.S.L.) in the south at Tinshu Akaki River valley to 2450 M.S.L in the north at Entoto Ridge (measured from base map 1:5000)

Regarding drainage, the Town is found in the Awash River drainage basin, and it is particularly drained by the TinishuAkaki River. There are many other perennial rivers and/or streams in the Tinishu Akaki River Catchments. Burayu, Leku, and sego are the major ones. The discharge of these streams is relatively very small during dry seasons whereas the volume of these rives/steams drastically increases during the summer season (June-September) and inundates the low gradient areas close to their banks. Therefore, an adequate buffer zone should be reserved along the river bank. The study area is mostly covered by flat and rolling terrain types (Burayu Town Profile, Municipal Office*)*.

3.1.2. Physiographic Conditions

Temperature

The mean annual temperature, the mean annual, maximum, and minimum temperatures of the Town is recorded to be about 14^0c, 22^0c, and 6^0c, respectively, which is the characteristic of a warm temperate climate **(**Burayu town Profile, Municipal Office).

Rainfall

The mean annual rainfall is about 1,188 mm. The highest rainfall concentration (70%-80%) occurs from June to September. Thus low infiltration of rainwater, stormwater occurrence, inundation of low gradient areas, sheet and gully erosion are common problems in the town (*Burayu town Profile, Municipal Office)*

Humidity

The mean monthly relative humidity for the nearest meteorological station varies from 79% in August to 49% in December. Such humidity is very comfortable (*Burayu town Profile, Municipal Office)*

3.1.3. Geological Aspect

The present topographic setting of the area is the result of internal geologic processes (Volcano-tectonic activity) and external or surface processes such as weathering and erosion by rivers or streams, and gully development. Man-made activities such as quarrying and deforestation aggravated the surface processes. The formation of Intoto ridge by the Amo-Kassam regional fault system is one the result of tectonic processes that mainly shaped the lad form of the Town and its environs, and hence the direction of surface runoff. The rugged topographic setting of the area has made infrastructure provision difficult (Burayu town Communication office, 2021).

Geology and Tectonics

BurayuTown and its neighborhood are made up of volcanic rocks of tertiary and quaternary age. Localized recent alluvial deposits in the area are rarely observed and are only found along the Gefersa stream above the junction with the Seqo stream. Concerning volcanic rocks, basalts the thickness of which ranges from 0 to 3 meters are found exposed at many places in the study area. This unit is found as massive large intact boulders (Burayu town Communication office, 2021).

Soil type

Two major soil types are identified in the study area. These are the reddish-brown silty clay soil of friable nature which is highly leached and the dark gray sticky clay soil with expansive nature. Soil development and the nature of the soil in the area are mainly controlled by geology, topography, and hence drainage (Burayu town Communication office, 2021).

3.1.4. Socio-economic Aspects

Burayu Town became following the trade route in search of jobs and livelihood and serving as a major focal point for trade and industries and factories. The Town is an important center of distribution of goods that are manufactured locally by the various industries and factories, full of travelers, many hotels, restaurants, bars, and cafes in the town (Burayu town Communication office, 2021).

3.1.5. Population Size

The population counts made by population and housing census conducted in 1999 E.C have been considered here to see the trend of the population size of the town. The 1999 E.C population census put the population size of the town at 63,889. Based on the 1999 E.C census, the projected population of the town in the year 2000 E.C is 92,433. Whereas population counted in year 2003E.C by Burayyu town municipality the population size of the town is around 152,000 B) Age and sex composition. But today the total population of Burayu town is counted as more than 375349. ***Let see the below table.***

Table 3:Distribution of Population of kebele of by sex and age group.

Kebele Name	No. Population			Population under 18 age		Pop above 18 age	
	Male	Female	Total	Male	Female	Male	Female
Geferssa Burayyu	50762	40552	91,314	20304.8	16220.8	30457.2	24331.2
Melka Geferssa	19850	19804	39,654	7940	7921.6	11910	11882.4
Leku Ketta	14847	17443	32,290	5938.8	6977.2	8908.2	10465.8
Burayyu Ketta	30285	26006	56,291	12114	10402.4	18171	15603.6
Geferssa Guje	48357	32685	81,042	19342.8	13074	29014.2	19611
Geferssa Nonno	34912	39846	74,758	13964.8	15938.4	20947.2	23907.6
Total	199013	176336	375,349	79605.2	70534.4	119408	105802

Source; (*Burayu Town Profile, Municipal Office)*

- The below table shows the growth rate population of the study area as the years 1999, 2001, 2004, 2011, and 2018. The researcher has used a formula to identify the estimation of population growth and increment rate of the study area. The used formula to know the change from one period to another is calculated from the formula:

PR = (V present – V past/V past *100/ N) …………………………………………………..3.1

Where; Pr = Percent Rate, V Present = present or Future Value, V post = past or present value

The annual percentage growth rate is simply the percent growth divided by N, the number of years. And also to estimate the future population of the study area; $P(t) = Po(1+P)^t$ where

Po= current population, P= Growth rate as a percentage, and t= time from now. Source; https://pages.uoregon.edu/rgp/PPPM613/class8a.htm

The above table indicates that the rate of population increment of the study area is very fast. The population of the study area during the past 2004 E.C was 152,000 this numbers increased by 21% of increment rate and reached 375349 this shows how the population increment of the study area spuriously the fastest one. But, according to the data of the education bureau of a town, the number of public primary schools of an area is not increased with the fast population growth of Burayyu town.

Table 4: Population increment rate of the study area.

Year	No population	Within a year difference	Increment rate in year interval.
1999 E.C	63,889		
2001 E.C	92,433	2	(1999 – 2001) 22%
2004 E.C	152,000	3	(2001 - 2004) 21.5 %
2011 E.C	375349	7	(2004 – 2011) 21%
2018 E.C	1,425,387.2(estimated)	7	(2011 -2018) 21.5%

This means that the number of public primary schools during 2004 E.C at the town was ten within past seven years there no new built-up public school added to the previous numbers of school an area at 2011 E.C. So that, the estimated population of a study area at 2018 E.C will be 1,425,387.2 for such amounts population increment the new primary school site needed with fair distribution of schools to the study area. This is why the study area is selected.

3.2. Material and software used

When any researcher aims to do research based on determined problems the materials or software must be mandatory. Because materials or software are very crucial and determinant factors for the success of this finding. Without the necessary materials and software, it seems difficult to meet researcher objectives. So that, the materials and software used by the researcher for this study are described below one by one.

3.2.1. The material used for this study area.

Table 5: Material used

No	Material used	Purpose
	GPS (Garmin GPS)	Collect Ground Controls Points (GCPs). To gather existing primary schools location

3.2.2. Software used for this study area.

Table 6: Software used

No	Software used	Purpose
1.	Microsoft office (2016)	Writing, chart preparing, graphs, and statistical analysis
2.	Arc GIS (10.8)	Performing suitability analysis, data acquisition, editing, manipulation, analysis, modeling, visualization, publication, and storage
3.	ERDAS(2014)	For image enhancement, noise correction. Digital image prepossessing, Classification image, map land use.
4.	QGIS	to perform all vector data processing such as shapefile creation
5.	IDRISI TAIGA 16.0	For image classification. Land use modeling and multi-criteria and multi-objective decision support, compare and predict location for the future
6.	Google Earth	Visualization and verification of the classification

3.2.3. The data used for this study

There are different types of data collected from both primary and secondary data sources for this study to reach success the desired goal. Data from primary sources include GCP data. Secondary data such as Landsat images, population, shapefiles, published research, journal, report, etc are gathered from different organizations and websites. Spot data types 2017 with a resolution of 1.5 m * 1.5 m acquired. Map projection: "UTM", Projection units: "meters", Datum and Ellipsoid: "WGS84" and UTM zone: 37 is used for output of all thematic map and resulted suitability map.

3.2.3.1. Data type, purpose, and source data would be used

Table 7: Data type, source, and their purpose in the study.

The data type used for this finding	Format	Purpose	Source
Topographic map of the study area	Shapefile	To indicate the boundary of the study and other necessary information. Topographic map of 1:50,000 scale.	From Ethiopian Geospatial Information Institute
Satellite image of the study area	.img	To detect land use land cover classification of the study area. Type of satellite image, SPOT 2017 of 1.5 m *1.5m resolution.Sentinel-2(2021).s	From Ethiopian Geospatial Information Institute
Drainage data of study area	Shapefile	To develop a river network. From SPOT 2017 and SP of 2016	Generate from DEM
DEM of study area	.img	For generating slope, aspect & stream map. For knowing terrain types.From 20m resolution of DEM, 2020	From Ethiopian Geospatial Information Institute
Structural plan of the study area.	.dwg	To generate some utility service like the road network, commercial religious, emergence area and industrial and factories	BurayuTown Municipality(SP of 2016 G.C)
Population data of study area	.txt	To analysis primary schools distribution concerning population.	National Central statistical Agency.
Aerial photo	.tiff	Extraction spatial data of plots of facilities. A river, main road, water pond, etc.	From Burayu Town Municipality
Land use plan map	.jpg	For extraction construction allowed area and administrative boundary.	Oromia Towns Development Office

3.3. Methodology

This research is conducted to evaluate the suitability of existing public primary schools and develop a suitability map for future primary school development sites. For this finding GIS and AHP techniques are used to identify and suitable site selection. Ten parameters that have been used for this thesis are Proximity to; Existing schools, Main Road, River, Water pond, Industry, and Factories, Commercial and Religious, Emergence service, Land Use, Slope, and Population Density. The identified parameters of this study were used based on scientific methods and standards.

The slope map is prepared from Digital Elevation Models (DEMs) that are obtained from United States Geological Survey (USGS). Rivers of the study area were obtained by digitizing the aerial photo and spot 2017 of the Burayu town. Land use prepared by using Sentinel satellite images. Exiting public primary schools has been gathered by handle GPS. From structural plan residential and industrial derived and cross-check with land use which is derived from Spot 2017 land image. And then the individual thematic maps were developed and used as input data to the GIS-based decision-making procedure. The combination procedure follows the conventional scheme for GIS-based MCDA (Malczewski, 1996). It involves three main steps.

First, the criterion of maps is standardized/ reclassified using Spatial Analyst's Reclassify tool. This step is necessary because the criterion maps will contain the ordinal values (Most suitable, suitable, less suitable, and unsuitable) that indicate the degree of suitability of location primary school site concerning particular criteria or standards.

The second, derivation of relative criterion importance is using the pair-wise comparison method. The criterion weights will be automatically calculated once the pair-wise comparison matrix is entered in the AHP weight derivation module.

Third, the criterion weights and the standardized criterion maps are combined by using the weighted overlay technique. The collected data and the individual geo-database has been generated, the methods of AHP analysis and GIS overlay approaches are used for the final result of this thesis.

3.3.1. Extraction of Data

The data which have been used for this research is extracted from its original data. The primary techniques used before taking the needed data into the software environment are mentioned below.

First, Digitization is used to converts the structural plan of the area into the digital map to use in the GIS environment by encoding the spatial coordinates of the features on the map such as boundaries, roads, and streams that exist in the study area from the structural plan. Burayu Town boundary, kebeles, Road and River are digitized (converts the structural plan of the area into the digital map) from Burayu Town Structural plan 20016 that exist in AUTOCAD form.

Second, make layer stake. This layer stake is used to stack multiple or usually single bands or layers into a single output of a multi-band image file. Since Sentinel 2 satellite image is downloaded and as separately in multi-band and selecting the bands combined into single multi-band for a satellite image of the study area.

Lastly, Clip/ Extract by the mask is Used to cut out a piece of one feature class using one or more of the features in another feature class, creating a new feature class also called study area or area of interest (AOI) that contains a geographic subset of the features in another, larger feature class. Layer stack image covers a large area of 3,111,000 hectares (170km * 183km) but in the case of this study area is 9000hectare. So using the boundary of Burayu Town Clip /extract by a mask the area of study or windowing as a rectangle.

3.3.2. Image classification and Accuracy Assessment

Broadly there are two main kinds of pixel-based classification are used by various researchers these supervised and unsupervised (Caetano, 2009). According to Mather(2011), supervised classification is a procedure used for identifying especially similar areas on an image by identifying “training” sites of known targets and extrapolating those spectral signatures to other areas of unknown targets. Further, the supervised classification is usually appropriate when relatively few classes when training sites are verified with ground truth data that means the homogeneous regions represent each class (Erdas Field guide, 2008). This is need to cross-check identified land use with ground truth.

In addition to that when the signature is collected its depends on the maximum Likelihood of the neighbor pixel. Because the maximum like-hood is parametric, meaning that it relies heavily on a normal distribution of the data in each input band. While selecting signature for identified land use in the Arc Map for Burayu Town and land cover using supervised classification method, maximum likely hood algorithm, finally making accuracy assessment for the year of 2021 and classified land use land cover maps.

3.3.3. Standardize Data Set

For this study, ten parameters are used. All identified parameters for further processing are stored in different units. To use those parameters standardizing techniques is an important task. This technique converts the measurement to the uniform unit, and results score lose their dimension along with their measurement unit of all criteria (Effat and Hasan 2013). So that all the vector layers of parameters are changed into a raster layer and then a weighted overlay model was developed.

After parameters are changed into raster format reclassification was done and used as input for the weighted overlay. In sum, all parameters were used or suitable site identification for primary school. The sub-criteria/each parameter was classified. This means unsuitable, less suitable, and suitable, and the most suitable into different ranking scales, and the value from 1 to 9 was assigned. The assigned score indicated that the rate of its significance. Scored values, one (1) is indicated the least significance while the greatest value(9) has the greatest significance.

3.3.4. Rasterization

The majority of GIS datasets are currently represented in vector format, which is convenient due to storage efficiency but can be difficult to manipulate analytically. To achieve tractability, vector format GIS data is often rasterized (conformed to a grid cell representation). This process of converting vector format to raster is called Rasterization. In this finding, all the parameters that are present in vector data format were converted to raster data format using spatial analyst tool. The need for Raster data is that it is an analysis of suitable site selection using GIS software.

3.3.5. Distance calculation

In this research calculating the straight line distance is the important step in the analysis process depending upon the international and national standards taken from a different research paper. This is done by inputting the maximum distance to the raster data. Hence, the spatial analyst tool calculates the distance from each cell to the nearest or closest source. The source identifies the object of interest such as a river, main road, industrial and factories, commercial and religious and existing primary school of Burayu Town, etc.

3.3.6. Reclassification

This is reclassification tool is used to reclassifying data and replacing input cell values with new output cell values. Further, the input data which means the parameter used for this study is supported raster format. In this process, reclassification functions reclassify or change cell values to alternative values using a variety of methods. It is possible to reclassify one value at a time or groups of values at once using alternative fields; based on criteria or standards.

Why raster data is reclassified?

The most common reasons for reclassifying data are: to replace values based on new information, to group certain values, and to reclassify values to a common scale (for example, for use in a Suitability analysis). Based on allowable standards reclassification is performed for each thematic map.

3.3.7. Analytical Hierarchy Process

This method has been used for the determination of ranks, pair-wise comparison, accuracy, computing weight, determination of score, and weighted overlay analysis. The ranks enable the researcher to indicate the level of parameters based on their importance. Moreover, the rank of parameters is assigned by the researcher depending on the evidence and its importance in this study.

Similarly, Pairwise comparison is required for the AHP method. This helped the researcher to make a precise judgment between two parameters and attempting for prioritizing the identified parameters. The main significance of using this technique is to enable the user to compare two parameters at once, this can reduce confusion. This is defined in the literature review of this study. Then after PCM is computed, the next term is computing Weight for each parameter. The judgment ranks were prepared based on expert opinion and comparisons made in PCM. To calculate the weight of each criterion, the cell value of PCM is divided into the sum of the column to obtain the cell value in Normalize PCM. In sum, the prioritized accuracy is performed to the judgment of ranking parameter by cheeking whether consistency or not consistent.

3.3.8. The methodological structure used for this finding

The below hierarchy is the designed methodology of this research and is used to get the objective of this research.

Technological Scheme

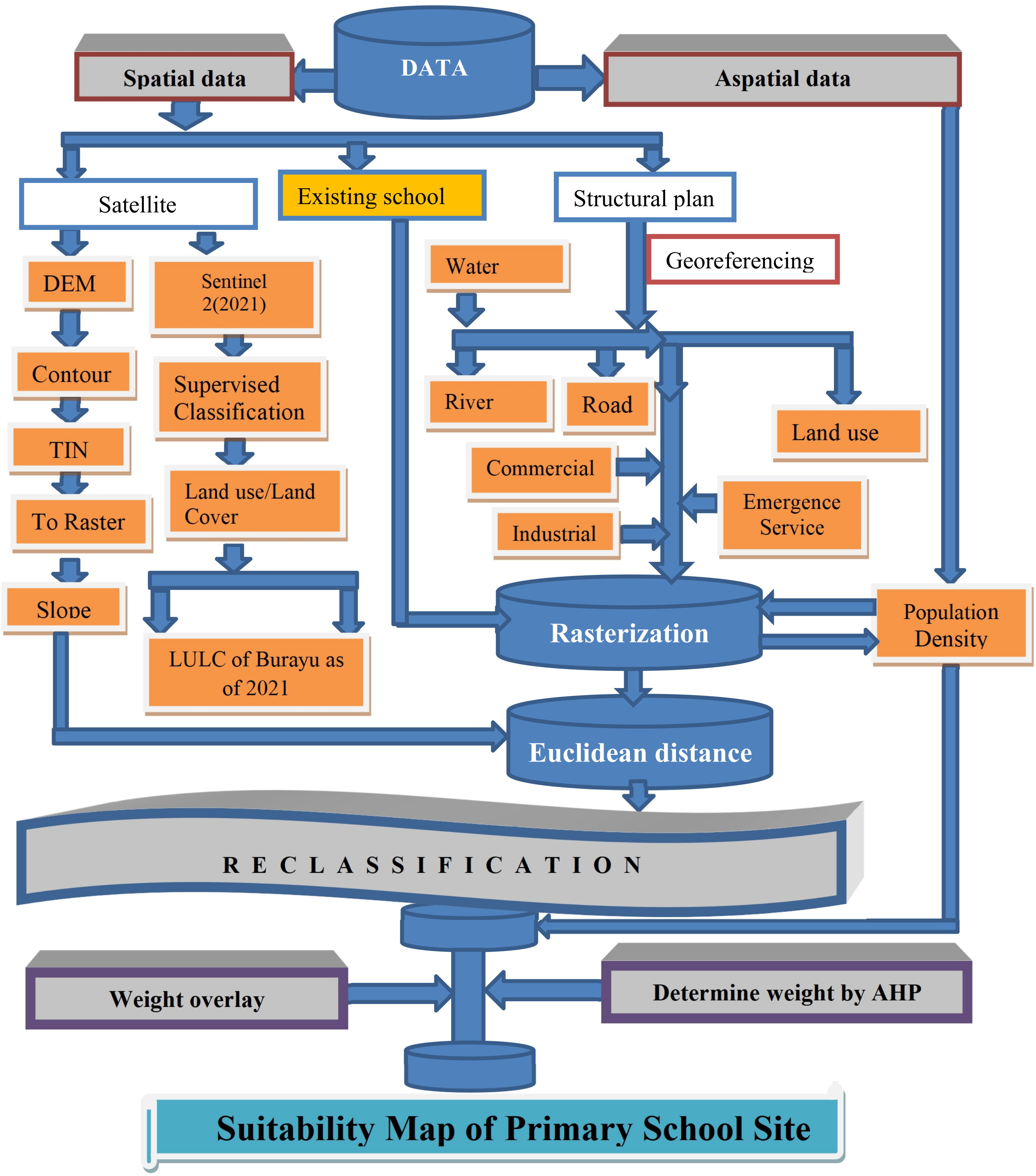

Figure 3: Flow chart of methodology.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1. Land Suitability analysis

Land suitability analysis is an evaluation of a problem involving several factors. Additionally, land-use suitability analysis is a method for determining the optimal future land uses based on a set of constraints, preferences, or predictors (Malczewski, 2004). This has been done by overlying different criteria on the GIS environment but previously hand-drawn overlay maps were used by different stakeholders.

Nowadays, GIS technology has become integral to the process of analyzing and mapping large datasets (Whitley and Xiang, 1993). Because using GIS approach for analysis enables the integration of several overlay maps or of maps indicating or carrying different criteria (e.g. slope, proximity to road, distance to the nearest road, soil type), to result in a final overall suitability map of the study area (Hopkins 1977, Malczewski 2004). Many parameters go into the selection of a site as the potential location for a primary school campus.

4.2. Current Land use Land cover of Burayu Town

The areas defined for each land cover type of study area is processed by creating the spectral signature of each categorized land use land cover is done by analyzing the pixel of the training site (Eastamn, J.R.,2009). For the study area, Land use land cover classification is performed on Sentile sat image of 2021, and pixel-based classification supervised classification method with the maximum likely hood algorithm is done. The land use of the study area is categorized into five types(Figure 4). The classified land use of 2021 demonstrate that, 1505 ha(16.74%)is shrubland, 1422 ha (15.81%)is forest,1015 ha(11.29%) is farmland,4938 (54.91%) and 113 ha(1.26)of Burayu Town is water body.

Accuracy assessment is done to check the reality of classified land use type with ground truth. To perform this accuracy assessment for LU classified by a researcher GCP collected from the known true study area, ortho-photo, and google earth pro 2021. The total number of collected reference points is 2020 are shown. And then after the error matrix table is produced a different statical measure of classified map accuracy including overall accuracy, percentage of omission and commission error, and kappa coefficient (Table 8). So that, depending on the equation classified LULC map of Burayu town is 87.72 % and 0.66 kappa coefficient. This indicates that the land classification is almost perfectly classified.

Table 8: Error matrix of Burayu town LULC classes in 2021

		REFERENCE DATA (2021)						
		Waterbody	Shrubland	Built-up area	Forest	Agricultural land	Total Points	U.A (100)
CLASSIFIED DATA 2(021)	Waterbody	20	-	-	-	-	20	100
	Shrub land	2	41	1	1	5	50	82
	Built-up	1	3	39	4	3	50	78
	Forest	-	2	2	44	2	50	88
	Agricultural land	-	-	1	-	49	50	98
	Total point	**23**	**46**	**43**	**49**	**59**	220	
	P.A(100%)	86.95	89.73	90.69	89.79	83.05	88.042	
	Overall Accuracy = 87.72							
	Kappa Coefficient (K)= 0.664							

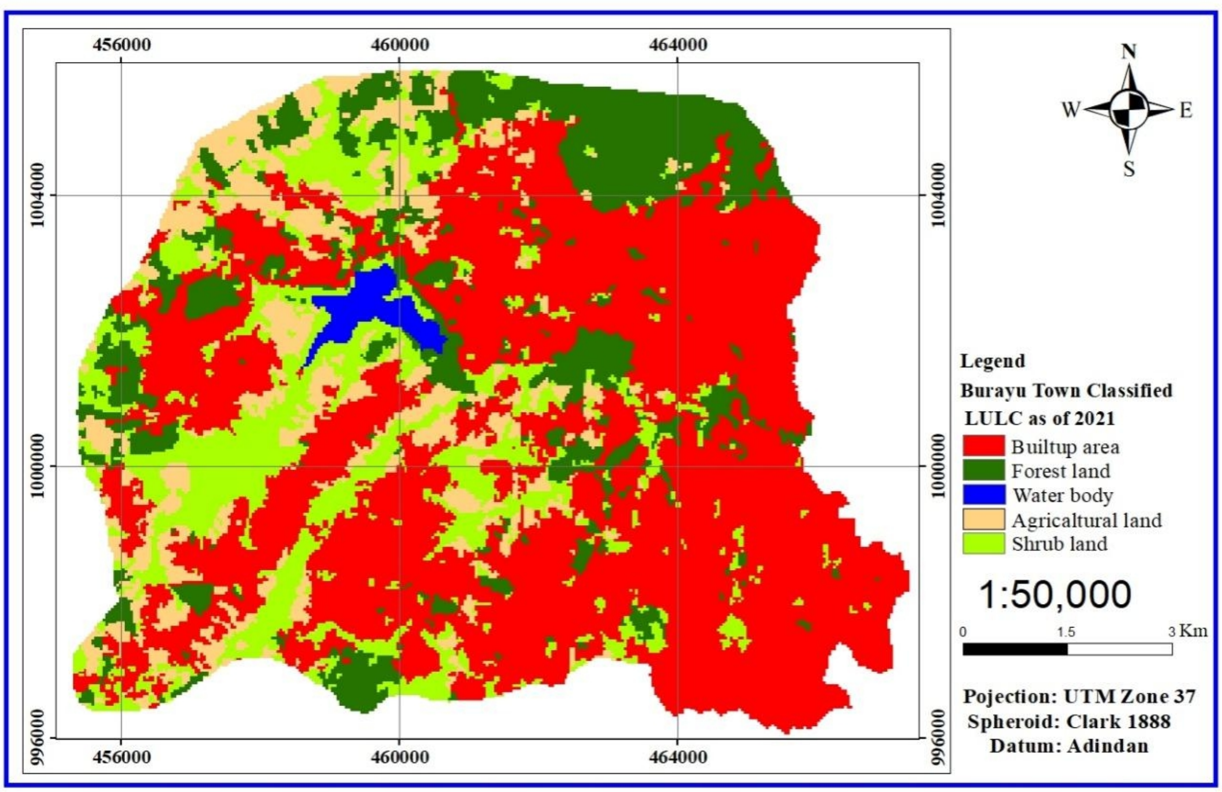

Figure 4: Burayu Town classified land use the land cover of 2021

4.3. Distribution of Schools in Burayu Town

The spatial distribution of schools in Burayu town as of 2021 is depicted in figure 5, figure 6, and figure 7. In Burayu town there are two hundred private and primary schools including Kindergarten, primary school, and High-schools. There is no public kindergarten school in the study area.

Table 9: Distribution of schools in Burayu Town

	Schools in Burayu Town			
Kebele	Kindergarten	Private Primary schools	No. Public Primary schools	Public & Private High school
Geferssa Burayu	32	18	3	1
Melka Gefersa	16	6	1	-
Leku Keta	12	5	1	2
Burayu Keta	15	7	1	1
Gefersa Gujie	12	8	3	-
Gefersa Nono	30	20	2	4

In Burayu town there are one hundred seventeen kindergarten schools are there. Distribution of school in terms of kindergarten school thirty-two school (27.35) found in Gefersa Burayu kebele and followed by Gefersa Nono Keble with thirty(25.64). The equal number of kindergarten schools means Twelve(10.25%)s are found in both Geferssa Gujie and Leku ketta. Many kindergartens clustered in the northeast of the town. And also clustered in the southeast of the town. Some kindergarten schools were found dispersed in the southwest and northwest part of the town.

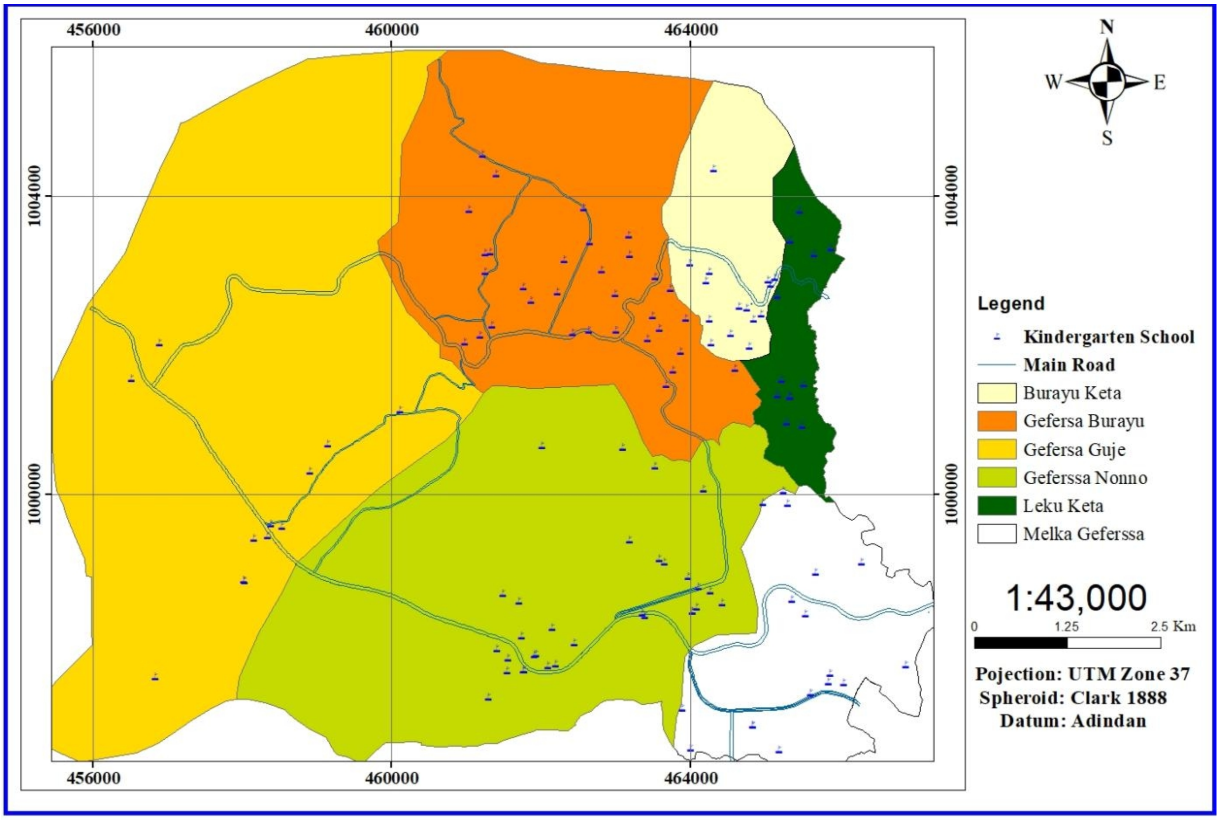

Figure 5: The spatial location of a kindergarten school in Burayu town

There are eleven public primary schools. The below figure demonstrates that most of the public primary schools are located in the northeast part of the town. And also the number of schools in each kebele is not uniform and dispersed across the study area. Moreover, there is wide variation is observed in the availability of public primary school facilities across the town. For example, from eleven existing public primary schools three schools are found in Gefersaa Burayu kebele and Geferssa Guje kebele and followed by Geferssa Nonno kebele account with two schools. In the rest three kebeles, one public primary school is there in each of kebele. Also, 54% of public primary schools are found in Geferssa Burayu and Geferssa Guje kebeles. Geferssa Nonno, Melka Geferssa, Leku Ketta, and Burayyu Ketta Kebeles followed by 18%, 9%, 9%, and 9% respectively (Table 7).

In terms of served population, according to Ethiopia Urban Planning and Implementation Manual to guide the planning process, locational standards stated that to build up primary education school needs 1.5 – 2.5 ha space with served population 12000-18000 (A.A) and 5,000 -15,000 in another area (source: MUDC, 2012). To identify the served population ratio with the existing schools, the distribution of existing schools ratio to the served population can be analyzed in terms of served population based on allowable standards for primary schools (Leta, 2018). So that, by this way the ratio of the population with schools is identified for this study. Furthermore, the proportion of the public primary school facility to the population of the town is about 1 to 34,122 which cannot be acceptable when compared to the developed standard and in terms of population index. When evaluating the existing public primary schools in terms of served population, existing schools can serve only 44 % of the whole population of Burayu town. This means 56% of the total population of the town demand additional schools.

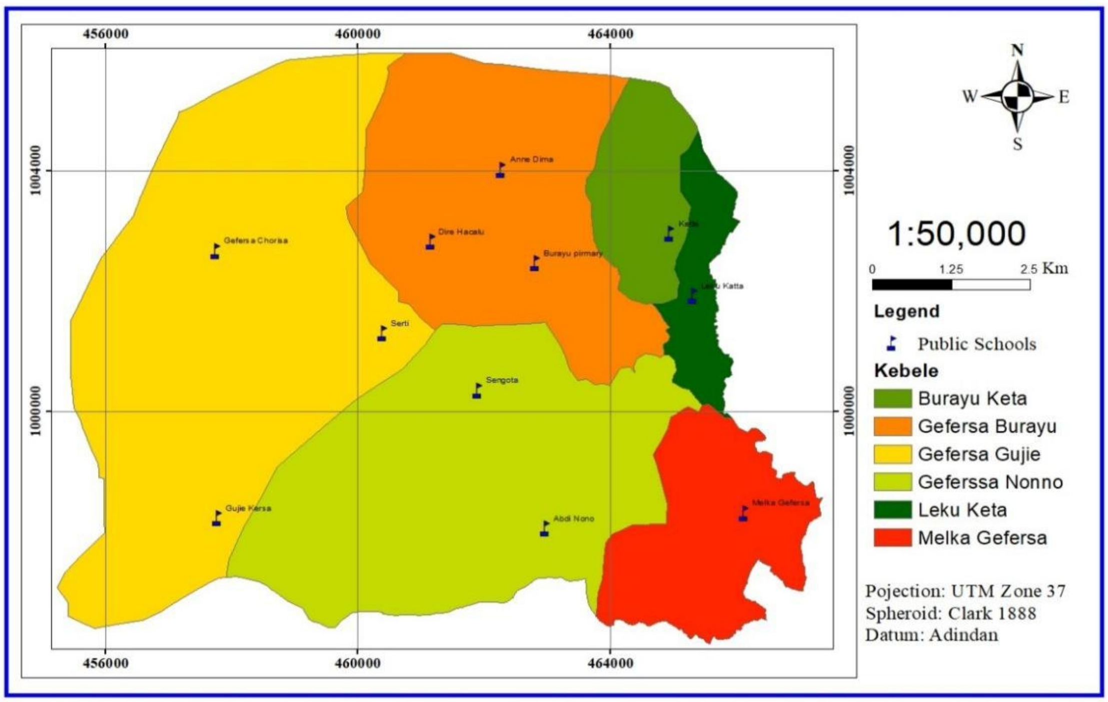

Figure 6: The spatial location of public primary school in Burayu town as of 2013 E.C

The spatial distribution of primary school depicted under figure 7 shows that the one primary school that existed at South East of the town and serving 39,654 of the population in Melka Geferssa kebele while standards stated maximum population served up to 15,000. In the North East of the town which means Leku Keta kebele, there is only one built-up public primary school serving 32,290 population. When the analysis is made according to an allowable standard of population index concerning the number of schools, the existing school is expected to serve 46% of the population. This indicates that 54% are underserved. This means that in school in Leku Keta kebele 46 % served and 54% of the population underserved when compared with allowable standards (table 10). On the other hand, in the Gefersa Burayu Kebele, there are three public primary schools with a total population of 91,314 with 49 % and 51% of the total population is served and under-served respectively (Table 10).

Generally, locational distribution analysis of public primary schools of Burayu town indicates that the number of public schools varies quite significantly across kebele and this leads the researcher to believe that considerable disparity found among public schools in terms of served and underserved population of the study area. So, that new primary school suitable site is needed for the study area.

Table 10: Distribution of public primary schools with a served and under-served population.

Kebele	Population	No. Public schools	Existing Schools in %	Served population %	Undeserved population %
Geferssa Burayu	91,314	3	27	49	51
Melka Gefersa	39,654	1	9	38	62
Leku Keta	32,290	1	9	46	54
Burayu Keta	56,291	1	9	27	73
Gefersa Gujie	81,042	3	27	56	44
Gefersa Nono	74,758	2	18	40	60

Distribution of Private primary schools, from sixty-four schools a large number of schools means twenty (31.25%) found in Geferssa Nono and followed by Geferssa Burayu kebele with eighteen(28.13%). Eight private primary schools(12.5%) are located in the Geferssa Burayu and followed by Burayu Keta with seven schools(10.94%). In terms of their direction, private primary schools are clustered in the northeast of the town and dispersed in the southwest and northwest of the town.

The spatial distribution of secondary schools, there are eight public and private primary schools. Three public secondary schools and five private secondary schools. From these schools, four(50%) of them are found in Geferssa Nono Kebele and followed by Leku Keta kebele with two(25%) of secondary schools. Only one high school is located in both Geferssa Burayu and Burayu Keta. In the rest keble there are no private and public secondary schools. There is no high school in the northwest and southwest of the town.

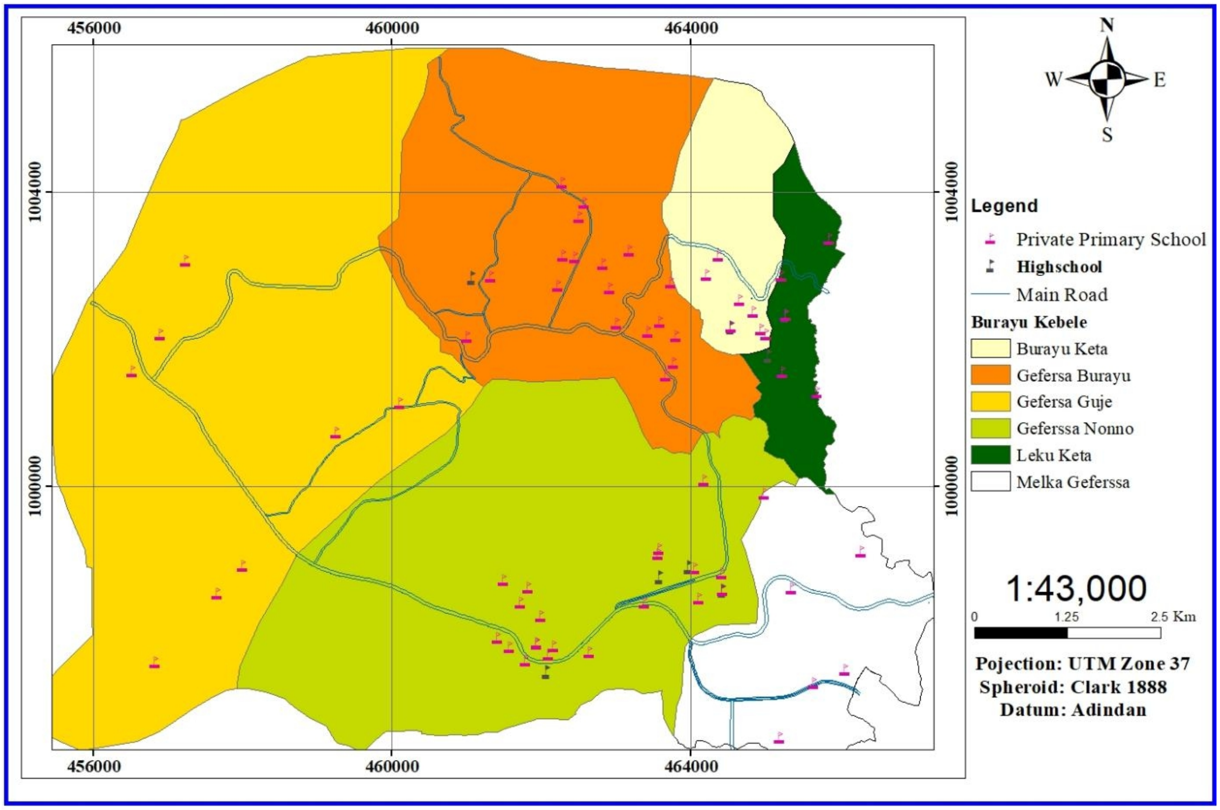

Figure 7: The spatial location of private primary schools and High schools in Burayu town

4.4. Parameters and criteria used for this study

In Ethiopia, as mentioned above developed standards and used for schools site selection have weaknesses which mean not deliver enough and detailed information for each parameter standard. Because only two parameters, slop, and road are defined in detail. For example, their standards were developed and used by the Oromiya State Educational Office in the year of 2012 G.C stated that schools must be away from factories but no detailed information about how long school sites should be away from it. This is why researcher the national current standards implemented across the country is not enough. So that, for this thesis the standards used by a researcher for each parameter are taken from various previously conducted researches by different scholars for suitable site selection for school. Now a days different developed country had own well-developed school site selection guideline and parameters to select a suitable site for school. For example, the School site guideline of the United State of America (School Siting Guidelines, 2011), and New School Site Selection, Processes and Criteria (Albuquerque Public Schools, 2014), and School Sites Selection and Development

(Kansa State Department of Public Instruction, 1976). School site standards, site selection, and site development, New York the State of the education department, 1976.

For this study, ten parameters were identified to map suitable sites for primary school. These criteria are proximity to existing primary school, population density, road network, industrial area, residential, commercial, and religious area, river, Geferssa water pond, land use, and slope. All parameters are supported by a known source. Because the selected parameters enable the researcher to develop a suitability map. Moreover, below Table 11 contains the list of parameters and criteria used by the researcher to develop a suitability map of school for Burayu Town.

Table 11: Standardization of parameters with their buffer classifications

No	Parameter	Classification	No	Parameter	Classification
1	Distance from existing school(in meter)		6.	Commercial And Religious (in meter)	
	0- 1000	Unsuitable		0 - 300	Unsuitable
	1000 – 1500	Less suitable		300 - 650	Less suitable
	1500 – 2000	Suitable		650 -1000	Suitable
	>2000	Most suitable		> 1000	Most suitable
2.	Distance from River (in meters)		7.	Emergency Service (in meter)	
	0 – 100	Unsuitable		0 – 300	Unsuitable
	100- 150	Less suitable		300 – 1000	Most Suitable
	150 -200	Suitable		1000 – 2000	Suitable
	Greater than 300	Most suitable		>2000	Less Suitable
3.	Distance from Main Road in meter.		8.	Geferssa water pond (in meter)	
	< 50	Unsuitable		0 – 200	Unsuitable
	50 – 100	Most suitable		200 – 350	Less Suitable
	200- 300	Suitable		350 – 500	Suitable
	>300	Less Suitable		>500	Most Suitable
4.	Slope (in percentage)		9.	Population Density	
	0 – 10	Most suitable			Less suitable
	10 – 15	Suitable			Moderate suitable
	15 – 20	Less suitable			Suitable
	>20	Unsuitable			Most suitable
5.	Industrial and Factories Area (meter)		10.	Land use	
	>1000	Most Suitable		Proposed Residential	Most suitable
	750 -1000	Suitable		Open Space, Green area urban, Agriculture, Built-up	Suitable
	500 - 750	Less suitable		Plantation, Special use.	Less suitable
	0 – 500	Unsuitable		Water Body/River Bank	Unsuitable
Source; MOFA,2005, Talam & Nigig,2015, Dadfar,(2014), Abera,G. (2019), Bukhari et al.,(2010), Jamal,(2016), Jayaweera, (2016), Lencho,A.(2019), School Siting Guidelines, (2011), MUDC, (2012)					

4.5. Result of Parameters/Criteria used for suitable site selection of primary school.

Thematic map of all parameters illustrated above each Euclidean distance calculated for ten criteria's dataset. Then after Euclidean distance has been done the reclassification for each parameter was computed. The result of reclassified; Land use, proximity distance to Existing schools, rivers, Roads, Slope, Industrial, and factories area, Commercial and Religions areas, Population Density, Emergence Service Area, Geferssa water pond developed respectively in scientific method and standards. Each reclassified suitability map of parameters is ordered from the most suitable to unsuitable by depending upon criteria that have been mentioned in the methodology part of this research.

4.5.1. Land Use

During suitable site selection for anything related to location, the primary task is understanding the existing land use of the study area. This assists the researcher to choose a safe and suitable site with the help of geospatial techniques/technology. Because the new suitable school location is must be compatible with land use planning of the study area. In sum, land use is one of the parameters that is used for the proper site selection of primary schools. This enables the researcher to understand the existing and proposed land use because the land is used for different purposes such as commercial, residential, general service, transportation station, administration, and green area. School is must be in a residential area, near parks and green spaces to support sports and outdoor activity (Prasetyo, 2018). In this study, the proposed residential area is the most suitable area rather than another land-use type. Open space, green area, and urban agricultural area are considered as suitable (Table 12).

Table 12: Land use detail and their buffer classification

Land use detail	Land-use type	Buffer zone/classification	Brief description
Proposed residential area	Non-build-up	Most suitable	B/c school should be a residential area. It reduces extravagant expenditure students exploit to get tax.
Existing residential area	Built-up	Suitable	Depending on the increment of population an area, if new primary schools are needed to be built-up area shall >>>>
Open space	Bare soil	Suitable	It's a freely reserved area. No much need for paying compensation to use for the public purpose
Special use Mountains area	Nonbuildup	Less suitable	This area is protected by the government and will be used for special purpose
Waterbody/River Bank	Swamp	Unsuitable	School should not be built upon the wetland/water body. Overflow of water.
Industrial area	Built-up	Unsuitable	Soil & groundwater contamination Accidental release/spill of a hazardous chemical.
Commercial & Religious	Built-up	Unsuitable	Traffic congestion. Noise sound.
Public service office	Built-up	Unsuitable	Instead of the public service area,s it's important using other land-use types.

Mountain Green Frame Area is considered less suitable. Water Body, River Bank, in industrial zone are unsuitable areas because it's difficult to use and considered as suitable for new public primary school. Clearly, from reclassified land use of study area 12.19% is less suitable, 23.06% of the area is most suitable, 42.49% is suitable and 22.26% of the area is unsuitable in percent. See below table 13 shows reclassified land use of the study area with the area of coverage in a hectare.

Table 13: Land-use suitability with an area of coverage

Parameter	Classification	Area in hectare	Area in percent	Score
Land use	Unsuitable	2003.06	22.26	Restrict
	Less suitable	1096.88	12.19	5
	Suitable	3823.31	42.49	7
	Most suitable	2074.46	23.06	9

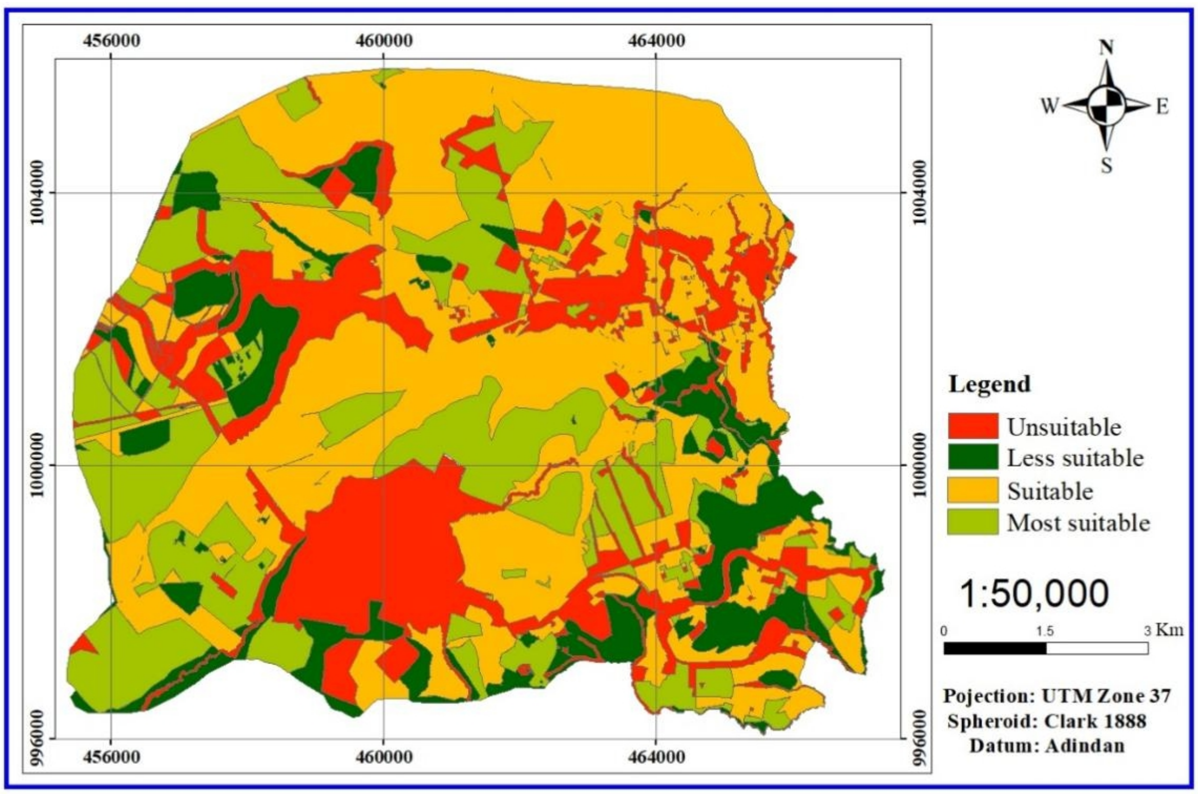

Figure 8: Reclassified land-use suitability map

4.5.2. Proximity to existing school;

The second parameter used in this study is the proximity to an existing school. While a new school site is proposed for construction it is important to give caries how far away from each other seriously. Keeping the proximity distance from other existing schools as well as anticipating impact from each other, it is not only relevant to rational resource allocation but also matters fair distribution of school among the community. So that, the new public primary school site is not near to the existing primary schools. This is why the Proximity distance of the existing primary school is chosen as an influencing parameter by the researcher.

Hence, in this study, the new primary schools are also wished to keep a distance of 2,000m the further away is better. This is based on how far a pupil should walk to reach schools. The buffer distance used for this factor was identical to the research done by (Talam & Ngigi, 2015; Abera, 2018). And also, in determining optimum buffer distances from schools, the School Siting Guidelines (the United States Environmental Protection Agency, 2011) were consulted. The guidelines outlined that the maximum acceptable walking/biking distance for high school children in the US is 1.5 miles or approximately up to 2,400 m. The standard used for this parameter is taken from these above sources.

Therefore, the result illustrates that the area coverage of suitability map concerning proximity distance of the existing primary school, area 27.05% is less suitable, 21.70% is suitable, 16.26 % of the area is most suitable, and 35.00 % of the area unsuitable in percent. It can be concluded that a large percentage (35%) of the study area is unsuitable conversely 16.26% is the most suitable. See below table 14 shows reclassified existing public primary school land use of the study area with the area of coverage in hectare

Table 14: Proximity to existing school suitability with the area of coverage

Parameter	Classification	Area in hectare	Area in percent	Score
Existing School	Unsuitable	3149.01	35.00	1
	Less suitable	2433.69	27.05	3
	Suitable	1952.34	21.70	5
	Most suitable	1462.66	16.26	9

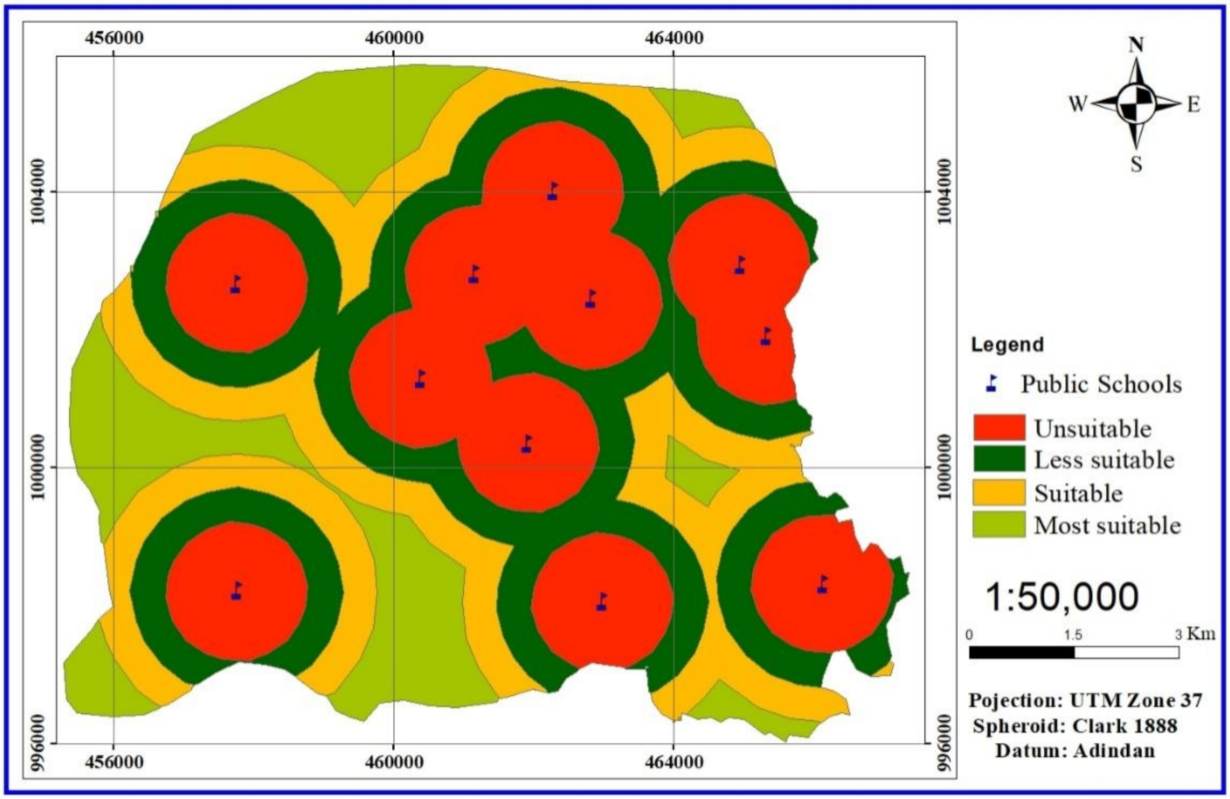

Figure 9: Reclassified proximity to existing primary school suitability map

4.5.3. Distance from River

The third parameter used for this study is proximity distance from a river that is far away from the new primary school site. This parameter is deliberately accepted as one of the influential parameters for this study. Because this is taken to ensure schools are safe from natural disasters such as flash floods, mud floods, and erosion problems. Further, if the proposed school is very near to stream/river school pupils may accidentally fall to it, this is exposed student life to danger. So that, the proposed site at least should be 100m away from the river for the safety of students and mask from being placed. Furthermore, more than 300 meters are considered as most suitable according to the experience of a recent study(Lencho, A.,2019).

Therefore, after the proximity distance is calculated and reclassifying the old value is replaced and giving new values according to allotted criteria the proximity distance to a river is identified. So that, the suitability of an area concerning guidelines or standard which is acceptable for new school site here its identified in percent perceived from reclassified river map. Ultimately, 16.41% of an area is less suitable, 14.69% is suitable, 51.29% of the area is most suitable, and 17.60% of an area is unsuitable. (Table 15). Finally, the results prove that

51.29% of an area is the most suitable for school construction and on the contrary to that 17.6% is unsuitable.

Table 15: Proximity to the river suitability with an area of coverage

Parameter	Classification	Area in hectare	Area in percent	Score
River	Unsuitable	1584.30	17.60	1
	Less suitable	1476.85	16.41	3
	Suitable	1321.85	14.69	7
	Most suitable	4615.94	51.29	9

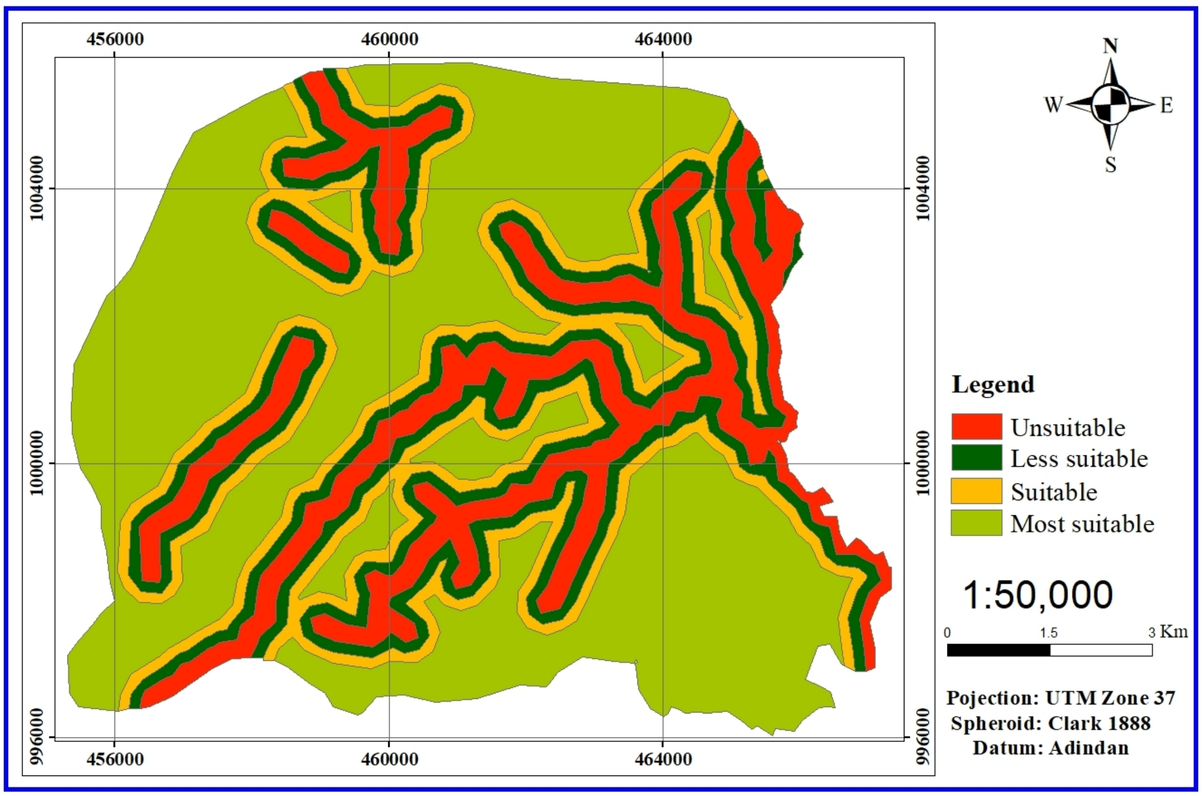

Figure 10: Reclassified proximity to river suitability map.

4.5.4. Distance from Main Road

The fourth parameter used for this study is the proximity distance of the main road to the new primary school construction. According to Salvesen and Zambito (2009), transportation on road produces a polluted substance that has side effects on human health. Various studies done on the risk of transportation pollution on human healthy show that the closeness of living or studying in school to main asphalt or road raising the risk of heart and lung problem but the risk is highly minimized after 150 m from the main road (Green, R. S; Smorodinsky, S.,2004). To be sure the school should not be far away above 2000m and not close up to 150 from the main road (Jamal, 2016; Jayaweera, 2016; Abera, 2018).

Moreover, the buffer size used for this study was assigned from 150 m to 2000m. This means 500m was assigned as minimum proximity and 2000m maximum proximity to the main road based on the above-cited research source. So that, the new suitable school site is considered distance from the major road at an average distance up to 150m. The result demonstrates how much area is most suitable or unsuitable according to allowable guidelines or standards which were used by previous research and is acceptable for news suitable school site selection. So that, allowable standards, the reclassified road map used for new proposed primary school suitable site based on their area coverage(Table 16). Area of 19.24% is less suitable, 19.60 % is suitable, 56.31% of the area is most suitable, and 19.24 % of an area is unsuitable. The result suggests that, as of this parameter, the largest area(56%) of the area is the most suitable and while 19 % unsuitable. (Table 16, Figure 11)

Table 16: The proximity distance to main road suitability analysis

Parameter	Classification	Area in hectare	Area in percent	Score
Main road	Unsuitable	1731.25	19.24	1
	Less suitable	435.70	4.84	3
	Suitable	1763.82	19.60	5
	Most suitable	5066.76	56.31	7

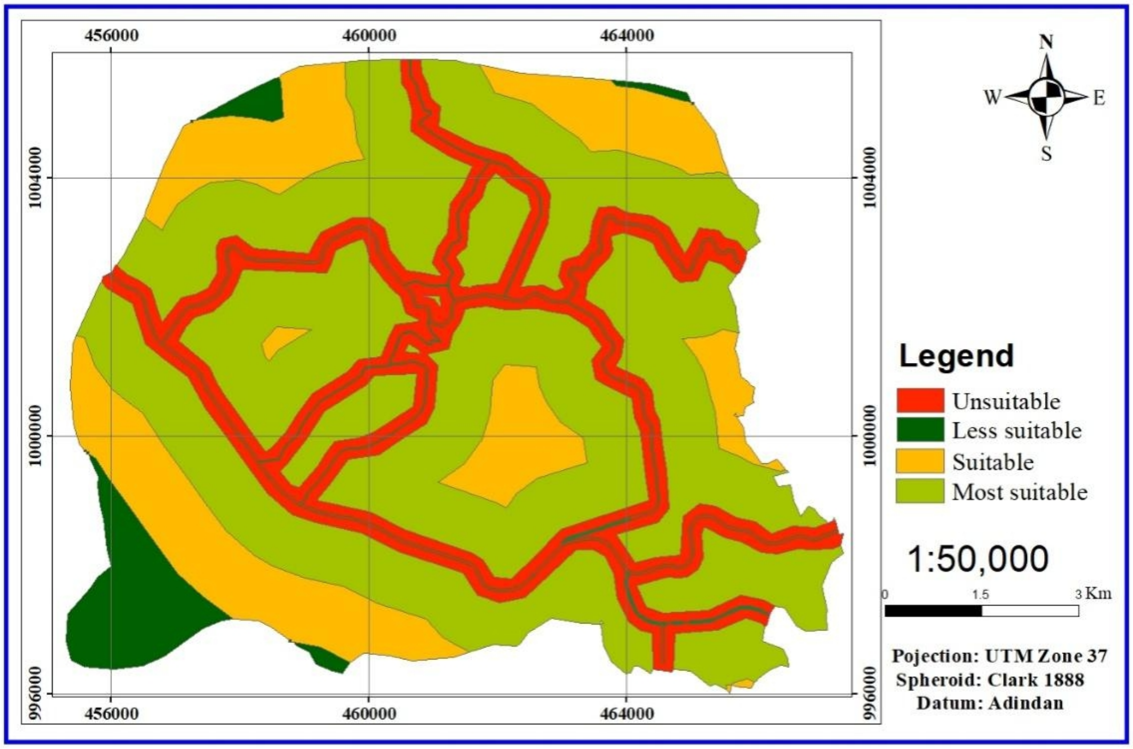

Figure 11: Reclassified proximity to road suitability map

4.5.5. Slope

The slope is the fifth parameter used for suitable site selection of primary schools by using scientific methods. The slope of the study area was derived from the 15m resolution of the Digital Elevation Model (DEM) which was taken from the Ethiopia Institute of Geospatial and masking by using a masking layer by limiting it to the study area boundary. This is another important feature considered and used as an important parameter by a researcher. And also, the school location should not be located on a steep slope or landscape. The intervals demonstrated that a high percentage value shows mountainous and is not considered as suitable to build schools. And on the other hand areas from zero to gentle slope or 10 % will be the most suitable. Especially, different research recognizes that slop less than 10% is convenient for a school construction site (MOFA,2005**;** Bukhari et al;2010; Dadfar (2014); Talam & Ngig (2015), Abera (2018). Because the site should be fairly level with some topographic relief that can provide opportunities for learning area development. This encourages students to reach school by walking or biking when the school site is suitable and build-up on flat terrain. Typically, the overall slope of a school site should be flat enough to allow for ease of construction and circulation, and yet be steep enough for proper site drainage.

Generally, Buffer size 10 to 20 is assigned for new reclassified slope based on previous research as of previous research cited above. So that, researchers have used this parameter to select a suitable site for new primary schools in scientific ways and standards. In sum, the result of the reclassified slope map indicates that an area of 23.72% is less suitable, 25.61% is suitable, 13.30% of the area is most suitable, and 37.38% of an area is unsuitable (Table 17). Finally, the results evidence that 37.38% of an area is unsuitable for school construction and in contrary to that 13.30% the most suitable.

Table 17: Slope suitability with the area of coverage

Parameter	Classification	Area in hectare	Area in percent	Score
Slope	Unsuitable	3363.68	37.38	1
	Less suitable	2134.05	23.72	5
	Suitable	2304.39	25.61	7
	Most suitable	1196.30	13.30	9

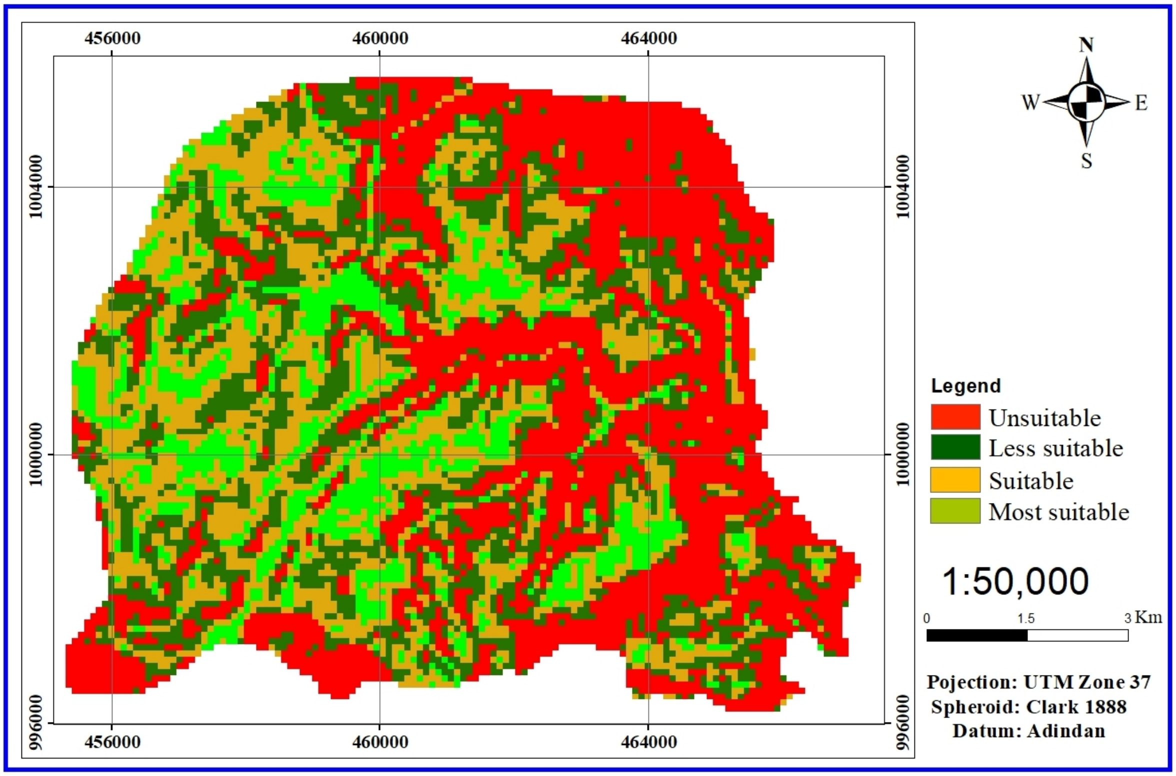

Figure 12: Reclassified slope suitability map

4.5.6. Distance from Industrial and Factories

The other parameter used for selecting a suitable site for the new primary school site is proximity distance to industrial and factories location. According to the data municipal office Burayu town, there are above five hundred medium and light industries and factories. This is why the researcher is motivated to include this parameter for suitable site selection of new primary schools. By any means school location is should not be near to industrial and factories areas to ensuring the safety of students. Because there is also a possibility of noise and polluted air based on types of industry and factories which may make risk to the health of pupils/students. Nowadays different research has been warning and shows that a least 500-meter school being apart from factories/industrial zone or areas (Bukhari et al., 2010; Jayaweera, 2016; Talam and Ngigi, 2015; Abera, 2018).

On the whole, a new suitable site for primary school construction has considered the verified and standards used by the previous researcher as their source is cited above for this study. So that, the result reclassified industrial and factories as of allowable standards for this parameter appeared manifested that 15.89% of the study area is less suitable, 14.92% is suitable, 31.80%

of the area is most suitable, and 37.39% of an area is unsuitable(Table 22). The researcher is concluded that a large percentage of an area which means 37.4 % of the study area is unsuitable for school construction as of allowable standard and also this indicates how the study area is filled with industries and factories.

Table 18: Reclassified Industrial and factories suitability analysis

Parameter	Classification	Area in hectare	Area in percent	Score
Industry & Factories	Unsuitable	3364.30	37.39	1
	Less suitable	1429.51	15.89	3
	Suitable	1342.38	14.92	5
	Most suitable	2861.57	31.80	7

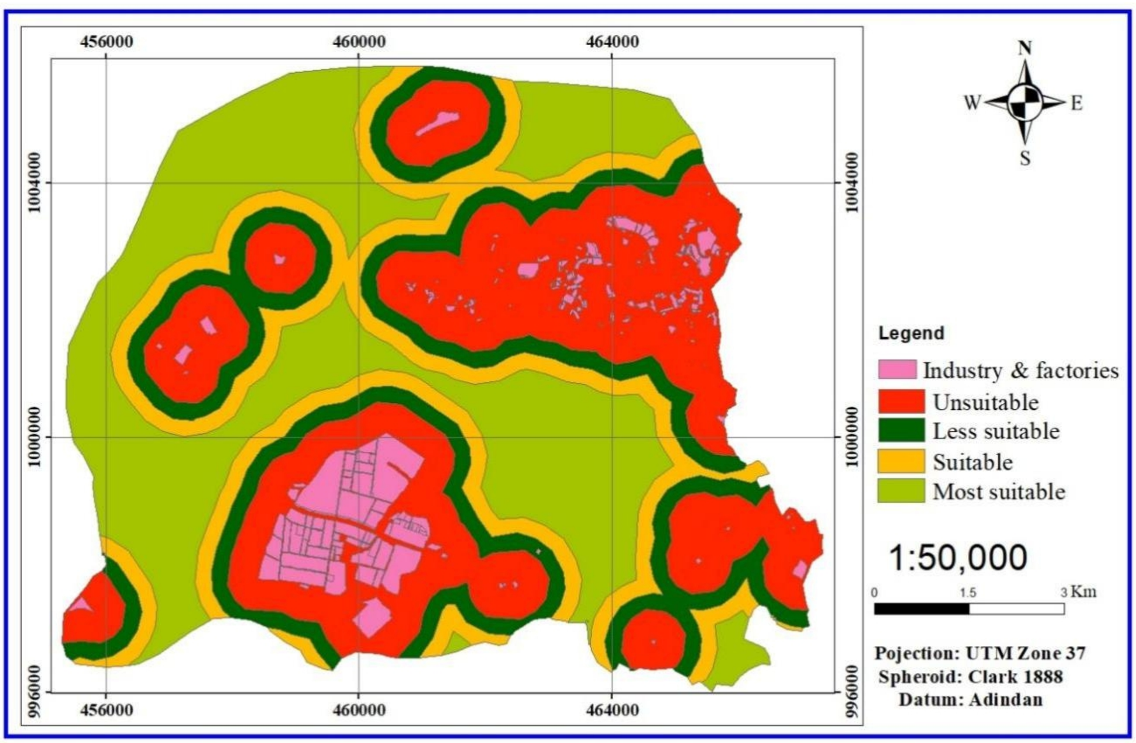

Figure 13: Reclassified industry and factories suitability map

4.5.7. Distance from Commercial and Religions Area

The other parameter used for this study is the proximity distance of the new school site to the Commercials and Religious areas. School is should not be located very near to commercials and religious areas. Because the commercial and religious area is the place where worship and business activity more exist. Further, as an example, if the school is found in the area where there is sound disturbance area such as; shopping centers, game zone, banks, grocers, hotels, bars, and Movie Theater, how could be students attending the lesson given in the class properly. Is that the goal set by the ministry of education of Ethiopia stated the quality of education for all is achieved? Especially without considering this parameter as an influential one. Because these areas are strong contributors to high traffic flow and sound pollution. Moreover, excluding these contributors area during suitable site selection in scientific methods and techniques, it may avoid school children to waste their time playing in the arcade game and minimize disturbing of students focus during class lesson/lecture. Different research stated that schools not be located within 300m of Commercial and Religious areas (Bukhare et al., 2010; Abera, 2018; Talam and Ngigi, 2015; Jayaweera, 2016).

Finally, the result revealed for this parameter which means by depending on the standards recognized by researchers as cited in above, the reclassified commercial and religious map, 40.42% of an area is unsuitable, 24.66% of the study area is less suitable, 14.60% is suitable, and 20.32 % of the area is the most suitable (Table 19). Besides, a large area (40%) is not suitable for primary school construction and results extrapolate in the study area there are many commercial and religious areas.

Table 19: Reclassified commercial and religious suitability analysis

Parameter	Classification	Area in hectare	Area in percent	Score
Commercial & Religious	Unsuitable	3636.89	40.42	1
	Less suitable	2218.66	24.66	3
	Suitable	1313.43	14.60	7
	Most suitable	1828.36	20.32	9

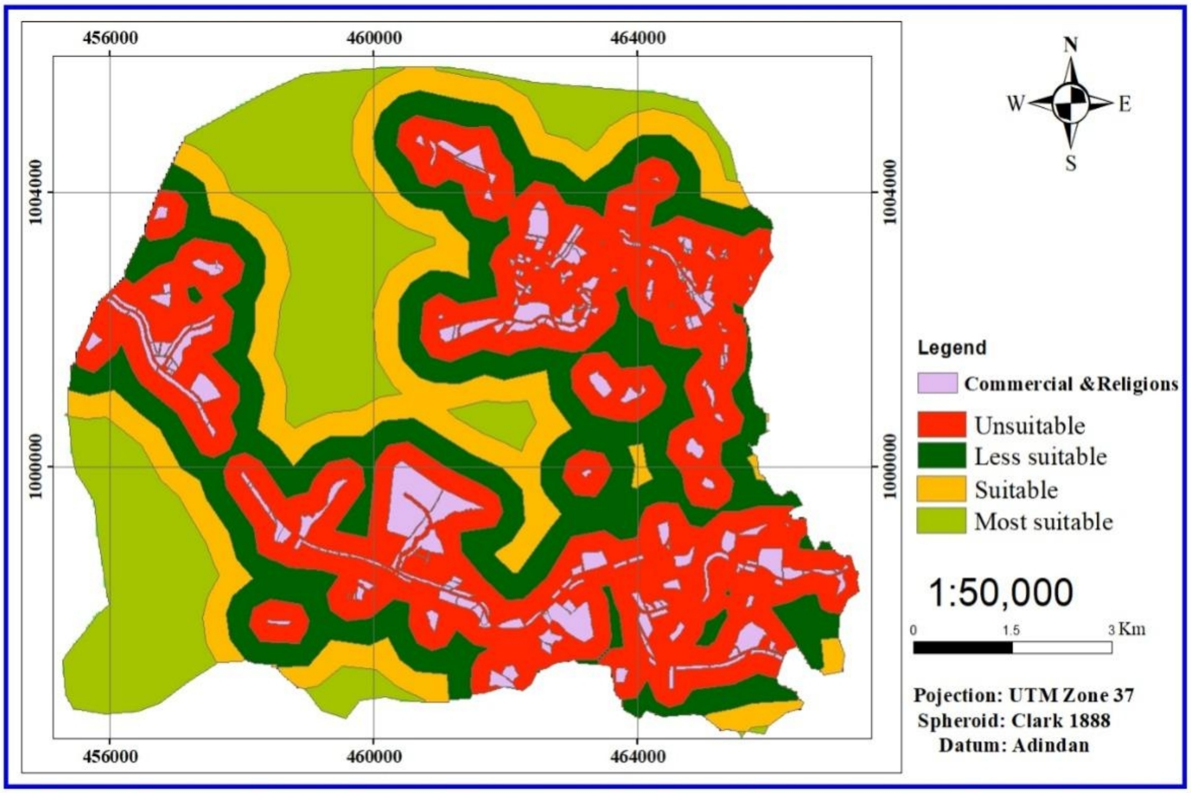

Figure 14: Reclassified commercial and religious suitability map

4.5.8. Population Density

School is should be located in a residential area with high population density (Dadfar, 2014). And also, Suitable sites and existing Population density have a positive influence to select suitable site selection for schools. As the research done by Wondwossen and Bedasa (2019) for location-allocation of school, they computed population density and used it as a parameter. So that a researcher of this study is also computed the population density of the study area(Figure 15). According to the results, the most suitable is the area where many populations are living, and less suitable is where a small number of the population is living. As stated previously school is very needed in the highest population density rather than the area with a small number.

Moreover, this parameter plays a greater role in new sites attract school services to be near to them. So that in this research population density of an area is used as a parameter. So that, analyzing population distribution is an important criterion to select a suitable site for school development. Because it is known that the school site should be in a relatively dense population. The results demonstrate that the new school site is most attracted to the buffer zone where the population of the study area living 49 per hectare (Table 20). Meaning that a new school is very needed to where 44 population living in per hectare than were 12 per hectares of population living. For this case, population density of the study area is categorized into four classifications. Please, don't consider this classification with an area of coverage as like as other parameters.

Table 20: population density of the study area attractions to new school suitability

Parameter	Pop. dens/ha	Zone classification	Area in percent	Score
Population	10 – 12	Less suitable	40.42	3
	12 – 21	Moderate Suitable	24.66	5
	21 – 44	Suitable	14.60	7
	44 – 49	Most suitable	20.32	9

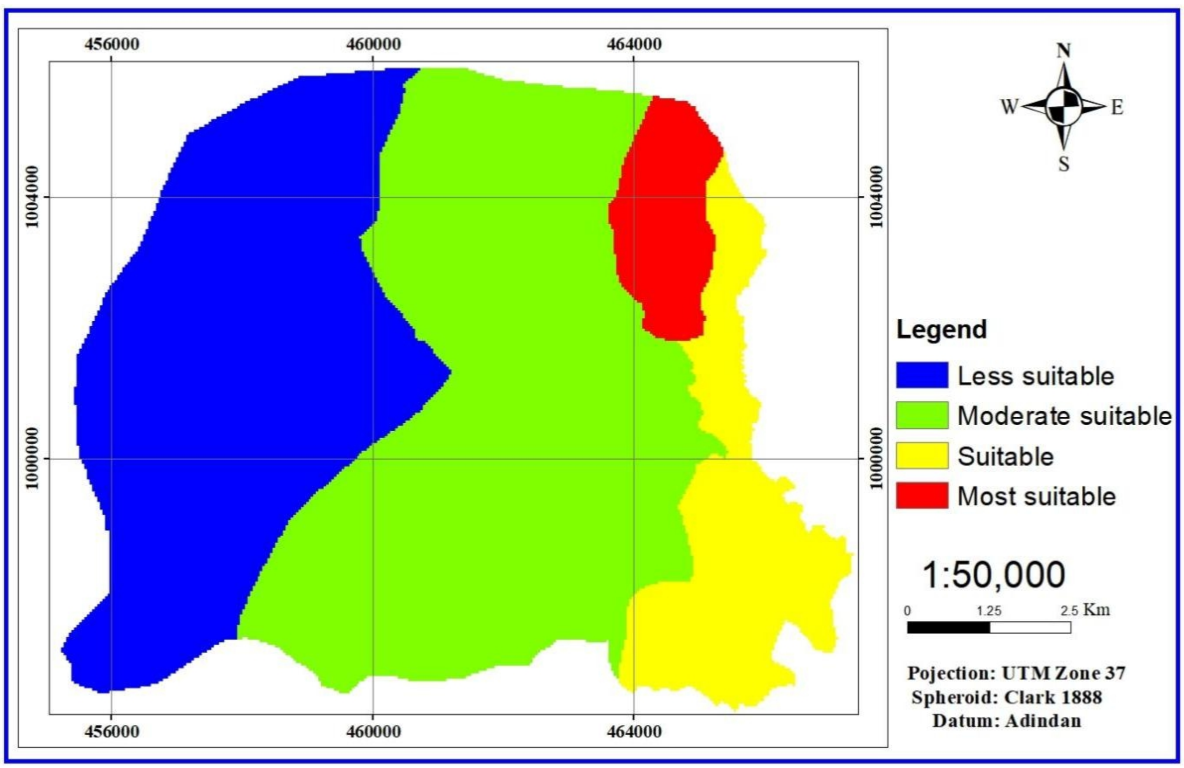

Figure 15: Population density attractiveness to new school suitability

4.5.9. Distance from Emergence Service

In this study, the distance of emergence service for new proposed suitable school site included as a parameter. Emergence service including the area where a medical facility, fire station, and police station. Furthermore, if a natural and human-made disaster happens to the schools it assists emergency service for the school community and others in need and minimizing the rate of accidents by giving emergence services near to them. So that, in the study area many industries and factories may be exposed to disaster, this is why the researcher has chosen this as an effective parameter during suitable site selection. Depending upon the previous research the proximity distance of emergence service from new proposed suitable school site from 0 to 1000meters is considered as suitable. This range is taken from a previous study(Jamal, 2016; Abera, 2018).

The results, based on former research and acceptable standards the reclassified emergence map of the study area, 21.73% of the Burayu town is less suitable, 47.67% is suitable, 26.81% of the area is most suitable, and 3.79% of an area is unsuitable (Table 21). So that, to conclude the reclassified maps of this parameter only a small percentage of an area which means 3.8 % of the study area is unsuitable for school construction as of allowable standard. This is the least area with a small percentage from an unsuitable zone of all parameters.

Table 21: Reclassified emergency analysis

Parameter	Classification	Area in hectare	Area in percent	Score
Emergency service	Unsuitable	341.31	3.79	1
	Less suitable	1955.64	21.73	3
	Suitable	4289.92	47.67	7
	Most suitable	2412.94	26.81	9

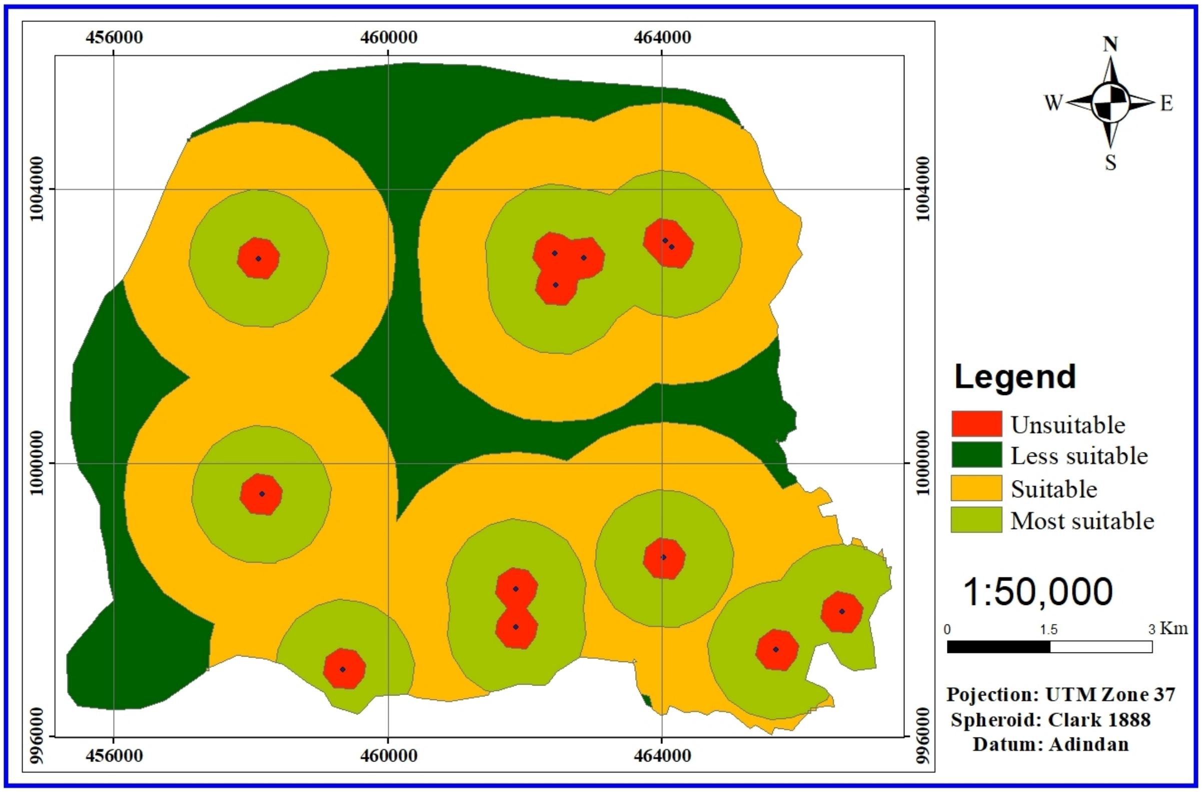

Figure 16: Reclassified emergencies service suitability map

4.5.10. Distance from Geferssa water pond.

Geferssa water pond is one of the man-made water reservoirs which has been used for drinking water in Addis Abeba. School is should be located outside this pond due to the possibility of personnel injury and loss of life. During the rainy season, this reserved water comes out to the main road and damage the property near to pond (Burayu Municipality Office). For this reason, during the new suitable site selection process researcher used as important a parameter. Based on a previous study, any infrastructure is constructed at a proximity distance above 400m from this water pond is very suitable (Lencho, A.,2019).

Generally, results from reclassified suitability Geferssa water map proffer that the value from the total area of study area 5.50 % is unsuitable, 1.91 % is less suitable, 2.12 % is suitable and 90.47 % of the area is most suitable. (Table 26).

Table 22: Reclassified water pond analysis

Parameter	Classification	Area in hectare	Area in percent	Score
Water pond	Unsuitable	494.782	5.0	1
	Less suitable	172.274	1.91	3
	Suitable	190.615	2.12	7
	Most suitable	8142.126	90.47	9

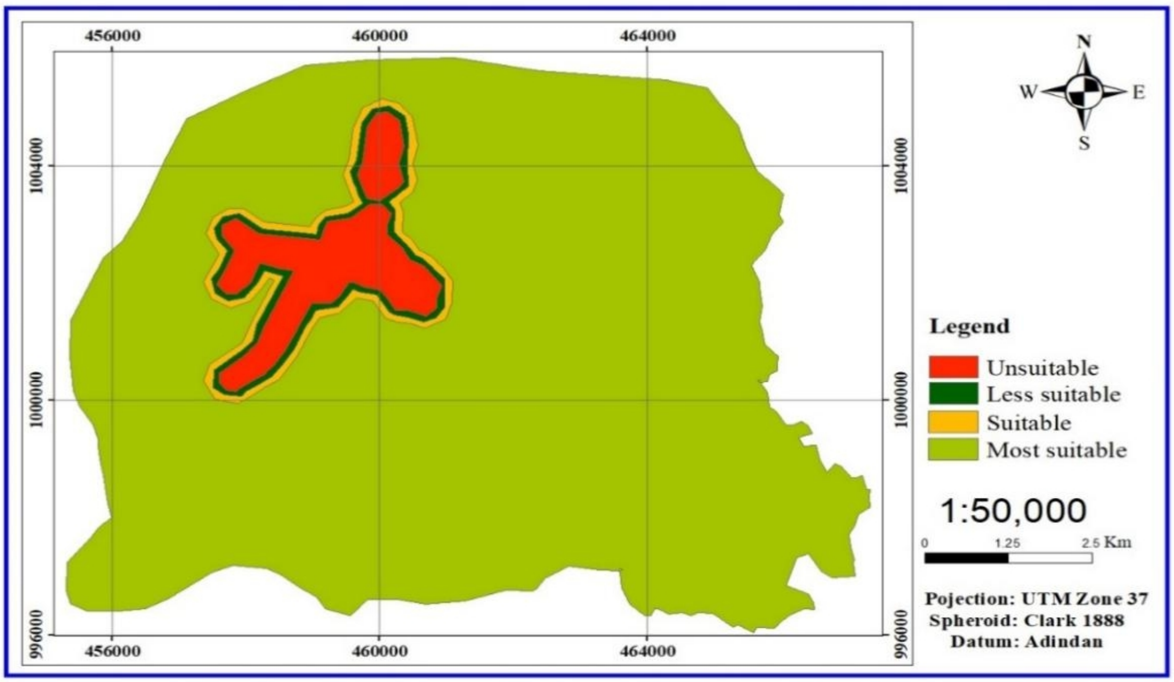

Figure 17: Reclassified water pond suitability map

Finally, the developed thematic maps were obtained from reclassified maps according to allowable standards which were supplemented by known sources and cited above in detail.

4.6. Prioritization of Parameters by using (AHP)

To get a suitability map of the primary school construction site for the Buaryu town ten parameters are used. So that, to make prioritize the chosen parameter based on their importance AHP method is selected. Because, AHP is a Multi-Attribute analysis technique that the primary task is constructing a hierarchy structure for the decision problem (Triantaphy, 2013; Wang and Chan, 2013). From different methods of MCA, the question of why AHP was chosen by a researcher is answered in detail in the literature review of this study. This method enables researchers to decide the weight of each parameter convincingly Moreover, the scholars use their empirical, observational or experiential judgment when they decided to prioritization of parameters. For this study also experts participated in giving priority to the parameters based on their influence weights. These identified parameters for this study are ordered according to Saaty's (1980) standards. Look at table 1 to give a preference scale for pair-wise comparison. So that for this research study parameters value is given based on the weight given by experts.

Moreover, ten parameters used for this study area were categorized into three main groups depending upon their functionality or effectiveness. This categorization is in terms of safety and environment, economy and accessibility. It's defined as follows.

- First, in terms of Safety and environment; slop, proximity to; Commercial and religions, Industrial and factories Area, rivers, Water pond. But also proximity to the road is considered in both safety and economic groups.
- Second, in terms of the economy; Land use, Existing schools, Population Density and Main Road.
- Third, in terms of Accessibility; Emergency facilities.

To get an acceptable weight by using the AHP method the researcher is pass through three main steps. These steps are clearly stated and analyzed to get convinced weight.

In the first step, the matrix form of ten parameters is formed in both columns and rows. All parameters used for this study get priority by following expert judgment. Those parameters abbreviation are; Existing School Location (ES), Population Density (POP), Slope(Slop), Main road (ROA) Land Use (LU), Commercial and Religions area(CO &RE), Industries and factories (INDS), River (RIV), Emergence service(EM.S) and Water Pond (POND) according to their priority. So that the below Pair Wise Comparison Matrix table shows the expert assigned priority weight for each parameter. The given value in each column is assigned based on the standards reveals in preference index (table 2) of chapter two of this study. As an example, the value in the third column of the second row indicates that ES is equal to 2 Slope. Where two (2) is given by an expert based on table 2. It means that existing schools are moderately important than the slope or existing schools are important than two times of slope.

All get values in this way. The last row of table 23 is computed by summing up all of each column.

Table 23: Pair Wise Comparison Matrix

	ES	POP	SLOP	ROA	LU	CO&RE	INDS	EM.S	RIV	POND
ES	1	2.	2	2	1	3	2	3	3	3
POP	1/2	1	2	2	2	2	2	3	4	3
SLOP	1/2	1/2	1	2	2	2	2	3	3	3
ROA	1/2	1/2	1/2	1	2	1	2	2	2	2
LU	1	1/2	1/2	1/2	1	2	2	2	2	2
CO& RE	1/3	1/2	1/2	1/2	1/2	1	2	2	2	2
INDS	1/2	1/2	1/2	1/2	1/2	1/2	1	3	3	4
EM.S	1/3	1/3	1/3	1/2	1/2	1/2	1/3	1	6	2
RIV	1/3	0.25	1/3	1/2	1/2	1/2	1/3	0.17	1	2.
POND	1/3	1/3	1/3	1/2	1/2	1/2	1/4	1/2	1/2	1
SUM	5.33	6.42	8.0	10.5	10.5	13	13.92	19.67	26.5	24

Second Step, after the pair comparison matrix is prepared(Table 23) the next step is to make normalize the matrix. Normalized pair-wise comparison is computed by dividing the resulted value in the above table each column and row into the summation of the column, this means value in the second column of the second-row value or (1) dividing into the summation of the second column or (5.33)the resulted values (0.18) this is called Normalized pair-wise comparison. (Table 24)

Table 24: Normalized Pair-wise Comparison Matrix table.

	ES	POP	SLOP	ROA	LU	CO&RE	INDS	EM.S	RIV	POND
ES	0.18	0.31	0.25	0.19	0.09	0.231	0.144	0.153	0.113	0.125
POP	0.09	0.16	0.25	0.19	0.19	0.154	0.144	0.153	0.151	0.125
SLOP	0.09	0.08	0.13	0.19	0.19	0.154	0.144	0.153	0.113	0.125
ROA	0.09	0.08	0.06	0.09	0.19	0.077	0.144	0.102	0.075	0.083
LU	0.19	0.08	0.06	0.05	0.09	0.154	0.144	0.102	0.075	0.083
CO&RE	0.06	0.08	0.06	0.09	0.05	0.077	0.144	0.102	0.075	0.083
INDS	0.09	0.08	0.06	0.05	0.05	0.038	0.072	0.153	0.113	0.167
EM.S	0.06	0.05	0.04	0.05	0.05	0.038	0.024	0.051	0.226	0.083
RIV	0.06	0.04	0.04	0.05	0.05	0.038	0.024	0.008	0.038	0.083
POND	0.06	0.05	0.04	0.05	0.05	0.038	0.018	0.025	0.019	0.042
	0.18	0.16	0.14	0.10	0.10	0.083	0.087	0.067	0.043	0.039

Third step, computing EIGEN VECTOR. Eigenvector is developed from each row value of pair-wise comparison matrix (Table 23) multiplying the last row of normalized pair-wise comparison matrix (Table 24) this is known or identified as EIGEN VECTOR. In other meaning, the value 2nd column and the row of table 23 means (1) multiplying by the 12th row of table 24 which means (0.18) is equal to the Eigenvector value of table 25 which means (0.18). All value in Eigenvector is developed by this form.

Table 25: Eigenvector weight

Factors	ES	POP	SLOP	ROA	LU	CO&RE	INDS	EM.S	RIV	POND	E/Weight
ES	0.18	0.32	0.27	0.20	0.10	0.25	0.17	0.20	0.13	0.12	0.18
POP	0.09	0.16	0.27	0.20	0.21	0.17	0.17	0.20	0.17	0.12	0.16
SLOP	0.09	0.08	0.13	0.20	0.21	0.17	0.17	0.20	0.13	0.12	0.14
ROA	0.09	0.08	0.07	0.10	0.21	0.08	0.17	0.14	0.09	0.08	0.10
LU	0.18	0.08	0.07	0.05	0.13	0.17	0.17	0.14	0.09	0.08	0.10
CO&RE	0.06	0.08	0.07	0.10	0.05	0.08	0.17	0.14	0.09	0.08	0.08
INDS	0.09	0.08	0.07	0.05	0.05	0.04	0.09	0.20	0.13	0.16	0.09
EM.S	0.06	0.05	0.05	0.05	0.05	0.04	0.03	0.07	0.26	0.08	0.07
RIV	0.06	0.04	0.05	0.05	0.05	0.04	0.03	0.01	0.04	0.08	0.04
POND	0.06	0.05	0.05	0.05	0.05	0.04	0.02	0.03	0.02	0.04	0.04

Therefore assigned a weight of each parameter with their percent (Table 26). Note; when the weight of each parameter is converted to percent it is displayed with a decimal point but the Arc Map can note take or recognized decimal points of Eigen weight when using on the weight overlay tool. So that, the researcher fixed the Eigenvector into the whole number. See Table 26 of the last column.

Table 26: Eigenvector used in overlay & weight in percent

Factors	Eigen weight	Influence (%)	Used in Overlay
ES	0.180	18.001	18.000
POP	0.161 `	16.066	16.000
SLOP	0.137	13.659	14.000
ROA	0.100	10.010	10.000
LU	0.103	10.288	10.000
CO&RE	0.083	8.269	8.000
INDS	0.087	8.721	9.000
EM.S	0.067	6.744	7.000
RIV	0.043	4.303	4.000
POND	0.039	3.937	4.000

4.6.1. Estimation of Consistency Ratio

The main objective of finding the consistency ratio is to verify whether the computed weight of parameters is consistent or not consistent. The acceptable consistency ratio value in AHP techniques when it is less than 0.1. To check the consistency ratio above weight here are its procedures.

- A weighted sum is the total sum Eigenvector table of each row. It means that summation of the first parameter of table 4.18 row which means an Existing public primary school (0.18 + 0.32 + 0.2730 + 0.2 + 0.103 + 0.248 + 0.174 + 0.202 + 0.129 + 0.12) is equal to weighted sum vector existing primary school is 1.950. For all parameters, the weighted sum vector is computed in such away. See below table 27.

Table 27: Weighted Sum Vector

Parameters	Weight sum
Existing schools	1.950
Population	1.762
Slop	1.502
Road	1.101
Land use	1.121
Commercial & Religious	0.917
Industrial and Factories	0.958
Emergence service	0.735
River	0.451
Pond	.0418

- To get a consistency vector, the researcher is used result from weighted Sum Vector or 12th column (table 27) divided by the Eigenvector weight or second column (table 26). Look at the below table

Table 28: Consistency vector of each parameter

Parameters	Weight sum	Consistency Weight	Consistency Vector
ES	1.95	0.18	10.83
POP	1.76	0.16	10.97
SLOP	1.50	0.14	10.99
ROA	1.10	0.10	11.00
LU	1.12	0.10	10.89
CO & RE	0.92	0.08	11.09
INDS	0.95	0.09	10.98
EM.S	0.73	0.07	10.90
RIV	0.45	0.04	10.47
POND	0.41	0.01	10.62

- So, that to compute the Consistency Index the researcher has used the below formula. **(CI) = (λmax - n) / (n-1)**

When (λmax) is the average value of the consistency vector and n is the number of parameters (which means ten).

Λmax = 10.877

Then CI = (10.877– 10)/ 9

= 0.097

- Compute for the consistency ratio (CR) by using the below formula

CR = CI / RI

When RI is the Random Consistency Index table and “n” is the number of parameters. See table 2.

Source; (Saaty 1980).

The number of parameters used for this finding is ten. So that, Random Consistency Index for this study is 1.49. Then Consistency Ratio = 0.097/1.49 = 0.065

Generally, the maximum consistency ratio value of this study parameter is 0.065. This is acceptable because the acceptable consistency ratio value in the AHP method is less than 0.1. Therefore, the comparison made is consistent. From the ten used parameters, the existing school is the maximum value in the economic groups because the highest preference was given on a pair-wise comparison

Similarly, in terms of safety and environment group slop and main roads gets the highest value and followed by commercial and religious, industry and factories. And also a small weight value is obtained in the river and pond. Correspondingly, in terms of accessibility proximity distance to emergence facility weighted medium value. Furthermore, the above weight value for each criterion indicates that the parameters which have the highest **preference** score in the pair-wise comparison result in the highest weight. The supreme weight shows that the weight of the criteria very significant than the others. On the other hand, according to their value, the minimum weighted scored criteria are less critical.

4.6.2. Determination of scores

To develop a suitable map for public primary school by using the scientific method and necessary standards two main core processes is hander taken. The first is comparing parameters with parameters using AHP to compute their weight as illustrated above in tabular form(Table 23 up to Table 28. The second step is comparing each parameter with its buffer zone or sub-criteria by giving a rank. The given ranks vary from 1 to 9 based on favorable conditions and limitations for suitable site selection for public primary schools. The higher rank/score indicates the maximum influence of sub-criterion whereas the lesser score shows the least suitability for this study. See 5th column of table 29. So that, the score selected for this study i.e. existing school, population, slope, land use, proximity to; industries and factories, road, river, commercial and religions, emergence service, etc were assigned accordingly.

Score nine is assigned for sub-criteria most suitable of this study parameter and which shows potential for suitable site selection for primary school. Score, five or seven was assigned to buffer class which belongs to suitable to build up schools. Score, three was assigned to the buffer class with less suitable and score, one and restriction are given to sub-criteria zone which is not suitable for the primary school site. And lastly, a restriction score was assigned to exclude these buffer classes from consideration during weight overlay. (Table 29)

Table 29: Areal and percentile distribution of the selected parameters criteria and sub-criteria.

No	Parameters	Class	Classification	Rank	Area(ha)	Area(%)	Weight
1.	Existing School	0 - 1000	Unsuitable	1	3149.01	35.00	18
		1000 - 1500	Less suitable	3	2433.69	27.05	
		1500 - 2000	Suitable	5	1952.34	21.70	
		>2000	Most suitable	9	1462.66	16.26	
2.	Population		Less Suitable	3	3708.22	41.27	16
			Moderate	5	4970.42	55.31	
			Suitable	7	307.42	3.42	
			Most suitable	9			
3.	Slope	0 - 10	Most suitable	9	1196.30	13.30	14
		10 - 15	Suitable	7	2304.39	25.61	
		15 - 20	Less suitable	5	2134.05	23.72	
		>20	Unsuitable	1	3363.68	37.38	
4.	Road	<150	Unsuitable	1	1731.25	19.24	10
		150 - 1000	Most suitable	7	5066.76	56.31	
		1000 - 2000	Suitable	5	1763.82	19.60	
		>2000	Less suitable	3	435.70	4.84	
5.	Land use	Water body	Unsuitable	Restrict	2003.06	22.26	10
		Special use ,mountains	Less suitable	5	1096.88	12.19	

		Open space, farmland	Suitable	7	3823.31	42.49	
		Proposed residential	Most suitable	9	2074.46	23.06	
6.	Commercial & Religions	0 - 300	Unsuitable	1	3636.89	40.42	8
		300 - 650	Less suitable	3	2218.66	24.66	
		650 - 1000	Suitable	7	1313.43	14.60	
		>1000	Most suitable	9	1828.36	20.32	
7.	Industry & Factories	0 - 500	Unsuitable	1	3364.30	37.39	9
		500 – 750	Less suitable	3	1429.51	15.89	
		750 - 1000	Suitable	5	1342.38	14.92	
		>1000	Most suitable	7	2861.57	31.80	
8.	Emergence Service	0 – 300	Unsuitable	1	341.31	3.79	7
		300 – 1000	Most suitable	9	2412.94	26.81	
		1000 – 2000	Suitable	7	4289.92	47.67	
		>2000	Less suitable	3	1955.64	21.73	
9.	River	0 – 150	Unsuitable	1	1584.30	17.60	4
		150 - 300	Less suitable	3	1476.85	16.41	
		300 – 400	Suitable	7	1321.85	14.69	
		>400	Most suitable	9	4615.94	51.29	
10.	Water pond	0 – 200	Unsuitable	1	494.782	5.0	4
		200 - 350	Less suitable	3	172.274	1.91	
		350 – 500	Suitable	7	190.615	2.12	
		>500	Most suitable	9	8142.126	90.47	

4.7. Weighted linear combination (WLC)

Weighted linear combination (WLC) is very important to solve complex spatial problems in suitable site selection. AHP is used to discover hierarchy influential factors from given in taking to WLC. Selected raster maps were overlaid by converting their cell values into a common scale and assigning a weight that is already driven from AHP techniques to each criterion. However, this method is highly dependent on the determination of parameters weights, where highly favored factors will result in higher values in the final output raster. This issue is critical, so experts' opinion is crucial in the defining scales applied to input layers. (Table 29)

The final suitability map for future primary school construction sites of this study is obtained by overlaying all prepared ten thematic maps. Therefore, the assigned score and the derived weight of each parameter are filled into the model and when it makes run on the GIS final suitability maps for primary school was resulted /generated from it (Figure 19). Then, developed suitable maps for primary school of Burayu town by using the weighted overlay results showed four classes of suitability. These are most suitable, suitable, less suitable, and unsuitable. (Table 30 and Figure19)

The coverage area of the suitability class from generated suitability map was computed after converting the raster output of the weighted overlay analysis to polygon by using the conversion tool of Arc GIS. Therefore, Table 30 shows the output of the converted raster to polygon feature to know the area of coverage in ha with their suitability class. The most suitable area which means 5.88 % is the area in which fulfills the selected standards with a score (9). The suitable area which means 23.90 is the area in fulfills the allowable standards with a score of 5 or 7.

Table 30: Suitability land for new build-up primary school site with their respective area coverage.

Map	Classification	Area in hectare	Area in percent
Suitability map analysis	Unsuitable	2055.75	22.85
	Less suitable	4262.30	47.37
	Suitable	2150.15	23.90
	Most suitable	529.50	5.88

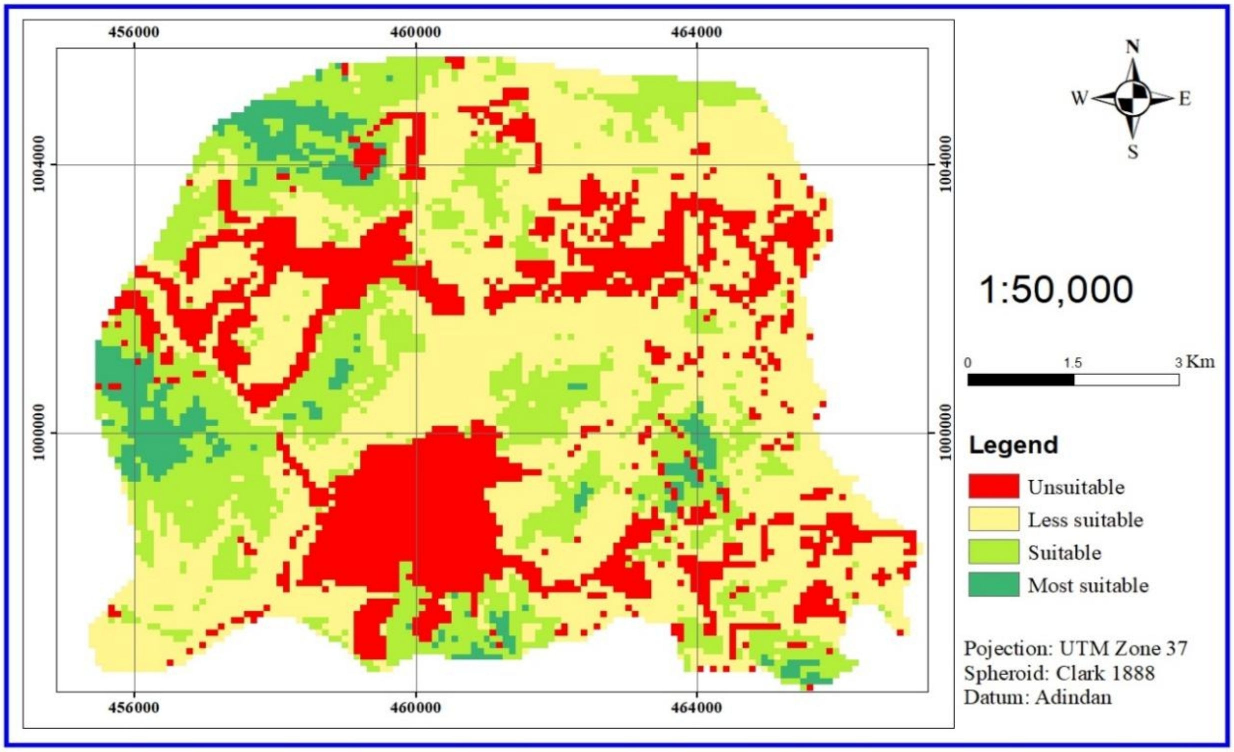

Figure 18: Final suitability map of primary school

The composite suitability map produced demonstrated in figure 19 that 529.50 ha (5.88%) of the total area is the most suitable area, 2150.15(23.90%) is suitable, 4262.30(23.90%) is less suitable and 2055.75(22.85%) is unsuitable. The unsuitable area is dispersed throughout the southeast and the northeast edge of the town. And also, clustered in the southwest and Northwest and covered 23.90% of Burayu town. The most suitable area is prevalent to the southwest and Northwest and scattered at southeast with 23.90% coverage area of the total town. There is not the most suitable area along the northeast of the town. The less suitable and suitable areas are dispersed and clustered across all directions of the town by covering an area of 22.85% and 23.90% respectively from the total land of the town.

Finally, when the final suitability maps of Burayu town are delineated in terms of kebele and the area coverage, the most suitable area to build up new primary schools are found in three kebeles. These kebeles are Gefersa Gujie, Gefersa Nono and Melka Gefersa. From total area of Gefersa Gujie, Gefersa Nono, Melka Gefersa kebele, 320.11 ha (10.39%), 85.38 ha (3.57%), and 17.37 ha (2.3) most suitable respectively. In the same way, the largest hectare which means 1082.87 ha (35.14%) belongs to suitable land and is found in the Geferssa Gujie kebele and the smallest suitable land, 1.08 ha (0.44%) found in Leku Keta kebele (Table 30).

So that, to conclude the suitability map primary school construction result, 22.85 percentage of the Burayu town is unsuitable for primary school. The results were performed and followed scientific methods integrated with necessary standards. (Table 30).

Table 31: Final suitability map of the study area in terms of kebele

No	Kebele Name	Suitability	Area_ha	Area in _%
1	Burayu Keta	Unsuitable	101.53	24.07
		Less suitable	298.37	70.73
		Suitable	21.94	5.20
2	Gefersa Burayu	Unsuitable	304.25	18.89
		Less suitable	1075.97	66.80
		Suitable	230.60	14.32
3	Gefersa Gujie	Unsuitable	528.44	17.15
		Less suitable	1150.41	37.33
		Suitable	1082.87	35.14
		Most suitable	320.11	10.39
4	Gefersa Nono	Unsuitable	797.20	33.29
		Less suitable	950.21	39.68
		Suitable	562.18	23.47
		Most suitable	85.38	3.57
5	Leku Keta	Unsuitable	64.73	26.30
		Less suitable	180.28	73.26
		Suitable	1.08	0.44
6	Melka Gefersa	Unsuitable	158.38	20.98
		Less suitable	450.47	59.68
		Suitable	128.61	17.04
		Most suitable	17.37	2.30

4.8. Suitability of Existing Schools

School buildings are essential components of educational processes. However, in past decades it's not seen while great consideration is given to choosing a suitable site for schools neither by planners nor by educational authorities. This means the selection of the school site has been done carelessly. Besides, if the environment in which school is found is not suitable for students it causes many problems on students. In this study area, there are some public and private schools located around risk areas such as very nearby; industries and factories, commercial and religions, and main roads, etc.

However, every student in Burayu town spends 5 to 8 hours at school (from 8:30 a.m to 3; 30 p.m) daily. They need to attend academic classes in the morning and afternoon. This is meaning that they spend almost half of their age in the school environment from five or six years old (Kindergarten level) until 18 years of their age which means when almost complete secondary level. On the other hand, when referring to the educational road map goal set by the government about the quality of education, it stated that the schools must be located in safe and healthy environments condition(MUDC, 2012).

But, in this document, no clear standards for each parameter researcher may use for the selection of a suitable site for a new school site. Only stated that at which slope scale school should be build-up and how far schools away from the main road. Moreover, in this research ten parameters are supported by previous research works.

Furthermore, the second specific objective of this research has the aim to evaluate the suitability of existing public primary schools of Burayu town. So that, existing schools are evaluated by the result of ten parameters which means a suitability map of the study area. These ten parameters are existing public primary schools, population density, Slope proximity to; emergence service, main road, commercial, and industry, river and water pond. From the risk existing at schools location of the study area.

So that, there are eleven public primary schools, one hundred seventeen kindergartens, sixty-four private primary schools, and eight secondary schools. In total two hundred schools are found in the study area including public and private schools. All are fully evaluated based on previously used standards in the various research done on school site selection(Table 11).

The result of evaluated existing kindergarten schools in the Burayu town, thirty-four (29.03%) schools located in the unsuitable area, sixty-three (53.85%) is located on the less suitable site, and seventeen schools (14.53%) were found on suitable sites and only three(2.56%) kindergarten schools are found on the most suitable area. This analysis is indicated that 29.03% of kindergarten schools are found in the location that may affect pupil health while 2.56% of these schools are found in the most suitable area. The column under the school code of the below table is demonstrated the code given for each kindergarten school to represent their names. For example, KGP 120 means Kindergarten private school number 120, so that the full name of this school is revealed in the appendix of this study. Note; for all other schools type mentioned in such way.

Table 32: Suitability of existing kindergarten schools in percent.

Kindergarten in Burayu Town(KGP)			
Suitability	No.Schools	In (%)	School Code
Unsuitable	34	29.03	KGP120, KGP118, KGP116, KGP115, KGP112, KGP111, KGP106, KGP105, KGP98, KGP92, KGP91, KGP87, KGP85, KGP52, KGP75, KGP74, KGP70, KGP69, KGP68, KGP60,KGP58, KGP55, KGP53, KGP49, KGP48, KGP42, KGP35, KGP34, KGP27, KGP21, KGP18, KGP15, KGP11, KGP8, KGP3
Less suitable	63	53.85	KGP124, KGP125, KGP123, KGP122, KGP121, KGP113, KGP108, KGP107, KGP104, KGP103, KGP102, KGP101, KGP100, KGP97, KGP95, KGP93, KGP90, KGP88, KGP86, KGP84, KGP80, KGP78, KGP77, KGP76, KGP73, KGP72, KGP71, KGP67, KGP65, KGP67, KGP62, KGP57, KGP54, KGP52, KGP51, KGP50, KGP45, KGP44, KGP43, KGP41, KGP40, KGP39, KGP37, KGP36, KGP32, KGP31, KGP30, KGP29, KGP28, KGP25, KGP24, KGP22, KGP20, KGP17,KGP14, KGP13, KGP12, KGP10, KGP7, KGP5, KGP6, KGP2, KGP1.
Suitable	17	14.53	KGP119, KGP114, KGP110, KGP109, KGP99, KGP96, KGP66, KGP63, KGP61, KGP56, KGP47, KGP46, KGP38, KGP33, KGP26, KGP23, KGP9
Most suitable	3	2.56	KGP94, KGP89, KGP16

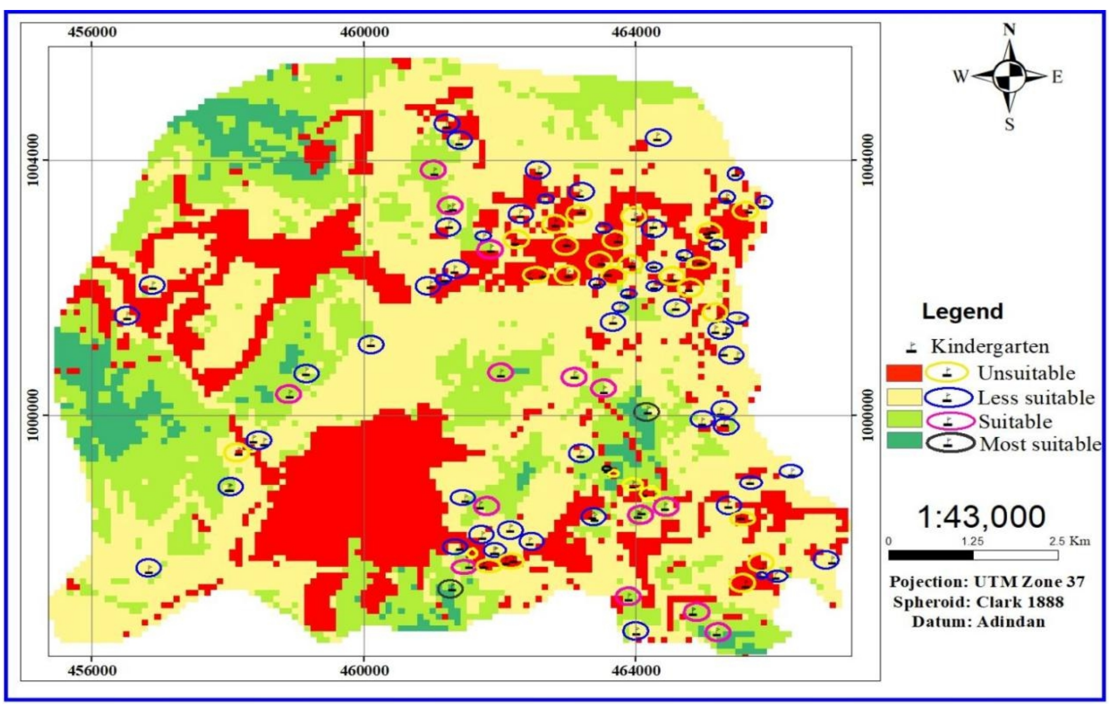

Figure 19: Suitability of location of existing kindergarten schools

There are sixty-four private primary schools. In terms of ten used parameters all are located in a different part of the study area. Eighteen(28.13%) schools are located in the unsuitable area, thirty-three (51.56) schools are found on a less suitable site, and eleven schools (17.19%) found on a suitable site, and only two (3.13%) private primary schools are located on the most suitable area. So that, the result from the analysis is showed that a large number of private primary schools is built-up up on the less suitable for school construction. This indicates that private primary school owners not giving great consideration for suitable site selection rather than following the profit collected from society. See below table and figure.

Table 33: Suitability of existing private primary schools in percent.

Private Primary Schools(PrP)			
Suitability	No.Schools	In (%)	School Code
Unsuitable	18	28.13	PrP2, PrP4, PrP7, PrP8, PrP19, PrP22, PrP23, PrP25, PrP28, PrP31, PrP40, PrP44, PrP54, PrP57, PrP59, PrP60, PrP62,PrP63.
Less suitable	33	51.56	PrP1, PrP3, PrP5, PrP9, PrP12, PrP13, PrP15, PrP16, PrP17, PrP18, PrP20, PrP21, PrP24, PrP26, PrP29, PrP30, PrP33, PrP35, PrP36, PrP37, PrP38, PrP41, PrP42, PrP43, PrP45, PrP46, PrP49, PrP50, PrP55, PrP56, PrP58, PrP61, PrP64.
Suitable	11	17.19	PrP10, PrP11, PrP14, PrP27, PrP32, PrP34, PrP39, PrP47, PrP52, PrP53, PrP65.
Most suitable	2	3.13	PrP6, PrP51,

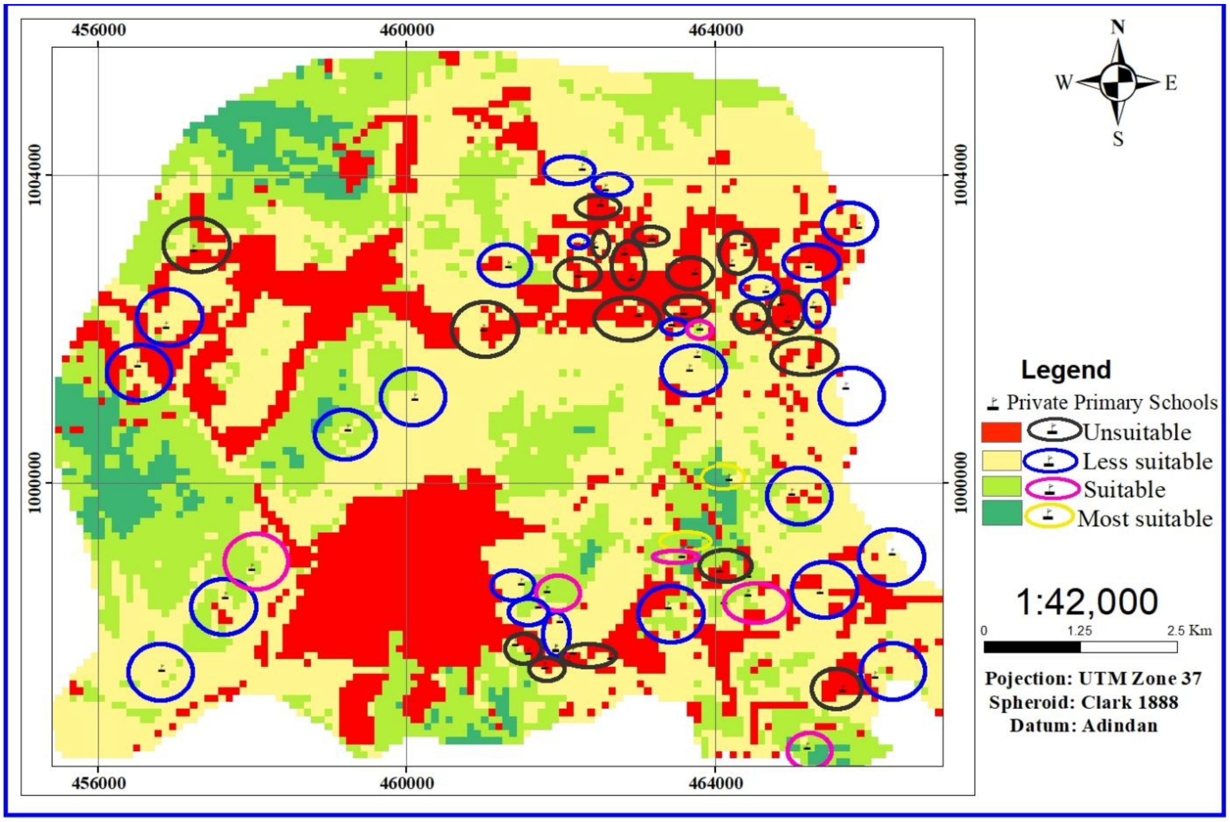

Figure 20: Suitability of location of existing private primary schools

Additionally, eleven existing public primary school suitability are analyzed with the result of ten parameters. The overlaid results exposed, six (54.5%) schools are located in the unsuitable area, and four (36.4%) schools are located in the less suitable site. And also, the rest school is found in the suitable area and no school at most suitable area. Further, the existing public primary schools are identified to show the suitability of the existing public primary schools site. See below table and figures.

Table 34: Suitability of existing public primary schools in percent.

Type	Buffer zone	Name of school	No. of school	In percent
Suitability of Existing Public primary school	Unsuitable	Dire Hacalu Burayu Primary Abdi Nono Melka Gefersa Leku Keta Gefersa Chorisa	6	54.5
	Less suitable	Sarti Hana Dima Guje Kersa Ketta	4	36.4
	Suitable	Sengota	1	9.1
	Most suitable	-	-	-

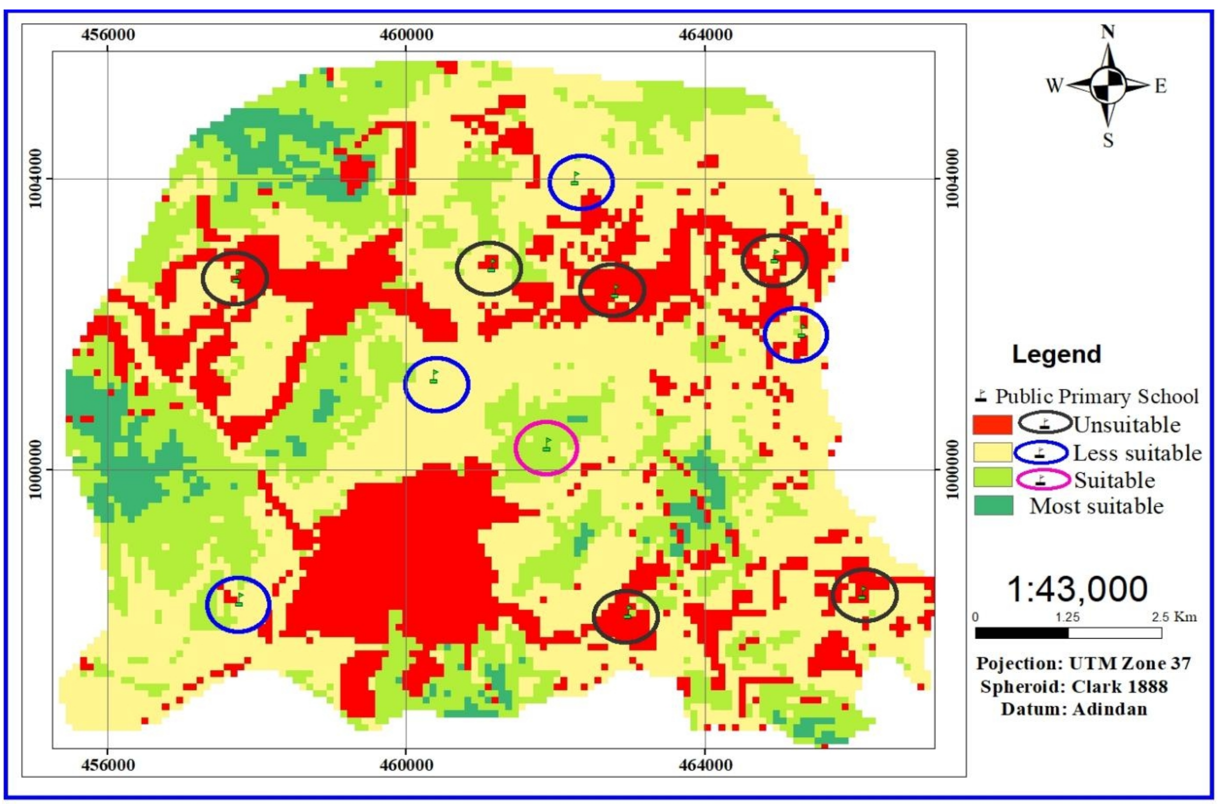

Figure 21: Suitability of location of existing public primary schools

Finally, the suitability of existing public secondary schools(PuSs) and private secondary schools (PrSs) of the study area researcher has overlaid these schools with a composite suitability map which is developed by selected ten parameters(Figure18). The overlaid results exposed, two PuSs and two PrSs four (50%) schools are located in the unsuitable area, and three secondary schools which mean one PuSs and two PrSs (37.5%) schools are located in the less suitable site. And also, the rest of private secondary shoos are found in suitable area and no school at most suitable area. The name of these schools is defined in the appendix of this study. Easily, it can get their name by taking the given code in the below table and read from the appendix. See below table and figure.

Table 35: Suitability of existing high schools in percent.

High schools(PuSs &PrSs)			
Suitability	No.Schools	In (%)	School Code
Unsuitable	4	50	PuSs1,PuSs2,PrSs5,PrSs6,
Less suitable	3	37.5	PuSs3,PrSs4,PrSs7,
Suitable	1	12.5	PrSs9

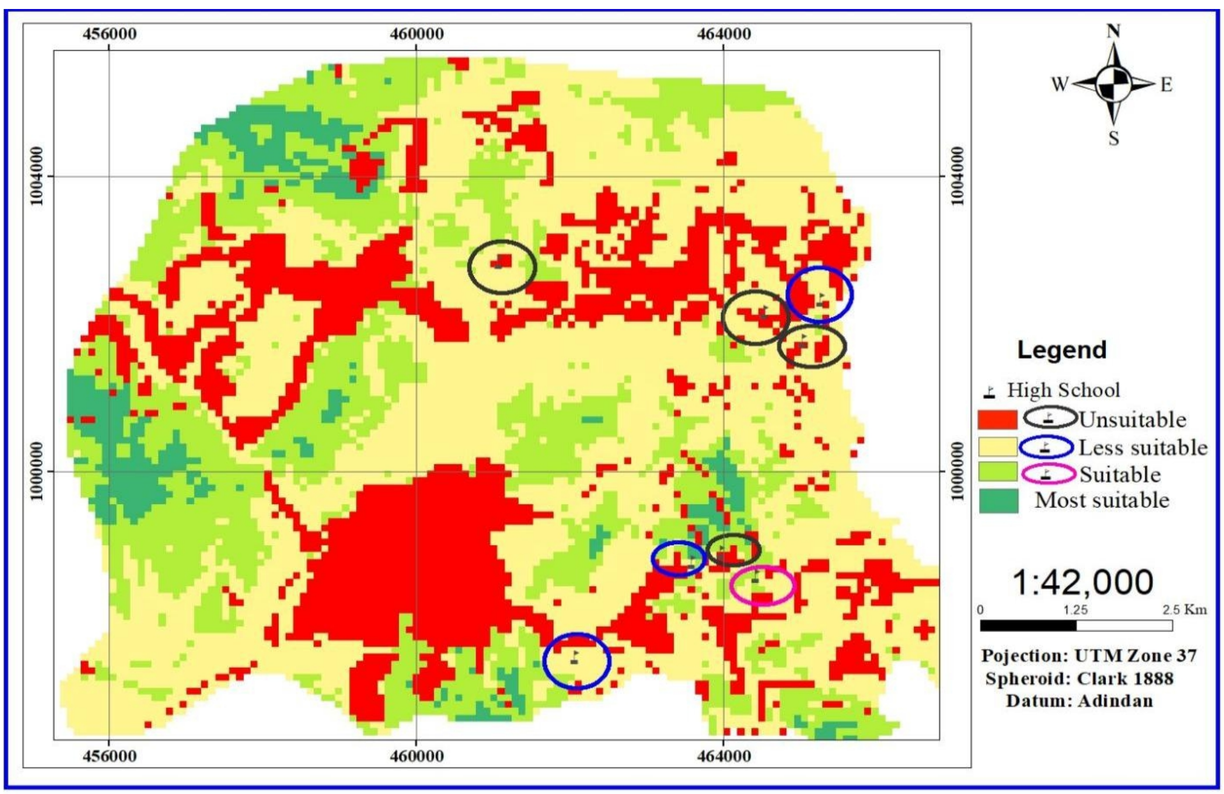

Figure 22: Suitability of location of existing secondary PuSs &PrS schools

4.9. Validating proposed primary school site in Structural plan of the town.

In Burayu town, the structural plan currently under implementation is developed in the year 2016 by Oromiya urban development and housing authority. In the developed structural plan of the town, there are eight areas has identified by the planner for future school development. However, when evaluating the proposed future school development areas which are already demonstrated in the structural plan it's not selected by following scientific methods and standards. Moreover, the result of this research means the suitability map of the primary school location of Burayu town is performed by using Geosptail techniques and scientific standards. When the researcher is validating the proposed primary school site which was demonstrated in the structural plan of the Burayu town by overlaying with the result of this study or suitability map of primary school (Figure 18), five selected area for future primary school development falls under unsuitable area or the area restricted for a school building(Figure 19) where three identified area falls under less suitable area. This shows that how the planner is a selecting site without considering allowable standards and scientific ways of selecting a suitable site. Because what about the safety of students? Why the planner is didn't followed the standards? this is the question that needs answers from the town planner. So that the result of this research can solve such problems by showing suitable site selection for future primary school development for Burayu town. Use this suitability map which is developed through scientific ways and standards. The areas encircled with blue color in fig 19 is show the proposed primary school site in the developed structural plan of 2016 of Burayu town.

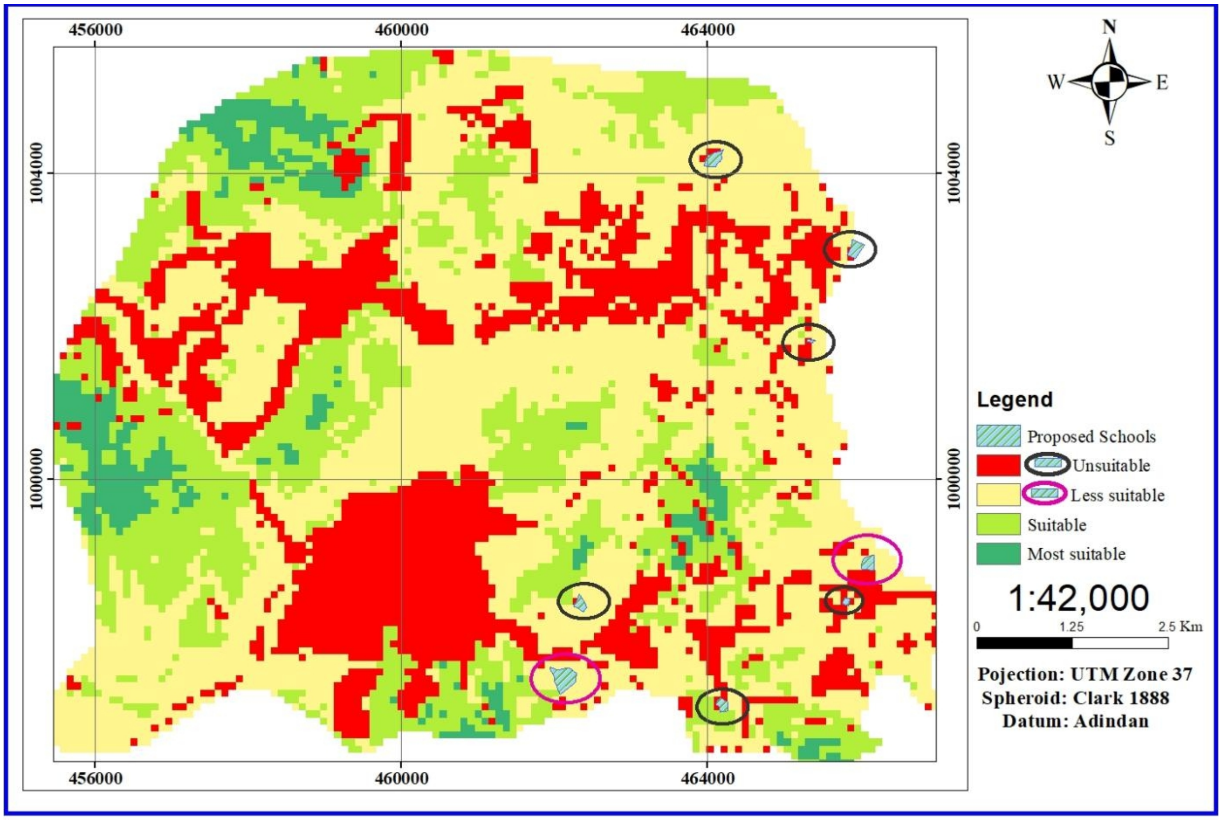

Figure 23: Proposed Primary school site in SP of 2016 & new suitability map of PS result

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

The main objective of this study was to select a suitable site for a new build-up primary school by using scientific methods which means geospatial techniques with considering the compulsory site suitable standards. Besides, this study was prepared/done to develop the suitability map for primary school by using ten parameters as input. Each parameter's standards were taken from the previous research and school guideline. These parameters are proximity to existing schools, population density, slope, land use, proximity to; the main road, river, industrial and factories, commercial and religions, water pond. The final suitability map of the study area was achieved by integrating GIS with MCDA.

Furthermore, GIS-based MCDA provides a more technological and precise choice regarding selecting a suitable site for primary school construction. Whereas, it can integrate both spatial and aspatial data to visualize the input information and enhances the decision-makers' understand easily without more effort. So that, the developed suitable map is very illustrative or demonstrative maps and enables decision-makers to get accurate solutions for the problem linked to suitable site selection for public facilities, especially for school construction. And also is very important because RS, GIS-based MCDA integrated with necessity tests that make aware and enhance good judgments of decision-makers. On the whole, MCDA, GIS, and RS were successfully demonstrated for suitable site selection. AHP techniques are also essential to give preference scores for all parameters in comparison. In this study, the set objectives which mean evaluating the suitability of existing public primary school sites and suitable site selection for new build-up schools already achieved.

In this study, the ten used parameters are rated from the most suitable to unsuitable. The result of this study indicates that there is a shortage of public primary schools. Because, when it was comparison is made the ratio of existing public primary schools with the population of the town is about 1 to 34,122 while the country regulation/standard stated one public school expected to serve up 15,000 population. Further, the suitability of existing public schools was evaluated according to international and national standards. The result reveals that 54.5 % of existing public primary schools are found in unsuitable areas. This is evidence to say schools have been built up without considering the safety of the location. This will be fixed for future new build-up primary schools if decision-makers of the town are following the developed suitability map which is developed by the researcher of this study. On other hand, the composite suitability map produced demonstrated that 529.50 ha (5.88%) of the total area is the most suitable and preferable site for primary school construction, 2150.15(23.90%) is suitable, 4262.30(23.90%) is less suitable and 2055.75(22.85%) is unsuitable. And also, there is not the most suitable area in Burayu Keta, Gefersa Burayu, Leku Keta kebeles. However, this is not mean that the area which lacks the most suitable area shall have no area for primary schools constructions. Because identified suitable and less suitable areas will be used according to their importance.

5.2. Recommendation

- The Federal Ministry of Education of Ethiopia, it is necessary to revise the current vague regulation and standards which functioned on school site selection. Because presently the standards under implication across the country on school site selection are lacking details. For example, the developed standard as the year of 2009 by the Ministry of Education of Ethiopia stated that schools site must be far away from the river, drainage, and industry and factories but no information for how long schools should be away from it. And also, stated that the school's site is preferable if located near hospitals or clinics but it has no detailed information for how long proximity is allowable for it. So that, this needs urgent revisions to make school location safe and free from unnecessary worries
- Using geospatial techniques is empowers decision-makers to give accurate decisions for illusion may happen during a suitable site selection for public facilities like schools. Burayu town urban planners, land administration office, and educational office use this suitability map of primary school which was developed by a researcher of this study to select a suitable site for new primary school development to meet the demand of the community. Because the result of this study demonstrates that 56% of the total population needs new primary schools. And also, 54% of existing public primary schools are located in unsuitable areas so that, it’s necessary to expect from you to fix such problems. Furthermore, the produced suitability map is economical, less time-consuming, and more productive than the traditional way of selecting the site for school construction.

- Any profitable and non-profitable organization and investors who have a plan to build primary schools have to give priority to the safety of schools rather than gathering high profit.
- The community must use the primary schools built upon the suitable area to enhance the safety of their children.
- This research shall be expanded if collecting and analyzing different parameters like soil type, stream discharge, and decibel rate in future research.

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APPENDICES

1. Kindergarten

Table

KG_in_Burayu

OBJECTID *	No	School name	X-coor	Y- coor	Shape *
1	KGP01	Hana Dima Academy	461216	1004560	Point
2	KGP02	Aba Sena	463174	1003482	Point
3	KGP03	Abebech Gobena	463734	1002763	Point
5	KGP05	Abenezer	461763	1002783	Point
6	KGP06	Abogida	465680	998967	Point
7	KGP07	Addis Youth Academy	466290	999096	Point
8	KGP08	Afrika youth Academy	465040	1002881	Point
9	KGP09	AG Academy	461546	997646	Point
10	KGP10	Alef	461333	1002280	Point
11	KGP11	Al-Emran Academy	463493	1002403	Point
12	KGP12	Alkemar Academy	462571	1003847	Point
13	KGP13	Andinet Academy	466883	997721	Point
14	KGP14	Beby Siter	465294	1000981	Point
15	KGP15	Bemahu Kidist	462632	1002211	Point
16	KGP16	Bero	464178	1000076	Point
17	KGP17	Bete Room	463187	999390	Point
18	KGP18	Big Home Academy	465222	1001548	Point
19	KGP19	Biftu	462212	1002723	Point
20	KGP20	Biles International Academy	461741	998104	Point
21	KGP21	Blue light Academy	464107	998773	Point
22	KGP22	Bright Academy	465246	1000054	Point
23	KGP23	Birhan Academy	458900	1000319	Point
24	KGP24	Biru Alem	465324	1001316	Point
25	KGP25	Bishalom Academy.	462148	998217	Point
26	KGP26	Boryad Youth Academy	464083	998496	Point
27	KGP27	Burayu Keta No 3	462808	1003016	Point
28	KGP28	Burayu keta no 1	464252	1002993	Point
29	KGP29	Burka Geda	456511	1001559	Point
30	KGP30	Bura Nano	462013	1000654	Point
31	KGP31	Dire Bataro	464308	1004366	Point
32	KGP32	Dire Gefersa	461249	1002990	Point
33	KGP33	DM Academy	461244	1003240	Point
34	KGP34	Eftaha	462418	1002179	Point
35	KGP35	F.F Academy	464783	1001995	Point
36	KGP36	Fedan	462439	998018	Point
37	KGP37	Fidal Academy	465519	1001488	Point
38	KGP38	Firaol Academy no 1	458026	998851	Point
39	KGP39	Future Hope No 2	456834	997565	Point
40	KGP40	Future Hope No 1	463522	1002924	Point
41	KGP41	Gabir Academy	464755	1002504	Point
42	KGP42	Gefarsa Academy	465657	1003228	Point
43	KGP43	Gefersa Green no 1	460972	1002046	Point
44	KGP44	Green youth	465355	998599	Point
45	KGP45	Haliwo	462651	1003388	Point
46	KGP46	Hayomina youth	463669	1001483	Point
47	KGP47	Haro Academy	463526	1000388	Point
48	KGP48	Hermon no 2	463645	999099	Point
49	KGP49	Hill tops	463964	998903	Point
50	KGP50	Emana	464972	999894	Point
51	KGP51	Hiwot Selam	465300	999880	Point
52	KGP52	Hosayina Academy	464000	996605	Point
53	KGP53	Efa Boru	464947	1002420	Point
54	KGP54	Efa Walif no 2	461180	1002141	Point
55	KGP55	Efa Walif no 1	463586	1002236	Point
56	KGP56	Elu star Academy	464421	998557	Point
57	KGP57	Smart Youth	456891	1002034	Point
58	KGP58	Esete	463186	1003218	Point
60	KGP60	Etsub Dink	458337	999454	Point
61	KGP61	Iyor Kindergarten	465191	996585	Point
62	KGP62	Genious	463359	998418	Point
63	KGP63	Joab Academy	463891	997138	Point
64	KGP64	Kebeki Academy	458010	998856	Point
65	KGP65	Kenbon youth Academy	461485	998681	Point
66	KGP66	Keyad Academy	461031	1003824	Point
67	KGP67	Kids Joy	464271	1002037	Point
68	KGP68	Kids Joy Academy	464251	1002361	Point
69	KGP69	Kofket family Academy	463766	1001677	Point
70	KGP70	Covenant no 1	462194	997736	Point
71	KGP71	Covenant no 2	461406	997933	Point
72	KGP72	Kusaye no 2	458374	999617	Point
73	KGP73	Kuwalit Academy	459146	1000682	Point
74	KGP74	LaliseTalent	464843	1002357	Point
75	KGP75	Lalistu Youth Academy	465543	998407	Point

76	KGP76	Lemat	463988	1003112	Point
77	KGP77	Loyal Academy	465334	1003413	Point
78	KGP78	Mark youth Academy	465886	1003316	Point
80	KGP80	Mahi International Academy	465169	1002676	Point
82	KGP82	Menan Academy	461554	997817	Point
84	KGP84	Mirak Academy	460104	1001132	Point
85	KGP85	Modern East Africa	463939	1002371	Point
86	KGP86	Mulata Hayu	463868	1001923	Point
87	KGP87	Nahima Academy	464270	998715	Point
88	KGP88	Niftalem	461394	1004299	Point
89	KGP89	Nono Academy	461293	997294	Point
90	KGP90	Ocean Academy	463389	998385	Point
91	KGP91	Orange Academy	465872	997609	Point
92	KGP92	Orange Sunflawor	465076	1002824	Point
93	KGP93	Pakos Academy (1)	461908	997861	Point
94	KGP94	Paradise Hills no 1	463583	999146	Point
95	KGP95	Paradise Hills	462301	1003154	Point
96	KGP96	Pyramid No 1	464030	998439	Point
97	KGP97	Pilanet Academy	463426	1002093	Point
98	KGP98	Pyranid No 2	462085	997711	Point
99	KGP99	Pirogress Academy	464030	998439	Point
100	KGP100	Kala Hiwot Academy	465161	1001342	Point
101	KGP101	Rim Academy	458523	999577	Point
102	KGP102	Rohobot	466053	997481	Point
103	KGP103	Sanyi Bori	464591	1001699	Point
104	KGP104	Snap Academy	465334	1001320	Point
105	KGP105	Solanet	461755	997651	Point
106	KGP106	Sonker	461766	997652	Point
107	KGP107	T.G Academy	465852	997499	Point
108	KGP108	Tees Home	464654	1002524	Point
109	KGP109	Trangle Academy	464831	996912	Point
110	KGP110	Trangle	464831	996912	Point
111	KGP111	Tsedaniyaa Mariyam	463000	1002210	Point
112	KGP112	Tsirha Tsiyon	462986	1002701	Point
113	KGP113	Venus Academy	461931	997869	Point
114	KGP114	Wabi Academy	461311	1003260	Point
115	KGP115	Wisdom Sidar	464537	1002159	Point
116	KGP116	Wisdom Youth Academy	465613	997345	Point
118	KGP118	Tibab Acedemy no 1	465126	1002912	Point
119	KGP119	Yabets	461701	998580	Point
120	KGP120	Yadano Urgecha Academy	458148	999420	Point
121	KGP121	Yod Acedamy	465500	1000929	Point
122	KGP122	Yom Acedamy	465465	1003810	Point
123	KGP123	Yunited kingdom	464206	1002870	Point
124	KGP124	Yunit	461864	1002610	Point
125	KGP125	Zewuya Acedamy	463095	1000635	Point

2. Public primary School

Public Primary School

OBJECTID *	Kebele	Name of School	Owner	X-Coord	Y- Coord	Shape *
1	Leku Katta	Leku Katta	Gov	465316	1001917	Point
2	Burayu Ketta	Ketta	Gov	464947	1002944	Point
3	Gefersa Burayu	Burayu pirmary	Gov	462812	1002455	Point
4	Gefersa Burayu	Anne Dima	Gov	462273.596	1004013.704	Point
5	Gefersa Gujie	Gefersa Chorisa	Gov	457747	1002661	Point
6	Gefersa Gujie	Gujie Kersa	Gov	457771	998227	Point
7	Gefersa Gujie	Serti	Gov	460389	1001292	Point
8	Gefersa Nono	Abdi Nono	Gov	462974	998057	Point
9	Gefersa Nono	Sengota	Gov	461901	1000349	Point
10	Melka Gefersa	Melka Gefersa	Gov	466126	998315	Point
11	Gefersa Burayu	Dire Hacalu	Gov	461155.994	1002812.494	Point

3. Private Primary School

Private_Primary_Schools

OBJECTID *	S-code	SCHOOL_NAME	X_COOR	Y_COOR	Shape *
1	PrP01	Hana Dima Academy	462273	1004116	Point
2	PrP02	Abebech Gobena	463734	1002763	Point
3	PrP03	Addis youth Academy	466285	999105	Point
4	PrP04	Africa youth Academy	465005	1002062	Point
5	PrP05	Alkemer Academy	462571	1003847	Point
6	PrP06	Bero	464178	1000076	Point
7	PrP07	Big Home Academy	465222	1001548	Point
8	PrP08	Biftu	462211	1002725	Point
9	PrP09	Biles Academy	461709	998419	Point
10	PrP10	Blue light	464413	998816	Point
11	PrP11	Birhan Academy	459238	1000726	Point
12	PrP12	Biru Alem	464206	1002870	Point
13	PrP13	Bishalhom Academy	461986	998229	Point
14	PrP14	Boriyad Youth Academy	464105	998475	Point
15	PrP15	Burayu Kata no 3	462818	1003016	Point
16	PrP16	Burka Geda	456511	1001559	Point
17	PrP17	Burayu Keta no 2	464364	1003135	Point
18	PrP18	Dire Geferssa	461311	1002842	Point
19	PrP19	Fedan	462637	997749	Point
20	PrP20	Fraol Academy	457645	998546	Point
21	PrP21	Future Hope	456821	997603	Point
22	PrP22	Gefarsa Academy	457230	1003059	Point
23	Prp23	Gafarsa Green Academy	460992	1002020	Point
24	PrP24	Green Youth	465350	998609	Point
25	PrP25	Haliwot	462501	1003653	Point
26	PrP26	Hayomina youth	463659	1001506	Point
27	PrP27	Hermon Academy	463561	999082	Point
28	PrP28	Hill Tops	464048	998884	Point
29	PrP29	Helina Academy	466066	997509	Point
30	PrP30	Himanan Academy	464982	999891	Point
31	PrP31	Efa Walif Academy	463586	1002236	Point
32	PrP32	Elu Star Academy	464422	998582	Point
33	PrP33	Esete Academy	463169	1003198	Point
34	PrP34	Eyor Academy	465191	996585	Point
35	PrP35	Kenbon Youth Academy	461485	998720	Point
36	PrP36	Covenant Academy no 2	461406	997933	Point
37	PrP37	Kofket Family Academy	463766	1001677	Point
38	PrP38	Covenant Academy no 1	462155	997820	Point
39	PrP39	Kusaye no 1	457988	998915	Point
40	PrP40	Lalise Talent	464836	1002363	Point
41	PrP41	Mark Youth Academy	465852	1003357	Point
42	PrP42	Mahi Academy	464932	1002132	Point
43	PrP43	Makibeb Academy	465683	1001273	Point
44	PrP44	Menan Academy	461569	997817	Point
45	PrP45	Miracle Academy	460102	1001121	Point
46	PrP46	Modern East Africa	462444	1003104	Point
47	PrP47	Mulata Hayu	463794	1002038	Point
49	PrP49	Ocean Academy	463382	998413	Point
50	PrP50	Pakos Academy (1)	461930	997858	Point
51	PrP51	Paradise Hills 1	463572	999148	Point
52	PrP52	Paradise Hills 2	462289	1003134	Point
53	PrP53	Planet Academy	463426	1002093	Point
54	PrP54	Primid Academy	462085	997711	Point
55	PrP55	Progress Academy	465264	1002326	Point
56	PrP56	Smart Academy	456882	1002056	Point
57	PrP57	Sonker Academy	461780	997627	Point
58	PrP58	Tees Hoom	464654	1002523	Point
59	PrP59	Tsadaniyan Mariyam	463000	1002210	Point
60	PrP60	Tsara tsiyon	462905	1002683	Point
61	PrP61	Venus Academy	461931	997869	Point
62	PrP62	wisdom Sender	464537	1002159	Point
63	PrP63	Wisdom youth Academy	465639	997328	Point
64	PrP64	Tibab Academy	465207	1002852	Point
65	PrP65	Yabets	461817	998625	Point

4. High schools

Highschool

OBJECTID *	No_	Kebele	School_type	School_Name	Grade	X__coor	Y_coor	Ownership
1	PuSs 1		secondary sup	Burayu secondary	(9-12)	464537	1002159	Gov
2	PuSs 2		secondary sup	DirreeSecondary	(9-12)	461069	1002836	Gov
3	PuSs 3		secondary sup	Burka Nono	(9-12)	462063	997484	Gov
4	PrSs 4		secondary sup	Progress	9	465264	1002326	Non-Gov.
5	PrSs 5		secondary sup	Wisdom Seender	(9-10)	465034	1001777	Non-Gov.
6	PrSs 6		secondary sup	Hil-Tops	(9-12)	463964	998903	Non-Gov.
7	PrSs 7		secondary sup	Bori yadi	(9-11)	463587	998769	Non-Gov.
8	PrSs 9		secondary sup	Elu-star	(9-10)	464424	998583	Non-Gov.