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ANALYZING SPATIAL DISTRIBUTION AND ACCESSIBILITY OF HEALTH FACILITIES

A Case Study of Kibaha Town

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ANALYZING SPATIAL DISTRIBUTION AND ACCESSIBILITY OF HEALTH FACILITIES

A Case Study of Kibaha Town

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A Dissertation Submitted to the Department of Geospatial Sciences and Technology in Partially Fulfilment of the Requirements for the Award of degree of Bachelor of Science in Geoinformatics (BSc. GI) of Ardhi University

CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by the Ardhi University dissertation titled "**Analyzing Spatial Distribution and Accessibility of Health Facilities, a Case Study of Kibaha Town"** in partial fulfillment of the requirements for the award of degree of Bachelor of Science in Geoinformatics at Ardhi University.

……	……
Dr. Zakaria Robert Ngereja	Mr. Method Gwaleba
(Main Supervisor)	(Second Supervisor)
Date ……	Date ……

DECLARATION AND COPYRIGHT

I, ZAID MARIAM AZIZI hereby declare that, the contents of this dissertation are the results of my own findings through my study and investigation, and to the best of my knowledge they have not been presented anywhere else as a dissertation for diploma, degree or any similar academic award in any institution of higher learning.

……..

Zaid, Mariam Azizi

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DEDICATION

I dedicate this dissertation wholeheartedly to my beloved family and cherished friends. Your unwavering belief in me and your continuous support has been instrumental in my journey. Your love, encouragement, and presence have inspired me to reach for the stars and never give up. This achievement is a testament to our unbreakable bond and the shared dreams we hold dear. Thank you for being my constant source of strength and motivation.

ABSTRACT

The research focuses on examining the spatial distribution and accessibility of health facilities in Kibaha Town, aiming to analyze and understand the availability of healthcare services to the population. Through the utilization of Geographic Information System (GIS) and spatial analysis techniques, the study examines the distribution of health facilities across town and asses their proximity to both residential areas and road network. Data collection involved gathering both spatial and attribute data including the location of health facilities, road networks and population data. these data were processed by using software tools such as QGIS, ArcGIS and MS Excell enabling the application of various spatial analysis methods. Spatial joining is employed to link health facilities data with corresponding administrative area allowing an assessment of the distribution of health facilities across different wards in Kibaha Town. Additionally, the proximity analysis and service area analysis are conducted to identify area within a specific distance from health facilities providing insight into extent of coverage and accessibility. The Finding reveal significance disparities in the distribution of health facilities, with some wards having a higher concentration of health facilities compared to others. The analysis of accessibility indicates that some people have reasonable access to health facilities within the recommended distance, and there are individuals who face challenge in reaching the nearest facilities due to longer travel distance. Understanding the spatial distribution and accessibility of health facilities is essential for equitable healthcare services provision.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

CSV	Comma Separated Values
GIS	Geographic Information System
MS Excel	Microsoft Excels
NBS	National Bureau of Statistics
OSM	Open Street Map
SDGs	Sustainable Development Goals
UTM	Universal Transverse Mercator
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

World health organization (WHO) defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO, 2004). The Sustainable Development Goal 3 (SDG3) in health matters is to ensure healthy lives and promote the well-being of all at all ages (SDGs,2022). This goal aims to achieve universal coverage including financial risk protection, access to inexpensive, high-quality essential medications and vaccination for everyone, and access to excellent essential healthcare services.

Health facilities are defined as any location, permanent or temporary, where healthcare services are provided to individuals or populations (Ahmad et al.,2017). World health organization emphasizes that these facilities must be equipped with the necessary resources, including trained healthcare workers, medicines, medical equipment, and appropriate infrastructure, to provide high-quality health services to the population (WHO,2010).

The accessibility of health service in Tanzania has been challenged by the inadequate fund, a shortage of fully trained health staff in the hospitals, and poor communication and transport infrastructure as it recorded that, about 45% of the population were living within 1 km of a health facility, 93% within 10 km and 72% within 5km (COWI, 2007). Furthermore, health service has been offered at different kind of level within the country. These include referral hospitals, specialized hospitals, regional hospitals, district hospitals, health centers, and dispensaries (COWI, 2007). The lowest level of healthcare is being offered by dispensaries, whereby some of them are still located in poor regions and each one of them has to serve as many as 6000 people.

The National Health Policy in Tanzania emphasizes the need for increasing community involvement in health development and improved access and equity in health and health services (Mwafisi & Abdallah 2003). The objective of the Health Policy in Tanzania is to ensure that health services are available and accessible to all the people in the country.

It is fundamental a human right to have access to healthcare services when it needed. It’s important or desirable for the government to ensure high quality provision and equal and easy access to fundamental healthcare services for all citizens (Hewko, 2001). Varying spatial distribution of the health care facilities, population distribution, and transport infrastructure

such as roads. To ensure equal and easy access it is essential to ensure that the population, health care facilities and transport infrastructure are positioned in a manner that facilitates high spatial accessibility (Talen,1998).

A study, conducted by Smith et al. (2018), found that the availability and accessibility of health facilities are often unequal within and between different regions, with rural and remote areas often having limited access to such facilities. The authors suggest that the use of spatial analysis techniques, such as GIS mapping and network analysis, can help to identify areas where there are gaps in health facility coverage and where additional facilities may be needed.

Furthermore, by incorporating road network data into these analyses, it is possible to assess the accessibility of existing facilities and identify potential barriers to accessing health care, such as poor road infrastructure or long distances to the nearest facility. This can help decision-makers to prioritize investments in new health facilities or improvements to the road network in order to improve the overall accessibility of health care (Ahmad et al.,2017).

The spatial distribution and accessibility of health facilities, such as hospitals, dispensaries, and health centers have a significant impact on the health and well-being of a population. In order to effectively analyze the distribution and accessibility of these facilities, it is necessary to consider both the population density and the road network in the area. This research focus on examining the distribution and accessibility of health facilities in Kibaha considering factors like population density and road network. It aims is aim is to identify area with unequal access to healthcare facilities and suggest ways to improve overall accessibility for the populations well-being.

1.2 Problem Statement

Access to healthcare facilities for citizens in many developing countries is challenge due to long distances to facilities, inadequate and unaffordable transport systems. Whereas most citizens live far from health centers and must travel long distances to reach health services, this may result in loss of life and patients due to receive delayed treatment.

The distribution of public health facilities in Kibaha Urban is characterized by location disparity often concentrated in one area. This results in unequal distribution of health facilities, especially for underserved areas. Thus, there is a need to carry out a study to analyze the spatial distribution and accessibility of health facilities in Kibaha town.

1.3 Research Objectives

1.3.1 Main Objective

The main objective of the study is to map and analyze the spatial distribution and accessibility of health facilities in Kibaha Town.

1.3.2 Specific Objective

i. To analyze the spatial distribution pattern of Health facilities in Kibaha town.
ii. To assess the travel distance driven accessibility within Kibaha town.
iii. To conduct the proximity analysis of health facilities in Kibaha town.

1.3.2 Research questions

i. What is the spatial distribution pattern of health facilities in Kibaha town?
ii. How accessible are health facilities in Kibaha town based on travel distances?
iii. What is the proximity analysis of health facilities in Kibaha town?

1.4 Significance of the Research

The spatial distribution and accessibility of health facilities are important factors in the health and well-being of a population. By analyzing the spatial distribution of healthcare facilities, it helps us to ensure that healthcare resources are distributed equitably across communities and develop strategies to improve healthcare delivery and access.

1.5 Beneficiaries of the Research

The beneficiaries of the research include

i. Policymakers and government officials, can use the findings to inform decisions about the allocation of resources for health care infrastructure.
ii. Patients and communities, can benefit from improved access to health care services and better quality of care.
iii. The general public, can benefit from a better understanding of the spatial distribution of health facilities and the accessibility of health care services.

1.6 Description of the Study Area

Kibaha Town Council located in Tanzania coast (Pwani), Is one of the seven councils in the region and serves as its headquarters. it is situated approximately 40km away from the city of Dar es Salaam. Kibaha town shares border with Kinondoni district to the east, Bagamoyo to the west, kisarawe to the south, and the small town of Mlandizi to the north. The town covers an estimated area of 750km^2 spinning latitudes 6.80 south and longitudes 38.20 and 38.50

east. It is connected to Bagamoyo town by a seasonal road, while access to other district headquarters such as Kisarawe, Mkuranga, Kilindoni (mafia), and Utete (Rufiji)is facilitated through Dar esSalaamm city. This council is administratively divided into 11 wards Tumbi, Mailimoja, Kibaha, Visiga, Kongowe, Misugusugu, Msangani, Picha ya ndege, Mbwawa and Viziwaziwa. As of the 2022 census the council has human population approximately 265,360.

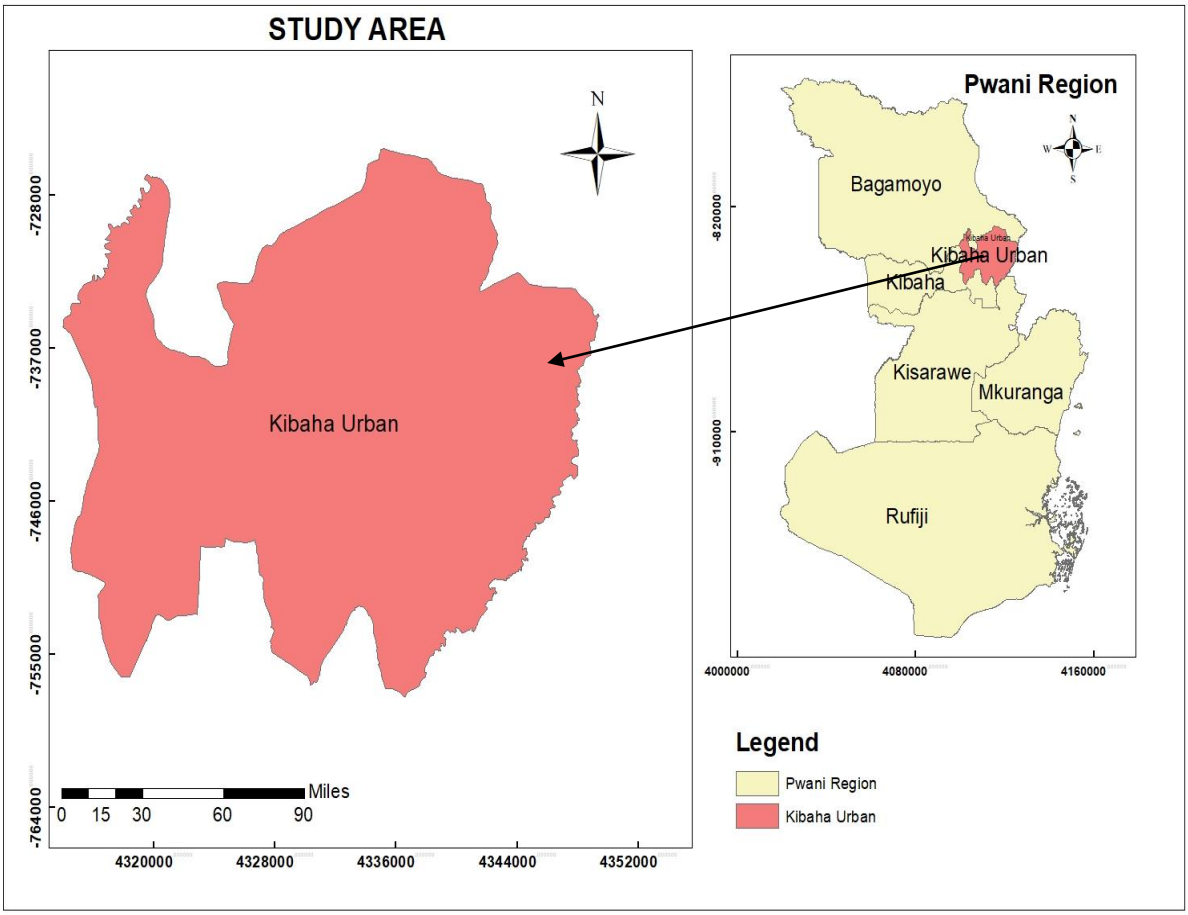


Figure 1.1: Location of the Study Area

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter explores various literature reviews related to Spatial distribution and accessibility of Health facilities that have been conducted by various researchers in different places. This chapter is to review various issues with the purpose of adding knowledge and familiarizing the research.

2.2 Spatial Distribution

Refers to the arrangement or spread of objects, features, or phenomena across space. It describes how the elements are located or distributed in relation to each other and to the surrounding environment. Spatial distribution can be characterized by various factors such as density, concentration, dispersion, and clustering. It provides information about the overall structure and organization of a spatial phenomenon. In the context of healthcare Spatial distribution Refers to the arrangement or pattern of health facilities such as hospitals, clinics, and pharmacies within a given geographic area (Fotheringham, & Wong 1991).

2.3 Health Facilities and Population

The population is an essential component and basic input when designing health facilities. It specifies the quantity and level of health facilities to be offered. An essential component of healthcare practice is the interaction between people and healthcare services. According to World Health Organization (WHO) guidelines there has to be 1 healthcare facility for every 5000 people for effective services. According to Tanzania specification include a population range of 7000 to 10,000 require 1 dispensary, 10000 to 25,000 require 1 health center and 25,000 to 120000 people and above requires 1 hospital (URT, 2011).

Tanzania's government recommends that people should have access to healthcare within 5km (3.1 miles) of their homes. This is based on the health organization's (WHO) definition of acceptable access to healthcare which is defined as a travel time of less than 1 hour. In reality, people live much further than 5km from the nearest healthcare facilities (Christopher et al., 2017).

This is based on the understanding that access to healthcare is a fundamental human right, and that timely access to care is critical in ensuring positive health outcomes and preventing avoidable deaths. However, it's important to note that the recommended distance may vary

depending on factors such as population density, geographic location, and availability of transportation (WHO, 2010).

The World Health Organization has not specified a standard distance from the road to health facilities, but it is generally recommended that health facilities be located as close to major roads or transportation hubs as possible to improve accessibility. In some cases, it may be necessary to provide transportation services to individuals who live far from the road or in areas with poor road conditions to ensure that they can access healthcare services.

2.4 Access to Healthcare

Since supply and demand are not equally distributed, some spatial differences are unavoidable in terms of access to healthcare, because the location of the supply (health professionals, health facilities, etc.) and demand (the population which benefits from healthcare services) directly affect access to healthcare (Luo & Wang, 2003).

Access to healthcare is a multi-dimensional and complex concept that depends on the characteristics of the supply (healthcare system) and demand (population) (Noor et al., 2009).

Researchers used two different perspectives to study the idea of healthcare access in terms of process and dimensions of access. According to (Guagliardo, 2004). There are two steps in the process of access to healthcare which is potential access, which refers to the population which needs and has the opportunity to access healthcare services, and realized access defines the population who actually benefits from healthcare services (examination, diagnosis, analysis, treatment, etc.)

Penchansky and Thomas (1981) explain five different dimensions to access to healthcare which are

- *availability***,** concerns itself with the resources available in delivering an intervention, such as those affecting utilization such as duration and flexibility of operating hours, and features of health facilities (density, dispersion and decentralization).
- *accessibility,* is the relation between the locations of the supply and the demand. It expresses how accessible the location of the demand is to the location of the supply (in terms of distance, time or cost).
- *accommodation,* consists of setting up and organizing health services to suit population needs.
- *Affordability,* is the relation between the price of healthcare services and the clients' levels of income, health insurance, and resources.

- *Acceptability,* implies the attitudes of the clients depending on the characteristics of healthcare providers and vice versa.

2.5 Factors Influencing Spatial Distribution and Accessibility of Health Facilities

- Population density

  The concertation of people in a particular area can affect the need for and availability of health facilities. area with higher population densities may require more health facilities to cater to the needs of the population.

- Transportation

  The availability of transportation is also impacting accessibility to health facilities. Areas with limited public transportation or poor road infrastructure may have lower accessibility.

- Geographical berries

  Physical berries such as mountains, rivers or other natural features can make it difficult for people to access health facilities, especially in remote or rural areas.

2.6 Geographic Information System

Is the system of hardware, software, and procedures to facilitate the management, manipulation, analysis, modeling, representation, and display of geo-referenced data to solve complex problems regarding the planning and management of resources (Escoba , 2008).

2.6.1 GIS and Health

GIS is a system composed of hardware and software to collect, process, and analyzes data like tabular and spatial to produce geographic-based information in order to improve decision-making. In the public health domain, GIS methods were mostly used for occurrence analysis and epidemiologic studies (Fuad et al., 2006). GIS aids in faster and better health mapping and analysis than conventional methods.

GIS is becoming a vital tool in healthcare applications. It includes database management, planning, risk service area mapping and location identification, etc. GIS helps to generate thematic maps that depict the intensity of a disease or vector. It can create buffer zones around selected features and then combine this information with disease incidence data to determine how many cases fall within the buffer. It can also map the impact zone of the vector propagation site, where control activity needs to be strengthened. GIS can identify

catchment areas of health centers and also locate suitable sites for a new health facility (Cromley et al., 2002).

In many ways, GIS is an ideal tool for planning and organizational issues of health service. Firstly, referral patterns of the hospitals and emergency clinic locations to share with emergency situations are extremely suited to GIS analysis. Secondly, an estimation of the service areas of hospitals can be established. There are problems of accurate enumeration as the population serviced by a hospital is usually geographically dispersed, and not neatly constrained by administrative and census boundaries. However, it is frequently desirable to characterize the population that a hospital serves, so that proper explanation can be taken of its demands. Overlay of map layers- address locations on census boundaries, and other geographical features- using GIS techniques can help to define a hospital's service area (Cromley & McLafferty 2002).

2.7 Fishnet or Grid Method

Fishnet or grid method, also known as grid tessellation or grid generation is a widely used technique in Geographic Information Systems for creating a regular grid of rectangular or square cells that cover a specific geographic area of interest. The main purpose of this method is to partition the study area into a network of uniformly spaced cells forming a grid-like pattern. (Huang & Zhang 2004).

2.7.1 The fishnet or grid method offers several advantages and applications within GIS

- *Spatial representation:* The grid cells provide a systematic spatial representation of the study area, allow to understand the spatial distribution of variables or phenomena under investigation. This enables spatial analysis and the identification of patterns or trends across the study area.

- *Efficient data management*: Dividing the study area into grid cells simplifies data management by organizing data according to each cell. This structure aids in data storage, retrieval, and analysis.

- *Compatibility with GIS and remote sensing technologies:* The fishnet or grid method aligns well with Geographic Information Systems (GIS) and remote sensing technologies. GIS software can easily overlay the grid cells onto spatial datasets, facilitating spatial analysis and visualization. Remote sensing data can also be processed and analyzed within the context of the grid cells.

2.8 Proximity Analysis

Is the type of spatial analysis that measures the distance between geographical features. It is a common tool used in GIS to identify areas that are close to each other such as schools and parks or to identify areas that are far from each other such as industrial zones and residential areas (Neutes, 2005).

2.8.1There are different tools to perform Proximity analysis

- Buffer

  Is the common spatial analysis technique used in GIS to create a zone or area around a specific feature. It involves generating a buffer zone around a point, line or polygon feature by specifying distance or size parameters. Buffer is often used in proximity analysis to assess the relationship between features.

- Near tool

  The spatial analysis technique used in GIS to calculate the distance from each feature in one dataset to the nearest feature in another dataset. It is used to assess proximity or distance relationships between different spatial features.

- Spatial join

2.8.2 Spatial Join

Is a common operation in Geographic Information Systems (GIS) that involves combining attribute data from two or more spatial datasets based on their spatial relationship. It allows for the integration of information from different layers or datasets by linking their spatial features (Power et al.,1999). Spatial join is a powerful tool for proximity analysis it can be used to identify areas that are underserved by certain type of services such as schools or hospitals.

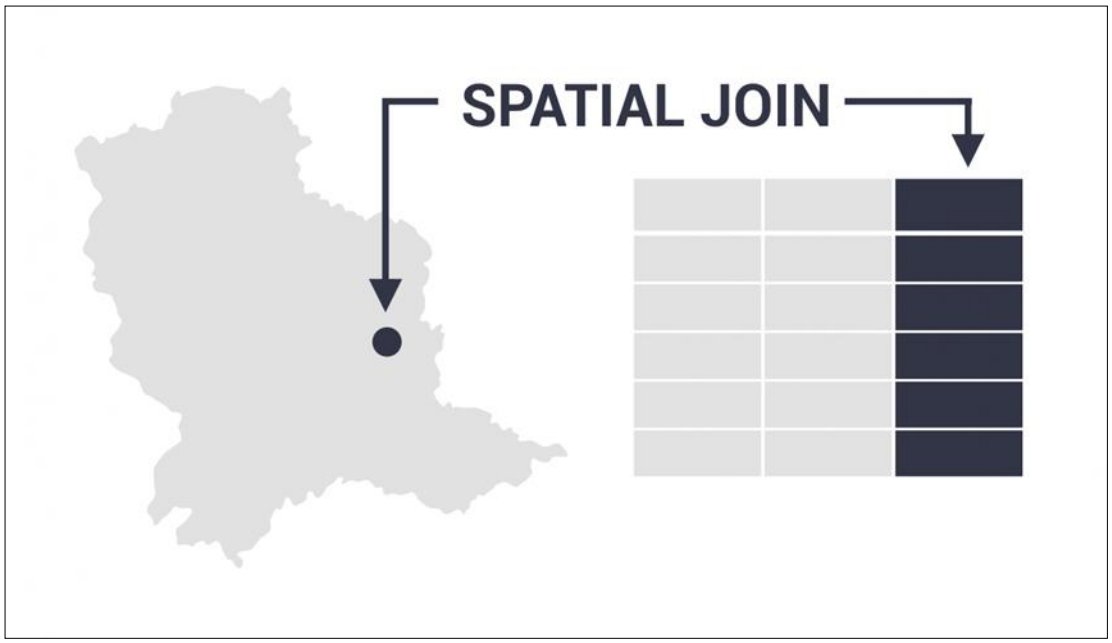


Figure 2:1 Spatial join (Source: GIS Geography 2023)

2.8.3 Components of spatial join

- *target layer*- is the layer to which the attribute data will be added or updated.
- *join layer*- contains the attribute data to be joined.

2.8.4 Common Types of Spatial Relationships Used in Spatial Joins include

- *Intersects:* Attributes from the join layer are combined with the target layer where the features overlap or intersect.
- *Contains:* Attributes from the join layer are combined with the target layer where the features in the target layer fully contain the features in the join layer.
- *Within:* Attributes from the join layer are combined with the target layer where the features in the target layer are fully contained within the features in the join layer.
- *Nearest:* Attributes from the nearest feature in the join layer are combined with the target layer based on proximity (Power et al.,1999).

2.9 Network Analysis

A network is a system of interconnected elements such as line connecting points. Examples of networks include highways connecting cities, streets interconnected to each other at street intersections, and sewers (Satish et al., 2017).

Network analysis is a collection of linked lines. These lines stand in for the various networks that must typically be analyzed, such as railroads, streams, roads, waterlines, pipelines, And communications lines. It can be both direct and indirect, as well as planned and unforeseen.

Network analysis examines the flow of matter and energy, the connectivity and accessibility of roads, pipelines, and telecommunications, as well as the movement of people, goods, and services. Any type of network is connected by vertices and edges (Bell et al., 1997).

2.9.1 Road Network

Is the system of interconnected roads, highways, streets, and other transportation infrastructure that allows vehicles to travel from one place to another. The road network can range from a small network of local streets to a large system of interstate highways and major urban arteries that span an entire country or even a continent (Bell et al., 1997).

2.9.2 Service Area

Service area refers to the geographical extent that can be efficiently served or covered by a specific facility or service. It is defined based on factors such as distance, travel time, or any other criteria relevant to the nature of the service (Gubara et al., 2014).

To determine the service area common approach is to consider transportation networks such as roads, streets, or public transit routes. The analysis takes into account factors like travel time, travel distance or a combination of both. The goal is to identify all locations that fall within the specified travel time or distance from a given starting point (Elhag et al., 2016).

CHAPTER THREE
METHODOLOGY

3.1 Introduction

In this part, all the procedures and methods followed during the analysis of spatial distribution and accessibility of health facilities are discussed and analyzed. This study involved methods of data collection of both spatial and attribute data as shown in Figure 3.2. The next step involves Data processing in which different geoprocessing tools are used to process the data including, spatial join, clip, buffer, vector creation and service area analysis tools. Lastly, the analysis is done so as to produce the maps which show the accessibility and distribution of health facilities by using the GIS software. Figure 3.1 depict workflow indicating the step-by-step execution of research activities.

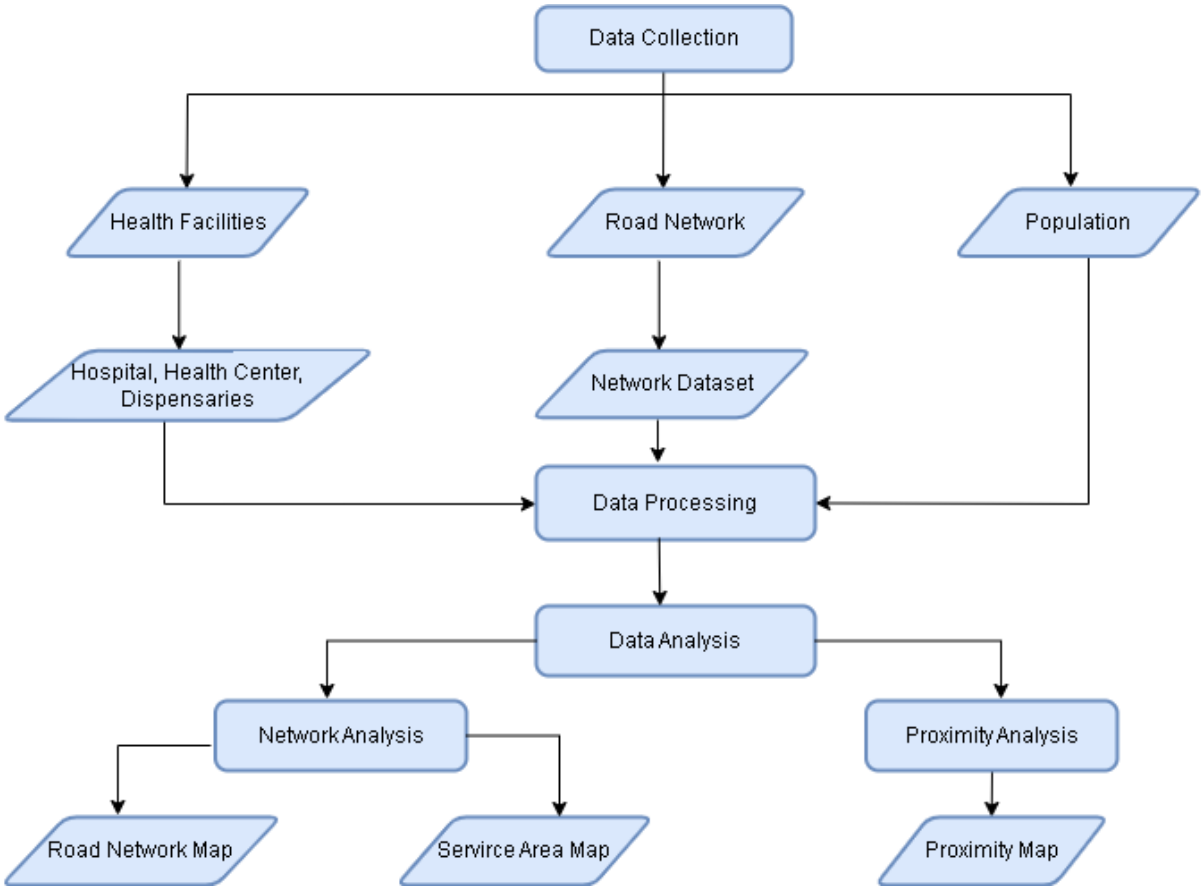


Figure:3.1 Research Workflow

3.2 Data Collection

In this research, different types of data were collected which include the locations of healthcare facilities such as hospitals, health centers and dispensaries, road data and population data.

The coordinates of each health services center were obtained through the use of Handheld GPS (Garmin GPS_ 60CSx) with an accuracy of not more than 2m, which helps to get the position (XY coordinates) of health facilities. The coordinates were recorded automatically in Handheld GPS others were written manually and saved in Excel sheets in a comma-separated value (CSV) format for further processing.

The administrative boundary of Kibaha town and Population data were obtained from National Bureau of Statistics (NBS) website, accessible at http://www.nbs.go.tz. Road network data was downloaded from the Open StreetMap (OSM) using QGIS software, this vector format was imported, overlayed, projected and edited to meet the requirement. Table 3.1 Displays the summary of the characteristics of the research data.

Table 3.1: Data Type and their Sources

DATA	FORMAT	SOURCES	USE
Coordinates of Health facilities	GPX (GPS Exchange Format) and CSV	Geographic Positioning System (GPS)	To show the location of health services
Road and Street network Dataset	Shapefile	OpenStreet Map (OSM)	Mapping of roads networks
Population data 2022	Shapefile and CSV	National Bureau of Statistics (NBS)	To map the population distribution
Administrative boundary	Shapefile	National Bureau of Statistics (NBS)	To show the administrative boundary

3.3 Data Preparation

Spatial data was prepared by making sure all the data is available and some necessary tasks were performed including data cleaning to ensure that the data are properly formatted and ready for analysis. For example, all the coordinates of health facilities should have specified locations such as wards, names, and sources so that they can be analyzed. All the data are prepared in the same coordinate system which is Arc1960 UTM Zone 37S.

3.4 Data Processing

In data preprocessing, the software used is

- QGIS - used for spatial data creation, analysis, mapping, and visualization of geospatial data
- ArcMap -used for processing and analysis of spatial data
- MS Excel – coordinates data preparation

3.4.1 Fishnet or Grid Creation and Analysis

The extent of the study area and cell size that appropriately balance the level of details was determined, and a series of regularly spaced horizontal and vertical lines that form a grid is generated. Kibaha town is divided into a grid whereby each cell represents a specific geographic area. by using vector creation tools the size of each grid cell used was 5km.

The health facility data was assigned to grid cells so as to determine which cell each facility falls within. The grid-based approach with 5km cells was chosen to ensure equitable access to health facilities within 5km radius in Kibaha town. This method enables efficient analysis, identify gap in coverage, resource allocation and promoting balanced distribution of healthcare services. Figure 3.2 show the creation of grid cell and health facilities distribution.

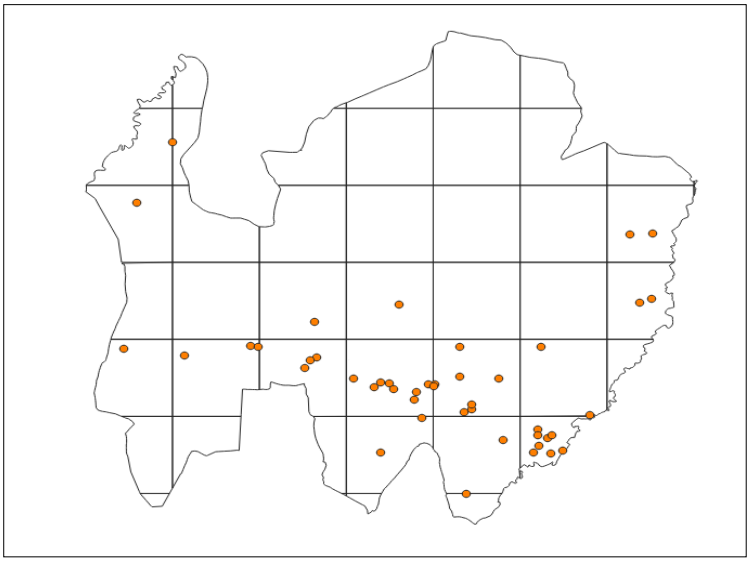


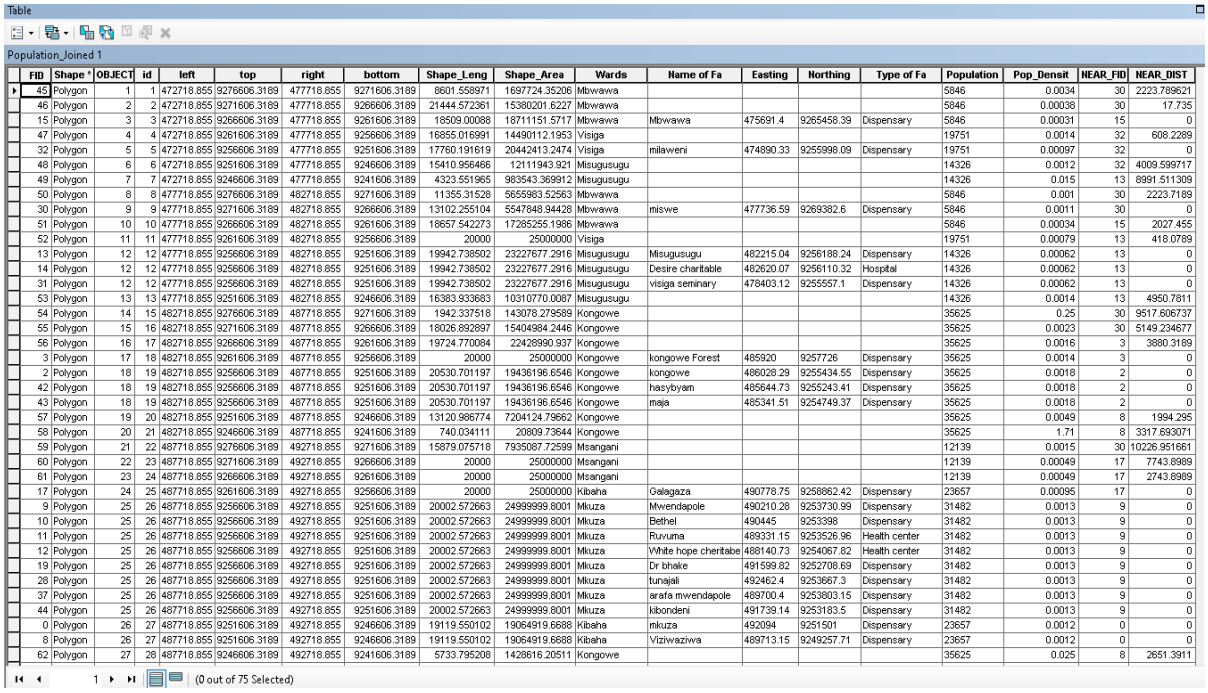
Figure 3.2 Creation of grid cell and health facilities distribution

3.4.2 Spatial Joining

The spatial join was performed using QGIS software version 3.18. The grid cell and health facilities shapefiles were imported into QGIS. To ensure spatial compatibility, both datasets were set to the common spatial reference system Arc 1960 UTM zone 37S. The join attributes

by location tool were utilized to perform the spatial join. The grid cell dataset was selected as the base layer, while the health facilities were chosen as the join layer. The join operation, such as within and contain, was determined to establish the spatial matching criteria. For the attribute field selection, the facility name and facility type were specified as the attributes to be transferred or joined from the health facilities to the corresponding grid cells. The specified attributes, including the facility name and facility type, were transferred from the health facilities to the containing grid cells.

By linked the attribute of the population data to their respective grid cells The join attributes by field value tool were used to perform the spatial join. This process allowed for the assessment of population distribution patterns, identification of underserved areas with limited healthcare accessibility, and identification of areas that may require additional healthcare infrastructure development.



Table

Population_Joined 1

FID	Shape *	OBJECT	id	left	top	right	bottom	Shape_Leng	Shape_Area	Wards	Name of Fa	Easting	Northing	Type of Fa	Population	Pop_Densit	NEAR_FID	NEAR_DIST
45	Polygon	1	1	472718.855	9276606.3189	477718.855	9271606.3189	8601.558971	1697724.35206	Mbwawa					5846	0.0034	30	2223.789621
46	Polygon	2	2	472718.855	9271606.3189	477718.855	9266606.3189	21444.572361	15380201.6227	Mbwawa					5846	0.00038	30	17.735
15	Polygon	3	3	472718.855	9266606.3189	477718.855	9261606.3189	18509.00088	18711151.5717	Mbwawa	Mbwawa	475691.4	9265458.39	Dispensary	5846	0.00031	15	0
47	Polygon	4	4	472718.855	9261606.3189	477718.855	9256606.3189	16855.016991	14490112.1953	Visiga					19751	0.0014	32	608.2289
32	Polygon	5	5	472718.855	9256606.3189	477718.855	9251606.3189	17760.191619	20442413.2474	Visiga	milaweni	474890.33	9255998.09	Dispensary	19751	0.00097	32	0
48	Polygon	6	6	472718.855	9251606.3189	477718.855	9246606.3189	15410.956466	12111943.921	Misugusugu					14326	0.0012	32	4009.599717
49	Polygon	7	7	472718.855	9246606.3189	477718.855	9241606.3189	4323.551965	983543.369912	Misugusugu					14326	0.015	13	8991.511309
50	Polygon	8	8	477718.855	9276606.3189	482718.855	9271606.3189	11355.31528	5655983.52563	Mbwawa					5846	0.001	30	2223.7189
30	Polygon	9	9	477718.855	9271606.3189	482718.855	9266606.3189	13102.255104	5547848.94428	Mbwawa	miswe	477736.59	9269382.6	Dispensary	5846	0.0011	30	0
51	Polygon	10	10	477718.855	9266606.3189	482718.855	9261606.3189	18657.542273	17285255.1986	Mbwawa					5846	0.00034	15	2027.455
52	Polygon	11	11	477718.855	9261606.3189	482718.855	9256606.3189	20000	25000000	Visiga					19751	0.00079	13	418.0789
13	Polygon	12	12	477718.855	9256606.3189	482718.855	9251606.3189	19942.738502	23227677.2916	Misugusugu	Misugusugu	482215.04	9256188.24	Dispensary	14326	0.00062	13	0
14	Polygon	12	12	477718.855	9256606.3189	482718.855	9251606.3189	19942.738502	23227677.2916	Misugusugu	Desire charitable	482620.07	9256110.32	Hospital	14326	0.00062	13	0
31	Polygon	12	12	477718.855	9256606.3189	482718.855	9251606.3189	19942.738502	23227677.2916	Misugusugu	visiga seminary	478403.12	9255557.1	Dispensary	14326	0.00062	13	0
53	Polygon	13	13	477718.855	9251606.3189	482718.855	9246606.3189	16383.933683	10310770.0087	Misugusugu					14326	0.0014	13	4950.7811
54	Polygon	14	15	482718.855	9276606.3189	487718.855	9271606.3189	1942.337518	143078.279589	Kongowe					35625	0.25	30	9517.606737
55	Polygon	15	16	482718.855	9271606.3189	487718.855	9266606.3189	18026.892897	15404984.2446	Kongowe					35625	0.0023	30	5149.234677
56	Polygon	16	17	482718.855	9266606.3189	487718.855	9261606.3189	19724.770084	22428990.937	Kongowe					35625	0.0016	3	3880.3189
3	Polygon	17	18	482718.855	9261606.3189	487718.855	9256606.3189	20000	25000000	Kongowe	kongowe Forest	485920	9257726	Dispensary	35625	0.0014	3	0
2	Polygon	18	19	482718.855	9256606.3189	487718.855	9251606.3189	20530.701197	19436196.6546	Kongowe	kongowe	486028.29	9255434.55	Dispensary	35625	0.0018	2	0
42	Polygon	18	19	482718.855	9256606.3189	487718.855	9251606.3189	20530.701197	19436196.6546	Kongowe	hasybyam	485644.73	9255243.41	Dispensary	35625	0.0018	2	0
43	Polygon	18	19	482718.855	9256606.3189	487718.855	9251606.3189	20530.701197	19436196.6546	Kongowe	maja	485341.51	9254749.37	Dispensary	35625	0.0018	2	0
57	Polygon	19	20	482718.855	9251606.3189	487718.855	9246606.3189	13120.986774	7204124.79662	Kongowe					35625	0.0049	8	1994.295
58	Polygon	20	21	482718.855	9246606.3189	487718.855	9241606.3189	740.034111	20809.73644	Kongowe					35625	1.71	8	3317.693071
59	Polygon	21	22	487718.855	9276606.3189	492718.855	9271606.3189	15879.075718	7935087.72599	Msangani					12139	0.0015	30	10226.951661
60	Polygon	22	23	487718.855	9271606.3189	492718.855	9266606.3189	20000	25000000	Msangani					12139	0.00049	17	7743.8989
61	Polygon	23	24	487718.855	9266606.3189	492718.855	9261606.3189	20000	25000000	Msangani					12139	0.00049	17	2743.8989
17	Polygon	24	25	487718.855	9261606.3189	492718.855	9256606.3189	20000	25000000	Kibaha	Galagaza	490778.75	9258862.42	Dispensary	23657	0.00095	17	0
9	Polygon	25	26	487718.855	9256606.3189	492718.855	9251606.3189	20002.572663	24999999.8001	Mkuza	Mwendapole	490210.28	9253730.99	Dispensary	31482	0.0013	9	0
10	Polygon	25	26	487718.855	9256606.3189	492718.855	9251606.3189	20002.572663	24999999.8001	Mkuza	Bethel	490445	9253396	Dispensary	31482	0.0013	9	0
11	Polygon	25	26	487718.855	9256606.3189	492718.855	9251606.3189	20002.572663	24999999.8001	Mkuza	Ruvuma	489331.15	9253526.96	Health center	31482	0.0013	9	0
12	Polygon	25	26	487718.855	9256606.3189	492718.855	9251606.3189	20002.572663	24999999.8001	Mkuza	White hope cheritabe	488140.73	9254067.82	Health center	31482	0.0013	9	0
19	Polygon	25	26	487718.855	9256606.3189	492718.855	9251606.3189	20002.572663	24999999.8001	Mkuza	Dr bhake	491599.82	9252708.69	Dispensary	31482	0.0013	9	0
28	Polygon	25	26	487718.855	9256606.3189	492718.855	9251606.3189	20002.572663	24999999.8001	Mkuza	tunajali	492462.4	9253667.3	Dispensary	31482	0.0013	9	0
37	Polygon	25	26	487718.855	9256606.3189	492718.855	9251606.3189	20002.572663	24999999.8001	Mkuza	arafa mwendapole	489700.4	9253803.15	Dispensary	31482	0.0013	9	0
44	Polygon	25	26	487718.855	9256606.3189	492718.855	9251606.3189	20002.572663	24999999.8001	Mkuza	kibondeni	491739.14	9253183.5	Dispensary	31482	0.0013	9	0
0	Polygon	26	27	487718.855	9251606.3189	492718.855	9246606.3189	19119.550102	19064919.6688	Kibaha	mkuza	492094	9251501	Dispensary	23657	0.0012	0	0
8	Polygon	26	27	487718.855	9251606.3189	492718.855	9246606.3189	19119.550102	19064919.6688	Kibaha	Viziwaziwa	489713.15	9249257.71	Dispensary	23657	0.0012	0	0
62	Polygon	27	28	487718.855	9246606.3189	492718.855	9241606.3189	5733.795208	1428616.20511	Kongowe					35625	0.025	8	2651.3911

1 (0 out of 75 Selected)

Figure 3.3 Joined attribute

3.5 Service area analysis

The service area is determined based on the travel distance that takes for an individual to reach the nearest facility using a road network. The road data was prepared by applying the dissolve and feature-to-line tools to simplify the dataset and enable distance calculations. Road length, travel time in minutes, and speed were calculated based on the prepared road data. Travel time was calculated using the following formula.

Mathematically,

Time (t) = (L/V) *60

Where,

L = Length

V= Velocity (speed)

The service area tools were then utilized to determine travel distances from the health services centers to residential area. The travel impedance was measured in meters with break distance values set at 2000m, 5000m, and 10000m.

3.6 Mapping Spatial Distribution of Health Facilities

The process of mapping the spatial distribution of health facilities involved data collected during fieldwork, which was compiled and organized within an excel sheet, a shapefile was created by integrating the Kibaha shapefile and with a layer depicting the location of health facilities. This allowed to employ geographic information system GIS techniques to map and asses the distribution of these facilities. The resulting map provides an overview of health facilities in the area.

Table: 3.2 show the location of health facilities.

No	Facility Name	Easting	Northing	Facility Type
1	Mendewell	500196	9249355	Hospital
2	Mailimoja	499301	9250180	Dispensary
3	Tumbi	496772	9250075	Hospital
4	Viziwaziwa	489713	9249257	Dispensary
5	Bethel	490445	9253398	Dispensary
6	Ruvuma	489331	9253526	Health center
7	White hope charitable	488140	9254067	Health center
9	Misugusugu	482215	9256188	Dispensary
10	Mwenda pole	490210	9253730	Dispensary
11	Mbwawa	475691	9265458	Dispensary
12	Lulanzi	496476	9254089	Hospital
13	Galagaza	490778	9258862	Dispensary
14	Mtakuja	498896	9256137	Dispensary
15	Dr bhake	491599	9252708	Dispensary
16	ICS Royal	498459	9249280	Health center
17	Mkoani	498823	9249700	Health center
18	Nhumba Lifecare	499540	9250356	Dispensary
19	Kidimu	504590	9258960	Dispensary
20	Dama Africa	504032	9263402	Dispensary

No	Facility Name	Easting	Northing	Facility Type
21	Vikawe	505357	9263506	Dispensary
22	Bhoke	494953	9252092	Dispensary
23	Mwembetayari	492794	9253671	Dispensary
24	Tunajali	492462	9253667	Dispensary
25	Filbert Bayi	494270	9254179	Health center
26	Kibondeni	491739	9253183	Dispensary
27	Maja	485341	9254749	Dispensary
28	kongowe forest	486028	9255434	Dispensary
29	Hasybyam	485644	9255243	Dispensary
30	kongowe	485920	927726	Dispensary
31	Mwanalunguli	505274	9259209	Dispensary
32	Amani	501757	9251662	Dispensary
33	Police	499515	9249215	Dispensary
34	Bokotimiza	494626	9246551	Dispensary
35	Arafa mwendapole	489700	9253803	Dispensary
36	Mashangilio	492732	9253574	Health center
37	Mkuza	492094	925150	Dispensary
38	Kellen	498746	9250404	Dispensary
39	Nyumbu	494245	9256135	Health center
40	Mpangile	494963	9252349	Dispensary
41	Mkuza magereza	494523	9251909	Dispensary
42	Visiga Seminary	478403	9255557	Dispensary
43	Milaweni	474890	9255998	Dispensary
44	Miswe	477736	9269382	Dispensary
45	HRC	498718	9250761	Dispensary

CHAPTER FOUR
ANALYSIS AND DISCUSSION

4.1 Distribution of Health Facilities

The analysis reveals that 45 public health facilities were selected and strategically located in different parts of Kibaha town to fulfill the policy requirement of having at least one health facility in each ward. However, the distribution of health in Kibaha town is uneven, with higher concentrations of 33 health facilities observed in Mailimoja, Kongowe, Tumbi, Mkuza, Kibaha and Picha ya ndege wards. This uneven distribution emphasizes the need for a more balanced approach to ensure equitable access to health services. The total number of health facility in Kibaha town include 4 Hospital, 7 Health centers and 34 Dispensaries.

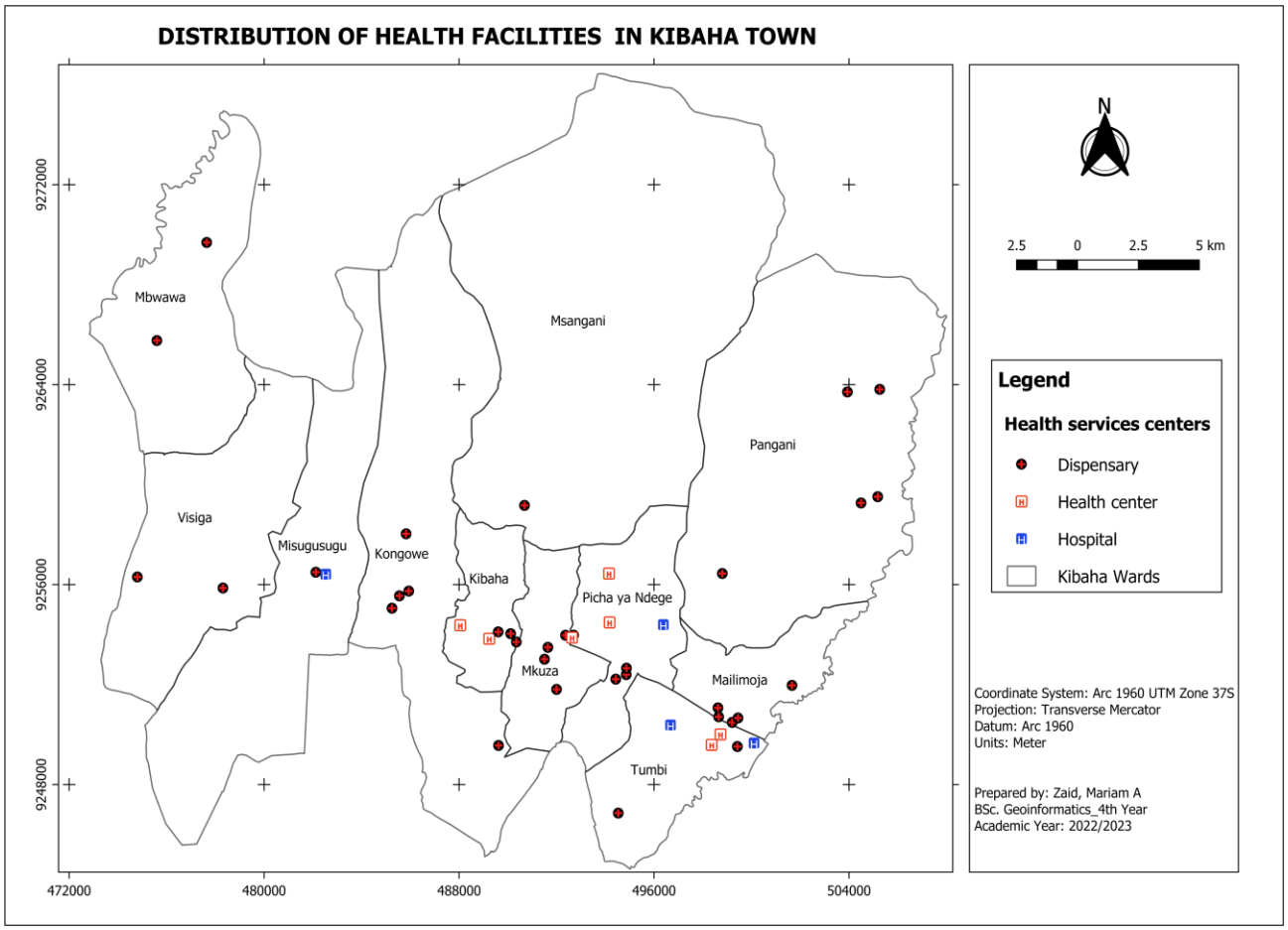


Figure 4.1: Distribution of Health Facilities in Kibaha Town

4.2 Road Network Map of Kibaha Town

The map presented in this research depicts the road network in Kibaha town. Comprise of secondary, tertiary, track, trunk and unclassified roads as shown in Figure 4.2 show the road network map in Kibaha town.

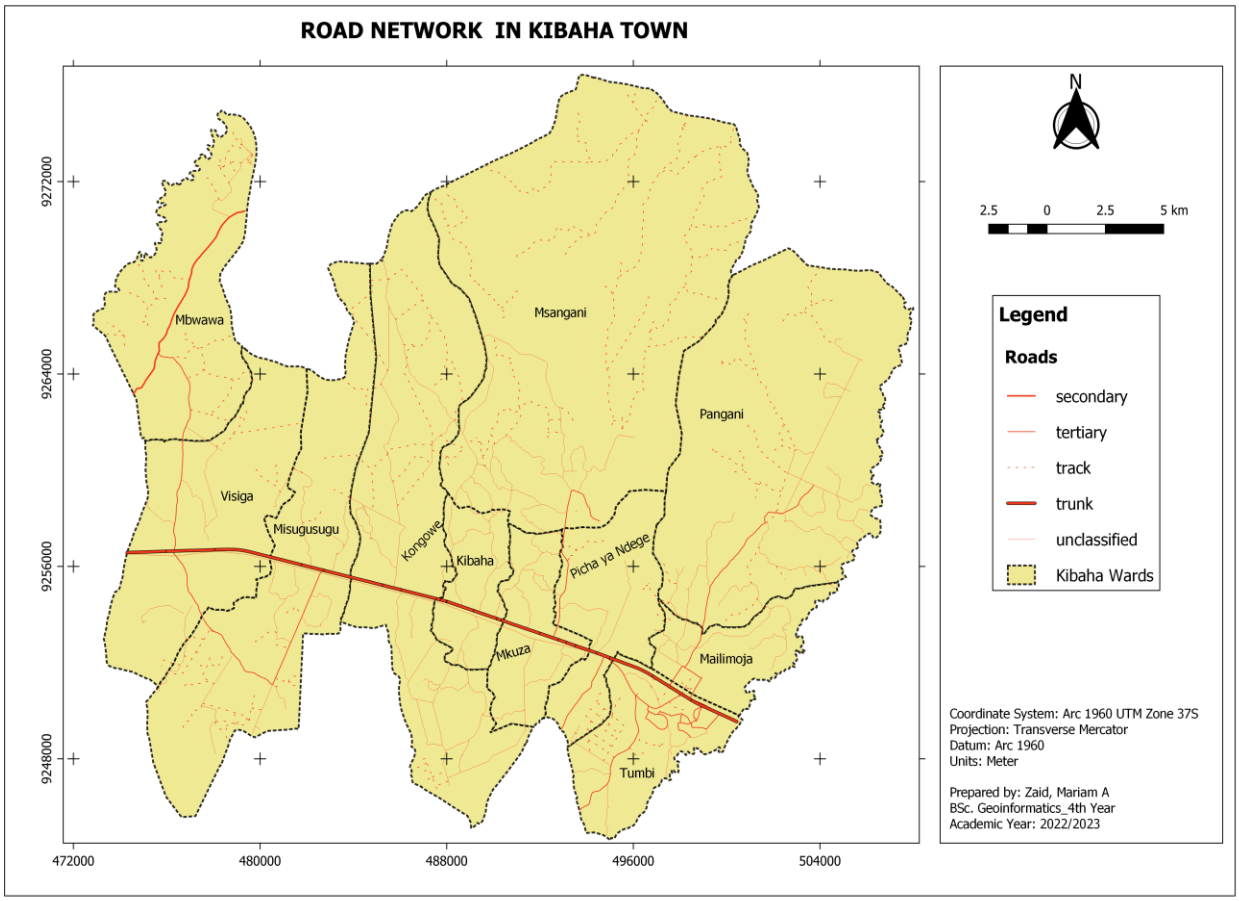


Figure 4.2: Road Network Map of Kibaha Town

4.3 Distribution of Health Facilities and Road Network in Kibaha Town

This map presented shows the spatial relationship between health facilities' location and the road network in Kibaha town. It gives a clear overview of health facility distribution and illustrates the infrastructure that connects the health facility. Figure 4.3 shows the Distribution of Health Facilities and Road Networks in Kibaha Town.

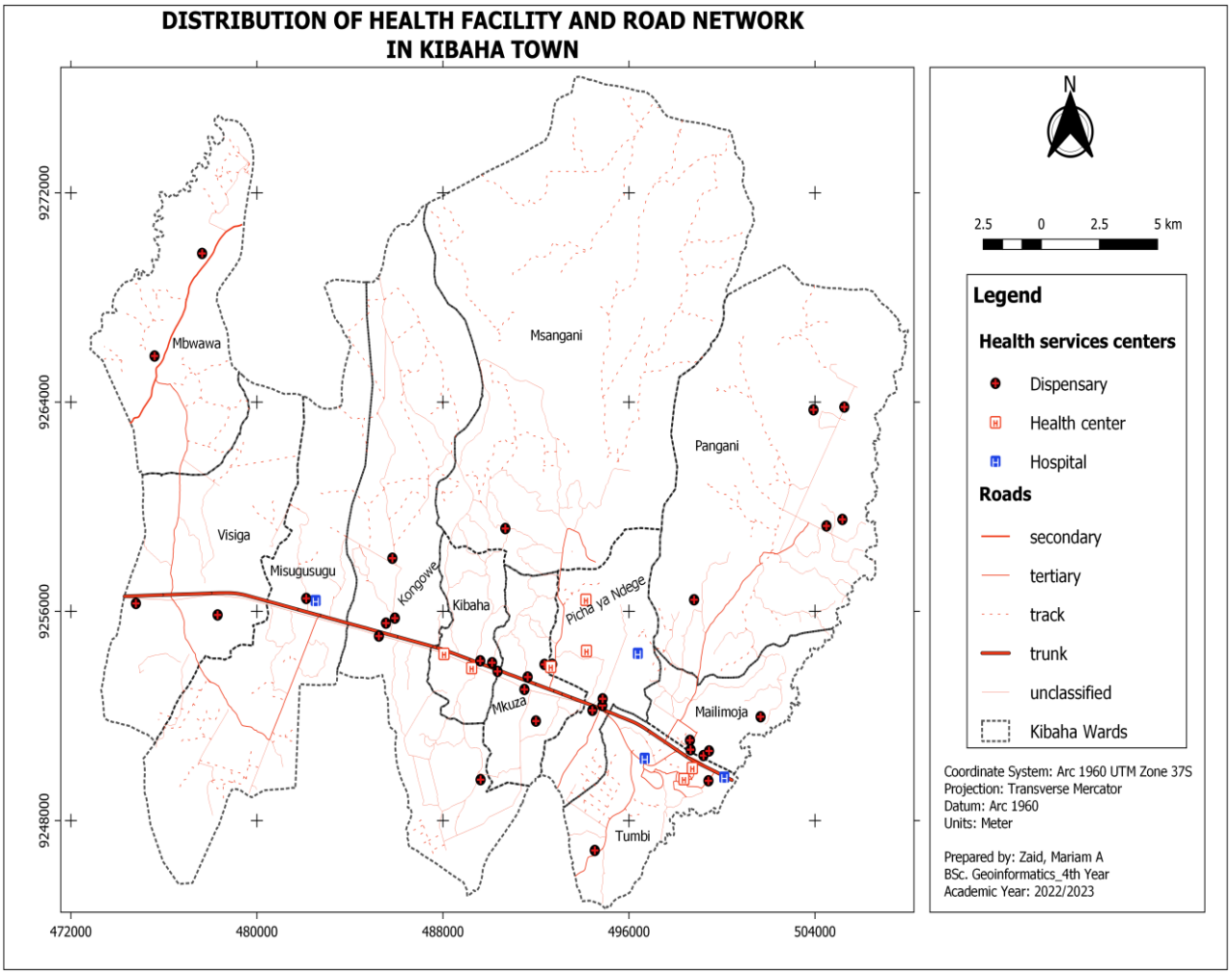


Figure 4.3: Distribution of Health Facilities and Road Networks in Kibaha Town

4.4 Proximity Map to Roads

A proximity map is created based on the criteria its recommended that health facilities should be located near roads, particularly the main road to ensure better accessibility for the surrounding population. Therefore, the distance of 200m buffer zone from the road is favorable for health facility placement. Figure 4.4 show a buffer zone of 200m from the roads.

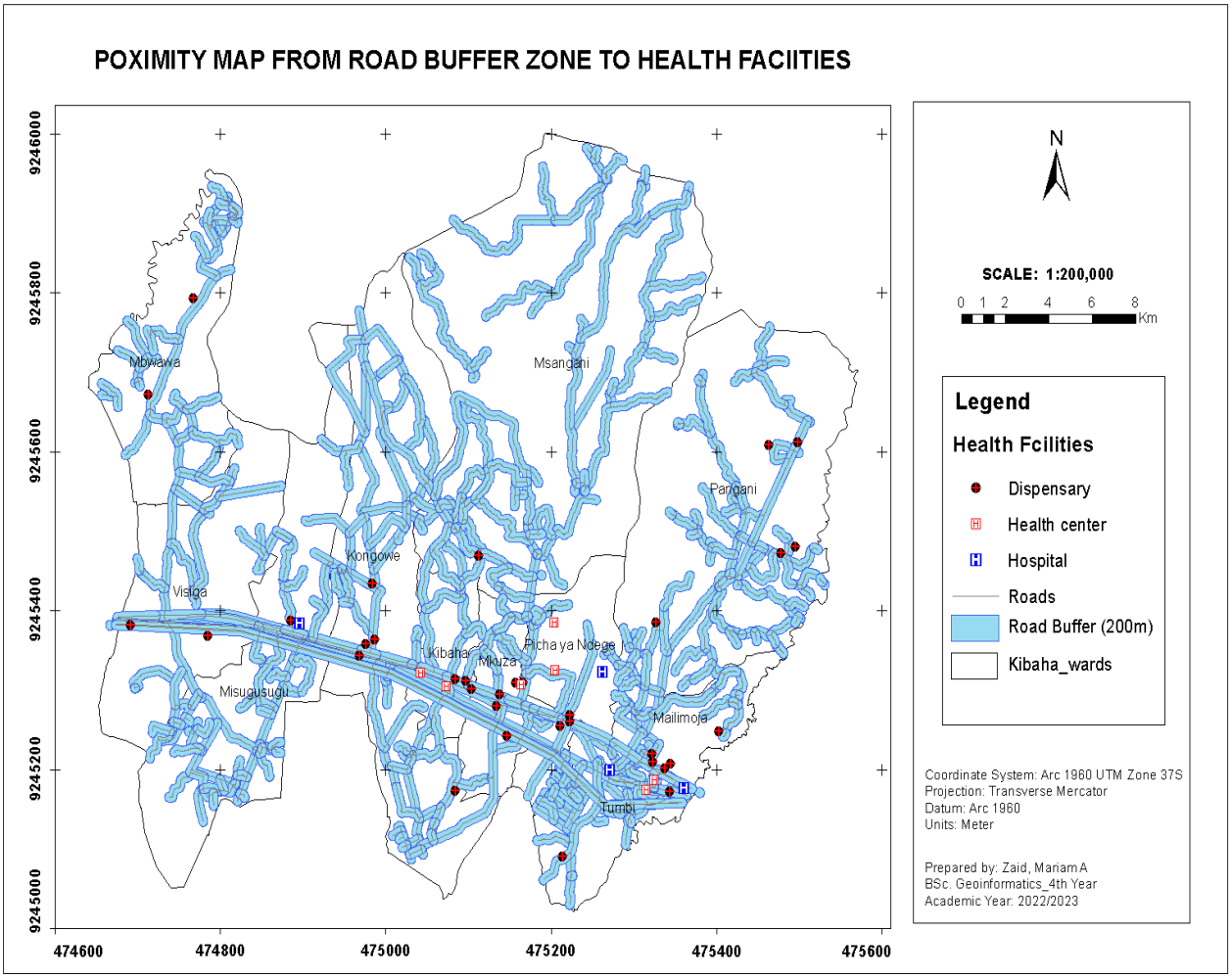


Figure 4.4 Buffer zone of 200m from roads to Health Facilities

4.5 Healthcare Service Area Based on Travel Distance

Healthcare service area analysis based on travel distance was conducted to assess the accessibility of health facilities in the studied wards. Figure 4.5 depict the services area generated at a distance of 2000m, 5000m and 10000m away from the facilities in Kibaha town. The selection of these distances was guided by the government recommendation that individuals should access to health facilities within a 5km Radius.

The analysis revealed that the service areas from studied wards generally fell within the 5km range, indicating that most residents had reasonable access to health facilities, it is noteworthy that the finding also indicated that the presence of individuals who had to travel beyond the 5km distance to access health Healthcare services.

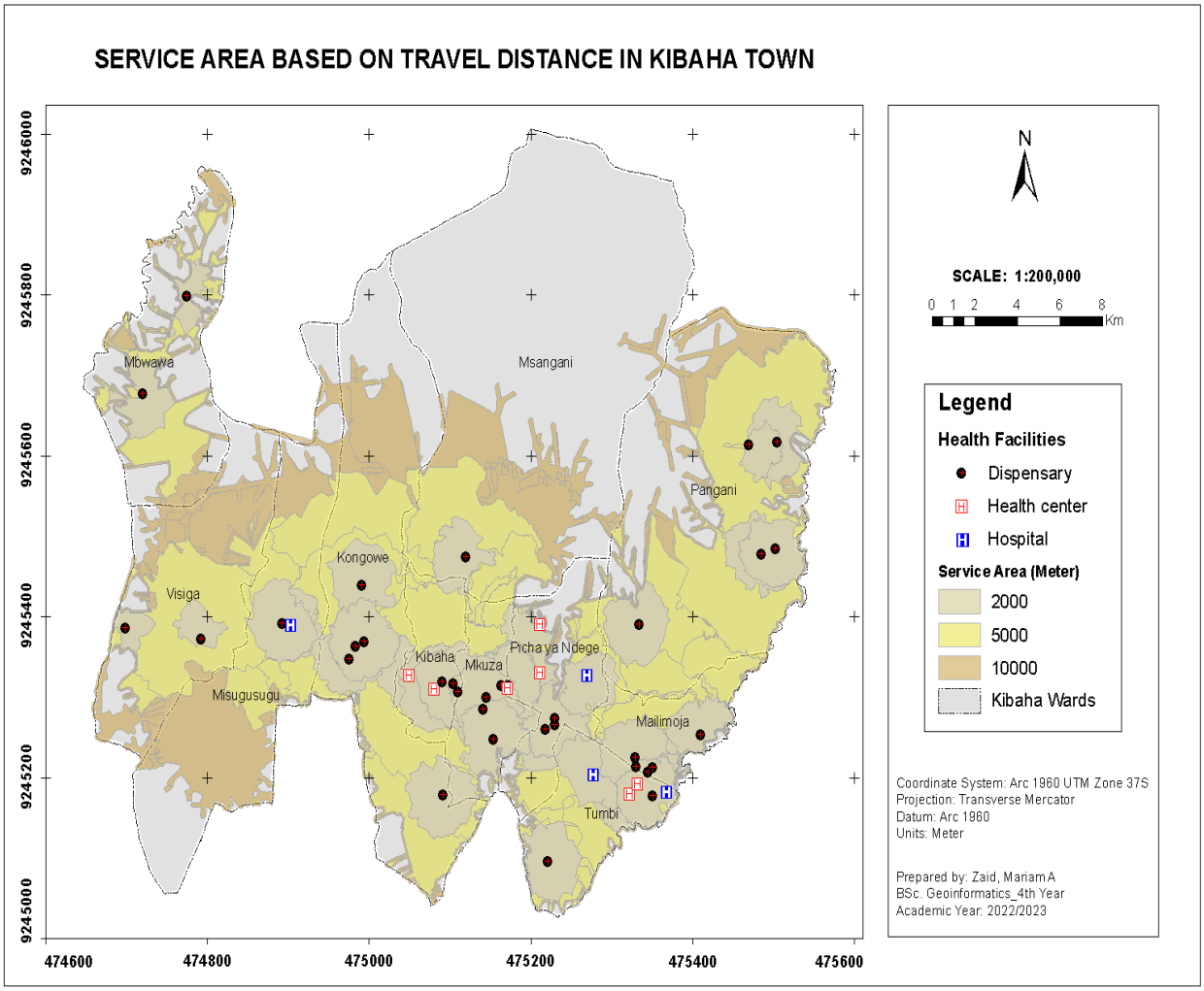


Figure:4.5 Map showing Service area based on travel distance

4.6 Distribution of Health Facility and Population Density in Kibaha Town

Figure 4. displays the map of health facilities that fall within a 5km distance for an individual to access healthcare services as well as the population density variation across Kibaha town with the higher densities in observed area. The distribution of health facilities in Kibaha town has significant negative consequences for the overall health of the population. One of the major issues arises from the fact that there are certain areas within the town with high population densities that lack any health facilities.

As a result, these densely populated areas become underserved, meaning that the healthcare needs of the residents are not adequately met. Without nearby health facilities, individuals in these areas face difficulties in accessing essential medical services, leading to a higher risk of untreated illnesses, delayed treatment, and overall poorer health outcomes.

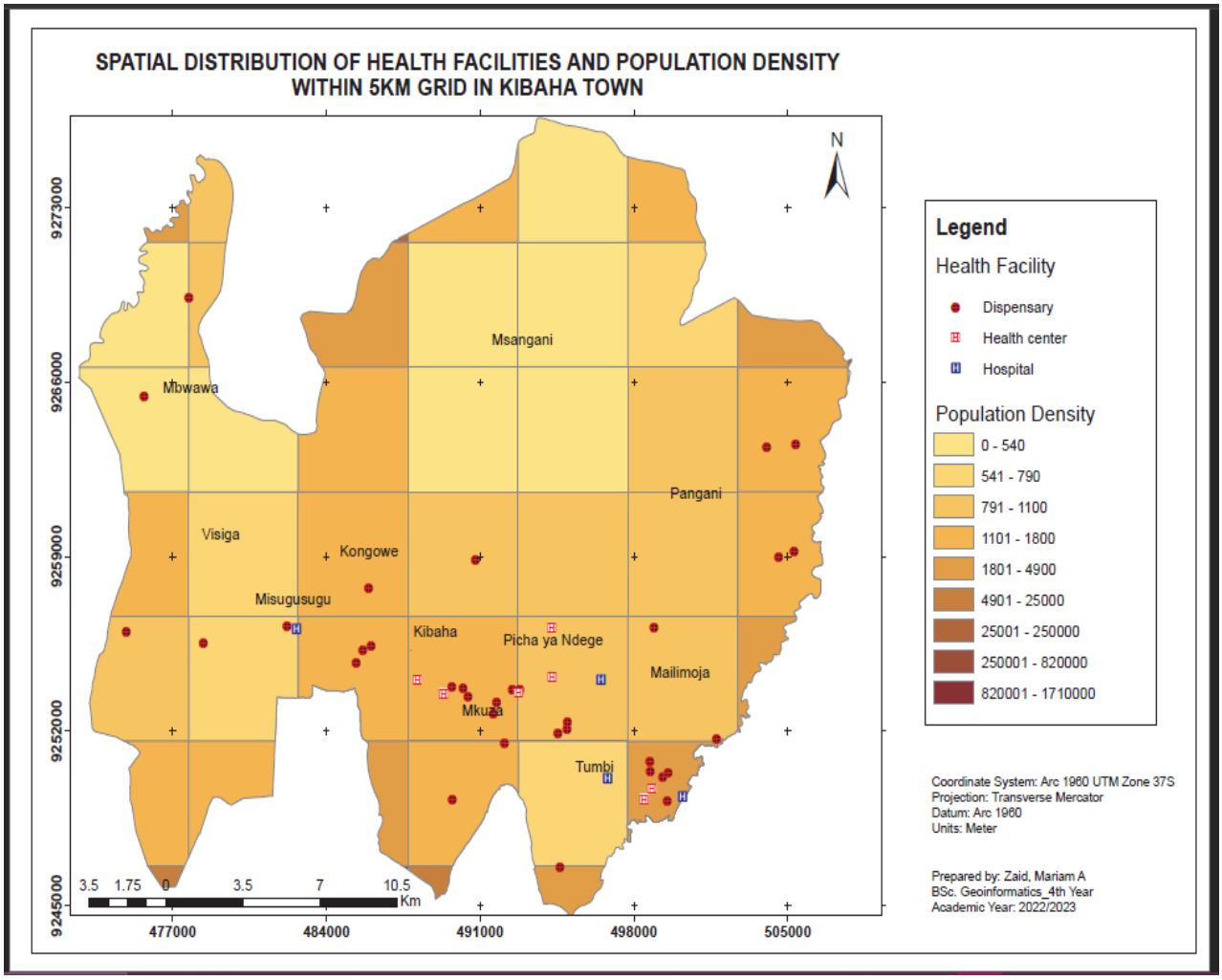


Figure 4.6 Distribution of health facility and population Density in Kibaha

In terms of distance and population density within a 5km grid, the findings of the study reveal that individuals residing in certain areas with higher population density have to travel long distances to access the nearest health facilities. The maximum distance observed was 10,352.05m and 10,226.95m, which significantly surpasses the 5km distance recommended by the government. A notable example of this disparity is the community of Msangani, where individuals have to cover extensive distances to reach the closest health centers. Table 4.1 provides a comprehensive overview of individuals who have to travel longer distances, beyond the recommended 5km, to access a health center in an area that is further from their residence.

Table 4.1: show the distance to the nearest facilities

IPUT_FID	NEAR_FID	Distance (meter)	Name of Facilities
1	30	2223.80	Miswe Dispensary
2	30	17.74	
8	30	2223.72	
9	30	0	
14	30	9517.61	
15	30	5149.23	
21	30	10226.95	
3	15	0	Mbwawa Dispensary
10	15	2027. 46	
4	32	608.23	Milaweni Dispensary
5	32	0	
6	32	4000.60	
7	13	8991.51	Misugusugu Dispensary Desire Charitable Hospital Visiga Seminary
13	13	4950.78	
11	13	418.08	
12	13	0	
22	17	7743.90	Galagaza Dispensary
23	17	2743.90	
24	17	0	
30	17	3360.50	
26	8	0	Mkuza Dispensary Viziwaziwa Dispensary
19	8	1994.30	
20	8	3317.70	
27	8	2651.40	
28	24	10352.05	Vikawe Dispensary Dama Africa Dispensary
29	24	7080.25	
35	24	8663.97	
36	24	3462.54	
37	24	1314.09	
42	24	0	
41	24	3099.69	
31		470.64	Lulanzi Hospital Bhoke dispensary Filbert Bayi Health Center Mkuza Magereza Dispensary Mpangile Dispensary Nyumbu Dispensary Mashangilio Health center
		0	
38	18	468.60	Mtakuja Dispensary Amani Dispensary
39	18	0	

CHAPTER FIVE
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

GIS plays a crucial role in analyzing the spatial distribution and accessibility of health facilities in Kibaha. This analysis serves as a valuable tool for healthcare planning and decision-making, assisting in the identification of the area where health facilities are appropriately located as well as the area that may require further attention to enhance accessibility. The study clearly indicates that uneven distribution of healthcare facilities and some of the individuals travel over long distances to access services.

5.2 Recommendation

Improvement should be made in healthcare provision by having a standardized regulation for establishing healthcare facilities. It recommended that the new health facilities must be located in underserved areas. Such as planned facilities are required to be located and distributed according to geographic distance, population size and population standards per health facility. However, having access to health facilities in the right places does not ensure that communities will receive high-quality healthcare services. Therefore, future studies should concentrate on how efficiently and effectively healthcare facilities provide high-quality healthcare services.

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