Spatial Analysis of Access to Health Services in Namibia

(Kunene and Omusati Regions)

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Declaration

I, *Maria Ndanyengwa Sigopi*, hereby declare that the work contained in the thesis entitled: "Spatial Analysis of Access to Health Services in Namibia (Kunene and Omusati Regions)" is my own original work and that I have not previously in its entirety or in part submitted it at any university or higher education institution for the award of a degree.

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List of Acronyms

DEM	Digital Elevation Model
GIS	Geographical Information System
GLM	Generalized linear model
GWR	Geographically Weighted Regression
GPS	Global Positioning System
HF	Health Facility
MLR	Ministry of Land Reform
MoHSS	Ministry of Health and Social Services
NGT	Namib Geomatics Technologies
NSA	Namibia Statistics Agency
OLS	Ordinary Leased Square
PHC	Primary Health Care
SASSCAL	Southern African Science Service Centre for Climate Change and Adaptive Land Use
SPSS	Statistical Package for the Social Sciences
TB	Tuberculosis
UNAM	University of Namibia
WHO	World Health Organization
XDR	Extensively drug-resistant

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Dedication

I would like to dedicate this thesis to my parents for encouraging me and giving me strength and hope to complete my thesis.

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Abstract

Health care accessibility is a vital component pertaining to the health of the people. As per the National Health Act of 2015, every person in Namibia is entitled to receive treatment or other medical care. Different factors influence the use of public health facilities in Namibia with accessibility being a primary factor. To comprehend geographic accessibility to public health facilities, data is required on the utilization of public health facilities and to define the public health facility catchments (buffer zones) at a regional level.

The main aim of the study was to identify barriers in accessing public health facilities by the most vulnerable inhabitants of both the Kunene and the Omusati region. This was carried out through applying GIS and other related spatial analysis methods. Secondary data obtained from the equitable project and geospatial data were used. Descriptive statistics were performed to explore the distribution of socio-demographic characteristics of the respondents. Furthermore, chi-square was performed to measure the association between certain variables. SPSS was used for descriptive and chi-square analyses, while arc-map was used for all spatial analysis. All significant conclusions were concluded at 0.05 level of significant. Results showed that 60% of the respondents reported that they always use the public health facility in their area, 11% reported that they occasionally use it whilst 23% do not used the facility in their area but make use of other facilities. A significant difference (χ^2 (4, N = 674) = 266.80, p = 0.000p-value) used between the two regions was observed in this study. Furthermore 82% of households in Kunene region were situated more than 10-kilometer from the public health facilities in comparison to 22% households in the Omusati Region. Overall barriers of access to public health facilities included distance from their home to the clinic (22%), waiting time to be helped (7%) and attitude of the health care providers (4%). The study recommends that the Ministry of Health and Social Services should consider assigning catchment areas for all health centres in the regions.

Keywords: Accessibility to public health facilities, Perceived access, GIS, catchment area, Geographical access, Network Analysis, Least cost path

Chapter 1: Introduction

1.1 Background

The Namibian government's National Health Policy Framework 2010-2020 on health states that everyone should live within a 10 km radius of a public health facility (Ministry of Health and Social Services 2010, El Obeid *et al.* 2001). This policy brings forth the issues of physical access and perceived access. The perception of the populace in terms of accessibility to a health care facility differs from measured access. A need, therefore, arises to investigate this divergence. This research attempts to explore this divergence using demographic, survey and measured data.

Access to primary health care is a vital component in the health sector, not only in Namibia but the world at large (McGrail 2012a, Black *et al.* 2004). This is because access to primary health care has contributed to a positive health status of the people (Ueberschär 2015). Moreover, primary health care is delivered to communities through hospitals, basic health units and outreach clinics (Jamtsho and Corner 2014). Patients access this primary health care for better health treatment and health care services. Primary health care service seeks to shape, maintain and improve the health of the people. However, although there are numerous public health facilities in many countries, most people are still vulnerable with regarding accessing these public health facilities. People in rural areas are the ones affected due to geographical, demographic and economic conditions (Wang 2012).

The concept of geographical accessibility also referred to as spatial or physical accessibility was discussed by Black, Ebener, Aguilar, *et al.* (2004), that it is concerned with the complex relationship between the spatial difference in population and the supply of primary health care facilities. This concept is significant not only when defining the time and the distance covered to travel to a public health facility, but also because it is seen as one of the factors that control the health status of the people (Yerramilli and Fonseca 2014, WHO 2013). The differences in geographical accessibility to primary health care services are formed from health facilities, population dispersal, and road structure (Yerramilli and Fonseca 2014).

In 1978, the World Health Organization (WHO) in the historic point of Alma-Ata statement recognized the Primary Health Care (PHC) concept of "Health for all" (Ministry of Health and Social Services 2007). Having the capacity to get good quality social insurance is a vital part of primary health care services for all. The Alma-Ata statement made essential primary health care services to encapsulate the standard of value and social equity of health for all. PHC is the first level of contact of people, the family and the community at large (Munoz and Källestal 2012). The PHC approach was received by the Ministry of Health and Social Services (MOHSS) at Independence and has been utilized to direct the rebuilding of the health sector in Namibia (Ministry of Health and Social Services 2010). The National Health Policy Framework (2010 – 2020) states that about 60% of the population lives in the northern part of the country which is where a high concentration of public health facilities has been established. The policy estimates that about 21% of Namibia's population is living more than 10 km away from a public health facility (Ministry of Health and Social Services 2010).

The primary health care approach in Namibia is guided by seven principles in the MOHSS Policy Framework. These principals are: **Equity** - which is to ensure equitable distribution of services/resources, **availability** of resources, **accessibility** and **affordability** of health and social services, **community involvement** – to ensure that the members of the community are involved in the planning and organization of quality primary health care in their regions, **sustainability**, inter-sectorial collaboration and **quality** of care (Peters *et al.* 2008, Ministry of Health and Social Services 1998). In Namibia, the earliest primary health care facilities were set up in the 1890s in Windhoek and Swakopmund to serve the German military. Before long, few facilities had been set up in the northern parts of Namibia by the Finnish missionaries. However, there has been growth in public health facilities since the country gained its independence. Before Namibia gained its independence, the majority of the people did not have access to public health facilities. El Obeid *et al.* (2001) investigated that subsequently 80% of the population in Namibia now lives inside a 10- km radius of a public health facility. This still leaves 20% or more than 300 000 individuals in remote regions, especially Omusati and Kunene, without proper access to primary health care (El Obeid *et al.* 2001a).

The effectiveness of geographical accessibility measures in urban, rural and various health areas has become easier over the past years, due to developments in the GIS field (Apparicio *et al.* 2008). GIS has been widely used to map access to primary health care and help improve the problem that comes about when accessing the facilities. Using GIS tools in primary health care studies is very important with planning and carrying out an analysis in the health sectors Ismaila and Usul (2013). These tools can be used to help identify locations, mapping service areas, identifying catchment areas within the surrounding of the public health facilities (Patel and Waters 2012). In Namibia, few studies have been done on access to geographical public health facilities. However, some authors such as (Van Rooy *et al.* 2015, El Obeid *et al.* 2001) have explored the use of GIS in health aspects. This shows that there is a fundamental need for more research on geographic access using GIS methods potentially in Namibia. Therefore, measuring accessibility must be considered especially for those regions that do not have access to public health facilities within 10 Kilometre distance. Several authors have concluded that there is a large volume of literature used when assessing Geographic Information System on primary health care accessibility (Higgs 2004, Black *et al.* 2004b, McLafferty 2003a). The authors also stated that although GIS has been utilized for many years to inspect social health care systems, the extent of GIS commitments has developed fast in the past years (Yerramilli 2014, McLafferty 2003).

Africa is identified to have the greatest disease burden and the poorest primary health care services in the world (WHO 2014). Some of these burdens have been because of inaccessible primary health care in many countries. It is against this background that this study of geographical health access in Namibia will focus on two regions; Kunene and Omusati. The study analysed and explored the spatial accessibility of public health facilities in Omusati and the Kunene region because of their geographic and population differences. Survey data on perceived access to primary health care, geographical data on measured access and qualitative data to explore the causes of divergence between perceived and measured access were used in the study.

1.2 Statement of the problem

Access can be measured as *actual* access, through directly observable dimensions like availability and costs, and as *perceived* access, through users' and potential users' self-reported and subjective experience of access (Fortney *et al.* 2011). Access to primary health care services is affected by contextual, cultural, community, health service, and individual level characteristics as well as an interaction of these (Obrist *et al.* 2007, Dixon-Woods *et al.* 2006). The suitability of GIS in improving primary health care in Africa was pointed out more than a decade ago (Tanser and Le Sueur 2002). Yet, despite the obvious inherent advantages in using GIS to map and plan access at the micro-level, the application of these methods remains low in most countries including Namibia. The importance of addressing the health needs of vulnerable groups, and challenges and needs for different categories of vulnerable people, have been recognised lately. The actual problem regarding primary health care access in Namibia is that there are limited studies that apply GIS to analyse accessibility to public health facilities. The current status of access to primary health care shows that the authors (El Obeid *et al.* 2001, Katzao *et al.* 2008) mainly concentrated on a straight-line distance measure using buffer zones. Travel time or network analyses to measure accessibility to clinics in Namibia have not yet been explored. Also, only limited statistical analysis is done on barriers that hinder access to public health facilities (Van Rooy 2018). Furthermore, for an equitable health system, there was a need to take distance and isolation into account due to the scattered and highly mobile population mostly within the Kunene region. Therefore, this study applied various spatial methodologies using GIS tools to explore the accessibility of public health facilities in Omusati and Kunene regions.

1.3 Research Aim and Objectives

The main aim of this study was to apply GIS and related spatial analysis methods that identified barriers to access public health facilities for most vulnerable people in the two study regions. Furthermore, the study identified factors that influence people when choosing public health facilities to visit.

The main research question is: How can the difference between measured accessibility and perceived access be analysed and explained? The hypothesis is that there is no spatial relationship between the local perspective and measured access to health care.

From the research question, the following objectives were derived:

1. To map health care facilities, infrastructure, and route access to these public health facilities based on different modes of transport.
2. To determine communities' perceptions to access to public health care facilities.
3. To develop and investigate models of access to primary health care facilities of the community by using Euclidean distance methods.
4. To identify causal mechanisms behind divergence of perceived access and geographical access.

1.4 Organization of the thesis

This thesis is organized to provide an understanding of the spatial differences in accessibility to public health facilities in Kunene and Omusati regions. The first chapter introduced spatial accessibility of public health facilities and presented an overview of the study and the focal objectives of this thesis. Chapter (2) highlights the literature review which provides a thorough interrogation of previous related studies. In this chapter, several articles were reviewed which provided different perspectives on health accessibility.

Chapter (3) is on the methodology used which provides the reader with an overview of steps taken to address the study objectives. The regional framework of Omusati and Kunene clinics was investigated. Different concepts were used to explore and understand methods that need to be considered for analysing the access to and the utilization of primary health care in the two regions. Further, the chapter summarizes the study design and the study area. Different approaches were tested for modelling catchment areas and carrying out analysis. The results and discussions of the questionnaire and of the different modelling methods are presented and deliberated in the chapter (4). Chapter (5) gives a review of the findings which leads to a brief conclusion and recommendation of the research.

Chapter 2: Literature Review

2.1 Introduction

This segment is based on previous research on access to primary health care. The section also reviews various GIS tools and methods used by various scholars. Moreover, this chapter reviews the theory behind perceived and measured access.

2.2 Investigating Accessibility to Health Care

All over the world, researchers have done a number of studies on access to health care in a broader view (Obrist *et al.* 2007, Guagliardo 2004, Perry and Gesler 2000). These studies concluded that there are several barriers that influence access to health care that can be grouped into spatial factors such as distance and time travel; personal factors such as age, ethnicity, lack of culturally competent care, cost of transportation, lack of transport and a high cost of care (Ueberschär 2015). These barriers contribute to a decrease in accessing primary health services further leading to an increase in mortality, unmet health needs, delays in receiving proper treatment and financial burdens.

2.2.1 Access and Spatial Accessibility

There is no agreed standard definition of access to primary health care. However, access to primary health care is broadly accepted as a key goal in meeting the health necessities of many individuals (McGrail 2012b). Access to primary health care differs across the globe and this is because access to primary health care is affected by the location of the public health facilities and where the person resides (Luo and Wang 2003). Researchers concluded that primary health care access is a very complex concept as illustrated in several of interpretations (Levesque *et al.* 2013, McGrail 2012). Also, the authors went as far to state that “It is as if everyone is writing about it (access) but no one is saying what it is” (McGrail 2012, p.1). Five dimensions of access to primary health care have been discussed by several authors; availability, accessibility, affordability, acceptability, and accommodation (Penchansky and Thomas 1981, pp. 40–127, Guagliardo 2004, p. 2, Peters *et al.* 2008, Munoz and Källestal 2012). According to Penchansky and Thomas (1981) access referred to “as a concept representing the degree of ‘fit’ between the clients and the system" (p.127). Furthermore, Peters *et al.* (2008) have summarized the five dimensions of access below as:

- *“Geographic accessibility — the physical distance or travel time from service delivery point to the user*
- *Availability — having the right type of care available to those who need it, such as hours of operation and waiting times that meet demands of those who would use care, as well as having the appropriate type of service providers and materials*
- *Financial accessibility — the relationship between the price of services (in part affected by their costs) and the willingness and ability of users to pay for those services, as well as be protected from the economic consequences of health costs*
- *Acceptability — the match between how responsive health service providers are to the social and cultural expectations of individual users and communities”* (Peters *et al.* 2008, p.162).

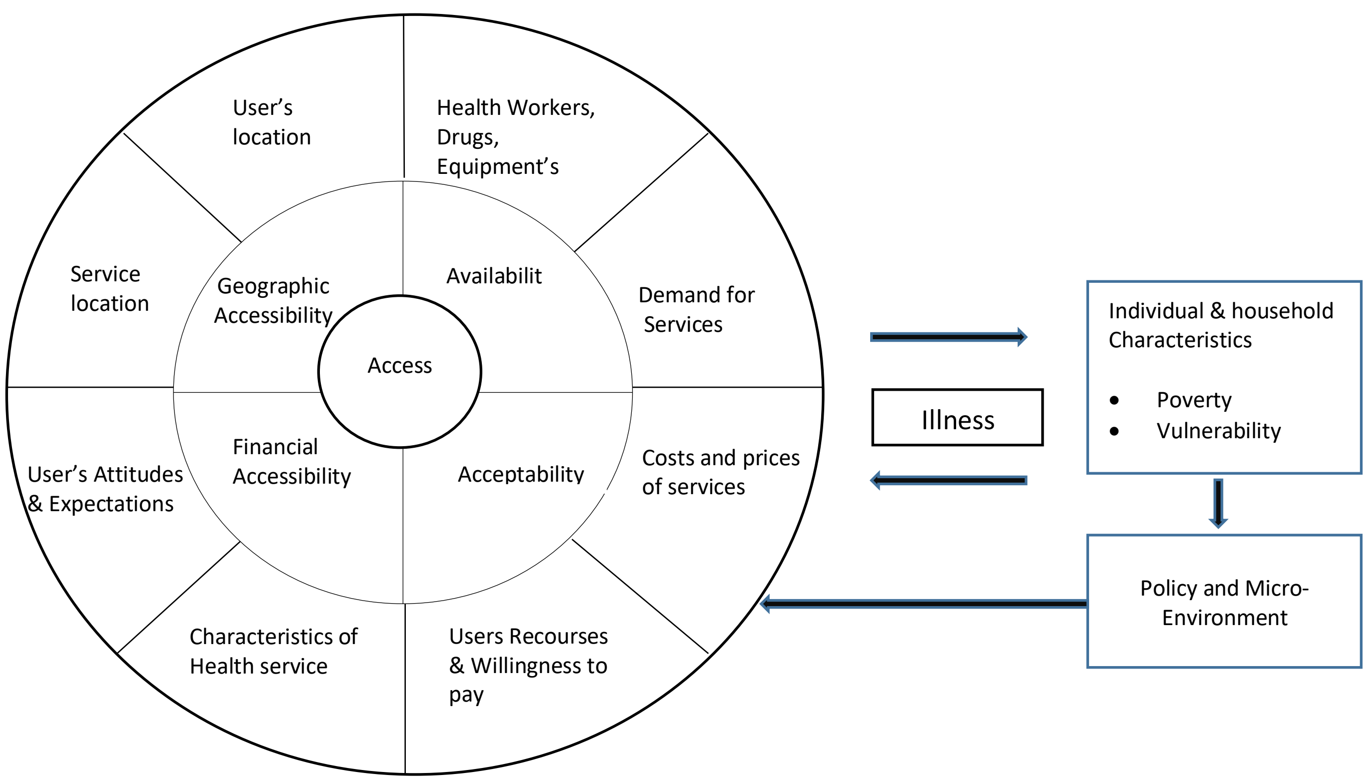


Figure 2.1: A theoretical design used for assessing access to health services

Source: Own structure derived from Peters et al. (2008).

Figure 2.1 above present four dimensions of access to primary health care services. The above conceptual framework was designed by the author with access as the focal point to represent the technicality and ability of health services. From the above four main dimensions of access in fig 2.1, two are explicitly spatial: availability refers to existing service points from which a user can choose, while accessibility refers to distance or travel time between patient location and service points (McGrail and Humphreys 2009b). Besides that, Luo and Wang (2003) referred accessibility to the relative ease by which the locations of activities, such as work, shopping, and health care can be reached from a given point of location. However, spatial access is therefore determined by the location of providers (is the distribution of providers ideal, given where people reside?) and the number of providers in an area (are their necessary providers, given the needs in the population?). Analysis of spatial access can answer these types of questions (Wang 2012). However, the dimensions allow researchers to assess access to health care from different viewpoints and give ideas on possible limitations (Ueberschär 2015). Finally, spatial accessibility underlines the importance of the spatial/distance variable as an obstacle or facilitator.

2.3 GIS as a tool for analysing and modelling health service access

GIS is a very important tool which can be used to assess the role of the primary health care needs for small areas by facilitating the spatial linking of diverse health, social, and environmental data sets. Even though the layering capabilities of GIS have been used for several years, researchers are now making use of the analytic capabilities to relate datasets that rely on non-consistent areal units in order to produce meaningful service areas (McLafferty 2003a). As information on diseases, demographics, and utilization becomes more extensively available, health data will be incorporated in GIS-based decision support tools that allow communities and decision-makers to examine questions of health care such as accessibility and availability. GIS provides a good platform when combining or displaying a variety of information on diseases and their analyses relating to population settlements, neighbouring social and health services and the natural environment at large. It is highly suitable for analysing health data, revealing trends and interrelationships that would be more difficult to learn in a tabular format. GIS can help inform proper understanding and strive for better decisions with primary health care accessibility. The GIS allows policymakers to easily visualize difficulties that contribute to existing public health facilities and therefore by implementing new strategies that can eliminate these problems (Mokhele *et al.* 2012).

2.3.1 Euclidean distances and Network Analysis measures

Euclidean distance has various definitions. Dos Anjos Luis and Cabral (2016) has conducted a study in Mozambique on Geographic accessibility to primary healthcare facilities where they described Euclidian and network distance as common techniques used to calculate accessibility to health care centres. The authors further stated that Euclidean distance defines a location in relation to a source or sources which are based on a straight-line distance. They also mentioned that the limitation of using the Euclidean distance method is that it does not consider the physical barriers and transportation routes as compared to the network travel distances. Therefore, because of these physical barriers or obstacles (water, mountains), the authors suggested that it is not sufficient to assess accessibility using Euclidean distance methods. Moreover, Jones *et al.* (2010) analysed the spatial implications associated with using Euclidean distance measures and the geographic centroid imputation in health care research. The authors' main aim was to determine the effect of using Euclidean distance versus more precise techniques. It was found that the measurement techniques (Euclidean) had a larger effect on distance values in relation to the geographic placement. The author concluded that there was a relatively small difference between the two measures.

Gutiérrez and García-Palomares (2008) assessed the overestimation of the straight-line-distance method, which is used more in coverage analysis, by linking it with that of network distance measures. It examines analytically the aspects influencing this overestimation, such as how dense the stops or stations, the coverage distance thresholds and the physical appearance of the area analysed such as road network designs, barriers, and distribution of the population in the neighbourhood. Lastly, they concluded that the network-distance method provides methodically better assessments of transportation than the Euclidean distance method. In order to minimize the limitations of the Euclidean distance method, various studies such as that by (Huerta Munoz and Källestål 2012) developed a method that implements the Euclidean distance with special consideration to terrain, land cover classes, water bodies, and many other barriers. Huerta Munoz and Källestål (2012) conducted a study to test three different scenarios the people make use of to access the nearest primary health facilities in the Western province of Rwanda. The methods resulted in scenario 1 which is based on walking and cycling to have the highest degree of geographical accessibility as compared to scenario 3 walking and public transportation. The author concluded that scenario 1 (walking) had the lowest level of accessing the health care centre.

A Network is made of "edges (lines), which characterize how entities move along a given location; junctions (points), which dictate how entities travel from line to line; and turns, which are optional elements limiting the movement at junctions between edges" (Ferguson *et al.* 2016a). Yerramilli *et al.* (2014) explained that by making use of a network analyst tool, a network-based GIS method, one can provide greater estimation on the travel time from the homestead to the health facility. This is done by utilizing the road network, health facility and the population data in each area. Yerramilli *et al*. (2014) also explained that the initial investigation of the results shows that there are limited significant gaps inaccessibility to health care service (p. 148). The travel time method was taken on by this study of which the population has a diverse level of accessing health facility using the transportation routes. Dos Anjos Luis and Cabral (2016) applied the same network-based method in Mozambique by using the Digital Elevation Model (DEM) and the road network to calculate the walking time to public health centres using the open source software QGIS (p. 4). The authors made use of health facilities locations with population, elevation and ancillary data to model accessibility to primary health care using GIS. In this case, only two scenarios of travel time (Driving and Walking) were used by the population (Dos Anjos Luis and Cabral 2016). They concluded that in

Mozambique, the majority of the people are living in the underserved areas in the walking scenario.

2.3.2 Terrain Model Analysis

By using DEM parameters, travel time is adapted to account for terrain effects and accessibility or barrier creation. (Jin *et al.* 2015) carried out a case study on spatial inequity in access to health care in Deqing County, Zhejiang China. The authors made use of DEM and network data to analyse and map the distance travelled to the nearest public health facilities. They found that about 50.3% of the people can access a county hospital within 15 minutes when driving while 55.14% can access the town hospital within 5 minutes. Moreover, 57.86% of the people living in the residential building areas can reach a village clinic within 5 minutes while 92.65 and 99.22% in about 10 to 15 minutes. The author concluded that GIS methods demonstrated to be effective given that evidence of quantitative analysis could be enhanced (Jin *et al.* 2015) for policy making.

2.4 Perceived barriers for health care accessibility

An increase in awareness among researchers shows that marginalized and vulnerable groups face various problems when accessing public health facilities. These vulnerable people are mostly found in low-income countries and in rural areas/villages (Eide *et al.* 2015).

2.4.1 Perceived barriers to health care

Goins *et al.* (2006) identified five categories of health care which included transportation difficulties and financial constraints as barriers to a health care facility. Overall, the authors concluded that rural older adults encounter various barriers to accessing needed health care. Amadhila (2012) stated that “Geographical challenges such as mountains, gullies, rivers, unpaved roads present physical barriers to accessing healthcare”. Trani *et al.* (2010) identified the cost of care, transportation, and coverage of remote areas as the main barriers when accessing public health facilities. Research conducted in Uganda showed distance as one of the factors or barrier when accessing health facilities (Kiguli *et al.* 2009). Further, Van Rooy *et al.*

(2015) investigated two types of barriers on a qualitative study that was carried out during a field survey in Namibia, these are structural and process barriers.

Structural barriers: This comprised of the geography, distance taken, transportation to health care centres, logistics and time. Van Rooy *et al.* (2015) stated that “a number of remote areas are experiencing problems to access the medical care long distances, bad roads and lack of transportations” (p. 5). The author further investigated that this problem has mostly become an issue for the older adults who have difficulties accessing public health facilities.

Process barriers: This comprised of health costs, appointments, cognitive (knowledge and communication) barriers, Language difficulties, the convenience of service, availability of medicine, confidentiality, security and staff members (Van Rooy *et al.* 2015).

2.5 A spatial analysis in primary health access: linking geographical distance, social access and access to perceptions

Bivand (2017) refers Geographically Weighted Regression (GWR) as “an exploratory technique mainly intended to indicate where non-stationary is taking place on the map that is where locally weighted regression coefficients move away from their global values”. The technique is used by authors to analyse and model accessibility to health care services (Comber *et al.* 2011, Bascuñán and Quezada 2016). GWR and Ordinary Least Square (OLS) can be used to analyse surveys on health care accessibility. Ordinary Least Square is another spatial regression method used to analyse accessibility to health care services statistically. ESRI (2009) states that OLS “performs global Ordinary Least Squares linear regression to generate predictions or to model a dependent variable in terms of its relationships to a set of explanatory variables”. Comber *et al.* (2011) combined the public perception analysis of accessibility from the survey with geographic road distance to analyse access to primary health care. The survey conducted by Comber *et al.* (2011) investigated the difficulties the respondents were experiencing when accessing medical facilities, the status of their health and car ownership.

2.6 Modelling of spatial and perceived accessibility

Spatial accessibility concept was considered in previous research and modelled to identify the need for accessing health care services. Jankowski and Brown (2014) referred to it as "the ability of an individual to 1) reach a location of health care service from a location of his/her residency within some prescribed maximum time interval, and 2) receive a medical service" (p. 40).

Several authors previously discussed frequently used models such as geographical accessibility, gravity models (catchment areas) and to investigate access to health care centres (Huerta Munoz & Källestål 2012, Wang 2012, Ueberschär 2015).

To carry out various investigations, one needs to clearly outline attributes used to carry out the results. Masoodi and Rahimzadeh (2015) used the location and name of a clinic as attributes to carry out GIS analysis on the accessibility of people to primary health care services in Iran. Also, Mansour (2016) aggregated attribute data and joined the spatial layer of district boundary to carry out spatial patterns of distance among health facilities. In addition to that, the author used the average nearest neighbour Euclidian distance, Zonal statistics and Near Analysis methods to analyse the data. Comber *et al.* (2011) Identified that minimal research was carried out on the spatial variation of factors in relation to perception against geographic factors. The author first studied how the perceptions of access to health facilities are captured by means of a survey in relation to spatial measures on health access using a generalized linear model (GLM). Secondly, the author analysed spatial variations by using a Geographically Weighted Regression (GWR) method. By using OLS and GWR method, Bascuñán and Quezada (2016) used six potentially explanatory socio-economic and transportation variables to model primary health care accessibility. They found that about 4.1% of the population have poor access to public hospitals (travel time above 30 minutes), which relate to rural areas in the south of Conception Metropolitan Are (CMA).

2.7 Hierarchy of health facilities

Health care facilities are arranged in a hierarchical manner based on the services they provide to people which starts from a lower level of clinics and community health centres, through to district hospitals, tertiary and teaching hospitals. Moreover, the location is not a factor when it comes to the health facilities as some that are closer provide service not considered for primary health care (The Structure Of Health Systems 2011).

- Hospitals: Hospitals have a wide range of units that provide intensive or non-intensive health care services.
  Intensive units: patients with dire life-threatening problems make use of this facility. Non-intensive: This includes childbirth, surgery, or step-down units for patients who have undergone intensive units.
- Clinics: Clinics are much smaller as compared to the hospitals and they operate merely on an outpatient basis. These are primary health care facilities that operate across a wide range of treatment.
- Private: these are privately owned clinics or hospitals because the costs tend to be much higher as compared to public facilities.
- New start centre: They offer specific services to patients like voluntary HIV testing and counselling.

2.8 Summary

Access to primary health care differs across the globe because it is affected by the location of the public health facilities and where the person resides (Luo and Wang 2003).

- Five dimensions of access have been discussed by several authors; availability, accessibility, affordability, acceptability, and accommodation (Penchansky and Thomas 1981, pp. 40–127, Guagliardo 2004, p. 2, Peters *et al.* 2008, Munoz and Källestal 2012).

- GIS provides a good platform when combining or displaying variety of information on diseases and their analyses relating to population settlements, neighbouring social and health services and the natural environment at large. A number of GIS models were used by other researcher pertaining to access health facilities.
- Dos Anjos and Cabral (2016) explained that using Euclidean distance method was not reliable since it does not take potential barriers on the ground into consideration as areas could be inaccessible due to topographical structures such as rivers and mountains.
- Gutiérrez and García-Palomares (2008) concluded that network-distance method provides methodically better assessments of transportation than the Euclidean distance method. Another model was network analyst tool which was used in the estimation of the travel time from the homestead to the health facility through the road network, health facility and the population data in each area.
- Dos Anjos Luis and Cabral (2016) applied a network-based method in Mozambique by using the Data Elevation Model (DEM) and the road network and concluded that majority of the people are living in the underserved areas in the walking scenario. In China, the same model was used to map accessibility to primary health care, and it was concluded that moreover, 57.86% of the people living in the residential building areas can reach a village clinic within 5 minutes while 92.65 and 99.22% in about 10 to 15 minutes.
- All in all GIS methods have demonstrated effective method given that evidence of quantitative for policy analysis by using data and methods could be enhanced (Jin *et al.* 2015).

Chapter 3: Methodology

3.1 Introduction

This section focused on the methods used to analyse access to public health facilities, in order to address the objectives of the research. A variety of methods were used in this research, these included data from survey, and data collected from other sources. Both quantitative and qualitative data have been used in this research.

3.2 The study Context

This study was part of a larger international project, the equitable project: www.sintef.no/projectweb/Equitable. It was a four-year project with researchers from Ireland, Norway, Sudan, Malawi, Namibia and South Africa, looking at access to primary health care for vulnerable groups in resource-poor settings in Africa. Four sites were selected for data collection in each country, except for Namibia which had five sites for data collection (Khomas, Hardap, Kunene, Omusati and Zambezi).

The design of the international equitable project of which this study was part of, included two components that were closely linked. The qualitative phase explored the perceptions of primary health care users (including persons with and without activity limitations) and providers concerning the facilitators and barriers to equitable and universal access to healthcare for all. The quantitative component was large scale survey that investigated the relationship between access to primary health care services and activity limitations. The Study context was adopted from (Van Rooy 2018).

3.2.1 Locality map of the study regions

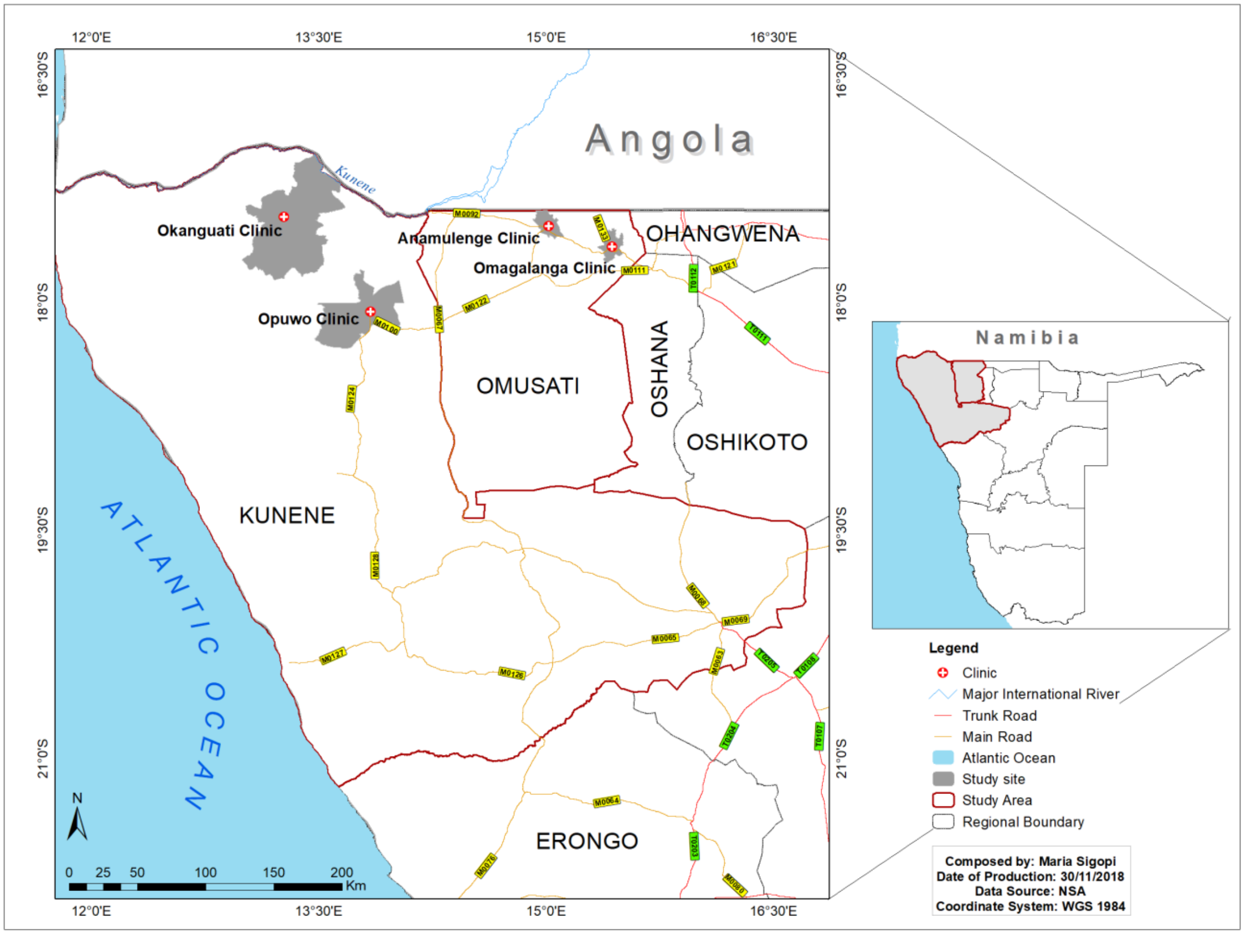


Figure 3.1: Locality map of the study regions

Figure 3.1 represents the locality map of the study area with the main study regions highlighted with red boundary. The figure also shows the four study sites represented with a grey colour on the main map. Namibia is situated in the south western part of Africa and bordered by Angola in the North, Zambia, Botswana in the East and South Africa in the South. Despite its area size of 824,290 Km2, Namibia is one of the least dense populated countries in the world of approximately 2.3 million, with a concentrated population in the northern part of the country (Namibia Statistics Agency 2012).

3.3 Study Regions

The reason for choosing these two regions was to show differences in access to primary health care, considering the following arguments. These regions have a topographical variation and a variation in vulnerability factors like poverty, and ethnic minorities mostly for Kunene region and for Omusati being one of the most populated regions in the country (Namibia Statistics Agency 2012).

3.3.1 Omusati Region

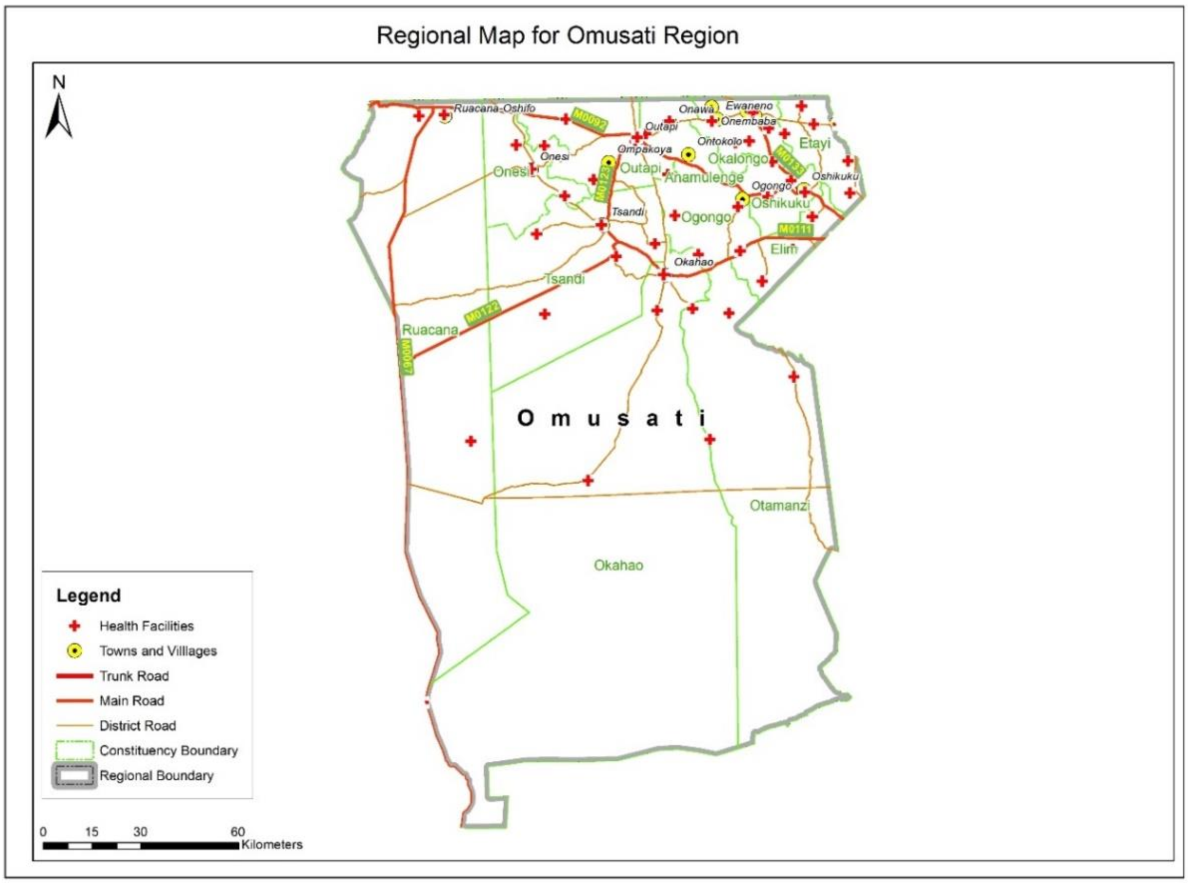


Figure 3.2: Regional map of Omusati

Omusati region is situated in the northern part of Namibia (figure 3.2), with a population of 243 166 people and a population density of 17 people per square kilometre (Namibia Statistics Agency 2012). The region was classified as the third most densely populated region in Namibia after the Khomas and Ohangwena regions, with a small surface area of 13 638 km^2 according to 2011 Population and Household Census (Namibia Statistics Agency 2012), Namibia: Regions, Cities & Urban Localities - Population Statistics 2018). It is moderately homogeneous as far as atmosphere, geology, seepage, water assets and vegetation are concerned. People in the Omusati region are mostly concentrated on the northern parts of the region as opposed to the southern-part which is sparsely populated (Namibia Statistics Agency 2012). The region has 4 main hospitals, 6 health centres and 40 Primary health care clinics, respectively. Furthermore, the region has 12 constituencies namely: Anamulenge, Elim, Etayi, Ogongo, Okahao, Okalongo, Onesi, Oshikuku, Otamanzi, Outapi, Ruacana and Tsandi (Omusati Regional Council 2010).

Selected site description:

1. *Omagalanga clinic* - The facility located 500m from the main road to Okalongo health centre. The clinic is located near cuca shops and next to an Oshana (flood plain). There are bushes and lakes between the health facility and community.
2. *Anamulenge clinic – It* is surrounded by floodplains. During the rainy season, frequently flooded especially on the main entrance side of the building. Accessing the clinic during the rainy season is difficult and dangerous as visitors must walk through water to reach the clinic. There is a tarred road from Outapi that ends +/- 150 meters from the Anamulenge clinic. The clinic is connected to a gravel road that passes through Onawa village to Okalongo town.

3.3.2 Kunene region

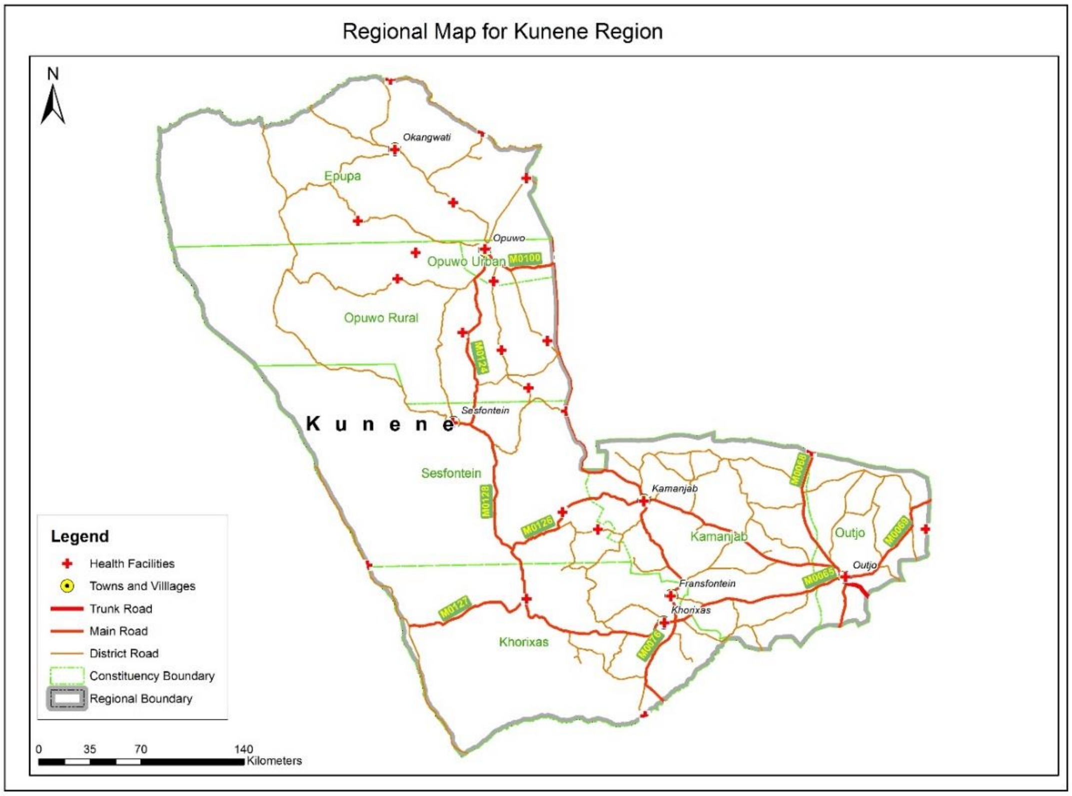


Figure 3.3: Regional map of Kunene

Also known as Kaokoland, Kunene region (Figure 3.3) is in the north-western corner of Namibia bordered to the north by Angola and to the northeast by the Omusati, Oshana and Oshikoto regions, while to the south are the Erongo and Otjozondjupa regions. The region has an estimated area size of 115293 square kilometres, and the population density is 0.8 square kilometres per person (Namibia Statistic Agency 2012). Kunene River is the only perennial river in the region. Majority of the inhabitants and their livestock depend on water in the shallow rivers, fountains and springs that are in abundant supply and boreholes that are sunk by the Department of Rural Water Supply (Van Rooy 2018). The region consists of six constituencies namely: Epupa, Opuwo, Outjo, Sesfontein, Kamanjab, and Khorixas. The town of Opuwo serves as the capital of the Kunene, and is one of the fastest growing towns in the region (Namibia Statistic Agency 2012). Most of the population live in rural areas. The region is home to 86 856 (female population 43 253, male population 43 603) inhabitants and minority ethnic groups which includes: Himba, Nama/Damara people and dhembas (Ministry of Environment and Tourism 2011, Namibia Statistics Agency 2012). The region is divided into three administrative health districts namely; Opuwo, Khorixas and Outjo. Kunene region has 3 state hospitals, 3 health centres and 24 primary health care clinics (Mashamba 2004). Kunene was chosen because it represents of a high number of ethnic minorities, topographical variation as well as variation in vulnerability factors like poverty.

Selected site description:

1 Opuwo clinic - The clinic is situated in the heart of Opuwo town serving the surrounding areas and it is connected to the main road in the town.
2 Okanguati clinic – Also located in the heart of Okanguati settlement approximately 110 km north of Opuwo in Epupa constituency. The predominant languages spoken in the area included Otjiherero and Otjizemba (the ethnic minorities), but another subgroup such as Oshiwambo was also present. Okanguati settlement have been proclaimed and targeted for urban development.

3.4 Data source, preparation and acquisition

This research was based on secondary data from geo-referenced survey data from *equitable* project (2011-2012) that was conducted in Namibia. This survey provided information on self-reported health status, vulnerability factors, health care use, and perceived barriers to access among users of health care in the study areas (Kunene and Omusati). A sampling of suitable clusters was carried out based on the knowledge of the country research teams together with the national statistical offices. The survey instruments comprising of demographic and health data and a series of questions intended to capture access to health facilities and barriers for access. A total of 674 individuals were interviewed for this study in Omusati and Kunene regions. To supplement interviews, geographical data from Namibia Statistics Agency and Ministry of Land Reform provided crucial information on physical barriers factors at the community level.

3.4.1 Data Sources

Geographical data (table 3.1) such as roads, villages, population and primary sampling units were collected from several sources. Collected data has been cleaned and checked for any possible errors and outliers. After data quality assurance, the collected data was clipped within the study areas.

Table 3.1: Data Source

Data	Type	Source of data	Use of data
Roads (tracks, major roads, district roads)	Lines	Ministry of Lands and Resettlement	Distance and Travel time mapping
Health facilities	Points	University of Namibia and Namibia Statistics Agency	For geographic health analysis
Water bodies	Lines	Ministry of Lands and Resettlement	Catchment Areas
Dwelling units (2011)	Points	Namibia Statistics Agency	Dwelling identification
Villages	Points	Ministry of Lands and Resettlement	To map catchment areas to public health facilities
Digital Elevation Model 30m	Raster file	SRTM of USGS	For terrain models, slope and aspect maps
Aerial photos of 2013	Raster Images	Ministry of Lands and Resettlement	To digitize tracks or footpaths that leads to health centres.
Survey Data	Spread sheet	Respondent	To establish perceived access
Primary sampling units	polygon	Namibia Statistics Agency	To determine the catchment area of each health facility

Source: own compilation

3.4.2 Workflow Diagram

The workflow in Figure 3.4 outlines the phases in which the research was conducted. It briefly presents what was expected to be done in each phase of the research methodology. The different themes or the main sections as displayed were as follows: Data collection, data processing and presentation phase. The secondary data was gathered from secondary sources to carry out spatial and statistical analysis and GIS modelling by using different GIS methods. The final output where presented in a form of maps, charts graphs and tables.

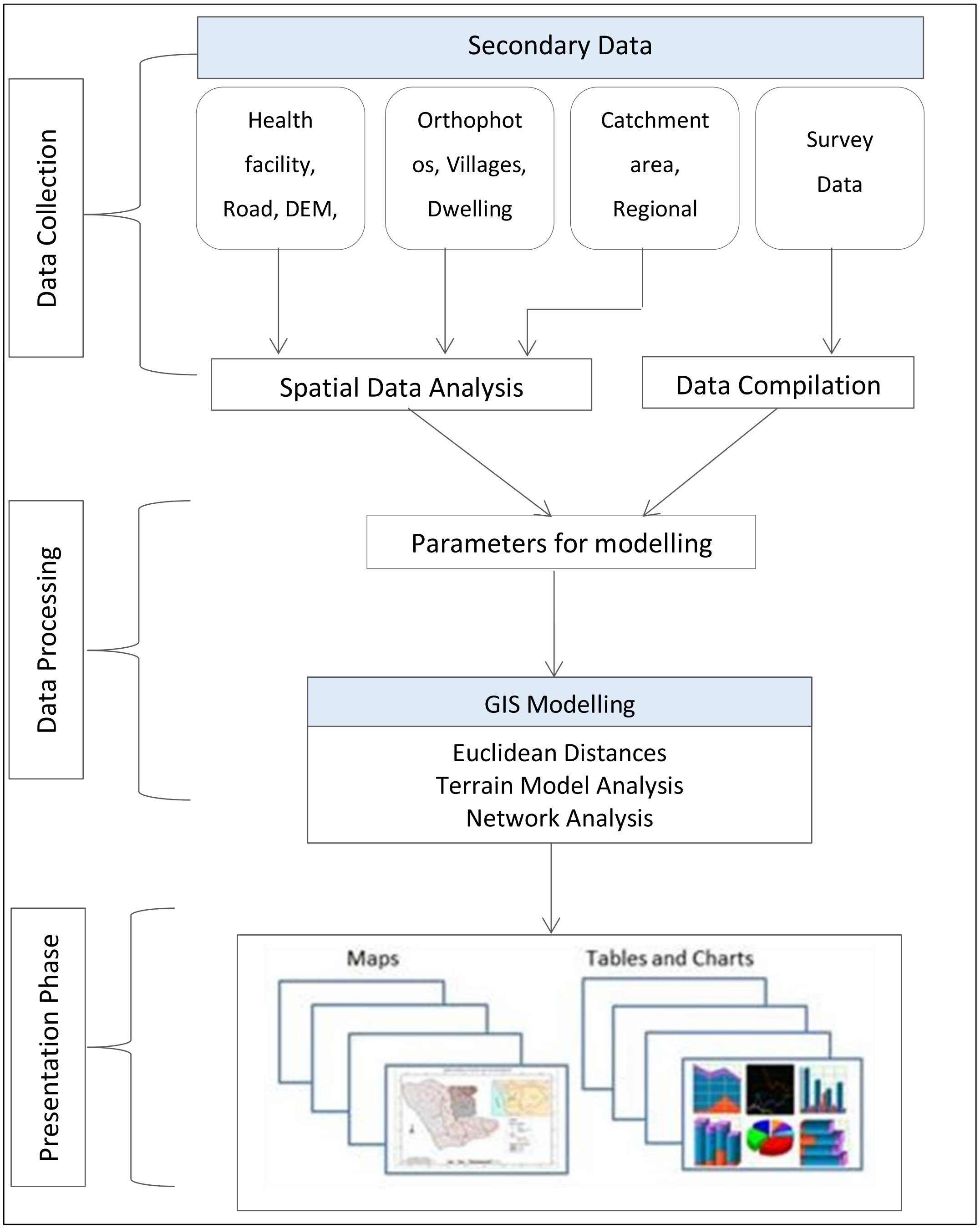


Figure 3.4: Workflow diagram *Source: own compilation*

3.5 Data Processing and Analysis

Geospatial Modelling

GIS tools such as buffer were used to generate catchment areas at a physical distance from health facilities. Overlay analysis was used as a method to explore the distance the patients take from and to a health facility. Moreover, Network analysis method was explored to measure how long (time) patients take to access health facilities.

3.5.1 Network Analysis

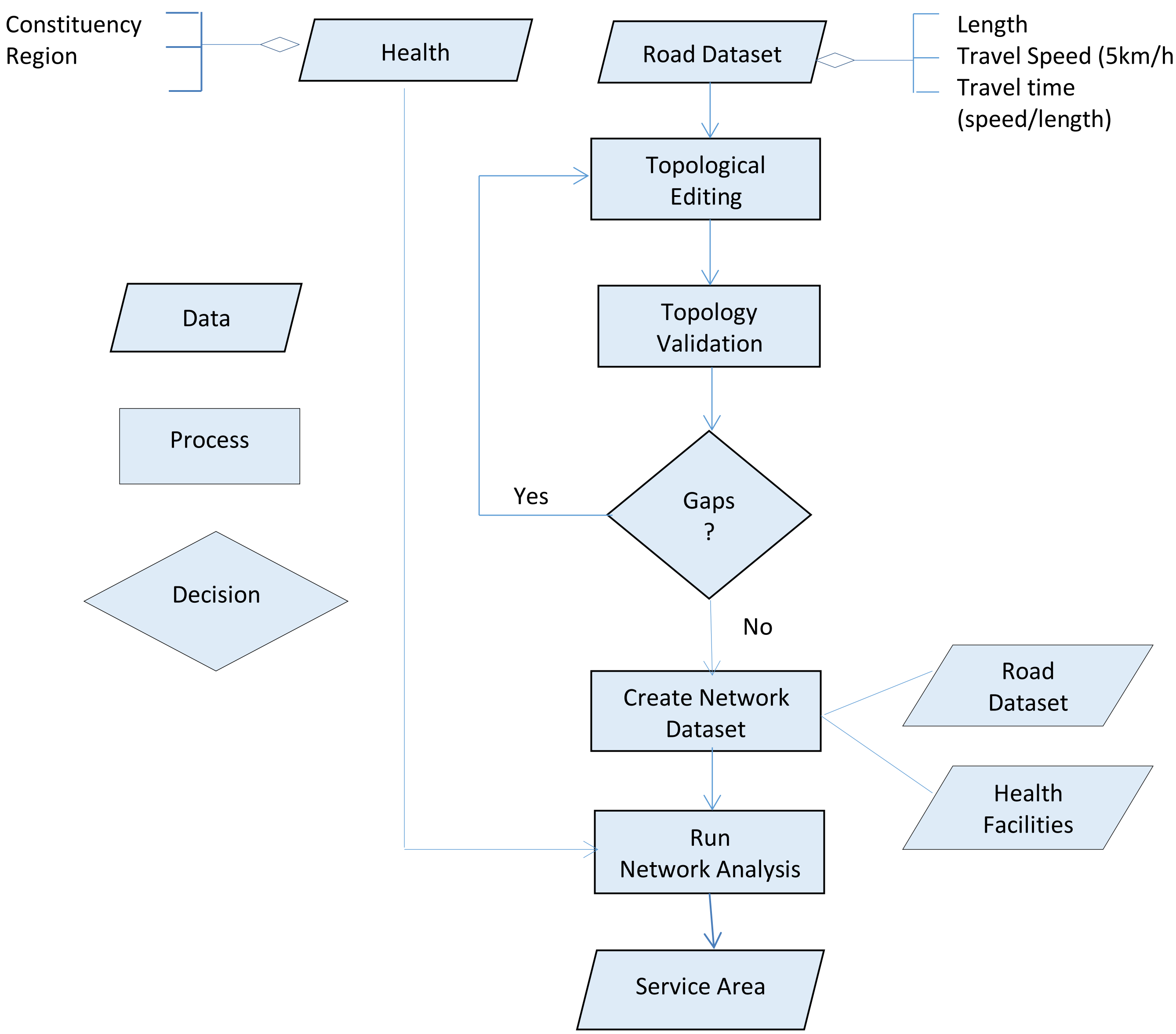


Figure 3.5: Network Analysis workflow *Source: Own compilation*

A Network Analyst extension in ArcGIS was used to create service areas for the public health facilities for both Kunene and Omusati region. According to Cullinan *et al.* (2018) "A network service area is a region that encompasses all accessible points on the network (e.g. streets) within a specified impedance. Service areas have been created to help determine the travel time to and from a health facility. After the service areas have been created, it is easier to see the time people take to travel to the clinics from their homesteads and from schools.

Figure 3.5 illustrates the steps used to create a road network based on health facility. In this case, network analysis was used to represent the transportation network from the public health facilities to dwelling units along the major roads or tracks. Ferguson *et al.* (2016) explained that Network is comprised of lines, which shows how objects move along the surroundings; junctions (points), which shows how objects travel from line to line; and turns, which are optional features that limits the movement at each junction between edges. In order to build a network dataset as presented in figure 3.5, health and road dataset were required and data had to be prepared. This is done by capturing all the road data using an Orthophoto and linking all the health data to the road dataset. Moreover, by using a field calculator, travel time was also calculated in the attribute table of each road data based on an estimated travel speed of 120km/hour when travelling on major roads and 5km/hour on foot. Appendix 2.4 shows an example of the public health facilities data that were linked to the roads dataset during data processing. While in appendix 2.1 presents an example of how the travel time by speed was calculated. Before creating a service area as indicated in appendix 2.2, a geodatabase was created to store all the data (roads) to be used when creating a new Network Dataset. Within a File geodatabase, a feature dataset was created to store all the road and health data. After all the data had been stored in the geodatabase, topology editing and validation were performed to ensure that no gaps were present between the datasets. A new network dataset was created after topology editing to store all the data that participated in the road network. All the data in the network datasets were loaded in ArcMap to perform a service area analysis using a network analyst tool. Figure 3.5 below shows the steps used to create a service area model using Model

Builder in ArcMap. The first step was to make a service area layer to accommodate all the network dataset. Secondly, the facility data that participated in the road network dataset were added to the network analysis classes and solved to obtain results.

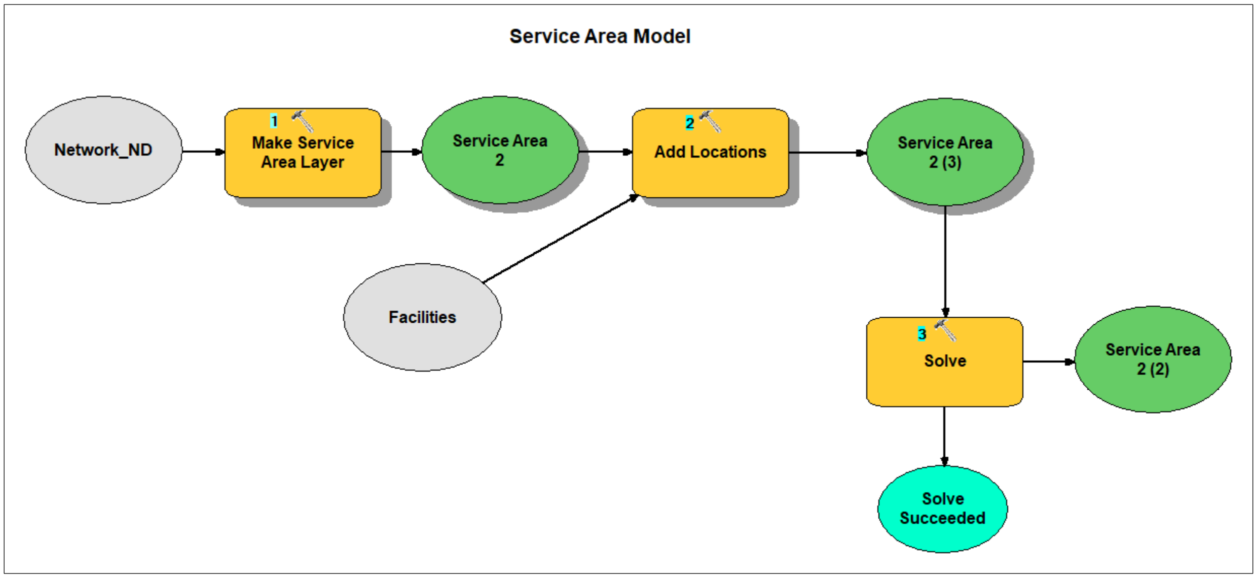


Figure 3.5: Modelling Service Area *Source: own compilation*

3.5.2 Model to measure physical accessibility to health care

Table 3.2: Travel speed estimation per Land Cover Type and motor vehicle

Land cover type	Class	Speed (km/h)
Water	1	0.06
Bare soil	2	6
Open bush	3	5
Moderate bush	4	4
Dense bush	5	3
Paths	6	5
Major roads	7	120
Tracks	8	60

Own compilation derived from Black et al. (2004)

Table 3.2 above was adopted from Black *et al*. (2004) and presents examples of travel speeds that can be used based on different land cover types. Some of the travel speed estimations such as water, open bush, moderate bush and dense bush in table 3.2 were not used to in this study. In addition to that, the author also created a formula which measures walking speed to the nearest clinic (Black *et al.* 2004, Tobler's 1993). This same formula was applied in this research to measure the walking and driving speed of people based on different land cover type.

A similar equation for calculating speed was used to calculate speed when using a motor vehicle or by foot:

Own method:

$$\boldsymbol{TTmn = \frac{L \times 60}{TS \times 1000}}$$

TTmn - traveling time (minutes)

TS - Traveling speed (Km/hour)

$\mathrm{L} = \mathrm{length}$

Black (2004) method:

$$\boldsymbol{TTmn = \frac{P \times 60}{TS \times 1000}}$$

TTmn - traveling time (minutes)

TS - Traveling speed (Km/hour)

$\mathrm{P} = \mathrm{pixel\ size\ (meters)}$

3.5.3 Geospatial Modelling of Catchment areas

Modelling of catchment areas was designed using various (clipping and buffer) tools in Arcgis. The catchment areas were determined by locating primary sampling units that intersect with the 10 km radius buffer which was the recommended distance in Namibia for a person to walk to a health facility. Potential areas were modelled based on the 5 km, 10 km, 20 km and 30 km buffer zone around each health facility. Moreover, the 20 km and the 30 km buffer zone were also used to identify and locate all the localities and dwelling units that access the same facility though not at a 10 km distance. The selected areas in figure 3.6 present a sample of the primary sampling unit that was selected based on the 10 km radius. Buffering was applied in order to model the potential accessibility around the clinics.

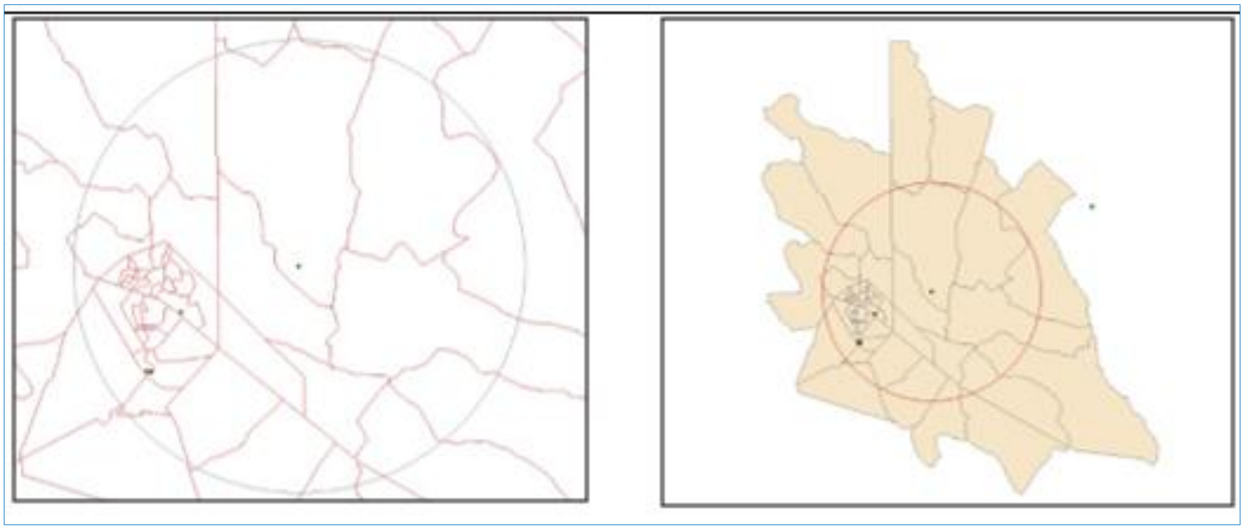


Figure 3.6: Modelling Catchment areas

3.5.4 Generating Thiessen Polygon

Apart from creating buffers around the public health facilities, Thiessen polygons assign any points in the study area to its most proximate location of the health facility. The Thiessen polygons assigned to each health facility were generated to estimate the density for each catchment area. The density was calculated as the sum of localities in each Thiessen polygon. Black *et al.* (2004) developed a model on measuring physical accessibility to health care of a clinic in Central America. Two methods were used to measure and compare the physical accessibility.

3.5.5 Modelling Cost Distance

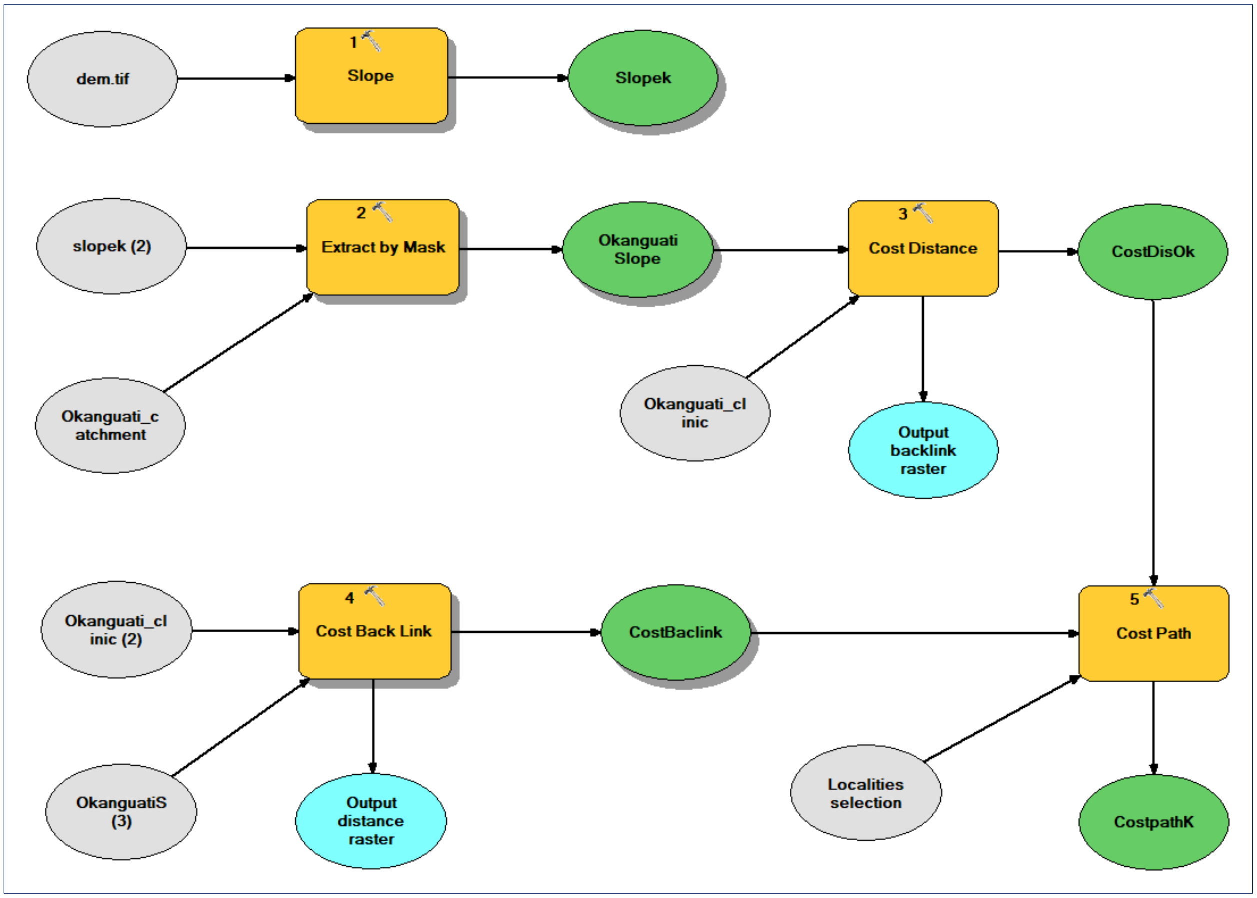
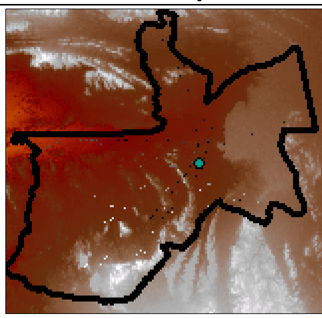
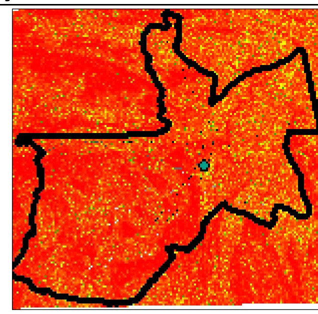
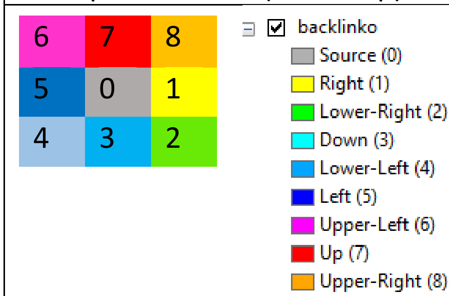


Figure 3.7: Cost Distance Model

Figure 3.7 above presents the processes used to build a cost distance model using model builder diagram in Arcgis. As indicated in fig 3.7 the DEM was used for the entire process to be executed. The Data Elevation Model was used because the slope is one of the parameters that affect travel time to a health centre. Slope map was obtained from the DEM to obtain grids resolution used to calculate cost distance. The Clinics and the catchment areas where used as a source for calculating the cost distance. The back-link in green was used to generate the cost path. The cost distance process is like the Euclidean distance. However, the cost distance measures the exertion for example in terms of the time it takes to travel to a given location like the clinics from the dwellings. The cost distance estimates the shortest distance or path from a health facility to the nearest source location. The tools were used to define cost distance measures in cost units and not in geographic units. Moreover, the precision of cost distance is based on the slope of the scene presented and the level of details depicted on a landscape (Understanding cost distance analysis 2018). Figure 3.8 below present an example of results obtained for each step taken when measuring cost distance. Moreover, the figure shows different layers of information derived from calculating path distance allocation.

<table>
<tr><th colspan="2">Differrent samples obtained from the cost path analysis</th></tr>
<tr><td>
Example of a DEM (First Step)</td><td>
Example of a Slope (Second step)</td></tr>
<tr><td>

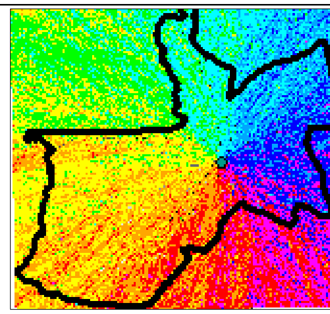
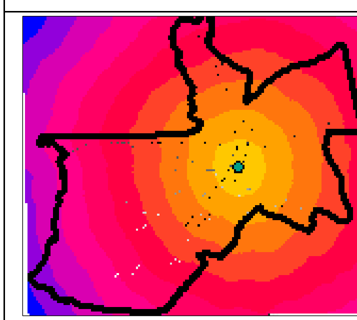
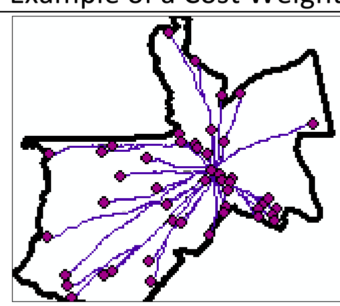
Example of Direction coding (Third step)</td><td>
Example of a Cost Weight direction (Fourth step)</td></tr>
<tr><td>
Example of a Cost Weight Distance (final step)</td><td>
Cost path allocation</td></tr>
</table>

Figure 3.8: Samples from measuring Cost Distance *source: own compilation*

3.5.6 Statistical Analysis

A database of the data obtained was cleaned to ensure that there were no duplications, typing errors or data incompleteness which could compromise the quality of data. Statistical Package for the Social Sciences (SPSS) Version 23 software was used for all the statistical analysis. Socio-demographic variables such as region and income were summarised in tables to indicate the distribution among the population. Furthermore, descriptive statistics presented data in graphs, tables, and charts. These variables (respondents in regions, languages, and ethnicity) were explored to determine how data was distributed. Furthermore, graphs and tables were used to understand the perceptions of the community members and utilisation of the public health facilities in their areas. Graphs were also used to understand barriers that prevented the utilisation of health facility services in the communities. Cross-tabulation was used to explore the relationship between socio-demographic factors and access to health facilities attributes. In conclusion, the chi-square test was performed to assess whether the association between socio-demographic factors and access to primary health facilities attributes was significant. Figure 3.9 shows the steps used to analyse the data by performing a Crosstab in SPSS.

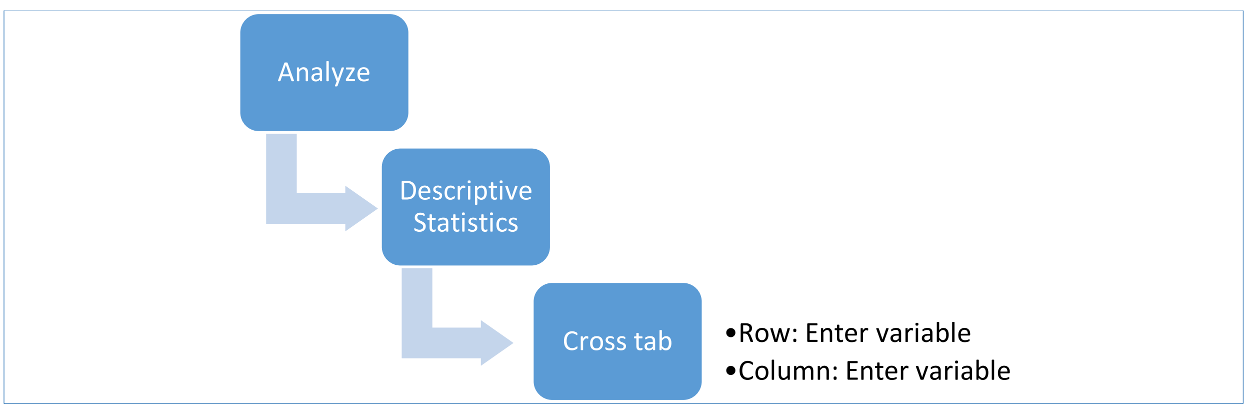


Figure 3.9: Steps when performing a Cross tabulation *source: own compilation*

Chapter 4: Results and Discussion

4.1 Introduction

The previous chapter focused on the research design and data acquisition methods used in this study. This chapter deals with the presentation, analysis and interpretation of the research findings. The purpose of the study was to identify barriers to access primary health care for most vulnerable people in the two study regions through the use of GIS and related spatial analysis methods. It further identified factors that influence people when choosing the public health facilities to visit. GIS and spatial analysis methods were used to analyse geographic primary health care factors regarding various effects such as travel time and distance taken and incorporate survey data to measure perceived access.

4.2 Descriptive statistics

The table 4.1 shows that the total number of respondents for Kunene and Omusati region was 674, with 56% of the respondents represented Kunene and 45% represent Omusati.

Table 4.1: Overall respondent's representation

	Frequency	Percentage
Kunene	374	55.5
Omusati	300	44.5
Total	**674**	**100.0**

Table 4.2 shows that there was an equal (50%) representation of the respondents in the two constituencies in the Omusati region. While for Kunene, Opuwo town had more (60%) respondents as oppose to Okanguati (40%). The analysis reported that there was a significant difference in the representation of respondents between regions and constituency which was mostly observed in the Kunene region. This can be concluded from a χ^2 (3, N = 674) = 674.0, p = 0.000p-value. This difference can not necessarily be because of bias selection but more of the situation on the ground since Opuwo was the urban centre of the region.

Table 4.2: Regions and Locality

Locality						Total
Regions		Opuwo town	Okanguati	Anamulenge	Omagalanga	
Kunene	Percentage	59.9%	40.1%	0.0%	0.0%	100.0%
Omusati	Percentage	0.0%	0.0%	50.0%	50.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	674.000[a]	3	.000

Figure 4.1 shows that the economic survival of the people in Omusati and Kunene depends mostly on substance farming/ fishing (27%), salary/wages (19%) then followed by old pension (17%) as the common source of income for these people. Furthermore, livestock (11%) and informal business are among some of the mentioned sources of income.

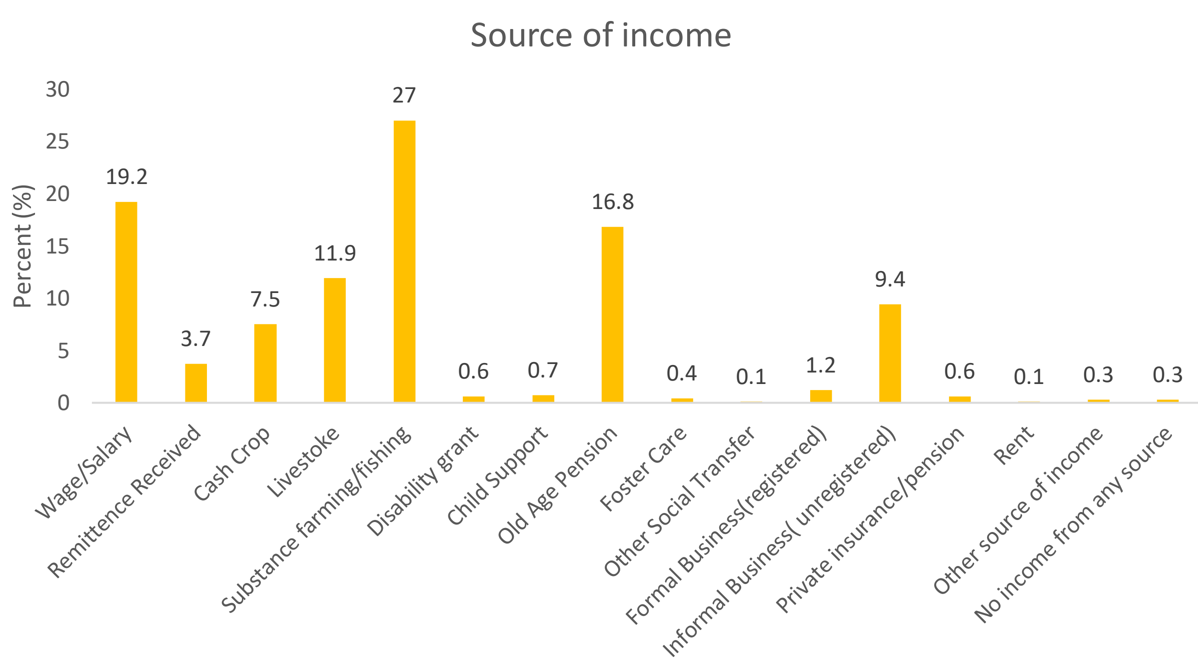


Figure 4.1: Source of income

In figure 4.2, the study explored the languages that are spoken in the two regions regardless of residence. It was revealed that in the Kunene region more than 70% of the respondents speak Otjiherero at home, followed by Oshiwambo with 17% than the rest languages represent less than 5%. On another hand in Omusati more than 90% of the respondents speak Oshiwambo, only 0.70% speaks English and the rest of the languages are not spoken in the region. Chi-square (table 4.3) (χ^2 (5, N = 674) = 460.74, p = 0.000p-value) also confirm that there was a significant difference among the languages spoken in the region as explained earlier.

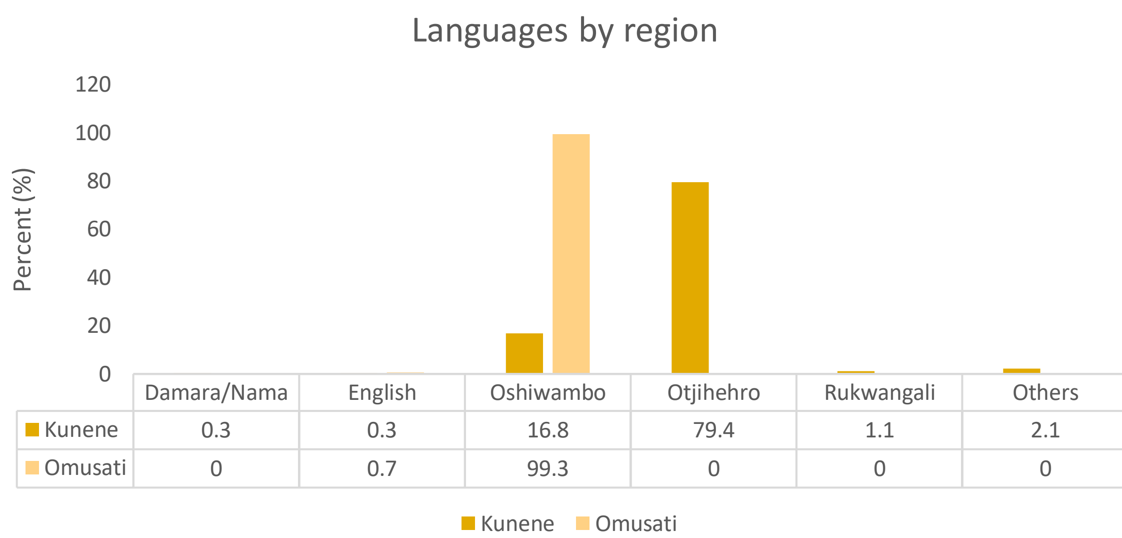


Figure 4.2: Language by regions

Table 4.3: chi-square results between region and languages spoken at home

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	460.740[a]	5	.000

4.3 Objective 1: To map health care facilities, infrastructure, and route access to these public health facilities based on different modes of transport.

Different spatial analysis including travel-time at the speed of 120 km/h and 5 km/h were used to explore route access to public health facilities based on the different mode of transport (walking and driving). Results are presented below;

4.3.1 Network analysis at the speed of 120 Km/h (driving)

Data collected from the Namibian Statistics Agency 2011 shows that there are about 17 251 dwellings in the Kunene region. About 61.45% of these houses lives within 5 minutes while the least percentage of people lives more than 60 minutes from the health centres when travelling at the speed of 120 Km/h.

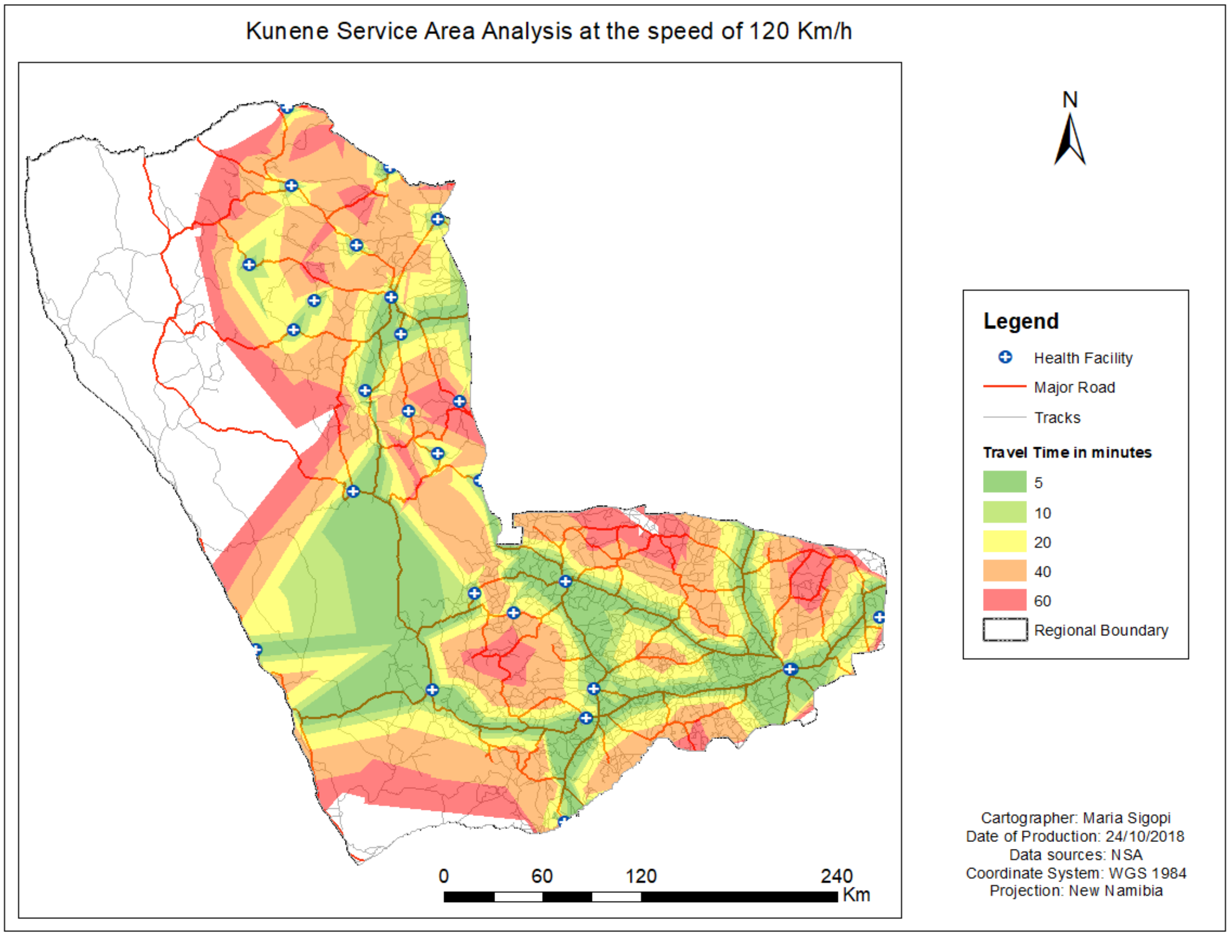


Figure 4.3: Kunene Service Area Analysis at 120 Km/h

Table 4.4: Kunene Service Area Summary at 120 Km/h

Total number of Houses/ Dwelling (17251)	% of locality/travel-time	Travel Time in minutes at the speed of 120 Km/h
239	**1.39%**	**60 +**
710	4.12%	60
2354	13.65%	40
2093	12.13%	20
1254	7.27%	10
10601	61.45%	5

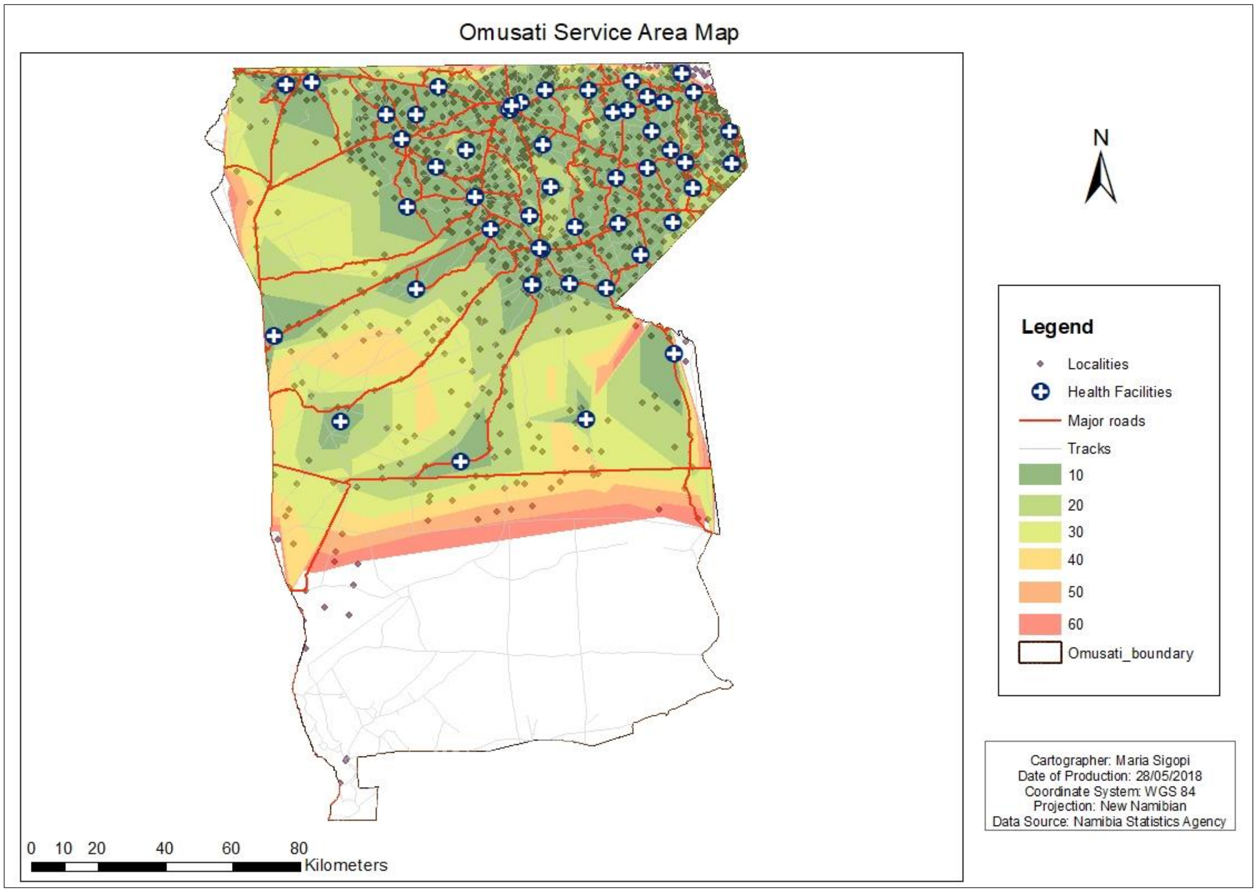


Figure 4.4: Omusati Service Area Analysis at 120 Km/h

Though the area was small, the region has a large population and over 62 252 dwelling units (Namibia Statistics Agency 2011). Omusati region has 55 clinics which were mostly accessible within 10 to 30 minutes by the patients. Clinics surrounded by the Oshana's are mostly affected by floods during rainy seasons and this increases the time people travel to get to a health facility.

4.3.2 Network Analysis at the speed of 5 Km/h (walking)

Figure 4.5 shows the travel speed of Kunene at 5 Km/h. This was designed to show the total number of the locality at 5 Km/h traveling speed by foot. Findings revealed the travelling time to access a public health facility in Kunene ranges between 5 minutes to 400 minutes, with more time to access a public health facility was observed to be dominant toward the west of the region. Table 4.5 indicated that about 29.29% of the people in Kunene travelled for about

40 minutes to access a public health facility, while 20.20% travelled for 20 minutes to access the same service. Furthermore, 8.07% travelled for 60 minutes to access a public health facility. All in all, only less than 2% of Kunene residence travels over 80 minutes to access a public health facility.

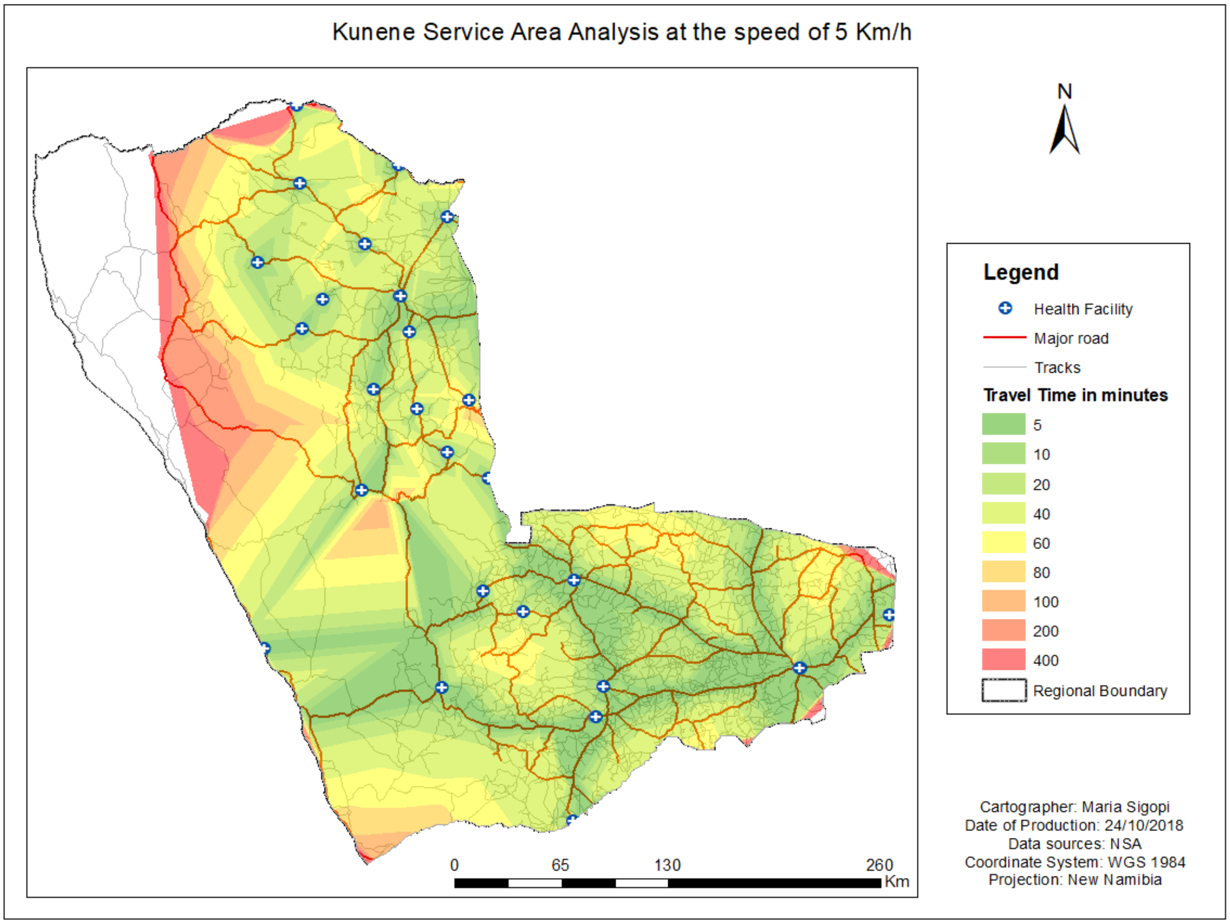


Figure 4.5: Kunene Service Area Analysis at 5 Km/h

Table 4.5: Kunene Service Area Summary at 5Km/h

Total number of Locality (1277)	% of locality/travel-time	Travel Time in minutes at the speed of 5 Km/h
13	1.02%	400 +
14	1.09%	200
9	0.70%	100
14	1.09%	80
103	8.07%	60

374	29.29%	40
258	20.20%	20
139	10.88%	10
353	27.64%	5

Figure 4.6 shows the map presenting the travel speed of Omusati at 5 Km/h. Unlike in the Kunene region, in Omusati the least time a person has to travel to access a public health facility was 10 minutes, while the longest time was 600 minutes. A general observation from the map indicated that people walk a long distance to access a public health facility. Table 4.6 showed that 30% of the people in Omusati region travelled for 200 or 400 minutes to access a public health facility, while 10% of the population travelled for 600 minutes to access a public health facility. It was also observed that less than 10% of the Omusati population travelled less than 80 minutes to access a health centre, which was the opposite observation for the Kunene region.

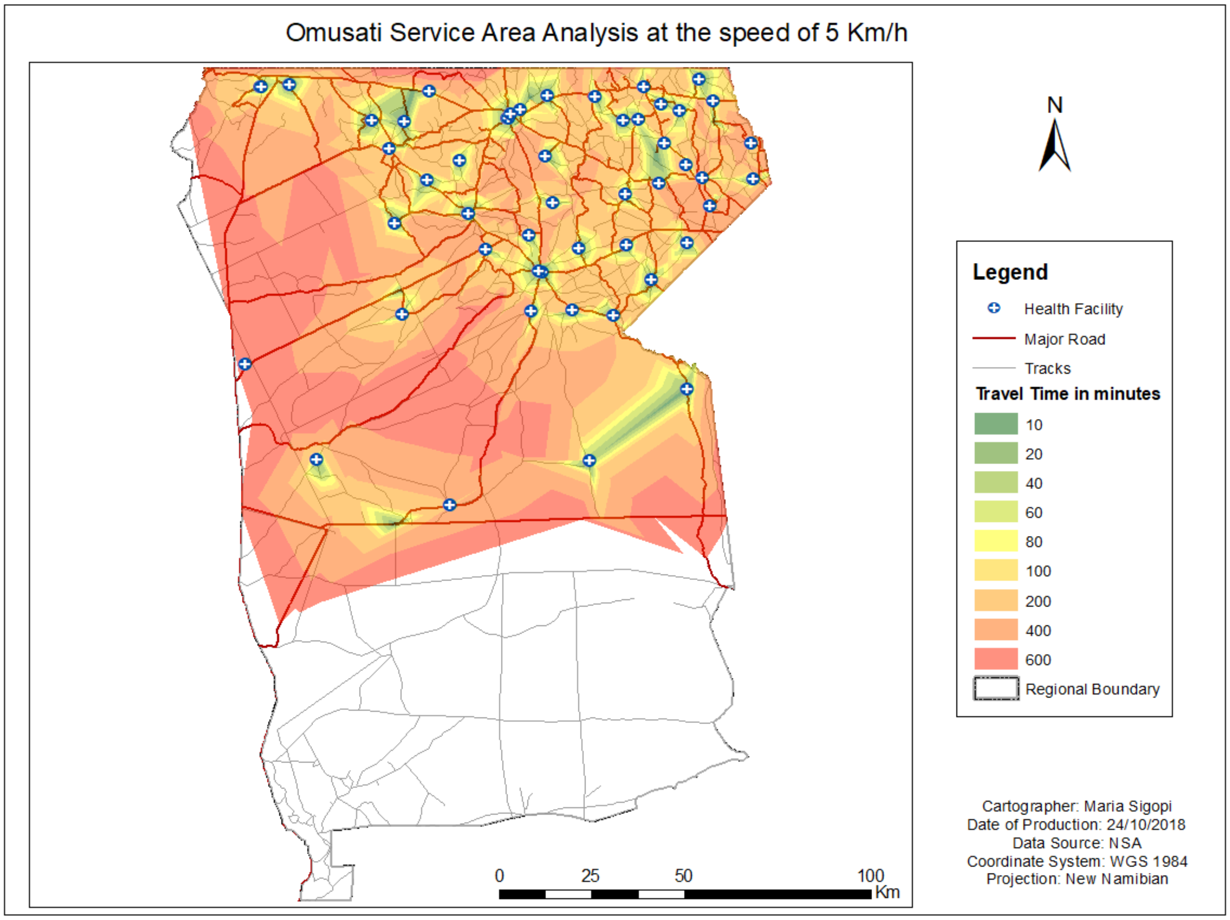


Figure 4.6: Omusati Service Area Analysis at 5 Km/h

Table 4.6: Omusati Service Area Summary at 5Km/h

Total number of Locality (853)	**% of locality/travel-time**	**Travel Time in minutes at the speed of 5 Km/h**
89	10.43%	600
253	29.66%	400
259	30.36%	200
87	10.19%	100
59	6.92%	80
51	5.98%	60
44	5.16%	40
11	1.29%	10 - 20

4.4 Objective 2: To determine communities' perceptions to access to health care facilities.

This study also aimed at understanding the perceptions of the community members about the utilisation of the public health facilities in their areas. Different views were reported by respondents and they are presented below.

In table 4.7, respondents were asked if they use the nearest public health facilities in their area. More than 60% reported that they always use the public health facility, 11% admitted that they use it sometimes while 4% reported that they use it plus other public health facilities. Also, 23% of the respondents reported that they do not use the public facility in their area but make use of other facilities. Only .30% of the respondents admitted that they never used the public facility in their area.

Table 4.7: Overall Public Health Facility Usage

	Frequency	Percentage
Yes, always	420	62.4
Yes, sometimes	76	11.3
Use both health facility plus others	25	3.7
No, but use other health care facilities	150	22.3
Never use any health care facilities	2	.3
Total	**673**	**100.0**

Narrowing down to a public health facility usage at the regional level (fig 4.7), over 80% of the respondent's in Kunene region reported that they always use the facility in their area, which is about three times as Omusati respondents agreed on. Furthermore, 16% of respondents in Kunene acknowledged that they sometimes use the public health facility in their area as oppose to only 5% of Omusati. About 49% of Omusati respondent claimed they opt to use other health facilities compared to only 1% of Kunene respondents in the same vein. It is also worth mentioning that 1% of Omusati respondents admitted that they do not use the public health facility in their area. Further analyses were done to assess if there was a difference in the usage of public health facilities between the two regions. Findings in table 4.8 concluded that there was a significant difference (χ^2 (4, N = 674) = 266.80, p = 0.000p-value) in the usage between the two regions.

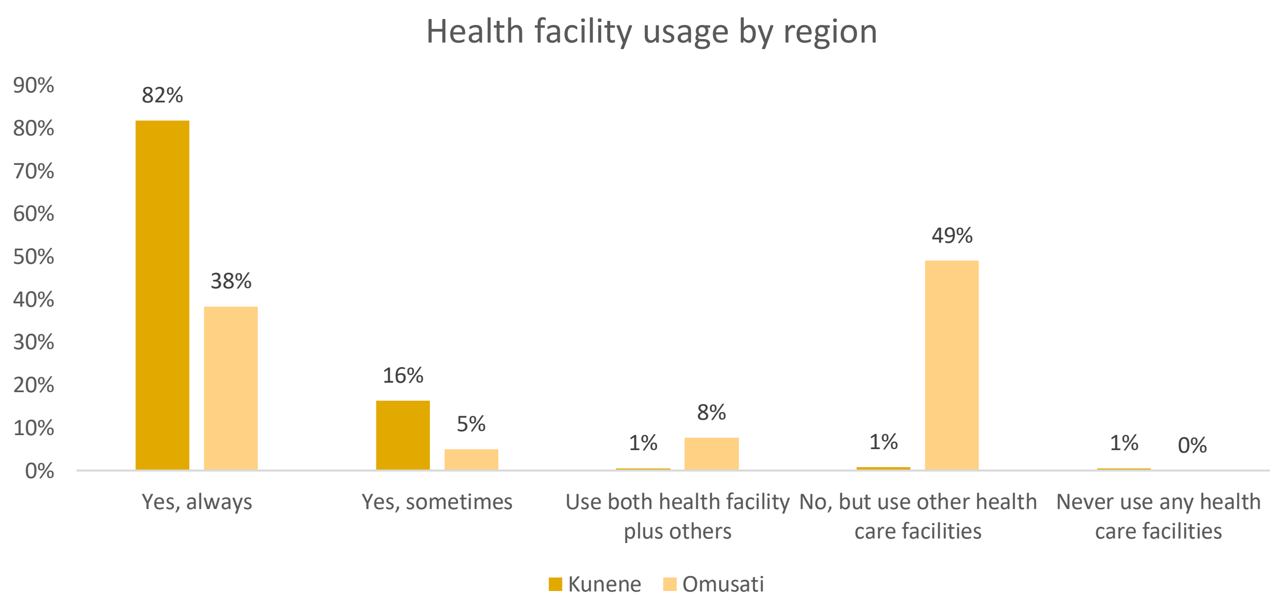


Figure 4.7: Public health facility usage by region

Table 4.8: Association between Public health facility usage and region

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	266.896[a]	4	.000

At locality level (table 4.9) similar trends of regional usage was observed in Opuwo and Okanguati, where more than 80% of the respondents acknowledged that they used a public health centre in their area. Also between 30% - 45% of the respondents in Anamulenge (45%) and Omagalanga (31%) indicated that they always used the public health centre in their areas. Additionally, 18% and 15% of Okanguati and Opuwo respondent admitted that they sometimes used the public health centre, as opposed to 9% and 1% of Anamulenge and Omagalanga respondents who respondents to the same question respectively. Like the regional difference in public health centre usage, at locality level, there was significant differences (χ^2 (12, N = 674) = 289.57, p = 0.000p-value) in public health centre preference among the respondents.

Table 4.9: Public health facility usage by locality

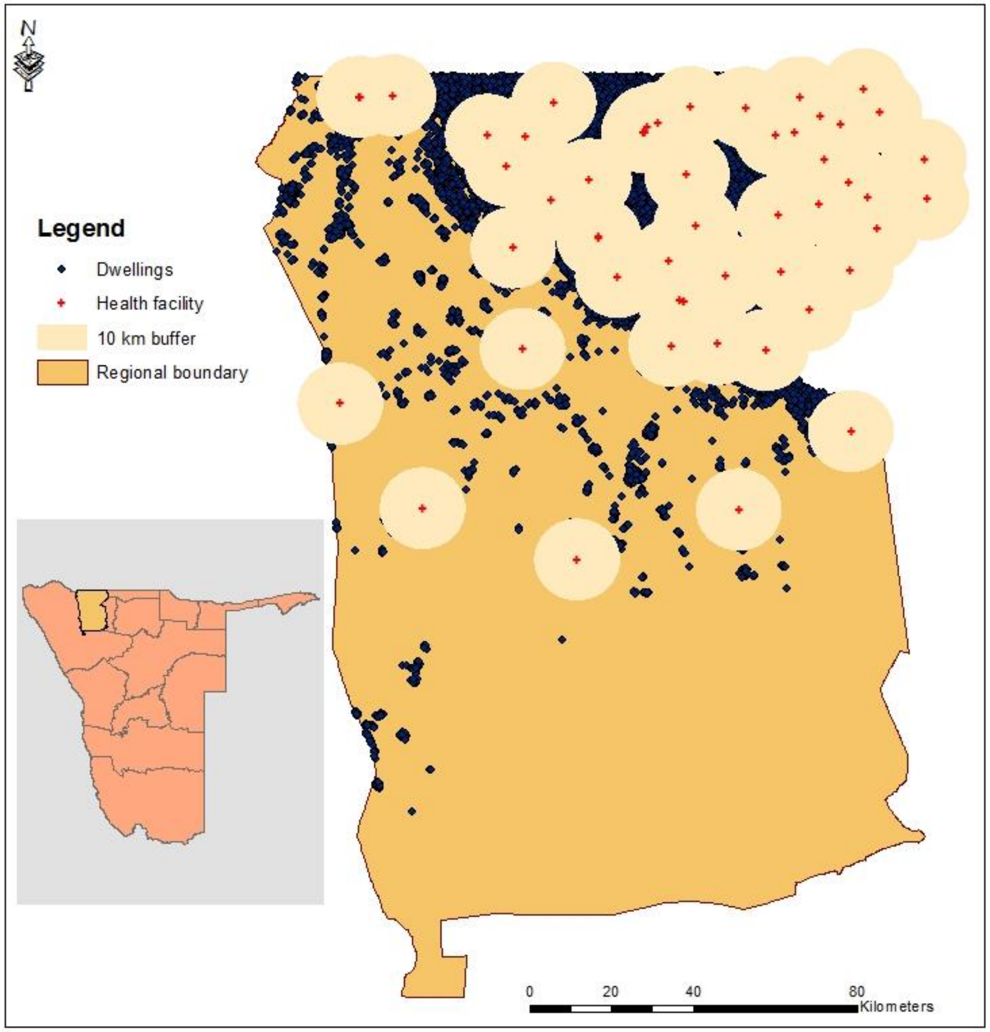
	Yes, always	Yes, sometimes	Use both health facility plus others	No, but use other health care facilities	Never use any health care facilities
Opuwo Town	82%	15%	1%	1%	1%
Okanguati	82%	18%	0%	0%	0%
Anamulenge	45%	9%	7%	39%	0%
Omagalanga	31%	1%	9%	59%	0%
Chi-Square Tests					
	Value	df	Asymp. Sig. (2-sided)		
Pearson Chi-Square	289.507[a]	12	.000		

4.5 Objective 3: To develop and investigate models of access to primary health care through Euclidean distance measure.

Euclidean measure such as buffer zones and Thiessen polygons were used to explore accessibility of public health facilities to the community in the selected regions.

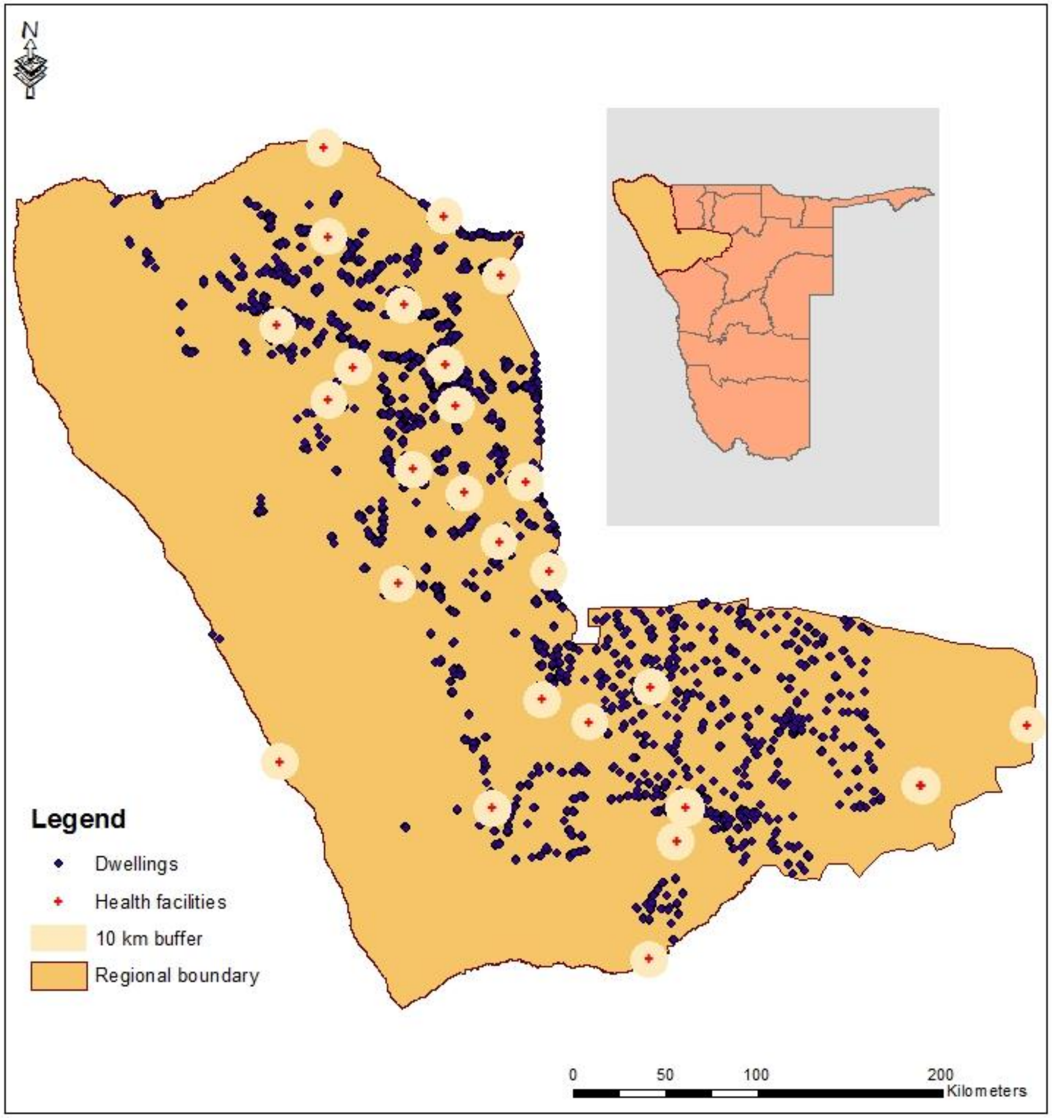
4.5.1 Modelling Service Area

4.5.1.1 Overall Euclidean distance measure



1	Total Population	243 166
2	Houses within 10 km buffer	55 294
3	Percentage of houses within 10 km buffer	88.8 %
4	Number of houses outside 10 km buffer	6 958
5	Locality within 10 Km	661
6	Percentage of villages within 10 km	77.5 %
7	Locality more than 10 Kilometres away from nearest HF	192
8	Percentage of Locality more than 10 km away from nearest HF	22.5 %
9	Total number of households	62252
10	Total number of Locality	853

Figure 4.8: Access to public health facilities in Omusati region *Source: Own Compilation from NSA 2011 Data*



1	Total Population	86 856
2	Houses within 10 km buffer	9747
3	Percentage of houses within 10 km buffer	56.5 %
4	Number of houses outside 10 km buffer	7 504
5	Localities within 10 Km	221
6	Percentage of Localities within 10 km	17.3 %
7	Localities more than 10 Kilometres away from nearest HF	1 056
8	Percentage of Localities more than 10 km away from nearest HF	82.6 %
9	Total number of households	17251
10	Total number of localities	1277

Figure 4.9: Access to public health facilities in Kunene region *Source: Own compilation*

The main purpose of this analysis was to identify households that are not within the 10-kilometre buffer zone. A 10-kilometre buffer zones around all the public health facilities were overlaid on the map of all dwelling units in the regions (figure 4.8 and 4.9). It was assumed that people who live further than 10 kilometres from a public health facility had difficulties accessing the health centres. Results indicated that approximately 6 958 of the mapped houses in Omusati region were situated over 10-kilometer from the public health facilities, compared to 55294 (89%) that were located within 10 km radius. It was further discovered that 78% of the locality in Omusati were located within 10 km radius, while more than 23% of the localities were located more than 10 km away from the nearest public health facility. A different picture was shown in the Kunene region were 7504 households lived outside 10 km radius in comparison to 9747 (57%) which lived within 10 km radius. Additionally, 17% of localities in Kunene were located within 10 km radius, while 83% were located outside 10 km radius.

4.5.1.2 Site level Euclidean Measure

The results above were narrowed down from the regional level to site level, to measure public health centres within the recommended distance of 10 km in the two regions. Figure 4.10 below shows homesteads are within 10 km buffer from the health facility.

Anamulenge area in Omusati region has several homesteads that are not within the 10 km zone of the public health facilities that is assumed to be the reasonable access to primary health facilities. As indicated in figure 4.10, people travel more than 10 km to reach the public health facility. As compared to the other regions, Anamulenge clinic covers a large number of people that access the health facility. However, within the 5 and 10 km buffer zone, there are alternative clinics such as Outapi and Onawa clinic which can accommodate a large number of patients. With a large number of about 4877 dwellings in the 10 km buffer zone, the other 2 clinics can accommodate these people. From the analysis presented in table 4.10, approximately 4877 of the mapped houses were situated within 10 kilometres from the public clinic.

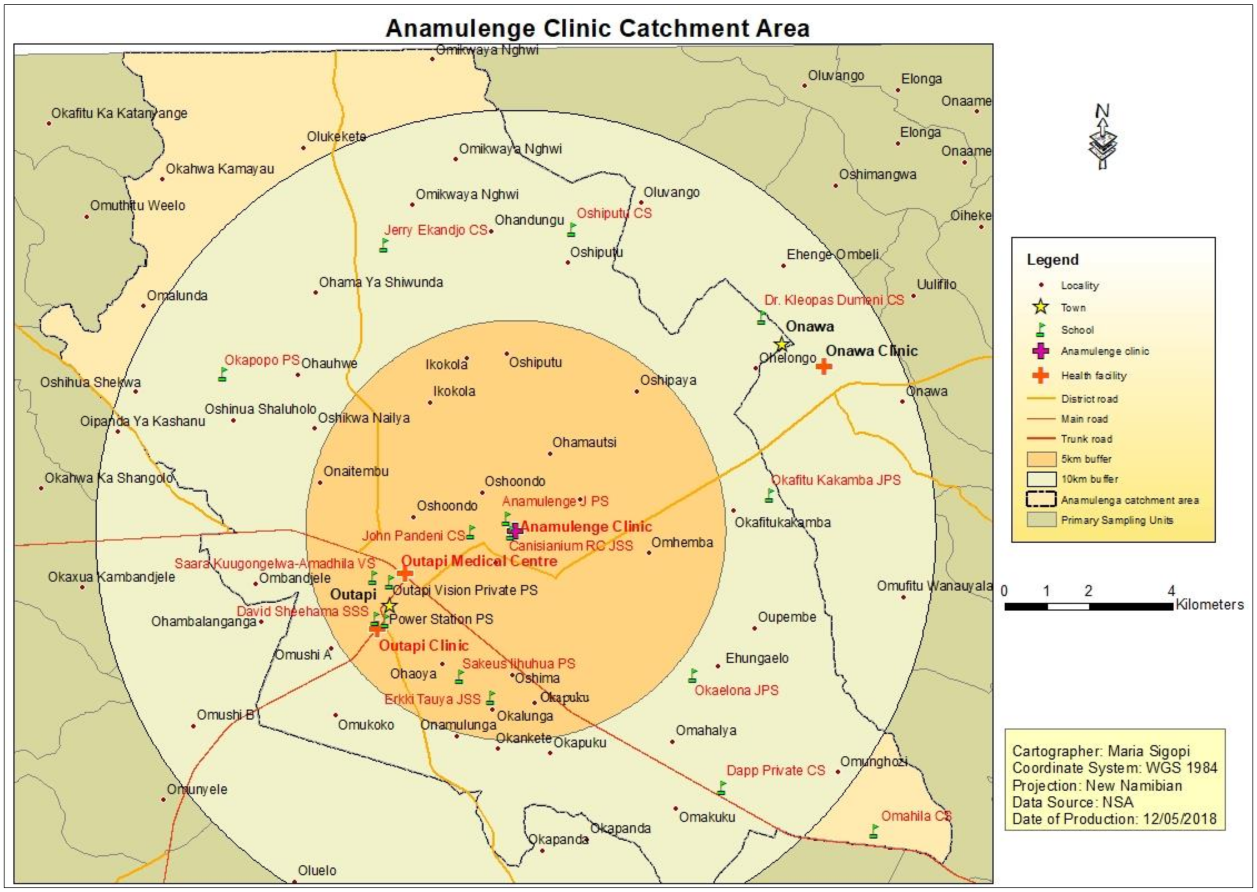


Figure 4.10: Anamulenge Clinic Catchment area

Table 4.10: Anamulenge Catchment area measures

Services Provided	Total number of Services provided in the region	5km Buffer	% of Services within 5Km Buffer	10 km Buffer	% of Services within 10 km Buffer
Localities	852	16	1.88%	48	5.63%
Schools	277	9	3.25%	20	7.22%
Dwellings	62252	2851	4.48%	4877	7.83%

Figure 4.11 illustrates the location of clinics in relation to households in Omagalanga area. Omagalanga clinic in Omusati region was also surrounded by other clinics within the 10 km buffer zone. The north-eastern part of Omagalanga clinic was surrounded by many villages that were not within the 10 km buffer zone, yet these people travel to the clinic to seek health care assistance. However, some of these people take up to 3 hours to access the clinic. Pensioners in this community will take them about 3 hours to access the clinic when on foot (Van Rooy *et al.*

2015). Table 4.11 showed that a total number of 3131 dwellings were located within the 10 km buffer zone, that implied that they had access to health care. Furthermore, of 62252 of the mapped houses in Omusati region, 1172 of them are situated within the 5-kilometre buffer zone.

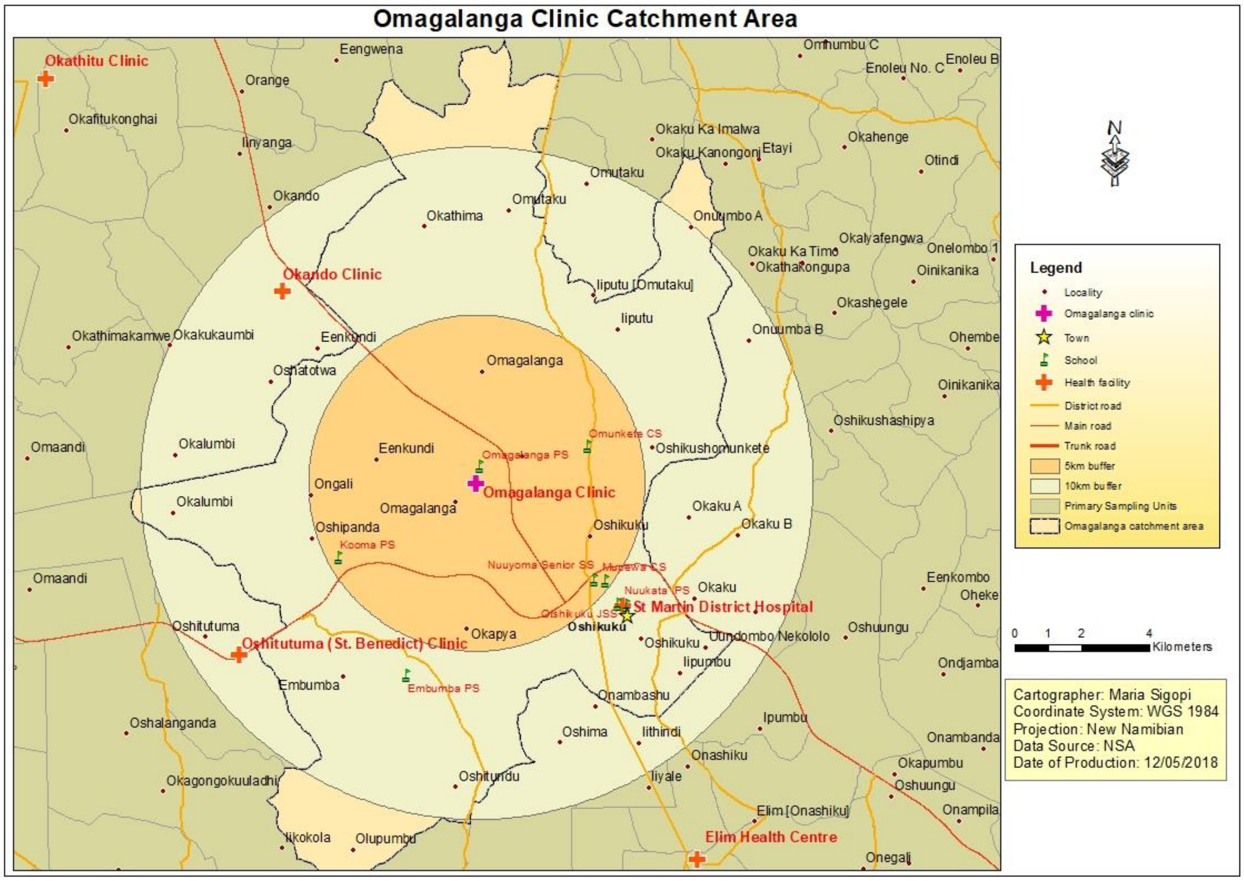


Figure 4.11: Omagalanga Clinic Catchment Area

Table 4.11: Omagalanga Clinic Measures

Services Provided	Total number of Services provided in Omusati region	5km Buffer	% of Services within 5Km Buffer	10 km Buffer	% of Services within 10 km Buffer
Localities	852	7	0.82%	34	3.99%
Schools	277	5	1.81%	14	5.05%
Dwellings	62252	1172	1.88%	3131	5.03%

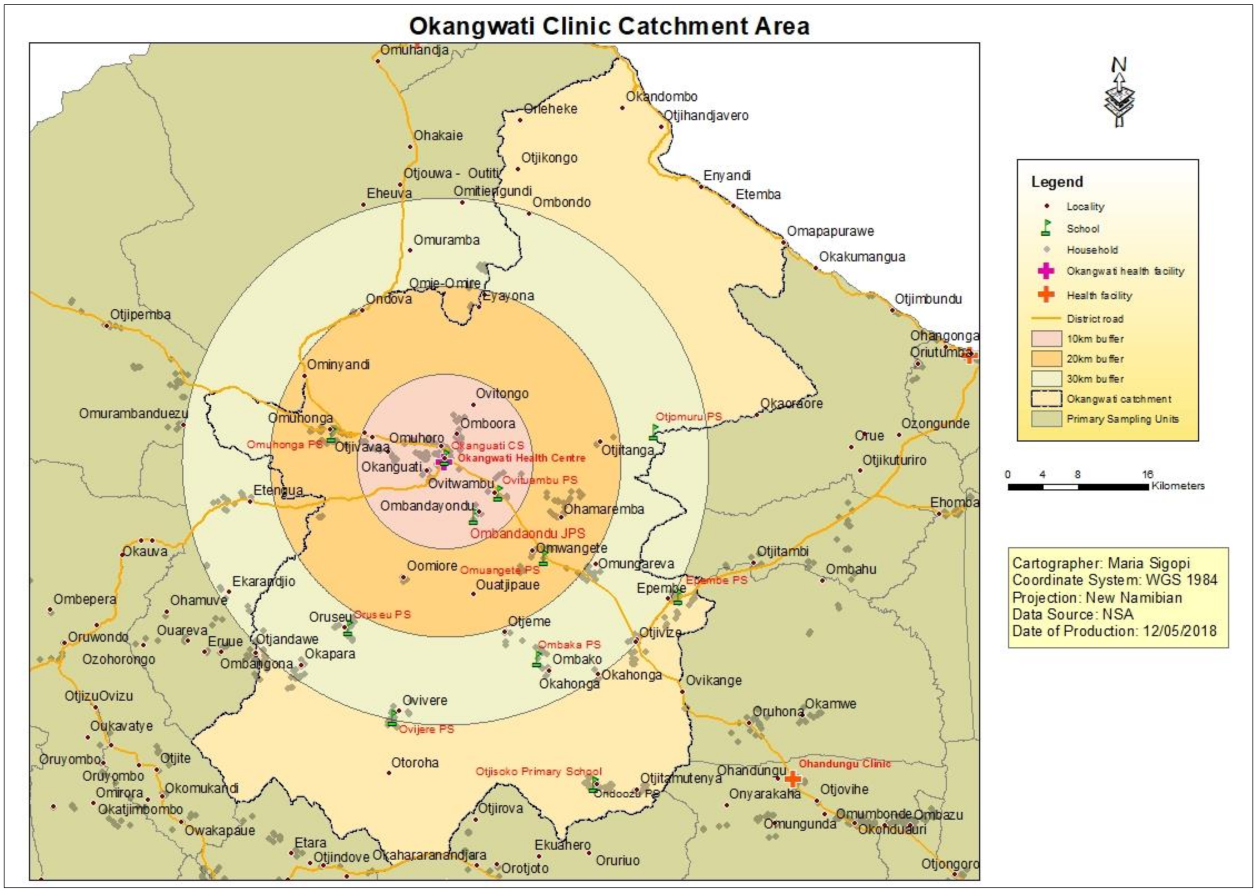


Figure 4.12: Okanguati Clinic Catchment Area *own compilation derive from Van Rooy (2018)*

Okanguati clinic as presented in figure 4.12 covers quite a large catchment area compared to the other clinics because there was no other alternative health facility closer to it. The clinic is surrounded by mountains that sometimes obstruct or slow down the people from accessing the health facility. Lack of proper road infrastructure at Okanguati was observed in the area. Some of the pensioners at Okanguati complain that their main problem was that the roads were not in good conditions and that there are people who do not know the purpose of the clinic and that leading them to use herbs as medicine. A 64-year-old pensioner at Etanga in Kunene region stated that "*It is difficult to cross rivers in rainy seasons*" and also people walk to clinics and pensioners find it difficult to walk at an old age (Van Rooy *et al.* 2015). Localities in Okanguati are situated further away from each other compared to the areas within the Omusati region. About 553 dwelling units are situated within a 30 km buffer zone around Okanguati clinic. Some homesteads are situated in mountainous areas found in the northern part of Okanguati clinic. Table 4.12 shows that about 314 households are with 10 kilometres as per health policy.

Table 4.12: Okanguati Clinic Measurements

Services Provided	Total number of Services provided in Kunene region	10 km Buffer	% of Services within 10 km buffer	20km Buffer	% of Services within 20Km Buffer	30km buffer	% of Services within 30Km buffer
Localities	1277	10	0.7%	20	1.57%	36	2.82%
Schools	99	3	3,03%	5	5.05%	10	10.10%
Dwellings	17251	314	1.82%	406	2.35%	553	3.21%

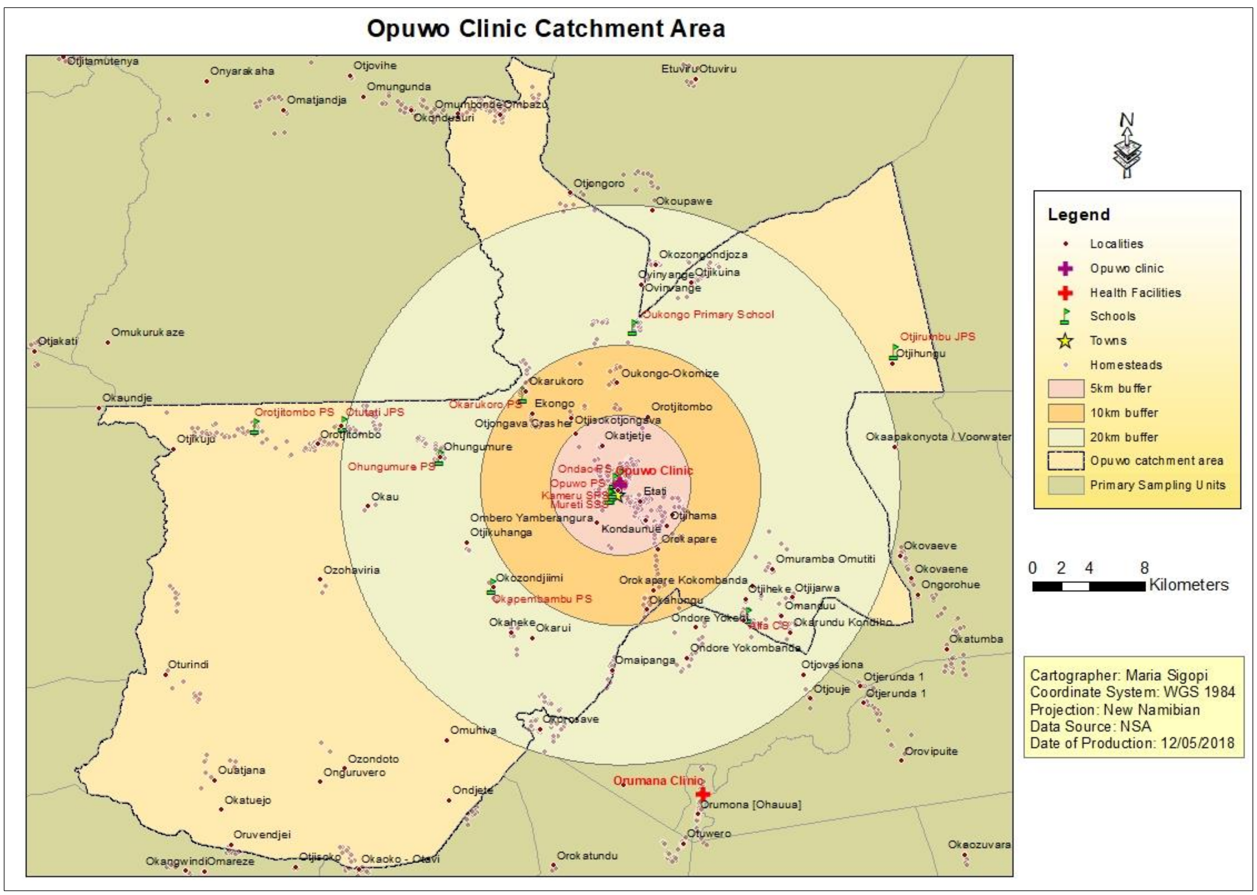


Figure 4.13: Opuwo Clinic Catchment Area

Opuwo clinic was located within the Opuwo town area and all the villages surrounding the area travel to the clinic for health care assistance (figure 4.13). People that are not within the town area must cross rivers and hills to access the clinic. Table 4.13 shows that approximately 2688 household lives within the 10-kilometre buffer zone. People living around the area must travel through mountains and valleys to access the clinic. On the other hand, 19% had to travel about 20km to reach Opuwo clinic which was a long distance and far from the recommended kilometre.

Table 4.13: Opuwo clinic measurements

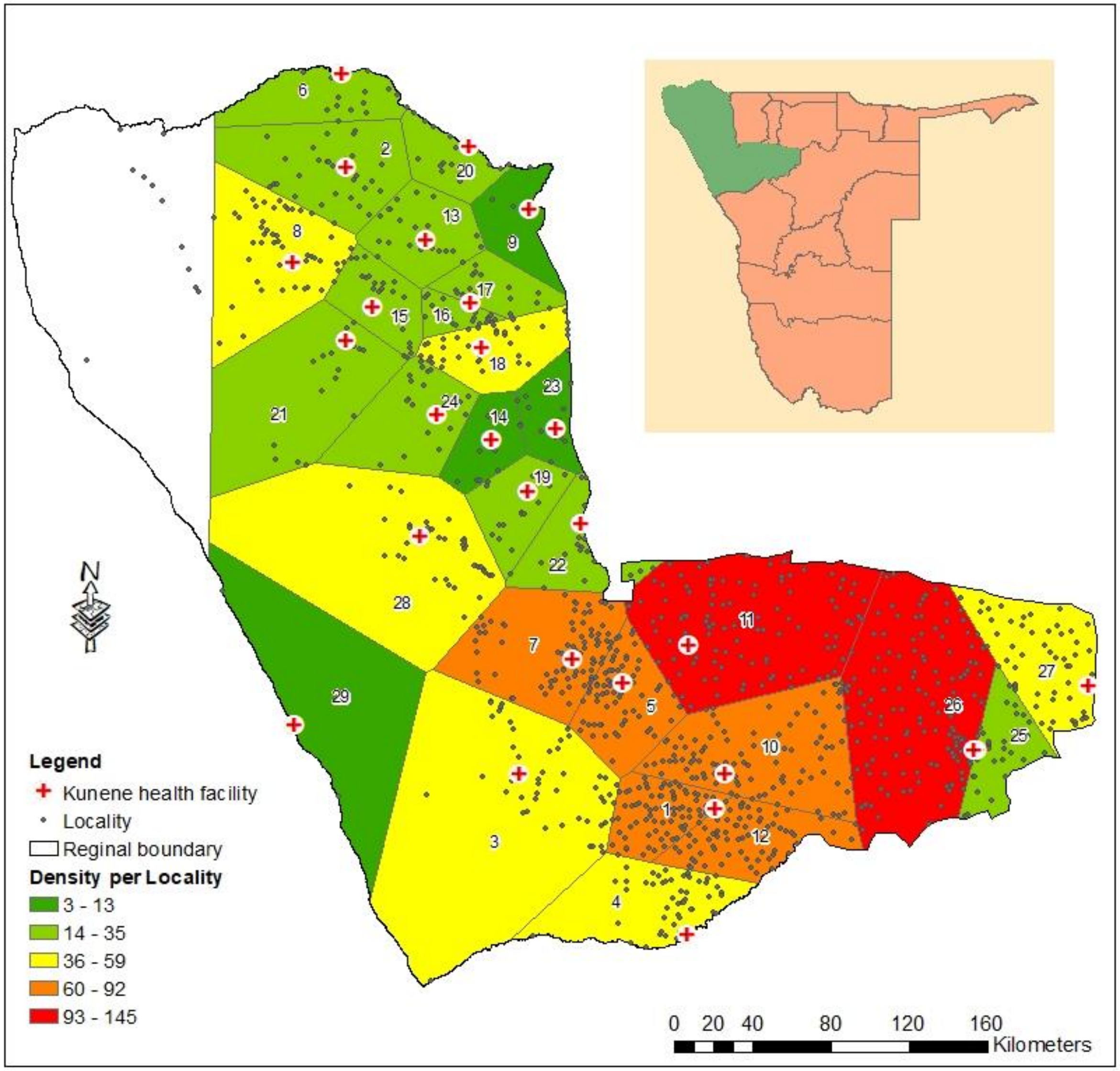
Services Provided	Total number of Services provided in Kunene region	5 km Buffer	% of Services within 5 Km buffer	10 km Buffer	% of Services within 10 km buffer	20km buffer	% of Services within 20Km buffer
Localities	1277	8	0.63%	16	1.25%	40	3.13%
Schools	99	5	5.05%	6	6.06%	11	11.11%
Dwellings	17251	1172	6.79%	2688	15.58%	3299	19.12%

4.5.1.2 Thiessen Polygons

In this section, the researcher created Thiessen polygons based on public health facilities in Kunene and Omusati regions. The Thiessen polygons represented catchment areas for each public health facility in the two study regions.

Figure 4.14 shows areas within Kunene region that are presumed to be serviced per clinic or health facility. Each polygon shows the number of houses that make use of a given public health facility. Based on the map, some of the public health facilities have more people that access them compared to others. Therefore, more clinics can be set up in areas that are densely populated. The polygons are not regularly shaped because some health facilities are either close to one another or further apart. Colston and Burgert (2014) stated that “the more evenly-spaced health facilities are across the area of interest the more their Thiessen polygons will be regular in shape, similar in size and with the public health facility point close to the centre”. Although this approach of assigning Thiessen polygons to each public health facility point assumes that the localities and dwelling units will be evenly spread. The density of dwelling unit should still be considered when interpreting the Thiessen polygons.

In figure 4.15, the red colour represents a high number of localities for each Thiessen polygon surrounding the clinic. Moreover, the green colours represent the least densely populated areas for each Thiessen polygon. In some areas, especially in the southern part of Omusati (fig 4.15) showed that a health facility was minimal, therefore no Thiessen polygons where created for the southern area of Omusati. However, in Figure 4.14 of the Kunene region, the Thiessen polygons have been created for the most part of the region because the public health facilities are scattered all over the area. Most of the populated areas are in the south-eastern part of the map except for Olupandu clinic catchment with a very high number of localities of about 51. The map (Kunene) also shows the present of localities that are not located within the Thiessen polygons. The tables accompanied by each figure (4.14 and 4.15) present the total number of localities in each Thiessen polygon. Outjo district hospital in Kunene had the highest total number of localities while Terrace Bay clinic had the least total number (3) of localities per Thiessen polygon.



ID	Facility Name	Count
2	Okanguati Health Centre	31
3	Bergsig Clinic	53
4	Anichab Clinic	59
5	Anker Clinic	72
6	Epupa Clinic	15
7	Erwee Clinic	81
8	Etanga Clinic	54
9	Etoto Clinic	4
10	Fransfontein Clinic	92
11	Kamanjab Health Centre	113
12	Khorixas Clinic	78
13	Ohandungu Clinic	24
14	Ombombo PHC Clinic	10
15	Ongongo Clinic	22
16	Opuwo Clinic	23
18	Orumana Clinic	41
19	Oruvandjei Clinic	19
20	Otjimuhaka Clinic	18
21	Otjiu Clinic	19
22	Otjokavare Clinic	20
23	Otjondeka Clinic	13
24	Otuani Clinic	20
25	Outjo Clinic	35
27	Queen Sofia Clinic	56
28	Sesfontein Health Centre	48
29	Terrace Bay Clinic	3

Figure 4.14: Thiessen polygons showing density per locality in Kunene region

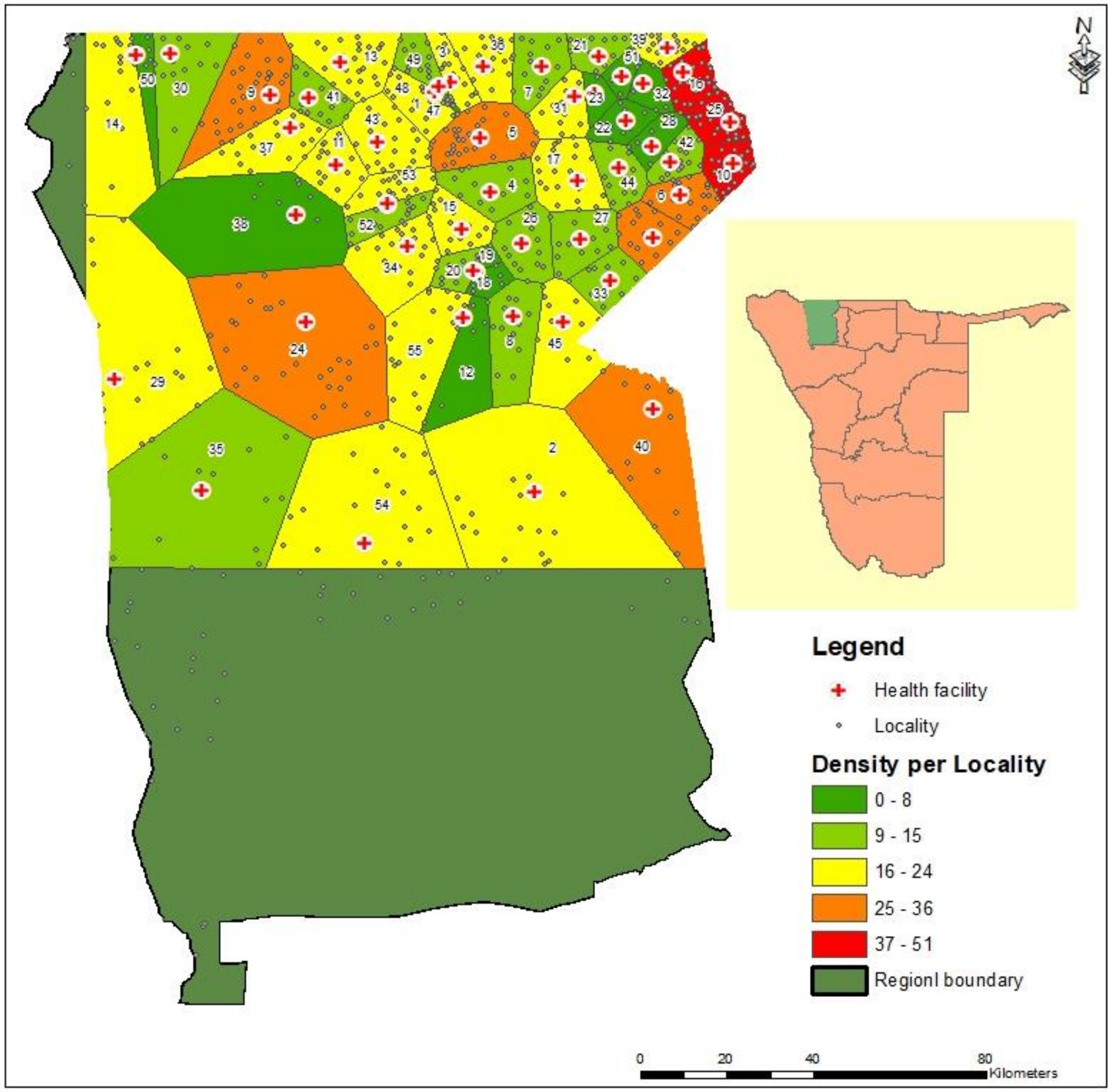


Figure 4.15: Thiessen Polygon showing density per locality in Omusati

ID	Count	Facility Name	ID	Count	Facility Name
2	17	Amarika Clinic	28	8	Omagalanga Clinic
3	19	Anamulenge Clinic	29	19	Omakange Clinic
4	12	Eendombe Clinic	30	13	Omona Watjihozu HC
5	28	Eengolo Clinic	31	16	Omuthitugwonyama Clinic
6	28	Elim Health Centre	32	7	Omutundungu Clinic
7	14	Epoko Clinic	33	15	Onaanda Clinic
8	12	Etilyasa Clinic	34	21	Onamandongo Clinic
9	31	Eunda Clinic	35	14	Onamatanga Clinic
10	44	Iipanddayamiti Clinic	36	18	Onawa Clinic
11	17	Ilyateko Clinic	37	18	Onesi Health Centre
12	7	Indira Gandhi HC	38	8	Ongulumbashe Clinic
13	24	Mahenene HC	39	20	Onheleiwa Clinic
14	17	Nampower Clinic	40	36	Onkani Clinic
15	17	Nujoma-Eya Clinic	41	13	Oshaala Clinic
17	20	Ogongo Clinic	43	22	Oshitudha Clinic
18	7	Okahao Clinic	44	11	Oshitutuma Clinic
20	10	Okahao Medical Clinic	46	30	Othika Clinic
21	12	Okalongo HC	47	4	Outapi Clinic
24	30	Okatseidhi Clinic	50	5	Ruacana Clinic
25	51	Olupandu Clinic	51	4	Sheetekela Clinic
26	13	Oluteyi Clinic	52	14	Tsandi Clinic
			54	21	Uutsathima Clinic

4.3.5.3 Root Path Analysis

Figure 4.16 shows the path where the least time and effort is used to access a health facility. As stated earlier, this root path where proposed for the village community to create their own shortest route path to a health facility. This method was only applied to study sites in Kunene regions because of the topography. The map shows that from 0 to 4 there is the least cost distance when accessing the clinic. Moreover, from 32 to 45 there is a high-cost distance value. The more the cost distance value, the longer one takes to access the health facility. A study by Black *et al.* (2004) used a DEM to produce a slope as one of the constraints that have an effect of travel time to the nearest clinic. The author derived the DEM from USGS GEOTOP30 dataset and was aggregated to obtain grid values of 30. They found that the cost distance results do not consider the "cost" of effort across the cells. However, make use of an average travel cost based on surrounding cells.

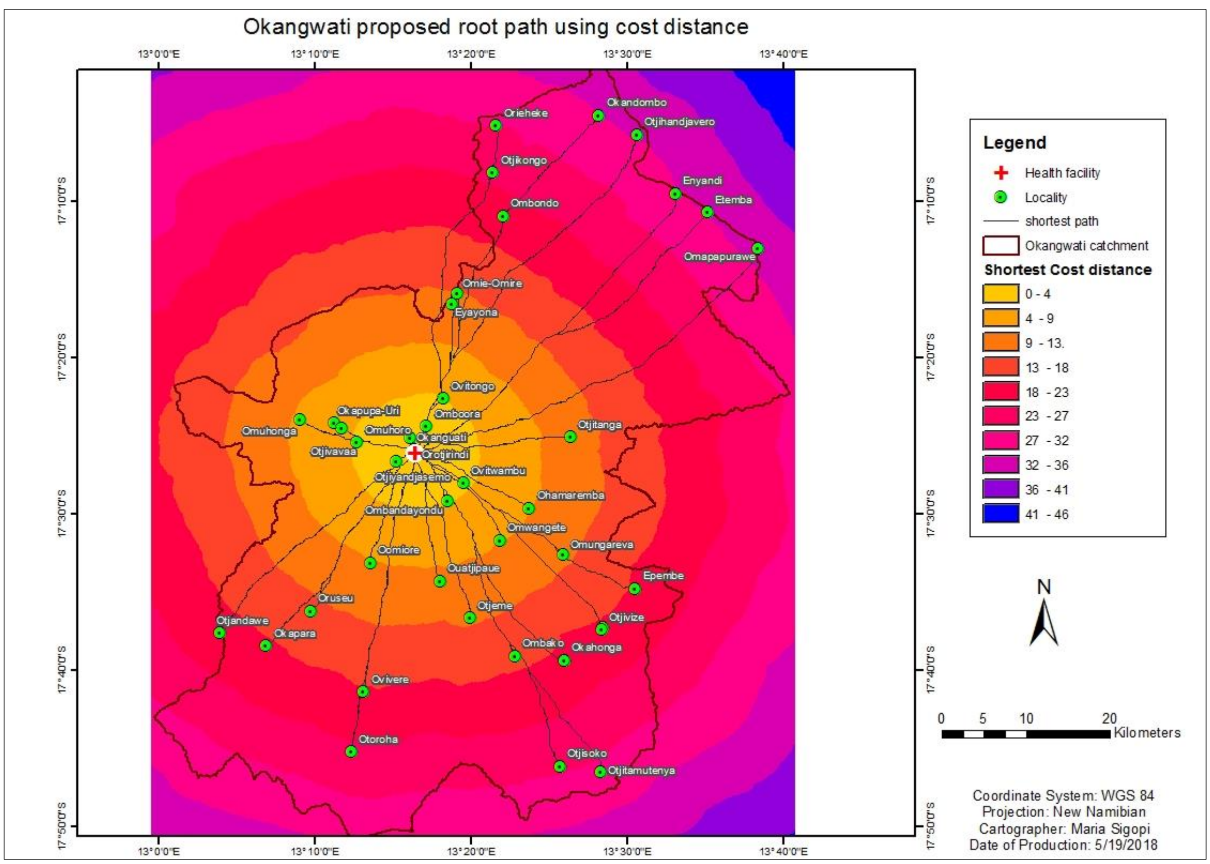


Figure 4.16: Root Path using Cost distance analysis for Okanguati

The least cost path in figure 4.16 and 4.17 was designed to determine the least cost path from the health facility to the locality. The least cost path from the clinic is determined for each cell by using a cost distance tool. Also, the cost distance applied to determine the shortest weight distance from the source to the destination by using the least amount of slope. The map shows that the higher the cost distance value, the further the locality is from the clinic. Areas from 0 to 3 show they have the least cost distance to access the clinic as compared to the locality in 25 to 34.

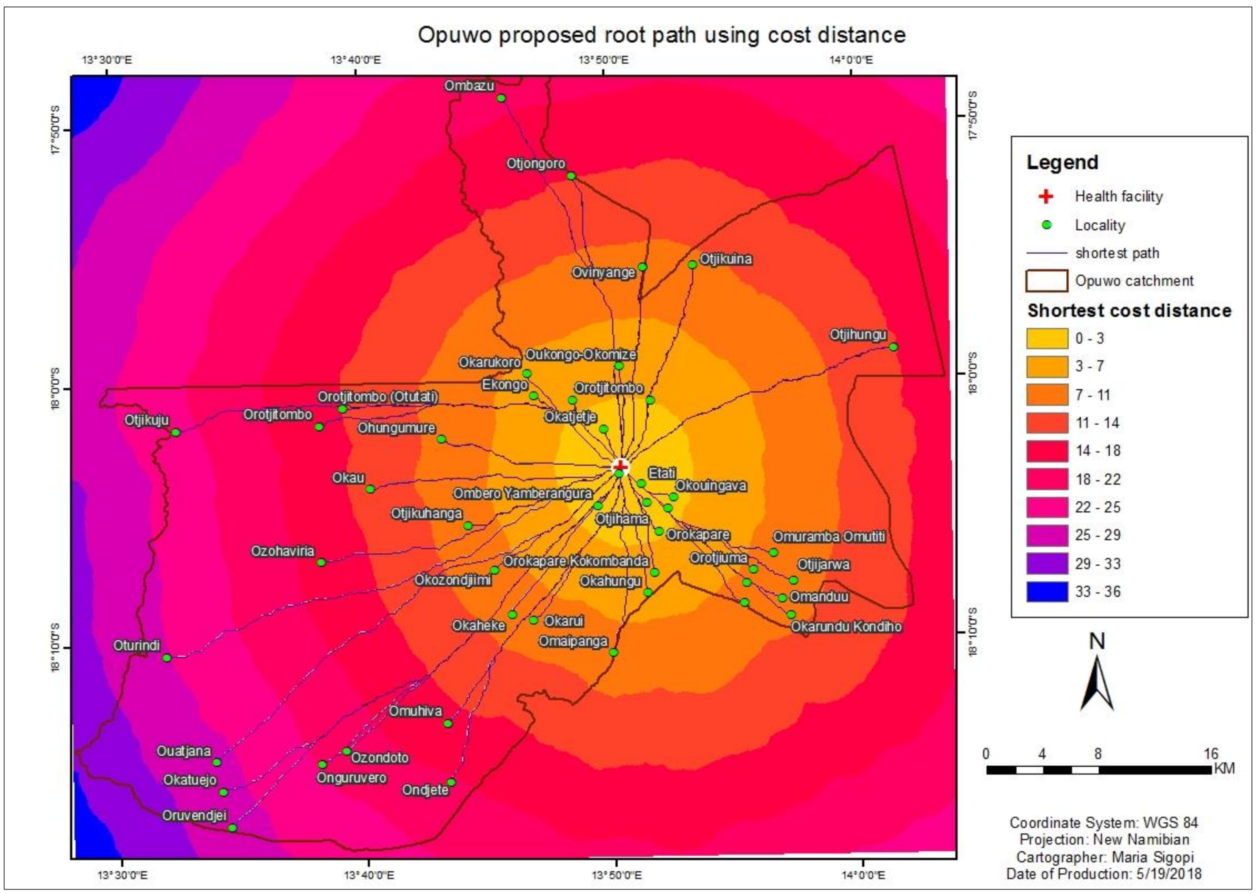


Figure 4.17: Root Path using Cost distance analysis for Opuwo

4.6 Objective 4: To identify causal mechanisms behind the divergence of perceived access and geographical access.

When respondents were asked why they never use or use it sometimes or use other facilities they responded as follows; 23% reported that from their home to the clinic was the main cause, while 7% reported that waiting time to be assisted was the reason. 4% highlighted that the attitude of health care providers was the reason. Less than 4 % of the respondents stressed either that cost, transport lack of service required, lack of satisfaction with the previous service rendered as one of the reasons why they do not use the facility.

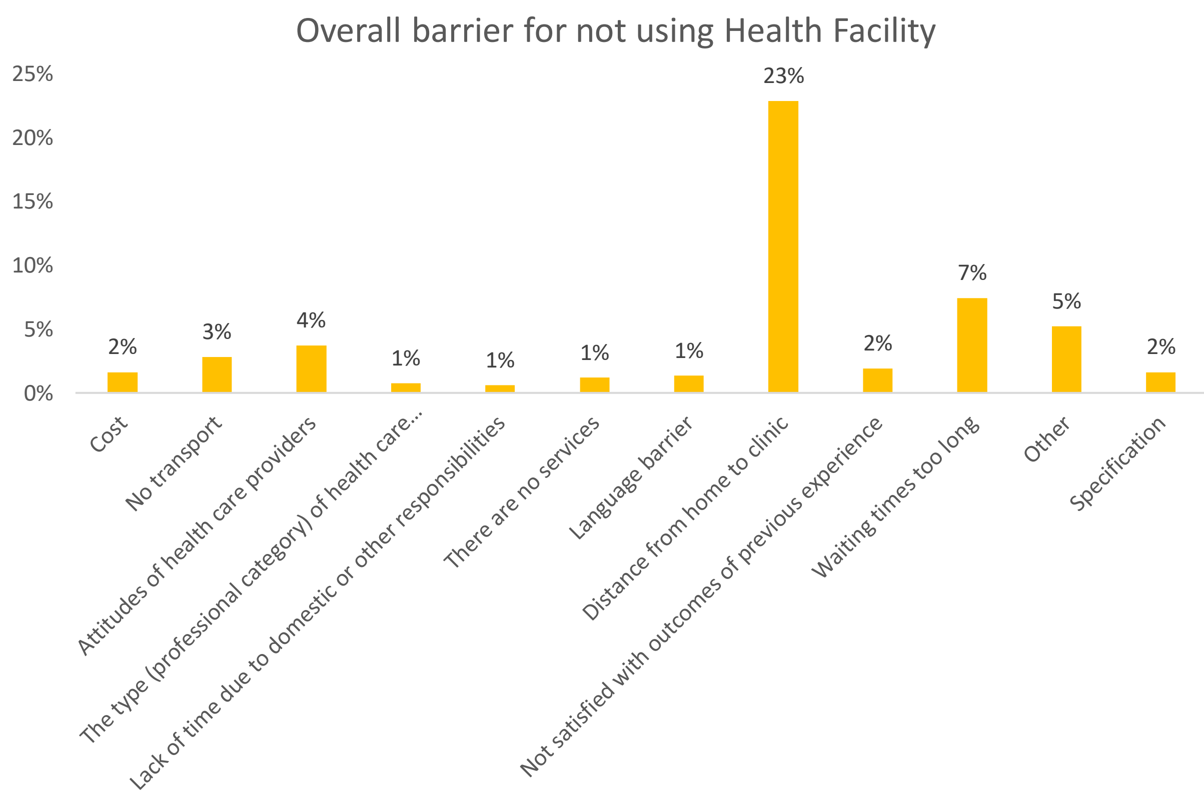


Figure 4.18: Overall barrier for not using the public health facility

At a regional level (fig 4.19), it was reported that distance to the clinic was a major challenge of facility usage in Omusati (22%) compared to Kunene (1%). Additionally, 7% of Kunene residents argued that waiting time at the facility was the reason for not using the facility and no one complained about it in Omusati. Finally, other factors for not using the facility were cost, attitudes of health care providers, satisfaction from previous experience, lack of service, language barrier as they account for less than 2% the regions.

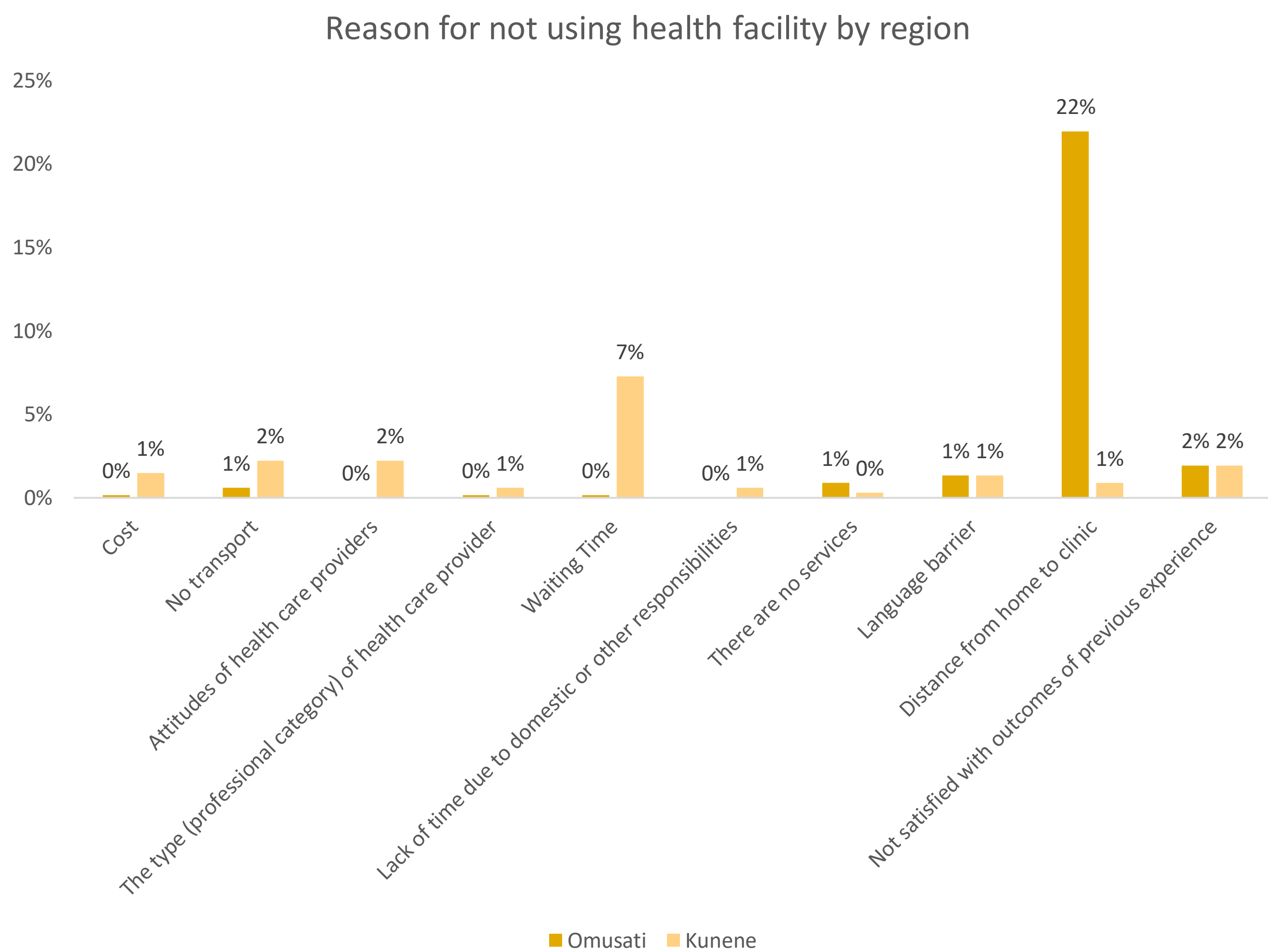


Figure 4.19: Reason for not using health facility by region

4.7 Spatial analysis of barriers to accessibility

4.7.1 Geographical barriers

Flooding in the northern part of Namibia has been a huge problem during rainy seasons due to the fact that most of the areas are located in low-lying areas also known as the '*Oshanas*'. Omusati region is surrounded by floodplains that cause problems when accessing the facility during rainy seasons. Some of the public health facilities in these regions get flooded during rainy seasons. Bich *et al*. (2011) conducted a study on the impact of floods on health. He concluded that the most affected people were those who settled in flood-prone areas (at risk for flooding) and that measures have to be taken to as people are exposed to greater health problems. This has also led to access to public health facilities being compromised when areas are severely flooded. During the heavy rains, roads get damaged, transportation to and from the public health facilities become minimal and sometimes clinics get very flooded. This becomes a problem as primary health care services are reduced at the clinics and medications get delayed as a result of flooded areas or damaged roads. Figure 4.21 and 4.23 shows the areas that are mostly flooded during the rainy seasons in Omagalanga and Anamulenge area.

Fig. 4.24 shows a gravel road constructed within the flood plains during the rainy season of 2009. This road is situated in the Omusati region and leads to Uuvudhiya from Elim junction. Shifidi (2014) stated that “It has been reported that water builds up on the side of the road, flooding households”. The road (fig 4.24) was poorly built and is reported to be shorter than necessary. It is with associated with various factors such as over toping and cut-off of accessibility. This shows that if roads poorly constructed than this could lead to a decrease in health accessibility during rainy seasons. Therefore, alternative measures have to be put into consideration to maintain access to and from the clinic during rainy seasons. The figure (4.23) shows some of the roads constructed along the flood plains that lead to Anamulenge clinic. Figure 4.21 also shows some roads were constructed along the flood plains. Moreover, figure 4.22 shows a house surrounded by flood water, and with this level of water, it is very difficult to access a health facility on time.

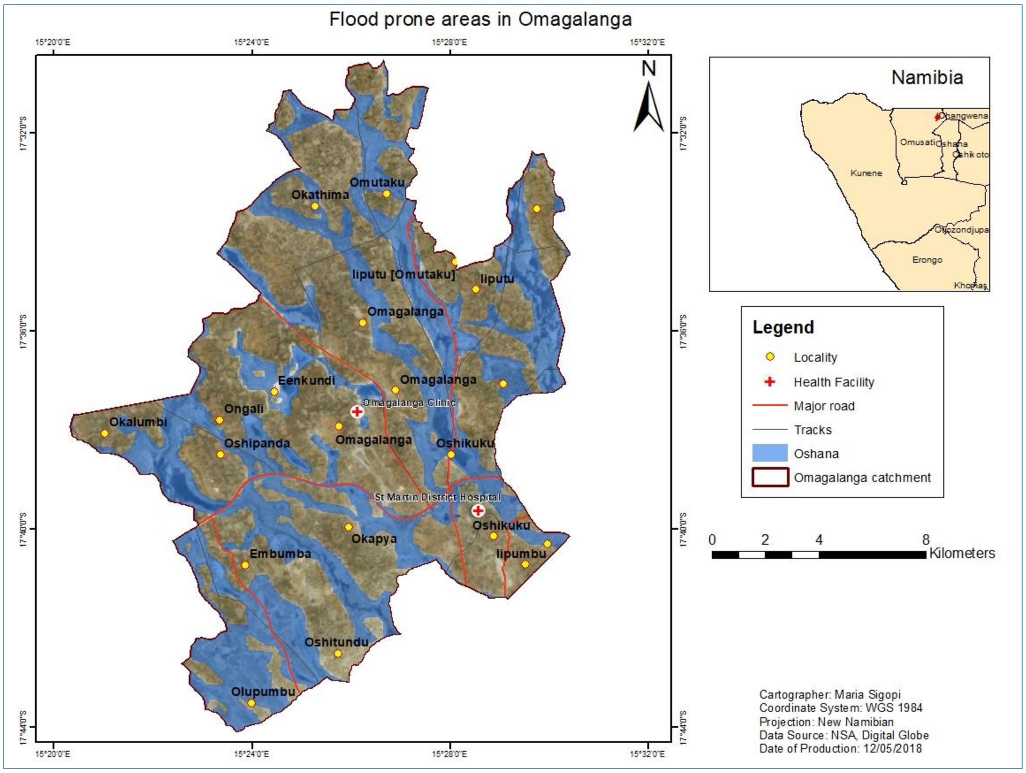


Figure 4.20: Flood plain in Omagalanga area

Figure 4.21: Household surrounded by Floodplains

Source: Mendelsohn (2013)

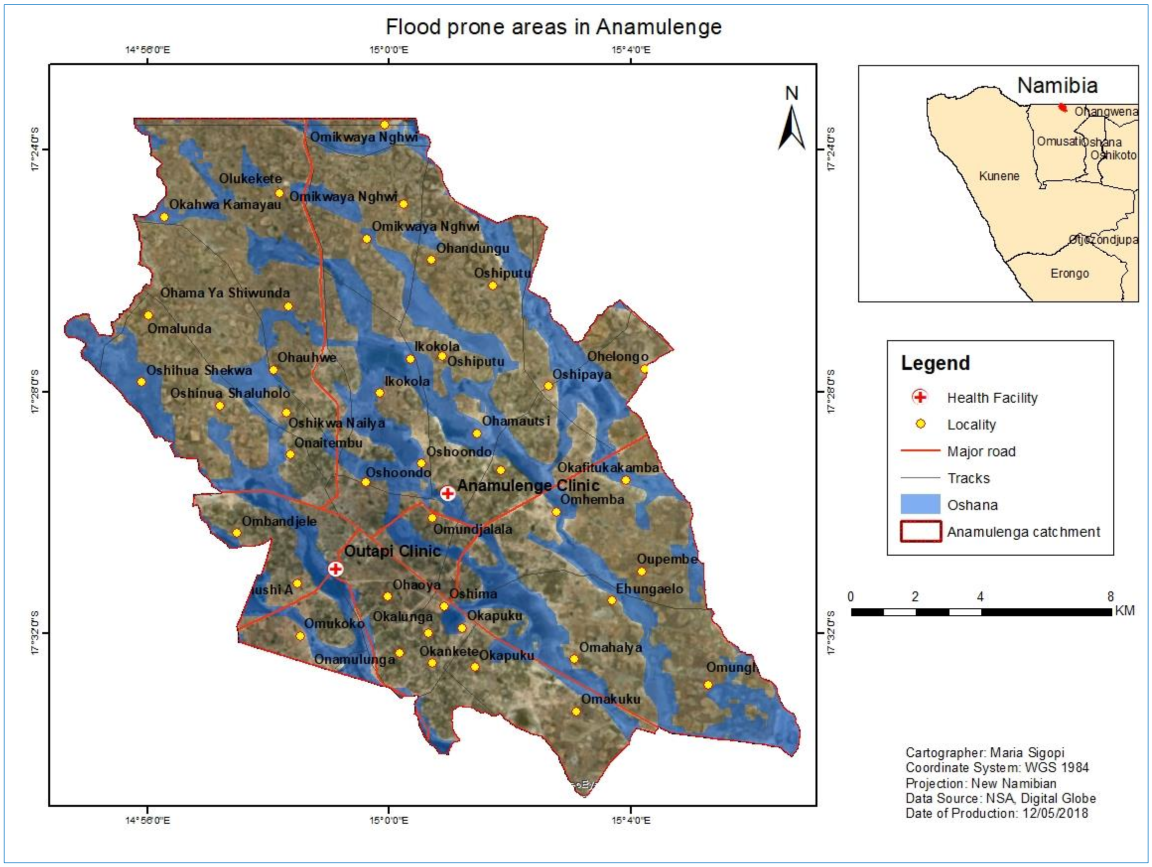


Figure 4.22: Flood Plain in Anamulenge area

Figure 4.23: Roads intersecting major iishanas (Flood Plains)

Source: Shifidi, 2014

4.7.2 Relief Analyses

Figure 4.25 illustrates the elevation of Okanguati area. This map shows the physical appearance or shape of the terrain in Okanguati area. Moreover, the map shows mountains and slopes which are some of the barriers that affected accessibility to clinics. Low values are indicated in yellow while a high value in a darker green color. Also, the yellow areas show that the area is less steep, while the darker green is steeper. This map allows the people to view the geographical area in a three dimensional (3D). On the other hand, figure 4.26 shows the relief map of Opuwo area. It shows that there is quite a high value surrounding Opuwo town. This is because the Opuwo town is surrounded by mountains.

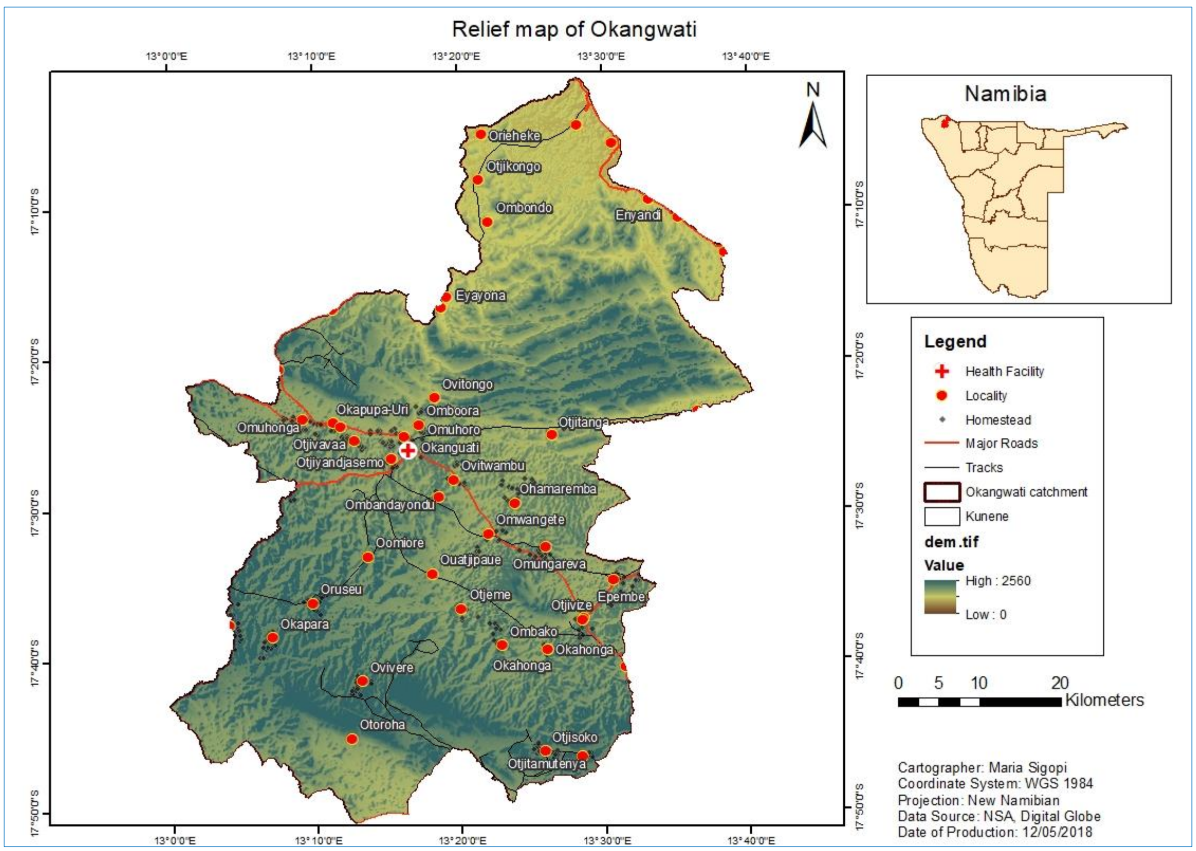


Figure 4.24: Relief map of Okangwati

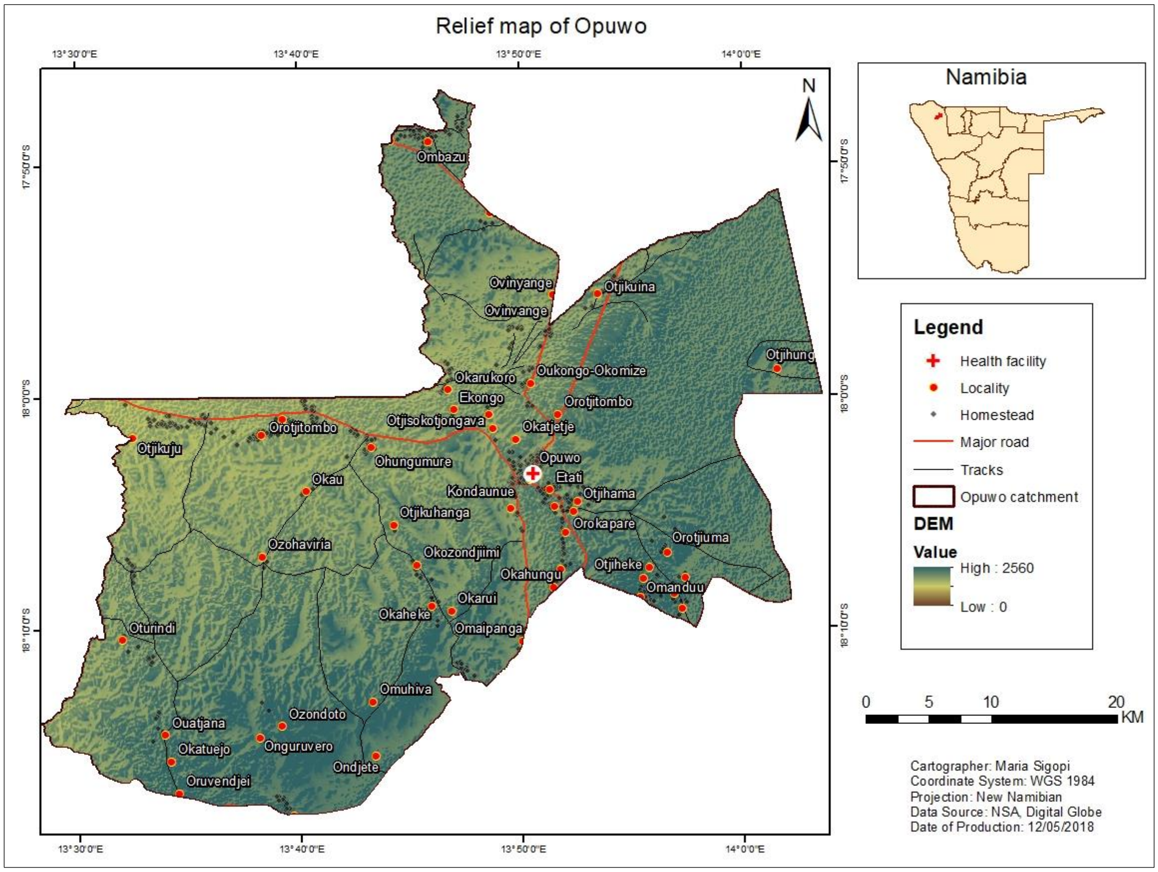


Figure 4.25: Relief map of Opuwo area

4.8 Hypothersis of the study

Spatial results showed that in Kunene region more than 80% of the households were located more than the 10 Km away from a health facility, which was the recommended distance for a person to access a health service. Also, 22% of the household in Omusati were located out of the recommended distance. The same was observed when respondent were asked on accessibility challenges or barriers to public health facilities, 23% reported that distance was the main reason. Looking at these finding one cannot really conclude there was an association between spatial analyses concerning and local perspective, hence an in-depth investigation needs to be launched to assess whether or not an association exist.

4.9 Discussion

Access to primary health care is defined in many studies. For example, Penchansky and Thomas (1981) stated that "access is most frequently viewed as a concept that somehow relates to consumers ability or willingness to enter the health care system" and define access as "a concept representing the degree of 'fit' between the clients and the system". Accessibility to primary health care can be classified based on several issues, including availability, accessibility, accommodation, affordability, and acceptability. In this study network analysis was used to assess accessibility by exploring access to primary health care facilities based on a different mode of transport which included walking and driving. Results indicated that in the Kunene region, the travelling time varies between 5 minutes to 60 minutes when driving. This was equivalent to 61% driving for 5 minutes and 1.39% driving for 60 minutes to access to primary health care services. A study by Jin *et al*. (2015) on spatial inequity in access to health care in Deqing County, Zhejiang and China concluded that about 50.3% of the people had access to a county hospital with 15 minutes when driving while 55.14% can access the town hospital with 5 minutes. This study further indicated that of the 29% of the people still walk for about 40 minutes, 27% walk for 5 minutes to access health service in the Kunene region. While in Omusati between 10%-30% of the population walked for between 100 to 600 minutes to access health services.

Over 80% of the respondent's in Kunene region reported that they always use the facility in their area because the facilities are further apart from each other and the fact that the population is also smaller compared to the population in Omusati region. This result is about three times as Omusati respondents agreed on. Furthermore, 16% of respondents in Kunene acknowledged that they sometimes use the public health facility in their area as oppose to only 5% of Omusati. About 49% of Omusati respondent claimed they opt to use other public health facilities compared to only 1% of Kunene respondents in the same vein. It is also worth mentioning that 1% of Omusati respondents admitted that they do not use the public health facility in their area.

The results also indicated that approximately 6 958 of the mapped houses in Kunene region are situated more than 10-kilometer from the public health facilities and this was equivalent to about 89%. Additionally, 77% of the village in Omusati were located within 10 km to the public health centre and opposed to 23% of locality that were reported to be outside 10 km to the public health facility. These results were in line with results reported by Yerramilli and Fonseca (2014) that identified hot spots of vulnerable populations residing outside the optimal service areas. A study conducted by Kapwata *et al.* (2017) in KwaZulu Natal province involving 404 participants reported that patients with XDR TB in three districts travelled more than 10 to 50 km to the health facility when diagnosed. The results of the study indicated that in Omusati, the distance was a big challenge as opposed to Kunene.

Findings on barriers that prevented the community from utilizing the primary health service among the two regions indicated that distance (22%), waiting time (7%), lack of transport (4%) were some of the barriers. At regional level, it was reported that distance to the clinics was a major challenge of public health care facility usage in Omusati (22%) compared to Kunene (1%). Moreover, the Omagalanga clinic in Omusati region was surrounded by the flood plain, which could affect the distance people travel to seek health care, especially during the rainy seasons. Some of the villages are located far from the clinic and this can course problems as the clinic is only accessible by one main road and people travel on foot. These results were similar to results discovered by Goins *et al*. (2006) who identified transportation difficulties and financial constraints as barriers to a health care facility. According to Trani *et al*. (2010) and Kiguli *et al.* (2009) cost of care, transportation and coverage of remote areas are the main barriers. Furthermore, Van Rooy *et al*. (2015) stated that "a number of remote areas are experiencing problems to access the medical care due to long distances, bad roads and lack of transportations" (p. 5). In conclusion, "Geographical challenges such as mountains, gullies, rivers, unpaved roads prevent physical barriers to accessing primary healthcare" (Amadhila 2012).

Chapter 5: Conclusion

5.1 Introduction

This chapter presents the conclusions and recommendations from the study. It is divided into two sections including conclusion based on the findings and recommendations, suggestions for further research.

The first objective of the study was to map health care facilities, infrastructure, and route access to these public health facilities based on different modes of transport. This was made possible through network analysis measure to explore a route to access public health facilities based on a different mode of transport (Driving and Walking). Results indicated that in the Kunene region the travelling time varies between 5 minutes to 60 minutes when driving. This was equivalent to 61% driving for 5 minutes and 1.39% driving for 60 minutes to access health services. This study further indicated that of the 29% of the people still walk for about 40 minutes, 27% walk for 5 minutes to access health service in the Kunene region. While in Omusati between 10%-30% of the population walked for between 100 to 600 minutes to access public health facilities. This was also revealed among barriers that distance was a major challenge in the Omusati region.

The second objective looked at understanding the perceptions of the community members about the utilisation of the public health facilities in their areas. Overall results showed that over 60% reported that they always use the public health facility, 11% admitted that they use it sometimes, 23% of the respondents reported that they do not use the facility in their area but make use of other public health facilities. Additionally, more than 80% of the respondents in the Kunene region reported that they always use the public health facility in their area, which is about three times as Omusati respondents agreed on. It was also concluded that there was a significant difference (χ^2 (4, N = 674) = 266.80, p = 0.000p-value) in the usage between the two regions.

The third objective investigated accessibility to primary health care through Euclidean distance measure. It was discovered that 89% of households in Kunene region were situated more than 10-kilometer from the public health facilities in comparison to 22% of households in Omusati in the same vein. Also, Thiessen model indicated that there was a pattern between the two regions where the concentration density of people in relation to health facilities was more onto to the central and north of the regions and scarcity of the density was more to the south in both regions. Cost distance was only carried out in Kunene region because it measures the sloppiness of the area as parameters that affect travel time and Omusati was not a mountainous region like Kunene to execute this model. In the last objective, the researcher seeks to understand possible barriers that prevented them from utilising the public health facility services in their area. According to the community response, barriers included a distance from their home to the clinic (22%), waiting time to be helped (7%) and attitude of the health care providers (4%).

Furthermore, analyses were also carried out to understand the steepness and possible flooded areas. It was observed that for Okanguati area steep slopes were observed toward the south and central of Okanguati area, while fewer steep slopes were observed toward the north of the area. Different results were observed in Opuwo, where steep slopes were more to the east, central and south while fewer slopes were observed to be toward the west of Opuwo when observing the steepness of the areas. Although this research was only based on Kunene and Omusati region, the same methods can be replicated countrywide through making use of GIS model to understand health access better in the country and this might help in the proper allocation of resources and planning.

5.2 Limitations observed

This study used secondary data that were collected for a different purpose; hence some demographic indicators such as age, sex, and education level were missing from the dataset used. These indicators are crucial for comparative analysis and also to have a greater picture of who the respondents were in terms of age and what they do, as this would have given a clear picture with their reasoning. Also, the study only gives the perception of health care users. The perceptions of health care providers are not covered because the data was not collected during the period of the research. Due to the hierarchy of health facilities, hospitals required people to be referred from clinics regardless of the situation the patient might be experiencing. Moreover, the network analysis had several limitations because for a service area analysis to take place and to produce accurate results, all the road data had to be connected. However, this was not possible because majority of the tracks of which the people mostly use to access health care facilities had a lot of gaps between them.

5.3 Recommendations

Despite Namibia being among countries with a good primary health system in the world, a lot still needs to be done in terms of robust planning to achieve a more equitable distribution of services in response to the growing need of primary health care and accessibility of public health facilities in the country.

From the results obtained after investigating and analysing accessibility to public health facilities, Findings showed that the Omusati region faces challenges with accessibility, mostly with long distances that people walk to access health facilities. Hence, there is a need for re-planning of health centres in the Omusati region to ensure everyone has access to health service. It is imperative that planning for health care services incorporates future population growth and changes in activity, trends occurring in the areas to be served. Therefore, the location and operation of these primary health care facilities must be carefully planned to ensure improved long term accessibility targeting current and future potential users of services. More studies on Geo-health still need to be done in Namibia to get a better understanding of accessibility of health in Namibia as this will be crucial in the planning and distribution of health facilities.

5.4 Suggestion for future research

Future researchers should look at overlaying health, population, and environmental data with GIS data to allow evaluation and quantity relationships between health-related variables and environmental risk factors at different geographical scales. There is also a need to explore infectious diseases, mapping and monitoring of the spatial and temporal distributions of vectors of infection, through the use of GIS as this will allow an understanding of the relationship between spatial and temporal trends, and risk between environmental factors and health.

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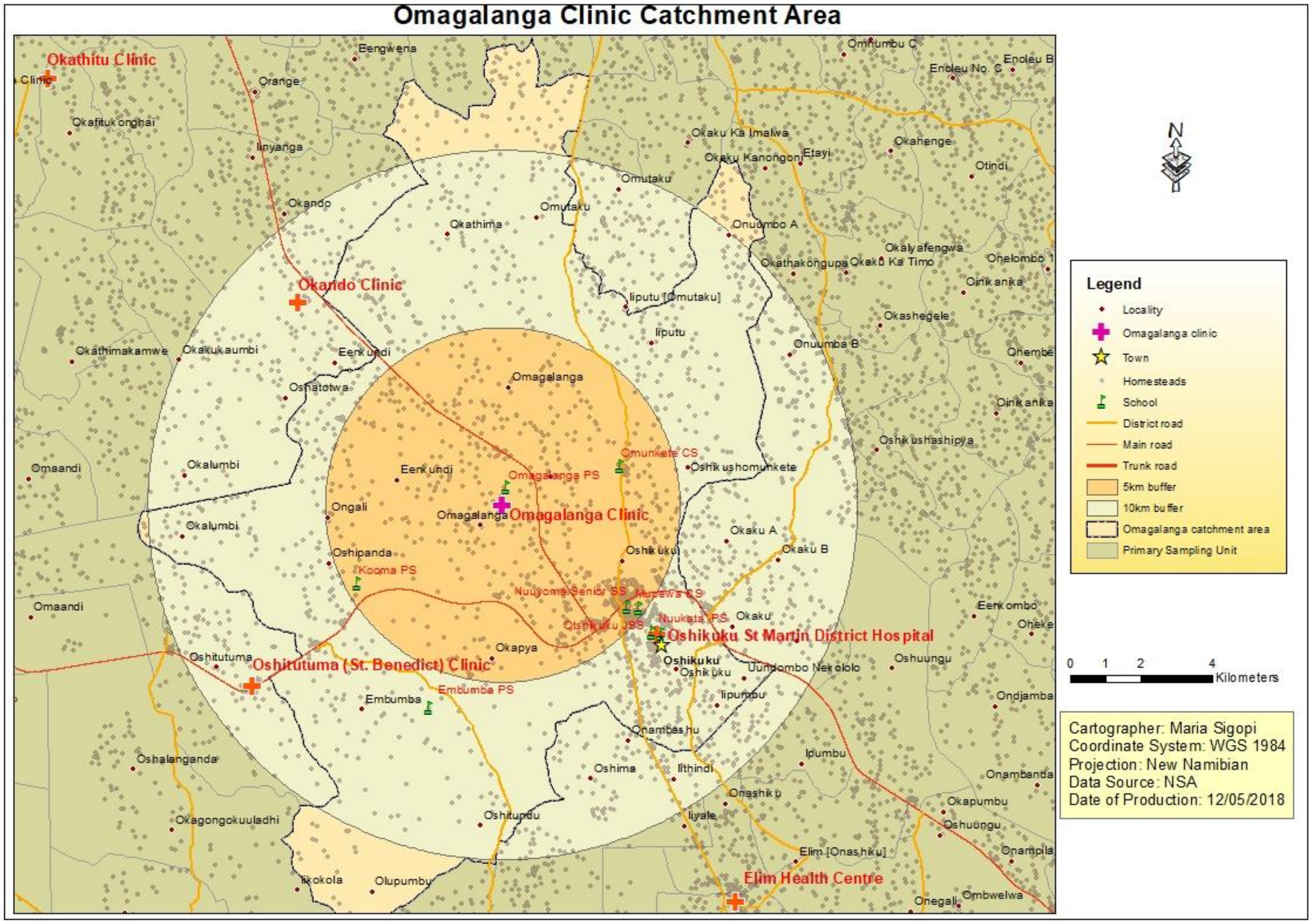
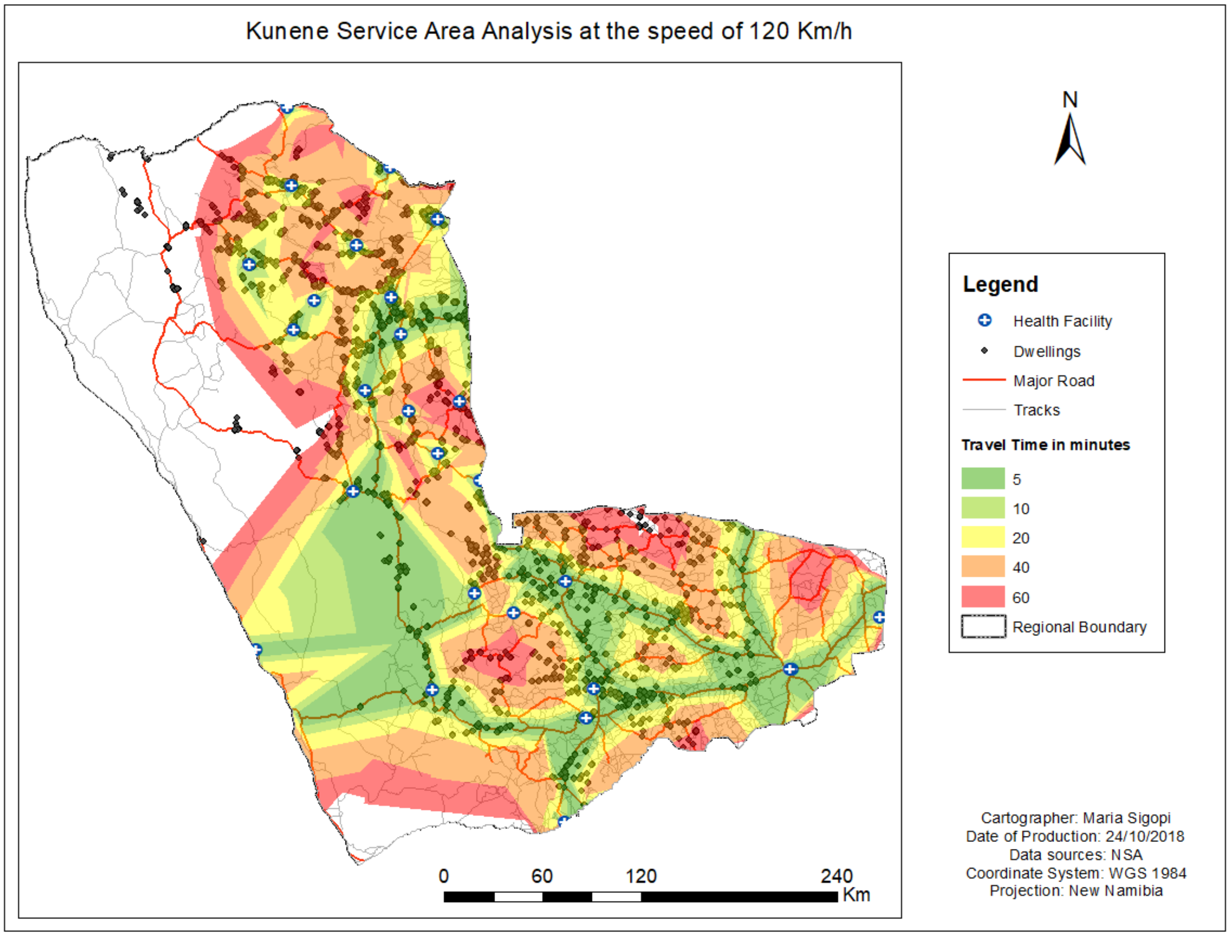
Appendix 1: Maps

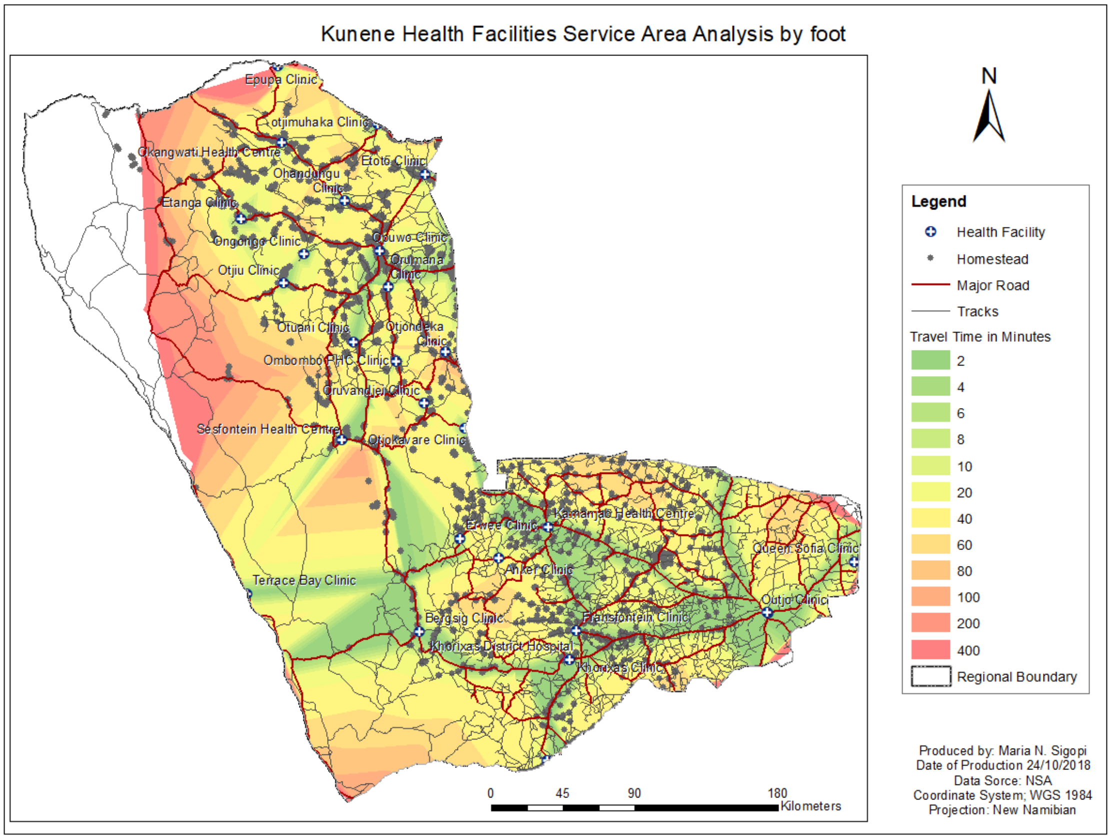
1.1 Omagalanga area map



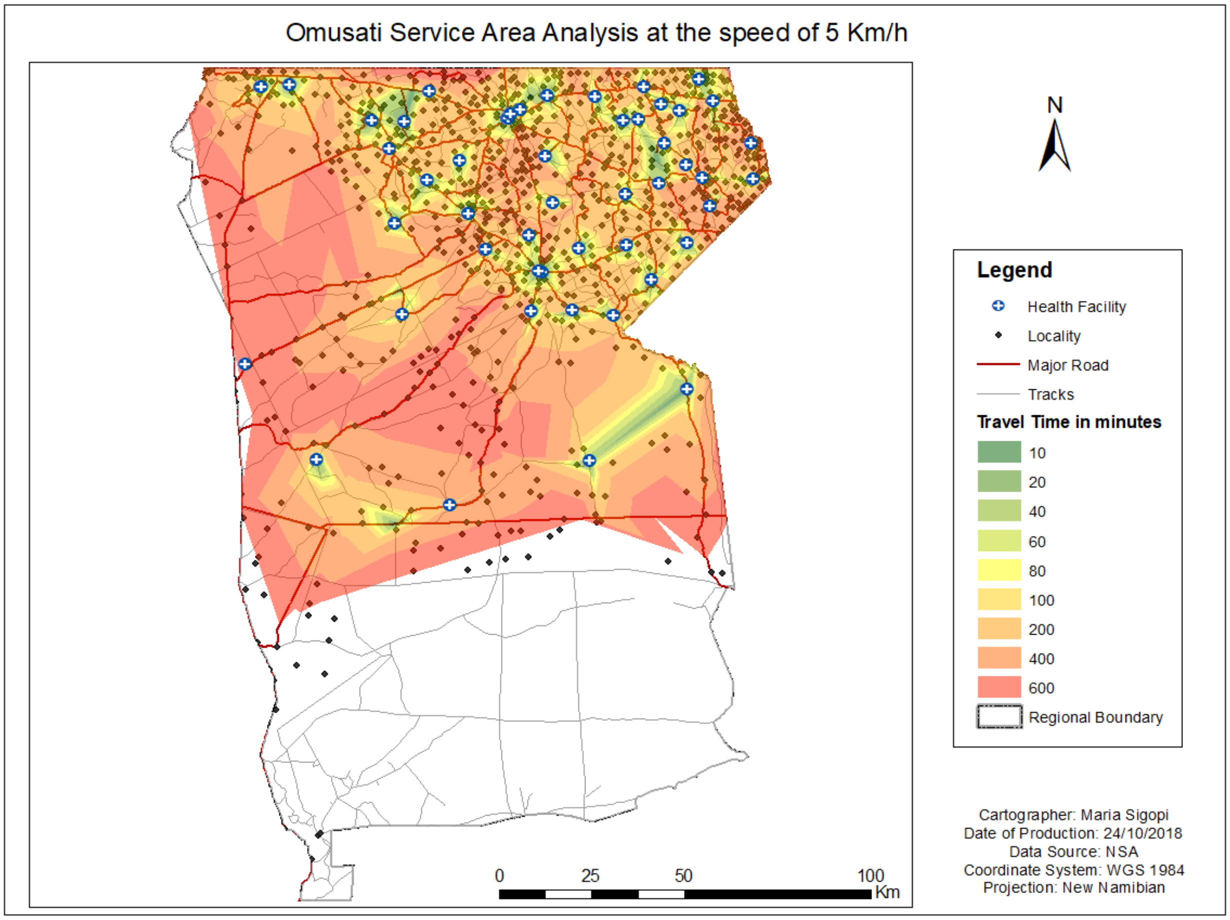
1.2 Kunene service area map at 120 Km/h



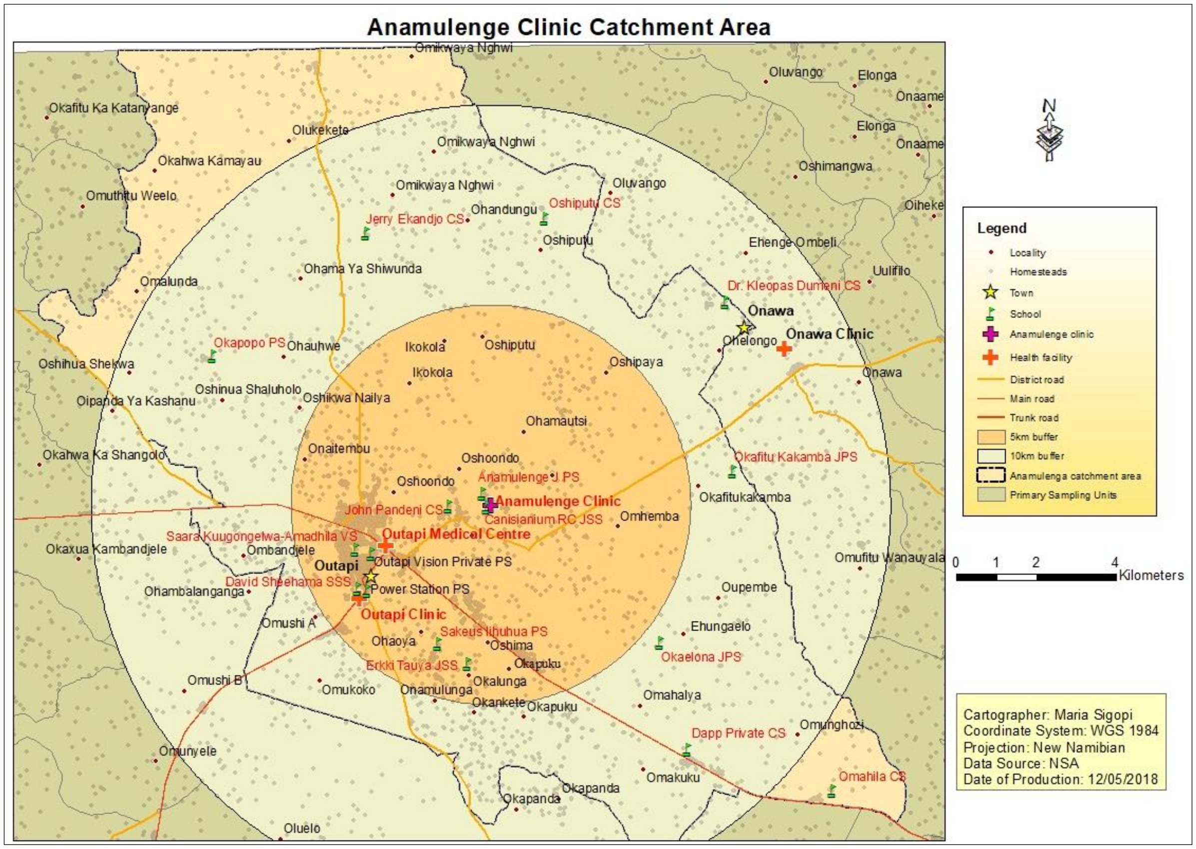
1.2 Kunene Health Facilities Service Area Analysis at 5 Km/h



1.3 Omusati Service area map at 5 Km/h

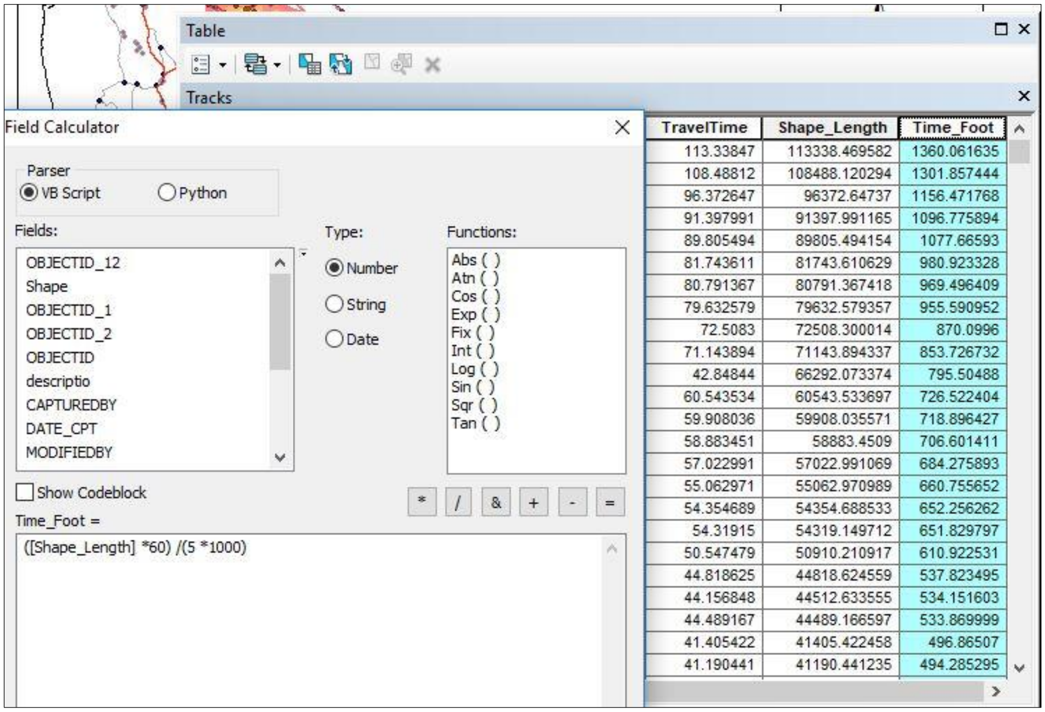


1.4 Anamulenge Clinic Catchment Areas

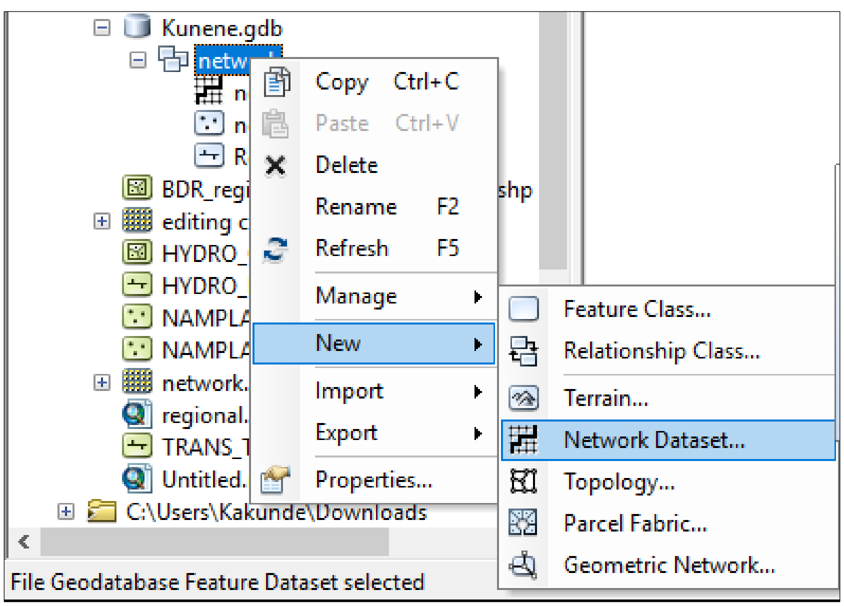


Appendix 2: Stages of Analysis

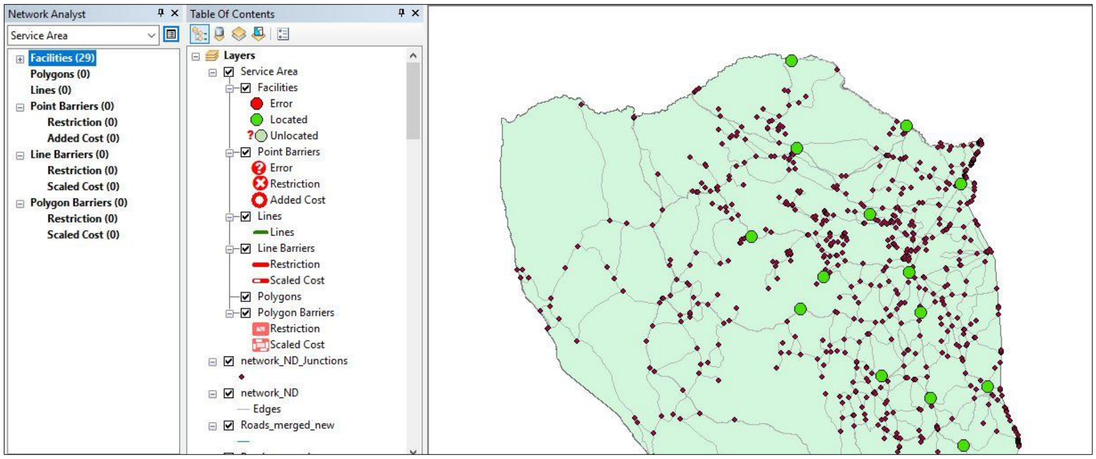
2.1 Calculation Travel Time in minutes



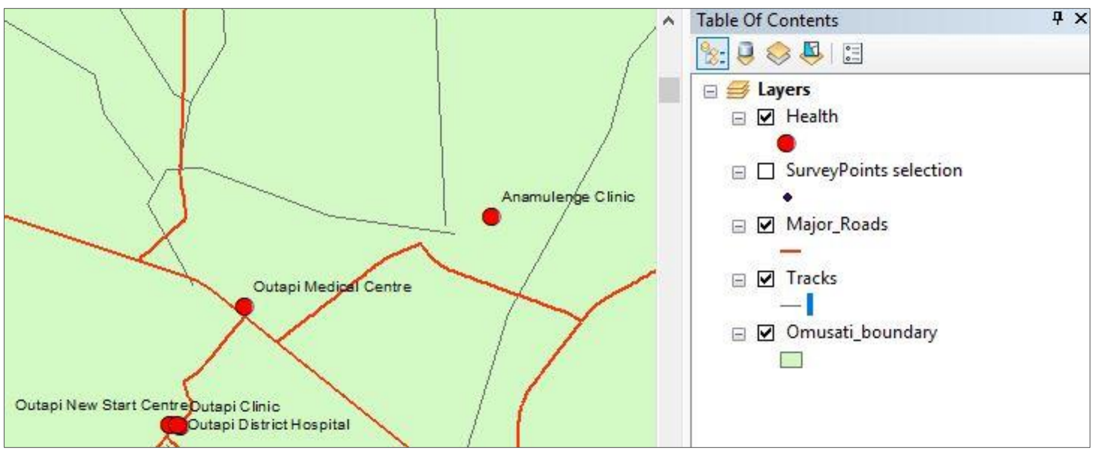
2.2 Creating a Network Dataset



2.3 Creating a new service area in ArcMap



2.4 Linking Health Facilities to Road



Appendix 3: Questionnaire

1. Do members of your household generally use the Anamulenge, Okanguati, Opuwo and Omagalanga health facilities?

Questions on the use of health facilities by members of household

Frequency	Code
Yes, always	1
Yes, sometimes	2
Use both health care facility plus others	3
No, but use other health care facilities	4
Never use any health care facilities	5

Source: University of Namibia 2014

2. What are the main reasons why you *never* use this facility, or only use it *sometimes,* or why you use *other* facilities?

Main reasons on the use of facilities

Main reasons	Code	Main reasons	Code
a. Cost	01	l. There are no services	12
b. No transport	02	m. Language barrier	13
c. Discrimination by health providers	03	n. Distance from home to clinic	14
d. Attitudes of health care providers	04	o. Physical accessibility of the facility	15
e. Had a bad incident and so don't go anymore	05	p. Not satisfied with outcomes of previous experience	16
f. The gender of health care provider	06	q. Opening times are not suitable	17
g. The type (professional category) of health care provider	07	r. Not sick enough or not sick (do not need)	18
h. Old age	08	s. Waiting times too long	19
i. Disability	09	t. Religious belief	20
j. Crime, danger	10	u. No knowledge about the health facility	21
k. Lack of time due to domestic or other responsibilities	11	v. Other, specify ……………………………….	22

Source: University of Namibia 2014