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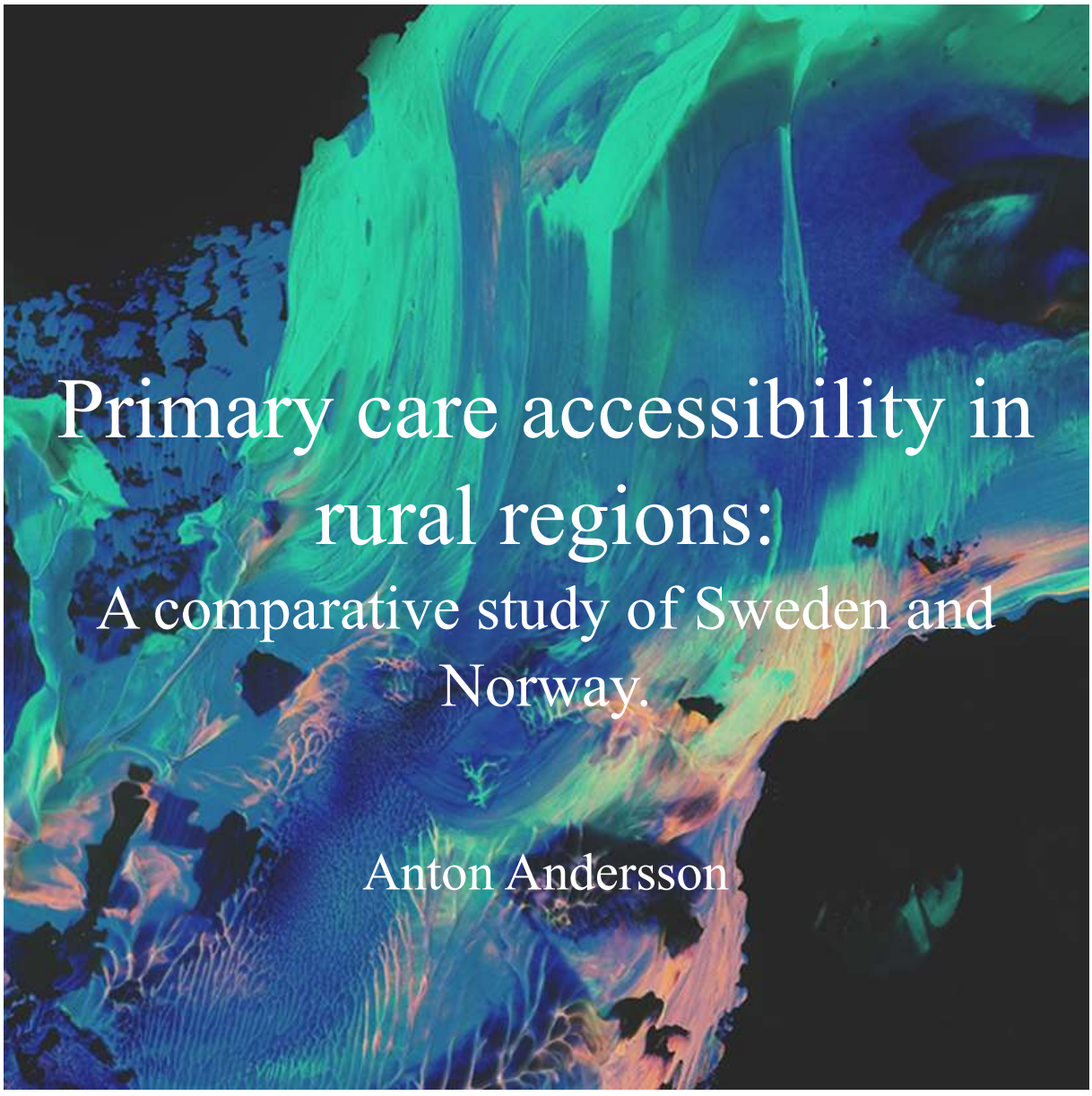

Primary care accessibility in rural regions:

A comparative study of Sweden and Norway.

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Preface

This thesis marks the end of my time at Umeå University as a student, at least for the foreseeable future. It does not feel like such a long time since I first stepped foot on campus in the autumn of 2019, fresh out of high school, however my time at university has been a great learning experience and a period of much personal growth, but most importantly, it has been fun. I would like to thank everybody that I have met both directly and indirectly through the university, who have made this time such a great experience. I would like to thank my supervisor Erika Sandow, who has given me great feedback throughout the writing process. I would also like to thank my partner for managing to keep us sane through the pandemic and beyond.

Abstract

This thesis has examined and compared physical accessibility to primary care facilities, or health centers, in two rural regions, one located in Sweden, and one located in Norway. The study areas are Västerbotten county in Sweden, and Nordland county in Norway. The analysis has been conducted via a service area analysis in ArcGIS, where the relative distance in terms of travel time to the health center determines accessibility. Good accessibility is defined as less than an hour of total travel time, including the return journey. Overall, accessibility is good in both study areas with around 95% of the population having good accessibility, while a vast majority of people live within five minutes one way to the nearest health center. However, there is a difference between the two study areas, where the Västerbotten population generally has better accessibility than their Norwegian counterpart. These differences are despite the fact that Nordland has almost double the amount of health centers that Västerbotten has. Overall, these differences appear to primarily be due to differences in population pattern, which in turn can be seen as a part of the difference in regional policy between the two countries, although it is hard to pinpoint the full effect that regional policy has on primary care accessibility.

Keywords: Healthcare, Accessibility, Regional policy, Rural regions, Network Analysis, GIS.

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1. Introduction

Sweden in the 21st century is a highly urbanized country. Around 85% of the population lives in urban areas, a number that has increased and will continue to increase over time (Statistics Sweden, 2015). The explanation for this phenomenon has multiple answers, such as international immigration, birth rates, and outmigration from rural areas, the last of which is closely tied to the urban-rural divide (Erlingsson, Wänström, 2015). As more people, especially younger individuals, decide to leave the countryside for a life in the city, the population of rural Sweden decreases in numbers and increases in age (Statistics Sweden, 2015). Alongside this decrease in population comes a lack of services. As people move away, the service base in that area decreases, and the services disappear. Most notably, public services see a decrease in tax revenue and have a hard time meeting the costs, resulting in downscaling (Erlingsson, Wänström, 2015).

Knudsen (2020) uses terms like palliative care and euthanasia when describing measures taken to combat challenges faced by rural areas, which paints a bleak picture of the future for rural areas. But the decay of rural areas is not a forgone conclusion. In neighboring Norway, the situation is described much differently in the public debate. Whereas in Sweden many rural municipalities have resorted to cost saving measures (Erlingsson, Wänström, 2017), even the smallest and least populated municipalities on the other side of the border have enjoyed brand new schools and sport centers, leading to a much different outlook on rural life (SVT, 2016).

This apparent difference is quite intriguing since Norway and Sweden in some respects are two very similar countries. For example, both are welfare states with long histories of social democratic rule, with a similar degree of urbanization. As previously mentioned, 85% of the Swedish population lives in urban areas, in Norway that number is 82% (Statistics Norway, 2022). Many might assume that these differences are simply down to one factor: the Norwegian oil fund, one of the largest in the world. While the oil money is by no means a small amount, another answer can be found in the different approaches in regional policy that Sweden and Norway have taken. Regional policy is a tool to affect economic growth within a specific region and can have both a direct and indirect effect on service supply in rural region (Hedström, Littke, 2011).

One public service that is affected by the challenges facing rural areas is healthcare. Healthcare services require well-educated personnel and is costly. Healthcare expenditure make up around 10% of GDP in both Sweden and Norway (Statistics Sweden, 2020. Saunes et al, 2020). A lack of accessibility to healthcare services can have serious consequences for public health. Long travel times to primary care facilities, which serve the purpose of discovering and preventing health conditions at an early stage (Region Västerbotten, 2021), can lead to patients not seeking care in time. Even here, there is another difference between Sweden and Norway in the way that the healthcare systems are structured. In Sweden, primary healthcare is mainly a responsibility of the county council, while in Norway it is a municipal responsibility.

One way to investigate these apparent differences between the two countries is via the use of Geographical Information Systems, or GIS. By conducting a service area analysis using GIS, it is possible to quantify accessibility to healthcare facilities by measuring distance in terms of travel time, helping better understand the challenges facing healthcare services in rural areas.

2. Aim & research questions

This thesis aims to investigate accessibility to primary care facilities in rural regions through examining and comparing two different counties: the county of Nordland in Norway, and the county of Västerbotten in Sweden. To help achieve this aim, the following questions have been asked:

1. How much of the population in the respective counties have good physical accessibility to primary care facilities?
2. What are the main differences in physical accessibility to primary care facilities between Nordland in Norway and Västerbotten in Sweden?

3. Background information, previous studies, and theoretical concepts

3.1. What is rural?

This thesis has a focus on rural regions, but the definition of rural is not as clearcut as it appears at first glance. Whoever is tasked with defining rural will be using their own experiences and point of view in order to come to a conclusion. When making a study of rural regions, it is therefore of great importance to define what a rural region is within the context of the study (Hedström, Littke, 2011). According to the OECD system of NUTS3 regions, a region is rural if there are less than 150 inhabitants per km^2, and there is no population center greater than 200 000 inhabitants (ibid). This classification system is clearly not suitable for the Nordic countries, as almost all areas in the Nordic countries would be classified as rural under this definition (ibid).

The Swedish agricultural department uses a different classification, based on the municipal level. This classification creates two types of rural municipalities: Countryside (*landsbygd)*, and sparse countryside (*gles landsbygd*). The first of the two is defined as a municipality which has less than 30 000 inhabitants, and/or the largest locality has a population of less than 25 000, while at the same time having a population density of more than 5 people per km^2. Sparse countryside is any municipality which fulfills the first two requirements but has population density of less than 5 people per km^2 (Jordbruksverket, 2013). The agricultural department does highlight issues with this classification method. By using the municipal level, the classification system disregards the fact that most municipalities contain areas which can be seen as both rural and urban (ibid).

In Norway, the term "rural areas" has no official definition as it is not used in an official capacity in the same way that it is in Sweden. Instead, Norway uses the term district, which means peripheral areas consisting of at least one municipality which is eligible for certain forms of aid. Indicators in the form of geography, in terms of physical accessibility and population density, demography, labor market and business, as well as standards of living are used to identify these districts, but there are no hard limits like in Sweden (Hedström, Littke, 2011).

In summary, the most common identifier of rural areas is that of a small population and more specifically a low population density. What constitutes as a rural area in terms of population density is relative and depends on the spatial context, both in terms of the size of the area but also dependent on each area's location in relation to each other. For example, a county can be classified as rural, but that does not mean that every municipality within the county is also considered rural.

3.2. Accessibility

The concept of accessibility can be defined in several ways depending on the context of which is it used in. For the purposes of this thesis, geographical, or physical, accessibility is of interest. Katarina Haugen (2012) describes accessibility as the opportunity for individuals to reach specific amenities, of which health care facilities is one. Furthermore, Haugen writes that the geographical dimension of accessibility can be divided into two categories, mobility, and distance. Mobility is described as distance-bridging accessibility (Haugen, 2012).

Mobility is constrained based on a number of factors, one of which is time. Torsten Hägerstrand (1970) pioneered time geography, a framework for understanding spatial and temporal processes. Individuals not only need the means to make the journeys, but they also need to have the disposable time to do so, as an individual can only be in one place at a time. This means that different activities have to compete for space in time, i.e., compete for a slot in the schedule. For example, a visit to a healthcare service would likely compete with work. This competition is further driven by what Hägerstrand describes as authority constraints, which concerns limitations from rules controlled by a given group or individual. In the healthcare service example, such a limitation would be the open times of the facility, which often overlap with working hours. Other constricting factors for mobility is the budget for travel, as well as the transport possibilities (Haugen, 2012). For example, individuals lacking a driver's license suffer mobility constrictions as they are forced to rely on others, either public transit, taxi services or acquaintances with access to a car, to travel distances beyond the reach of walking or cycling, thus limiting their accessibility to amenities beyond that distance (Chang, et al, 2005)

Furthermore, distance is described as locational accessibility (Haugen, 2012). Distance can be measured in different ways. *Absolute* distance refers to the distance between two points expressed in absolute units, such as kilometers. *Relative* distance instead refers to the distance between two points expressed in relative units, such as travel time or monetary cost, although relative distance can also be expressed in kilometers (Rodrigue, 2020).

With all of this in mind, accessibility can be seen as a sign of equality. As traveling is associated with a monetary cost, such as ticket prices, fuel costs or the price of a vehicle, an individual's mobility is dependent on their socioeconomic status. Those who cannot afford to travel are locked out of reaching amenities requiring travel beyond their means. This in turn causes a societal inequality based on socioeconomic status. Accessibility is also associated with a cost of time, creating an unequal society for those with long travel time.

3.3. Regional Policy

Regional policy is a term used by, among others, the European Union to describe policies used to boost economic activity in a specific region. (European Commission, n.d.). The aim and means of regional policy differ between countries and have also evolved over time. In Sweden, what is now called "Regional policy" (*Regionalpolitik*) used to be called "Regional growth politics" (*Regional-tillväxtpolitik*), while in Norway the terms "Rural policy" (*Landsbygdspolitik)* or "District policy" (*Distriktpolitik)* is used to describe practically the same thing (Tillväxtanalys, 2021). For the sake of cohesion, the term regional policy will be used for both countries in this thesis. Originally, regional policy primarily focused on aiding the primary sector, but has since evolved to focus on developing welfare and services in the entire country (ibid). Within a Nordic context, policy makers have traditionally distinguished between narrow and broad regional policy (Hedström, Littke, 2011). Broad policy includes sectoral policy, such as transport policies, labor policies, etc., which affect rural areas without specifically targeting them. Narrow policy instead refers to direct measures targeting rural areas (ibid). In other words, regional policy can both directly and indirectly affect the supply and quality of both public and commercial services in rural regions.

As mentioned in the introduction, Norway and Sweden are highly urbanized countries, and the share of the population living in urban areas continues to increase over time (Knudsen, 2020). As urban areas grow, and the population becomes more centralized, rural areas struggle (ibid). Common challenges for rural areas include shrinking and ageing populations as well as a lack of both private and public services (Hedström, Littke, 2011). Brain drain, which is a term used to describe circumstances where the highly educated leave one area for another, is another common issue facing rural areas (Erlingsson, Wänström, 2015).

Despite this trend, both countries argue that rural and marginal areas should be sustained and not left to "die", and this is especially expressed in Norway's regional policy. As Hedström and Littke writes: "In Norway the line of argument is most explicit, there it is argued that the individual's basic choice of where to live and work is deemed to be of value, as is the notion of having population located near the nation's dispersed natural resources." (Hedström, Littke. 2011, p24). For example, Norway utilizes policies for economic development for even the most marginal localities (Knudsen, 2020). In Sweden, the focus on rural areas is not as specified in the regional policy. The national strategy for sustainable regional development states that one of the strategic areas for regional policy is equal opportunity to housing, employment, and welfare in the entire country (Skr. 2020/21:133).

Economic aid and investments are the main ways in which regional policy takes shape. Both countries make use of different systems and investment funds (Tillväxtanalys, 2021). These often take form as targeted funds aiming to aid different economic aspects in struggling regions, such as entrepreneurship or grocery stores (ibid). In Norway, there is also "*Statens pensjonsfond"*, perhaps better known as the Norwegian oil fund, one of the largest and most profitable in the world. The fund is primarily used to help counteract economic issues facing the country. While it is not directly meant for regional policy, the fund can still be used for such projects, and was crucial in aiding the industrial structural change during the 1970's, spurred on by the oil crisis (Sätre Åhlander, 2003). Another important aspect is that of membership in the European Union. Sweden is a full member since 1995, while Norway is not. As a member, Sweden has the opportunity to take part of the "European Structural and Investment Funds". While not an EU member, Norway does have the ability to take part of some EU funds (ibid).

Both Norway and Sweden have equalizing systems in place to even economic differences between different regions and to offer an even standard of public welfare services. In Sweden, the system is called "*Utjämningssytemet*", which serves to even differences in tax power and public services between different parts of the country (Tillväxtanalys, 2021). In Norway, the system is called "*Inntektssystemet*", or The General Purpose Grant Scheme, which in turn mainly consist of two parts, the general grant and income tax revenues (Rejgeringen, n.d.).

In terms of more concrete differences between the two countries is the degree of decentralization. Sweden has generally moved further to privatization and market-oriented solutions, while in Norway, the public sector and the state have been seen as the main solution, with the public sector being described as an engine for local development in Norway (Sätre Åhlander, 2003). There is a general impression that the Norwegian governing agencies contribute more to local development than their Swedish counterparts (ibid). In Norway, regions in need receive support specifically tailored for the problems and conditions for that specific region, while in Sweden, the support is more general (ibid).

A tool that Norway makes use of is a differing payroll tax (*Arbeidsgiveravgiften*). This system divides the country into 7 different zones, with each zone corresponding to a payroll tax at a certain percentage. The central parts of the country have a higher percentage, while the more peripheral parts have a lower percentage. The percentages differ drastically, as the highest percentage is 14,1%, while the lowest is 0%. The original purpose of this system was to combat unemployment in rural Norway during the 1970's. Today, unemployment is much lower in rural areas, and the purpose of the system is instead to counteract emigration from rural areas (Tillväxtanalys, 2021). This entire system is different from the way the payroll tax (A*rbetsgivaravgift)* is structured in Sweden. In Sweden, there is no geographical difference in the employers' fee percentage. Everybody generally pays a percentage of 31,42%, with slight differences based on the age of the worker (Skatteverket, 2023).

Examining the effects of regional policy is complex, even more so when attempting to evaluate more indirect effects, such as how regional policy affects healthcare accessibility. A 2022 writing to the Swedish government states that evaluations of the effect of regional policy are rare and that the few that exist are old (SKR 2022/23:5). In addition to this, most evaluations of regional policy tend to only focus on economic aspects. For example, a 2012 study examining the effects of EU regional policy found a positive impact on economic growth but has not investigated other consequences of the policy. (Pellegrini et al, 2012).

3.4. Healthcare systems and accessibility

Sweden and Norway rank high in terms of healthcare quality, although waiting times are seen as big issue in Sweden (Anell et al, 2012). In both Norway and Sweden, healthcare is mainly publicly funded through taxes. Healthcare expenditure in 2019 made up 10,9 % of GDP in Sweden (Statistics Sweden, 2020), while the corresponding number for Norway in 2017 was 10.4% (Saunes et al, 2020). Citizens in both countries over a certain age, 20 in Sweden and 16 in Norway, must pay out of pocket for any healthcare service up to a ceiling of 1300SEK in Sweden, and 2369NKR in Norway (Anell et al, 2012 & Saunes et al, 2020).

Healthcare in both countries is divided into primary and hospital care. Primary care consists of more basic healthcare that aims to prevent, diagnose, and treat common conditions and ailments (Region Västerbotten, 2021). This is usually the first contact that the patients have with the healthcare system, and primary care has a gatekeeping function which refers patients to specialized hospital care when deemed necessary (Saunes et al, 2020). Hospital care is a more specialized form of health care, which is offered in more serious or complex cases. Because of this, hospital care is only given at hospitals, as more specialized personnel or more resources are required. The two countries differ regarding the way that primary care is organized. In Sweden, healthcare is a responsibility of the county council, who govern the regions in Sweden, and primary care is mainly given through "vårdcentraler," which can be both publicly and privately owned, although the former is more common (Anell et al, 2012). Patients are free to seek care throughout the entire country, although there are differences between the regions (1177, 2023). This differs in Norway, where primary care is a municipal responsibility and is based on a system of "fastlege," or general practitioners, shortened to GP's. Unlike in Sweden, where patients apply to a specific healthcare facility and get given a doctor at that facility, in Norway, patients apply directly for a GP, which are usually self-employed. (Saunes et al, 2020). As such, primary care is given at the "Fastlegekontor," or the general practitioners office (Helsenorge, n.d.), and private facilities are more common than in Sweden (Saunes et al, 2020). For the purposes of this thesis, a facility which provides primary care is referred to as a health center, in order to have a singular term for both countries.

The access to healthcare has changed over time and differs geographically. A report from the Swedish agricultural department examined healthcare accessibility between three different types of municipalities, urban, rural, and sparse rural (Jordbruksverket, 2013). According to this study, in 2011, there were on average 2315 inhabitants per health center in urban municipalities in Sweden, 3002 inhabitants per health center in rural municipalities, and 2744 inhabitants per health center in sparse rural municipalities (ibid). The same report also shows that the overall distance to a healthcare facility has decreased over time. In 2009, 23% of population in urban municipalities, 40% of the population in rural municipalities and 48% of the population in sparse rural municipalities had more than 5 minutes of car travel to the closest healthcare facility. In 2012, the numbers were 21%, 37% and 46% respectively (ibid).

However, each healthcare facility is not equal. As mentioned before, hospital care offers more specialized healthcare than the more general healthcare facilities, and as such there are much fewer hospitals than health centers. 70% of urban municipalities, 43% of rural municipalities and 33% of sparse rural municipalities offer hospital care. Furthermore, there is on average 8,4 facilities that offer hospital care in urban municipalities, while the corresponding number is 1 and 0,5 for rural- and sparsely populated rural municipalities respectively (ibid). The report

concludes stating that healthcare differs from other services, in that the population basis is somewhat even no matter the type of municipality (ibid).

Earlier in part 3.2, the importance of accessibility was discussed on a more general level, and how accessibility functions as a proxy for equality. This is even more prevalent regarding healthcare. Poor accessibility to healthcare comes with consequences and can lead to serious health issues. Several studies have pointed out that the rural population tend to utilize healthcare services less frequently than the urban population (Arcury et al, 2005; Chan et al, 2006), although it should be mentioned that these studies concern an American population and might differ in a Nordic context. For example, long travel times can lead to not seeking care in time. If a health center is an hour of travel away, that results in a total of two hours of travel time, as the patient also has to travel back to their residence, not including the actual time spent at the health center. Also, when the distances to overcome become longer, the importance of having a driver's license and access to a car increases, as public transport is usually quite poor in rural areas, thus decreasing accessibility to healthcare for those without (Arcury et al 2005). Finding the time to commit to such travels can be difficult, potentially leading to skipping out on more routine checkups deemed less important by the patient. This in turn can have dire consequences. As previously mentioned, a vital part of the primary care system is to find and prevent ailments before they evolve into something more serious.

Finally, another important aspect of healthcare is at home care, both in terms of having a healthcare professional visit a patient in their residence, but also the emergence of digital healthcare products, which aim to lower to need to travel for healthcare (1177b). At home care is important, but a physical presence at a health center is still necessary in many cases (ibid). Therefore, at home care will not be considered in this study.

4. Study areas

This analysis has been conducted on the county level, *Län* in Sweden, and *Fylke* in Norway. The study areas were mainly chosen due to their low population density. As mentioned under 3.1, low population density is a defining characteristic of rural areas, which this study aims to examine. For the Swedish part of the study, Västerbotten county was chosen, and can be seen in figure 1. Västerbotten county has a population of 271 500 (SLU, n.d.). The county has a population density of 5 inhabitants per km^2, which can be compared to the national population density of 25,4 inhabitants per km^2 (Statistics Sweden, 2019). There are a total of 15 municipalities in Västerbotten, which can be seen in figure 1. The influence of Christaller's (1933) central place theory is apparent in Västerbotten, as the theory was used a basis for the Swedish municipal reform in 1971, which focused on each municipality having a central place or central locality, and as such, several smaller municipalities were merged together, and each municipality has a clear population center (Statistics Sweden, 2020).

The coast of Västerbotten is significantly more populated than the inland. Almost 80% of the population lives in one of the four municipalities along the coast, with 47% of the county population living in Umeå municipality alone (Statistics Sweden, 2019). The three biggest urban localities in Västerbotten are Umeå, Skellefteå and Lycksele (Statistics Sweden, 2020). Further inland is much less populated, with the westernmost parts of Västerbotten mainly consisting of mountainous areas, which means that the roads there are fewer and farther between.

Figure 1: Overview of the Västerbotten study area, divided into the municipalities.

For the Norwegian part of the study, the county of Nordland was selected as the study area. Nordland has a total population of 241 626 (Geonorge n.d.). Nordland is one of the least densely populated counties in Norway, having a population density of 6,2 inhabitants per km^2, which is the second lowest population density of any county in Norway after Troms og Finnmark, and can be compared to the national population density of 15 inhabitants per km^2 (Statistics Norway, 2019a). However, Troms og Finnmark is as of writing going through a separation process. Therefore, Nordland was chosen instead, as an analysis of an area that will not "exist" in the near future was deemed less interesting.

Nordland is a narrow county mainly consisting of a coastline, with many fjords and mountains. These geographical features heavily impact the population pattern and transportation opportunities in the county (Geonorge, n.d.). Many localities only have a few roads going between them, while some areas are even completely inaccessible via road travel. As can be seen in figure 2, there are a total of 45 municipalities in Nordland. It is worth noting that Norway has started municipal reformation, which aims to drastically lower the number of municipalities in the country by merging smaller municipalities together (Stortinget, 2015).

Of the 45 municipalities in Nordland, only three are landlocked. Several of the islands along the coast are populated, with some even constituting their own municipality. These are connected to the mainland via ferry (Reis Nordland, n.d.). The three biggest urban localities in Nordland are Bodø, Mo i Rana, and Narvik. Their respective municipalities have a population of 52 024, 26 315 and 18 630 (Statistics Norway, 2019a). The population of Norway is generally more spread out than that of Sweden (Knudsen, 2020), which can be seen on the county level as well. For example, Nordland has a total of 7 urban localities with a population of more than 5000 (Statistics Norway, 2019a), comparatively, Västerbotten only has 4 (Statistics Sweden, 2020). Umeå, the biggest municipality in Västerbotten, has almost twice the population of Bodø, the biggest in Nordland.

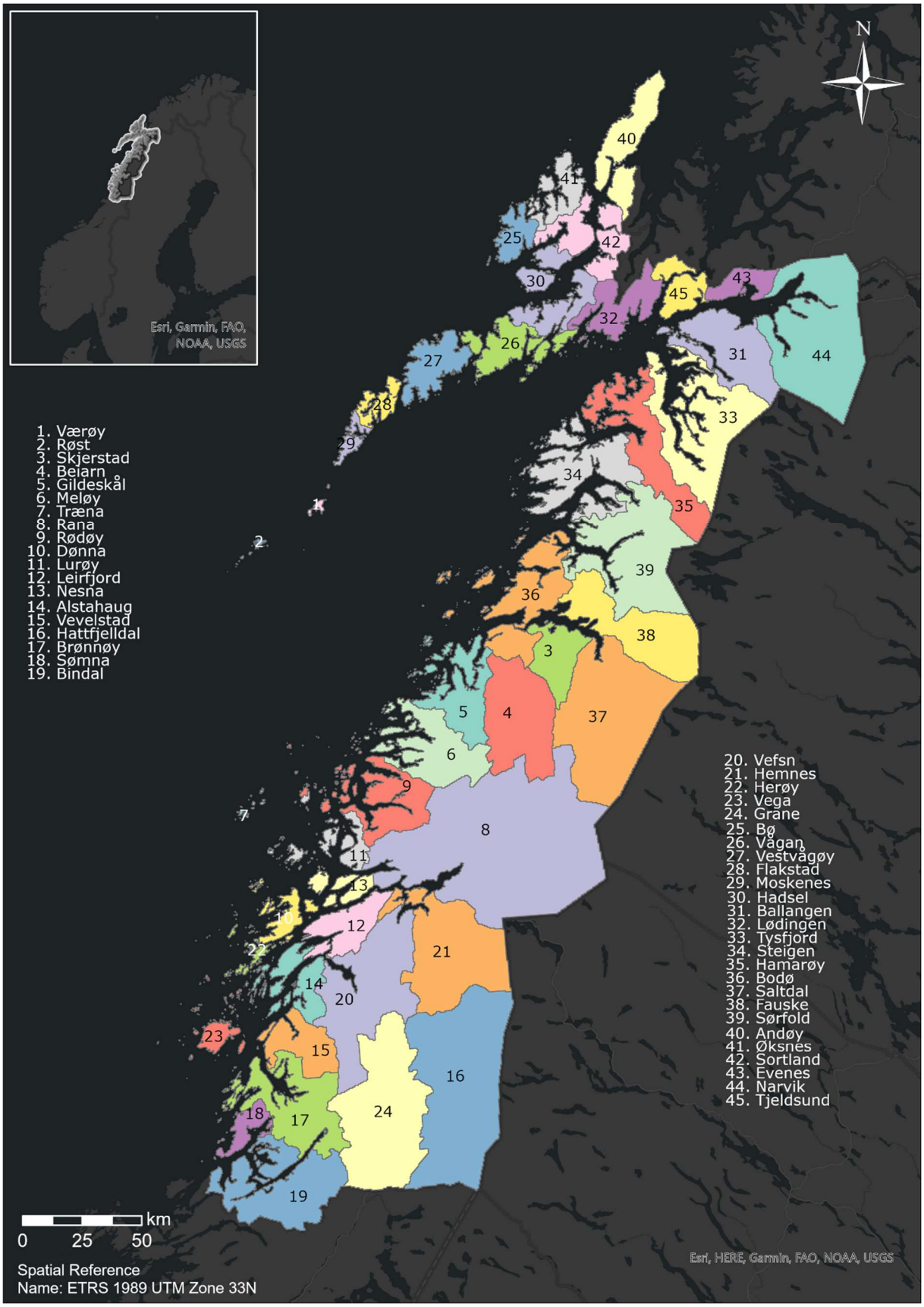

Figure 2: Overview of Nordland study area, divided into the municipalities.

5. Method

5.1. Methodology

This study has had a positivist point of view and has been performed with a deductive approach. This means that this thesis sees knowledge as hard data and views the world as objectively measurable (Söderbom & Ulvenblad, 2016). A quantitative method was chosen as it is a suitable method for analyzing large amounts of data (ibid), such as geographical data in the form of a network analysis.

5.2. Delimitations

This analysis is based on accessibility to health centers via car travel. Given the large distances across the study areas, pedestrian and cycling travel modes are deemed unrealistic choices. In addition to this, the personal car is the most common mode of travel in rural areas (Trafikanalys, 2019). This selection also excludes public transit from the analysis. While public transportation no doubt is an integral part of travel in rural areas, public transit is less prevalent in rural areas than in urban areas (ibid). Furthermore, implementing more travel modes would make the scope of the analysis far bigger, creating potential problems in adhering to the strict deadlines for submission.

In this thesis, accessibility is measured by examining the number of people living within a certain relative distance, measured in travel time, from a healthcare facility. Other aspects of accessibility, such as economic accessibility or waiting times, have not been included in the analysis. The analysis is limited to examine health centers offering general primary care, and do not include the more specialized areas such as alcohol and drug rehabilitation or youth receptions, which are also categorized as primary care (Region Västerbotten, 2021).

5.3. Method description

This analysis has been made using a Geographical Information System, (GIS). GIS is a system that creates, manages, analyzes, and maps different types of data (ESRI, n.d.). A normal paper map can be seen as a type of GIS, but in modern times GIS is often a computer-based system. In this case, the software used was ArcGIS Pro, developed by ESRI.

In order to model and analyze travel time, a network analysis has been performed. A network analysis is a type of analysis which is based on a network dataset, which in turn is a way of modeling a transportation network using GIS. A network dataset consists of lines and points, or edges and junctions, in this case representing roads and intersections (ESRI, 2023a). A network can be more or less realistic, such as implementing speed limits, restricting travel for certain travel modes on roads where they are not allowed, or implementing traffic (ibid). It is also important that the network has correctly implemented connectivity. If two lines intersect, they are not automatically aware of each other (ibid). The connectivity, which makes it possible for the travel mode to switch from one line to another, is therefore implemented in a network dataset. On the other hand, it is also important that not every line is connected to each other, as certain lines represent tunnels or overpasses (ibid). All of these aspects have an effect on the results of the analysis.

There are several different types of network analyses, called solvers within ArcGIS. The cornerstone of this analysis is a service area analysis. A service area analysis is a type of network analysis solver which creates a service area for facilities imported into the analysis (ESRI, 2023b). The size of the service area is determined by the cutoff values defined by the user and

represents the maximum distance that can be traveled along the network, given the specified distance and travel mode. For example, a service area analysis would be able to show how far you can travel from a facility in five minutes, if you were to drive, following the speed limits. (ibid).

In this thesis, good accessibility is defined as less than an hour's total travel time to and from the nearest health center. This means anybody living within the 30-minute cutoff value. In addition to this, poor accessibility is defined as anybody living in uncovered areas, meaning more than an hour one way to the nearest health center, or two hours of total travel time.

To conduct the analysis, data for population, locations of the health centers, roads, and other contextual information was required. Table 1 shows the downloaded data used in the analysis, a description of the data, the year it concerns, the shape it was downloaded in, as well as the data source. All data used in this analysis is available to the public, although some required a university account to access.

Table 1: Data used in this study.

Features:	Description:	Date:	Shape:	Source:
Norway population data	Population data in the SOSI file format for the Nordland study area consisting of 1km*1km squares.	2019	Polygon	Geonorge (n.d.)
Sweden population data	Population data for the Västerbotten study area in a shapefile consisting of 1km*1km squares.	2019	Polygon	Svergies lantbruksuniversitet (n.d.)
Nordland health care facilities	Feature class containing the name and location of each health center in Nordland.	No date	Point	Based on a table from Helsenorge (n.d.), file created by the author.
Västerbotten healthcare facilities.	Feature class containing the name and location of each health center in Västerbotten.	No date	Point	Based on a map from 1177 (n.d.), file created by the author.
Swedish municipalities	Shapefile containing all the Swedish municipalities.	2015	Polygon	University of Texas at Austin (2015a).
Norwegian municipalities	Shapefile containing all the Norwegian municipalities.	2015	Polygon	University of Texas at Austin (2015b).
Urban localities Sweden	Shapefile containing every urban locality in Sweden with a population greater than 1000.	2020	Polygon	Statistics Sweden (2020).
Urban localities Nordland	Feature class containing every urban locality in Nordland with a population greater than 1000.	2019	Point	Created by the author, based on a list from Statistics Norway (2019b).

5.4. Workflow

The workflow for this analysis can be divided into several steps. The first step was to import the health centers into ArcGIS. No downloadable data with spatial information was found, so the health centers had to be digitized manually. For the case of Västerbotten, this was done by cross-referencing a map on 1177, the Swedish healthcare information service (1177, n.d.), containing every health center in Västerbotten against satellite imagery in ArcGIS Pro and creating a new feature for every health center. Overall, there were 39 health centers in Västerbotten.

For the health centers in Nordland, the process was more complex. Unlike in Sweden, in Norway, patients do not belong to a health center but to an individual general practitioner, or GP. As such, there is no data on the location of health centers within a region, only the GPs. Helsenorge, the Norwegian counterpart to 1177, has a webservice for changing GPs (Helsenorge, n.d.). This webservice consists of a table with a field containing address information for every GP. By filtering the table to only display GPs in the study area, and then sorting the address field by alphabetical order, it was possible to manually make a new excel list containing each unique health center in Nordland, including both the name of the facility as well as the address.

Then, by inputting the name of the health centers into google maps, it was possible to cross reference the address information between google maps and the excel list. Once the address was confirmed, it was imported into ArcGIS's address locator functionality, and then digitized in the same way as described before. In most cases, the address for the facility in google maps matched the address in the excel list. Occasionally, however, the address would not match. These issues were settled on a case-by-case basis, manually examining the locations to determine the most reasonable outcome. Examples of such issues include name-changes of the practitioner's office and incomplete addresses in the original source.

The next step was to conduct the service area analysis, which requires a network data source to base the analysis on, i.e., the road network from which to calculate the drive time to each health center. This was done by connecting to ArcGIS Online and making use of the network data available from the ArcGIS Online services. These services give access to road network data across the world managed by HERE, with Sweden and Norway having some of the highest quality data available for any country, recently updated in Q3 of 2022 (ESRI, 2022). The network includes not only car roads, but also includes car ferries. The network dataset restricts car travel on roads where it is prohibited to drive, such as on cycleways. Moreover, the network takes speed limits into account when calculating drive time, and also implements turn delays. A turn delay is a constant time delay for any turn performed during travel, depending on the type of turn. For example, if the car has to make a left turn at an intersection, five seconds is added to the travel time (ESRI, 2023c). Without turn delays, the network will assume that the car turns instantly on to the next road, which is less realistic and results in lower travel times than in reality. One-way directionality and roadblocks are also implemented in the network, once again resulting in a more realistic network. In addition to this, elevation is implemented in the network, leading to tunnels and overpasses being correctly modeled. It is also possible to enable traffic, however, given that traffic is highly dependent on time of day, it was not enabled for this analysis.

The following step was to create the service areas, representing the area of accessibility to a health center. The health centers were imported as facilities in a service area layer. The settings used for the creation of the service areas were as follows: The travel mode was set to car. The direction was towards facilities, given that patients travel to health centers. The service areas use standard precision and are of the polygon type. The service areas were set to dissolve, meaning that one service area is created for each cutoff value, instead of one service area for each health center. Four different cutoff values were used, the first of which was 5-minutes, as previous studies (Jordbruksverket, 2013) have stated that around 50% of the population live within 5 minutes of a health center. The second cutoff value was 15 minutes, the third cutoff value was 30 minutes, and the final cutoff value was 60 minutes. Given that these cutoff values represent traveling towards the health center, the total travel time is twice as long, as the patients in most cases need to return home.

With the service areas created, the final part was to analyze how many people and what share of the population lives within each cutoff value. The population data used to calculate this was downloaded in a polygon grid format. This means that the data consists of 1x1 km squares, which contain a value representing the total population living within that grid. By utilizing selections and selecting each grid within a service area, it was possible to summarize the total population living within a distance from a health center. The selected grids were then deleted to prevent the population from being counted again in case the grids overlapped. This was done for each service area, finally ending up with only those living in uncovered areas, that is, areas which are further than 60 minutes from a health center.

Another way of doing this would have been to transform the grids into points, which would prevent any overlapping of grids between service areas. The current method slightly overestimates the population in the service area that was counted first, as that service area was "given" any population which overlapped between two service areas. In this case, the lower cutoff values were counted first. The reason this alternate method was not done is because many points end up slightly outside the service areas, even though they are clearly supposed to be within, thus leading to an overestimation of the population in uncovered areas instead. The overall issue of using grids instead of points was not deemed to have a significant impact on the results.

Lastly, with all population data counted, the size of each service area, the share of each service area, the total population, the population share, and the population density of each service area was calculated and compiled in a table, with maps being created to show the service areas in both study areas.

5.5. Method discussion

A service area analysis works on the presumption that individuals will always choose the closest available facility and does not take factors outside of distance, such as personal preferences, into consideration. According to Haugen (2012), distance is far from the only factor affecting the choice of destination. Over time, individuals have become more selective when deciding their destination, picking destinations that match their personal preferences instead of settling for a closer but less attractive option (Haugen, 2012). However, the overall impact that this has on the results of this study is deemed to be low. Farrington and Farrington (2005) argue that in rural areas it is a matter of being able to reach the services that exist, lowering the importance of personal preferences.

When searching for litterature and scientific articles, there has been a limitation on me as a researcher, given that I do not speak Norwegian. This has made me unable to access and process some sources which might have been of use for the thesis. However, the most important parts are still available written in English, and as such should not significantly impact the thesis.

Manually having to digitize the health centers comes with the risk of missing facilities, which would result in the accessibility appearing lower than in reality, thus decreasing the validity of the analysis. This is particularly noticeable in Nordland. During the digitization process of the health centers in that county, an issue became apparent regarding certain healthcare facilities showing up on google maps that were not on the list. These were generally spotted in urban areas while digitizing other facilities nearby. Given that the list is based on Helsenorge, the official website for healthcare services in Norway, any facility not included in the original table was not digitized and as such is not part of this analysis, as attempting to manually examine the entire county is not feasible.

The definition of good and poor accessibility is subjective and can be discussed. It is hard to find a previous study whose definition of good accessibility properly fits this study, as any value is dependent on that specific study area and also the specific activity. Good accessibility in urban Amsterdam is not the same as in rural Norway, nor is poor accessibility to supermarkets the same distance as poor accessibility to primary care facilities. The definitions used in this thesis is based on the concepts of time geography discussed earlier in section 3.2. At more than an hour of travel time, it becomes hard to fit health center visits in daily life without missing out on other semi-required activities, such as work.

The population data is based on the year 2019. This was the latest year which population data for GIS could be found for Nordland. Therefore, to better compare the two, the same year was used as a basis for all population data. The only exception to this is the shapefile containing urban localities in Sweden, which is from 2020. This file was mainly used for contextual information and does not impact the results.

5.6. Reflexivity and ethical considerations

This thesis has been written from a Swedish perspective, given that I, the author, am Swedish. I am aware that this can affect my judgement, especially when comparing Sweden with another country. Even though a quantitative study contributes to making the study more objective, it is impossible to be fully objective. I have kept this in mind throughout the entire writing process and have actively worked to diminish the influence of my own personal values. In addition to this, this thesis has only made use of publicly available data from official sources which follow international guidelines regarding the managing of data (Statistics Sweden, n.d.). Health is normally seen as sensitive information, however that is in regard to personal information, which this thesis does not include. With all of these aspects in mind, I deem that this thesis does not entail any ethical issues with either the data material or the study as a whole.

6. Results

6.1. Västerbotten

6.1.1. Health centers in Västerbotten

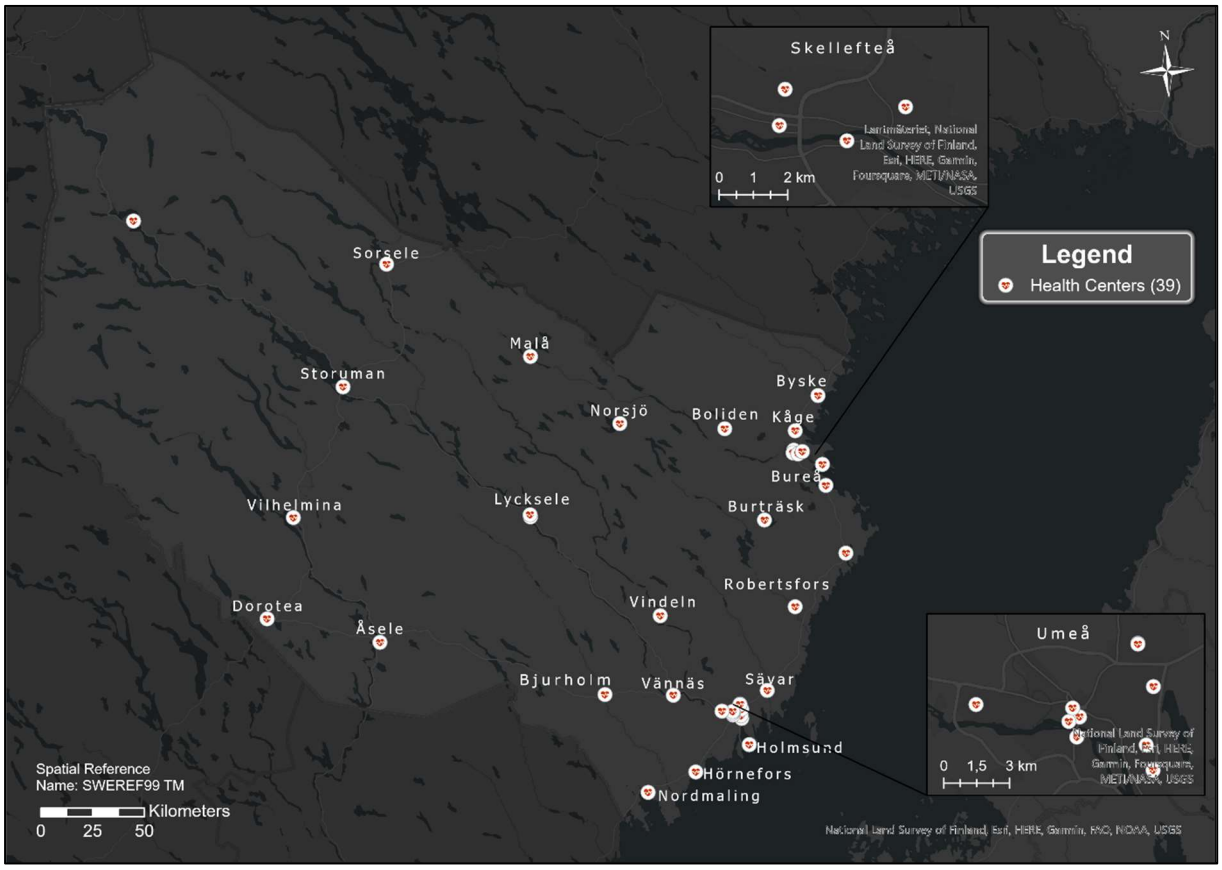

Figure 3: Health centers and urban localities with more than 1000 inhabitants in Västerbotten.

Figure 3 displays every health center in Västerbotten, alongside a label for every urban locality with a population of more than 1000 inhabitants. In total, there are 39 different health centers in Västerbotten, which when divided by the total county population of 271 500 results in an average of 6962 inhabitants per health center. Out of the 39 health centers, five are privately owned. One of them is located in Lycksele, while the others are located in Umeå. Most of the health centers are located along the coastal areas of the county. Within the urban area of Umeå there are a total of nine health centers. Within the urban area of Skellefteå, there are four health centers. Lycksele is the only other urban area that has more than one health centers, having two. Moreover, there are two health centers which are not located in urban localities with a population of more than 1000. These are located in Tärnaby, in the northwestern parts of the county, and Lövånger, located along the coast. No urban locality with more than 1000 inhabitants is without a health center.

The municipalities of Umeå, Skellefteå, Lycksele and Storuman are the only ones with more than one health center within their borders. In addition to this, and with the exception of Umeå and Skellefteå municipality, Tärnaby is the only health center not located in the central locality of the municipality.

6.1.2. Västerbotten service area analysis

Table 2: Area and population statistics for each service area in Västerbotten.

Västerbotten

Service area cutoff value	Area size (1000 km^2)	Area%	Population Amount	Population%	Population density (per km^2)
5	0,29	0,49%	191 990	70,71%	662,03
15	3,79	6,40%	52 267	19,25%	13,79
30	16,07	27,15%	22 568	8,31%	1,40
60	23,37	39,49%	3560	1,31%	0,15
Uncovered	15,66	26,46%	1115	0,41%	0,07
Total	59,18	100,00%	271 500	100,00%	4,59

Table 2 shows the attributes of each service area. Service area cutoff value refers to the upper drive time limit of each area. For example, the service area cutoff value of 5 represents the service area that is between 0 and 5 minutes of driving to the closest health center. Area size refers to the total size of that service area, while Area% shows the share of the county's total area. There is a big difference in service area size between the different cutoff values. Slightly less than 0,5% of the total county area is within 5 minutes of driving from a health center. The largest share of the county area has between a 30- and 60-minute drive to the nearest health centers. 26,46% of the county area is classified as uncovered, meaning that there is more than a 60-minute drive to the nearest health center.

Population amount refers to the amount of people living in each service area, while Population% shows the share of the total population living in each service area. Over 70% of the population in Västerbotten live within 5 minutes of driving from a health center. Slightly less than 20% live within 5 to 15 minutes driving time of a health center. Together, these two service areas contain more than 90% of the population, a total of 244 167 people. About 8,3% of the population live in the 15-to 30-minute range, while 1,3% of the population live in the 30- to 60-minute range. Only 1115 people, or 0,41% of the population lives more than an hour's drive away from a health center. Both the population amount and population percentage decrease with every cutoff value farther away from a health center, as does the population density, which shows how densely populated each service area is.

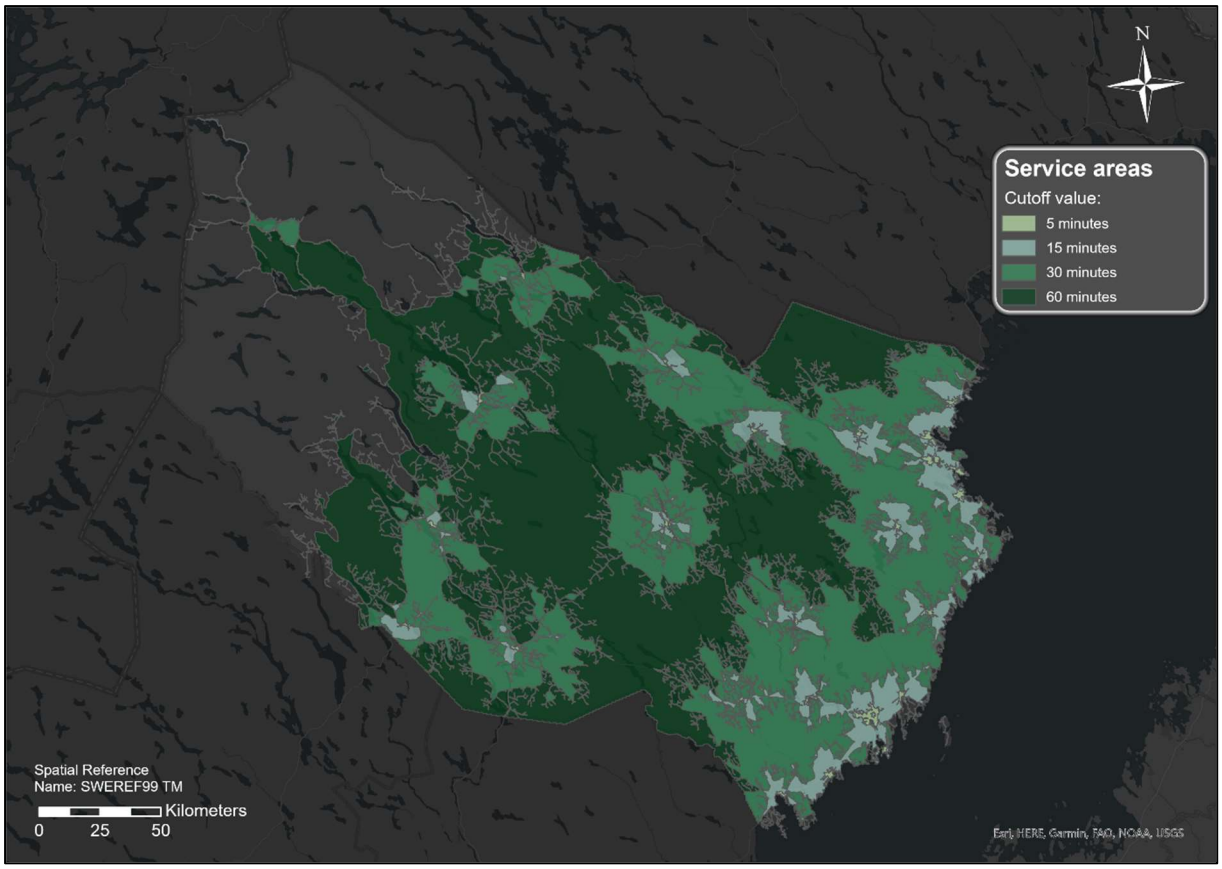

Figure 4: Service areas for health centers in Västerbotten.

Figure 4 shows the output from the service area analysis conducted for Västerbotten. The figures shows that most of the uncovered area is located in the western parts of the county, while parts of the coast are also uncovered. The latter has more to do with a lack of roads in the area, while the uncovered area in the west has more to do with the distance to the nearest health center. In the easternmost parts of the county, most areas generally have a lower travel time to the nearest health center compared to the areas more to the west.

6.2. Nordland

6.2.1. Health centers in Nordland

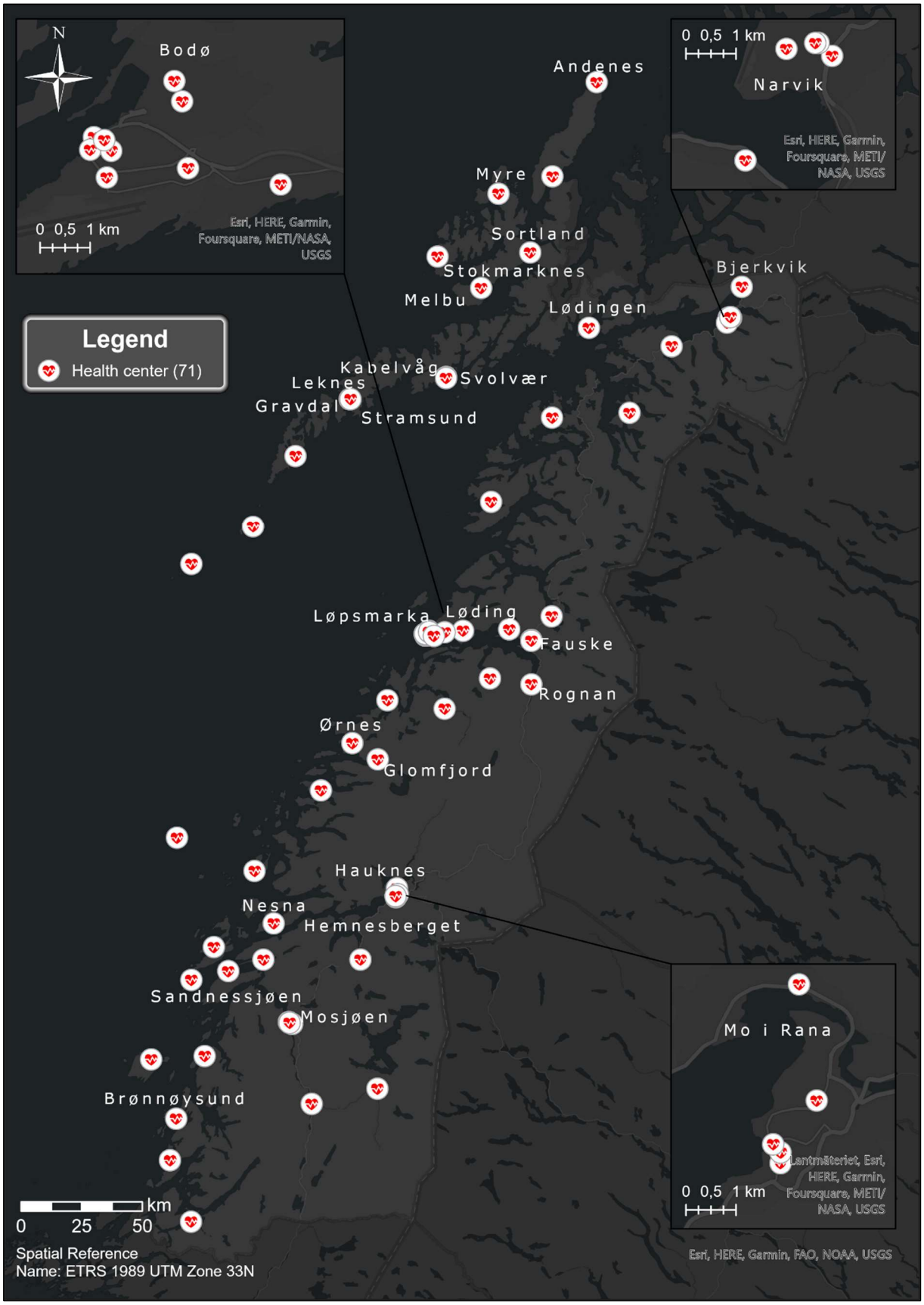

Figure 5: Health centers and urban localities with more than 1000 inhabitants in Nordland.

Figure 5 shows all the health centers in Nordland, alongside labels for every urban locality with a population greater than 1000. There are a total of 71 health centers in Nordland. Dividing this number with the total county population results in an average of 3403 inhabitants per health center. The health centers are geographically spread out over the county. 27 of the health centers are not located in urban localities with more than 1000 inhabitants.

Six out of the forty-five municipalities have more than one health center within their borders. On the other hand, two municipalities have no health centers, these being Evenes and Tjeldsund. There is at least one health center in every other municipality.

6.2.2. Nordland service area analysis

Table 3: Area and population statistics for each service area in Nordland.

Nordland

Service area cutoff value	Area size (1000 km^2)	Area%	Population Amount	Population%	Population density (per km^2)
5	0,27	0,70%	160 701	66,51%	591,04
15	1,03	2,67%	49 920	20,66%	48,35
30	2,90	7,50%	19 603	8,11%	6,77
60	5,94	15,37%	9036	3,74%	1,52
Uncovered	28,49	73,76%	2366	0,98%	0,08
Total	38,63	100,00%	241 626	100,00%	6,26

Table 3 show the attributes of the service areas in Nordland. Almost 74% of the entire county area is classified as uncovered, while 15% of the county area is between a 30-to 60-minute drive to the nearest health center. Together, these two service areas make up almost 90% of the total county area. 0,7% of the area has less than five minutes of drive time to the nearest health center. 2,7% of the area is within 5 to 15 minutes away, and 7,5% is 15 to 30 minutes away.

On the other hand, 160 701, or 66,5% of the population lives within the 5-minute range, while 49 920, or 20,6% of the population lives within the 5-to 15-minute range. Together, these make up around 87% of the total county population. Around 8% of the population have between 15 to 30 minutes of driving to the nearest health center, while 3,7% have between half an hour to an hour to drive before arriving at the closest health center. Lastly, 2366 people, or around 1 percent, live more than an hour's drive away to the nearest health center.

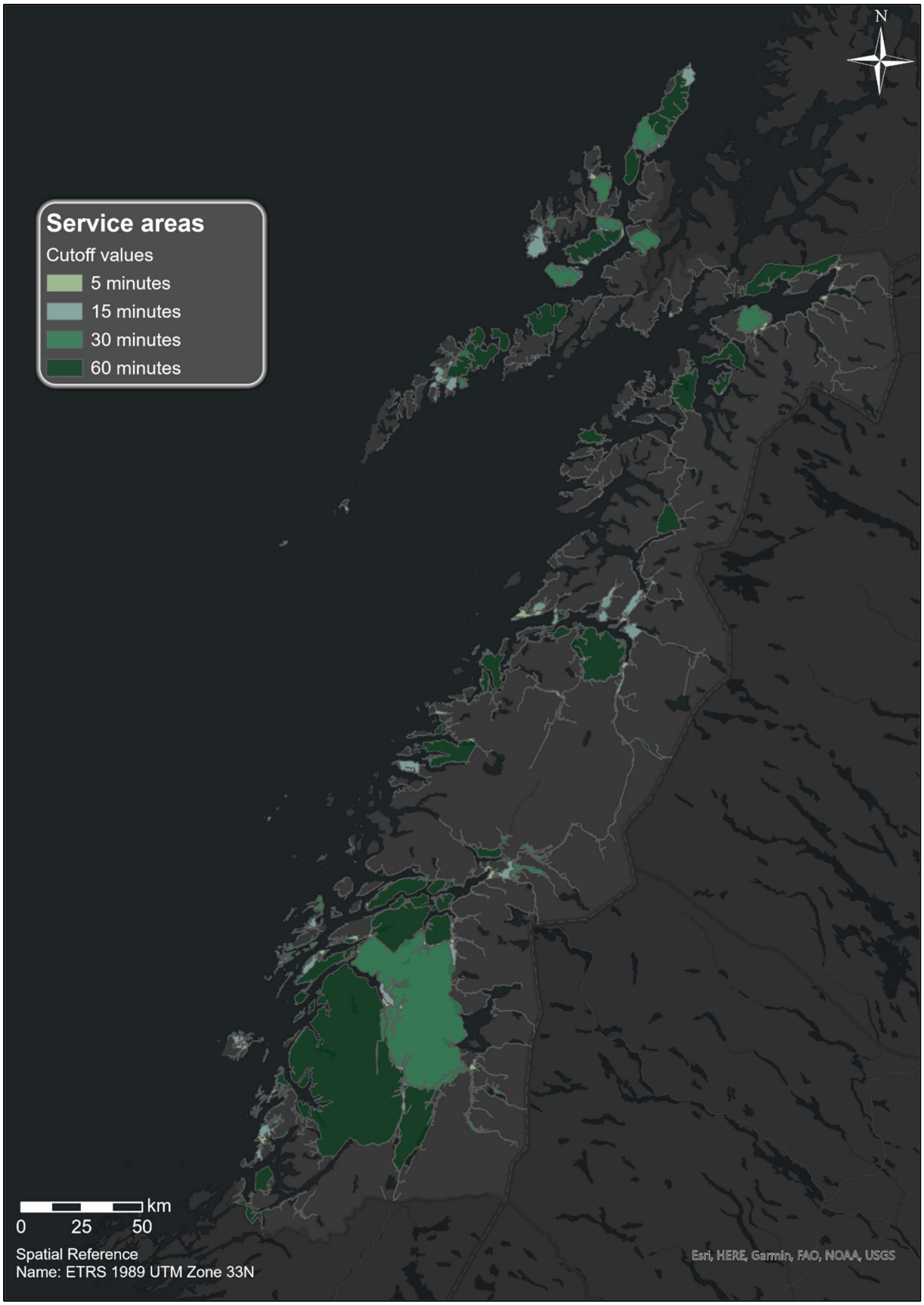

Figure 6: Service areas for health centers in Nordland.

Figure 6 shows the resulting output of the service area analysis conducted on the health centers in Nordland. Many parts of the country are completely uncovered, with individual roads connecting larger covered areas together. Noticeably, the entire border region to Sweden is mostly uncovered, as are many of the islands along the coast. The travel times for ferries are included in the service area analysis, however they are not visible in the map due to cutting the results against the county border in ArcGIS. They do not however impact the results, as no ferry has less than an hour of travel time.

6.3. Comparative analysis

Comparing the results between the two study areas, both counties have a high level of accessibility to health centers. Accessibility is somewhat better in Västerbotten than in Nordland, with 70,7% of the population in Västerbotten having less than five minutes to the nearest health center, while the corresponding value for Nordland is 66,5%. Both of these numbers are much higher than the previously mentioned figure of 48% (Jordbruksverket, 2013), although that value was derived from a study looking at the municipal level, which would affect the findings.

Both study areas follow a similar pattern, with the population decreasing alongside an increase in distance from a health center. In addition to this, the population density value of each service area generally shows that areas farther away from a health center are more sparsely populated, as it decreases with distance. At the 5- to 15-minute cutoff value, Nordland has a slightly higher share of the population, 20,6% compared to 19,2% in Västerbotten. At the 15- to 30-minute cutoff, Västerbotten has a population share of 8,3% while Nordland has a population share of 8,1%. At the 30- to 60-minute cutoff, there is a much bigger difference. Västerbotten has a value of 1,3%, while Nordland has 3,7%. This results in a difference of 5477 more inhabitants having between 30 to 60 minutes of travel time to a health center in Nordland than in Västerbotten. Lastly, 2366 people, or around 1% of the population in Nordland, live more than an hour away. That number is 1115 people, or 0,4%, in Västerbotten, resulting in a difference of 1251 people. These differences are despite the fact that Nordland has a population that is smaller than Västerbotten by 29 874 inhabitants.

Overall, including the fact that patients have to make return trips as well, 266 825 people, or slightly more than 98% of the total Västerbotten county population have good accessibility to health centers. Furthermore, 1115, or 0,4% of the population, have poor accessibility, living more than two hours of total travel time away from the nearest health center. In Nordland, 230 224 people, or about 95% of the total county population have good accessibility to health centers, while 2366 people, about 1% of the population, have poor accessibility.

The size of the service areas also varies between the two counties. In Västerbotten, the 30- to 60-minute range make up most of the land area, constituting 39,49% of the total county area, or 23 370 km^2. In Nordland, the vast majority of the county is instead classified as uncovered. 28 490 km^2, or 73,7% of the total county area is classified as uncovered. These differences can mainly be explained by differences in geography between the two counties. Many of the roads in Nordland are built around natural objects, such as mountains and fjords. Therefore, in Nordland, many areas have comparatively few roads in the less populated areas of the county. Since the service areas are created based on the network dataset and the roads in the dataset, a lack of roads will lead to a lack of coverage.

It also interesting to note that the 5-minute service area has a greater share of the total county area in Nordland than in Västerbotten, despite the population share being much bigger in that service area in Västerbotten, with a difference of about 4 percentage points.

There is also a substantial difference regarding the amount of health centers. Despite having a smaller population and a smaller total area, Nordland has 71 health centers compared to the 39 health centers in Västerbotten. Due to this, Nordland has an average of 3403 inhabitants per health center, while Västerbotten has an average of 6962 inhabitants per health center, which is more than double, and is also more than twice as a high compared to the numbers stated in the previously mentioned report from the agricultural department (Jordbruksverket, 2013).

7. Discussion

In summary, the results indicate two main differences between the study areas. The first is the difference in accessibility. In both counties, accessibility is generally good, however, it is noticeably better in Västerbotten than in Nordland. The second, and bigger difference is the amount of health centers between the two study areas as well as the resulting average amount of inhabitants per health center. Västerbotten having more than double the inhabitants per health center could be seen as an indication of the longer waiting times that have long affected the Swedish healthcare system (Anell et al, 2012), there are simply too few health centers per person, leading to it taking longer for the patients to get care. It is important to note that this does not consider differences in size between different health centers. If a health center in Västerbotten can handle twice as many patients as one in Nordland can, this difference is moot.

Both of these differences can mainly be explained by geographical factors, such as the different population patterns. As mentioned before, the population of Nordland is much more spread out and not as concentrated in the biggest urban areas as in Västerbotten. This leads to a larger share of the Nordland population having comparatively longer distance to the nearest health center than in Västerbotten, as fewer people live in the central locality where the health center most often is located. I would argue that the population pattern in Nordland has historical roots based in the county's natural geography, however, the regional policy of Norway has enabled the population to actually stay spread out in a way that Sweden has not. Another example of this are the municipal reforms that Sweden has performed, which have drastically lowered the number of municipalities. However, the fact that Norway is now also in the process of a new municipal reform, aiming to decrease the number of municipalities by a very large number, might be an indication of change.

For this thesis, it is impossible to assess the direct impact regional policy has had on primary care accessibility, however the indirect impact from regional policy is noticeable. The Norwegian focus on local development, tailormade support and the outspoken value of keeping the entire country populated can be seen in, for example, the different population patterns. A good indicator of the different approaches that Sweden and Norway have taken in regard to regional policy can be seen in the amount of health centers located outside of urban localities with more than 1000 inhabitants in the respective study areas. In Västerbotten, that number is two, in Nordland, that number is twenty-seven. This shows that in Norway, services are not just located in the central locality of each municipality, although Nordland also has a lot more municipalities than Västerbotten, which could also be seen as a consequence of the different approaches. This difference in the health centers' location could also be a consequence of the GP system in Norway, which focuses on privately owned and operated healthcare facilities, financed by the municipality.

On a personal level, these results are surprising. Not only did the amount of the population in both countries have drastically better accessibility than I imagined at the start of this thesis, but also because much of the public debate that I have seen has revolved around Norway being "better" than Sweden regarding rural questions. Therefore, I was expecting Nordland to have noticeably better accessibility than Sweden, which is not the case. However, it is not hard to envision that the public debate is influenced by "the grass is always greener" thinking, and also that the main differences between Sweden and Norway would not be seen in this type of study, aspects like healthcare quality, working conditions, etc.

On a more general level, the results help point out the underlying inequality between the urban and rural population in both countries. As pointed out in previous studies (Arcury et al, 2005 & Chan et al, 2006), the rural population utilizes healthcare services to a lesser extent than the urban population. The difference in travel time no doubt impact this. Keeping in mind that most health centers are open during standard office hours, such as 08:00 to 17:00 on weekdays, a total travel time of one hour can be very difficult to fit in the patient's daily schedule, as it would have to compete for time with other activities such as work. Comparatively, with a total travel time of less than 10 minutes, a health center visit is much more manageable, sometimes even possible during a lunch break. Although it might not seem like such a big difference, as previously mentioned in section 3.4, healthcare, specifically primary care, is one of the services that the rural population generally enjoys good accessibility too, while other services are the ones where the big differences are found between the urban and the rural. It also worth noting that there might be bigger differences regarding the quality of the healthcare provided between rural and urban facilities, which this thesis has not been aimed to address.

When relating the findings of the analysis to Haugen's concepts of accessibility, a difference between the two study areas emerges. In Nordland, there seems to be bigger issues with mobility hampering accessibility, as the geographical landscape limits transportation opportunity. Areas close together the way the crow flies become further apart in relative terms due to natural obstacles. Comparatively, in Västerbotten, the issue mainly seems to be distance based, with the biggest uncovered areas being those located farther away from the population centers. This can most clearly be seen in figure 4 and 6.

Lastly, it is worth discussing the extent of the goals of both countries regional policy. As previously mentioned, Sweden and Norway have stated, although to differing extents, that the entire country should have access to equal welfare and services, no matter where you live. This thesis indicates that this is not the case, as a part of the population has far less access to primary care services than others. On one hand, 2% or 4% of the total population of a rural county having more than an hour of total travel time for a health center visit might not seem like much. However, these are people who especially in Sweden, pay the same county council taxes as everybody else in the county, contributing just as much to the regional healthcare system, yet do not enjoy the same accessibility. On the other hand, is it really possible to accommodate absolutely everyone? It is not economically possible for everybody to have a health center within 5 minutes of their home, and other solutions such as digital healthcare and home visits do exist. The challenges of rural areas are well known, and it can certainly be argued that the cost of a lack of service is weighed up by the benefits of rural life for those who chose it. Because in the end, it is ultimately up to the individual to decide where they want to live their life.

Follow-up studies: While writing this thesis, several ideas for follow-up studies in the future have appeared. One suggestion is to conduct a similar study examining the accessibility to specialized healthcare instead of primary care. In addition to this, examining the accessibility to other public services, such as schools would bring further light on the topic of rural accessibility. Also, it would be interesting to analyze the consequences that closing a health center would have on accessibility. Another continuation is to conduct a survey-based study targeting the rural population and finding out what is considered good or poor accessibility from their perspective. Preferably, these last two suggestions are done comparing both Sweden and Norway, to go along with the theme of this thesis.

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