

Accessibility to urban areas of different sizes

- Modelling through indexed accessibility

The Swedish Agency for Growth Policy Analysis has developed a tool for measuring and analysing accessibility to urban areas, service and labour markets, which are important for people and businesses to be able to live and operate within a geographic area. The strength of the model is that, independently of geographical boundaries and working with different sizes of urban areas, you can "put reality on the map" and thereby provide a quick overview of how a certain area looks like in terms of, for example, population and access to different kinds of service.

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Preface

The Swedish Agency for Growth Policy Analysis has developed a tool for measuring and analysing accessibility to urban areas, service and labour markets, which are important for people and businesses to be able to live and operate within a geographic area. The model was created by the Swedish National Rural Development Agency, but has now been further developed within the framework of PiPoS; Pin Point Sweden; the geographic GIS-platform of Growth Analysis.

The strength of the model is that, independently of geographical boundaries and working with different sizes of urban areas, you can "put reality on the map" and thereby provide a quick overview of how a certain area looks like in terms of, for example, population, access to different kinds of service, etc.

The report was created by analyst Imber Råbock, whilst Erik Fransson, Anders Dahlgren and Annika Ryegård have also participated.

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1 Introduction

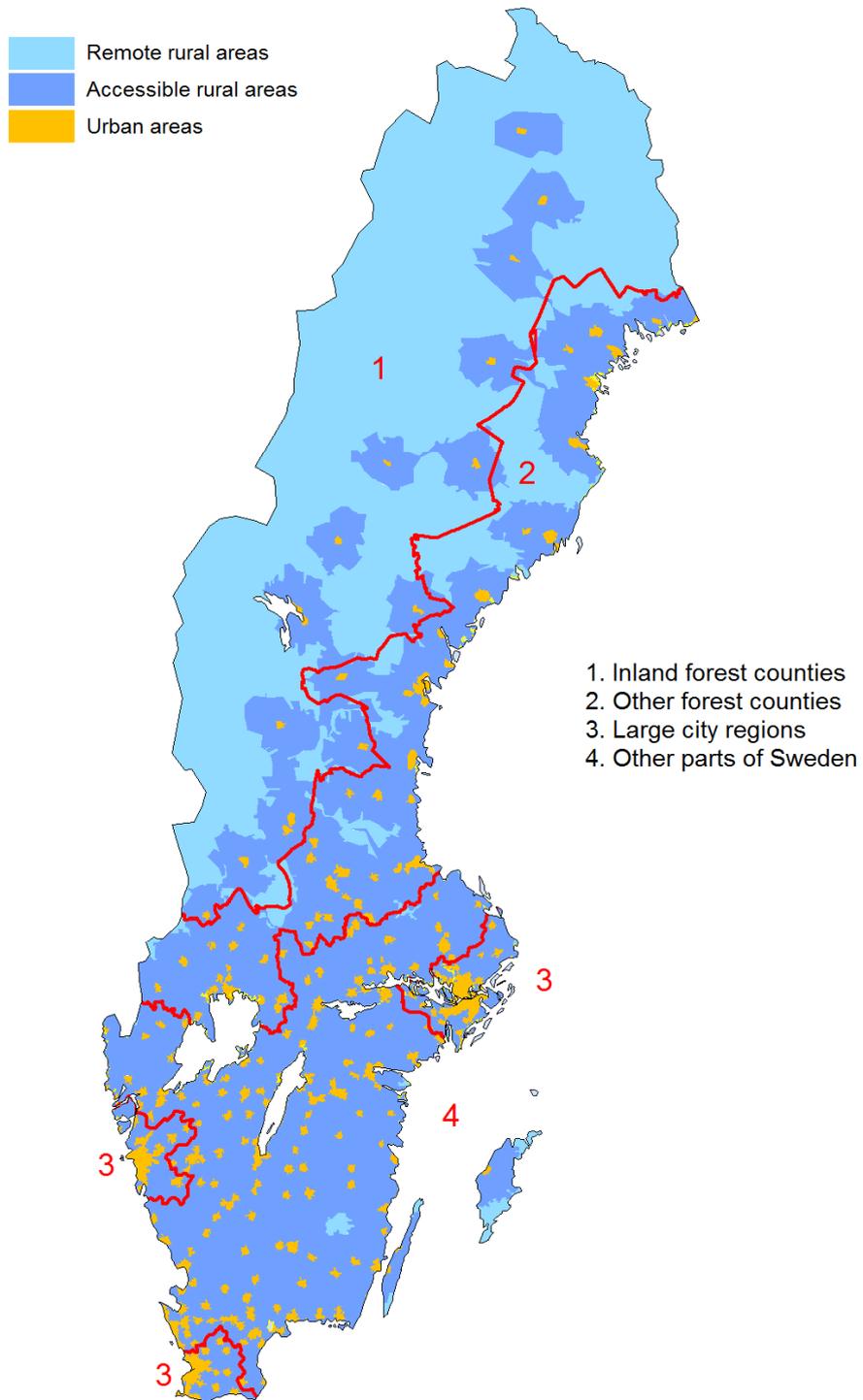
Growth Analysis needs to be able to do analyses regardless of administrative borders, and for this purpose coordinate data is used, where the population has been aggregated within 250 meter or kilometre tiles. This data is available in a geographic information system (GIS) that makes it possible to geographically slice statistics in a manner that is most relevant to the context.¹ Growth Analysis has developed an analysis tool to allow for investigations based on the accessibility of the population to different target points, in this context, urban areas. Accessibility to urban areas, and therefore to service and the labour market, is important to enable people and businesses to be able to live and operate within a geographic area, and is the main reason behind the model's development.

The model that is presented in this report has the accessibility of the population to urban areas as its starting point. This is based on the area type definition of the National Rural Development Agency², which differentiates between remote rural areas, accessible rural areas and urban areas. The purpose of the delimitation of the National Rural Development Agency is to separate, from an accessibility perspective, remote rural areas and accessible rural areas from urban areas, so as to make it possible to describe and follow up on the developments in these different areas. The definition does not take any administrative borders into account, which has been part of its strength, as administrative areas have been shown to be unsuitable in this context. The definition is based on settlements with a population of 3,000 or more. These settlements, including a surrounding commuting area of 5 minutes, are defined as urban areas. Areas with 5-45 minutes commuting time outside of the urban areas are called accessible rural areas, and areas with over 45 minutes distance to the closest urban area are defined as remote rural areas. In addition to the area type classification, four regions were developed to separate different parts of the country; *Inland forest counties*, *Other forest counties*, *Large city regions* and *Other parts of Sweden*. For years this definition has been used extensively, but the time has now come when it needs to be improved. Growth Analysis has therefore developed a **model for indexed accessibility**. The main objective of this document is to describe the method as a whole and the results from calculations of accessibility to urban areas.

It is important to point out that Growth Analysis, unlike the former Swedish National Rural Development Agency, does not have a mission to develop a new rural area definition, but rather to develop methods for regional analyses. Indexed accessibility can be used both to describe accessibility to urban areas and accessibility to the service functions of the community.

¹ This activity at Growth Analysis is gathered under the name *Pin Point Sweden (PiPoS)*

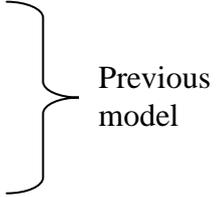
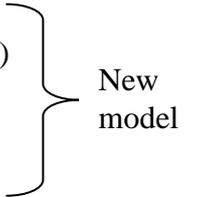
² Closed in 2009 (the operations were transferred to Growth Analysis and The Swedish Agency for Economic and Regional Growth)



Map 1 The definition of the National Rural Development Agency

2 Model specification

The new model, which is built on the former National Rural Development Agency definition of rural areas, is based on a number of demands being fulfilled. The model will retain the advantages of the previous model, whilst at the same time there are a number of areas that need to be improved. The demands on the model are shown below, together with the four points to be preserved from the earlier model, and four areas for improvement.

- Easy to convey
 - Independent of administrative borders
 - Accessibility as a common indicator
 - An overall picture of Sweden
- 
- Previous model
- More nuanced image of Sweden
 - Include different urban area sizes (not as sensitive to changes)
 - Give larger urban areas a greater weight
 - Show a gradient from the urban area and outwards (greater flexibility)
- 
- New model

3 Material and application

An important part of the model is that it will be based on nationwide official databases, to make it possible to use the results for national comparisons. The starting point comprises three layers of data:

The National Road Administrations' National Road Database (NVDB)

The population statistics of SCB (250 m resolution)

Target points, in this case Statistics Sweden's (SCB) definition of urban areas (2005)

The indexed accessibility analysis is then performed using an application called MapProx, developed by Growth Analysis and its predecessor, The National Rural Development Agency. Population statistics, target points (in this case urban areas) and the selected road network database are input into the application. The application calculates the actual distance between a populated tile and an urban area and then allocates each tile an index number, based on its distance from the target point. A number of functions have been created to refine the analyses. It is possible to choose which target points the application will calculate the distance to, based on their specific characteristics, for example, as in this case, different population sizes in the urban areas. The application also allows a maximum search distance to be set. The meaning of this is further described under section 4, Method.

The application is under constant development.

Map 2 shows the populated tiles that have been used in the calculations. Where there are no tiles, there is no population either. The tiles indicate where people are, or have been, registered to live during the period 1997-2008. This is the time interval for which Growth Analysis had access to data when the map was created. Archipelagos are not included.



Map 2 Populated 250 meter tiles

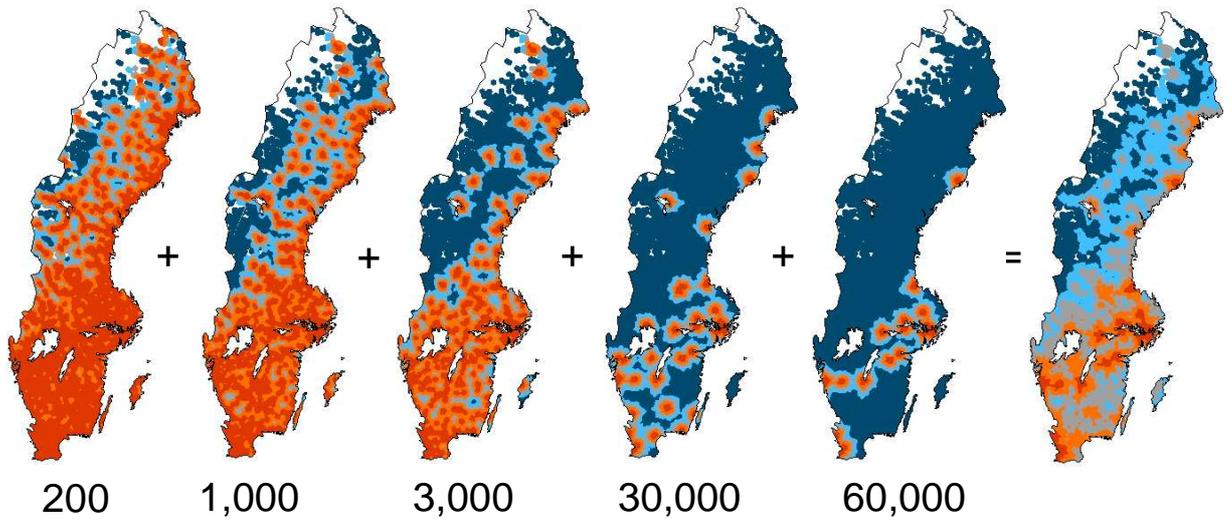
4 Method

4.1 Technical prerequisites

The model of Growth Analysis for indexed accessibility is based on a simple accessibility index, created by a number of accessibility analyses, where the target points can be, for example, urban areas of different sizes. The index is calculated by giving the populated tile furthest away from the target point the index value 100, and the one with the shortest distance is given the value 0. Because of human restrictions in movement over time and space, a 45 minute limit has been set in the calculations, based on an imagined longest day commuting time. The populated 250 meter tiles lying further than 45 minutes from the target point have been given the index value 100, that is, the highest value.

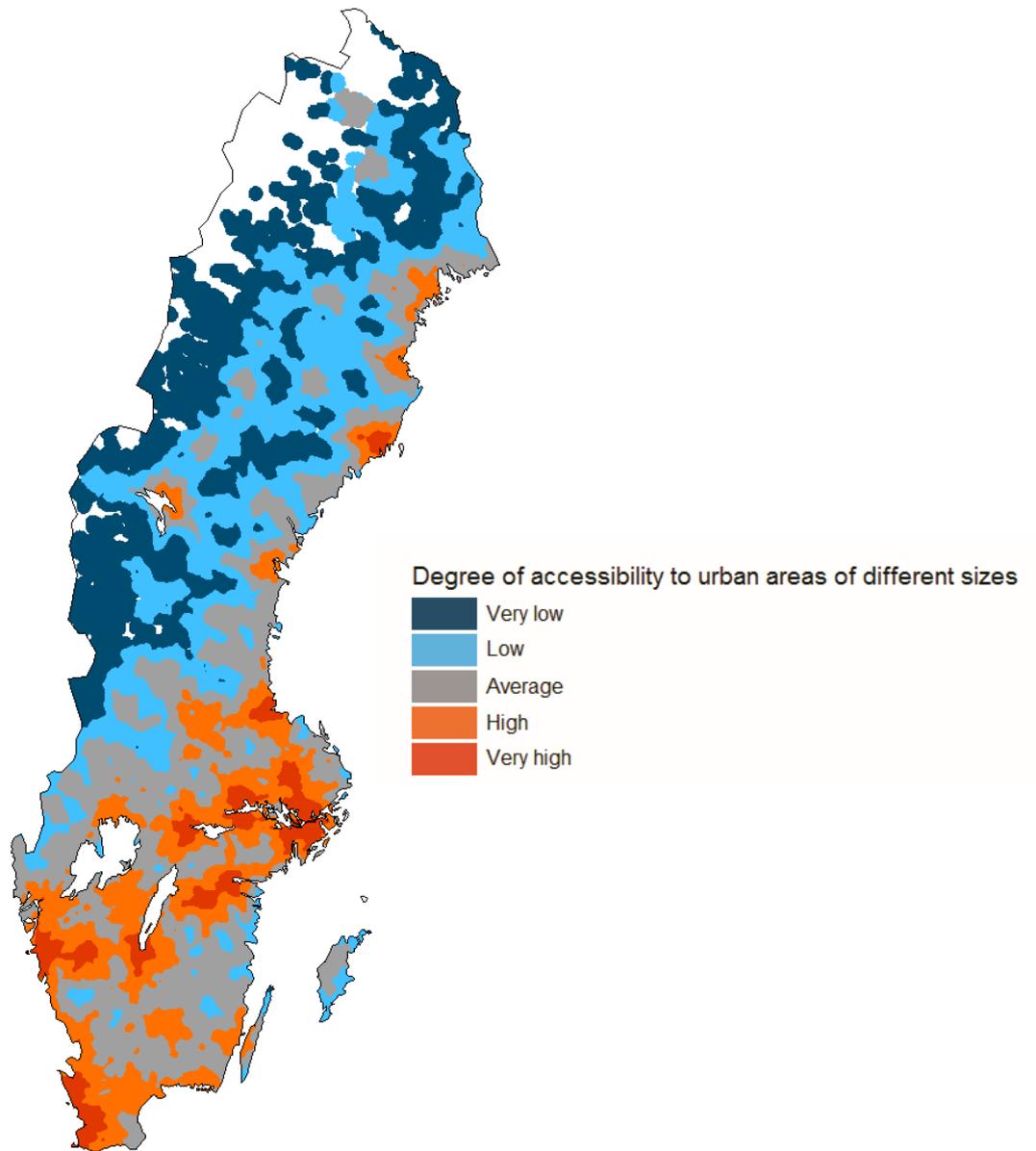
The model excludes areas defined as archipelagos, in this case, islands without a fixed land connection, excluding Gotland. The reason why these areas have not been integrated into the model is that in the archipelagos there are special circumstances regarding accessibility. It is also technically difficult to include these areas in the model.

The target point layer in the analysis presented in this report is based on urban area polygons of SCB from 2005, that is, the latest delimitation from SCB (a new classification will be available in 2011). The urban area sizes which have been considered relevant in this context and that have been used in the model are 200, 1000, 3000, 30,000 and 60,000 inhabitants. Thus, in the calculations, all urban areas with 200 and *more* inhabitants, 1000 and *more* inhabitants, etc. are included. As a result, the large urban areas will always get low index values in relation to the smaller ones. This is also a deliberate choice, as a large urban area should have a greater weight than a small one. The selection of urban area sizes have been made with the aim of differentiating the image in the sparsely populated areas, while at the same time marking the importance of the big cities. Which urban area sizes are the most important can probably vary a lot depending on the topic focused upon. For the analyses that are relevant for Growth Analysis, it has been shown that the urban area intervals chosen provide a good foundation for analysing the population of Sweden based on its accessibility to urban areas, and what consequences different accessibility to urban areas have on, for example, population development, employment, level of education and access to service.



Map 3-8 Basic data for index map and results

5 Results



Map 9. Classified map

5.1 Classified map

Since every accessibility calculation gives the tiles an index value of between 0-100, and five urban area classes are used in the analysis, every populated tile gets an index value of between 0-500. One way of making the material understandable is to divide the tiles into classes according to the index value, as in map 9. The classes are divided as follows; 0-99, 100-199, 200-299, 300-399, 400-500. Areas with an index of 500 are those which have the worst accessibility in the country. The model is flexible for several class divisions, and new divisions can be made as required.

What then is hidden in the different classes on the map? In areas with *very low* accessibility there are no urban areas with 1,000 inhabitants or more. These are very sparsely populated with small urban areas. Areas with *low* accessibility have no urban areas with 3,000 or more inhabitants, so they are also fairly sparsely populated with small urban areas, but not as clearly sparsely populated as the areas with *very low* accessibility. Areas with *average* accessibility contain urban areas with between 3,000-30,000 inhabitants. Areas with high accessibility contain relatively large urban areas (30,000-60,000 inhabitants), but also surrounding rural areas. In the areas with very high accessibility lie the largest cities in Sweden (over 60,000 inhabitants).

5.2 Population distribution

The population in the five intervals is very unevenly distributed. Close to 55 percent of the population lives in areas with *very high* accessibility, which have a rather limited surface area, but contain the large cities of Sweden. Just over 30 percent of the population in Sweden lives in areas with *high* accessibility, which encompasses areas close to the large cities. Almost 13 percent of the population is found in areas with *average* accessibility, comprised mostly of rural areas with smaller urban areas, primarily in southern Sweden. 2 and almost 0.5 percent respectively of the population live in the peripheral and sparsely populated areas, with *low* and *very low* accessibility. These areas take up a very large part of the country, but contain a small proportion of the population, while the geographically relatively limited areas with *very high* accessibility contain more than half the population.

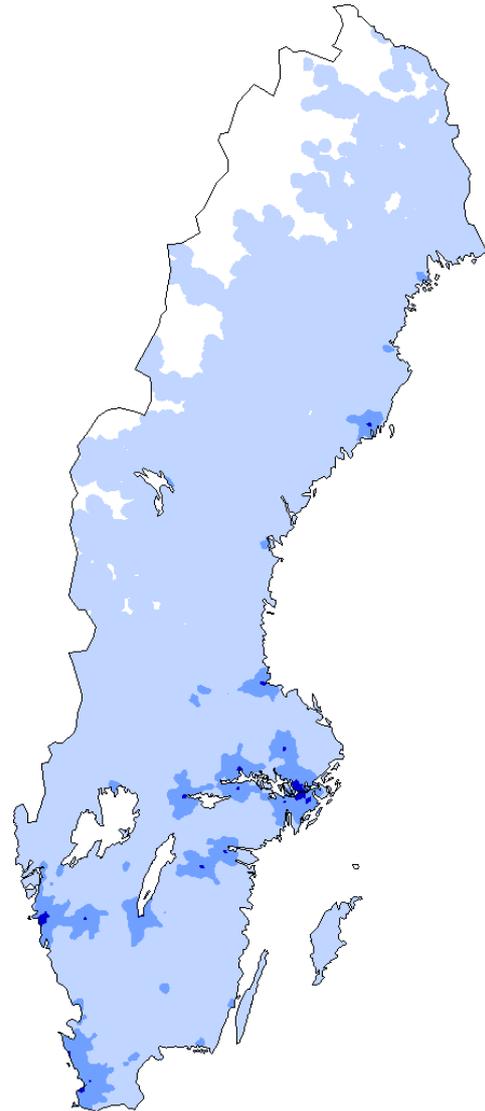
Degree of accessibility	Population 2008	Share of population
Very high	4984084	54,0
High	2858427	31,0
Average	1190613	12,9
Low	158801	1,7
Very low	32411	0,4

Table 1. Population distribution 2008, per class

A relevant question may be why the choice has been made to so forcefully clarify the most peripheral areas, while the most accessible, and thereby most populated, have been so generalised? It is difficult to model an image that is valid for all of Sweden, since the

population is very unevenly spread. In this context, we have chosen to show a picture of Sweden governed by the geographic spread of the population, rather than the concentration of the population numbers. That doesn't mean that the latter is uninteresting, but for the purposes of Growth Analysis it has been more worthwhile to start from geographic spread. Part of the continued development work is to see how the more densely populated areas can be further differentiated.

One example of how the population distribution in Sweden appears is shown on map 10. The distribution here is also based on accessibility to urban areas corresponding to map 9. It was only possible to make three classes, as so many live within index 0, and the individual index numbers cannot be divided. About one third of the population live within each class, and the map shows the great variations in population concentration. One third of the population of Sweden are spread out over almost the whole surface area of Sweden, while two thirds are gathered in geographically very small areas.



Map 10 Index map in three classes

6 Development

6.1 Cross border analyses

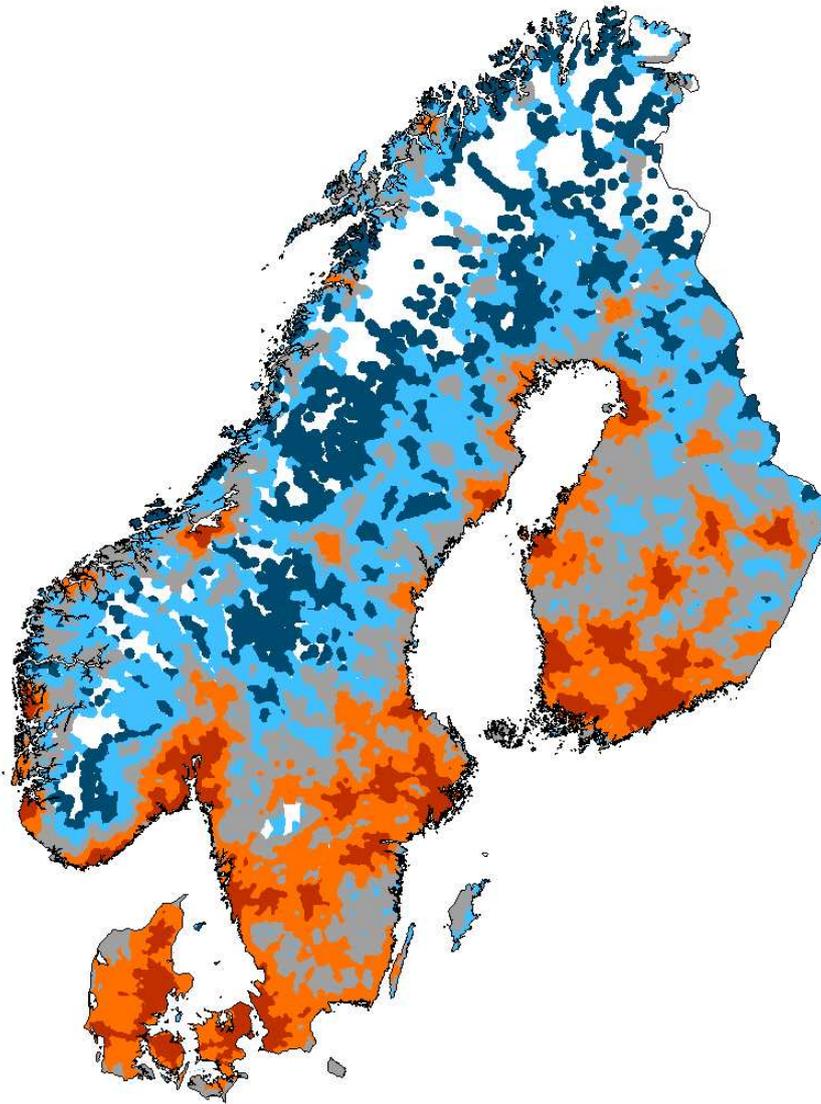
The model for the indexed accessibility was presented to the Nordic Council of Ministers working group, "Framtida landsbygder" in connection with a working group meeting during the fall of 2009. Following their discussions, interest was shown in the working group, and a first partial project was started, where the goal was to create a common platform for the analysis of regional border conditions within the Nordic region, and to enable comparative studies between different geographic areas in the Nordic region.

For this purpose, Growth Analysis have obtained comparable Nordic data on basic population statistics, urban area delimitations and road networks, and have further developed the current accessibility platform to suit Nordic conditions.

With the indexed accessibility platform and the data now available in the database of Growth Analysis, many possibilities for applications are made possible. The agency can, without much preparation, do specific comparisons between areas which according to the calculated delimitation have similar conditions for accessibility. This will also make it possible to identify areas that are found to have a different level of accessibility when target points and road networks outside of the national borders are included in the calculations.

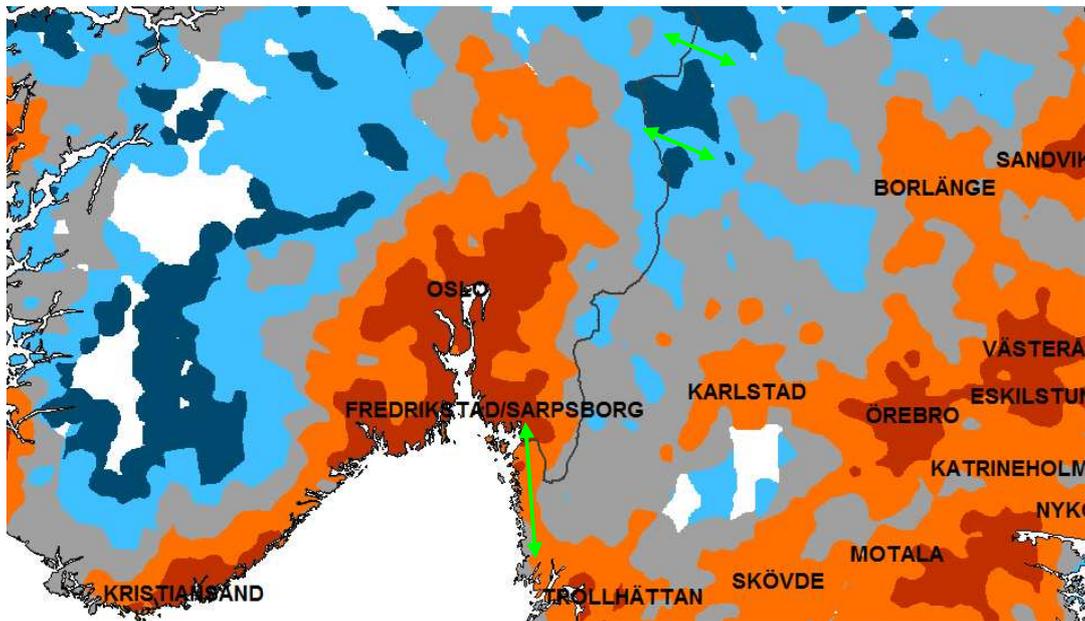
If population data is purchased in time series it will also be possible to make forecasts for a possible evolution in different geographical areas from an accessibility perspective. With access to more data about different existing service functions, it is also possible to describe the existence, spread and accessibility to service within the different categories, and with this as a foundation, also to be able to do indexed accessibility analyses showing the populations' accessibility to service with different quality content (for example, different sizes of grocery stores).

Below are some examples of calculations already performed by applications of the indexed accessibility model for the Nordic region, and comparisons between results where accessibility calculations have been made for the whole Nordic region at the same time, and separately for the respective countries. The map images and the information for the Nordic countries are somewhat different from the previously reported results for Sweden. This is mostly due to the fact that a different road network and a different maximum search distance have been used in the calculations.

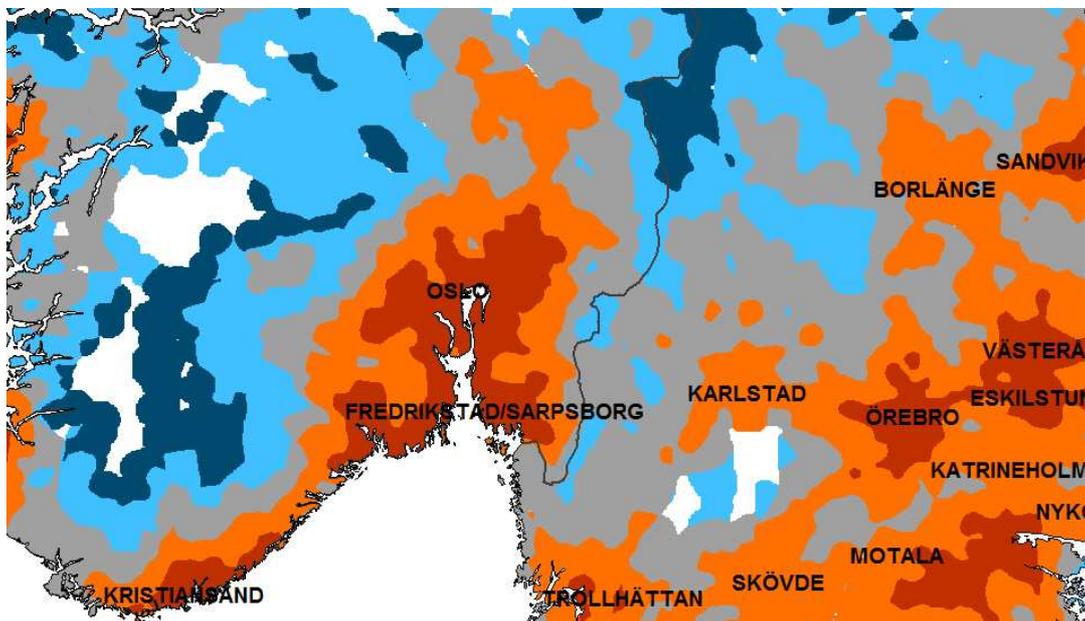


Map 11. Degree of proximity to different sizes of urban areas - Proportion of the total population within respective category and country.

Category	Finland	Sweden	Norway	Denmark
■ Very high	65.6%	61.6%	64.7%	73.7%
■ High	22.6%	28.3%	17.7%	21.6%
■ Average	10.0%	8.6%	11.2%	4.6%
■ Low	1.5%	1.3%	5.2%	0.1%
■ Very low	0.3%	0.3%	1.2%	0.04%
Total	100.0%	100.0%	100.0%	100.0%



Map 12. The above map is a cut-out of map 11 where the calculations have been done with one single data set for the whole Nordic region. The green arrows are examples of "corridors" of changed levels of accessibility that emerge between Sweden and Norway in a common calculation.



Map 13. In this cut-out the calculations have been done with separate data sets for each country.

7 Discussion

The method of dividing Sweden geographically through indexed accessibility to urban areas of different sizes can be a practicable way of providing a new definition for processing statistics and showing developmental trends in different parts of the country. The application itself is flexible, which means there is a great potential for further development. It is relatively straightforward to make changes in the material based on urban area sizes, largest search distance, road network and input data.

Making a map encompassing all of Sweden is problematic. There are substantial differences between different parts of the country, as the population is very unevenly distributed. At first glance the distribution on the map may look geographically correct, but if you consider that the areas with low and very low accessibility, which are very large geographical areas, only contain about two percent of the population, it is clear how unevenly the population is distributed over the country. But, if the classification were to be made based on population, the generalisation in the more sparsely populated areas would be so extensive that the differentiation would be minimal. A question that might be asked in this context is whether defining the whole country in the same way is a practicable way forward, considering the large differences?

The work on the model for indexed accessibility is based on the work of the National Rural Development Agency to distinguish areas and thereby highlighting intra-regional differences, but a significant difference, compared to the definition of the National Rural Development Agency, is that urban areas are not distinguished. However, there may be a point in not separating the urban area from the surrounding rural areas, considering the symbiotic relationship between land and city, and the mobility of modern people.

Another important difference from the delimitation of the National Rural Development Agency is that the purpose of this model is not to define what an urban area and accessible/remote rural areas are; instead it is a tool for analysing intraregional and regional differences. However, the model could be used as one of several entry points in the creation of a rural area definition. The important thing in this context is what an eventual rural area definition will be used for, and what is really meant when one talks about urban areas and accessible/remote rural areas. Is accessibility to an urban area a useful starting point for such work? Or does the real question relate to sparseness, the structure of the labour market or perhaps access to service? Is it habitation and landscape? There are many possible entry points, and an abundance of opinions as to what characterises rural or urban areas. It is probably not possible to create a definition that works in every context; the likely scenario is that we will have a number of definitions that can be used depending on the context.

The Swedish Agency for Growth Policy Analysis (Growth Analysis) is a cross-border organisation with 60 employees. The main office is located in Östersund, Sweden, but activities are also conducted in Stockholm, Brussels, New Delhi, Beijing, Tokyo and Washington, D.C.

Growth Analysis is responsible for growth policy evaluations and analyses and thereby contributes to:

- stronger Swedish competitiveness and the establishment of conditions for job creation in more and growing companies
- development capacity throughout Sweden with stronger local and regional competitiveness, sustainable growth and sustainable regional development.

The premise is to form a policy where growth and sustainable development go hand in hand. The primary mission is specified in the Government directives and appropriations documents. These state that the Agency shall:

- work with market awareness and policy intelligence and spread knowledge regarding trends and growth policy
- conduct analyses and evaluations that contribute to removing barriers to growth
- conduct system evaluations that facilitate prioritisation and efficiency enhancement of the emphasis and design of growth policy
- be responsible for the production, development and distribution of official statistics, facts from databases and accessibility analyses.

About the Working paper/Memorandum series:

Some examples of publications in the series are method reasoning, interim reports and evidential reports.

Other series:

Report series – Growth Analysis' main channels for publications.

Statistics series – continuous statistical production.

Svar Direkt [Direct Response] – assignments that are to be presented on short notice.