ACCESS TO EMERGENCY HOSPITALS

-AN OPERATIVE CASE STUDY FOR TESTING GRIDDED POPULATION DATA

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ABSTRACT

In the GEOSTAT 1B project the project partners (number of National Statistical Institutes, NSIs) agreed on working together on a case study calculating the population within 30 minutes from emergency hospitals. The aim of this case study was to show the possibilities as well as the advantages of using population data in GRID format. Another part of the project has been to study the consequences of data confidentiality policies applied by various NSIs.

This case study is making use of the 1km² GEOSTAT1B population grid in combination with georeferenced road networks and emergency hospitals in order to determine the travel time to emergency hospitals. The population within the driving distance of interest is divided into various groups of age and sex. This makes it possible to generate statistics over any part of the population: for example female population over 65.

In the European context this study has similarities to The European Core Health Indicators (ECHI). ECHI is a list of 88 health indicators identified by policy area. One of these is indicator 80: Equity of access to health care services, which is based on survey results and include question about travel distance to medical care[1].

Using GIS (Geographical Information Systems) for studying travel time to emergency hospitals can complement the surveys of Eurostat and be an input into ECHI's indicator 80.

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[1] ECHI indicator development and documentation, 2012

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1. INTRODUCTION

1.1 BACKGROUND

The GEOSTAT 1B project is the second part of an ESSnet action launched by Eurostat. GEOSTAT aims to undertake mapping of the 2011 Population and Housing Census on a 1 km² grid. The project is making guidelines and is setting standards for European National Statistical Institutes (NSI) aiming at producing a population grid including breakdowns by sex and age. The project started in 2012 and lasted until end of 2013.

1.2 AIM

In the project one important part has been to prove the usability of grid statistics as well as to demonstrate the advantages of using grid statistics instead of administrative boundaries when analysing population data with spatial analysis methods. Another part of the project has been to study the consequences of data confidentiality policies in various NSIs. This implies that the study considered the consequences of various confidentiality thresholds used by NSIs when publishing population data. In the case of population grids this means the minimum number of persons in each cell that can be published without having to suppress the data.

1.3 RELEVANCE

As a case study the project consortium decided to study the population's access, by distance, to health care services with a focus on different age-groups. In the European context this study has similarities to The European Core Health Indicators (ECHI). ECHI is a list of 88 health indicators identified by policy area. One of these is indicator 80: Equity of access to health care services. This indicator is relevant for following policy areas:

- Sustainable health care systems
- Health system performance, Quality of care, Efficiency of care, patient safety
- Health inequalities (including accessibility of care)
- Health in All Policies (HiAP) including occupational and environmental health[2]

The indicator is an index of self-declared unmet need for health care services, defined as the total self-reported unmet need for medical care (medical examination or treatment) for the following three reasons: 1. financial barriers, 2. waiting times and 3. too far to travel[3]. The preferred data type is survey data and the preferred source is Eurostat, European Statistics of Income and Living Condition (EU-SILC)[4].

ECHI is mentioned in the European Commission staff working document's on investing in Health as a part of "Towards Social Investment for Growth and Cohesion - including implementing the European

2 ECHI shortlist, 2012
3 ECHI indicator development and documentation, 2012
4 Ibid

Social Fund 2014-2020"[5]. This working document establishes the role of health as part of the Europe 2020 policy framework. It strengthens the link between European health policies and support for health system reforms in the context of the European Semester. In order to help member states design reforms and improve the efficiency of health systems the Commission and the Economic Policy Committee identified a number of areas where structural reforms and efficiency gains could improve the sustainability of health systems. One of these areas are; improving data collection and using available information to underpin the improvement of the performance of health systems; in particular the collection of health data using the European Community Health Indicators (ECHI) and developing tools to better assess the efficiency of health systems[6].

Using GIS (Geographical Information Systems) for studying travel time to emergency hospitals can complement the surveys of Eurostat and be an input into ECHI's indicator 80. Comparisons of results will be done with the work of the Regional Development Policy Division at OECD who has carried out a similar study and suggested this as an indicator of accessibility to public services and a way to measure well-being at the regional level[7].

1.4 EMERGENCY HOSPITAL

An emergency hospital is a part of a broader Emergency Medical Services (EMS). EMS includes also pre-hospital care. Pre-hospital care provides care at the site of accident as well as transporting the patient. The EMS varies in between countries and the emergency hospital can here have an important role in the pre-hospital care as a center for ambulance vehicles, staff and for communication. However, in this case study it is not the pre-hospital care that is in focus, but access to hospitals with emergency care that can handle "in-patients". An "in-patient" is a patient that stays overnight at the hospital. Below follow an example (figure 1) illustrating the trajectory from a medical emergency to a patient's departure from a hospital[8].

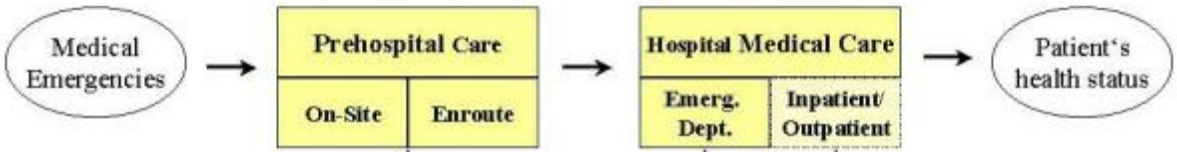


FIGURE 1. THE FRAMEWORK FOR SYSTEM ANALYSIS OF EMERGENCY MEDICAL SERVICES (EMS)[9]

2. METHODOLOGY

The project consortium agreed on using a common methodology based on comparable datasets and approach when studying access to emergency hospitals. In addition to the so called "bottom-up partners" in the project the case study was complemented with a similar case study carried out by Statistics Bulgaria. Statistics Bulgaria used their newly generated "hybrid" population grid dataset in order to calculate the access to all Centers for Emergency Health Care and regional branches.

5 Commission Communication, Investing in health, 2013
6 Ibid
7 OECD, 2012
8 Thomas Krafft et al, 2003
9 Ibid

- Bottom-up population grid is based on register data that include geo-referenced information that allow the NSI to aggregate the data to statistical units of a larger scale in form of grids or municipalities (LAU2).
- Hybrid population grid uses only partly register data and have to complement this using large scale data. This can be data on a municipality level or an even higher level in the hierarchy for example county level (LAU1).

The various partners interpreted Emergency hospitals as the following institutions in their country:

Czech Republic: 136 hospitals with intensive care units and internal or cardiology departments. This is a selection out of 184 hospitals with beds for acute care (excluding narrowly specialized or detached establishments).

Estonia: 19 hospitals providing emergency care (taking into account the hospitals of the Estonian "Hospital Master Plan" and not ambulance stations).

Finland: 56 hospitals' and health centres' emergency rooms with 24/7 service (excluding "mobile emergency rooms" in the northern part of Finland).

Norway: 44 hospitals with emergency rooms (excluding pre-hospital services as ambulance services, emergency medical communication centres and emergency clinics "legevakt").

Bulgaria: 28 Centers for Emergency Health Care and regional branches in the smaller towns (in most cases municipality centers) including medical teams with equipped vehicles.

In spite of differences in between the project partners the data was still found valid for proving the advantages of using population data on 1 km x 1 km grids instead of municipality areas. The location of these emergency hospitals was later used for **calculating the percentage of the population living within 30 minutes of driving time from emergency hospitals.** The reasons for choosing 30 minutes in this study were based on discussions in the project consortium and on similar studies at OECD[10] and Statistics Norway[11].

2.1 DATA USED

It was also decided to use the following georeferenced data in this assignment:

- Hospitals with emergency assistance as described under the introduction chapter
- Road network including information about speed limits
- Finland and Norway used in this study their national road network from road authorities while Bulgaria, Czech Republic and Estonia used the TeleAtlas[12] road data with assistance from European Commission's Directorate General (DG) for Regional and Urban Policy
- Statistical units in form of 1km x 1km grids and municipalities with related population data divided by age groups and sex

[10] OECD, 2012

[11] Statistics Norway, 2010

[12] http://mapinsight.teleatlas.com

- Centroids (central point) of buildings or addresses with population data divided by age groups and sex. These centroids refer in the case of Czech Republic, Estonia and Finland to point data of buildings carrying information about the people living on these addresses. In the case of Norway the points refer to addresses with the same information

More about the data used by the various partners can be found under the result chapter.

2.2. DRIVING TIME DISTANCES – SERVICE AREAS

In order to calculate the driving time distances the road network data was used based on attributes of speed limits and lengths. This data was used in order to establish 30-minutes so called "service areas" around emergency hospitals.

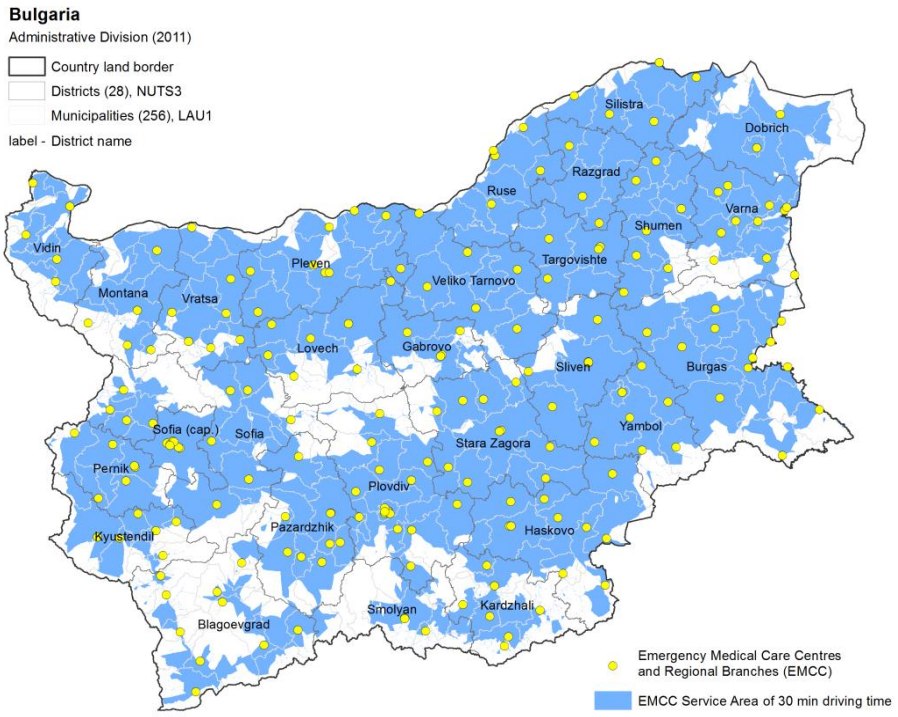


FIGURE 2. SERVICE AREAS WITHIN 30 MINUTES DRIVING TIME FROM EMERGENCY MEDICAL CENTRES AND REGIONAL BRANCHES[13]

The service area map is here delimited by a series of so called isochrones (isoline for travel time) that connects the hospitals with places from/to which it takes 30 minutes to travel using the road network.

When generating the service areas ArcGIS give the user the option to convert the isochrones to areas in a detailed or generalized manner. For this study a large portion of areas will be in rural environments and it is therefore recommended to use detailed service areas. A more thorough description of these two alternatives can be found in the national case study of Finland see chapter 5.4.

2.3 CALCULATING THE POPULATION IN SERVICE AREAS

The service areas were thereafter used for identifying the population within 30 minutes driving distance. The population data were here represented on the following statistical units (geometrical

[13] Statistics Bulgaria, 2013

objects): 1km x 1km grids, municipality areas or centroids (central point) of buildings or addresses. When overlaying the various datasets all grids/municipalities/centroids were selected that were overlapping the service areas. Working with GIS "overlap" is better known as intersect and will therefore be used in this text (see figure 3).

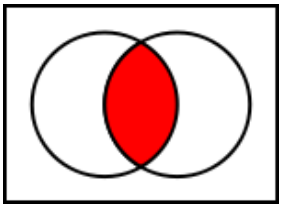


FIGURE 3. INTERSECTION OF A SERVICE AREA AND STATISTICAL UNIT[14]

When selecting 1km x 1km grids and municipality areas that intersect the service area they will cover population that exceeds the population within the service area while the detailed address/building points cover only the population within the service area. This means that the intersection as illustrated in figure 3 can be produced as a new geometrical object, but the population data will still include data for the whole original grid/municipality. Due to confidentiality and data protection issues the NSIs do not publish population distribution on a more detailed level than grid – or municipality units.

2.4. THE CONSEQUENCES OF APPLYING DATA CONFIDENTIALITY RULES

A constraint to the advantages of publishing population data on grids is the data confidentiality policies of the various NSIs. These policies are not applied on municipality units but only on grid units. By introducing these confidentiality thresholds and suppressing data the advantages of smaller and standardized grids are reduced and eventually lost.

In order to verify the consequences of applying thresholds Estonia and Norway tried out how four different thresholds would affect the result of this case study. The levels used here were 3, 5, 10 and 50. These thresholds were then tested on different variables: 1. total population, 2. population by sex, 3. population by age and 4. population by age and sex.

When testing the various population break-downs the project suppressed grid cells that had any variables below the threshold of interest. This means that a grid cell will be suppressed for a specific variable in case the threshold is set to 3 and any population group under this variable is below 3. Textbox 1 below shows an example of how to test the most detailed population break-down; "population by age and sex".

TEXTBOX 1. TWO EXAMPLES OF HOW TO TEST THE CONFIDENTIALITY THRESHOLDS

1. Total Population for grid cells where: "TotalPopulation" >= 3

2. Total Population for grid cells where:

"FemalePopulation 0 to 14" >= 3 AND " FemalePopulation 15 to 64" >= 3 AND "FemalePopulation over 65" >= 3 AND "MalePopulation 0 to 14" >= 3 AND " MalePopulation 15 to 64" >= 3 AND "MalePopulation over 65" >= 3

[14] http://en.wikipedia.org/wiki/Intersection_(set_theory)

3. RESULTS AND DISCUSSION

3.1. RESULTS OF INTERSECTING 30 MINUTES SERVICE AREAS WITH TOTAL POPULATION DATA ON STATISTICAL UNITS

Benchmarking grids and municipality boundaries with addresses/buildings shows that grids are the most appropriate statistical unit. Figure 4 illustrates the differences in geographical coverage. The map in the middle shows that intersecting municipality centroids with the service area results in a fact, that many address/building points that are within the service area, are located outside the selected municipalities. When intersecting with the whole municipality areas the result is the opposite; Address/building points outside the service area fall inside the selected municipalities. These differences are not as important in the right hand map, where grid centroids and grid polygons are compared.

Figure 4 illustrates the advantages of using grids as the more detailed alternative. The address-/building centroids are here used to benchmark the two other statistical units.

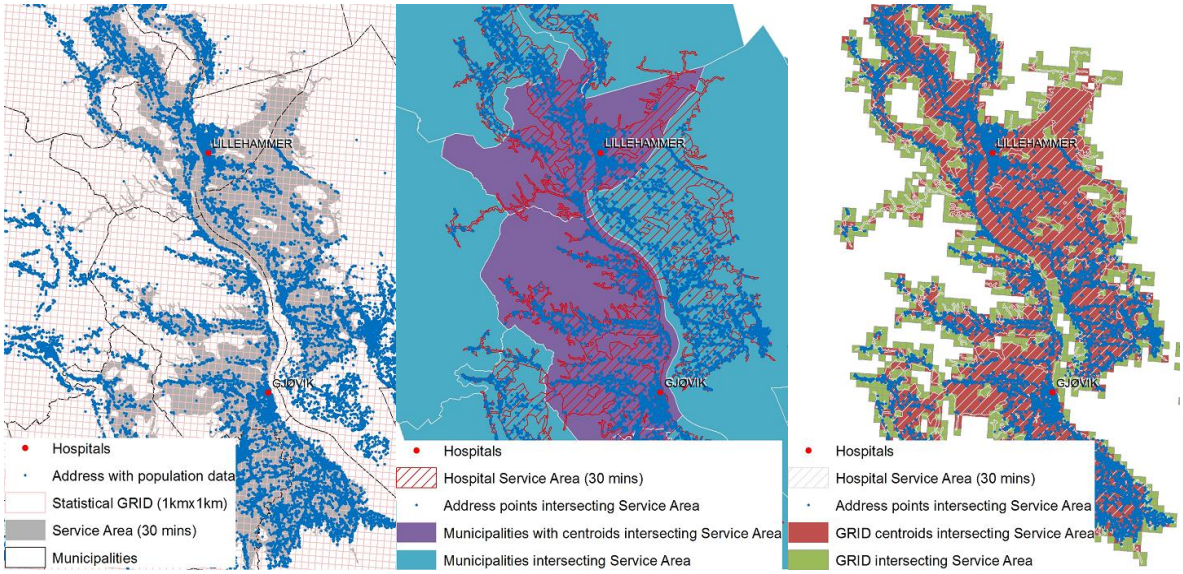


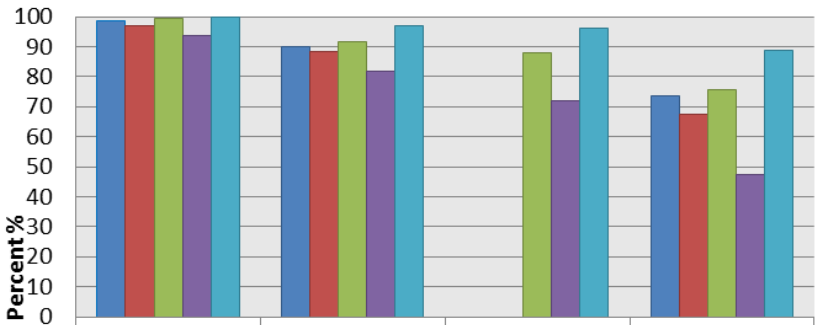
FIGURE 4: SERVICE AREAS ACCESSIBLE IN 30 MINUTES FROM EMERGENCY HOSPITALS INTERSECTING POPULATION AT DIFFERENT LEVELS OF STATISTICAL UNITS.

Left: Statistical units on various geographical levels used in the analysis

Middle: Result of intersecting the municipalities alternatively the municipality centroids with the 30 minutes service areas. Some of the municipalities have both centroids and municipality areas that intersect the service areas. In the figure this has as a consequence that the municipalities in violet are also included in the turquoise category.

Right: Result of intersecting the grids alternatively the centroids of the grids with 30 minutes service areas. Some of the grid cells have both centroids and grid cells that intersect the service areas. In the figure this has as a consequence that the grids in dark red are also included in the green category.

CHART 1: RESULTS OF INTERSECTING 30 MINUTE SERVICE AREAS WITH POPULATION DATA ON STATISTICAL UNITS. THE COLOR CODE IS THE SAME AS IN FIGURE 3 ABOVE.



	Czech Republic	Estonia	Finland	Norway
Intersecting address/building centroids with service areas	98,8	90,2	0,0	73,7
Intersecting 1km*1km grid centroids with service areas	96,8	88,3	0,0	67,3
Intersecting 1km*1km grid polygons with service areas	99,4	91,5	87,9	75,6
Intersecting municipality centroids with service areas	93,9	81,7	72,1	47,5
Intersecting municipality polygons with service areas	99,8	97,1	96,1	88,6

The impact of differences in geographical coverage becomes even more obvious when statistics are attached to the intersected address/building point, grids and municipalities. This is illustrated in chart 1, in which different countries are compared in terms of their population proportion living within 30 minutes service areas. The most important factor here is the size of the municipalities that varies inside and in between the countries, while the size of the grids is constant.

In chart 1 it also appears that the results for the Czech Republic are significantly better than in the other countries. The main reason for this is that the 30 minutes service areas in the Czech Republic cover most of the country's territory while this is not the case in the other countries.

The main differences in between the countries in this accessibility study lie in:

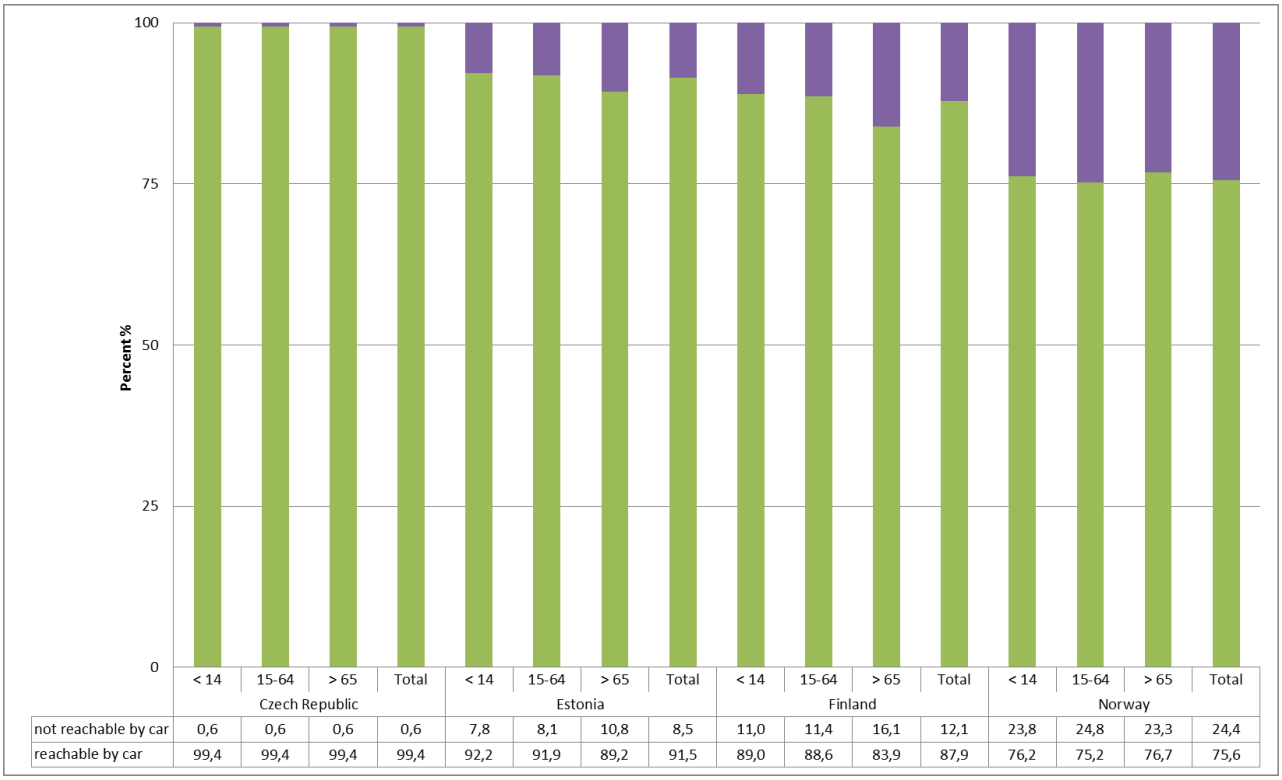
- Hospital coverage
- Population distribution
- Size and the physical geography (e.g. hilliness, coastline, lakes, islands) of the countries.
- Road network (incl. coverage and speed limits)

The results of the benchmarking show that the best approach is to use grid polygons. The centroids of the grids are easier to handle, but as for the municipalities the population distribution inside the grid polygon is not known. However, based on the theory that people live close to the road network the service areas might indicate where the population is situated in the grid. The case studies proved that results based on grid data are more similar to building based centroids results than municipality level data. The centroids of building/address give the most correct results, but as mentioned in chapter 2.3.confidentiality and personal data protection policy make this not possible.

3.2. RESULTS OF INTERSECTING 30 MINUTES SERVICE AREAS WITH POPULATION DIVIDED BY AGE GROUPS

As described above there are differences in between the project partners when it comes to the population's access to emergency hospitals. Chart 2 illustrates the differences between age-groups and is based on population data on grids.

CHART 2 RESULTS OF INTERSECTING 30 MINUTES SERVICE AREAS WITH POPULATION DATA ON 1 KM*1 KM GRIDS (GREEN IS AREAS REACHABLE BY CAR AND VIOLET IS THE OPPOSITE)



	Czech Republic				Estonia				Finland				Norway			
	< 14	15-64	> 65	Total	< 14	15-64	> 65	Total	< 14	15-64	> 65	Total	< 14	15-64	> 65	Total
not reachable by car	0,6	0,6	0,6	0,6	7,8	8,1	10,8	8,5	11,0	11,4	16,1	12,1	23,8	24,8	23,3	24,4
reachable by car	99,4	99,4	99,4	99,4	92,2	91,9	89,2	91,5	89,0	88,6	83,9	87,9	76,2	75,2	76,7	75,6

The coverage of the Czech territory with 30 minutes service areas of emergency hospitals is very high and consequently there are no major differences in between age groups and sexes.

Considering differences in various age groups access to emergency hospitals there are similarities between Estonia and Finland. As illustrated in Chart 2, the hospital access for children and working population is better than access to the same institutions for elders.

In Norway the figures are very different. Only 75,6 % have access to emergency hospitals in 30 minutes driving distance. This can be compared to 99,4 % in the Czech republic, 91,5 in Estonia and 87,9 % in Finland. The access is also different when comparing age groups. In Norway it is the working age group that reduces the average and not the elders. Apart from this situation in Norway the population distribution is characterized by a concentration of elderly people in the countryside and the working people in the cities. The differences in between the accessibility to various population groups can be explained by differences in regional and social policy.

Comparing these results with the work of the Regional Development Policy Division at OECD called "Measuring the Access to Public Services: the Case of Public Hospitals"[15] show that the accessibility

[15] OECD, 2012

(driving time) in the Czech Republic is very similar to the situation in Germany. The results in the OECD report show that 99,9 % of the German population have access to a public hospital in 30 minutes driving distance. In France, the corresponding percentage is 98,4. However, it is not clear, how comparable the OECD definition of Public Hospitals is with our definition of emergency hospitals.

3.3 Results of studying confidentiality thresholds

National Statistical Institutes (NSIs) depend on reliability and therefore issues as personal data protection and confidentiality issues are important when publishing statistics. The rules to assure the confidentiality of personal data are different in between the European NSIs. In this case study we have focused on the population within 30 minutes from emergency centers. However, the confidentiality issue is an even more important issue in sparely populated areas and for data representing many variables. For example in Estonia there is no threshold for total population data when published on grid level, but thresholds exists for the other variables. In Finland the threshold is 9 for all variables. In Norway there are no thresholds for total population and sex, but age break-downs can only be provided as the average age of the population by grid.

When introducing thresholds of confidentiality on the population grid, the suppressed data will lead to a loss of grid cells and consequently to the loss in number of population. This is illustrated in chart 3 and 4. These charts show that in case a NSI is publishing population data with many variables at the same time as they suppress data the result can be an underestimation of 35–39% compared to the benchmark. In such case it should be considered to use the data of municipality unit level.

CHART 3. BENCHMARKING POPULATION DATA FOR FINDING OUT THE CONSEQUENCES OF DATA SUPPRESSION, INSIDE 30 MINUTES SERVICE AREAS IN ESTONIA. 0 % REFER TO THE POPULATION BY ADDRESS/BUILDING CENTROIDS.

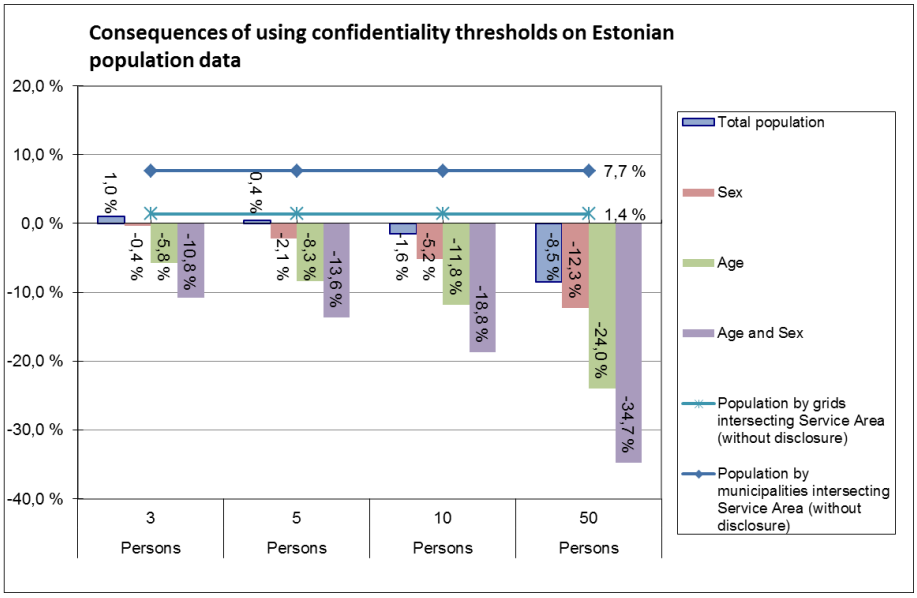
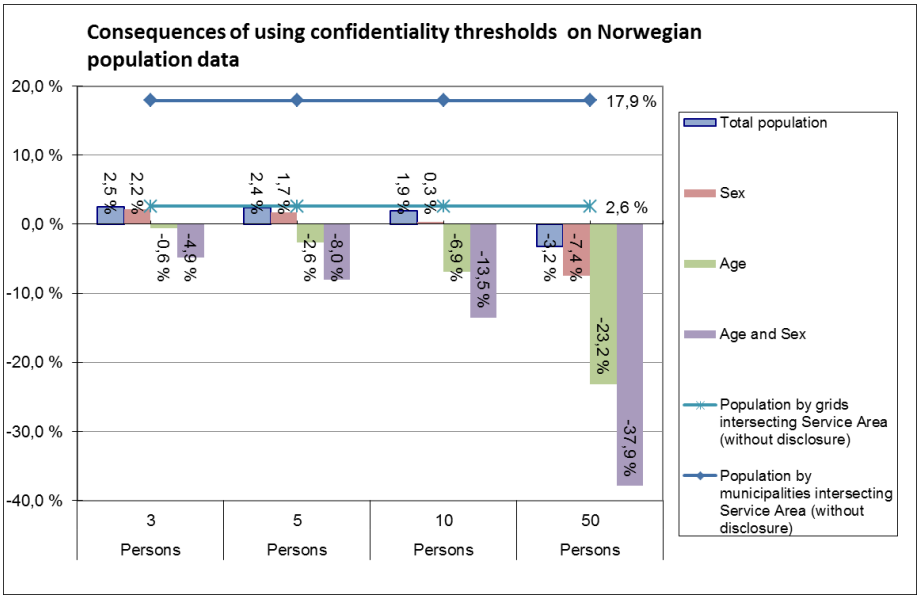


CHART 4. BENCHMARKING POPULATION DATA FOR FINDING OUT THE CONSEQUENCES OF DATA SUPPRESSION, INSIDE 30 MINUTES SERVICE AREAS IN NORWAY. 0 % REFER TO THE POPULATION BY ADDRESS/BUILDING CENTROIDS.



According to the two charts it is also clear that there are more cells with population variables under the threshold values in Estonia than in Norway. The reason to this is that the service areas in Estonia cover also remote and less populated areas. This means that in case the resulting statistics for Norway would focus on the population outside the service area this would lead to a big loss of data due to suppression, as in Norway the remote areas stands mainly outside the service areas. Statistics Estonia is currently working on ways to improve the confidentiality threshold issues by using a controlled rounding method. More information about this can be found at http://www.stat.ee/67636 and read about in the coming GEOSTAT 1C project reporting.

4. CONCLUSION AND FURTHER IMPROVEMENTS

The results of the different case studies demonstrates clearly the advantages of grid based statistics compared to administrative boundaries for carrying out spatial analyses. Grids give a more correct result of the population distribution. Nevertheless, introducing of confidentiality thresholds and consequently suppression of grid cells below these thresholds may result in that the advantages of grid statistics are lost. In case a NSI is about to publish population data with multiple variables at the same time as they operate with a high threshold level they better use administrative boundaries as reporting unities.

Grid statistics in this case study proved to be very useful when identifying the population's driving distance to emergency hospitals. This work can be an important complement to Eurostats surveys in connection to the work with ECHI and indicator 80. Some modification will be needed, but this study might already give Eurostat a better understanding of why the interviewees reply differently based on nationality.

Using GIS in this work can be further improved, and it is first of all important to improve the definitions and ensure a common understanding of the definitions when comparing the medical service sector in Europe. It would also be an advantage to further study existing national legislation, in this case legislation on emergency medical services, and eventually include additional service areas with a lower driving time distance.

As pointed out in the OECD study, traffic load is an important limiting factor for the accessibility and it is therefore relevant to study the capacity of the road network. In remote areas it can also be an advantage to find out more about how to include emergency transports by helicopter, plane or boat in the study.

5. Country case studies

5.1 Czech Republic

5.1.1 National context

Since 1st of April 2012 a new law for the emergency medical services has came into force according to which an arrival time of an ambulance to a patient has been set to 20 minutes. One of the targets of this health reform was that the **ambulances** response time will not exceed twenty minutes in 95 per cent of cases. This time limit does not need to be fulfilled only in bad weather conditions. The previous recommended time limit, which was not nevertheless defined by law, amounted to 15 minutes.

However, the object of this case study does not consist in the accessibility to ambulance stations, but in the accessibility to emergency hospitals. Apart from the crucial difference in the character of provided services (pre-hospital care X acute care for in-patients), the emergency hospitals are characterized by a less dense network of facilities and therefore often also by a different localization. It is related to the fact that an ambulance has to reach a patient as soon as possible in order to save and stabilize its life and only then transport it to the hospital to provide it further intensive care. Even though the driving time to a hospital is crucial information for an ambulance, it is absolutely obvious, that even the decision makers should have reliable data about which regions, countries or age groups have worse accessibility to hospitals than the others, in order to take appropriate equalizing measures.

5.1.2 National data used

Population

Contents

Population data in 1km x 1km grids as well as in municipalities come from the Population and Housing Census 2011. Population data comprise of a dataset for the total population and of 8 datasets for the population broken down by sex and age into three age groups according to EFGS Standards: (F_00_14; F_15_64; F_65_; M_00_14; M_15_64; M_65). All datasets include usually resident population only.

The total population and the population by sex is equivalent to the official census results. The sum of the population breakdowns by sex and age groups does not equal with the total number of men or women population, or with the total population as a whole because of unknown age by 35 627 persons.

Coverage

Population data are linked to the georeferenced building points in the Register of Census Districts and Buildings. The total georeferenced population is lower (by 31 998) than the total population reported under the official census results, since some persons were not possible to assign to the building points (e.g. homeless people, people living in buildings without final approval or in emergency buildings or shelters). However, the percentage of the census population georeferenced to building points amounts

to 99,7 %. The calculated shares of population within service areas are related to the total georeferenced population, which may cause a moderate distortion (overestimation) of the results, but this approach seems to be methodically more correct than division by the total population, which would significantly influence the results of the population breakdowns.

UPDATING

Population data comes from the Population and Housing Census 2011, exactly they relate to the 26th March 2011 (census decisive moment). Population and Housing Census is being carried out every 10 years. As a result of the absence of a population register detailed population data are available only on the municipality level in intercensal period. Thus, production or an update of the population grid based on the aggregation method between censuses is not possible yet.

SOURCE

Czech Statistical Office

EMERGENCY HOSPITALS

CONTENTS

Georeferenced dataset of emergency hospitals was produced by the Czech Statistical Office based on the data of the Institute of Health Information and Statistics of the Czech Republic (IHIS CR), which is in charge of collection, processing and providing health establishments statistics in the Czech Republic. Czech Statistical Office received from IHIS CR tabular address data of 184 hospitals with beds for acute care that approximately correspond to the definition of emergency hospitals. However, the list contained some narrowly specialized or detached establishments like psychiatric, rehabilitative, surgical or gynaecologic institutes, which do not fit the thematic scope of the case study. In the first step of processing this data, checking all the facilities in terms of their suitability for the case study had been conducted. Finally, overall 136 suitable hospitals with intensive care units and internal or cardiological departments have been chosen. In the second step Czech Statistical Office georeferenced address data of selected hospitals. As a result a point dataset of relevant hospitals including their coordinates and unique identifiers for delineating service areas around the hospitals has been prepared.

COVERAGE

The dataset covers whole country.

UPDATING

Dataset on hospitals and other health establishments produced by IHIS CR is updated continuously. The data on hospitals with beds for acute care used in the case study came from 30. 6. 2013.

SOURCE

Institute of Health Information and Statistics of the Czech Republic (IHIS CR)

ROAD NETWORK

CONTENTS

Georeferenced dataset (line features) representing the comprehensive road network (main roads and street network), and including a speed attribute per road segment (speed appropriate for safe driving while respecting the regulatory speed limitations per road category).

COVERAGE

The dataset cover the entire territory.

UPDATING

Road network data are regularly updated. The data used in this case study have been provided in 2012 and reflect the network situation of 2011.

SOURCE

TomTom Multinet 3.6

ADMINISTRATIVE BOUNDARIES

CONTENTS

Administrative boundaries dataset applied in the case study consist of a dataset with boundaries of 6253 municipalities, which delimit the municipality area and of a dataset with a country boundary. Map outputs also contain a dataset with boundaries of 14 NUTS 3 regions.

COVERAGE

Administrative data cover the whole territory of the Czech Republic.

UPDATING

Administrative geodata produced by Czech Statistical Office are updated every quarter and the version used in the case study comes from 1. 7. 2013. Updating is based on the spatial data of cadastral areas from the Czech Office for Surveying, Mapping and Cadastre.

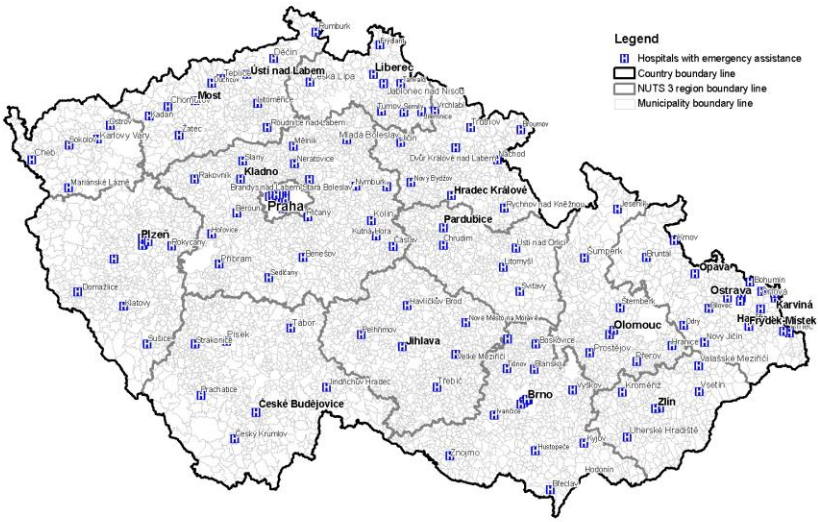
SOURCE

Czech Statistical Office and Czech Office for Surveying, Mapping and Cadastre

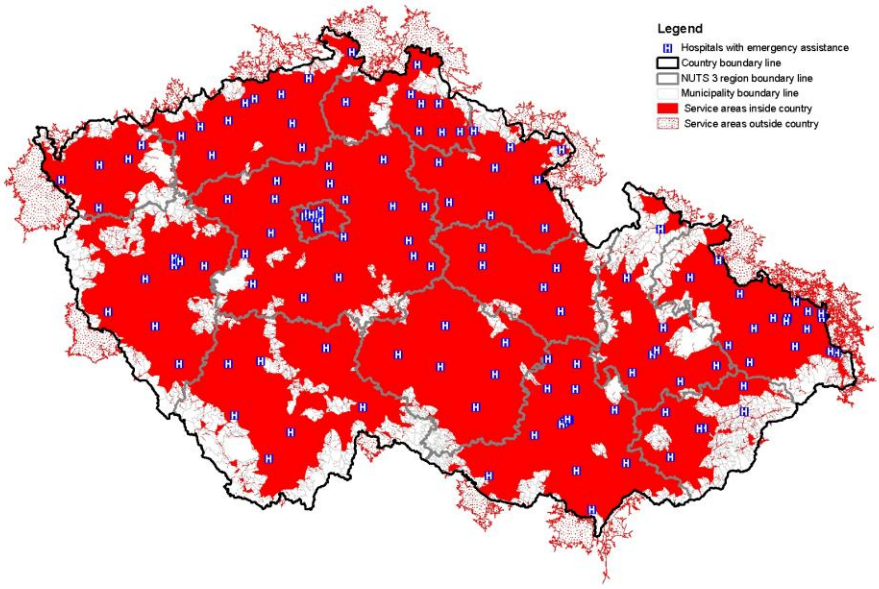
5.1.3 RESULTS

MAPS

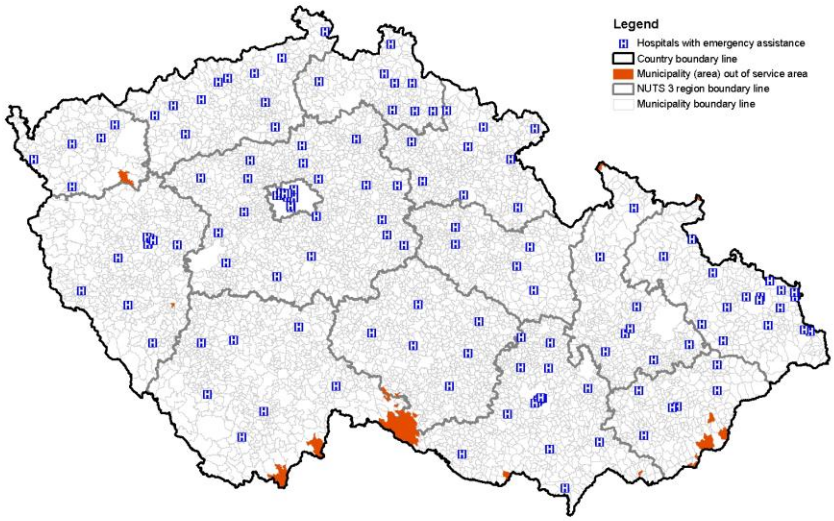
MAP 1: LOCATION OF EMERGENCY HOSPITALS IN THE CZECH REPUBLIC



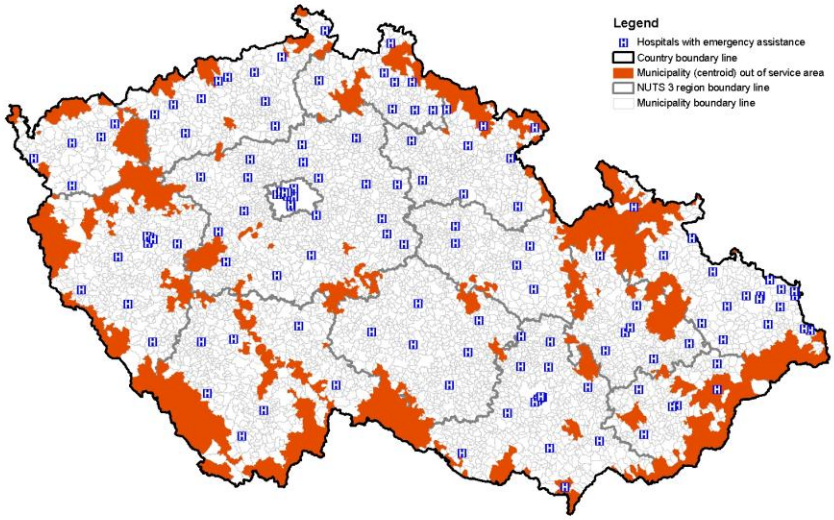
MAP 2: SERVICE AREAS FOR 30 MINUTES OF DRIVING TIME FROM/TO EMERGENCY HOSPITALS IN THE CZECH REPUBLIC



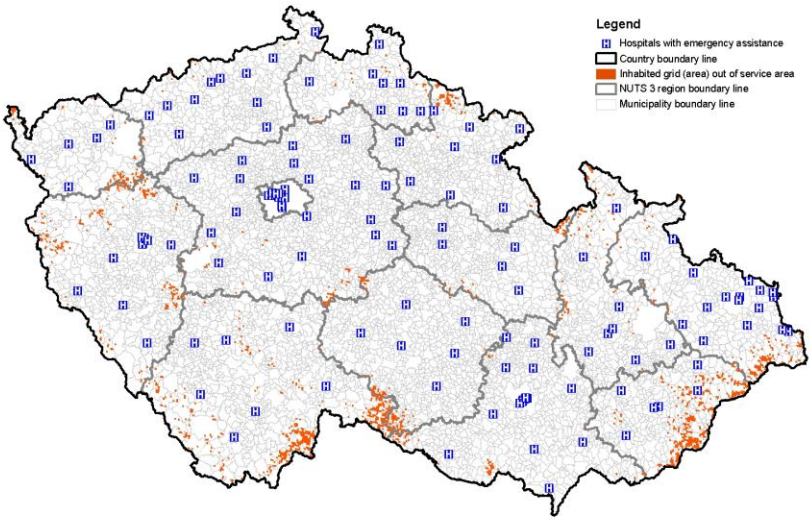
MAP 3: WHOLE AREA OF MUNICIPALITIES OUTSIDE 30 MINUTES SERVICE AREAS



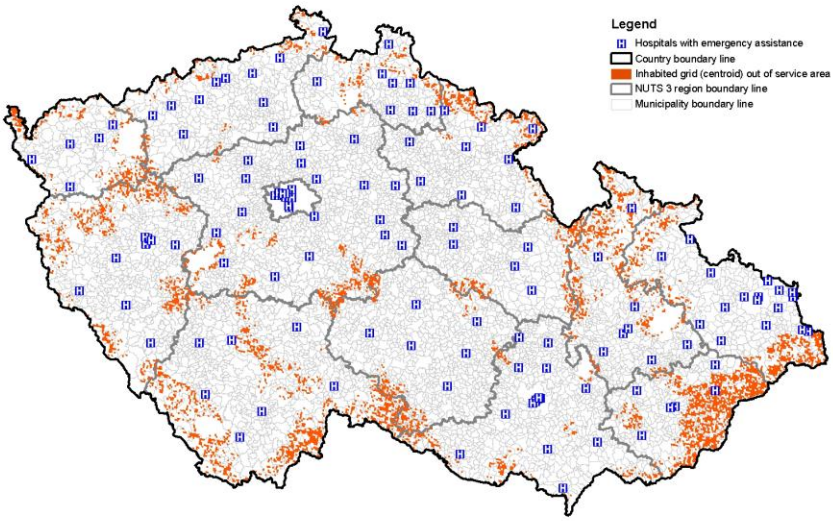
MAP 4: CENTROIDS OF MUNICIPALITIES OUTSIDE 30 MINUTES SERVICE AREAS



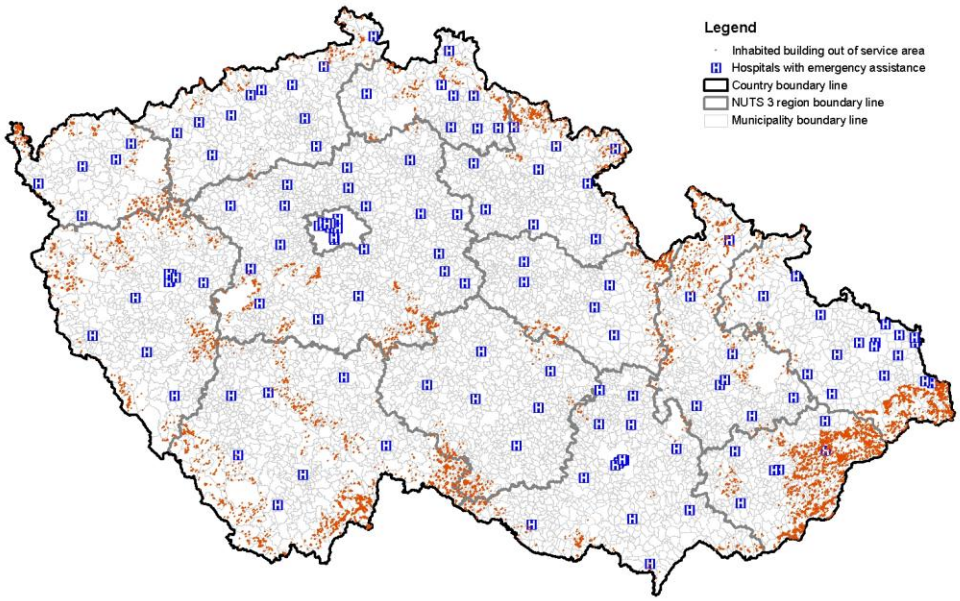
MAP 5: WHOLE AREA OF INHABITED GRIDS OUTSIDE 30 MINUTES SERVICE AREAS



MAP 6: INHABITED GRID CENTROIDS OUTSIDE 30 MINUTES SERVICE AREAS



MAP 7: INHABITED BUILDING CENTROIDS OUTSIDE 30 MINUTES SERVICE AREAS



STATISTICS

TABLE 1: PERCENTAGE OF MALE POPULATION IN DIFFERENT AGE GROUPS LIVING WITHIN 30 MINUTES SERVICE AREAS

Population of 30-min service area according to chosen spatial option	Males 0-14 years	Males 15-64 years	Males 65+ years	Males in total
			in %	
Total georeferenced population	99,6	99,6	99,9	99,7
The values below relate to the total georeferenced population				
Centroid of municipality is within service area	93,7	93,8	93,9	93,8
Service area intersects municipality	99,8	99,8	99,8	99,8
Centroid of grid is within service area	96,7	96,7	96,7	96,7
Centroid of building is within service area	98,8	98,8	98,8	98,8
Service area intersects grid	99,4	99,3	99,4	99,4

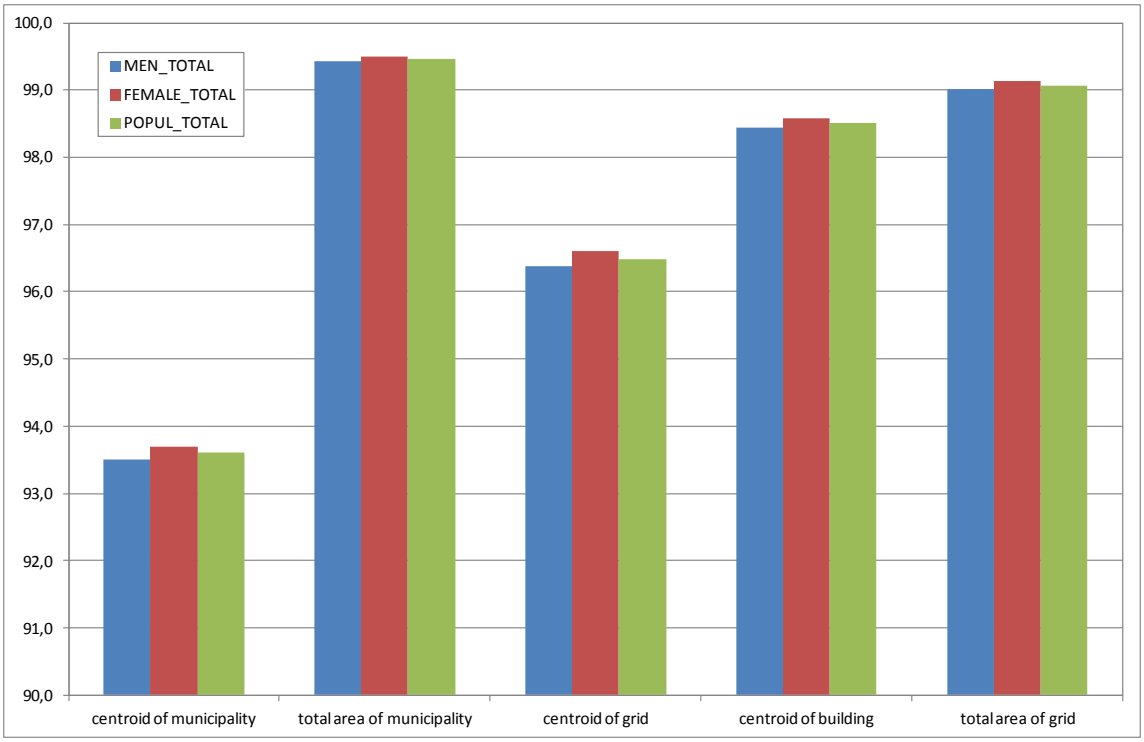
Table 2: Percentage of female population in different age groups living within 30 minutes service areas

Population of 30-min service area according to chosen spatial option	Females 0-14 years	Females 15-64 years	Females 65+ years	Females in total
			in %	
Total georeferenced population	99,6	99,7	99,9	99,7
The values below relate to the total georeferenced population				
Centroid of municipality is within service area	93,8	94,0	93,9	94,0
Service area intersects municipality	99,8	99,8	99,8	99,8
Centroid of grid is within service area	96,7	96,9	96,8	96,9
Centroid of building is within service area	98,8	98,9	98,8	98,9
Service area intersects grid	99,4	99,4	99,4	99,4

TABLE 3: PERCENTAGE OF TOTAL POPULATION IN DIFFERENT AGE GROUPS LIVING WITHIN 30 MINUTES SERVICE AREAS

Population of 30-min service area according to chosen spatial option	Population 0-14 years	Population 15-64 years	Population 65+ years	Population in total
			in %	
Total georeferenced population	99,6	99,7	99,9	99,7
The values below relate to the total georeferenced population				
Centroid of municipality is within service area	93,8	93,9	93,9	93,9
Service area intersects municipality	99,8	99,8	99,8	99,8
Centroid of grid is within service area	96,7	96,8	96,8	96,8
Centroid of building is within service area	98,8	98,8	98,8	98,8
Service area intersects grid	99,4	99,4	99,4	99,4

CHART 5: PERCENTAGE OF POPULATION LIVING WITHIN 30 MINUTES SERVICE AREAS WHEN INCLUDING DIFFERENT SPATIAL ENTITIES



REFLECTIONS

REFLECTIONS ABOUT THE RESULTS

In total 136 hospitals providing emergency assistance met the requirements of the case study and entered the analysis. As we can see from the Map 1 their distribution over the country is quite even. They are located at least in one city in almost every district (NUTS 4 level). Thus, we can speak about very broad network of health facilities, which is a result of historical and socio-economical development.

On the Czech territory is the coverage of 30 minutes service areas very high as we can see from the Map 2. Some larger and compact areas not covered with delineated service areas can be found particularly in a borderland, in the mountains or in military areas, i.e. in a peripheral areas, which are mostly very sparsely populated. On the contrary there are service areas of some hospitals in the borderland that extend to the neighbouring country (see Map 2). These occur particularly in those border areas, where are no natural barriers, in the Czech case particularly mountains, and where is available high density and quality of the road network. These areas can be found along the northern border line with Poland, at the northern part of a border with Saxony, and small service areas are also along the western part of a border with Austria and northern part of a border with Bavaria. As a result of the dense and relatively even coverage of the Czech Republic with service areas, the percentage of population living within 30 minutes of driving time from emergency hospitals measured by all spatial options is very high.

If we assume, that a calculation based on intersecting the building centroids is the most accurate method, a percentage of the Czech population living within 30 minutes driving time from emergency hospitals reaches 98,8 %. It was found 32 523 centroids of inhabited buildings outside the delimited service areas (see Map 7), i.e. about 1,8 % of all inhabited buildings. More detailed results showed almost no differences between sexes and age groups.

As the second most accurate method appears to be a calculation based on intersecting grid with a share of a total population of 99,4 %. In comparison to the previous method the results are very slightly overestimated (by 0,6 %). The number of inhabited grids outside service areas makes 1 561, what is equivalent to 3,7 % of all inhabited grids (see Map 5).

The highest percentage of total population reachable by car from emergency hospital within 30 minutes was observed when using intersection of service areas and municipalities (99,8 %). This share was same for all the population breakdowns. In the map 3 can we see all the municipalities (only 57) whose total area was located beyond service area, i.e. they did not intersect it.

On the contrary, lowest percentage of population residing within 30 minutes from emergency hospitals was found out, when centroids of municipalities had to be located inside service areas (93,6 %). In total 691 municipalities (11 %) did not meet this condition (see Map 4). The values for population broken down by sex and age varied between 93,4 % for male in the age group 0-14 up to 93,9 % for female in the age group 65+. The difference between this and the "reference" method based on building centroids amounts to 4,9 % and is the biggest from all observed approaches.

The last calculation method was based on location of grid centroids inside service areas. The percentage of population residing within 30 minutes driving distance from emergency hospitals reaches 96,5 %. The differences between sexes and age groups are also very negligible (+- 0,4 %). The placement of inhabited grids, whose centroids were outside service areas (in total 5 441, i.e. 12,8 %), is visible on the map 6.

The national results are most likely influenced by:

- good quality of primary geographical and population data and high rate of their georefencing
- assumptions made about definition and selection of hospitals entering into a case study
- assumptions made about traffic flows and speed limits
- even distribution of emergency hospitals which corresponds with a concentration of population
- quite even distribution of the population
- branched structure of the road network

With respect to the aforementioned facts it is probably not surprising, that the results for the Czech Republic look much better than in Scandinavian countries, but they are comparable with another Central European country – Germany[16]. This difference between central and northern part of Europe is

[16] OECD, 2012

likely caused by dissimilar natural conditions for living resulting in totally different population distribution. Social and historical development may play also some role, but these factors seem not to be so important. The big amount of different influences, which are present at the national level, makes the comparability of the results among countries relatively difficult.

SUMMARY

The coverage of the Czech territory with 30 minutes service areas of emergency hospitals is very high. As a result of a chosen driving time the differences among different methods of calculation are rather moderate. Nevertheless, it came out, that more accurate results can be gained using intersection of grids and whole area of spatial units than using municipalities and centroids. The accessibility of emergency hospitals for different age groups and sexes is also comparable. Only slightly better results were achieved for females than for men. For broader and more practical use of this analysis would be useful to count the results for a different time frame (20 minutes driving time) with respect to a national legislation on emergency medical services.

5.2 ESTONIA

5.2.1 NATIONAL CONTEXT

In Estonia the location of hospital network takes into account the spatial distribution of population. In addition, circumstances that hospitals should locate inside 1-hour driving distance or distance to the hospitals should be less than 70 km, are considered. The ambulance stations exist in addition to the hospital network. Their location is set so that 90% of population should be inside 15-minutes service area of ambulance stations.

5.2.2 NATIONAL DATA USED

POPULATION

CONTENTS

The population data by grids (1 km × 1 km) and municipalities by sex and age-groups 0–14, 15–64 and 65+ were created by Statistics Estonia according to the 2011 Population and Housing Census. The population data are georeferenced by Statistics Estonia according to the location of the buildings. The grid data includes also the data on people whose data were tagged to the centre of settlement unit or census enumeration area because the location of the place of residence was not identified or was partially identified during the census. The population grid data are equivalent to the official census data.

COVERAGE

The population data cover the population encountered during the census. The census decisive moment was on 31.12.2011. The under coverage of census (1–2% of total population) is not taken into account. The data used in this study cover the whole territory of Estonia.

UPDATING

The data on municipality level are updated yearly. The grid data are planned to be updated.

SOURCE

Statistics Estonia

EMERGENCY HOSPITALS

CONTENTS

The analysis includes hospitals providing emergency care. Only the hospitals of the Estonian "Hospital Master Plan" were taken into account. The ambulance stations are not included. The list of emergency care hospitals was received from the National Institute for Health Development. The locations of hospitals were geo-referenced by Statistics Estonia according to the address.

COVERAGE

Estonian territory

UPDATING

No regular updates

SOURCE

National Institute for Health Development

ROAD NETWORK

CONTENTS

The service areas around the hospitals within a 30-minute driving distance were created by the European Joint Research Centre using the Tele Atlas road network. The ArcGIS Network Analyst was used.

In the basic speed attributes of the network segments, there is no distinction between summer or winter. Instead, the speed attribute essentially depends on the functional road class and the type of road (dual carriageway or not).

COVERAGE

Whole Estonian territory

UPDATING

No regular updates are planned.

SOURCE

Tele Atlas

ADMINISTRATIVE BOUNDARIES

CONTENTS

The borders of local municipality units were downloaded from the Estonian Land Board website. The generalization was made by Statistics Estonia. In the analysis, the original shapes were used. The generalized shapes of municipality units were used only on the illustrative maps.

COVERAGE

Whole Estonian territory

UPDATING

The dataset is updated regularly according to the changes in the administrative division. In the current study the version 3 from 2010 is used as it describes the census moment.

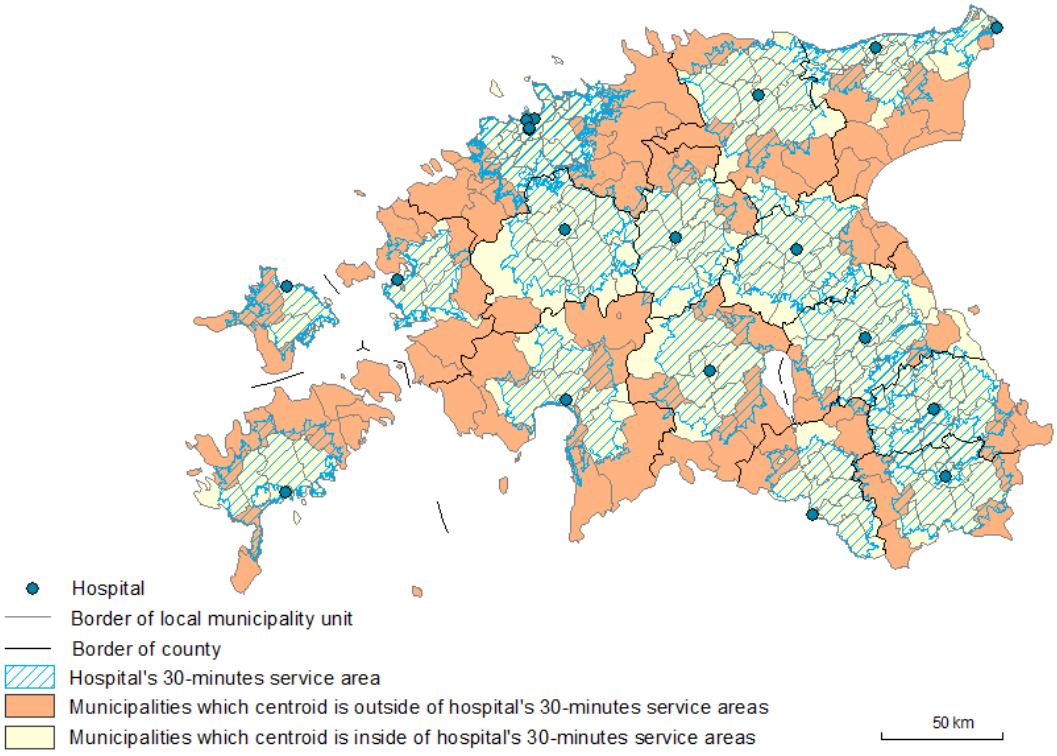
SOURCE

Estonian Land Board

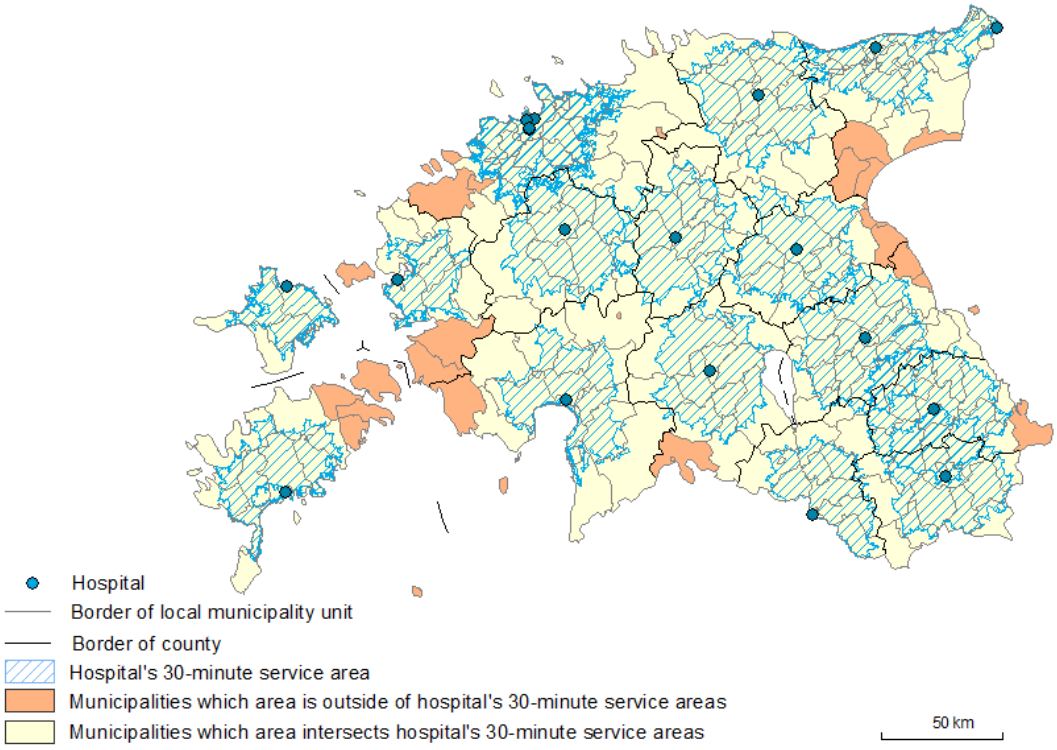
5.2.3 RESULTS

MAPS

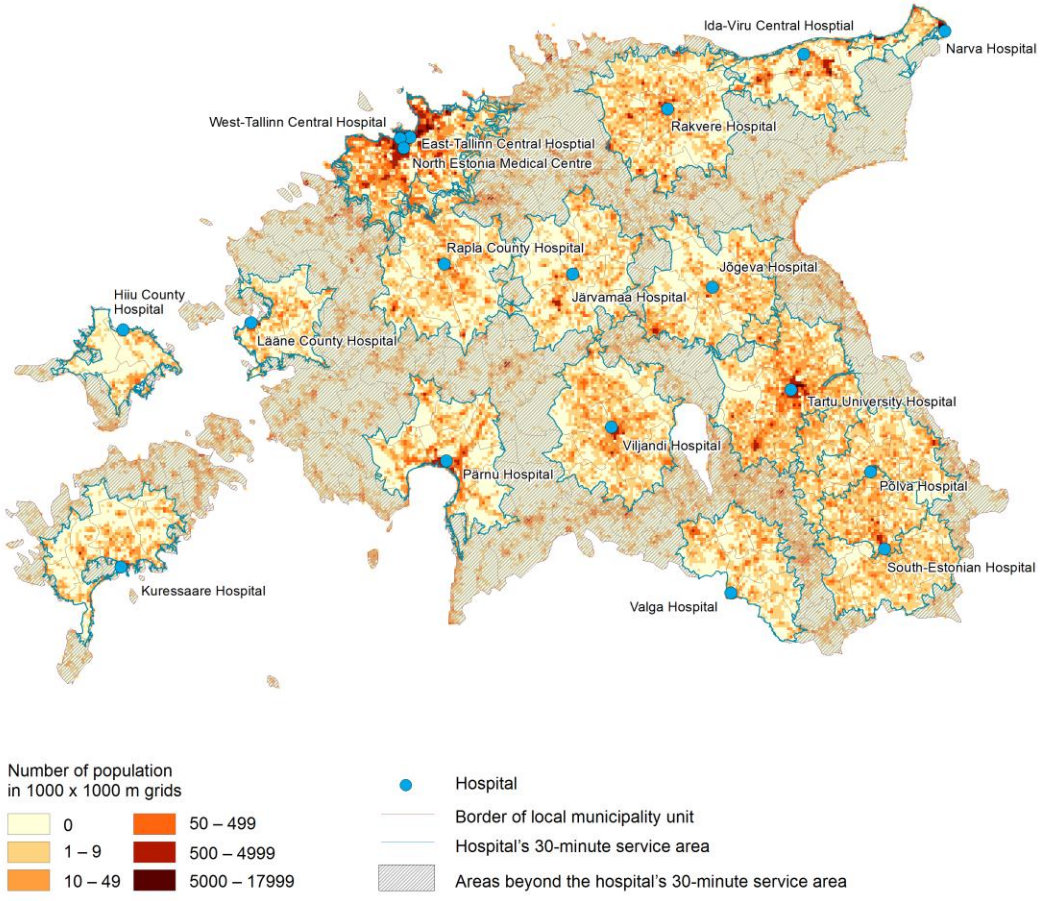
MAP 8 MUNICIPALITIES WHICH CENTROID IS INSIDE OF 30-MINUTES SERVICE AREAS



MAP 9 MUNICIPALITIES WHICH AREA INTERSECTS 30-MINUTES SERVICE AREAS



MAP 10 POPULATION LIVING WITHIN 30-MINUTES SERVICE AREAS FROM EMERGENCY HOSPITALS



STATISTICS

CHART 6. COMPARISON OF RESULTS OBTAINED WITH DIFFERENT SPATIAL MATCH OPTIONS IN CASE OF TOTAL SERVICE AREA OF ALL HOSPITALS

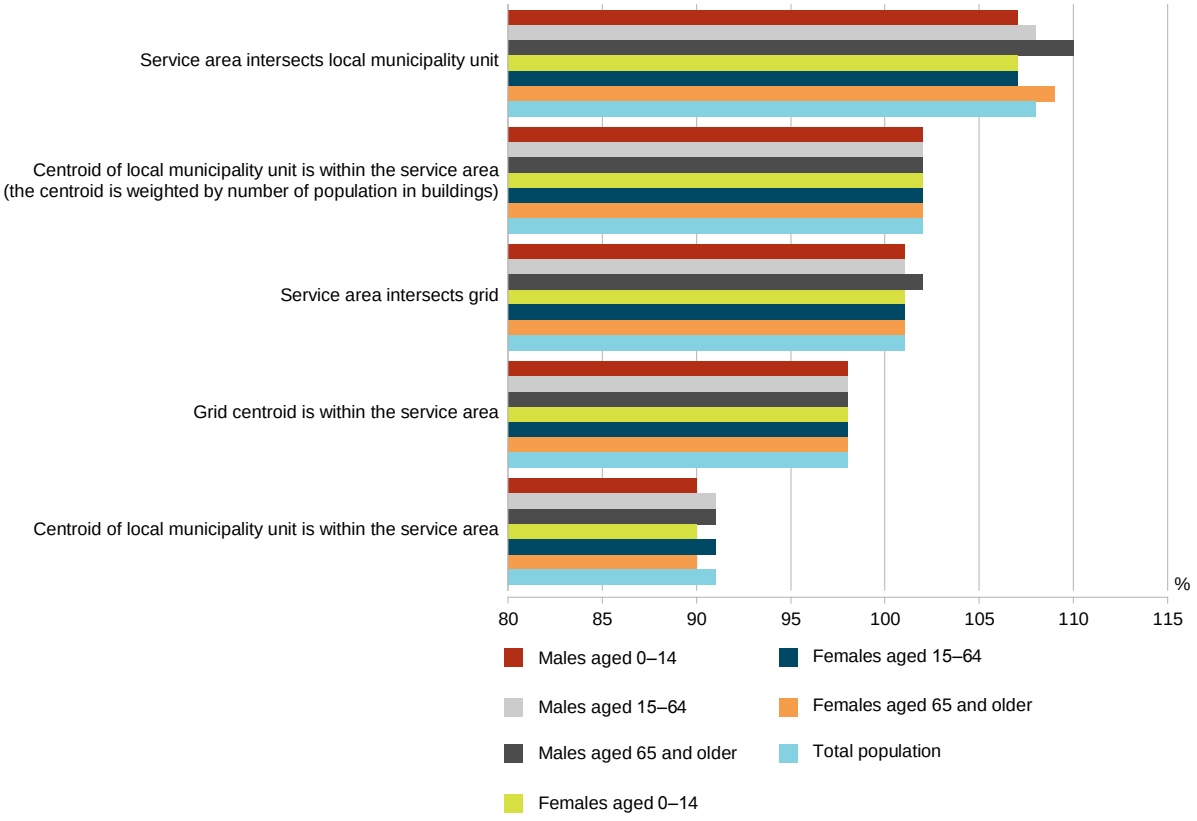


CHART 7. COMPARISON OF RESULTS OBTAINED WITH DIFFERENT SPATIAL MATCH OPTIONS IN CASE OF SERVICE AREA OF A SINGLE HOSPITAL

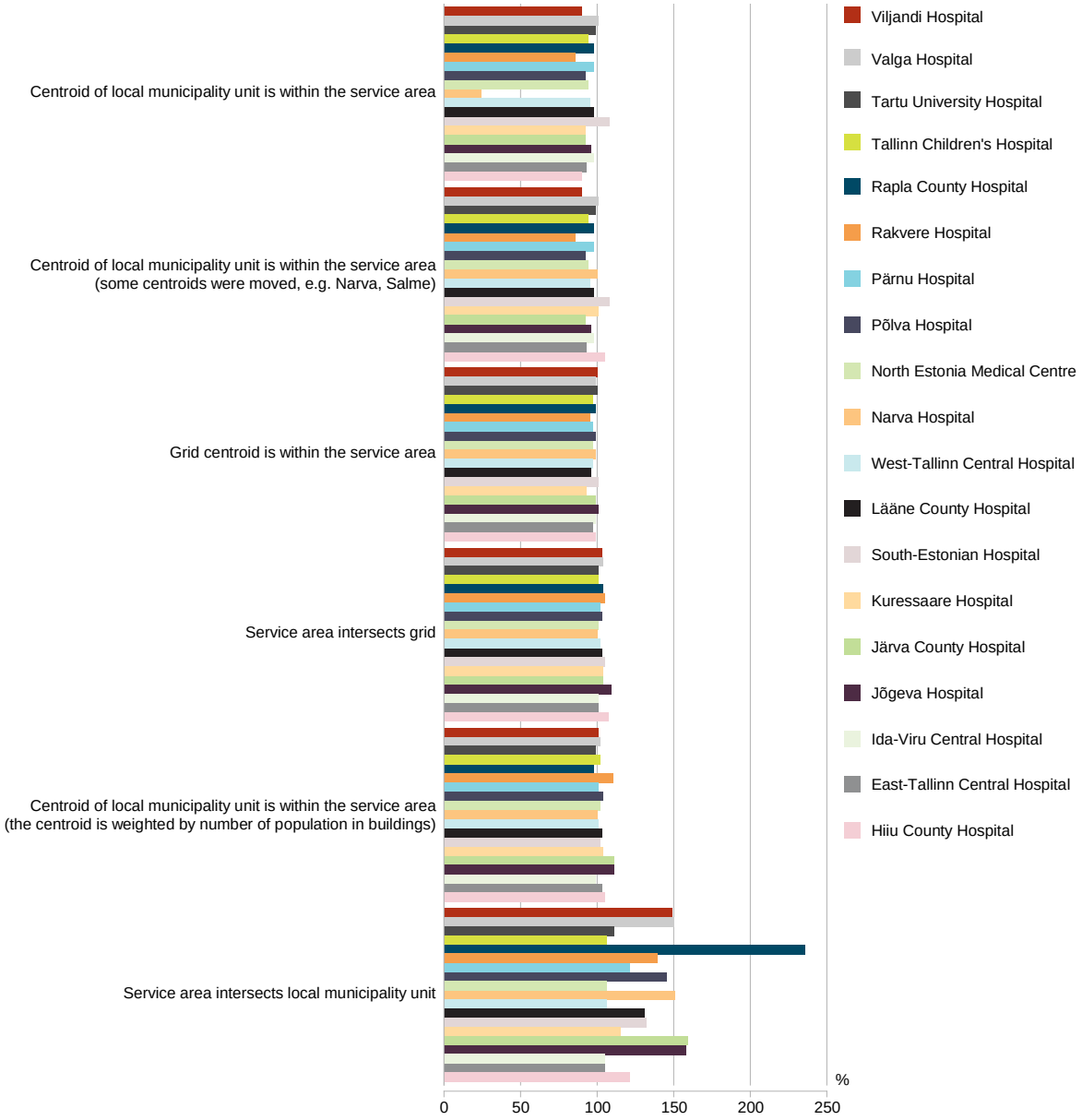


TABLE 4. RESULTS OF SPATIAL ANALYSIS OF POPULATION LIVING WITHIN A 30-MINUTE SERVICE AREA FROM EMERGENCY HOSPITALS, 31 DECEMBER 2011

Percentage of total population living within a 30-minute service area from emergency hospitals in total population				
	Population aged 0–14	Population aged 15–64	Population aged 65+	Population total
Population of buildings intersecting the service area is taken into account	91	91	88	90
Population of municipalities where the centroid (inside the polygon) intersects the service area is taken into account	82	82	80	82
Population of municipalities intersecting the service area is taken into account	98	97	96	97
Population of grids where the centroid intersects the service area is taken into account	89	89	86	88

Population of grids intersecting the service area is taken into account	92	92	89	91
Percentage of male population living within a 30-minute service area from emergency hospitals in total population				
	Males aged 0–14	Males aged 15–64	Males aged 65+	Males total
Population of buildings intersecting the service area is taken into account	91	90	87	90
Population of municipalities where the centroid (inside the polygon) intersects the service area is taken into account	82	82	79	81
Population of municipalities intersecting the service area is taken into account	98	97	96	97
Population of grids where the centroid intersects the service area is taken into account	89	88	86	88
Population of grids intersecting the service area is taken into account	92	91	89	91
Percentage of female population living within a 30-minute service area from emergency hospitals in total population				
	Females aged 0–14	Females aged 15–64	Females aged 65+	Females total
Population of buildings intersecting the service area is taken into account	91	91	88	91
Population of municipalities where the centroid (inside the polygon) intersects the service area is taken into account	82	83	80	82
Population of municipalities intersecting the service area is taken into account	98	97	96	97
Population of grids where the centroid intersects the service area is taken into account	89	89	87	89
Population of grids intersecting the service area is taken into account	92	92	90	92

REFLECTIONS

The results show that 90% of the Estonian population lives within a 30-minute driving distance from the emergency hospitals (Table 4). For elderly people (aged 65 and older) the accessibility of emergency hospitals is slightly worse – 88% of persons aged 65 and older live inside the 30-minute service areas of hospitals. The situation is better for women (91%) and worse for men (90%). Children and working-age people have slightly better accessibility – 91% of them live inside the 30-minute service area of emergency hospitals. This result is based on the building based point data. The areas outside the 30-minute driving distance are mainly remote areas near the border, small islands, mire complexes and the areas around them. In some places the service areas overlap.

In case of the local municipality unit data, much better results were obtained when the match option "centroid of local municipality unit is within the service area" was used (Map 8, Chart 6). The results are underestimated by 9% on average but the discrepancy compared to building based data is not as obvious as in case of the spatial match option "service area intersects local municipality unit" (Map 9). Also, the variance between different service areas is smaller. With this method, the biggest error was found when the hospital is located near the border and does not have a radial-symmetric service area. Therefore, the centroid of local municipality unit could be left out of the analysis. For example, the biggest underestimation is found in case of the service area of Narva Hospital where the centroid of Narva city is not within the hospital service area (Chart 4). Compared to the building based data, only 24% of the persons who live within the service area of Narva Hospital are taken into account. The results improve (underestimation 3%) when the populations of Narva city and some other local municipality units are also taken into account.

Grid based analysis gave more precise results (Map 10). Compared to the building based data, the difference is –2% to 3% depending on the spatial match option used. The biggest underestimation is found in case of the service area of Kuressaare Hospital, when the spatial match option "grid centroid is within the service area" is taken into account. It is difficult to find out the reason for that. There is a long negative curve in the coastal area of this service area and it could be that this part of the densely populated coast is left out from the service area when using the grid centroids. With the option "service area intersects grid", the biggest overestimation is found for Jõgeva Hospital. Such a big overestimation is caused by the fact that there are some densely populated grids near the boundary of the service area (in Tartu city).

CONCLUSION

The results show that 90% of the Estonian population lives within a 30-minute driving distance from the emergency hospitals. For elderly people, the accessibility of emergency hospitals is slightly worse than for children and working-age people.

The comparison of different data shows that with grid data the results are always closer to the building based data than with municipality level data. The spatial match option also influences the results. With the method where the service area intersects the local municipality unit or grid, the results are overestimated. The use of centroids of local municipality unit or grid causes underestimation of the results. In case of grid data, it is difficult to say which spatial match option is the best. In some cases, one method gives more exact results and in other cases the other method is better. With local municipality unit data, the results are better when using centroids. Manual check is sometimes needed. The differences between sex and age groups on single hospital level are not remarkable.

5.3 FINLAND

5.3.1 NATIONAL CONTEXT

In Finland an emergency care is traditionally divided into a primary health care and a special care. A municipality alone or together with other municipalities take care of the primary care. Finland is divided into 20 hospital districts which are responsible to provide more demanded emergency care (special care). The most advanced emergency care is available in the University hospitals. A new regulation enters in force in 2015 giving common criteria for providing emergency care for all citizens. The major objectives of the regulation are to improve quality of emergency care and patient safety. This can be achieved only by establishing more efficient network of emergency assistance rooms.

This study measures accessibility to hospitals' emergency rooms by different age groups in 2011. The purpose is to give background information to a potential need to optimise locations of different type of emergency rooms. The study, in the first case, tests different type of data and methods to measure population within 30-minutes from emergency rooms providing 24/7 service.

5.3.2 NATIONAL DATA USED

POPULATION

CONTENTS

Population by grids (1 km x 1km) and municipalities in 2011 by sex and age groups (1-14, 15-64, 65+)

The data is based on Statistics Finland's population database, which is updated yearly from the Population register of Finland. In the population database all inhabitants have map coordinates by centroids of their

housing unit.

COVERAGE

The population database covers the whole of Finland, this is the mainland of Finland and the Åland islands. The coverage of map coordinates of all inhabitants is 99 % . The data was aggregated to grids and used before any data protection procedures.

UPDATING

The Population register of Finland is continuously updated, but the version of the Statistics Finland's database used in this case study dates 31.12.2011.

SOURCE

Statistics Finland

EMERGENCY HOSPITALS

CONTENT

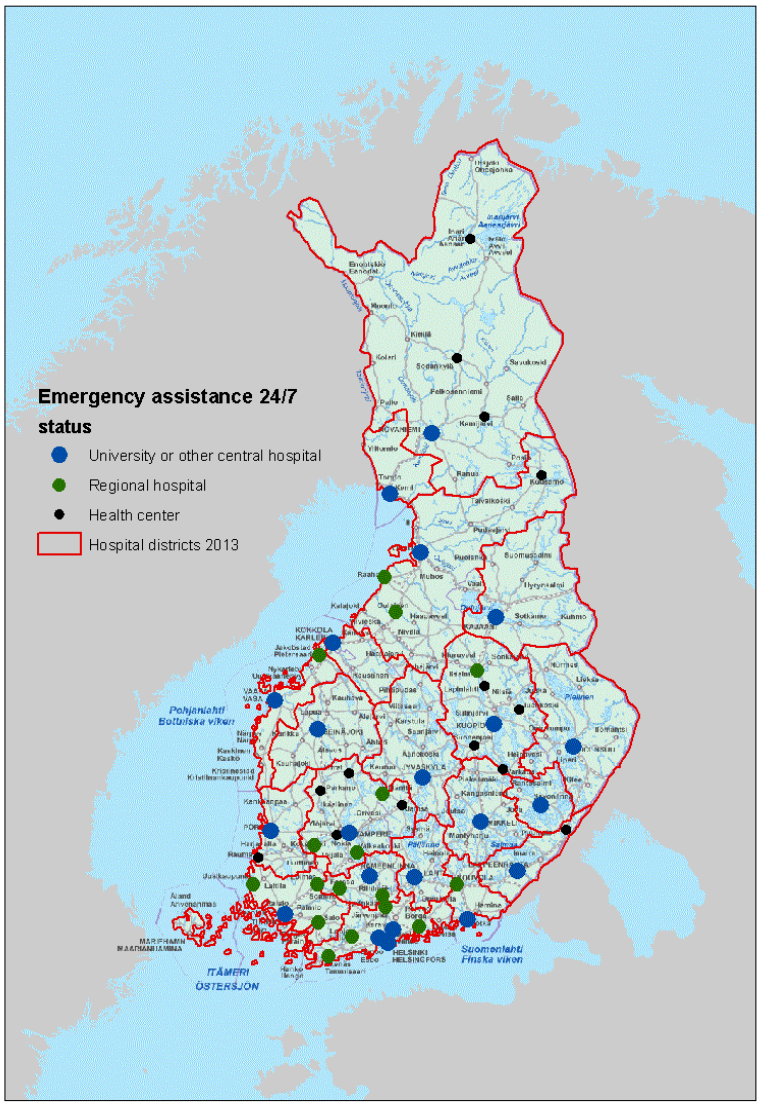
Location of hospitals with an emergency assistance in Finland.

The data is based on a study, where hospitals' and health centres' emergency rooms with 24/7 service were identified[17]. Locations of emergency rooms were geocoded by their address information. (The Finnish Business register consists of locations of hospitals but with no information about their emergency room service).

The emergency rooms were classified according to their administrative status, which also indicate their service capacity (Map 11). This data does not include three "mobile emergency rooms" which exist in the northern part of Finland.

[17] Reissell, e. et al, 2012

MAP 11: EMERGENCY ROOMS OF HOSPITALS AND HEALTH CENTERS PROVIDING 24/7 SERVICE IN 2011



COVERAGE

The data covers the mainland of Finland. Åland islands were excluded mainly because of their special status and their extraordinary circumstances in terms of accessibility.

UPDATING

No regular updating exist.

SOURCE

The study of where hospitals' and health centres' emergency rooms with 24/7 service were identified (Reissell et al. (2012).

ROAD NETWORK

DigiRoad is a National Road and Street Database which contains precise and accurate data on the location of all roads and streets in Finland as well as their most important physical features (covering a total of 483,000 km).

http://www.digiroad.fi/en_GB/

COVERAGE

Best available national data. The quality of Digiroad has been measured and reported systematically since the spring of 2010. Quality is monitored and assessed using the Digiroad Quality Model. http://www.digiroad.fi/laatu/en_GB/quality/

UPDATING

The maintenance organizations are the National Land Survey of Finland, the Finnish Transport Agency and Finnish municipalities. New data is published four times a year, in January, April, July and October. Statistics Finland updates the data once a year

SOURCE

DigiRoad. The Digiroad operator. User agreements and support. tuki@digiroad.fi

ADMINISTRATIVE BOUNDARIES

CONTENT

The municipality dataset contains the administrative units of municipalities including centroids of each municipality as well as their boundaries by the scale 1:100 000.

COVERAGE

The data covers mainland Finland and is limited by the border with Sweden, Norway and , Russia. The data set contains no sea borders.

UPDATING

The dataset of municipalities is updated once a year. The version used is from 01.01.2013 January.

SOURCE

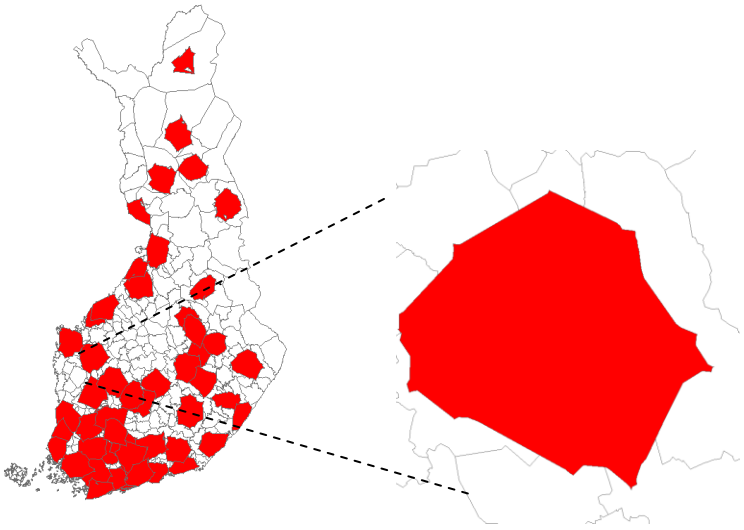
The National Land Survey

5.3.3 PROCESS

The 30-minute service areas were established around hospital's emergency rooms using national road and street data base and using ArcGIS Network analyst with an estimation of travel times to the nearest emergency rooms.
Travel times were estimated by using in the first place speed limit information of road segments, and if it was not available, estimated speed of the road segments according to a functional type of the road.

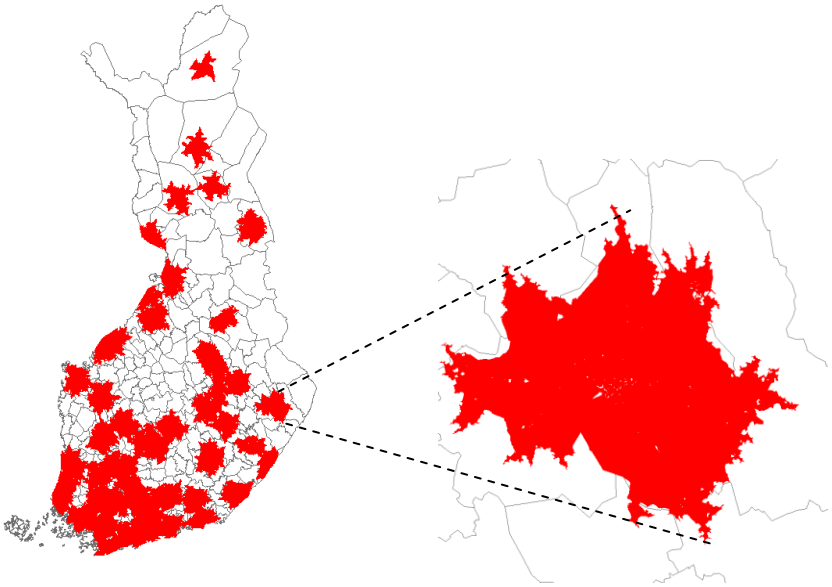
The service areas were created by testing both, generalised and detailed (polygons) options of the Network analyst (Map 12a, Map 12b). The option detailed was chosen for best results.

MAP 12A: THE 30 MINUTES SERVICE AREAS OF THE EMERGENCY ASSISTANCE (24/7)



(GENERALIZED)

MAP 12B: THE 30 MINUTES SERVICE AREAS OF THE EMERGENCY ASSISTANCE (24/7) (DETAILED)



Population by different age groups and sex and total population in all service areas were calculated as well as their percentage of similar population groups in the whole country.

The population counts of the 30-minutes service areas were based on three georeferenced data level; on municipal level (in Finland 320 municipalities) georeferenced by 1) municipal boundaries (polygons) and 2) by centroids of municipalities (points), and on grid level (101 479 inhabited 1km x 1km grids) georeferences 3) by grid polygons. Polygon centroids were not used, because the reference points, as such, are not representing the reality better than polygons. A distribution of population inside grid cells is not known.

5.3.4 RESULTS

Most accurate results are made by population data by grids and by the Network Analyst option "detailed". In this case the study shows that in 2011 88 % of the total population in Finland live 30-minutes from emergency rooms of 24/7 service. The accessibility to emergency rooms is better among younger age groups (89 %) than older age groups (84 %) and slightly better among female (88 %) than among male inhabitants (87%) (Table 5). However from all inhabited grid cells (1 km x 1 km) 46 % are outside the

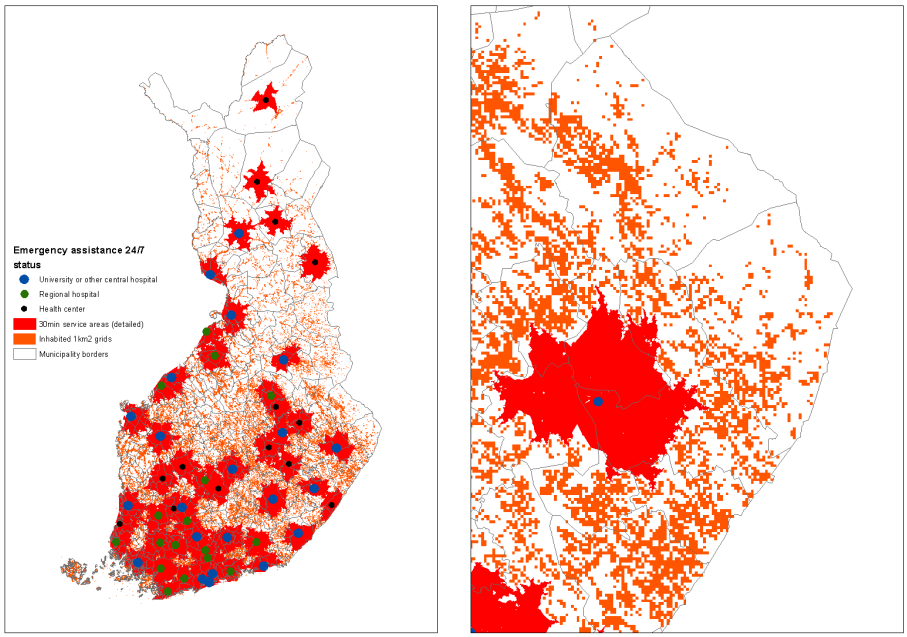
service areas having population of 646 971 (, which is 12 % of the total georeferenced population). This population is distributed unevenly in the country (Map 13). The grids cells with majority of inhabitants aged 65 + are scattered in countryside outside the service areas (Map 14).

The results by using generalised and detailed options of Network Analyst with grid data are almost similar on country level. Also results by using generalised option with point data (municipal centroids) are close to those above on country level (Table 5).

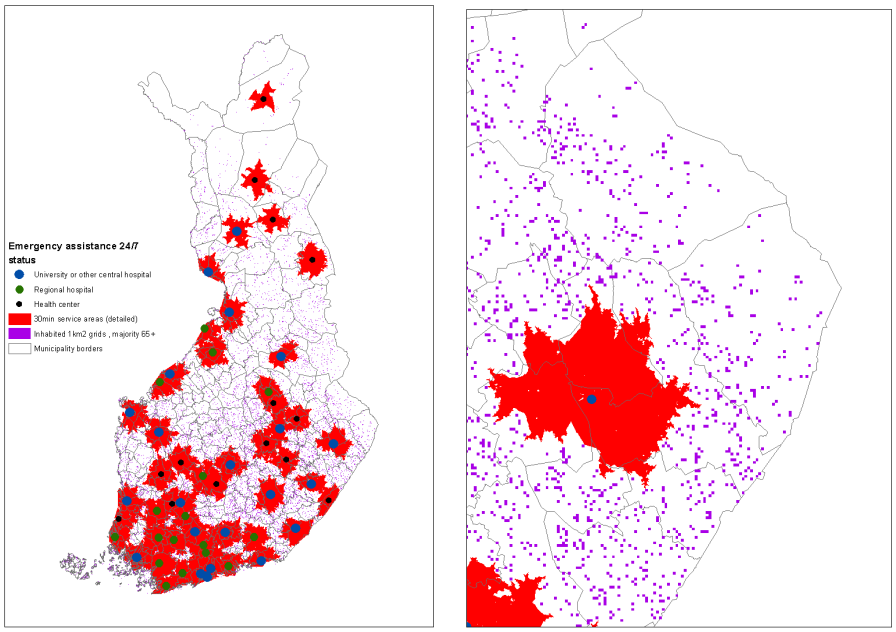
The Accessibility to emergency rooms varies by different hospital regions (Map 15). The use of detailed service areas makes more differences from region to region than the use of generalized service areas (Table 6).

MAPS

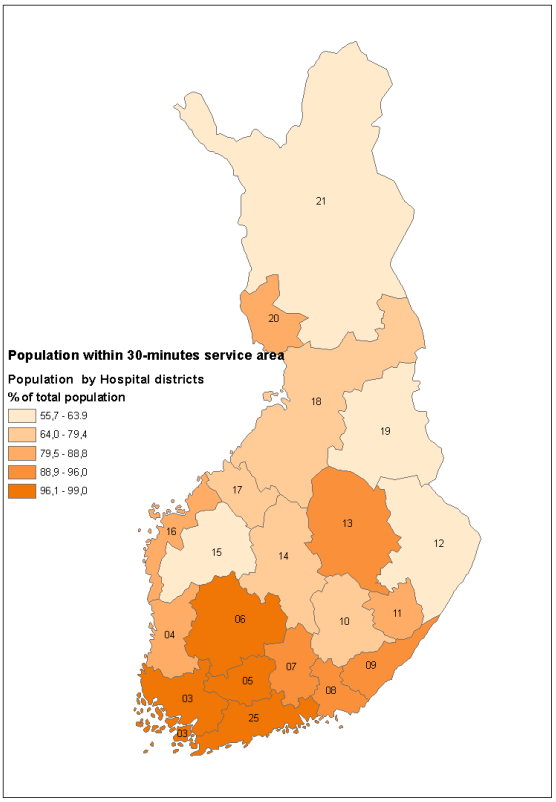
MAP 13: THE 30-MINUTES SERVICE AREAS (OPTION DETAILED) TO THE NEAREST EMERGENCY ROOMS AND INHABITED GRIDS OUTSIDE THE SERVICE AREAS



MAP 14: THE 30-MINUTES SERVICE AREAS TO THE NEAREST EMERGENCY ROOMS AND INHABITED GRIDS WITH MAJORITY POPULATION AGED 65+.



MAP 15: SHARE OF POPULATION WITHIN 30-MINUTES SERVICE AREAS OF NEAREST EMENGENCY ROOMS BY THE HOSPITAL DISTRICTS



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STATISTICS

TABLE 5 POPULATION BY SEX AND DIFFERENT AGE GROUPS WITHIN 30 MINUTES SERVICE AREA (OPTIONS GENERALIZED AND DETAILED) BY DATA OF DIFFERENT GEOREFERENCED LEVEL.

2011	Selected features	TOTAL_POP	M_TOTAL	F_TOTAL		Total_0_14	Total_15_64	Total_65_up
Total population		**5401267**	**2652534**	**2748733**		**888982**	**3532645**	**979640**
Total georeferenced population	101315 inhabited grids	5339896	2613645	2726251		881738	3484516	973642
Service area; option generalized								
Population of 30 minutes service area -intersect municipality centroids	169 points	4640509	2268021	2372488		766362	3068714	805433
Population of 30 minutes service area -intersect municipality boundaries	248 polygons	5147187	2523470	2623717		851209	3378208	917770
Service area; option detailed								
Population of 30 minutes service area -intersect municipality centroids	150 points	3892938	1911835	1981103		659699	2551858	681381
Population of 30 minutes service area -intersect municipality boundaries	246 polygons	5135334	2517424	2617910		848525	3371250	915559
Service area; option generalized								
Population of 30 minutes service area - intersect grid (polygons)(1km x 1km	58852 inhabited grids	4734142	2304990	2429152		791238	3117069	825835
Service area; option detailed								
Population of 30 minutes service area - intersect grid (polygons)(1km x 1km	54623 inhabited grids	4692925	2283656	2409269		784650	3091616	816659
SHARE FROM TOTAL POPULATION		**TOTAL_POP**	**M_TOTAL**	**F_TOTAL**		**Total_0_14**	**Total_15_64**	**Total_65_up**
Total georeferenced population		98,9	98,5	99,2		99,2	98,6	99,4
Service area; option generalized								
Population of 30 minutes service area -intersect municipality centroids		85,9	85,5	86,3		86,2	86,9	82,2
Population of 30 minutes service area -intersect municipality boundaries								
Service area; option detailed								
Population of 30 minutes service area -intersect municipality centroids		72,1	72,1	72,1		74,2	72,2	69,6
Population of 30 minutes service area -intersect municipality boundaries		95,1	94,9	95,2		95,4	95,4	93,7
Service area; option generalized								
Population of 30 minutes service area - intersect grid (polygons)(1km x 1km)		88,7	88,2	89,1		89,7	89,5	84,8
Service area; option detailed								
Population of 30 minutes service area - intersect grid (polygons)(1km x 1km)		87,9	87,4	88,4		89,0	88,7	83,9

Also figures on comparison using detailed/general service area see chapter 2.2 above

TABLE 6: POPULATION WITHIN 30-MINUTES SERVICE AREAS (SA) OF THE NEAREST EMERGENCY ASSISTANCE BY HOSPITAL DISTRICTS IN 2011. THE SERVICE AREAS ARE DEFINED BY TWO DIFFERENT ACCURACY LEVEL (OPTIONS GENERALIZED AND DETAILED).

Hospital district	Total	30-minutes sa.	30 minutes sa.	Generalized	Detailed	Generalized -Detailed	Generalized-Detailed
	georefernced pop.	Generalized	Detailed	sa. , %	sa., %	population	%
00	28080						
03	464304	448804	445827	96,7	96,0	2977	0,6
04	223556	203566	198692	91,1	88,9	4874	2,2
05	173570	172238	171538	99,2	98,8	700	0,4
06	509746	498897	495870	97,9	97,3	3027	0,6
07	211039	192994	191953	91,4	91,0	1041	0,5
08	173583	167754	166654	96,6	96,0	1100	0,6
09	131340	120342	119168	91,6	90,7	1174	0,9
10	104714	82610	78011	78,9	74,5	4599	4,4
11	44945	39325	38479	87,5	85,6	846	1,9
12	168107	98503	95433	58,6	56,8	3070	1,8
13	245971	223245	220139	90,8	89,5	3106	1,3
14	247360	177617	175341	71,8	70,9	2276	0,9
15	197750	115816	111871	58,6	56,6	3945	2,0
16	166822	142052	140801	85,2	84,4	1251	0,7
17	77810	55002	53708	70,7	69,0	1294	1,7
18	396429	317070	314838	80,0	79,4	2232	0,6
19	77457	43634	43264	56,3	55,9	370	0,5
20	64640	55960	55526	86,6	85,9	434	0,7
21	117348	75185	75010	64,1	63,9	175	0,1
25	1515325	1503528	1500802	99,2	99,0	2726	0,2
Sum	5339896	4734142	4692925	88,7	87,9	41217	0,8

REFLECTIONS

The results are most dependent on:

-degree of accuracy of data; geographical level of population data, road net-work

-quality of data in terms of coverage and correctness

-methods used for creation of service areas; generalised or detailed

-methods used for estimation on travel times

Finland has 320 municipalities and their size varies a lot. Housing is quite concentrated. Localities (concentration of housing with more than 200 in-habitants) cover less that 2 % of land area of the whole country but in them lives more than 80 % of the total population of the whole country. This is why it is obvious that in accessibility studies grid based data serves for much more reliable results than data by municipalities.

The fragmented terrain of Finland in the first place caused by many lakes and rivers makes a challenge for the road network and often causes long travel distances. It is obvious that Euclidean distances between places are quite misleading in comparison of the real travel distances and travel times along roads.

The detailed service area option (in the Network Analyst tool) gives more reliable results together with grid data because of our fragmented street network caused by lakes and rivers and because of our settlement structure; centralised on one hand and scattered on the other hand.

5.4 Norway

5.4.1 National context

In Norway the Emergency Medical Services (EMS) includes pre-hospital and hospital care. The pre-hospital emergency health care includes the ambulance services, emergency medical communication centres, centres for municipal General Practitioners and physicians on call as well as emergency clinics[18]. Out of the EMS it is primarily the pre-hospital care that has a "response norm". The government states that:

"When optimizing the localization of ambulance stations a "response norm" is pronounced nationally and indicates that 90 per cent of all call-outs in category "acute" shall be with the patient within 12 minutes (including time spent contacting the emergency medical communication center) in urban areas, while 90 per cent of all call-outs should be with the patient in 25 minutes in rural areas[19]."

In Norway the ambulance services are not necessary localized at the emergency hospitals, but can also be in the community. Depending on the size of the population they are staffed either with hospital personnel, or are on call from home. Another important factor when considering the travel distance to emergency hospitals is the different types of ambulance services that is not only provided by cars, but also by boats and helicopters. Advanced ambulances, including air ambulance, are staffed with physicians in addition to other health care staff reduces the need for acute transporting of the patient to the emergency hospital.

5.4.2 National data used

Population

Contents

2011 Population by (1 km x 1km) grids and municipalities divided by sex and age groups (1-14, 15-64, 65+). The population data are joined with the address data in the National Cadaster (Statistics Norway's version). This results in that 99,7 % of the total population is georeferenced to addresses.

[18] Norwegian Ministry of Health and Care Service, 2008

[19] Ibid

COVERAGE
The population register cover the Norwegian mainland and Svalbard.

UPDATING
The population register of Norway is continuously updated, but the version used in this case study dates 01.01.2011.

SOURCE
Statistics Norway

EMERGENCY HOSPITALS

CONTENTS
Georeferenced dataset over health care service was produced by Statistics Norway based on the Business and Enterprises register (VOF). Business and Enterprises (VOF) is Statistics Norway (SSB) register of companies (legal entities) and organizations in the private and public sector in Norway. VOF should be a comprehensive and high-quality registry, and constitute a common population for economic and trade statistics and social statistics.

COVERAGE
The business register cover the Norwegian mainland

UPDATING
No regular updating of health care centers

SOURCE
Statistics Norway

ROAD NETWORK

CONTENTS
Elveg is a database of all drivable roads, including a selection of road information from the broader National Road DataBase (NRDB). The data are suitable for transport planning, electronic address map, car navigation, surveillance, and road maintenance. The attributes associated with each road link can be tunnel, bridge, vegoverbygg, physical confinement, locked bar etc.

COVERAGE
Elveg stores information about all state, municipal and private roads in Norway.

UPDATING
The data here is from February 2013

SOURCE
The Norwegian Public Roads Administration (Statens vegvesen)

ADMINISTRATIVE BOUNDARIES

CONTENTS
The municipality dataset contains the administrative units of municipalities, as well as the boundaries defining these. These limits can also be national borders, municipal borders and county border. Marine areas are also included with no distinction between land and sea. Coastline is not included, because the coastline is not part of the administrative division.

COVERAGE

The data covers mainland Norway and is limited by the border with Sweden, Finland, Russia and the territorial sea. The data set contains no sea borders otherwise.

UPDATING

The dataset Counties and municipalities updated held twice a year and the version used is from 01.01.2013 January.

SOURCE

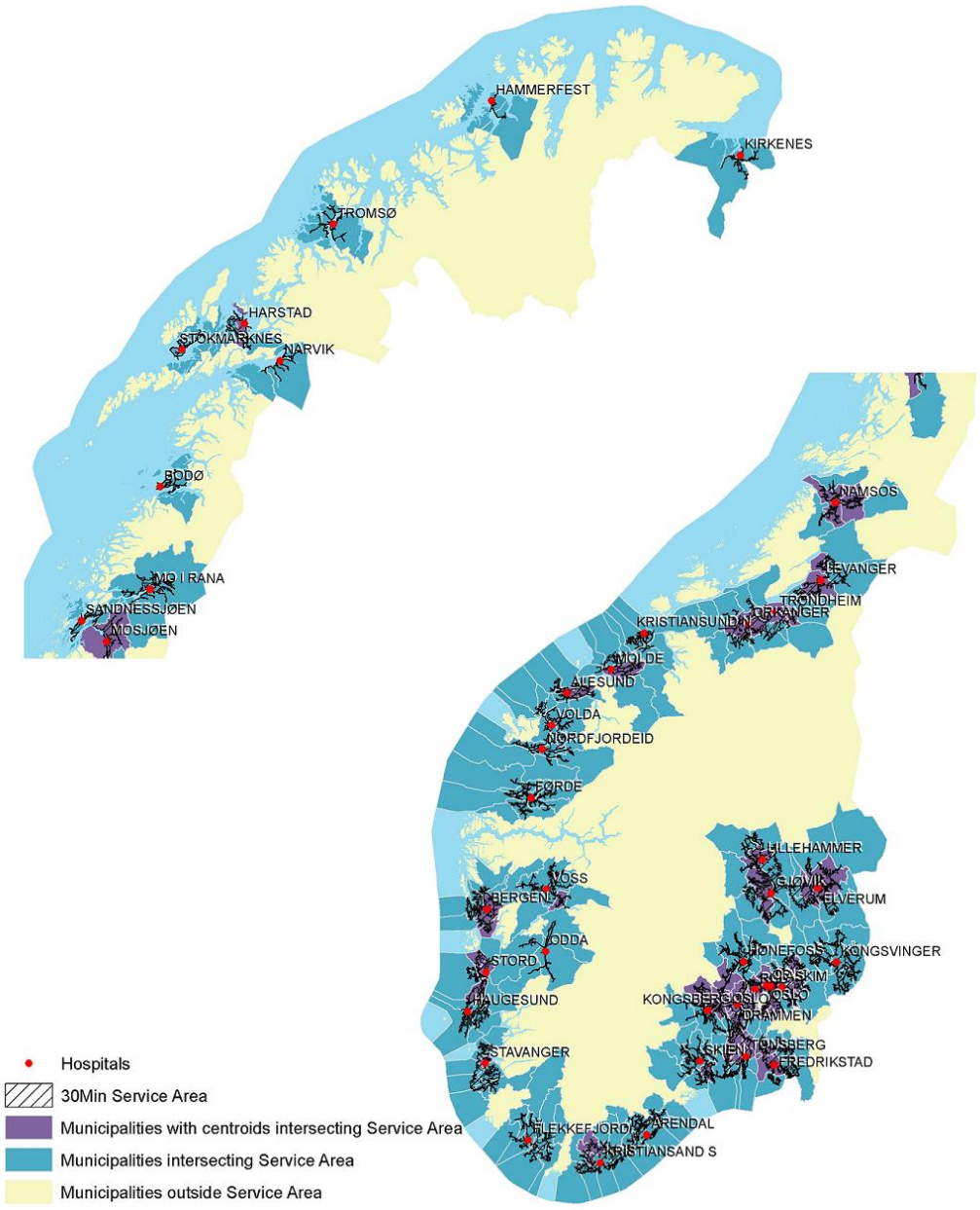
The Mapping Authority is responsible for the data

5.4.3 RESULTS

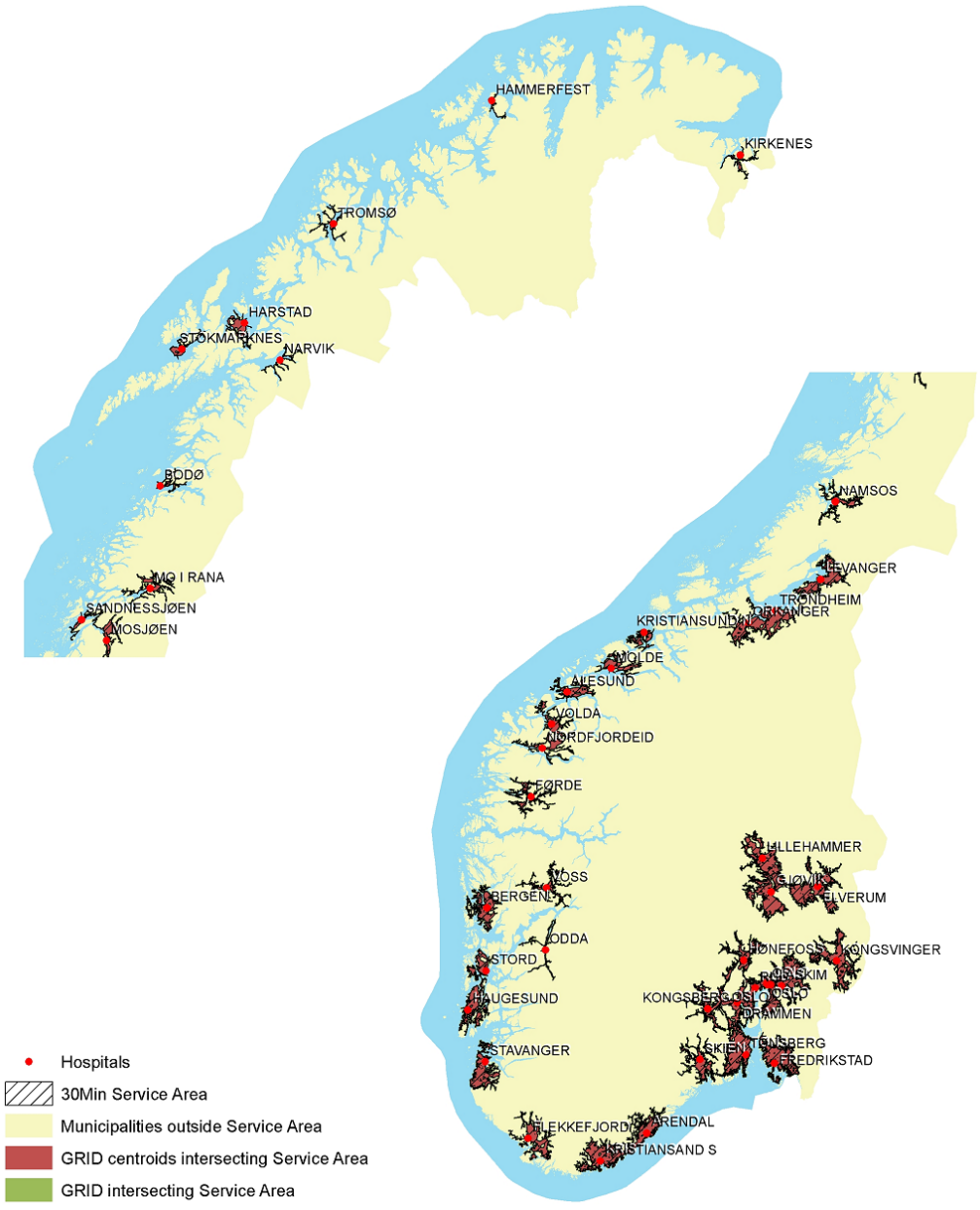
MAPS

Map with grids and administrative areas within 30 minutes from emergency hospitals.

MAP 16. MUNICIPALITY AREAS AND CENTROIDS WITHIN 30-MINUTES SERVICE AREAS



MAP 17. POPULATION GRIDS 1 KM X 1 KM WITHIN 30-MINUTES SERVICE AREAS



MAP 18. POPULATION GRIDS 1 KM X 1 KM FROM EMERGENCY HOSPITALS

STATISTICS

CHART 8. COMPARISON OF RESULTS OBTAINED WITH DIFFERENT SPATIAL MATCH OPTIONS IN CASE OF TOTAL SERVICE AREA OF ALL HOSPITALS

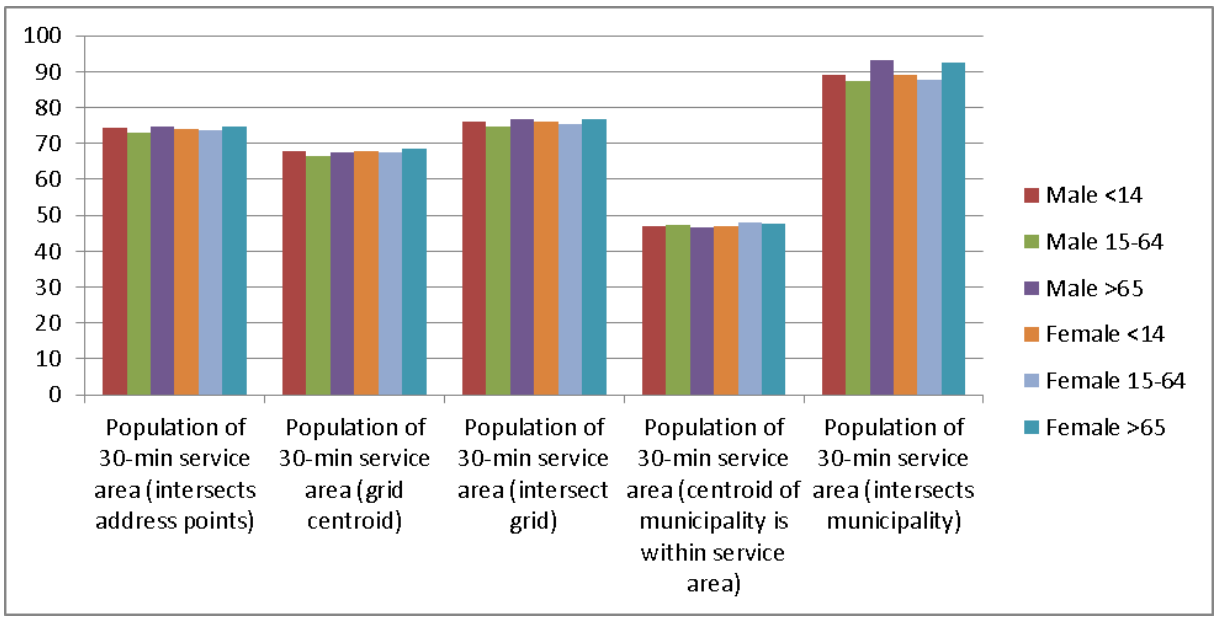
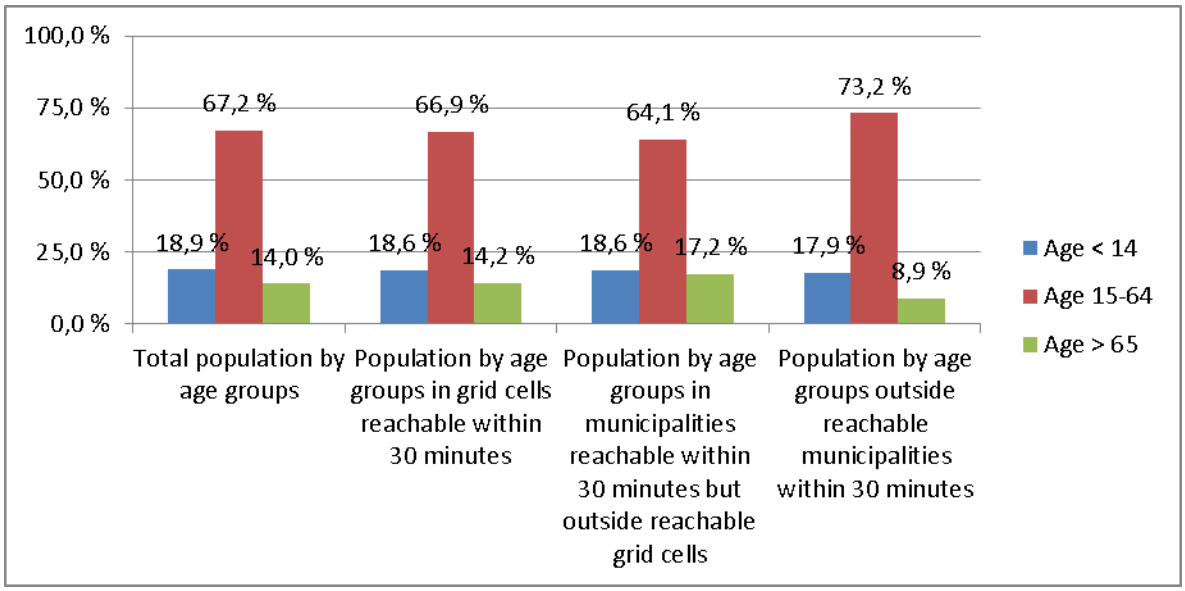


CHART 9. THE POPULATION DISTRIBUTION WITHIN VARIOUS DISTANCES FROM EMERGENCY HOSPITALS



REFLECTIONS

44 emergency hospitals cover the Norwegian Main land with a land surface of 323 779 km^2 and a population of 4 920 305. Urban settlements cover only 0,75 % of the Main land surface but hosted in 2011 79,2 % of the population. The remaining 20,8 % outside settlements are distributed over the Main land of Norway with mountains and a long shore line. This has resulted in important investments in emergency transports by air. However, this study focuses only on access by road.

Population by address centroids was the most detailed georeferenced object in this study and used as a benchmark for calculations of the Norwegian population living within 30 minutes from emergency

hospitals. According to this benchmark 73,7 % of the Norwegian population live within a 30-minute driving distance from the emergency hospitals (chart 8). When comparing this benchmark with other datasets the spatial match was also assessed, here comparing centroids within or intersecting polygons. This is illustrated in chart 1 where the result differ from -26,2 % to 14,9 % for municipalities. The difference can here be explained by the use of spatial match option. By intersecting the service area with the municipality polygons result in overestimation of 14,9 % while intersecting with centroids result in an underestimation of 26,2 %.

Using grid data gave a better result than using municipality units. Making comparable analysis to the municipality data above resulted in an underestimation of 14,9 % when intersecting with centroids and an overestimation of 1,9 % intersecting with grid cells.

Breaking down the total population in age groups and sex when comparing the result from the approaches described above show an overestimation of the age group >65 when using municipalities. For men 93 % are in municipalities intersecting with service areas while only 75 % of the men are in grids intersecting with service areas. The same figure for women >65 is 92 % for intersecting municipalities respectively 77 % for intersecting grids. This difference in between grids and municipalities is also illustrated in chart 6 where population by age groups is geographically located. Comparing the category "population by age groups in municipalities reachable within 30 minutes but outside reachable grid cells" with the other categories illustrate the advantages of using grids instead of municipality units.

Conclusion

The results show that using grids as statistical unit data give better result than using municipalities. The best spatial match is intersecting service areas by grid polygons and not by grid centroids. When generating service areas 30 minutes travel time was set and due to a disperse road network the option of detailed service areas was set in ArcGIS. Using this baseline data and approach resulted in that 75,6 % of the 2011 population live in grids reachable in 30 minutes driving distance from the emergency hospitals.

FURTHER WORK

The Norwegian mountainous landscape and long shoreline has resulted in a need for other types of emergency transport by helicopter, plane or by boat. Including these in to this accessibility study is not easy since the capacity and accessibility is different. Considering accessibility include parameters as type of transport and limitations in weather condition.

It is also important to consider traffic load in urban areas as a parameter to be included in this road accessibility study. This has been done by Regional Development Policy Division at OECD and with some adaptations this can be used the network analysis work of this study[20].

5.5 BULGARIA

5.5.1 NATIONAL CONTEXT

Emergency is part of the common organization of public primary health care system till 1995. Since the reform in 1996 it works in its new form. Twenty-eight Centers for Emergency Health Care and their regional branches in the smaller towns (in most cases- the municipality centers) were established as autonomous structures. They comprise medical teams with equipped vehicles for providing emergency

20 OECD 2012

health care at the place of accident, in the patient's home, during transportation or in emergency wards, with patients transferred if necessary to the appropriate inpatient facility. This network is financed and coordinated by the Ministry of Health.

5.5.2. NATIONAL DATA USED

POPULATION

CONTENTS

Population data by grids (1 km x 1 km) and by municipalities, broken down by sex and age-groups 0-14, 15-64 and 65+, according to the official Census 2011 results of usually resident population in Bulgaria.

The census sex and age-group population data were aggregated by municipality codes and linked to the corresponding municipality feature through the code.

The population grid of Bulgaria 2011 is produced by BNSI as part of GEOSTAT1B project. It is generated by hybrid approach –top-down/bottom-up. The share of the population data geo-referenced to the address location and aggregated into grids is 57% of the whole census population.

The population grid data are equivalent to the official census 2011 data.

COVERAGE

The whole territory of Bulgaria and the population encountered during the census.

UPDATING

Census decisive moment is 01.02.2011. The population data on municipality level are updated yearly. The grid data are planned to be updated. The updating period is not defined yet.

SOURCE

Bulgarian National Statistical Institute (BNSI)

EMERGENCY HOSPITALS

CONTENTS

The information about the Emergency Medical Care Centers (EMCC) and their regional branches comes from the Register of Health Establishments. 237 locations of EMCC are geo-referenced by BNSI according to their address.

COVERAGE

The whole territory of Bulgaria

UPDATING

Regularly updated

SOURCE

Register of Health Establishments - maintained by Ministry of Health

ROAD NETWORK

CONTENTS

Georeferenced dataset (line features) representing the comprehensive road network (main roads and street network), and including a speed attribute per road segment (speed appropriate for safe driving while respecting the regulatory speed limitations per road category).

COVERAGE

The dataset cover the entire territory.

UPDATING

Road network data are regularly updated. The data used in this case study have been provided in 2012 and reflect the network situation of 2011.

SOURCE

TomTom Multinet 3.6

ADMINISTRATIVE BOUNDARIES

CONTENTS

Administrative boundary dataset, describing administrative division of the country as it was in the census moment. These include – national border, district and municipality borders.

COVERAGE

The territory of Bulgaria

UPDATING

The dataset is updated regularly according to the changes in the administrative division.

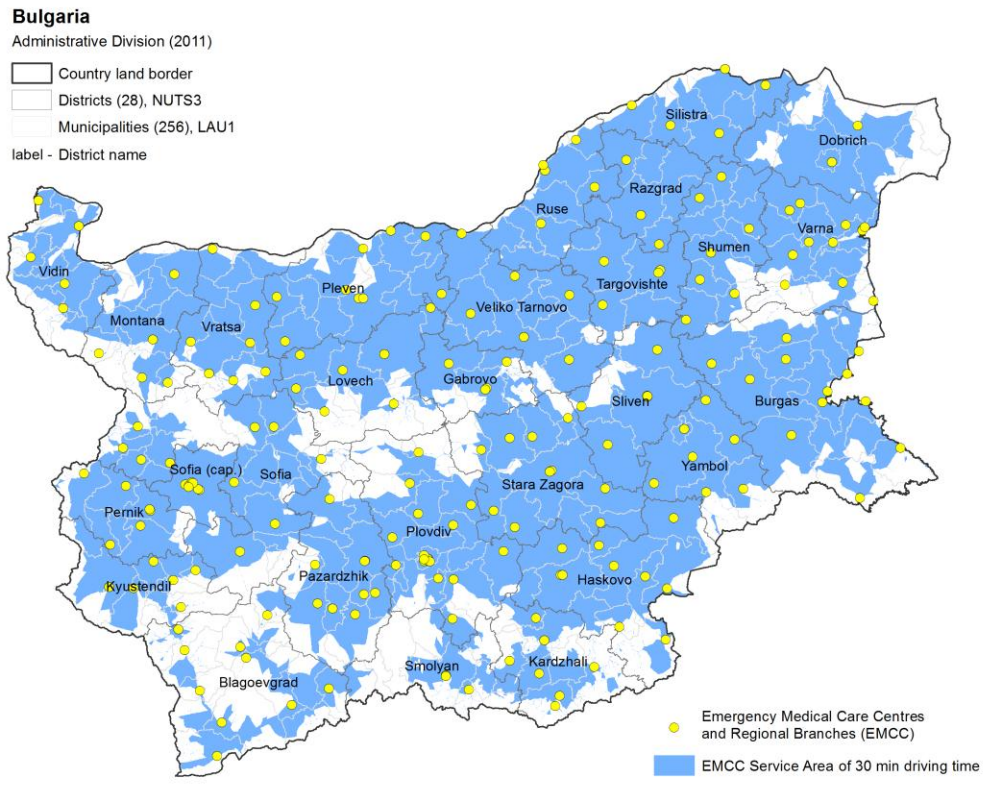
SOURCE

Bulgarian Ministry of Agriculture and Foods

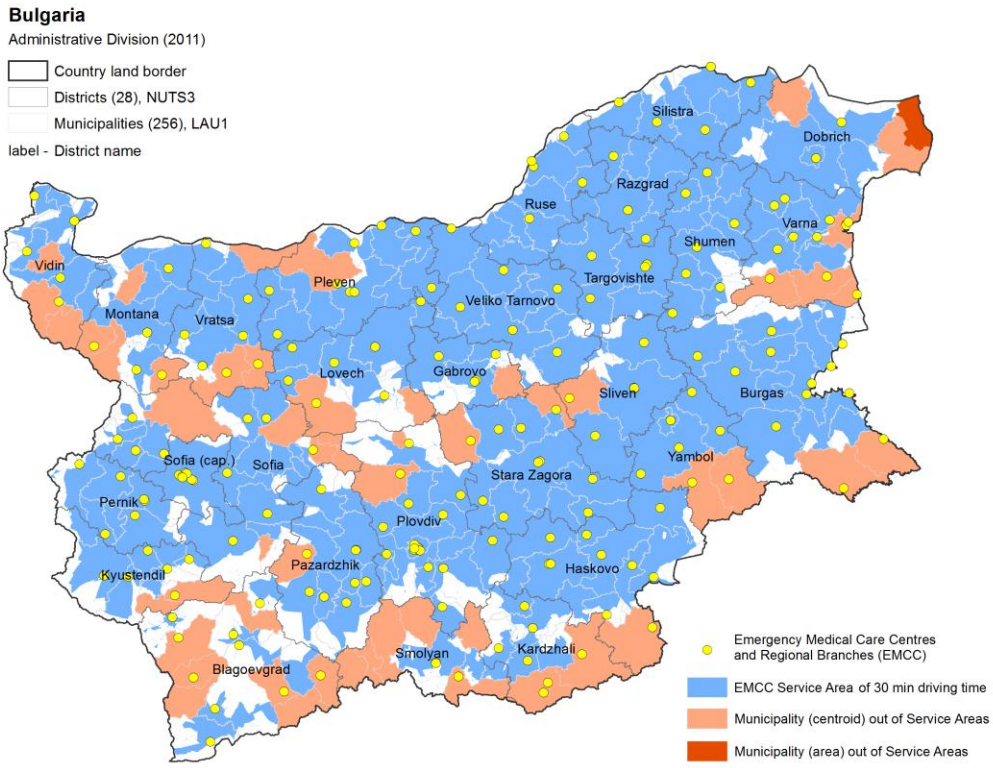
5.5.3 RESULTS

MAPS

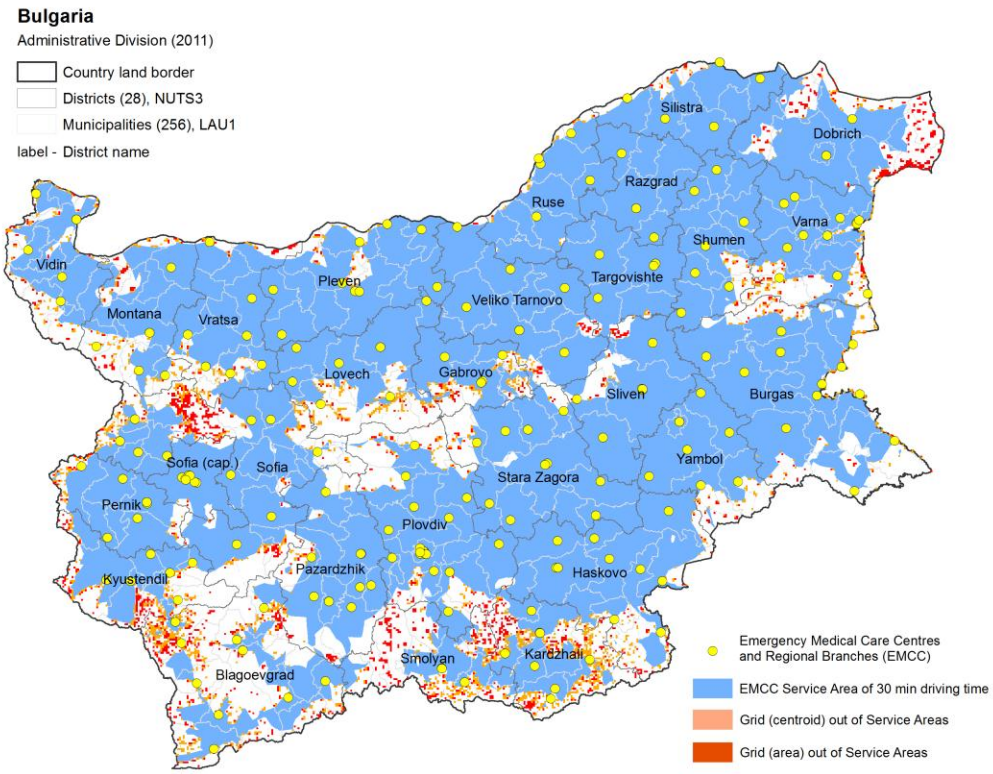
MAP 19: LOCATION OF EMERGENCY MEDICAL CARE CENTRES AND SERVICE AREAS OF 30 MINUTES DRIVING TIME



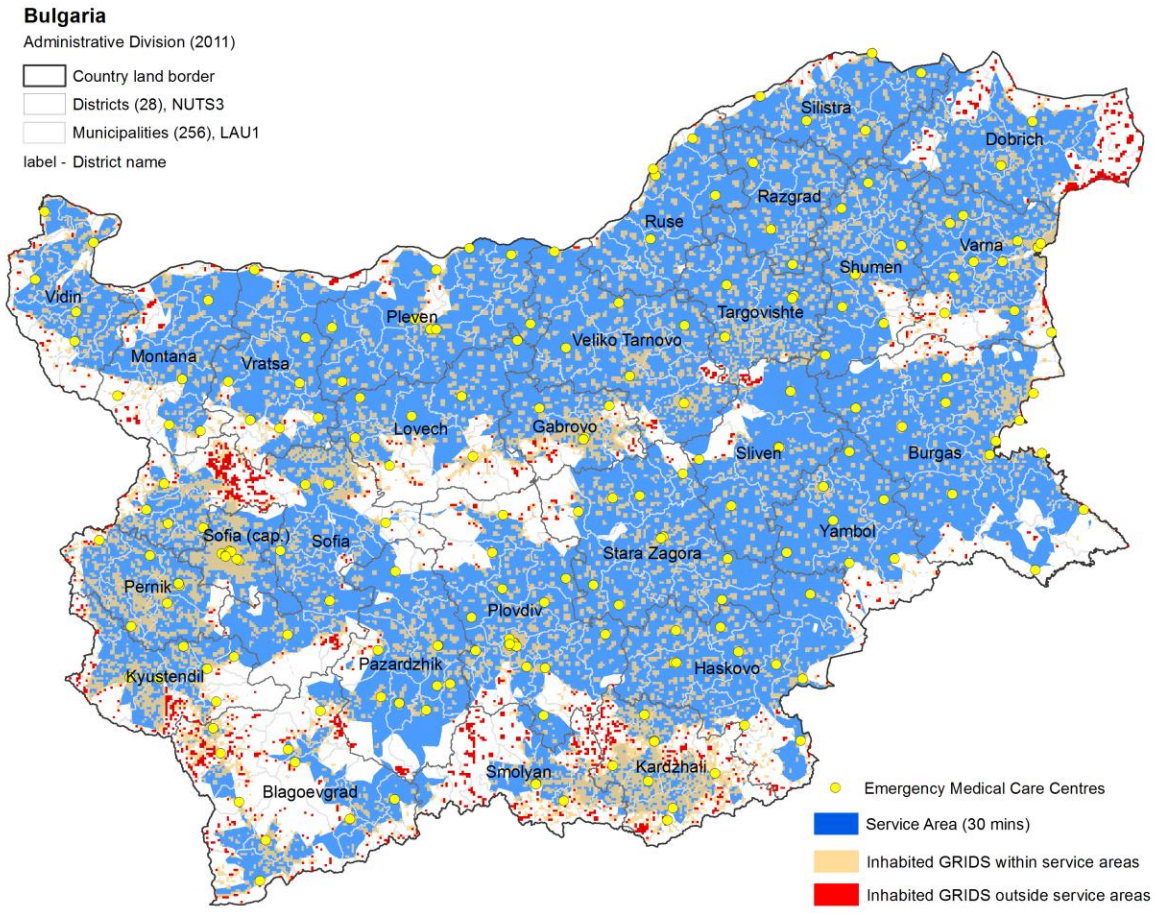
MAP 20: MUNICIPALITIES OUTSIDE 30 MINUTES SERVICE AREAS (TWO MATCH OPTIONS)



MAP 21: GRIDS OUTSIDE 30 MINUTES SERVICE AREAS (TWO MATCH OPTIONS)



MAP 22. POPULATION GRIDS 1 KM X 1 KM WITHIN 30-MINUTES SERVICE AREAS



STATISTICS

CHART 1. COMPARISON OF RESULTS OBTAINED WITH DIFFERENT SPATIAL MATCH OPTIONS IN CASE OF TOTAL SERVICE AREA OF ALL EMERGENCY MEDICAL CARE CENTERS

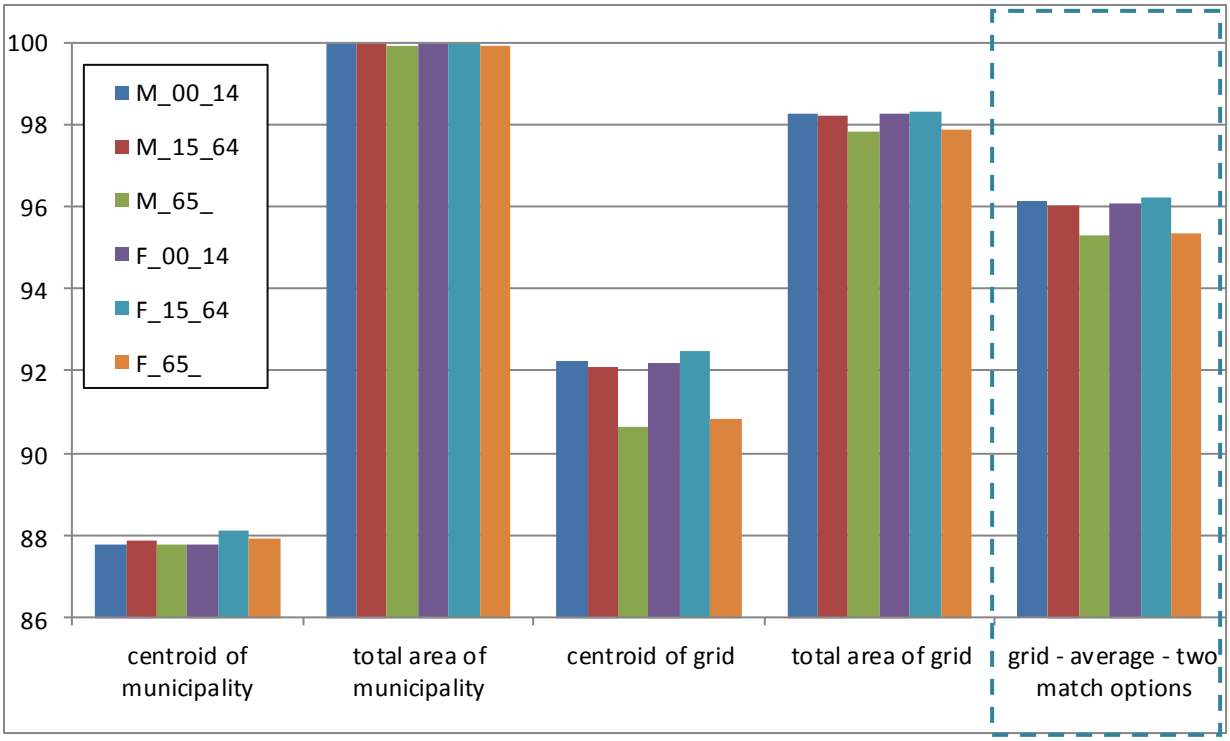
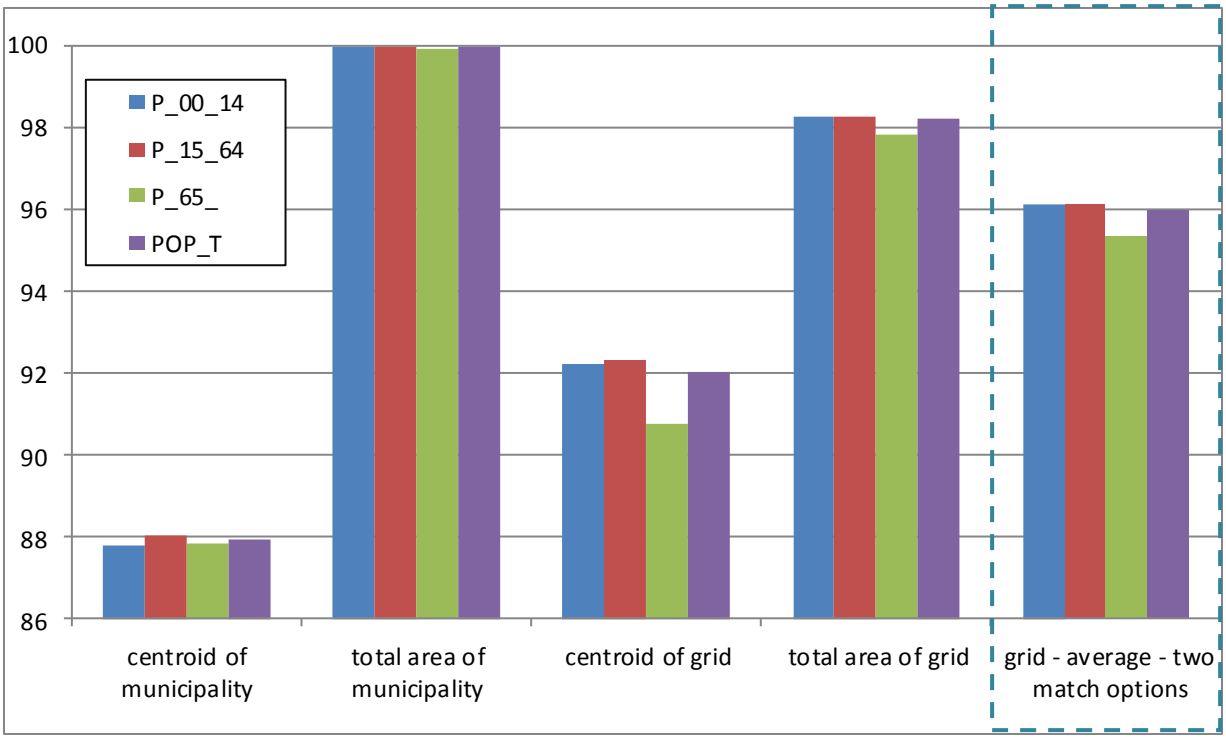


CHART 2. COMPARISON OF RESULTS OBTAINED WITH DIFFERENT SPATIAL MATCH OPTIONS. AGE GROUPS



REFLECTIONS

Two types of analysis were made in order to illustrate the advantages of using the 1 km*1 km grid as a standard when carrying out geographical studies. The results show that over 90% of the Bulgarian population lives within a 30-minutes service area of the emergency hospitals.

The roughest method seems to be the estimation of the accessibility when the service area intersects the local municipality unit. In this case the result is that 99.9% of the population is within the service areas and consequently there are no major differences in between age groups and sexes. In the Map 20 we can see that only one municipality (Shabla) has its total area underserved, i.e. located outside the service areas.

When the service area intersects the grids (in the both match options) the access is different when comparing the age groups. For elderly people (aged 65 and older) the accessibility to emergency hospitals is slightly lower than for the people from the other population breakdowns.

The comparison between the local unit data based analysis and that one based on grid shows as follows. In both cases the use of the match option "centroid of the municipality/grid cell is within the service area" causes an underestimation of the accessibility of the population to emergency hospitals. The other match option "intersect municipality/grid with service area" overestimates the real accessibility.

The difference between the results obtained using the two match options is not so significant in case of grid data which shows that the grid based analysis gives more precise results. (By the municipality difference reaches to 12% for the children and for the males aged 65 and older)

Since the population data by address centroids are not available for the whole territory of Bulgaria, this most detailed geo-referenced object cannot be used for a benchmark calculation in this case. We cannot conclude for sure which one of the two match options is closer to the reality when using grid units, so we find that the average between the two results (centroids of grids within SA, intersecting grids with SA) approaches best the real situation.

CONCLUSION

The coverage of the Bulgarian territory with 30 minutes service areas of Emergency Medical Care is very high which is a consequence of quite uniform geographical distribution of EMCCs. Underserved areas are mainly high mountains and peripheral areas which are particularly very sparsely populated. (Map 22.)

Except the geographical scale (grid or municipality) the spatial match option influences the results also. It is much more precise to work with grid data than with municipality data.

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