

TRACC

Transport Accessibility at Regional/Local Scale and Patterns in Europe

Applied Research 2013/1/10

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Volume 3

TRACC Regional Case Study Book

Part E

Poland case study



This report presents a more detailed overview of the analytical approach to be applied by the project. This Applied Research Project is conducted within the framework of the ESPON 2013 Programme, partly financed by the European Regional Development Fund.

The partnership behind the ESPON Programme consists of the EU Commission and the Member States of the EU27, plus Iceland, Liechtenstein, Norway and Switzerland. Each partner is represented in the ESPON Monitoring Committee.

This report does not necessarily reflect the opinion of the members of the Monitoring Committee.

Information on the ESPON Programme and projects can be found on www.espon.eu

The web site provides the possibility to download and examine the most recent documents produced by finalised and ongoing ESPON projects.

This basic report exists only in an electronic version.

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1 Introduction

The ESPON project TRACC (**TR**ansport **ACC**essibility at regional/local scale and patterns in Europe) aimed at taking up and updating the results of previous studies on accessibility at the European scale, to extend the range of accessibility indicators by further indicators responding to new policy questions, to extend the spatial resolution of accessibility indicators and to explore the likely impacts of policies at the European and national scale to improve global, European and regional accessibility in the light of new challenges, such as globalisation, energy scarcity and climate change.

The Transnational Project Group (TPG) for the ESPON project TRACC consisted of the following seven Project Partners:

- Spiekermann & Wegener, Urban and Regional Research (S&W), Dortmund, Germany (Lead Partner)
- Charles University of Prague, Faculty of Science, Department of Social Geography and Regional Development (PrF UK), Prague, Czech Republic
- RRG Spatial Planning and Geoinformation, Oldenburg i.H., Germany
- MCRIT, Barcelona, Spain
- University of Oulu, Department of Geography (FOGIS), Oulu, Finland
- TRT Trasporti e Territorio, Milan, Italy
- S. Leszczycki Institute of Geography and Spatial Organisation, Polish Academy of Sciences (IGSO PAS), Warsaw, Poland

This report is part of the TRACC Final Report. The TRACC Final Report is composed of four volumes.

- Volume 1 contains the Executive Summary and a short version of the Final Report
- Volume 2 contains the TRACC Scientific Report, i.e. a comprehensive overview on state of the art, methodology and concept, and in particular results on the global, Europe-wide and regional accessibility analyses and subsequent conclusions of the TRACC project.
- Volume 3 contains the TRACC Regional Case Study Book. Here, each of the seven case studies conducted within the project is reported in full length.
- Volume 4 contains the TRACC Accessibility Indicator Factsheets, i.e. detailed descriptions of all accessibility indicators used in the project.

This report on the Poland case study region is one of the major parts of Volume 3 TRACC Regional Case Study Book. The report starts with a short description of the case study region. Then, the results for six different accessibility indicators will be presented and discussed, first for the whole case study region and then in more detail for selected subregions, so called zoom-in regions. This analysis of the current accessibility conditions in the region for car travel as well as for public transport is followed by an analysis of how the planned trans-European transport networks would change the accessibility pattern within the region.

The design of the case study analysis was made in a way that all seven case studies are highly comparable as the definition of the accessibility indicators and its implementation were handled in a rather strict way. Also, the way results are presented in maps, diagrams and more general in the case study reports is highly comparable. A comparable analysis across all case studies is provided in Volume 2, the TRACC Scientific Report. All reports are available at the ESPON website www.espon.eu.

2 The Poland case study region

The case study region

Poland covers an area of 312,685 km², which makes it the ninth largest country in Europe. Since the beginning of the 1990s population of Poland has remained rather constant in size and equals about 38.2 million people (ranking eighth in Europe and sixth in the European Union). According to the preliminary results of the National Census (2011), resident population is lower than projected – it has decreased by ca. 1 million.

The territory of Poland has been divided rather arbitrarily into 6 NUTS-1 regions (regiony) and 66 NUTS-3 subregions (podregiony) for statistical purposes. The 16 NUTS-2 regions correspond to the 16 voivodeships (województwa). The voivodeships are divided into 379 NUTS-4 (LAU1) districts or counties (powiaty) including 65 cities with powiat status. The powiaty are further subdivided into 2479 municipalities (gminy; LAU2). The gmina is the basic unit of the country's territorial structure. The gmina, powiat and voivodeship councilmen as well as mayors of rural and urban gminas and mayors of major cities are elected in general, equal, direct election.

The northern border of Poland runs partly (about 440 km) along the Baltic Sea coast. Poland shares the rest of the border (3511 km) with its seven neighbouring countries including, since 2004, 1,908 km of internal EU borders (since 2007 within the Schengen zone) with Germany, the Czech Republic, Slovakia and Lithuania and, since 2007, about 1,163 km of new eastern Schengen borders with Ukraine, Belarus and Russia. The Sudety mountains are located on the Polish-Czech border and the Carpathian mountains are along Poland's border with Slovakia. However, the majority of the country is lowland.

The zoom-in regions

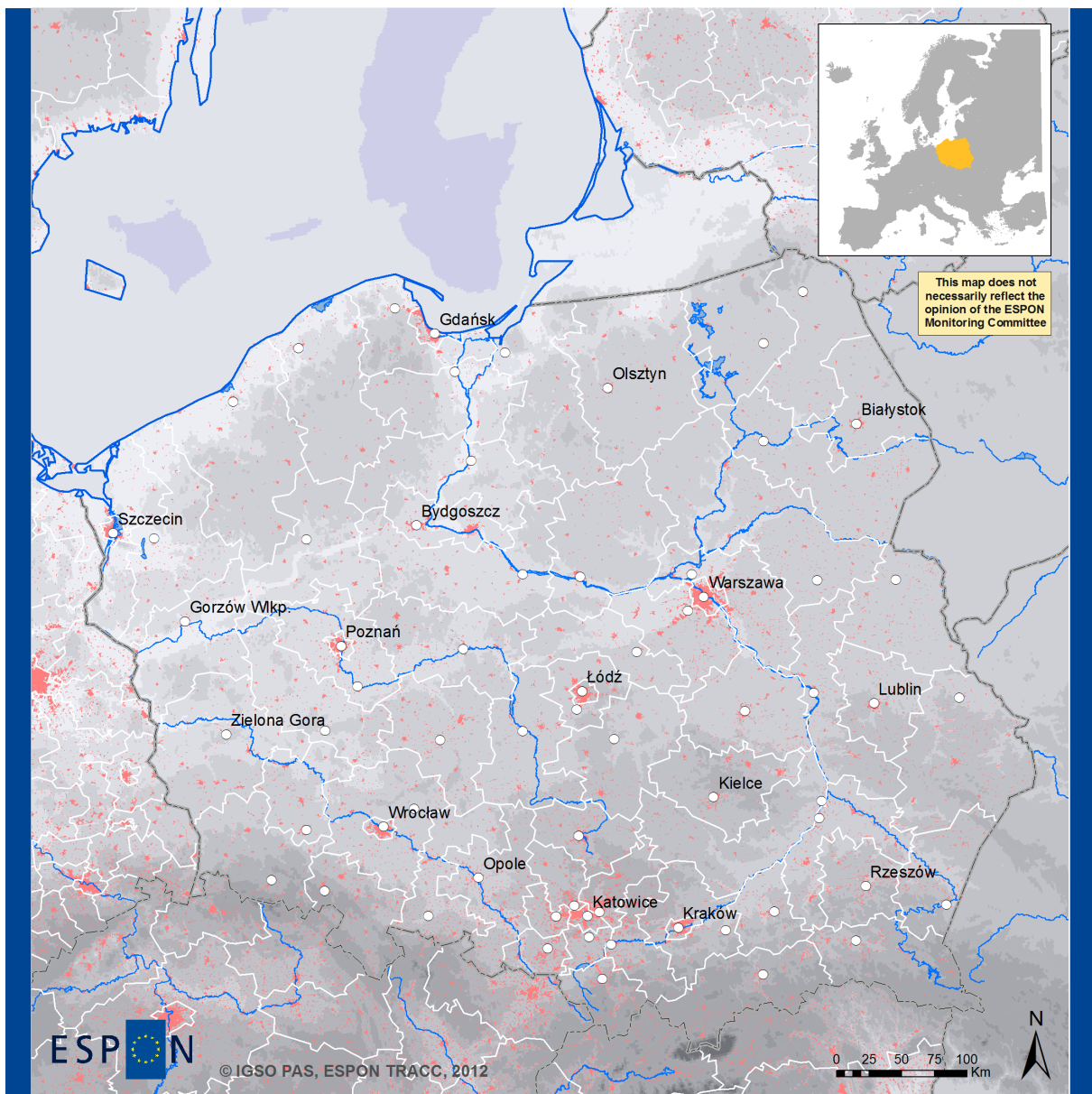
The selected zoom-in areas are of specific nature due to their many distinctive characteristics. Concerning location, they differ in terms of a distance to the national border (one is centrally located, while three other are border regions) and the European core (two located near the German border with a relatively small distance to the European core and two located much further). One of the zoom-ins is located near the outer Schengen border. Another region involves a European metropolis of the third level, and two others of the fourth-level. The next region is a peripheral one (according to ESPON Mega's typology).

Warsaw region consists of three subregions (city of Warsaw, Warszawski-Wschodni and Warszawski-Zachodni) and is located in the central-eastern Poland. The area of the three subregions combined together is a little bigger than that of the Warsaw Metropolitan Region.

Dolnośląskie is a voivodeship located in the south-western Poland close to the German and Czech border. The distance to the European core is the smallest one for this voivodeship among Polish regions. From the Czech Republic, the voivodeship is separated by the Sudety Mountains.

Zachodniopomorskie is a voivodeship located near the Baltic sea and German border in the north-western part of Poland. It is relatively close to the European core.

Przemyski and Krośnieński subregions are located close to the outer Schengen border with Ukraine and internal Schengen border with Slovakia. They are rather remote periphery in the European Union. For Polish case study their remoteness can be only compared with north-eastern Poland.




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Poland Case Study Physical framework





-  NUTS 3 Capitals
-  Rivers
-  Settlement area
-  National borders

Figure 1. The Poland case study region.

2.1 Spatial structure

The case study region

The Polish urban system is characterised by a polycentric structure. In comparison with the urban systems of other big European countries like Spain or France, the capital of Poland (Warsaw) is less dominant in the Polish urban hierarchy. The official population of Warsaw is about 1.7 million people (only 4.5% of the total population of the country) and the metropolitan area – around 2.8 million. Besides Warsaw, the population of Kraków, Łódź, Wrocław and Poznań is more than 500,000 inhabitants, and in twelve other cities the population exceeds 200,000 inhabitants. There are 306 urban municipalities (12% of all the municipalities).

The NUTS-2 population density differs from 59 persons per km² in north-eastern Poland (Warmińsko-Mazurskie and Podlaskie voivodeships) to more than 200 persons per km² in the south-central part of the country (217 persons per km² in Małopolskie and 377 persons per km² in Śląskie voivodeships). The average population density in Poland is about 122 persons per km².

The actual distribution of population proves to be slightly different from the one that is shown by the statistics. Large part of migrations, both internal and foreign, is not registered by the population records. As a result, population of major Polish cities, and especially of their suburban zones, is higher than officially estimated, whereas peripheral areas have, in fact, lower population number.

The zoom-in regions

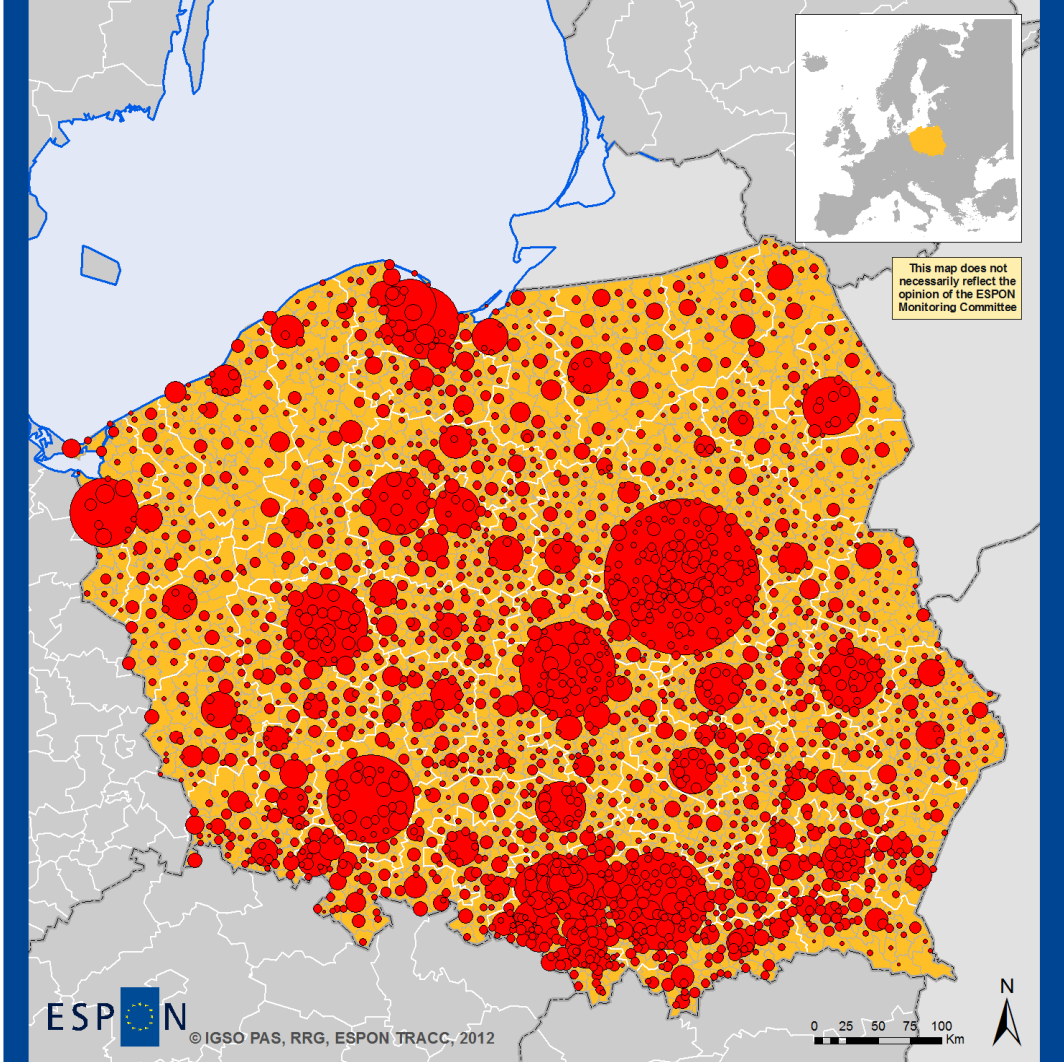
Warsaw region is inhabited by 3.3 million people and is characterized by high population density which is 328 persons per km². The population increased between 1995 and 2010 at about 9% but the increase was much smaller in Warsaw (5%) than in other subregions where exceeded more than 10% emphasizing the suburbanization process. However the number of urban municipalities is still only 19 which means that the majority of the area (the whole Warsaw region consists of 107 municipalities) is rather rural and the concentration of population is in the outer suburbs of Warsaw and suburban cities like Piaseczno, Pruszków or Legionowo. The concentration of most activities, including working places is in the city of Warsaw and its city centre in particular. According to various estimates, the actual population of Warsaw (after having taken into consideration people who have not registered change of residence) is estimated to have increased by 200-400,000.

Dolnośląskie voivodeship makes up 169 municipalities inhabited by 2.9 million people. The population density is higher than the average of Poland and equals 144 persons per km². The number of urban municipalities is also very high (36). The clusters of towns are located in the Wrocław Metropolitan Region, near Wałbrzych and in Legnica-Głogów Copper Basin. Since 1995 the population has decreased in the whole region by about 4%. However, the population of the Wrocławski subregion has increased (suburbanization process) while the population of the Wałbrzyski subregion has decreased nearly by 10%.

The Zachodniopomorskie voivodeship consists of 114 municipalities including only 11 urban municipalities. The population of 1.7 million is highly concentrated in Szczecin, its suburban area and Stargard Szczeciński located east of Szczecin. Population density is much smaller than the Polish average. Although in the Zachodniopomorskie the total population decreased in the years 1995-2010 by about 2%, the processes of suburbanization took place in the Szczeciński subregion. There are some municipalities within the subregion where the number of inhabitants increased threefold within 15 years. The eastern part of the voivodeship is relatively sparsely populated.

The Przemyski and Krośnieński subregions are remote rural areas with only 8 urban municipalities (out of 82). The population of 0.9 million inhabitants lives mainly in Przemyśl, Krosno and other cities in the Carpathian Foothills, while the Bieszczady and Beskid Niski mountains are

sparsely populated. The population is decreasing in general, mainly because of migration process. On the other hand, however, the Podkarpatie region is traditionally characterised by a high fertility rate.



**Poland Case Study
Population**

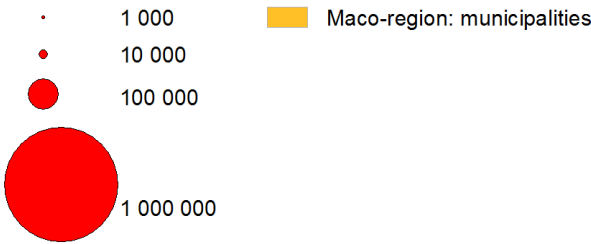
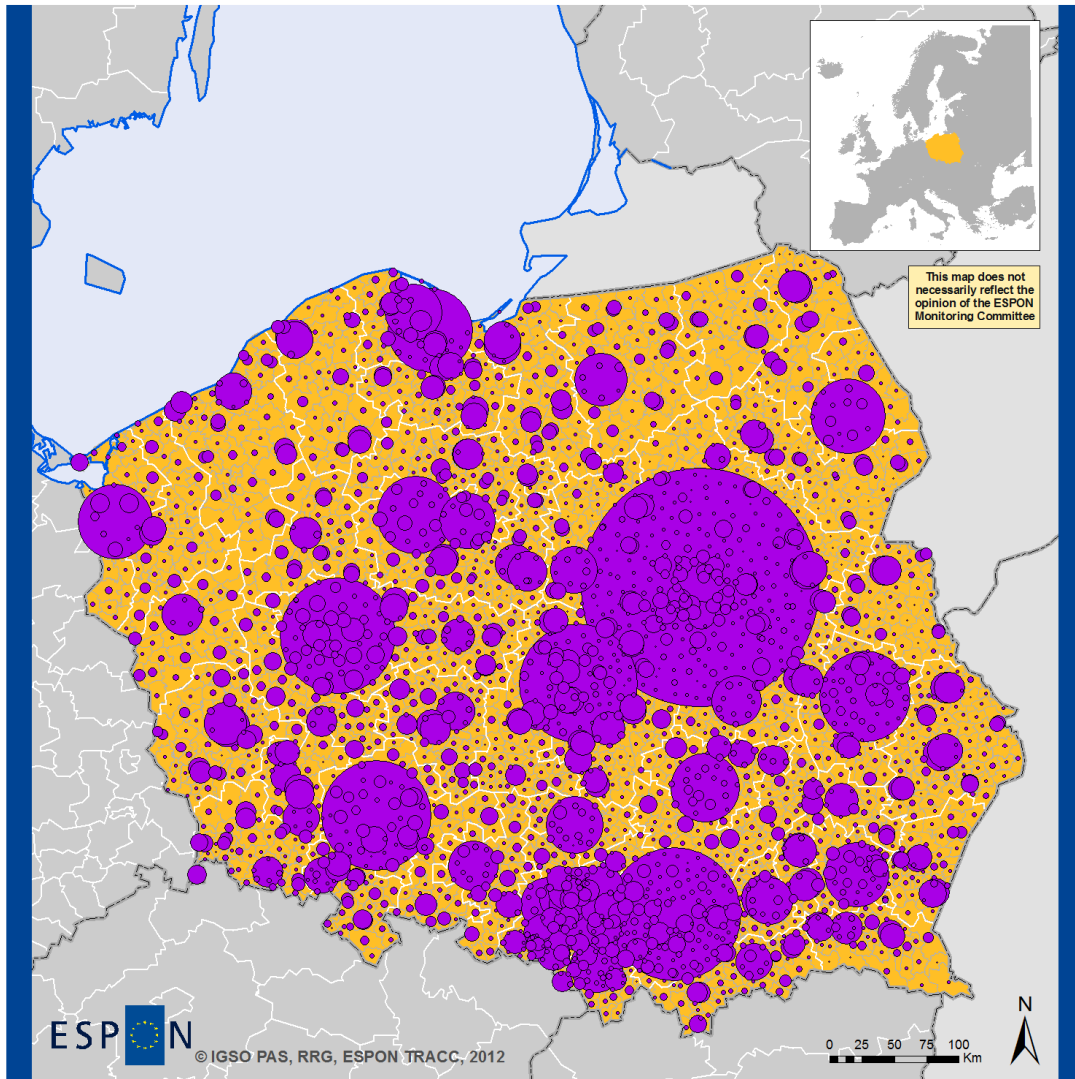


Figure 2. Population distribution



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Source: data estimated by IGSO PAS based on Local Data Bank, GUS, 2012
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Poland Case Study Workplaces

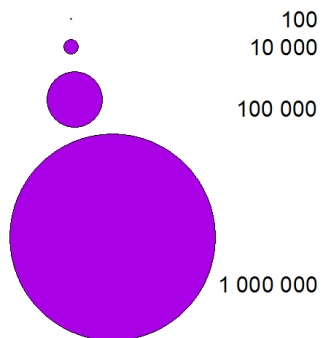


Figure 3. Job distribution

2.2 Socioeconomic situation

The case study region

During the last two decades Polish GDP has expanded rapidly and Poland today ranks sixth in the EU in terms of real total GDP (PPP-based). The Polish economy avoided a decline in GDP during the financial crisis and has created the highest GDP growth in the EU in 2009 when Polish GDP increased by 1,6%. In 2010 GDP growth amounted to 3,9%. There is a considerable inner differentiation of the GDP. In the current EU programming period all of the regions (NUTS2) have been eligible for support under EU structural funds, since their GDP level was below 75% of the EU average. In case of regions of East Poland, that level was even lower, not exceeding 40% of the EU average. Currently, the Mazowieckie voivodeship's GDP oscillates at 90% of the EU GDP average level (by the purchasing power parity).

However, the restructuring of heavy industry and the agricultural sector after 1989 led to the higher rate of unemployment in Poland (20 % of the economically active population without job in 2002-2003). In the following years, after Poland joined the European Union in 2004, the situation has improved and the unemployment rate has decreased to the level of 7.1 % in 2008 (e.g. as a result of investment projects, but also due to economic migration). However, due to the financial crisis, it has increased again to 9.7 % in 2011 (in the Warmińsko-Mazurskie voivodeship it exceeds 20 %).

Poland's large internal market of 38 million consumers could help in being more independent of world economy than the rest of Eastern European countries. Exports consists of 41% of GDP. However, as early as 1995, 70 % of Polish export was directed to EU members (particularly to Germany). This number has even increased, constituting nearly 80% in 2010 (including 26% to Germany).

The GDP structure is formed mainly by the service sector (68 %), followed by industry and construction (29 %) and agriculture (3 %). The overemployment in agriculture (about 15 % of the workforce), particularly in the eastern parts of the country, still remains an obstacle to modernisation.

The spatial structure of industry in Poland has its roots in the time when Poland was partitioned by the Prussian, Austrian and Russian empires. The western and southern parts of Poland became more industrialised than the central and eastern parts (with the exception of metropolitan areas and the Świętokrzyskie voivodeship). Despite the strong decline of coal mining and metallurgy in terms of employment, the main industrial part of Poland remains the industrial conurbation of the Upper Silesia voivodeship. The automobile industry has developed to a considerable extent in south-western Poland but most of the headquarters and foreign direct investments are located in Warsaw and its surroundings or in the other large metropolitan areas. In some regions (also in the eastern Poland), new clusters of furniture and food (e.g. dairy) industries have emerged.

For several years Poland has experienced a large amount of emigration to the UK and Ireland where 1 million Poles outnumber other immigrants from eastern Europe.

The zoom-in regions

Warsaw region is characterised by the highest GDP per capita in Poland. However, there are huge differences between the subregions. The GDP per capita in the city of Warsaw is three times higher than the Polish average while in the Warszawski-wschodni subregion it is only 82% of the national average. The position of Warsaw is partly conditioned by location of seats of major Polish companies and branches of international businesses. There is a huge difference between the west and east of Warsaw region. The Warszawski-zachodni subregion located along the new Łódź-Warsaw motorway is developing very fast, GDP per capita exceeds there 120% of national average and the rate of unemployment only about 8%. However, most of the headquarters and

working places are located in Warsaw. Consequently, travelling to work is of much significance and in some cases people commute/travel even from really large distances (including travels on a weekly basis). Eastern fringes of the investigated region have preserved their primarily agricultural character.

The Dolnośląskie voivodeship is characterized by a high number of employees working in the industry and construction (close to 40% in some areas). The region is very high in the ranking of GDP per capita (109% of Polish average). However, there are huge income disparities among different parts of the region. In the Legnicko-głogowski subregion (Legnica-Głogów Copper Basin) GDP per capita is close to 160% of the national average while in the Jeloniogórski and Wałbrzyski subregions the GDP per capita is below 80% of national average and the rate of unemployment in old industrial area of the Wałbrzyski region is close to 20%. The situation in the subregion has undergone some improvement, owing to development of the Special Economic Zones. The capital of the voivodeship, Wrocław, is at present one of the most dynamically developing major cities of Poland. In 2018, it is to be the European Capital of Culture. Also, it is an important academic centre. In the Sudety Mts., tourism is of critical significance.

The Zachodniopomorskie voivodeship is a region which loses its traditionally high position based on the shipyard industry. The GDP per capita much higher than the national average in the nineties is now less than 88% of the Polish average (in the Stargardzki subregion – only 63%). The unemployment rate exceeds 20% in the Koszaliński and Stargardzki subregions (it is an after-effect of large state farms existing here before 1989). The situation near the coast sea is better due to the tourism industry and a lot of visitors, not only from Poland but also from Germany and Sweden as well. There are also many new windmills constructed near the Baltic coast.

Located in the eastern Poland, the Przemyski and Krośnieński subregions are much below the Polish average in terms of GDP per capita (less than 60% of the average). The situation has even slightly deteriorated during the last decade. The region is traditionally agricultural one with about 40% of population working in the agriculture on relatively small family fields. Many people who declare themselves as farmers, at the same time take up work in other towns of the region (under the framework of grey-zone) Some people living close to the Polish-Ukrainian border are employed in the petty trade with Ukraine. The area of the Bieszczady Mts. is a typical tourism region.

2.3 Transport aspects

The case study region

Before 1989 the Polish transport system was characterised by freight traffic flows in the east-west direction between the Soviet Union and the GDR and in the north-south direction between the Polish harbours and the Upper Silesian coal region. After 1989 the decline in freight transport and the rapid increase in private mobility and motorisation (much faster than GDP growth) led to more than 450 motor vehicles per 1000 inhabitants in 2010. In spite of the process of the growing motorization of the society, the 1990s were the decade of further delay in major decisions concerning transport infrastructure investments. After 2000 Poland is making up for the lost time by the biggest national motorway construction programme in Europe. In 2000 about 500 km of motorways and express roads were in operation, while 12 years later in July 2012 more than 2000 km is in operation and next 1000 km is in construction. However, after 2012 the process of road infrastructure improvement will significantly slow down due to the budgetary limits.

Road traffic is particularly concentrated in high population density areas – the Upper Silesia region, Poznań and Warsaw agglomerations. The highest traffic volumes are observed on the international roads: the existing motorway sections of the A4 (E40), A2 (E30) and A1 (E-75; mainly Upper Silesia-central Poland section), the E-77 (from Gdańsk through Warsaw to Kraków) and the E-67 from (from Wrocław through Warsaw to the Polish-Lithuanian border). The main

transit roads are the routes from Germany through Poznań and Warsaw to the Baltic States and from Germany through Wrocław, Katowice and Kraków to the Polish-Ukrainian border.

Up to the very end of the centrally planned economy period, in Poland there had been huge disparities as regards the density of rail network, which can be accounted for by the pattern of borders dating back to the partition period. At the same time, however, after the WW2, due to enormous efforts the majority of important rail lines in Poland was electrified (the level of electrification is estimated to be in the order of 60%, belonging to the highest in the whole world). However, it was not accompanied by modernization in terms of construction of additional supplementary rails, replacement of dilapidated trackages and implementation of up-to-date technologies in railway signalling. After 1990, the rail network has been subjected to the increasingly accelerated processes of regression, which began as early as in the 1970s. In the years 1985-2004, in total 8,200km of rail lines were closed down for passenger traffic. That regression occurred, in the first place, in west Poland, characterized by higher network density, which led to a decrease in regional disparities. After 1990, new lines ceased to be constructed, as well as significantly slowing down the pace of further electrification. Among huge investment projects, only Warsaw-Berlin line was successively modernized. Furthermore, some cross-border connections were restored, however, some of these connections were liquidated again due to a poor demand. Nowadays, south Poland enjoys the best developed rail network (especially Upper Silesia), with north and east Poland lagging behind with significantly underdeveloped network (in the Podlaskie voivodeship – merely 3.4 km per 100km² in 2006).

As a result, Poland suffers from the lack of a proper railway infrastructure. The large decrease of technical speeds on many railway lines has enforced the modal shift from rail to road. The government's plan, of building the first Polish high-speed railway running from Warsaw to Poznań, Wrocław and Łódź (Y line) has been postponed to the remote future.

Poland's regional airports are catching up in terms of number of passengers with the country's main airport in Warsaw after the accession to the EU. In 2011 more than 57 % of all 21.7 million passengers in Polish airports flew through regional airports. The main flight destinations are the UK and Germany. The expansion of low-cost carriers has caused in the recent years the increase in the number of domestic flights and passengers.

The port cargo operations are concentrated in Gdansk and Gdynia (Pomorskie voivodeship), and at a smaller scale also in Szczecin and Świnoujście (Zachodniopomorskie voivodeship). Since 2011 the sudden increase in the international container shipping was possible thanks to the Post-Panamax ships which handle the direct weekly Far East container service from Shanghai to Gdansk.

The zoom-in regions

Warsaw region has been seriously underinvested in the last decades. The result is that according to TomTom Warsaw is the most congested city in Europe in 2011. The main problem is that the city still does not have a completed ring road. There are some express roads in construction in the south-western part of Warsaw Metropolitan Region (S2, S7 and S8 express roads) and on the north (S8 express road). All investments when completed in 2012 and 2013 should ameliorate the traffic. However the lack of bypass road on the right bank of Vistula would be probably still considered as a one of major obstacles for commuters from the Warsaw Metropolitan Region. In 2012, section of the A2 motorway between Warsaw and Łódź was finalized, which allowed including Warsaw to the European system of motorways (through Berlin).

Concerning the railway system within the metropolitan area of Warsaw, there are three important public services operating at different spatial scales serving at several railway lines. Next to the main Chopin Airport (9.3 mln passengers in 2011) there is also a new Warsaw-Modlin Mazowia international passenger airport being opened in 2012 located about 35 km north from the Warsaw city centre intended for low-cost carriers.

Dolnośląskie voivodeship is located along the A4 motorway. The traffic on the A4 corridor has increased in the recent years (2005-2010 the increase of 50%) and in 2010 exceeded 30 thous. vehicles a day. However, except of new A4 motorway section to Zgorzelec/Görlitz opened to traffic in 2009, there are no modern international roads connections. The extension of the S3 express road to the Polish-Czechia border is planned in the years of next European financial perspective (2014-2020). The another problem of Dolnośląskie region is lack of good road and railway connections to Warsaw. The S8 express road linking Wrocław with Warsaw is under construction and should be opened to traffic in 2013 or 2014. The high speed railway connection is postponed and still the shortest railway time from Wrocław to Warsaw is about six hours (the distance is only 344 km). The Wrocław Starachowice airport observed 1.6 mln passengers in 2011 which is more than a 21% increase comparing with 2009.

Zachodniopomorskie voivodeship has relatively well developed road infrastructure. The new sections of the S3 express road opened in the recent years allows to travel smoothly to the south (lubuskie voivodeship) where the A2 motorway allows to travel by motorway to Warsaw and central Poland. The A6 motorway provides good connection from Szczecin to German motorway network and through German A11 to Berlin. According to the government missing parts of the S3 express roads near the Baltic sea and the S6 express road from Szczecin to Kołobrzeg, Słupsk and Gdynia will be in construction during the next European financial perspective of 2014-2020. The distance from Szczecin to Warsaw (524 km) is covered by train in 5 hours and 30 minutes which is a reasonable time taking into account Polish railway system and its problems. Świnoujście is the third and Szczecin is the fourth largest Polish port in terms of cargo traffic (loading/unloading). Goleniów airport observed 258 thous. passengers in 2011 (7% decrease comparing with 2009). Oder Waterway linking Szczecin through Oder and German canal system to Berlin is the only one existing waterway in Poland.

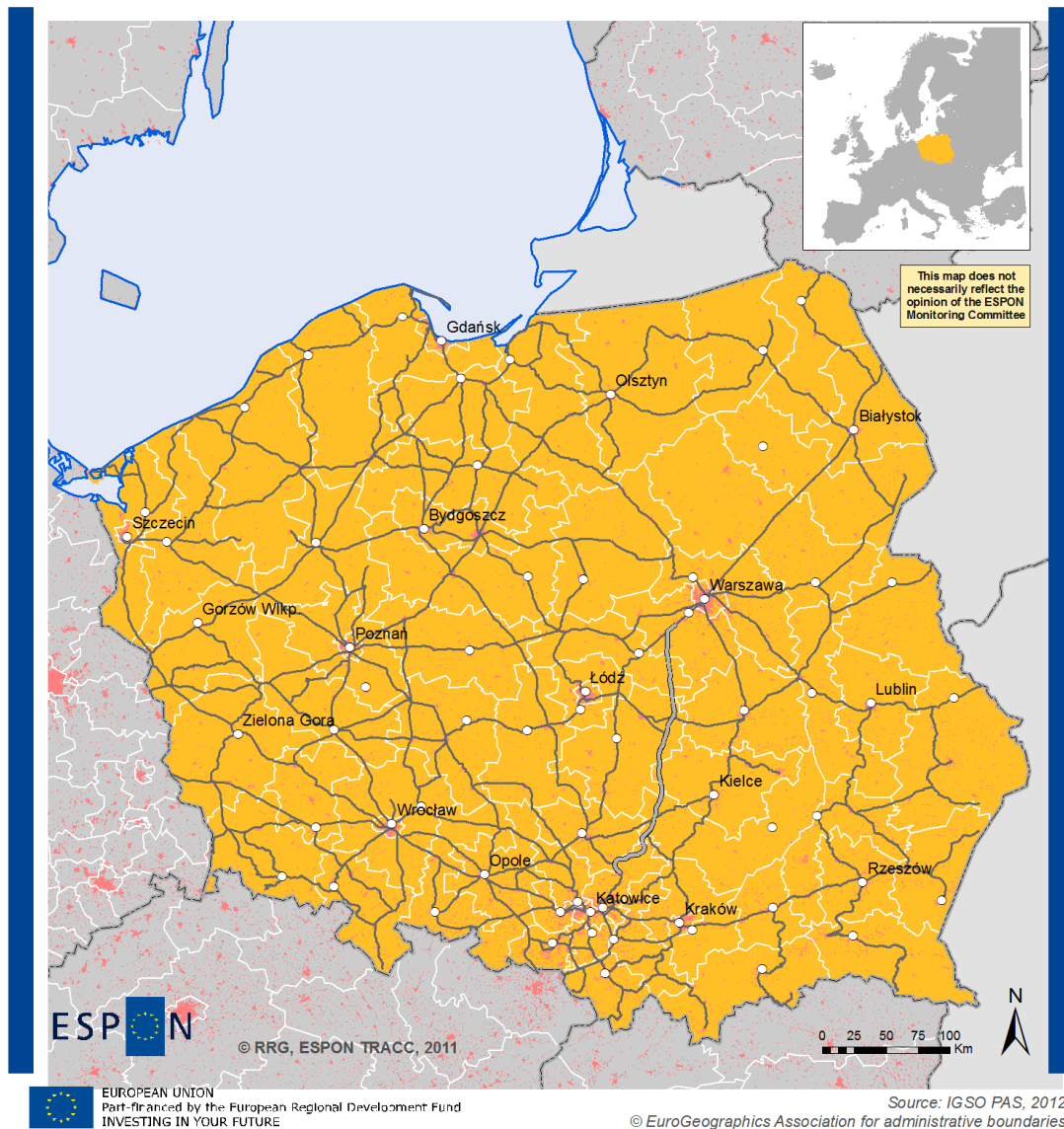
The Przemyski and Krośnieński subregions are beneficiaries of the A4 motorway construction. The section of this route located in the Podkarpacie region should be opened to traffic in 2012-2013 giving the opportunity to travel fast to Kraków and Wrocław and further to Germany. However, there is still no good road connection to Warsaw, although the connection through Rzeszów and Lublin is in the government's plans for the years of 2014-2020. A railway connection form Przemysł to Kraków allows to cover the distance of 243 km in the time of 4 hours and 15 minutes which is not sufficient in the XXI century. The nearest airport for the Przemyski and Krośnieński inhabitants is Rzeszów Jasionka airport.



Poland Case Study
Private transport network

- | | |
|-----------------|-----------------------------|
| Road category | ○ NUTS 3 Capital |
| Motorways | Settlement area |
| Primary roads | Maco-region: municipalities |
| Secondary roads | |

Figure 4. Road network



**Poland Case Study
Railways**

- High Speed Network
- Railways in use
- NUTS 3 Capital
- Settlement area
- Maco-region: municipalities

Figure 5. Rail network

3 Accessibility patterns at regional and local scale

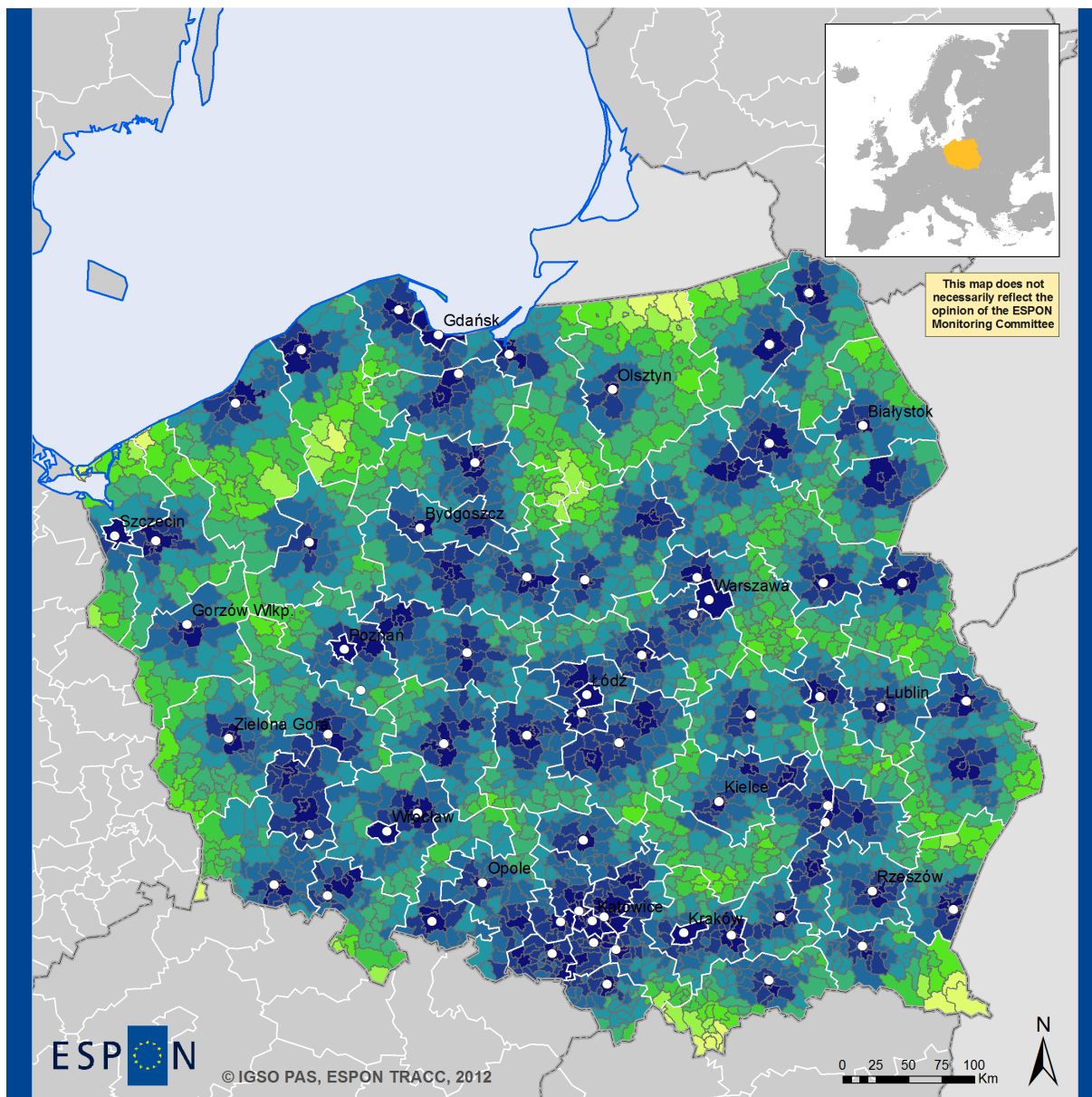
3.1 Access to regional centres

The travel time to the nearest regional centre is significantly worse by public transport than by car (in line with the adopted methodology). The average access to the regional centres (population weighted) is about 20 minutes by car and 40 minutes by public transport. When taking into account the median values, the difference between individual and public transport increases (around 30 minutes by car and around 65 by public transport). There are only few parts of the country where the nearest regional centre is located more than 80 minutes by car (Bieszczady mountains, north of Mazuria) (fig. 6) while by public transport most of the municipalities are characterized by more than 80 minutes travel to the nearest regional centre (fig. 7).

Simultaneously, the analysis that has been carried out has clearly revealed the zones of the so-called inner peripheries (not located near the state borders), where a distance to regional centres is noticeably greater. These occur, in the main, in north (for example, internal zone of Pomorze region) as well as in the eastern Poland. Existence of such inner zones is in some cases determined by a distribution of settlement network (e.g., a lack of large cities in the Pomorze region, areas lying at the German border are cut off from principal historical centres located on the western side of the Oder river. In other regions the occurrence of these zones can be accounted for by acute shortages in transport infrastructure (e.g. in direction of Warsaw-Kraków and Warsaw-Gdańsk corridor).

A spatial range of peripheral zones seems to be distinctively greater in case of public transport. It concerns primarily north Poland. In the eastern part of Poland, there is a relatively better situation in public transport services. In central Poland, area of poor accessibility to regional centres by public transport involves also a belt along the Central Rail Line (Warsaw-Górny Śląsk), which is due to the fact that there is no railway station available over the 150km-long, the fastest, section of the line.

Naturally the urban municipalities have on average much better access to the regional centres than the rural ones. The conclusion is that for the people living in the rural areas the best solution to get to the nearest regional centre is by their own car. This is confirmed both by box-plot analysis (fig. 8) and the cumulative chart (fig. 9). Differences in case of all the other categories (except for urban) are, however, relatively small (in particular in individual transport). That proves that under Polish conditions accessibility of urban regions is not markedly better than that of rural regions or even peripheral ones. However, urban units are characterized by smaller differences in time travel to regional centres by individual and public transport. In addition, the cumulative chart (fig 9) shows that curves illustrating individual and public transport (rural and transitory units) are becoming increasingly divergent at the 20 minutes time-level of commuting. This means that in suburban zones of regional centres the situation in terms of public transport is relatively better, being a viable alternative, for example, for commuting to work. As regards inhabitants of municipalities located further away, there is an unquestionable advantage of passenger cars.




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Poland Case Study

Travel time by car to next regional centre

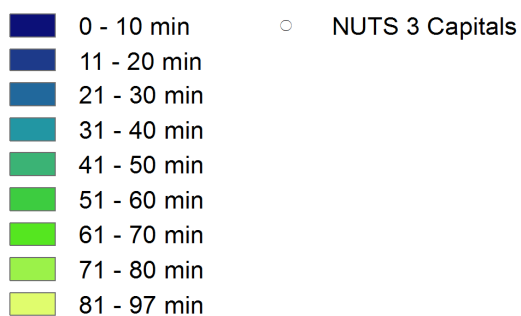
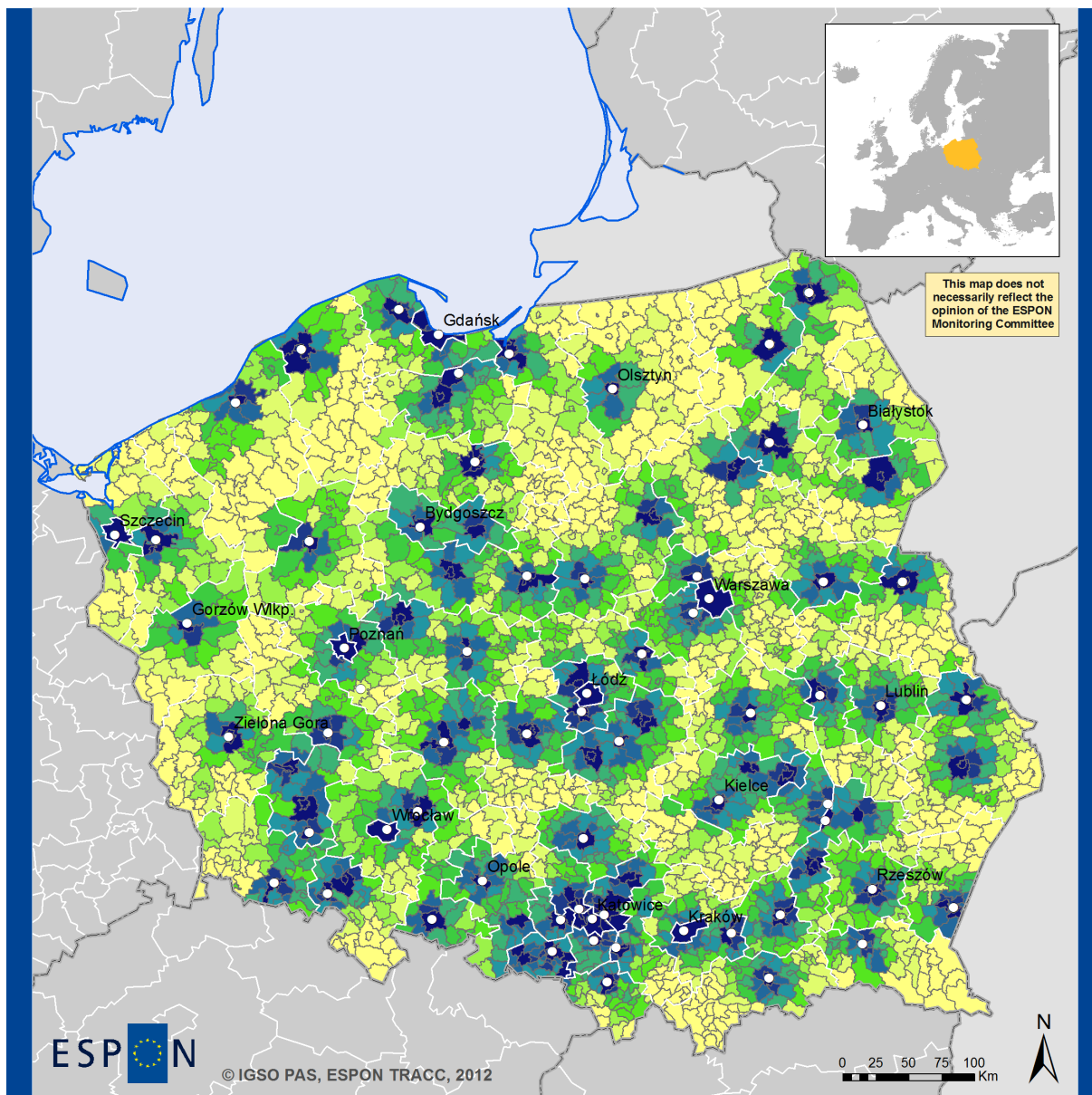


Figure 6. Travel time by car to next regional centre



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Travel time by public transport to next regional centre

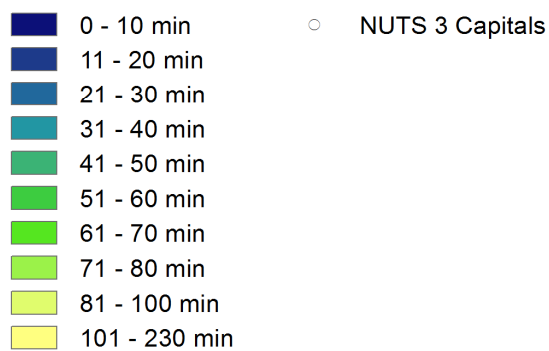


Figure 7. Travel time by public transport to next regional centre

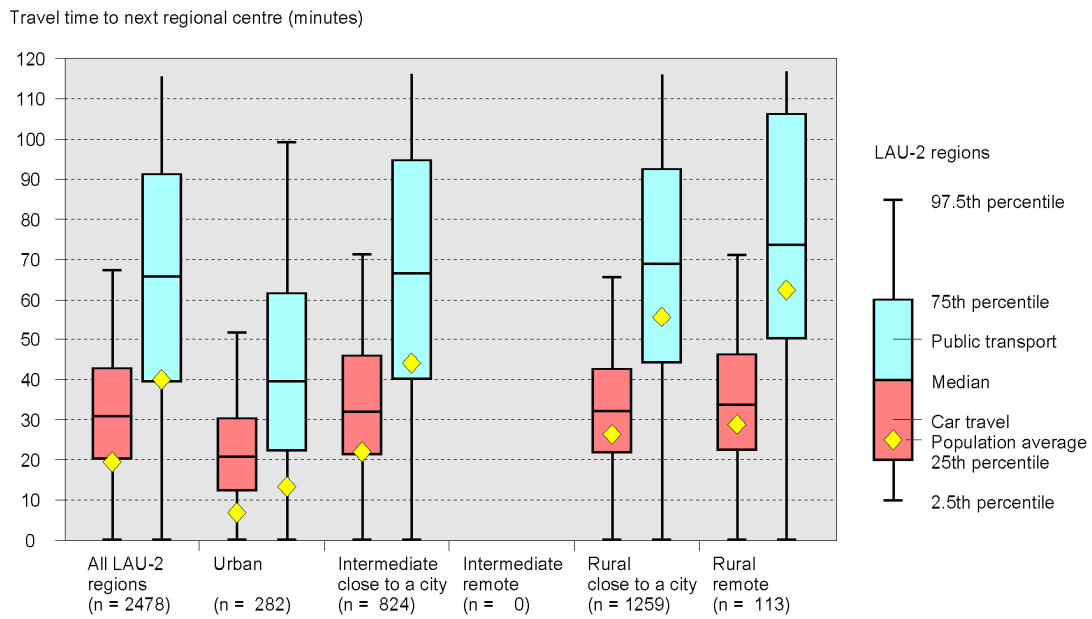


Figure 8. Travel time to next regional centre, by urban-rural typology

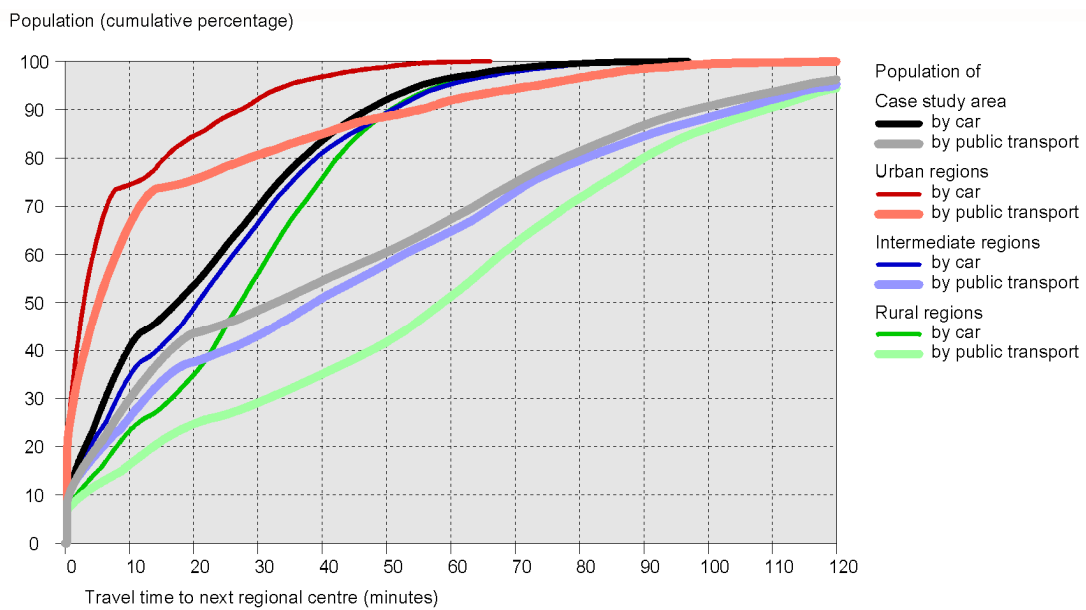


Figure 9. Travel time to next regional centre, cumulative distributions

3.2 Daily accessibility of jobs

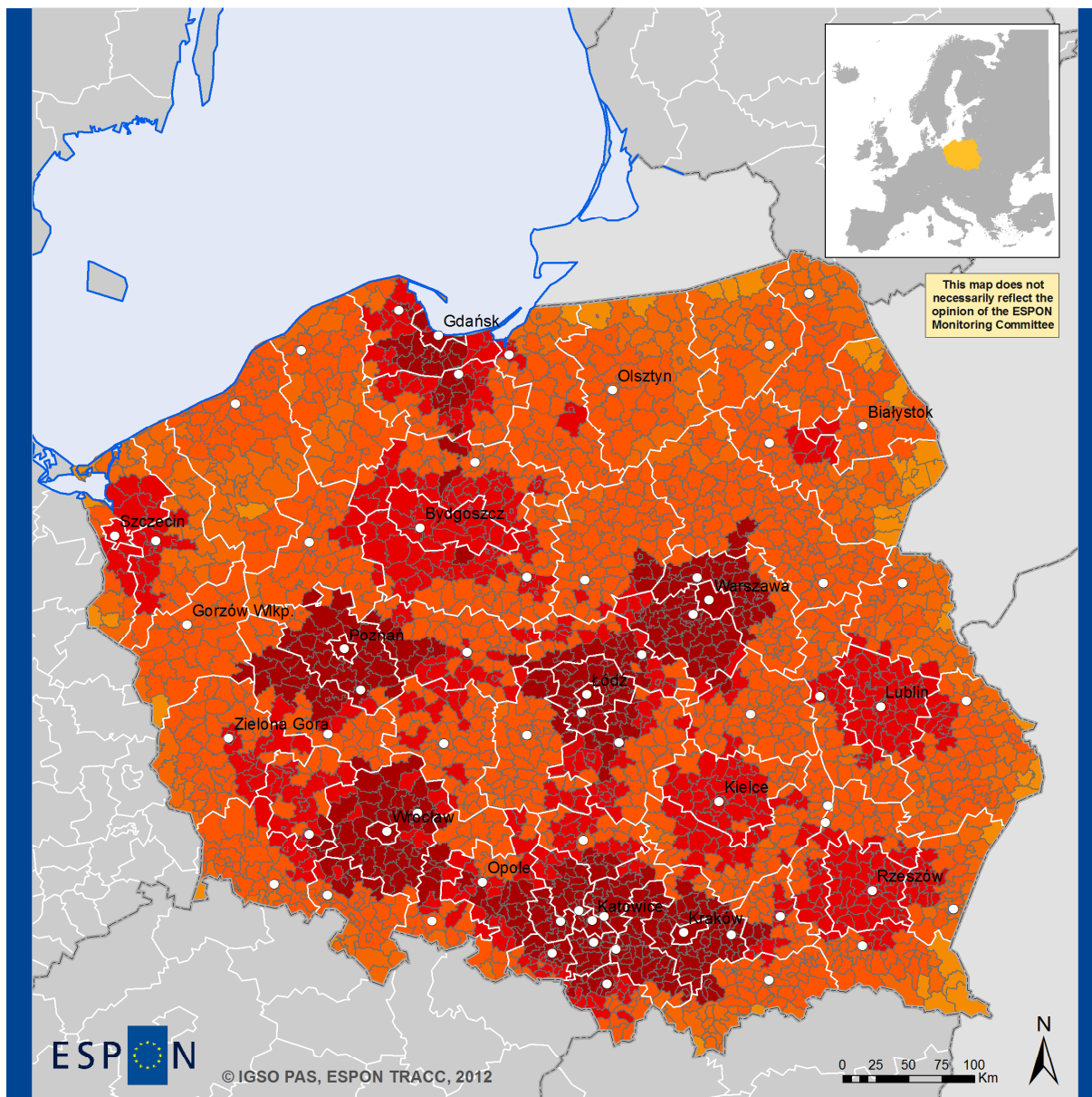
The best accessibility of jobs within 60 minutes travel time is within the metropolitan areas of Warsaw, Łódź, Wrocław, Poznań, Kraków and Upper Silesia conurbation. In general working places are distributed in particular in the metropolises of more than 500 thous. inhabitants. The access is better also on long distances if there is a good motorway or express road connection, for instance along the A2 motorway near Poznań and the A4 motorway near Wrocław, the A1 motorway between Gdańsk and Toruń or along the S8 express road section on the northern-east of Warsaw. A relatively favourable accessibility to places of working occurs also in the voivodeships of the south-eastern Poland (Podkarpackie, Lubelskie, Świętokrzyskie). In this case, it is due to a greater dispersion of industrial companies in medium-sized towns (that region in the latter half of the 20th century was industrialized not on the basis of migration but commuting to work from rural areas).

The worst access to jobs is observed in the municipalities located near the border, especially on the outer Schengen border with Ukraine (Bieszczady mountains), Belarus (south of Białystok, close to Białowieża forest) and Russia. These areas are known from their migration outflow (fig. 10). The situation is much worse when taking into account public transport. The good access to jobs is reserved only for the municipalities located close to the big cities. The poor public transport connections lead to relatively small catchment areas and long commuting travels, during the peak hours in particular. The areas of poorest accessibility to jobs are located not only near the national borders, but also in the central Poland, close to many subregions' borders (fig. 11). To a larger extent than in the case of individual transport, zones with a poor accessibility to places of working can be clearly identified. It occurs, for example, in the northern Mazovia.

Zones that are characterized by poor accessibility to jobs seem to directly correspond to regions affected by highest unemployment. This corroborates the thesis that unemployment in Poland is of structural nature. At the same time, several studies on travels to places of working (Wiśniewski 2012) prove that a significant part of these trips is made at the distance greater than 60 minutes (for example in the north-eastern Poland). This leads to general conclusion that accessibility to work is not correlated to demand for work. There occurs acute spatial incompatibility between places of living and places of working. It can be solved only by way of migration or development of infrastructure and/or of public transport.

The average (population weighted) number of jobs accessed by car within 60 minutes is more than 550 thous. and for public transport the above mentioned indicator value is two times smaller and equals only slightly more than 200 thous. There is also a huge difference between the urban and rural areas, easily visible on box-plot and cumulative charts (fig. 12, 13).

As opposed to accessibility to regional centres, in the case of places of working, there is a visibly better position of regions located close to the city (only in individual transport). Box-plot analysis strongly attests to the thesis that population of rural areas (including peripheral regions) have great difficulties with finding work, since hugely restricted availability of potential jobs within 60-minute access isochrone. Lack of individual transport, practically, spoils their chances on the labour market. A set of curves in the cumulative chart is very similar for the most of categories. Clear differences take place only in regard to public transport in rural areas (negative) and in individual transport in urbanized areas (positive).



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Poland Case Study Jobs accessible by car within 60 minutes

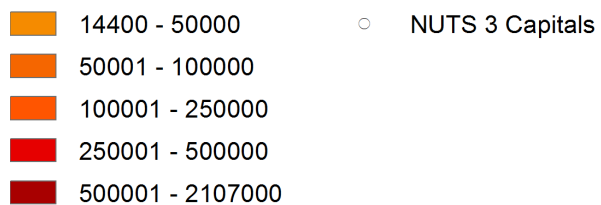
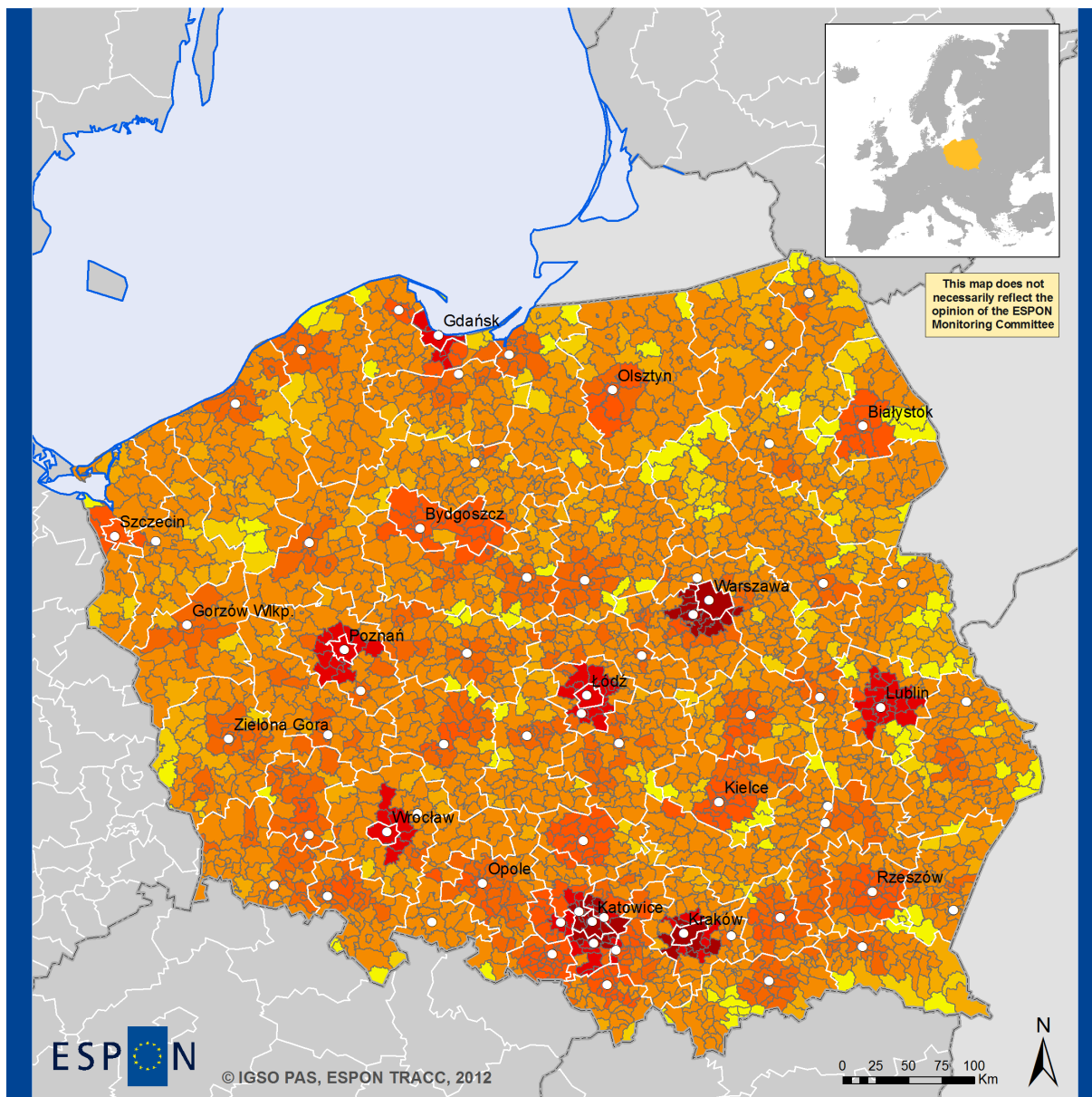


Figure 10. Jobs accessible by car within 60 minutes




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Poland Case Study

Jobs accessible by public transport within 60 minutes

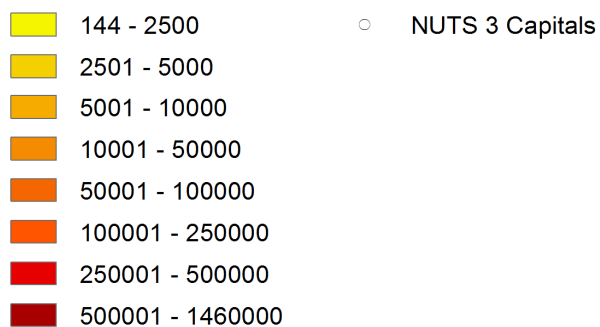


Figure 11. Jobs accessible by public transport within 60 minutes

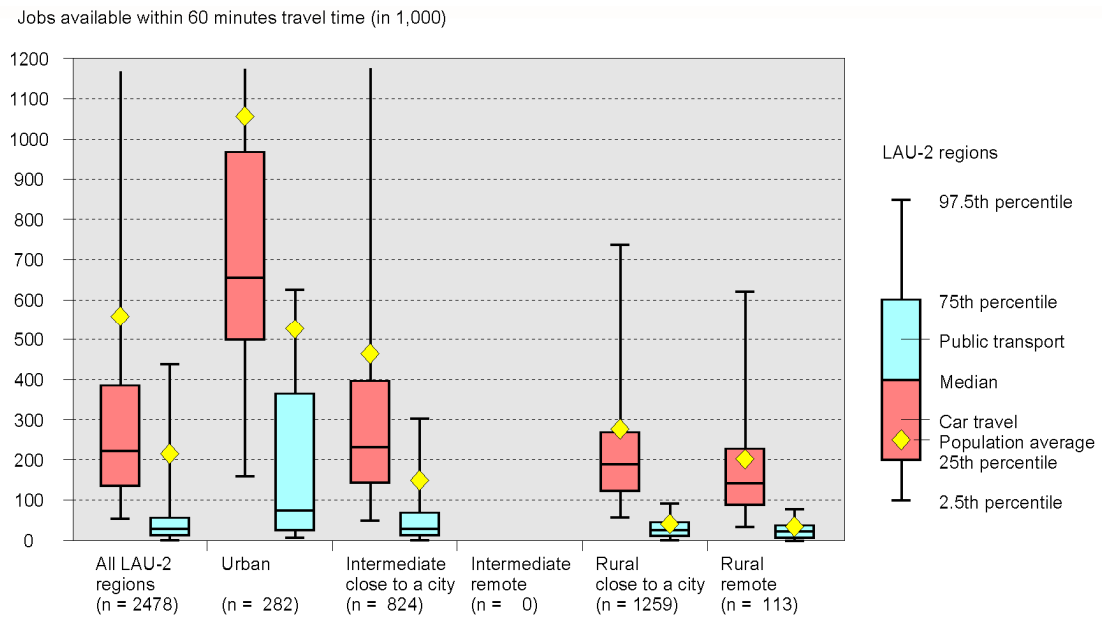


Figure 12. Jobs accessible within 60 minutes, by urban-rural typology

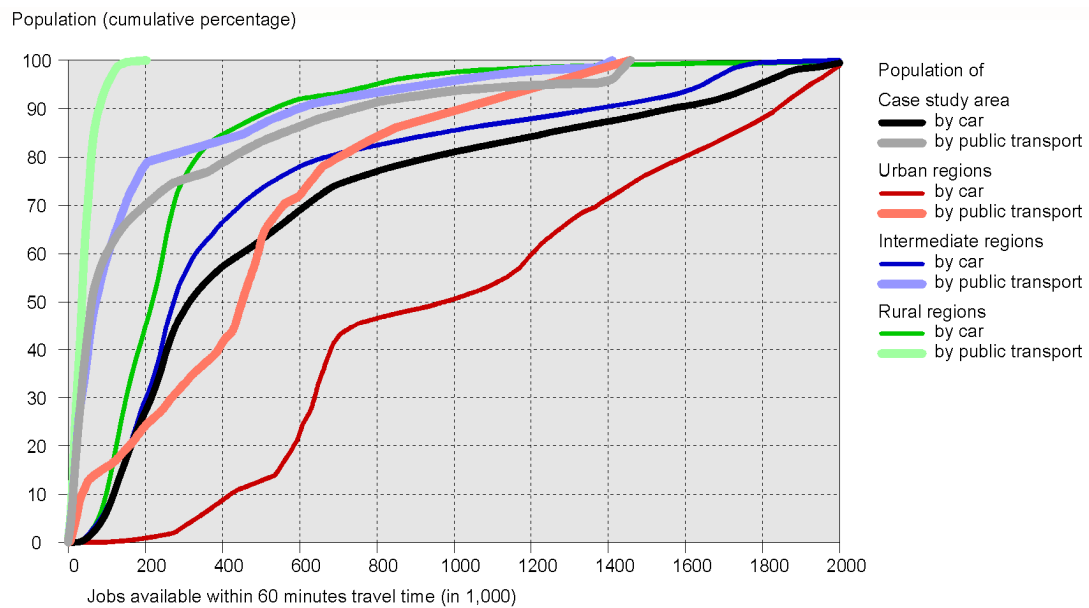


Figure 13. Jobs accessible within 60 minutes, cumulative distributions

3.3 Regional accessibility potential

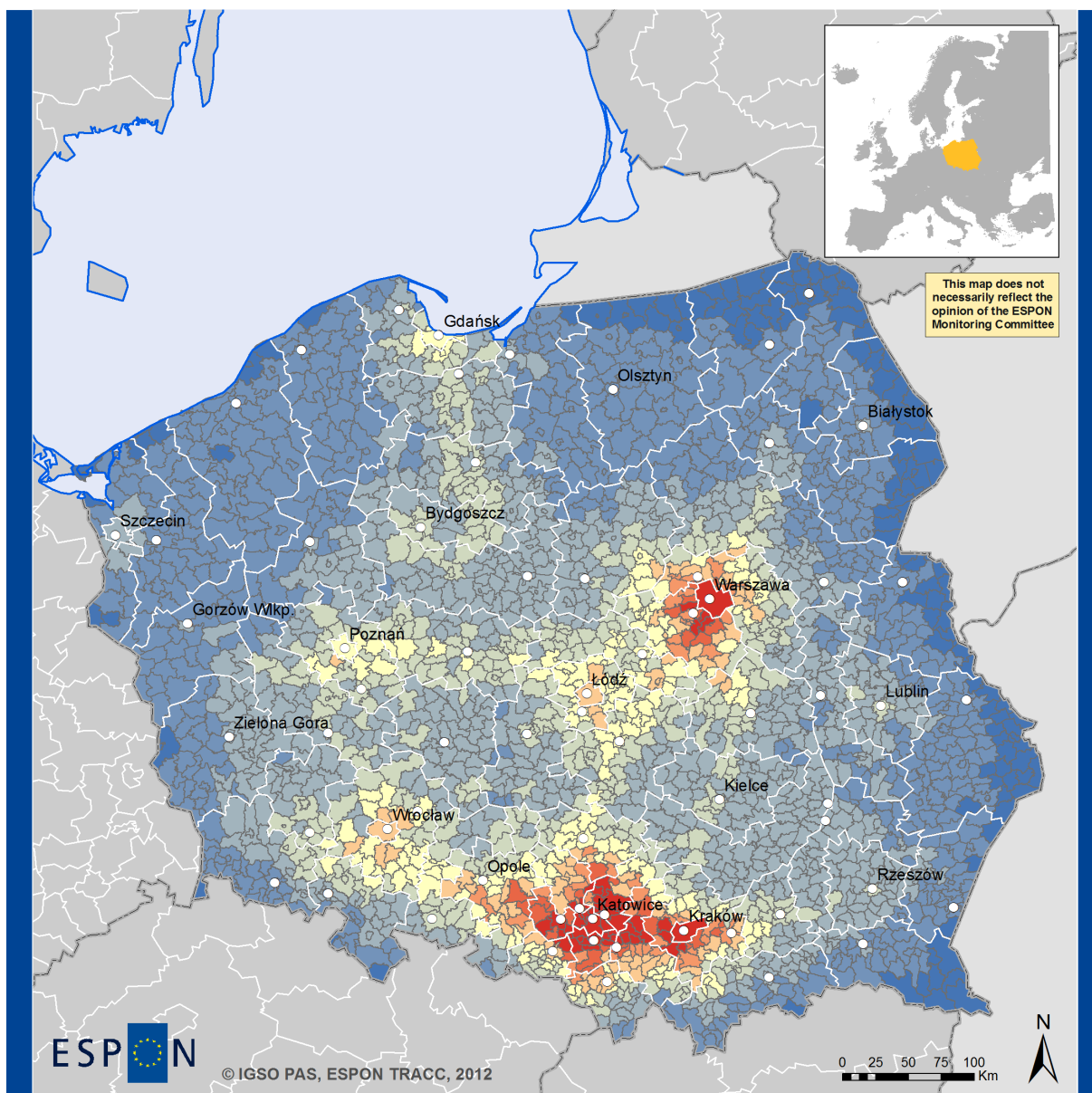
The best accessible against the background of the entire country are the Metropolitan Area of Warsaw and Upper Silesia and Kraków, the areas along the motorway routes A2 (between Poznań and Łódź; the calculation was carried out before the Łódź-Warsaw section was opened to traffic), A4 (between Wrocław and Kraków), A1 (between the Gdańsk and Toruń), along the dual carriageway between Warsaw, Piotrków Trybunalski and Katowice and, though to a lesser extent, the areas of the remaining large agglomerations, characterised by high population densities. The worst accessible regions are again these located near the border, the outer Schengen border in particular (fig. 14), but also, fragmentarily, along the border with Germany and Czech Republic. The compact areas of poorer potential accessibility occur in the Pomorze region (except for the Gdańsk subregion).

The map of potential accessibility to population by public transport (standardized on road average) shows the general weakness of the railway system in Poland. Only few municipalities, mainly the major cities and their suburban areas are above the road average (fig. 15a). At the same time, some of the minor regional centres are found to be below that level. On the map there is a visible system of few sections of up-to-date railway infrastructure, which indicates that, as compared to road network, investments in rail transport have not made a noticeable improvement in the magnitude of indicator in specific directions.

The similar map standardised on public transport average shows the more equal distribution of accessibility in the whole country (of course at the relatively low level). In this case, the better accessibility along the main railway lines is visible. The north-eastern Poland (with the exception of the municipalities along the railway line between Warsaw and Białystok) is at the worst situation. Historically falling behind in terms of railway infrastructure this area is waiting for the implementation of the Rail Baltica project. Only slightly better situation can be witnessed in the western and central Pomorze region. There are also parts of central Poland where public transport is relatively poor, for instance the Płocko-ciechanowski or the Sieradzki subregions (fig. 15b).

The average potential accessibility to population (population weighted) by public transport is less than 40% of the same indicator for individual transport. The difference between the car average and values for public transport is much lower for urban regions (public transport close to 80% of car average), but much higher for rural ones (less than 20% of car average) (fig. 16 and 17).

The situation in peripherally located units is generally little diversified in that respect. Though in road transport it is possible to indicate some peripheral units with a relatively favourable accessibility (which can be linked to, for example, the course of motorways and express roads), however, in public transport in the same group there are no municipalities where the level of accessibility would exceed 30% of the value of road indicator. The course of curves in the cumulative chart points to the existence of three basic types of dependencies. Relatively satisfactory situation occurs only in individual transport in the urbanized areas. The worst level of accessibility is noted in public transport for all categories located except for urbanized areas. An intermediate situation occurs in the other cases.



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Poland Case Study Potential accessibility to population by car ($\beta = 0.034657$)

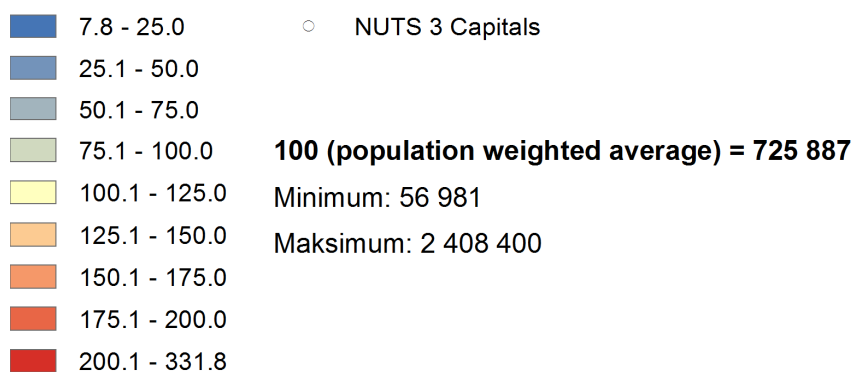
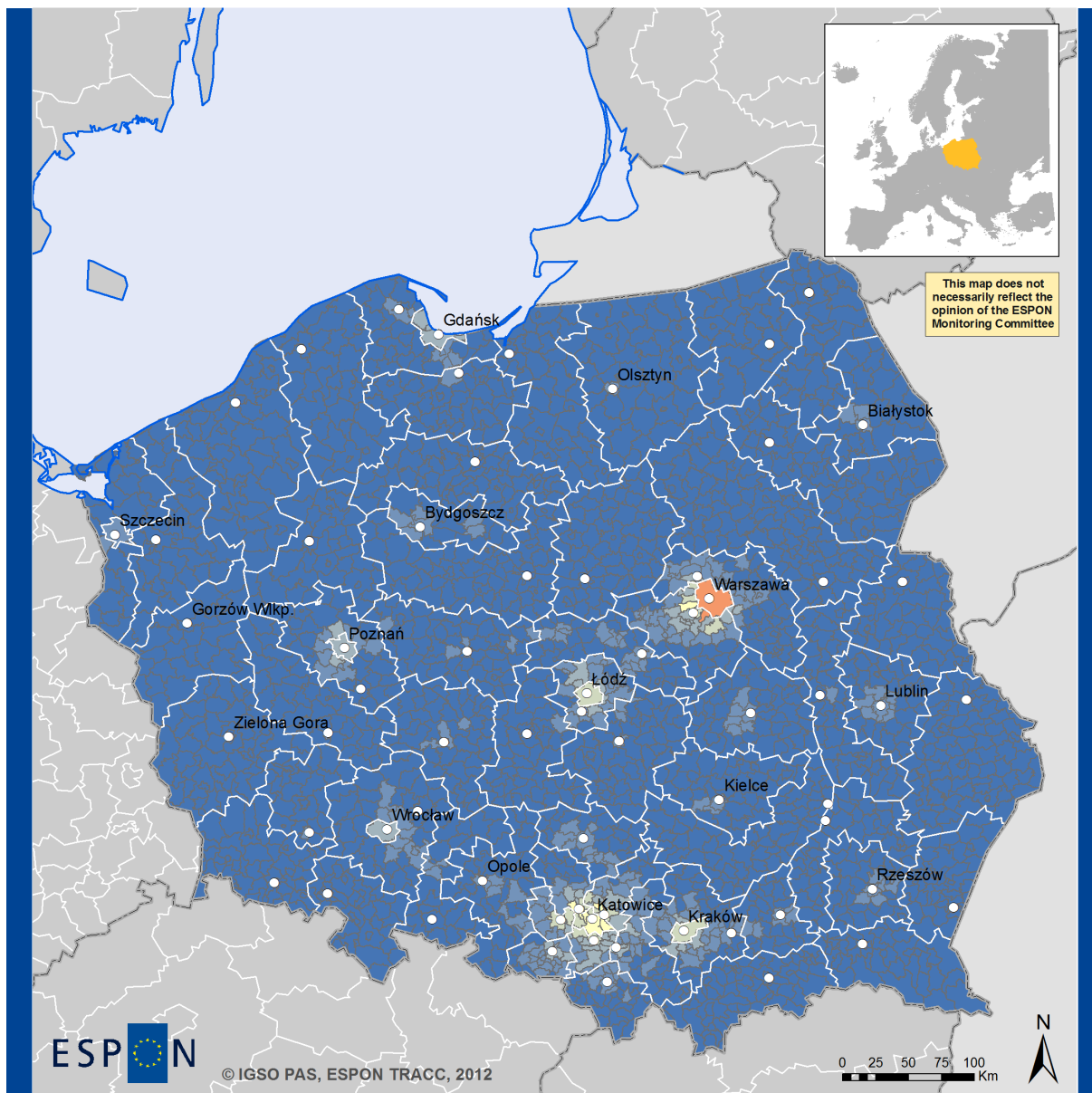


Figure 14. Potential accessibility to population by car




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Poland Case Study
Potential accessibility to population by public transport
(standardised on road average; $\beta = 0.034657$)

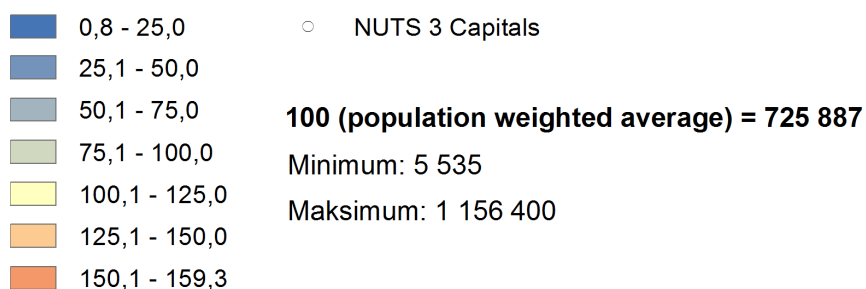
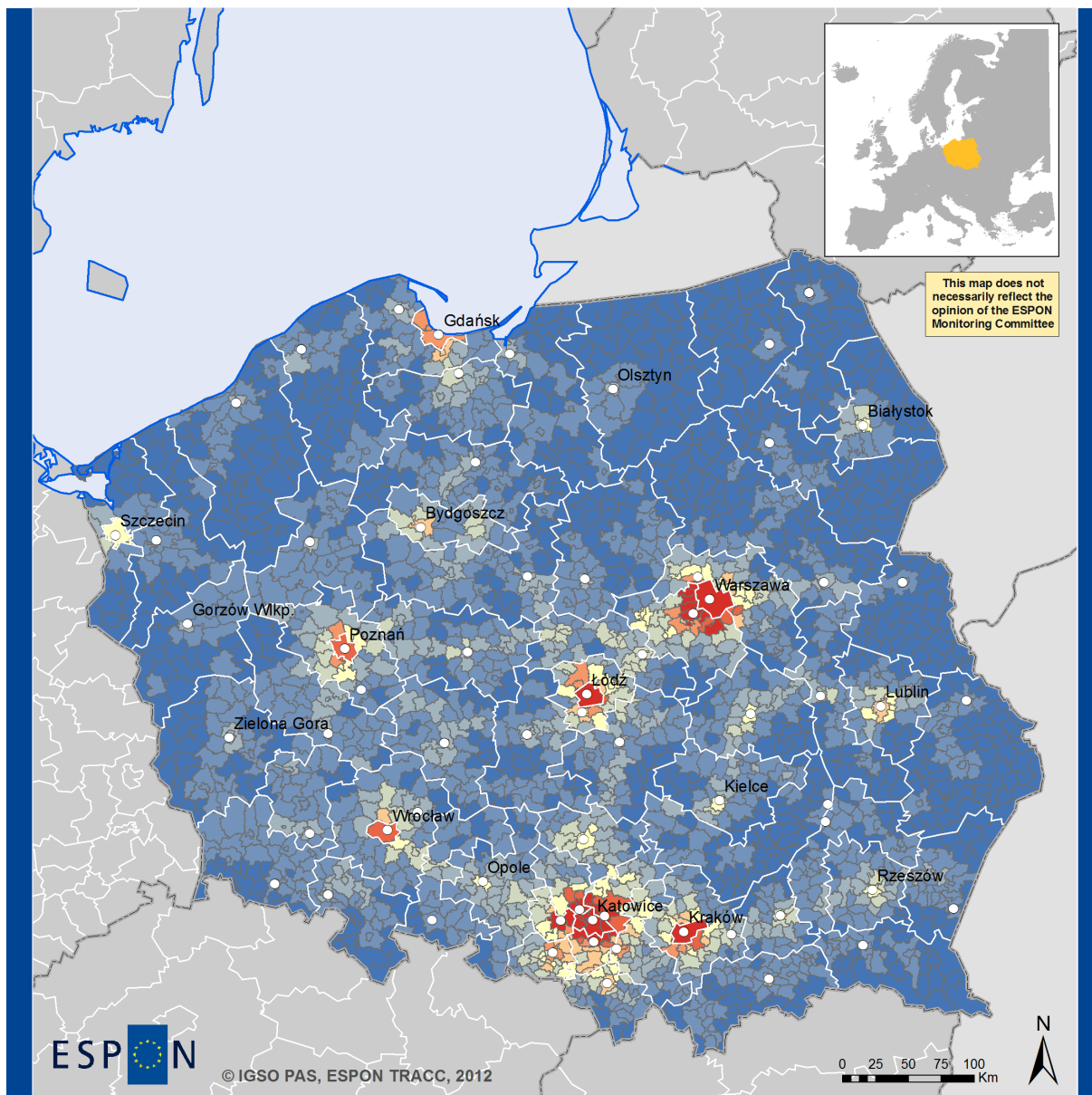


Figure 15a. Potential accessibility to population by public transport (standardised on road average)



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Potential accessibility to population by public transport (standardised on public transport average; $\beta = 0.034657$)

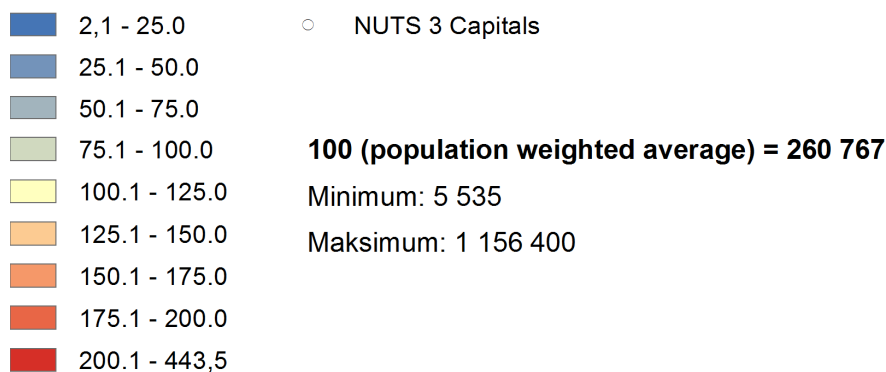


Figure 15b. Potential accessibility to population by public transport
(standardised on public transport average)

Potential accessibility to population (car average = 100)

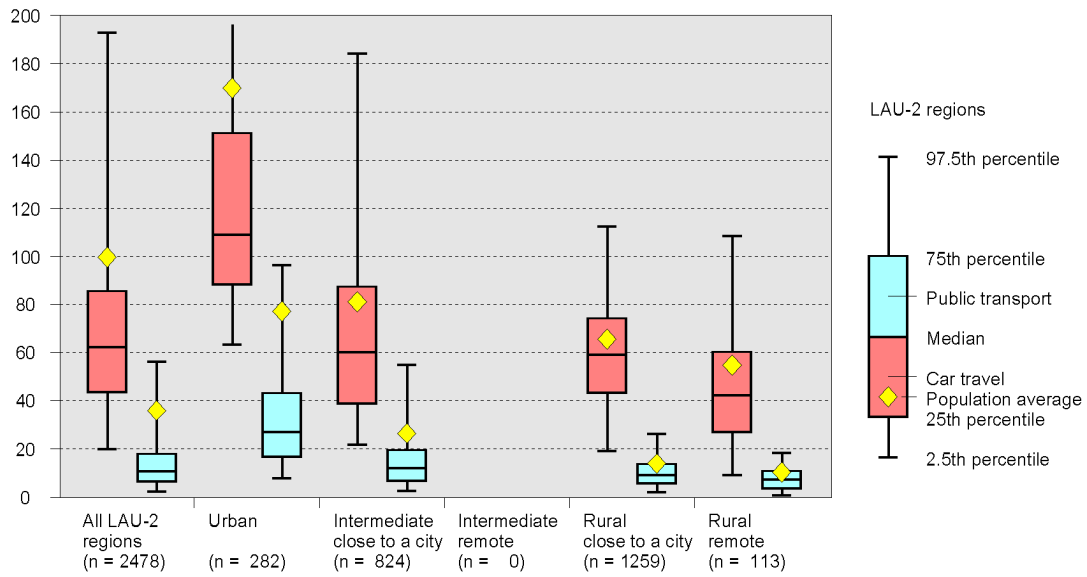


Figure 16. Potential accessibility to population, by urban-rural typology

Population (cumulative percentage)

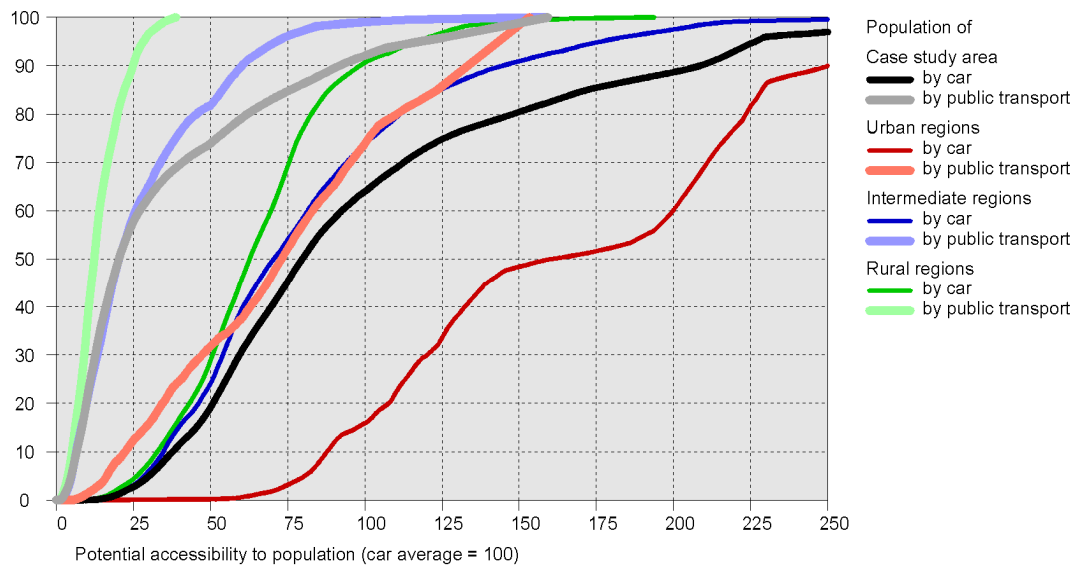


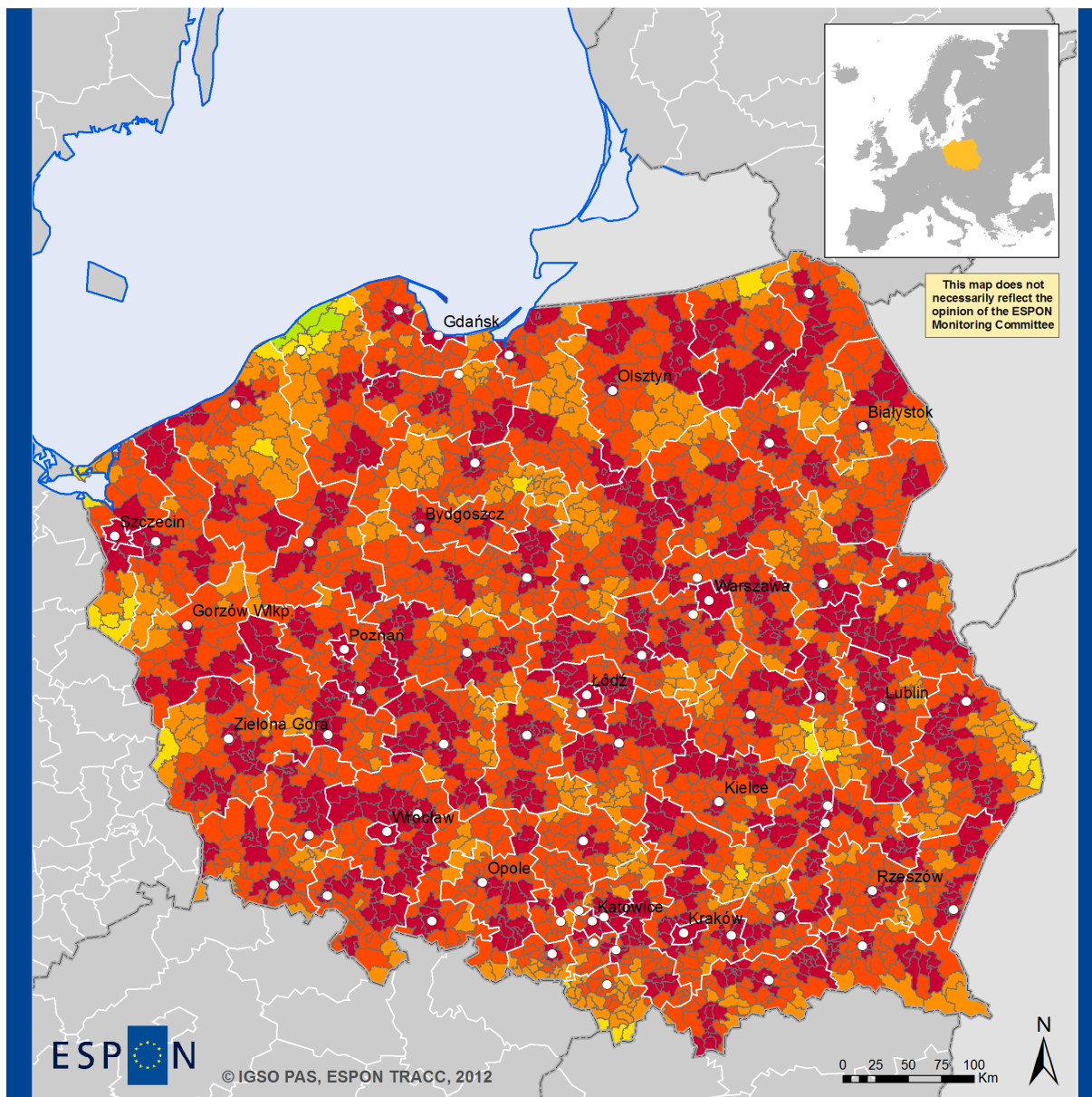
Figure 17. Potential accessibility to population, cumulative distributions

3.4 Access to health care facilities

Hospitals are in general much more equally distributed among the whole country than other services. There are many hospitals located in the rural areas, in poviats centres (LAU1). For that reason the travel time to the nearest hospital in Poland rarely exceeds 30 minutes. There are also many hospitals located near the borders of Poland, even in the cities which are not regional centres (fig. 18). A more inferior situation is noted only in several borderland regions as well as on the Baltic coast. In the case of area near Słupsk, there has been already a change in the situation due to opening up a new medical facility in 2011. To the south-east of Warsaw the zone of poor accessibility to hospitals is adversely affected by shortage of bridges on the middle Vistula River.

The accessibility of hospitals by public transport is relatively good. Most of the hospitals are traditionally located in a close distance to railway stations or little towns being known as tourist's destinations (fig. 19). Despite that, differentiation on the national scale is in this case clearly stronger. There occur quite vast areas with access-time to a hospital exceeding 60 or even 90 minutes. Peculiarly, these areas are not concentrated in borderland zones. Their distribution is rather associated with local shortages of transport infrastructure (to mention rail and lack of bridges on the Vistula River).

The population weighted average travel time to the nearest hospital by car for all municipalities equals 10 minutes, and for public transport – slightly more than 30 minutes. The situation in the urban areas is only a little better than for the rural ones. It means that the box-plot analyses and cumulative chart confirm the conclusion that hospitals are equally distributed in Poland and the access to hospitals for all the people, even in the most remote areas is relatively good (fig. 20, 21).



Poland Case Study Car travel time to next hospital

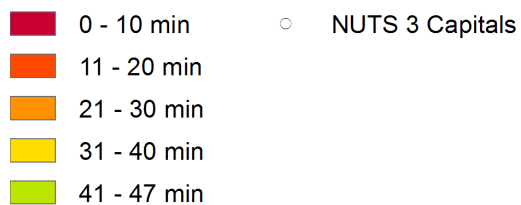
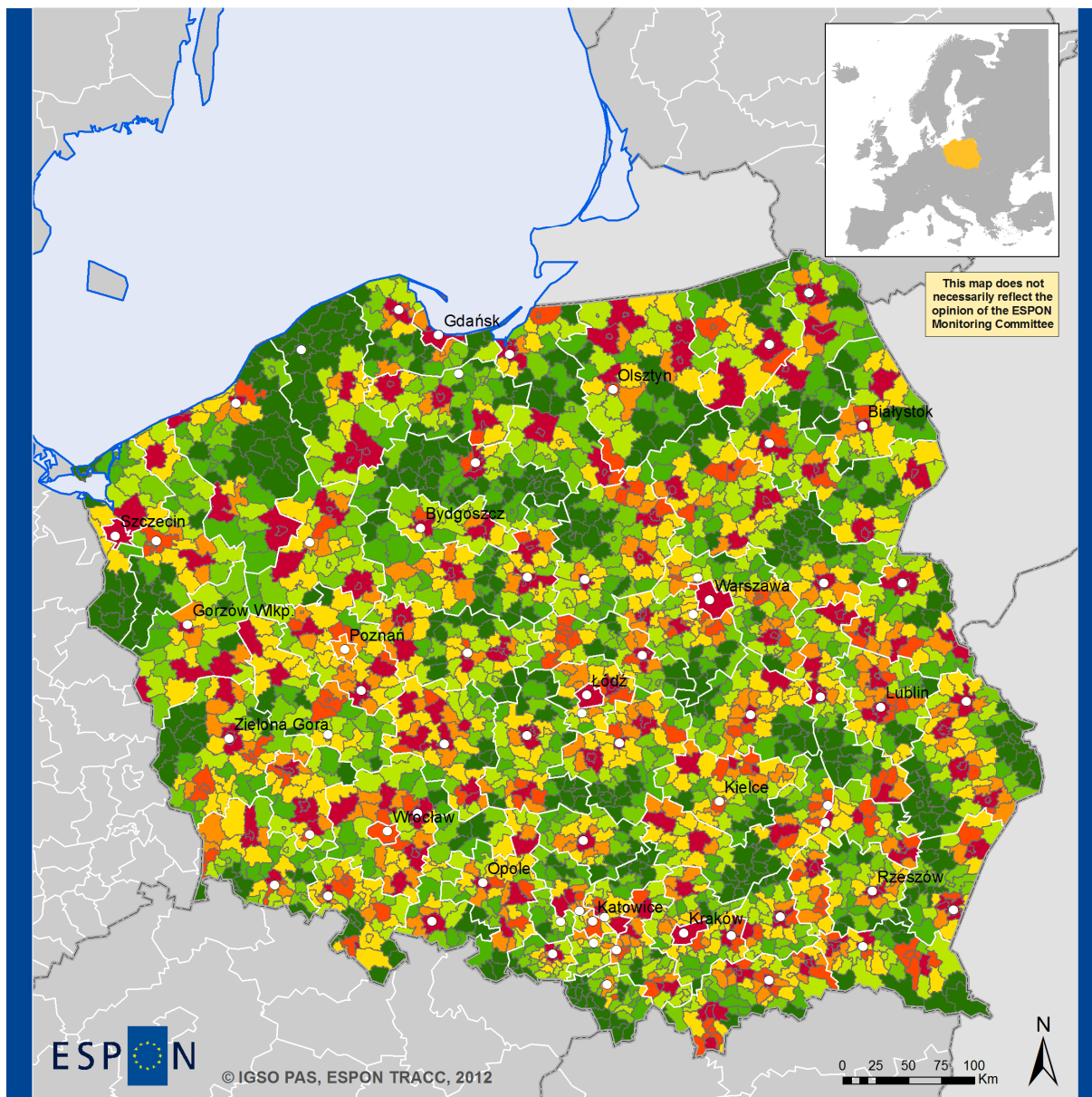


Figure 18. Car travel time to next hospital



Poland Case Study

Public transport travel time to next hospital

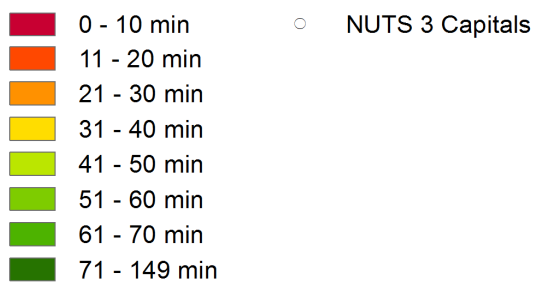


Figure 19. Public transport travel time to next hospital

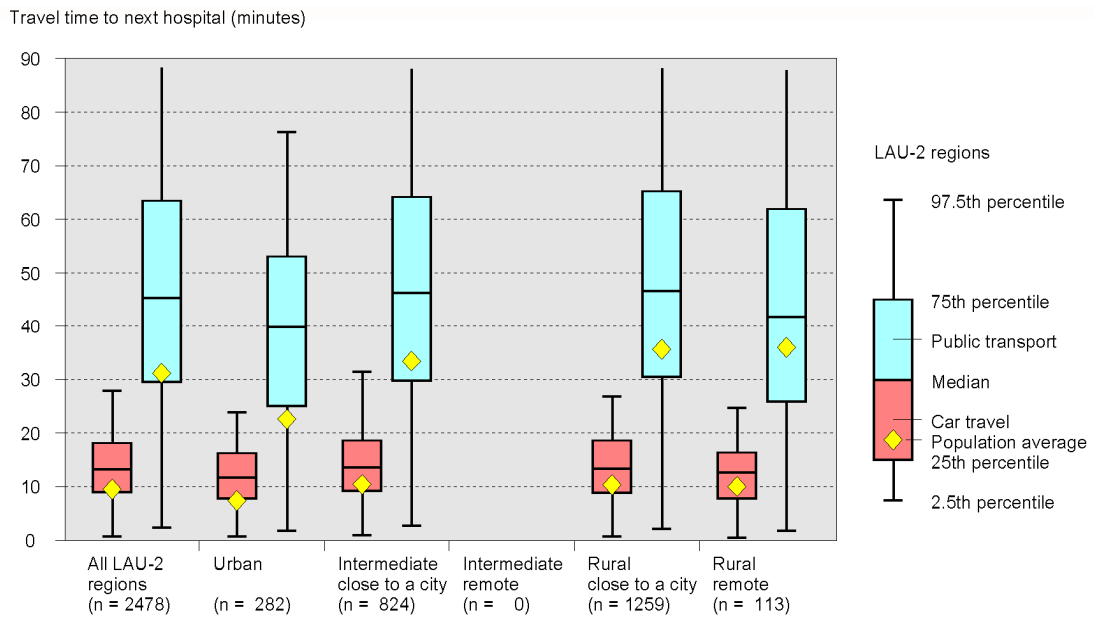


Figure 20. Travel time to next hospital, by urban-rural typology

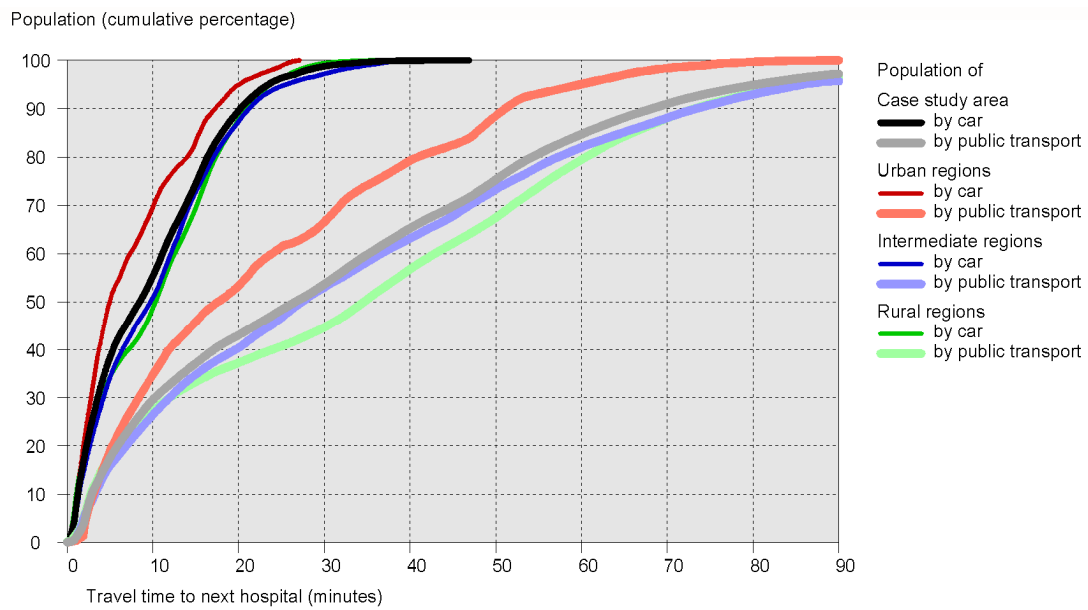


Figure 21. Travel time to next hospital, cumulative distributions

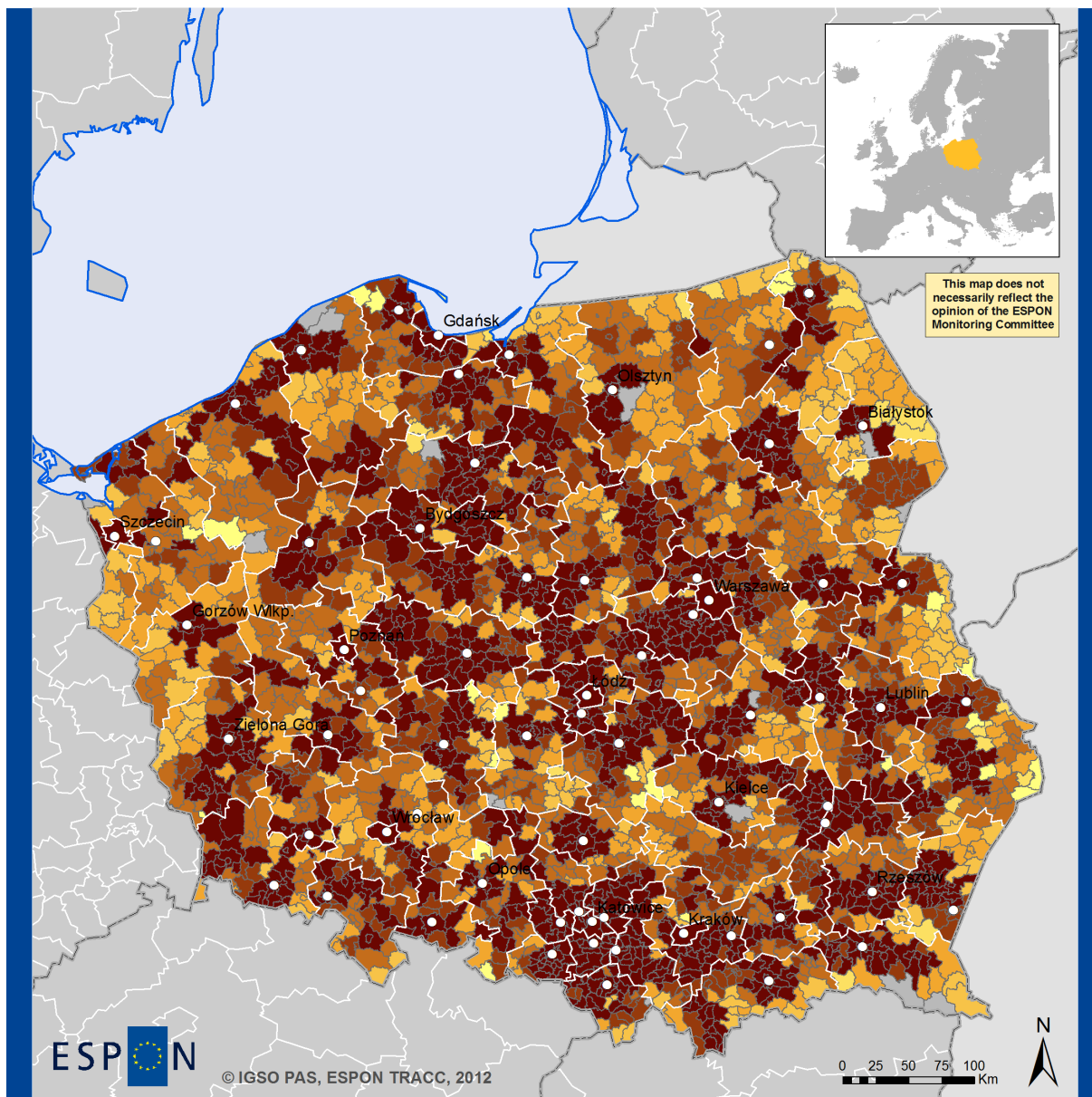
3.5 Availability of higher secondary schools

There are many higher secondary schools which are located not only in regional cities but also in smaller poviats (LAU 1). The inhabitants of the north-eastern Poland and the areas along the Polish-German and the eastern border have less choice when travelling by car to higher schools than people living in the other parts of the country (fig. 22). Disadvantageous situation occurs also in north-eastern Poland as well as in some units located on the Baltic coast and in the Carpathian Mountains.

The wide choice of more than 20 higher secondary schools within 30 minutes travel time by public transport is reserved only for the inhabitants of regional centres. The situation is much worse in the municipalities located near the borders: national, voivodeship or subregional borders (fig. 23). Accessibility to secondary schools by public transport is noticeably poorer, and there are vaster zones of its low level. What is more, they can be met over the territory of the whole country.

Accessibility to secondary schools by public transport is noticeably poorer and zones of its low level much vaster. Even in the central and southern Poland there occur units where no school is available within time shorter than 30 minutes. Dense areas covering several such municipalities can be found in the Carpathian Mountains (especially in the Bieszczady Mts.) as well as in the eastern borderland and in the Pomorze region.

A wide choice of secondary schools is typical for urban municipalities. The average population weighted score is even more than 100 by car and slightly less than 100 for public transport. Between the remaining types of units these differences are not so great. The conclusion is that higher secondary schools are well served in Polish urban areas both by individual and public transport. There is a huge difference between urban and rural areas in terms of choice of higher secondary schools, irrespective of the remoteness of the rural area (fig. 24, 25).



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Higher secondary schools within 30 minutes travel time by car

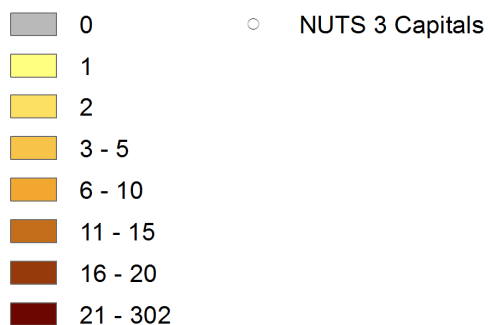
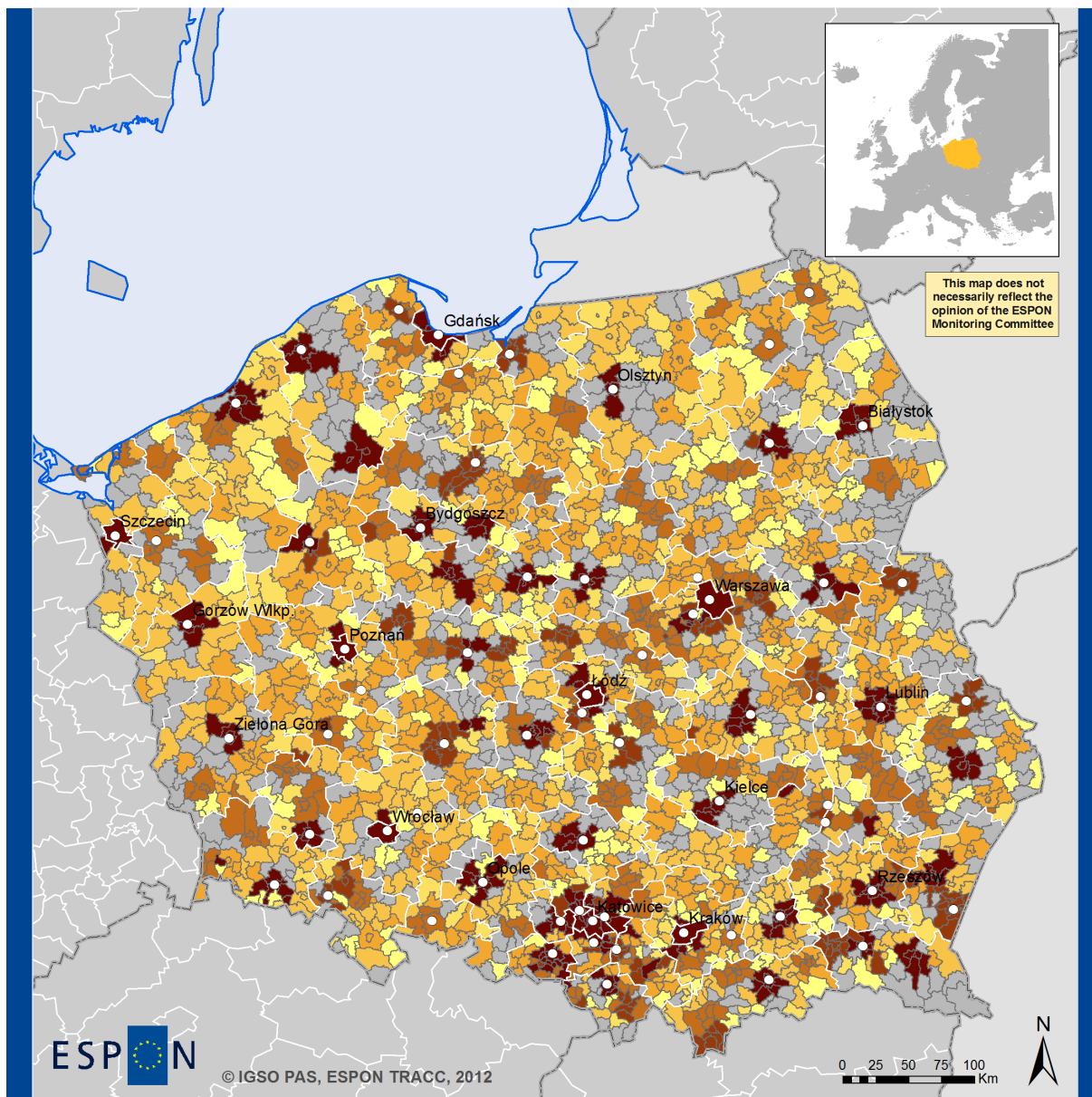


Figure 22. Higher secondary schools within 30 minutes travel time by car




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Higher secondary schools within 30 minutes travel time by public transport



Figure 23. Higher secondary schools within 30 minutes travel time by public transport

Higher secondary schools available within 30 minutes travel time

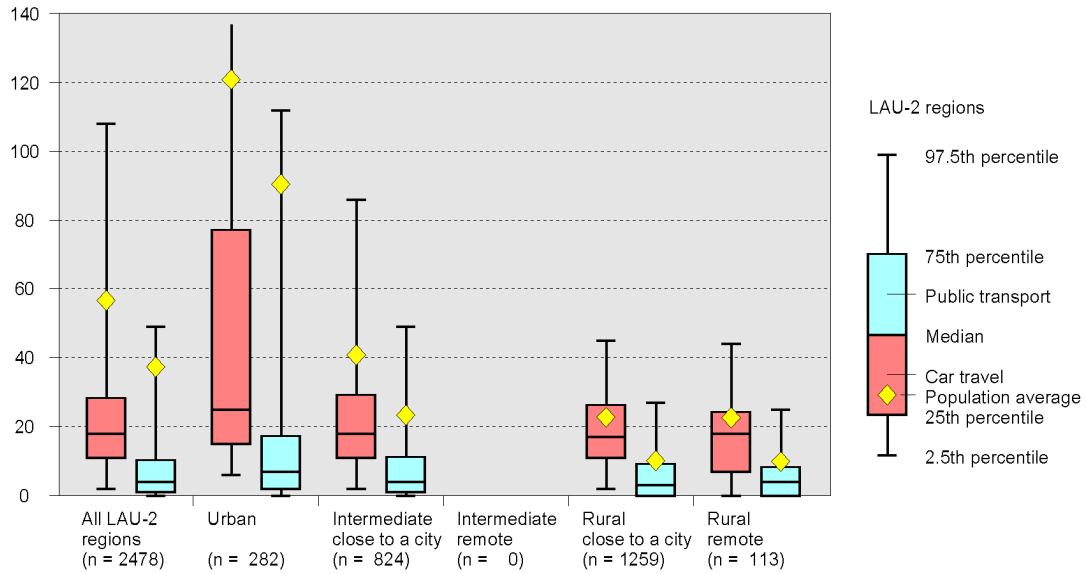


Figure 24. Higher secondary schools within 30 minutes travel time, by urban-rural typology

Population (cumulative percentage)

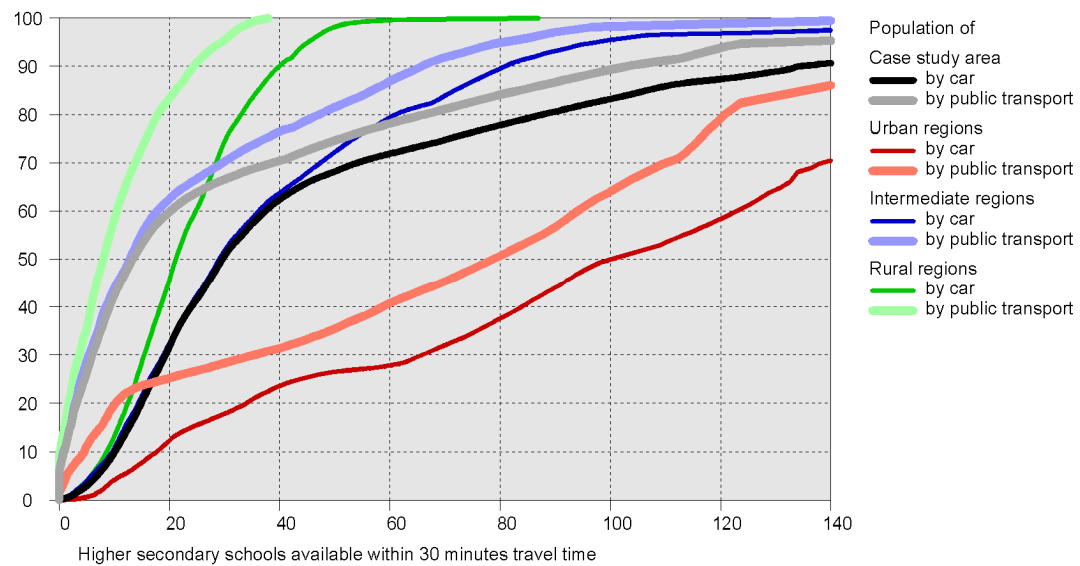


Figure 25. Higher secondary schools within 30 minutes travel time, cumulative distributions

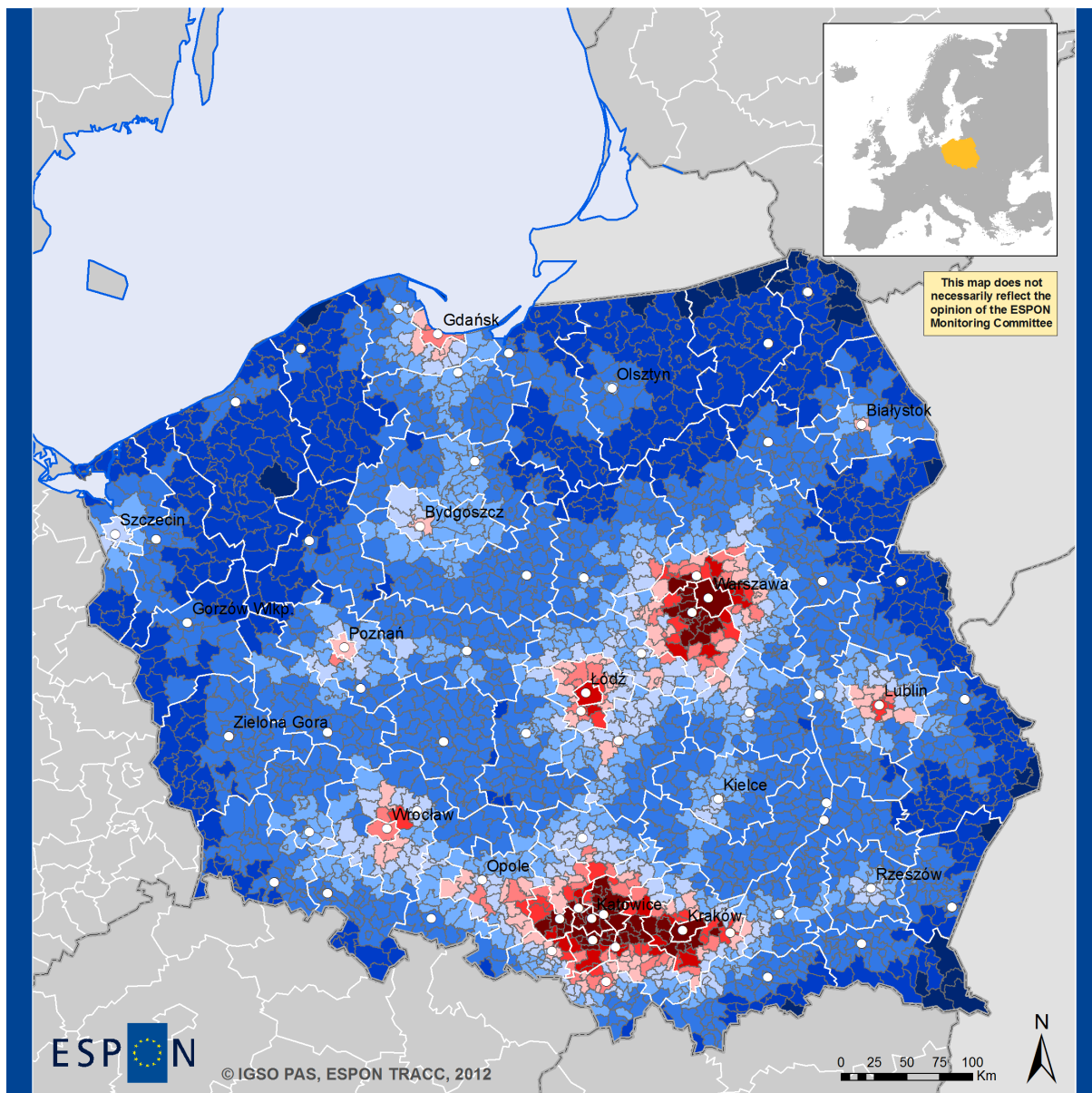
3.6 Accessibility potential to basic health care

Potential accessibility to basic health care is being measured by the similar indicator as potential accessibility to population. However, taking into account the importance of basic health care it is assumed that while the travel time is increasing the attractiveness of basic health care is decreasing much faster in comparison with the population. Difference in potential accessibility to population and to medical doctors is de facto a measure of extra-proportional spatial concentration of medical doctors (in relation to population). For that reason the area of Warsaw metropolitan region, Upper Silesia conurbation and Kraków are much more visible as areas of the best accessibility by car. In the other cities with more than 500 inhabitants, like Poznań, Wrocław, Tricity (Gdańsk, Gdynia and Sopot) and Łódź the access to the basic health care is also at the very high level. There are also some relatively smaller cities which have the sufficient number of medical doctors. Lublin, Szczecin, Bydgoszcz, Białystok and Rzeszów belong to them. All the aforementioned centres concentrate medical doctors, due to the fact that there is a great concentration of medical institutions and private practices, which is peculiar to places with high-income levels of population.

The cities in the eastern part of Poland seem to have relatively better access to basic healthcare in comparison with the general accessibility to population. The worst situation in terms of accessibility to basic health care is in the sparsely populated areas of the Zachodniopomorskie and Warmińsko-Mazurskie voivodeships (fig. 26). In the map, there are visible some of the road routes with higher speed parameters. These routes form corridors with better accessibility to the primary health care between Warsaw and Łódź as well as between Poznań, Wrocław and Kraków, and also between Warsaw and Kraków, and between Kraków, Gdańsk and Toruń.

The map of accessibility to basic health care by public transport shows again that in comparison with individual transport the situation is rather poor and needs to be improved (fig. 27a). The same map based on the indicator which is standardised on public transport average leads to the same conclusion – if someone is ill and lives in the rural areas needs to have own car to go to the doctor (fig. 27b). Areas with better accessibility to primary health care by public transport are limited to an immediate neighbourhood of large and some of the medium-sized urban centres. Only in the southern Poland (region of Upper Silesia, Kraków and Częstochowa) these areas form a more compact zone.

The average population weighted accessibility to basic healthcare by public transport is two times worse than the same indicator for individual transport. Urban areas are in much better situation than the rural ones. A little better situation than in the rural areas is in the municipalities which are intermediate (between urban and rural) and close to the city, in suburban areas in particular. It is easily seen that basic health care facilities are not as equally distributed among the population as hospitals (fig. 28,29). In rural areas, practically, no spatial differentiation is noted. The level of accessibility by public transport is evenly distributed. In the case of individual transport, these differentiations are higher, and rural remote units are noticeably in worse situation than that of other rural areas.

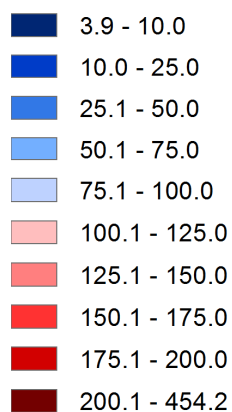


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Potential accessibility to medical doctors by car ($\beta = 0.04621$)



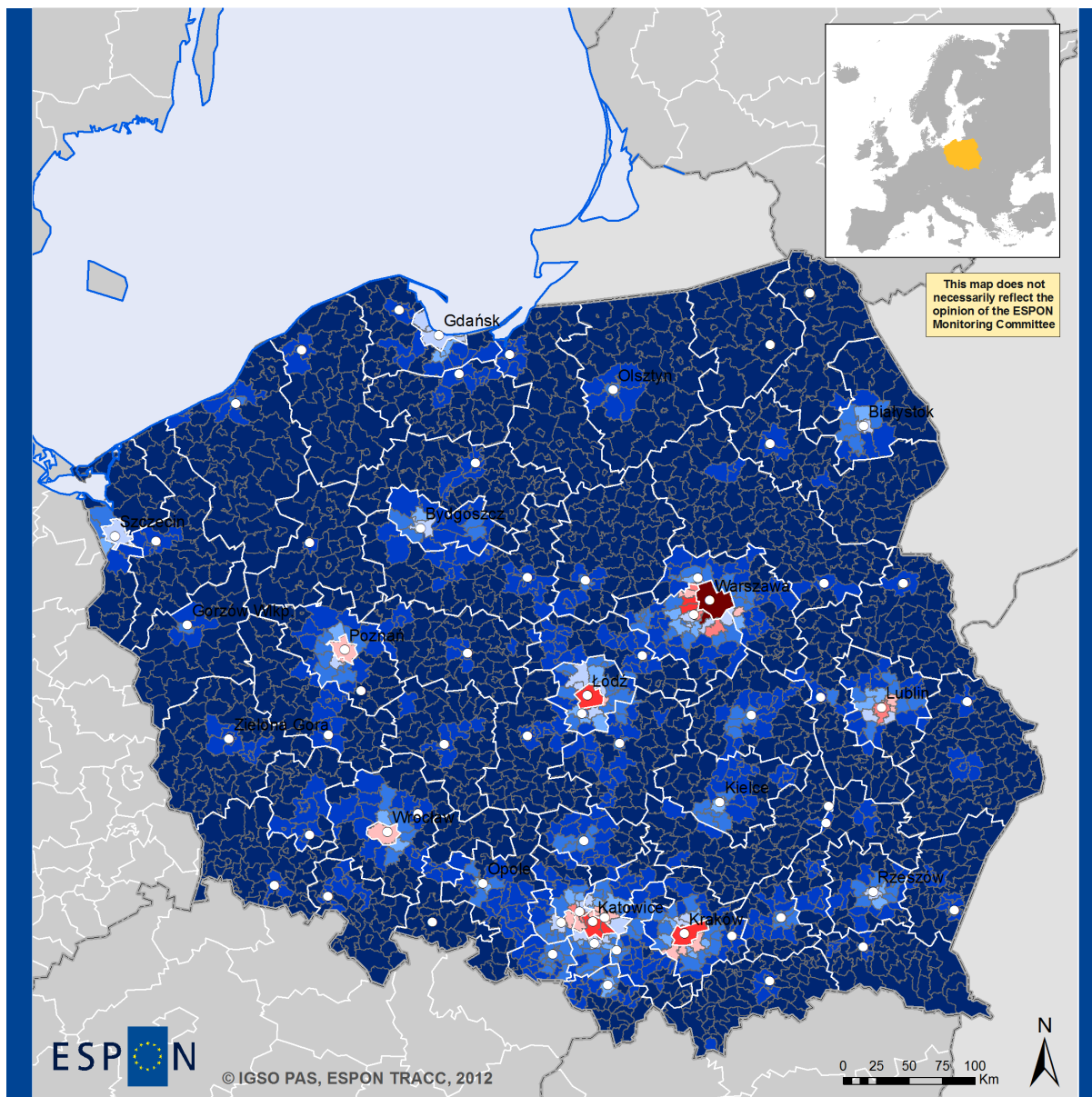
○ NUTS 3 Capitals

100 (population weighted average) = 1 109

Minimum: 43

Maksimum: 5 038

Figure 26. Potential accessibility to medical doctors by car



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Potential accessibility to medical doctors by public transport

(standardised on road average; $\beta = 0.04621$)

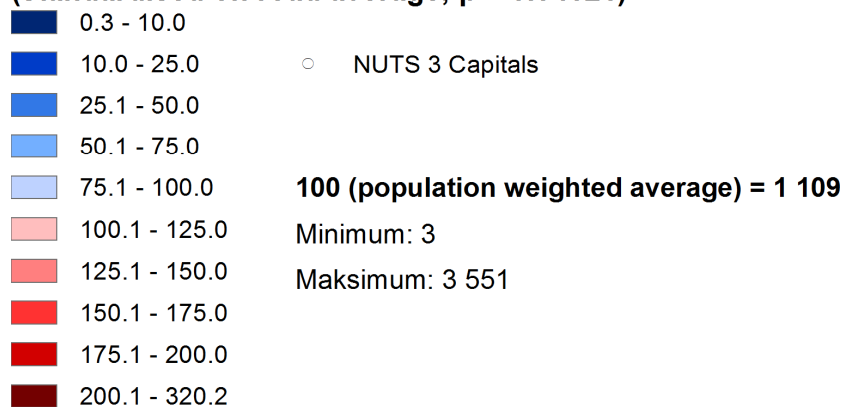
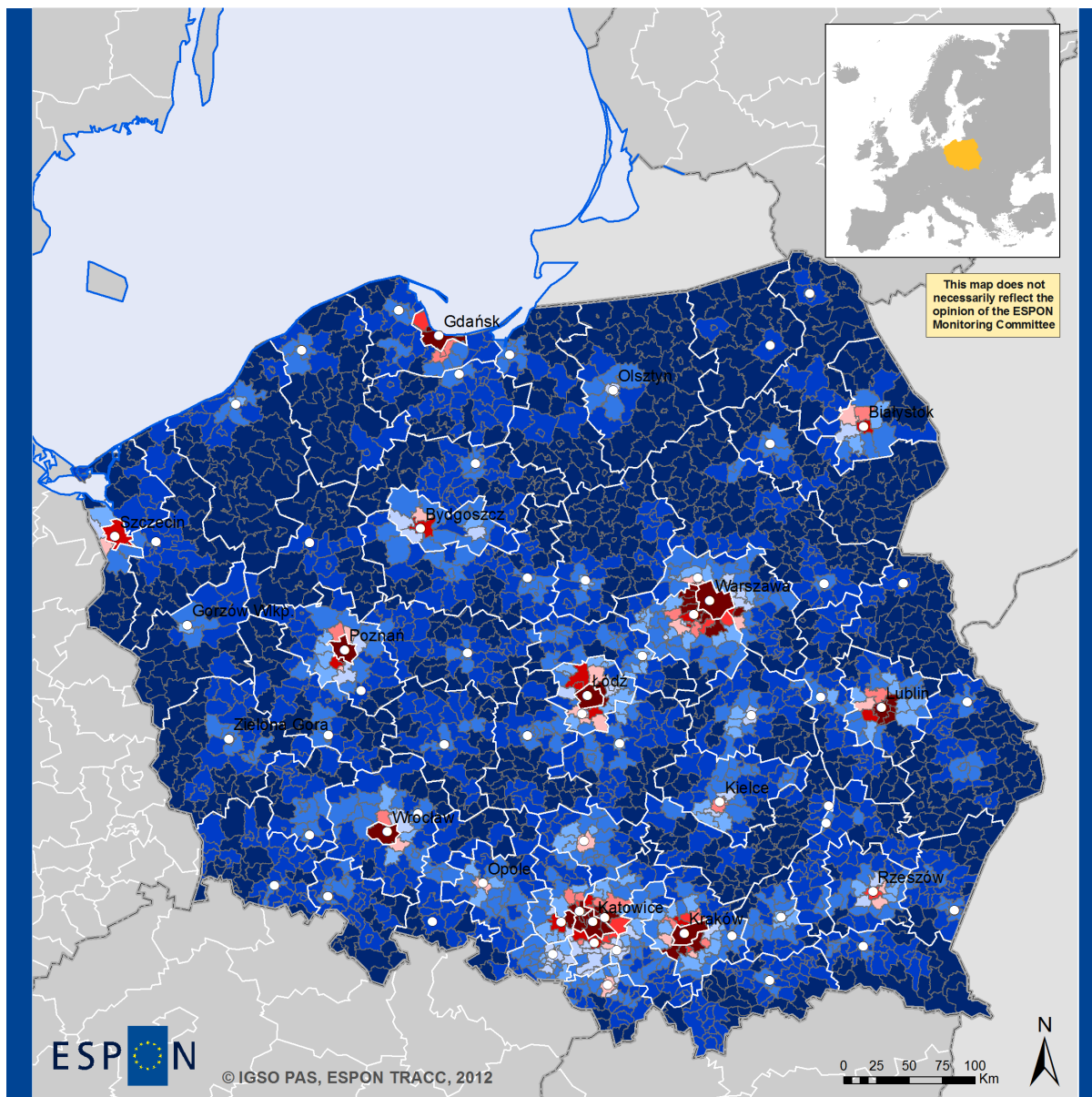


Figure 27a. Potential accessibility to medical doctors by public transport (standardised on road average)



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Source: IGSO PAS, 2011
Origin of health care data: estimated by IGSO PAS
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Poland Case Study

Potential accessibility to medical doctors by public transport

(standardised on public transport average; $\beta = 0.04621$)

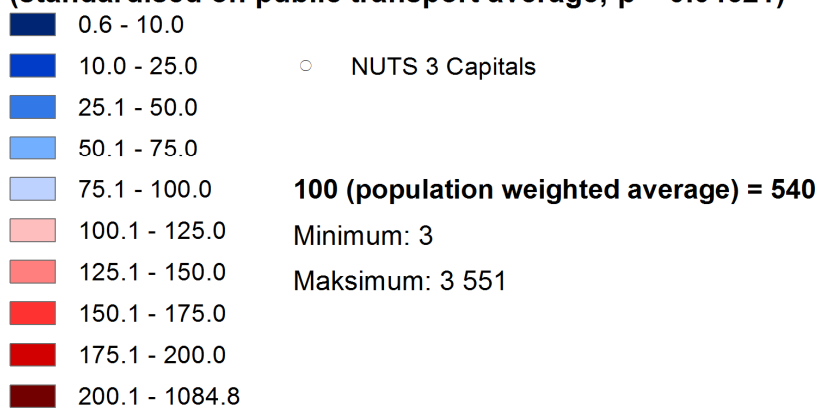


Figure 27b. Potential accessibility to medical doctors by public transport
(standardised on public transport average)

Potential accessibility to medical doctors (car average = 100)

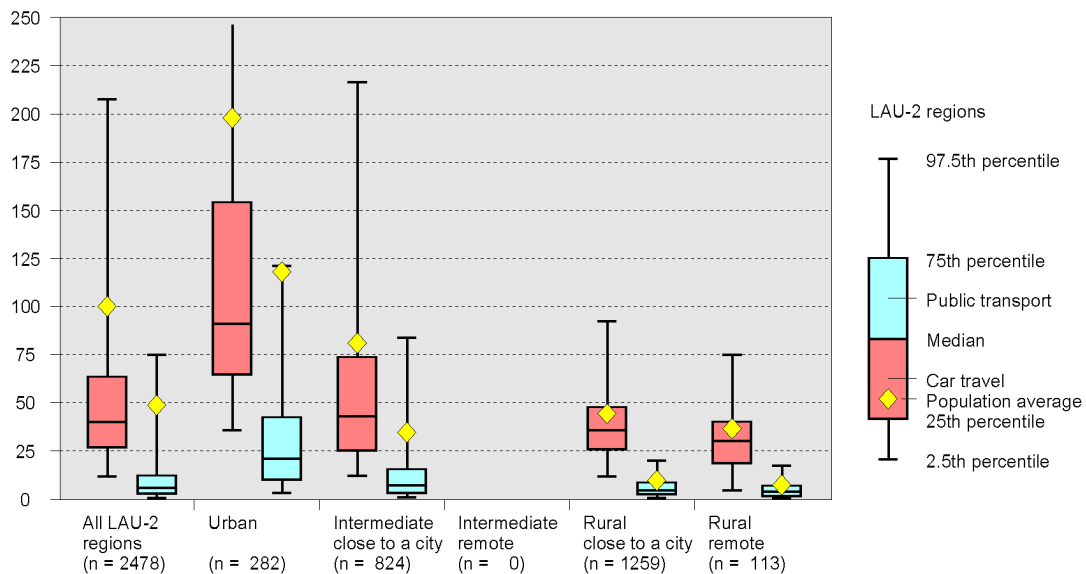


Figure 28. Potential accessibility to medical doctors, by urban-rural typology

Population (cumulative percentage)

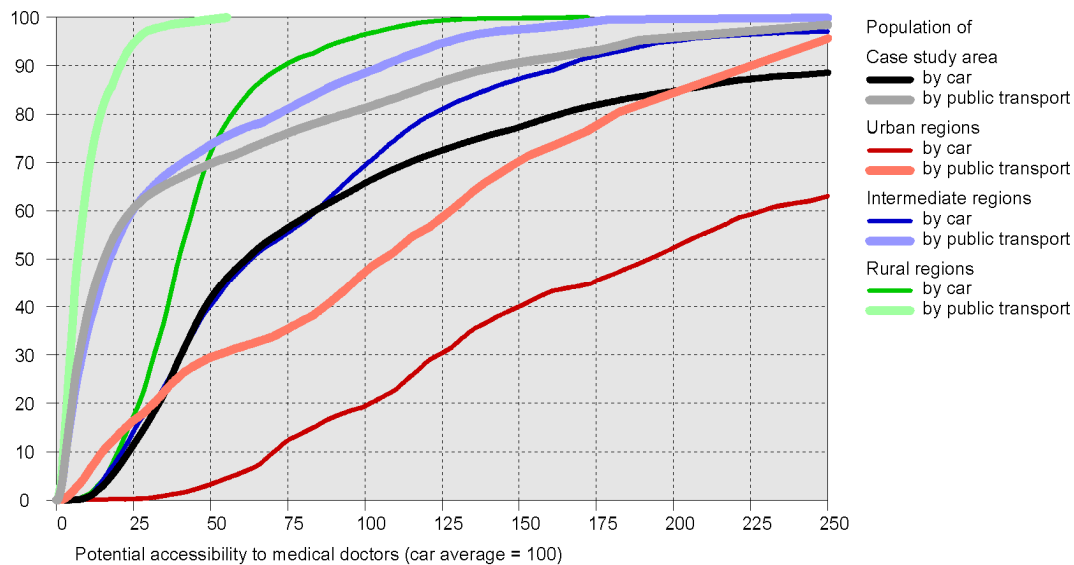


Figure 29. Potential accessibility to medical doctors, cumulative distributions

4 Accessibility situation at different regional subtypes

The zoom-ins differ between each other in terms of accessibility at the national and European level. The European context is discussed at the very beginning of this case study. For that reason the analysis in this chapter is devoted to accessibility at the national level.

Warsaw region is centrally located and due to the existence of Warsaw, the economic and socio-demographic growth pole its accessibility of the Warsaw region is in general one of the best in the country and can be compared only with the accessibility of Upper Silesia conurbation and Kraków. However, on the other side all major cities except of Warsaw are located very close to Warsaw like Piaseczno, Pruszków or Legionowo. Especially in the Warszawski-wschodni subregion most of the area is rather rural. State of public transport and railway connections to the city are not sufficient in terms of travel times.

For the above mentioned reasons there are important differences in accessibility between Warsaw itself and the eastern and southern parts of Warsaw region defined as Warsaw, the Warszawski-wschodni and the Warszawski-zachodni subregions. The difference between the average accessibility weighted population and the median value is for that reason significant for Warsaw region. Changes in the level of accessibility are slowly taking place in the Warsaw region, despite significant transport investment projects implemented after accession of Poland into the EU. The reason for that is that the majority of investments has been carried out either within the capital city of Warsaw (e.g., investments in development of metro network) or in the interagglomeration or international corridors (TEN-T network). Only small number of development projects has been undertaken in the suburban zone of Warsaw, which is associated with numerous occurrence of spatial conflicts (in the conditions of fast-paced suburbanization) as well with a deficient system of spatial planning. As a result, for example, transport development projects, undertaken in the programming period 2004-2006), practically, did not change the range of isochrone for 60-minute travel-access-time to the city centre (Komornicki et al. 2010).

Taking into account travel times to regional centres the average population weighted travel time is shorter than the national average, while the median is longer (fig. 31,32). Travel time to regional centres by public transport is noticeably longer. There are also clearly larger travel time variations between particular units in case of mass transit. The cumulative chart allows for asserting that deficiency in public transport is associated essentially with time travel exceeding 20 minutes. This corroborates the thesis that inside the core of metropolitan area public transport can compete with individual transport. Already in suburban zones the situation is undergoing rapid changes.

Warsaw region is an economic growth pole and many well-paid jobs in Warsaw attract number of commuters. Jobs accessibility within 60 minutes both by car and by public transport is much above the national average (fig. 33,34). The course of cumulative chart is clearly different from other analyzed regions (both in case of individual as well as public transport). These differences result in part from delimitation as a zoom-in region only the zone directly surrounding the national capital.

The same refers to potential accessibility to population (fig. 35,36). However, in the context of potential accessibility one can see the huge difference between the population average and the median value. Potential accessibility by public transport is simultaneously markedly better than that of other zoom-in regions. Also, there is a greater differentiation in that respect in a group of LAU2 units.

Travel times to the nearest hospital are shorter than the national average (fig. 37,38) as well shorter than in other investigated regions. This concerns both individual as well as public transport. The cumulative chart reveals that around 55% of inhabitants have equally favourable accessibility to hospitals in road and public transport (travel times up to 10 minutes). These are the inhabitants of Warsaw. In a group of other inhabitants of the region (chiefly the residents of the suburban zone), the situation changes markedly to the disadvantage of public transport. In

road transport 30-minute access to a hospital is available to 100% of population of the region, however by public transport – to only 70% of population.

The accessibility of higher secondary schools in Warsaw is the best in the country. However, in case of secondary schools again we can see a huge difference between the city of Warsaw and the rest of the Warsaw region. The median value is very low, which means that the accessibility of higher secondary schools in the municipalities located farther from Warsaw is very poor (fig. 39,40). At the same time, a disparity by individual and public transport is relatively small. Number of school accessible within 30-minute travel time is in the Warsaw region much larger than in any other zoom-in region.

Potential accessibility to medical doctors is at the very high level not only for Warsaw, but also for the whole analysed area of Warsaw region (fig. 41,42). As regards accessibility by public transport to medical doctors, there is a relatively favourable situation (as compared to the national average as well as to other analyzed regions). There is a group of units with an indicator value exceeding average for road transport. This concerns partly suburban units in an immediate neighborhood of Warsaw.

Dolnośląskie voivodeship, while very well accessible at the European level, in the national context is in general very close to the national average. It is connected some way with the structure of accessibility indicators which promote short trips instead of long trips. If we take into account longer trips, then we can see the weakness of the road and railway connection of Wrocław, the capital of Dolnośląskie region with Warsaw. However, in case of short trips Dolnośląskie voivodeship due to its relatively high population, road and railway density is quite well accessible. There are also some city clusters in Dolnośląskie region and for that reason the difference between the population average and the median value is rather lower than for the whole country (the opposite situation than in Warsaw region where the Warsaw dominates the whole region). In addition, accessibility indicators for the Dolnośląskie voivodeship are further strengthened by its A4 motorway link with a huge demographic potential of Upper Silesia.

Travel times to the nearest regional centre are in the Dolnośląskie region quite similar to the national average. The population weighted travel times by public transport are much shorter than the national average due to the fact that most of the regional centres in the Dolnośląskie region are located along the railway lines (fig. 31,32), some of these have been modernized in recent years (e.g. Wrocław-Legnica). In case of jobs accessibility within 60 minutes, the Dolnośląskie is a little below the national average in terms of population weighted and little over in terms of median indicator. In general the job accessibility is worse when compared with Warsaw and much better when compared with other two zoom-ins (fig. 33,34). The difference in favour of the Dolnośląskie as compared to the Zachodniopomorskie as well as the Przemyski and Krośnieński subregions, however, is not so clearly evident in case of public transport.

The conclusion is the same in case of potential accessibility to population (fig. 35,36) and travel times to hospitals. In case of the potential accessibility to population, a considerable difference becomes manifest between individual and public transport (close to that noted in the Warsaw region). It is probably, partially, due to the impact of the A4 motorway. In case of travel times to hospitals the median values both for individual and public transport are very similar to those obtained for Warsaw region (fig. 37,38). Taking into account higher secondary schools, one can conclude that the situation in Dolnośląskie both for the individual and public transport is much worse comparing with other indicators. The median for individual transport is even worse than for the Przemyski and Krośnieński subregions (fig. 39,40). In case of medical doctors the accessibility is relatively better than to higher secondary schools but still below the national average (fig. 41,42).

Zachodniopomorskie voivodeship at the national level represents in general the accessibility below the national average. The population average travel time to the nearest regional centre is also below the national level both for individual and public transport. The reason is that

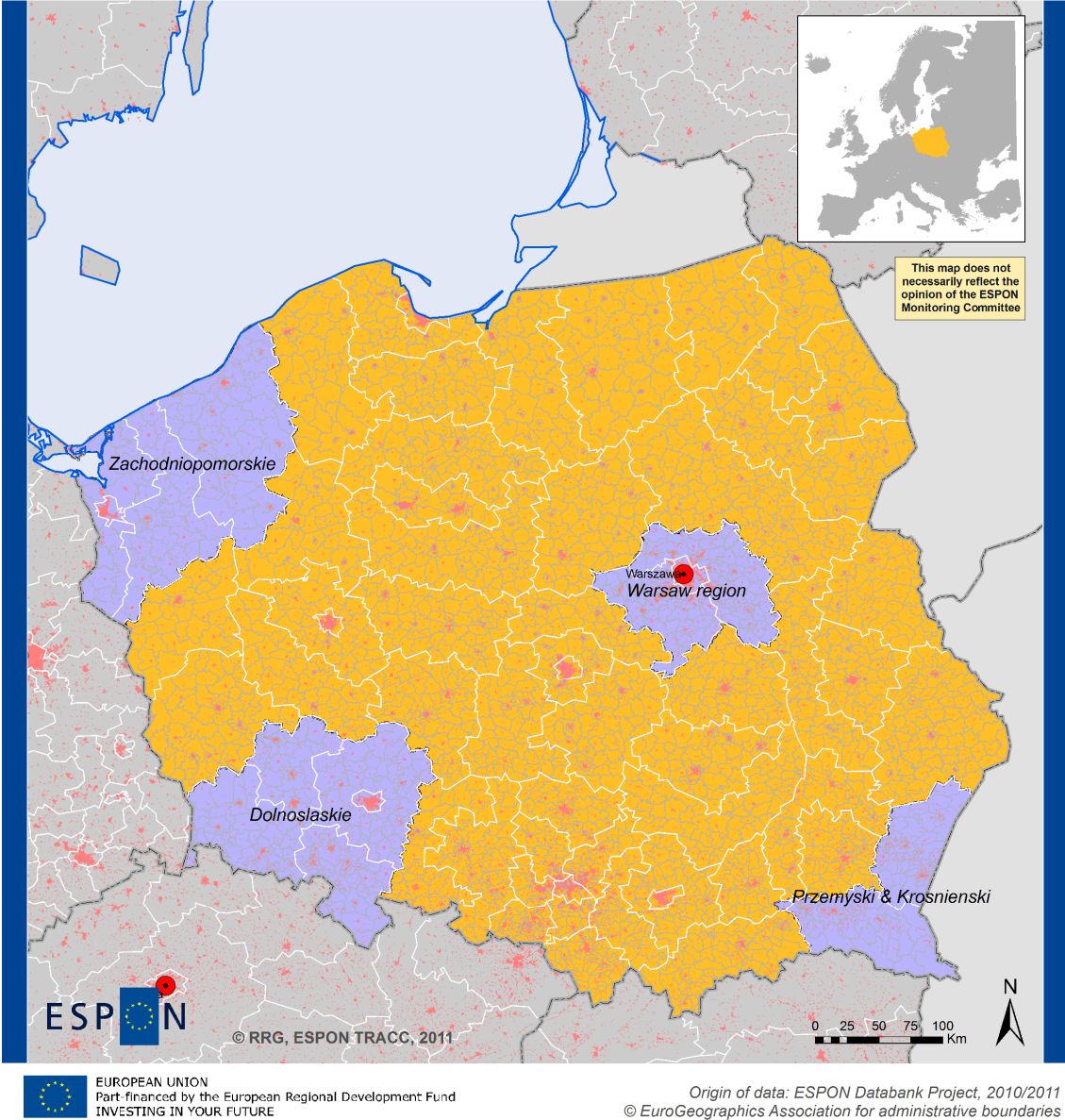
Zachodniopomorskie is sparsely populated with only Szczecin, Koszalin and Stargard Szczeciński as cities over 50 thous. inhabitants (fig. 31,32). Population within a 20-minute isochrone from regional centre remains similar in numbers in case of individual and public transport. Then both the curves are fast becoming increasingly divergent. The very bad situation is in terms of job accessibility. In comparison with the Dolnośląskie voivodeship the situation in this context is two times worse. One can only hope that the windmill industry or new factories like Bridgestone in Stargard Szczeciński will improve the situation in this economically declining region (fig. 33,34). The value of indicators is affected by factors such as the vast extent of the region's area and the occurrence of internal large-scale peripheries in its western part – this being sparsely populated and devoid of large urban centres (except for Koszalin). Additionally, carrying out analysis only in the national context does not allow for taking into consideration its relatively satisfactory accessibility to population as well to labour market in Berlin.

The region is characterized by one of the worst potential accessibility to population in Poland. The median values both for individual and public transport are worse even than those located on the other "pole" of Poland - the Przemyski and Krośnieński subregions (fig. 35,36). A poor potential accessibility to road transport makes that the disparity between the both modes of transport is relatively smaller. The same situation is when concerning travel times to the nearest hospital which are also the worst among the zoom-ins (fig. 37,38). The little better situation is when concerning the accessibility to higher secondary schools (average population weighted). However, the median values in this case are also the worst among the zoom-ins (fig. 39,40). The same conclusion refers also to the accessibility to the medical doctors (fig. 41,42). However, in this case, indicators' values for the Zachodniopomorskie are closer to those noted in the Dolnośląskie than the values referring to the Przemyski and Krośnieński subregions. Significant concentration of medical doctors can be associated with a development of private health care services directed toward German clientele.

The accessibility results for **Przemyski and Krośnieński** subregions are in case of some of the indicators very similar to these obtained for Zachodniopomorskie voivodeship. Both zoom-ins are remotely located. The closeness of Ukrainian border (outer Schengen border), lack of big masses on the other side of the internal Schengen border (Slovakian Preszów is not comparable with Berlin) and the distance to the European core are the causes for much worse European accessibility than in the Zachodniopomorskie voivodeship. However, at the national level the population density in the Przemyski and Krośnieński subregions, in the Carpathian Foothills in particular is much higher than in the Zachodniopomorskie. Although there is no such a city like Szczecin in the analyzed subregions, a relatively high population density is the main reason for relatively higher accessibility indicators in the Przemyski and Krośnieński subregions than in Zachodniopomorskie voivodeship. The main difference is that in the Przemyski and Krośnieński subregions due to the lack of one big city, the average weighted population values are very close to the median values (figs. 31,32,33,34,35,36,37,38,39,40,41,42). The situation in the analyzed subregions in terms of accessibility will significantly improve when the A4 motorway that is nowadays under construction will be completed (in 2013).

A curve in the cumulative chart that illustrates population within a given travel-time access to regional centres has a s-shaped course slightly different from those peculiar to the other zoom-in regions. It is characterized by very low values in the zone remaining within 20-40-minute isochrone limits and by clearly better ones (e.g., as compared to the Zachodniopomorskie region) in the more remote zones. This is a by-product of the settlement network pattern present in the investigated area as well as in its neighbourhood (regional centres situated closely outside the subregions' limits, especially Rzeszów, which are lacking in the Zachodniopomorskie zoom-in region). This factor itself conditions a relatively large differentiation of accessibility indicators to places of working. Within the investigated area, there occur both the local units situated far away from labour markets as well as those remaining in the vicinity of the Rzeszów labour market. In case of all the distinctive characteristics, the difference to the disadvantage of public transport is

clearly visible. This results from a poor density and quality of rail network in that area (except for Kraków-Lviv line). However, the density of bus transport network in the south-eastern Poland is on the sufficient level. The accessibility by public transport to secondary schools is amazingly well advanced there. It can be linked to their massive concentration in the Przemyski subregion, with a simultaneous scarce number of secondary schools in other parts of the region. However, this does not influence the fact that a number of schools available within a 30-minute access time isochrone is in that zoom-in region clearly the lowest. Also, a potential accessibility to medical doctors is evidently the worst of all the zoom-ins.



**Poland Case Study
Macro region and zoom-in regions**

- Macro-region: municipalities
- Zoom-in regions
- Capital city
- Settlement area
- NUTS-3 region boundary

Figure 30. Zoom-in regions

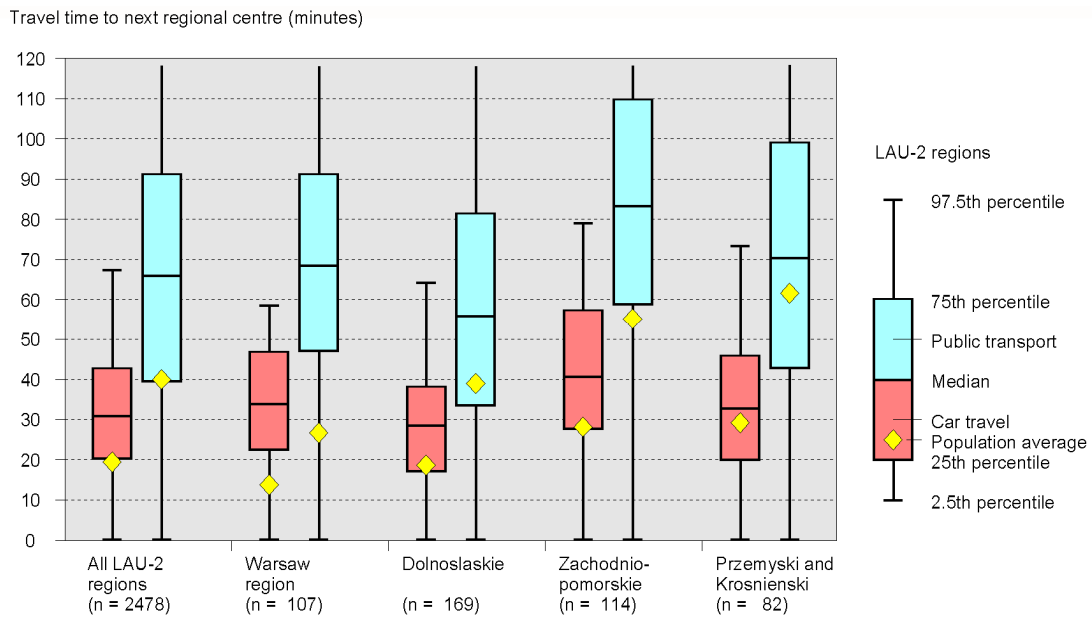


Figure 31. Travel time to next regional centre, by zoom-in region

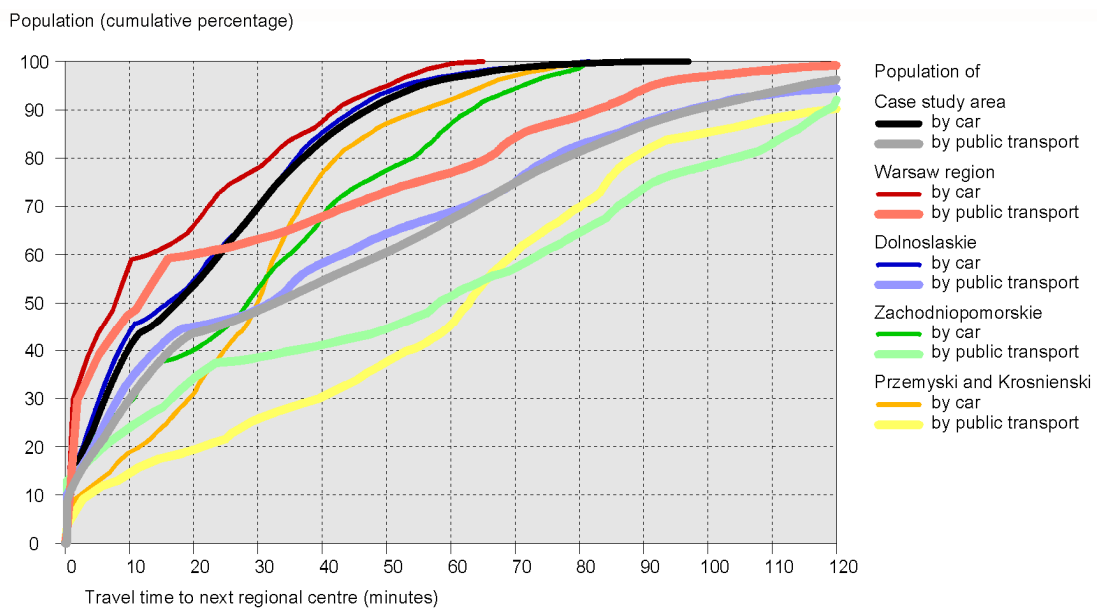


Figure 32. Travel time to next regional centre, cumulative distributions by zoom-in region

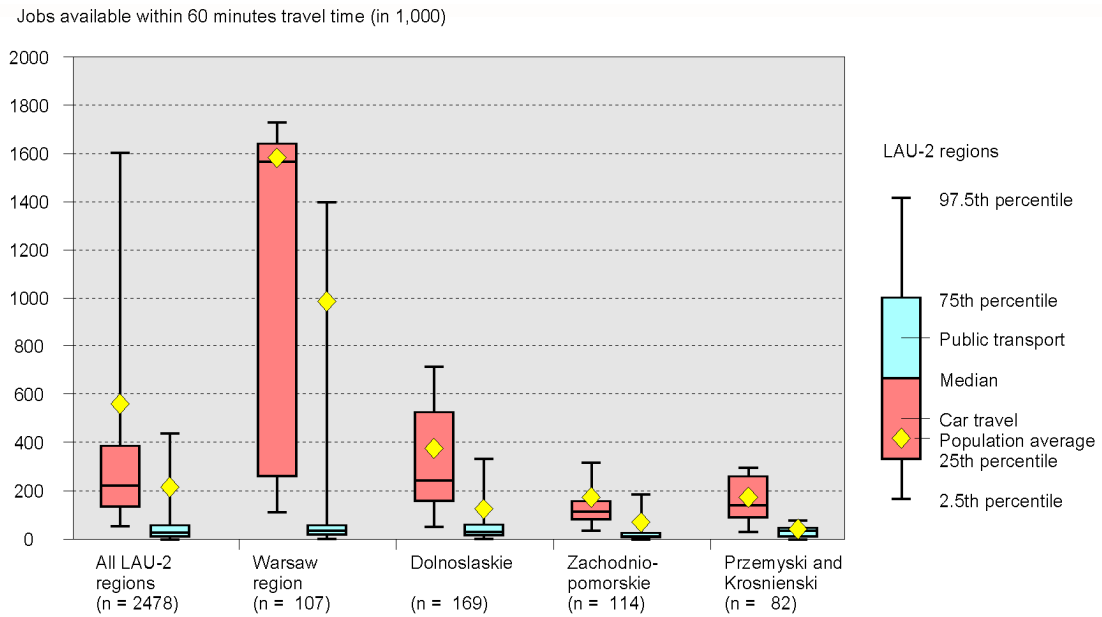


Figure 33. Jobs accessible within 60 minutes, by zoom-in region

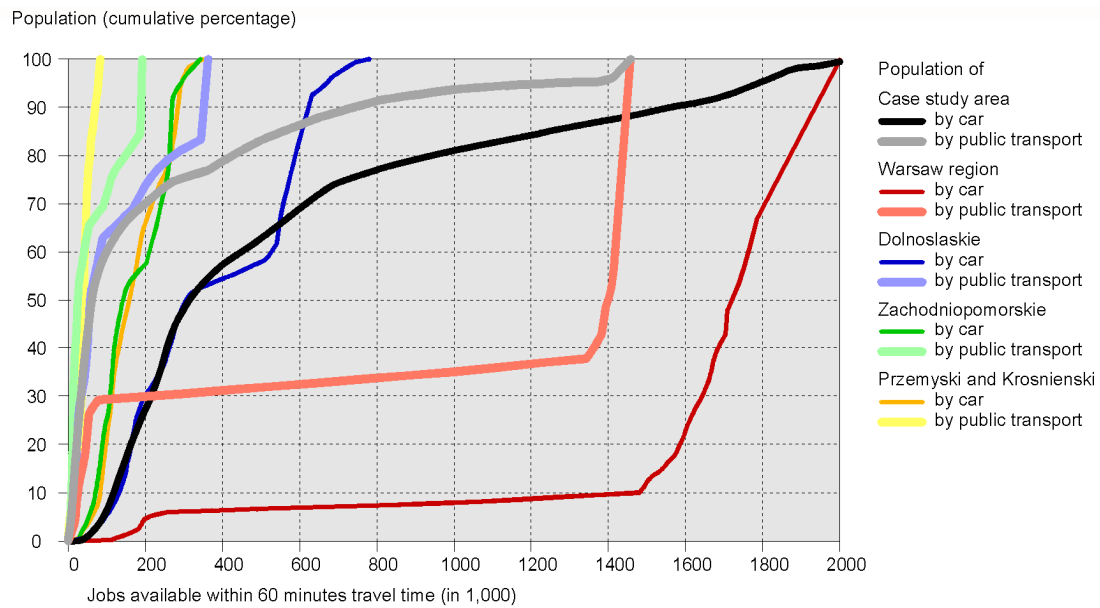


Figure 34. Jobs accessible within 60 minutes, cumulative distributions by zoom-in region

Potential accessibility to population (car average = 100)

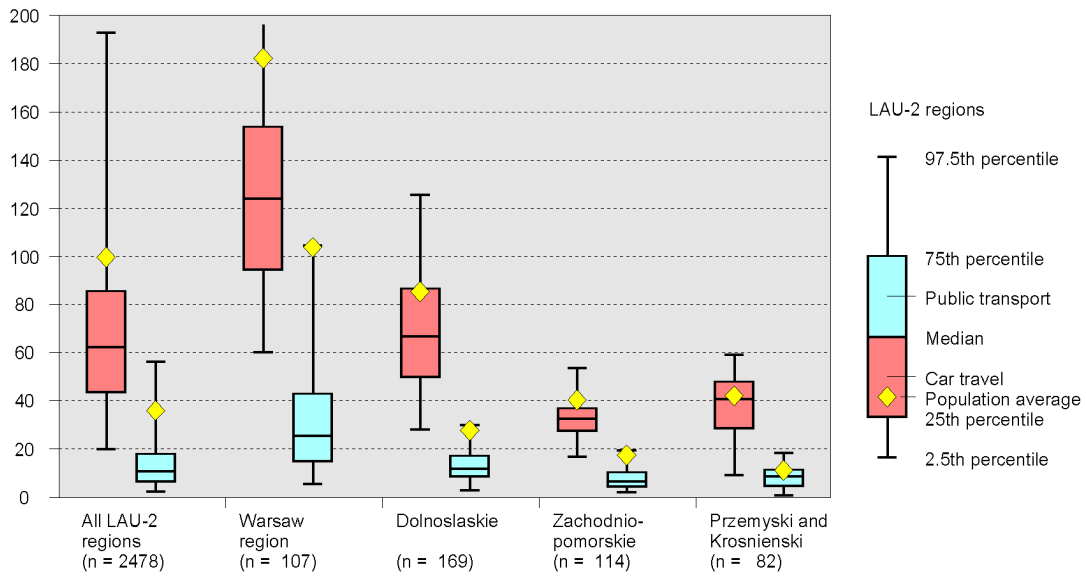


Figure 35. Potential accessibility to population, by zoom-in region

Population (cumulative percentage)

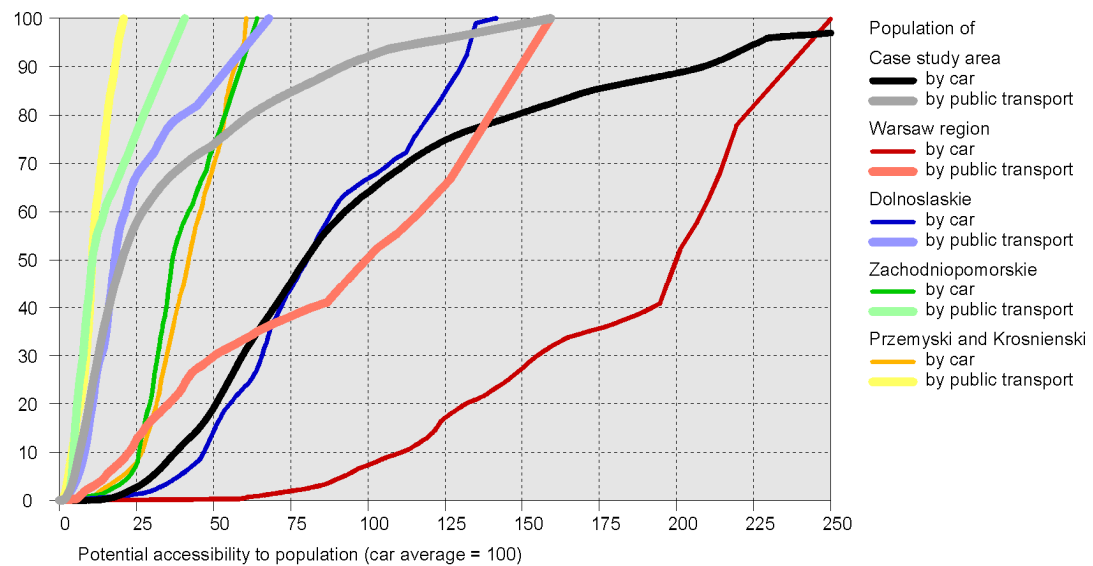


Figure 36. Potential accessibility to population, cumulative distributions by zoom-in region

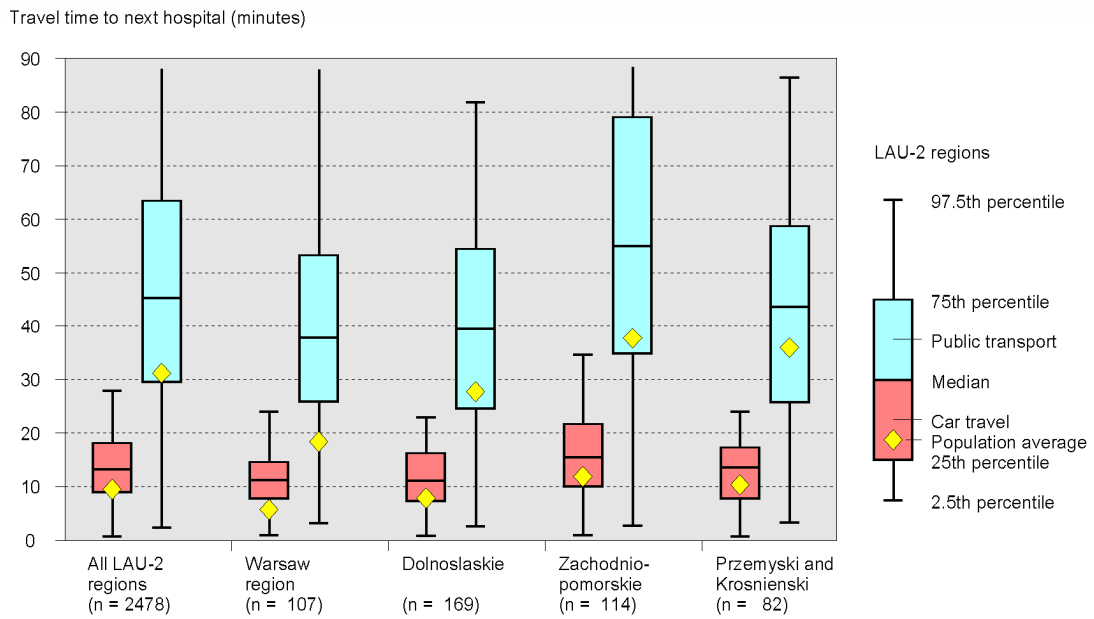


Figure 37. Travel time to next hospital, by zoom-in region

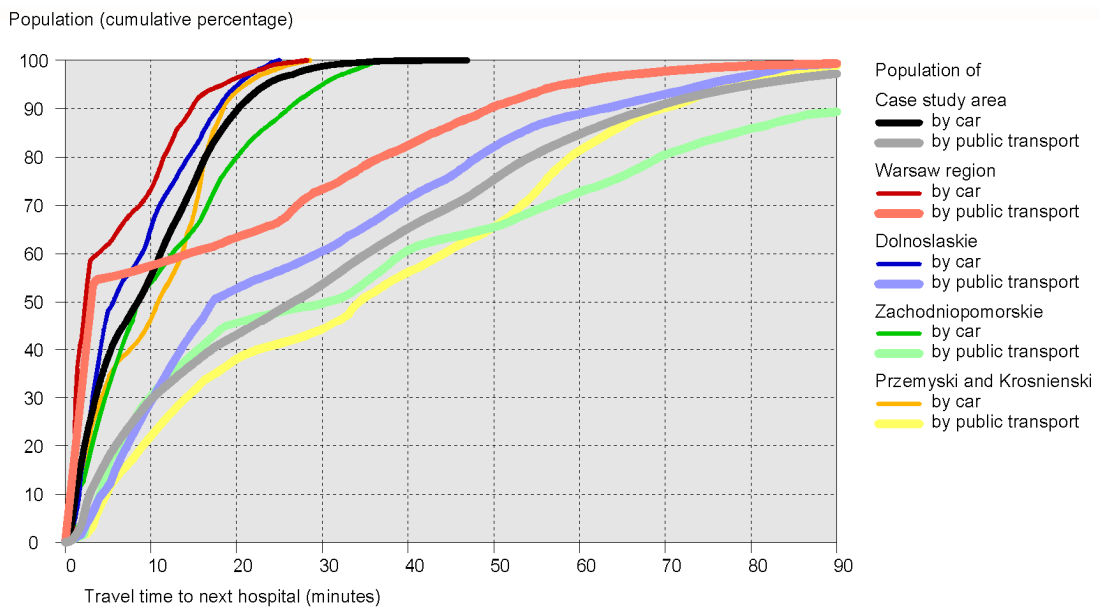


Figure 38. Travel time to next hospital, cumulative distributions by zoom-in region

Higher secondary schools available within 30 minutes travel time

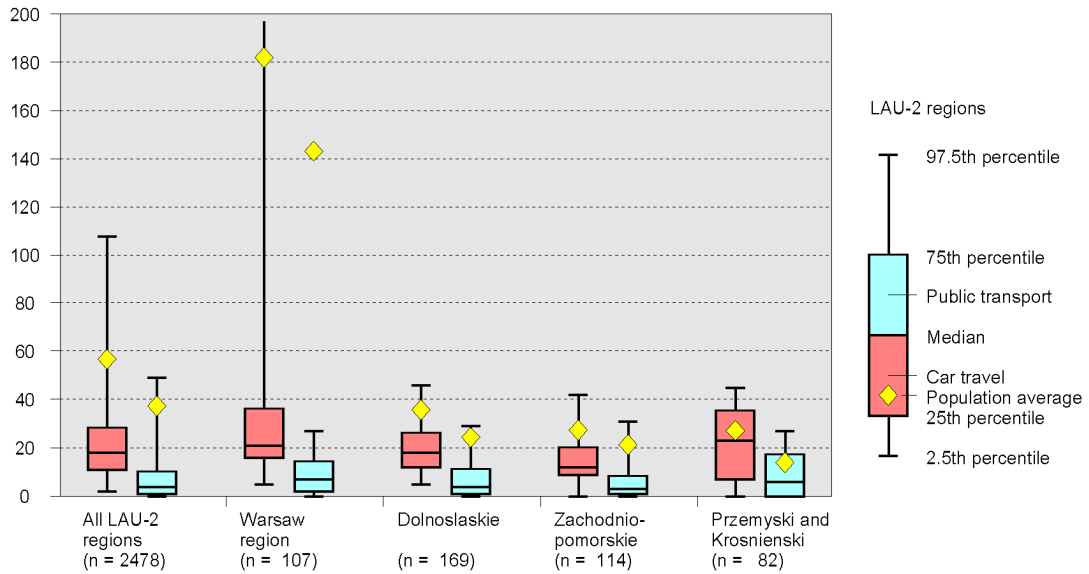


Figure 39. Higher secondary schools within 30 minutes travel time, by zoom-in region

Population (cumulative percentage)

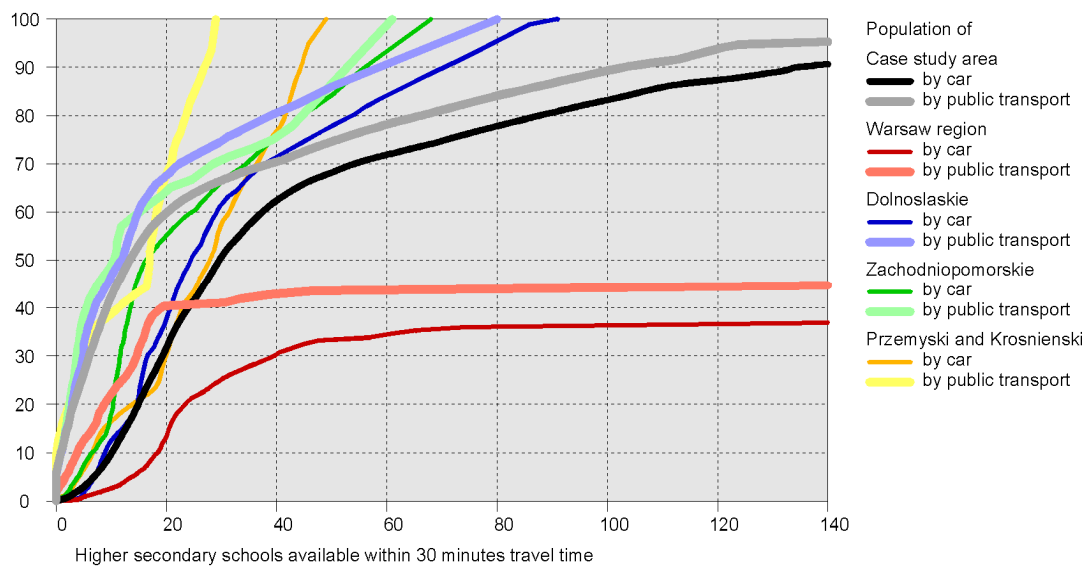


Figure 40. Higher secondary schools within 30 minutes travel time, cumulative distributions by zoom-in region

Potential accessibility to medical doctors (car average = 100)

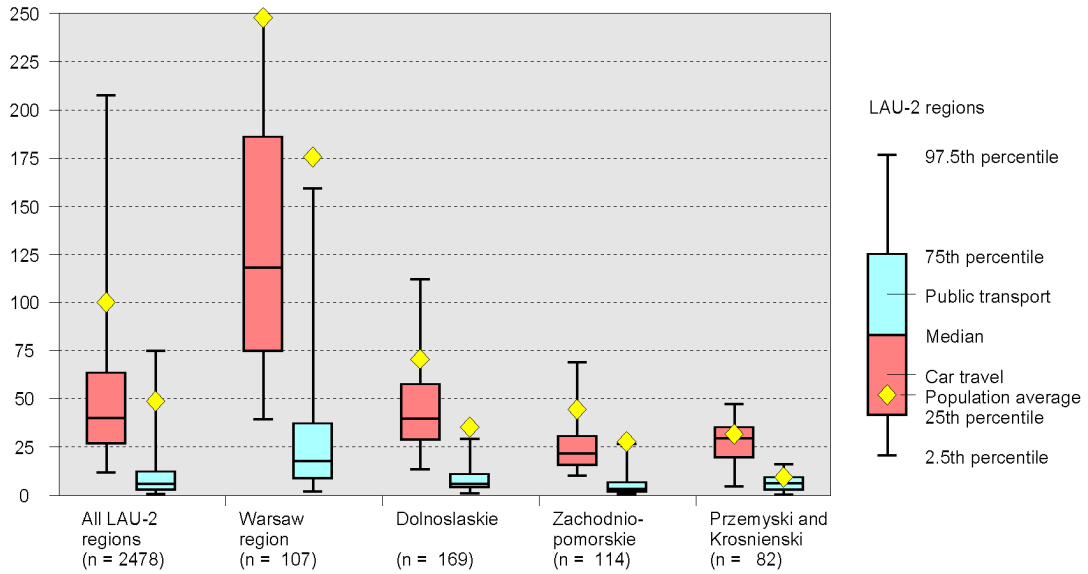


Figure 41. Potential accessibility to medical doctors, by zoom-in region

Population (cumulative percentage)

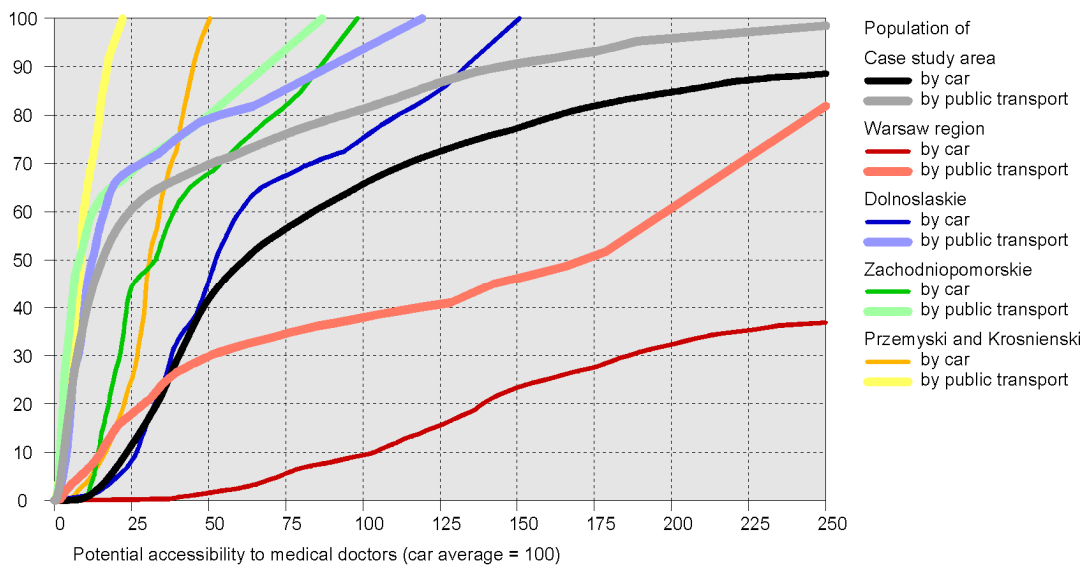


Figure 42. Potential accessibility to medical doctors, cumulative distributions by zoom-in region

Table 1. Accessibility by car, deviations of zoom-in regions from case study averages

Area	Travel time to next regional centre		Jobs accessible within 60 minutes		Potential accessibility to population	Travel time to next hospital		Higher secondary schools within 60 minutes		Potential accessibility to medical doctors
	Minutes	Index	In 1,000	Index	Index	Minutes	Index	Number	Index	Index
Warsaw region	34.6	108	1202.2	342	128.7	11.6	86	52.8	212	142.2
Dolnośląskie	29.2	91	321.4	92	70.8	11.7	87	21.2	85	47.3
Zachodniopomorskie	42.0	131	138.3	39	33.5	16.2	120	15.9	64	25.8
Przemyski and Krośnieński	35.8	112	164.5	47	38.6	12.8	95	22.7	91	28.3
Case study region	32.0	100	351.1	100	100	13.5	100	24.9	100	100

Table 2. Accessibility by public transport, deviations of zoom-in regions from case study averages

Area	Travel time to next regional centre		Jobs accessible within 60 minutes		Potential accessibility to population	Travel time to next hospital		Higher secondary schools within 60 minutes		Potential accessibility to medical doctors
	Minutes	Index	In 1,000	Index	Index	Minutes	Index	Number	Index	Index
Warsaw region	68.7	103	256.1	394	97.9	41.0	87	14.8	170	78.3
Dolnośląskie	61.3	92	50.5	78	38.4	40.7	87	7.2	83	19.7
Zachodniopomorskie	82.6	124	25.7	40	23.1	57.3	122	6.2	71	13.6
Przemyski and Krośnieński	76.9	115	34.0	52	24.9	44.3	94	9.8	113	14.2
Case study region	66.8	100	65.0	100	100	46.9	100	8.7	100	100

5 Accessibility effects of future TEN-T developments

In Poland, the primary and supplementary TEN-T network is more sporadic than in the majority of European countries (both in case of road and rail network). Although TEN-T projects cover most of the area of Poland, the particular attention is being paid on the modern roads and railway lines connecting Warsaw and other metropolises with the rest of the country. There are no investment projects in the areas which have a shape of two bog triangles, the first triangle between Szczecin, Gdańsk and Bydgoszcz and the second triangle between Gdańsk, Warszawa and Białystok. The system aims at the improving mainly accessibility between the main metropolises where the majority of Poles live. The cohesion effect in the areas located within the above mentioned two triangles will be seen by improving rather local roads than express roads or railway lines. TEN-T projects are prepared for most congested corridors and are the answer for the demand expectations.

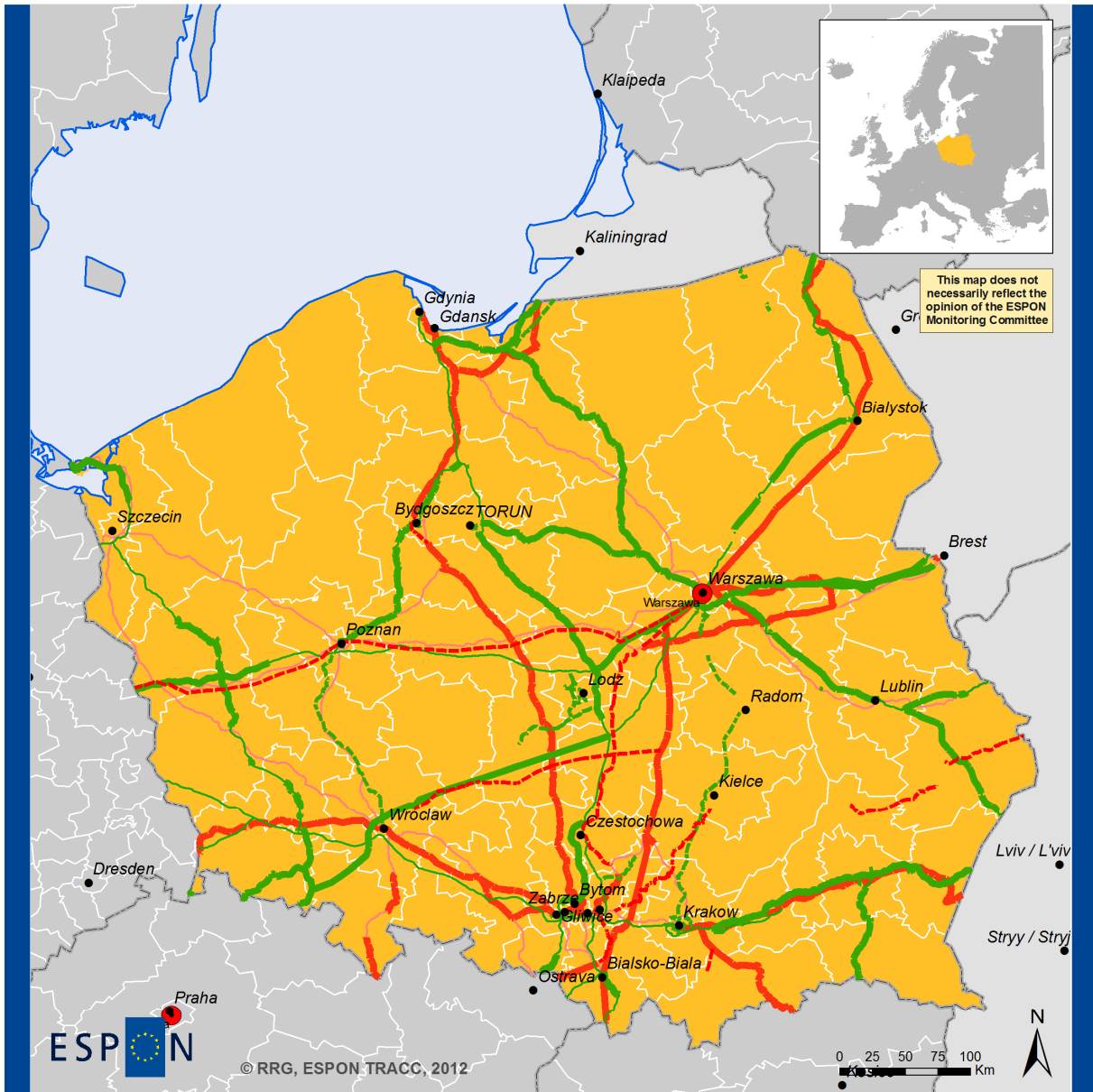
Currently, Poland makes great efforts to enlarge TEN-T network in its area. Adding the new sections is primarily of service to rail network, modernization of which is envisaged in the subsequent programming period. Also, planned fragments of high-speed rail are to be included into the TEN-T network, such as Warsaw-Łódź – Wrocław/Poznań, extendable to Berlin and Prague. It is envisaged to make corrections of certain road sections (e.g., the course of express road Warsaw-Wrocław).

TEN-T rail projects are prepared to improve the north-south railway axes linking by modern railway connections harbours of Gdańsk and Gdynia with the Upper Silesia conurbation and Czechia. The another important axis is the Rail Baltica connecting Warsaw with Białystok to Baltic States and the modern railway line from Kraków to Ukraine (fig. 43).

TEN-T road projects are mainly lacking parts of the most important motorways and express roads. There are missing parts of the A1, A2 and A4 motorways (most of them are or will be completed till the end of 2012) and the S3, S5, S7, S8, S10, S12, S17 express roads which are to be completed in this (2007-2013) or next (2014-2020) European financial perspective.

The implementation of the all TEN-T projects (in the current course of the route remaining in effect) lead to significant changes in the accessibility pattern of Poland. The improvement of express roads in all directions from Warsaw improves significantly the accessibility of the eastern Poland and its big cities of Lublin and Rzeszów which still today suffers from the lack of modern road connection to the capital of Poland (fig. 44). Besides the eastern Poland the central Poland is also the beneficiary of the motorway and express road construction programme. The north-western Poland, where the traffic needs are the lowest, is the main loser of the programme. This is mainly due to the fact that neither the S6 express road (Gdańsk-Szczecin) nor the S10 express road (Szczecin-Bydgoszcz section) are at the list of TEN-T projects and will be realized in the remote future (fig. 46, fig. 48). Relatively not fully satisfactory advantages in the north-eastern Poland, hopefully, will be additionally strengthened as a result of change made in the course of road route Via Baltica and the choice of a variant located more to the west (forced by environment protection considerations).

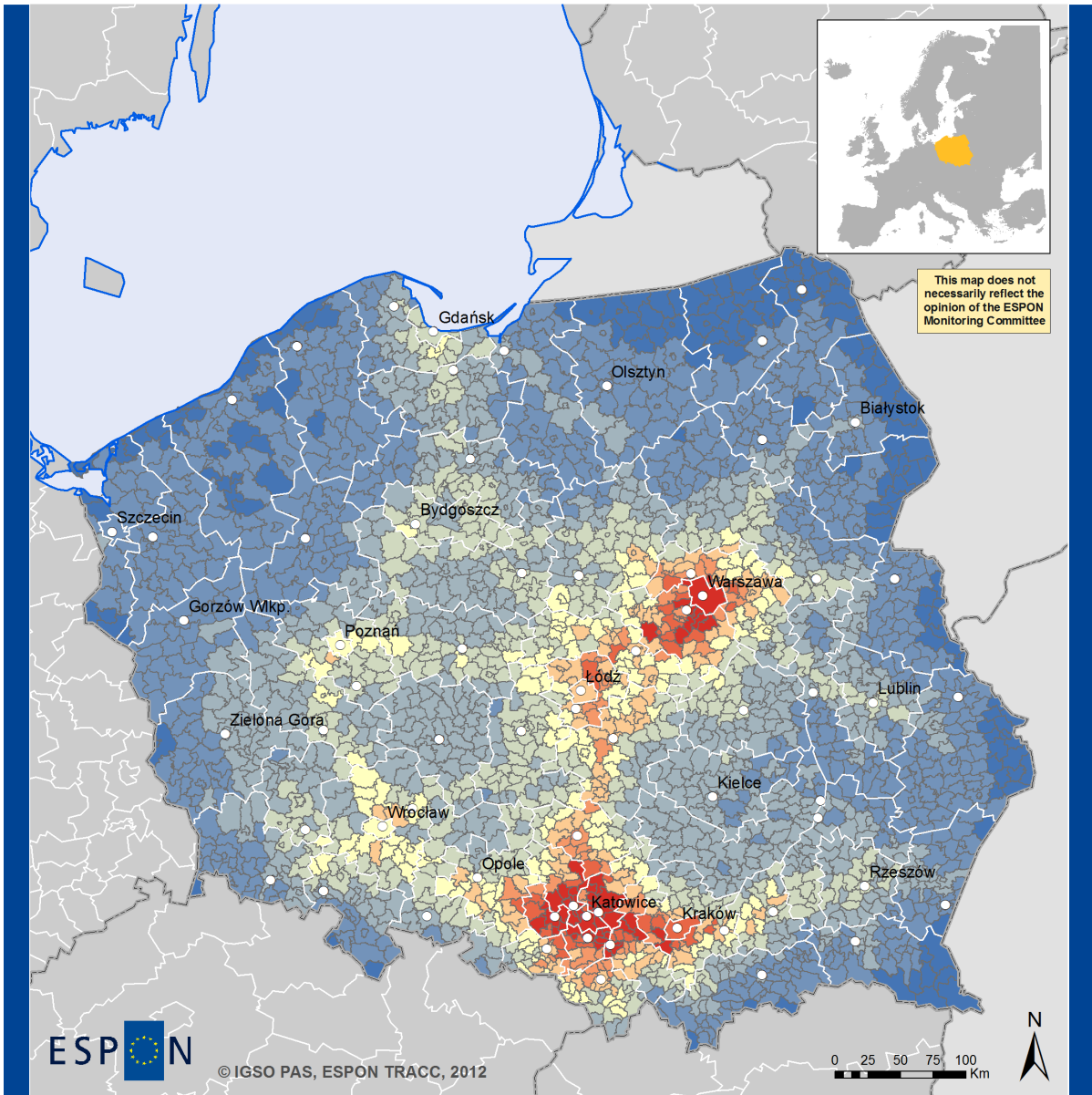
The potential accessibility to population by public transport shows that new railway axes are easily visible as corridors of better accessibility. The connectivity of main agglomerations by both individual and public transport significantly improves (fig. 45a, fig. 45b). The changes in potential accessibility are seen mainly in the western part of Poland, thanks to the improvement of major passenger and freight railway axes located in the CETC corridor connecting Szczecin with Lower and Upper Silesia. The actually modernized railway line linking Gdańsk with Warsaw leads also to significant accessibility improvements (fig. 47, fig. 49). However, the north-western and north-eastern Poland still remains in inferior position in terms of improvements in accessibility as a result of potential rail investment projects, but also do such regions as Polish-German borderland as well as centrally located areas between Warsaw, Kraków and Lublin.



Poland Case Study Road and rail infrastructure projects

- | | | | | | |
|--|---------------------|--|--------------------|--|-------------------|
| | TEN-T road projects | | TEN-T rail project | | Capital city |
| | Other road projects | | Other rail project | | Case study region |
| | TEN-T road network | | TEN-T rail network | | |

Figure 43. TEN-T road and rail infrastructure projects




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Source: IGSO PAS, 2011
 Origin of population data: Local Data Bank, GUS, 2011
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Poland Case Study

Potential accessibility to population by car with TEN-T projects ($\beta = 0.034657$)

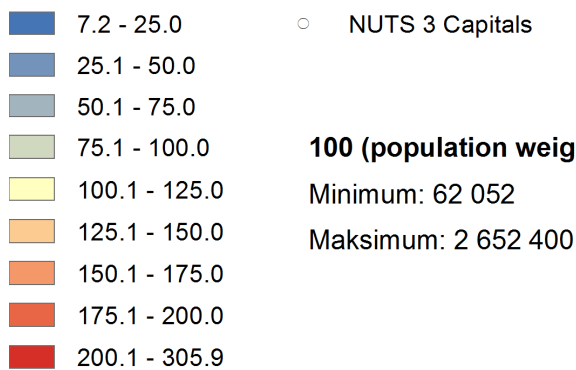
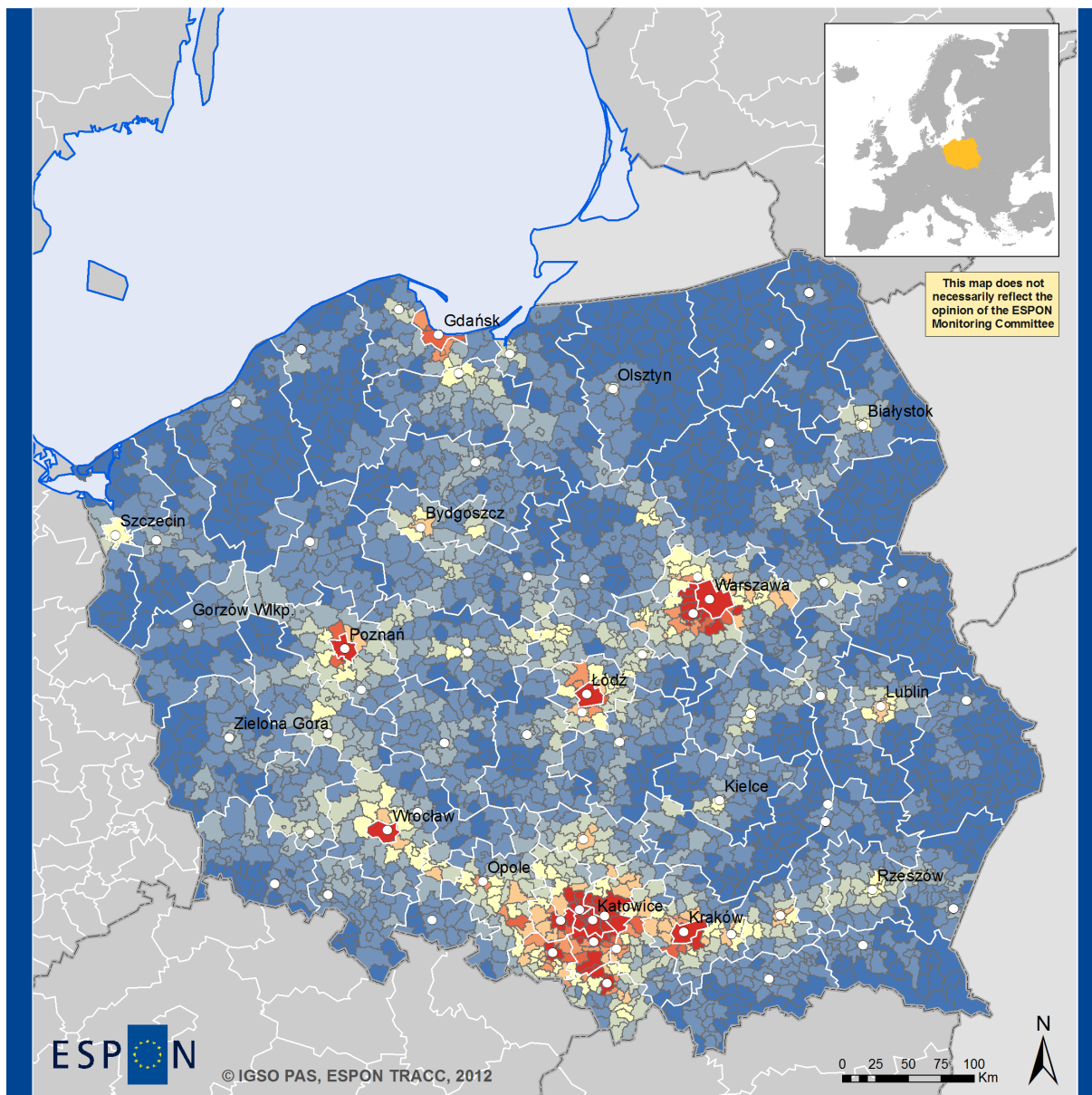


Figure 44. Potential accessibility to population by car with TEN-T projects




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Source: IGSO PAS, 2011
 Origin of population data: Local Data Bank, GUS, 2011
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Poland Case Study
Potential accessibility to population by public transport
(standardised on current public transport average; $\beta = 0.034657$)

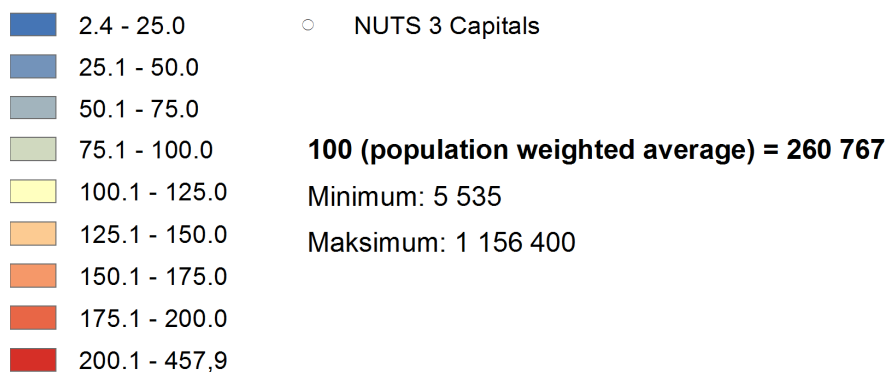
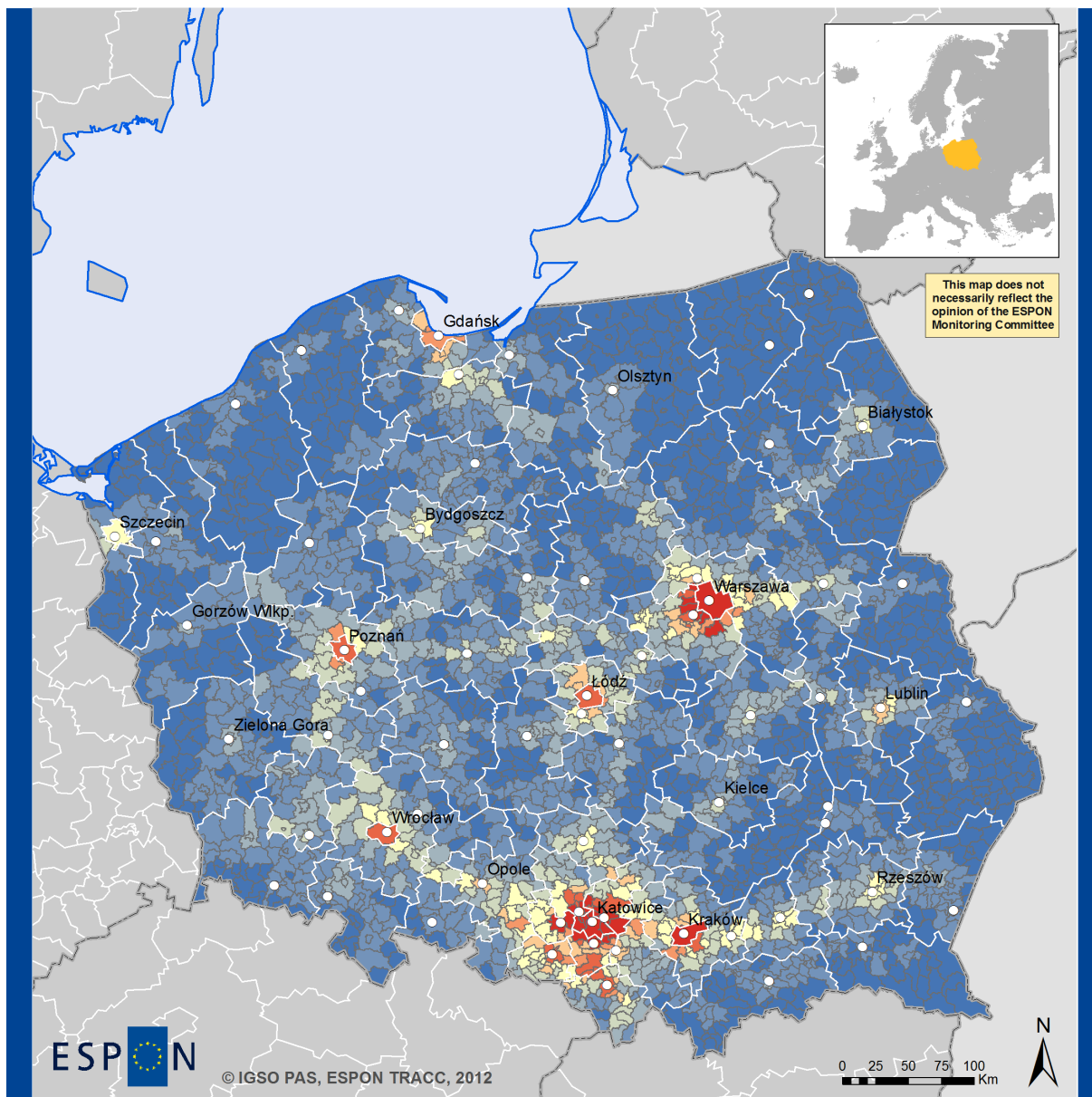


Figure 45a. Potential accessibility to population by public transport (standardised on current public transport average)



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Origin of population data: Local Data Bank, GUS, 2011
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Poland Case Study

Potential accessibility to population by public transport with TEN-T projects (standardised on future public transport average; $\beta = 0.034657$)

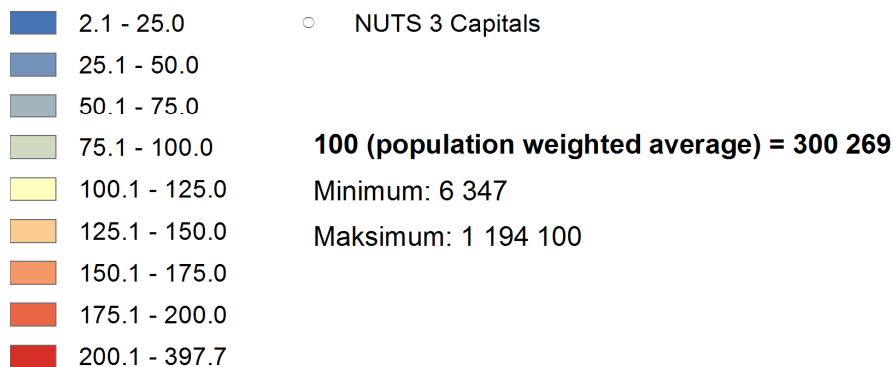
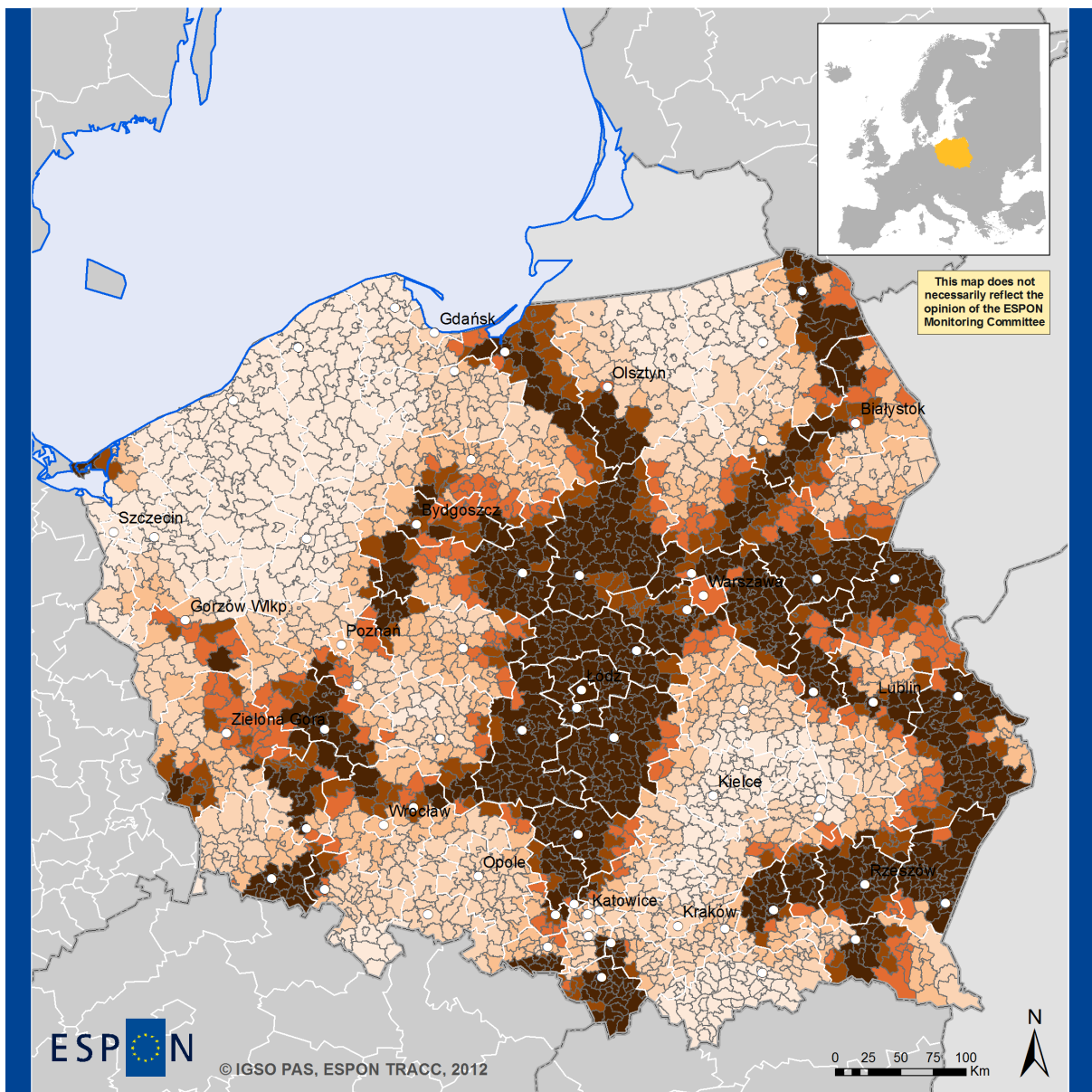


Figure 45b. Potential accessibility to population by public transport with TEN-T projects
(standardised on future public transport average)



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Origin of population data: Local Data Bank, GUS, 2011
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Poland Case Study

Relative increase of potential accessibility to population by car with TEN-T projects

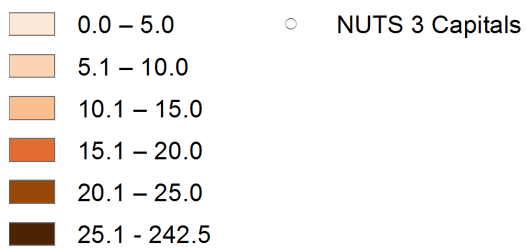
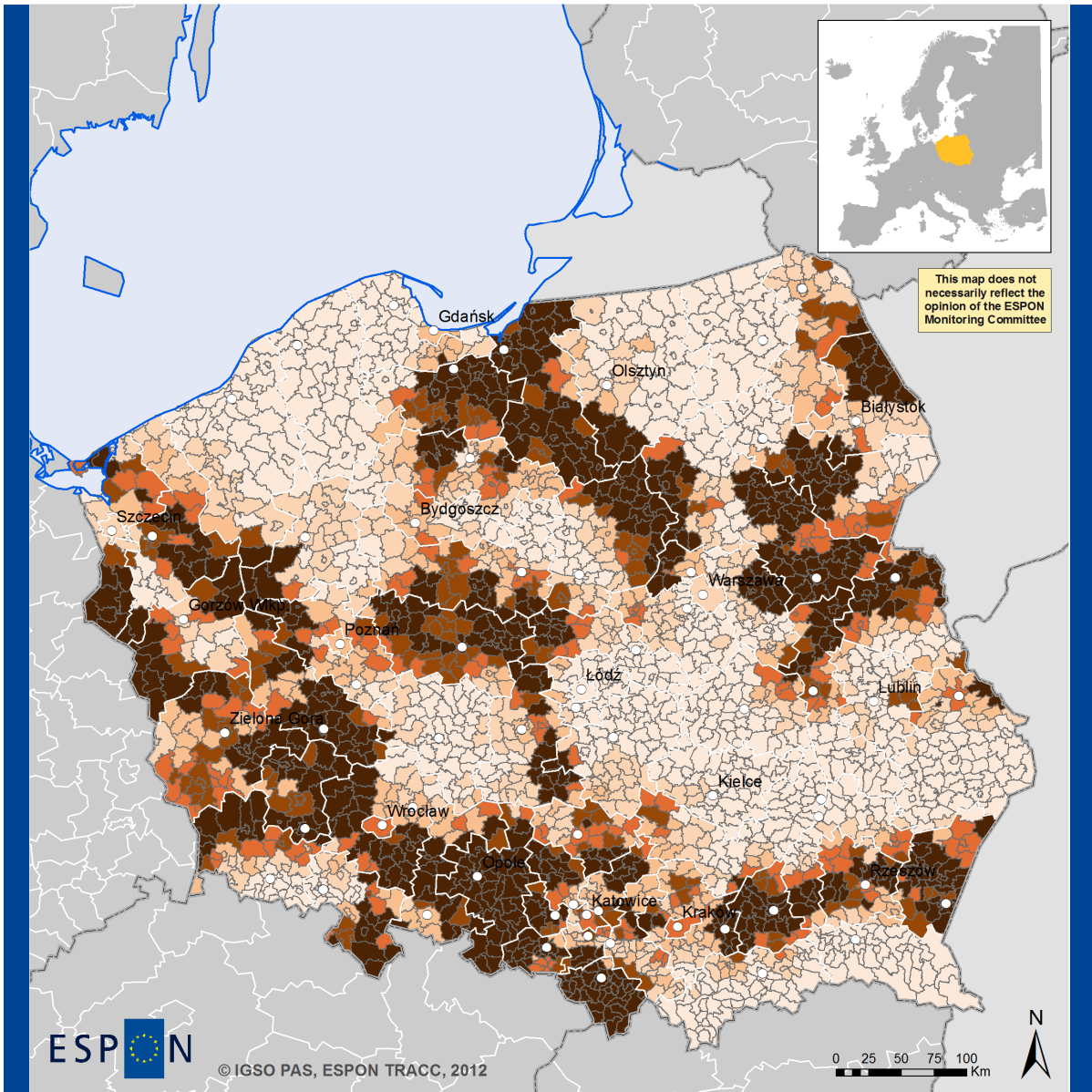


Figure 46. Relative increase of potential accessibility to population by car with TEN-T projects



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Origin of population data: Local Data Bank, GUS, 2011
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Poland Case Study

Relative increase of potential accessibility to population by public transport with TEN-T projects

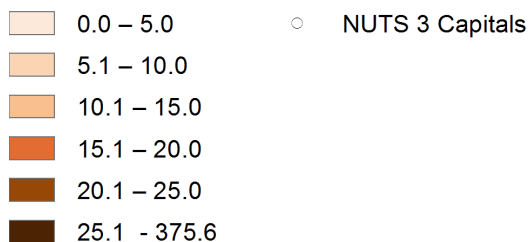
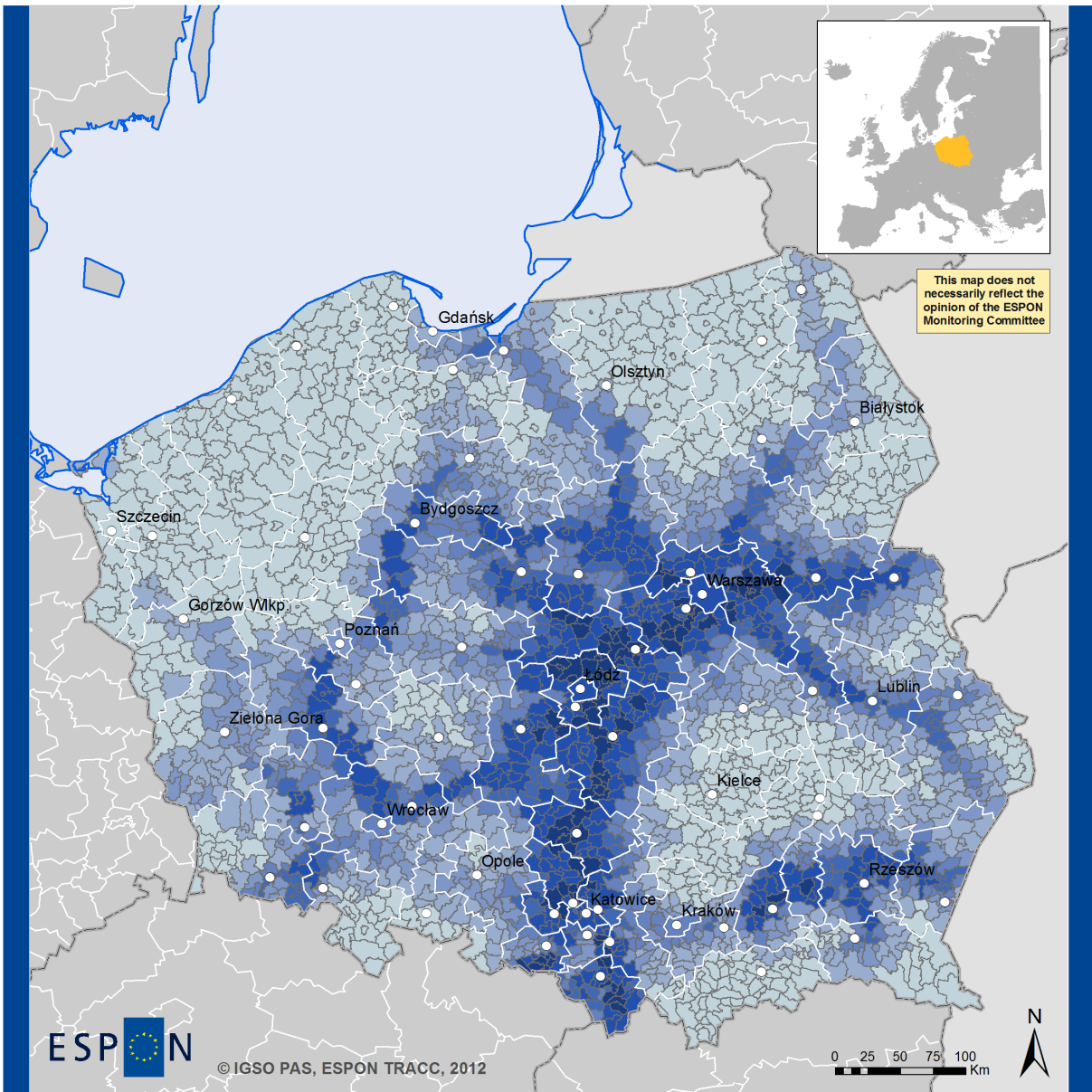


Figure 47. Relative increase of potential accessibility to population by public transport with TEN-T projects



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Source: IGSO PAS, 2012
Origin of population data: Local Data Bank, GUS, 2011
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Poland Case Study

Absolute increase of potential accessibility to population by car with TEN-T projects

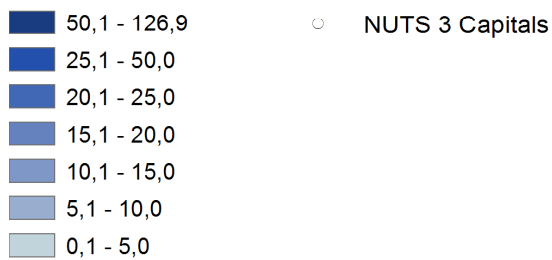
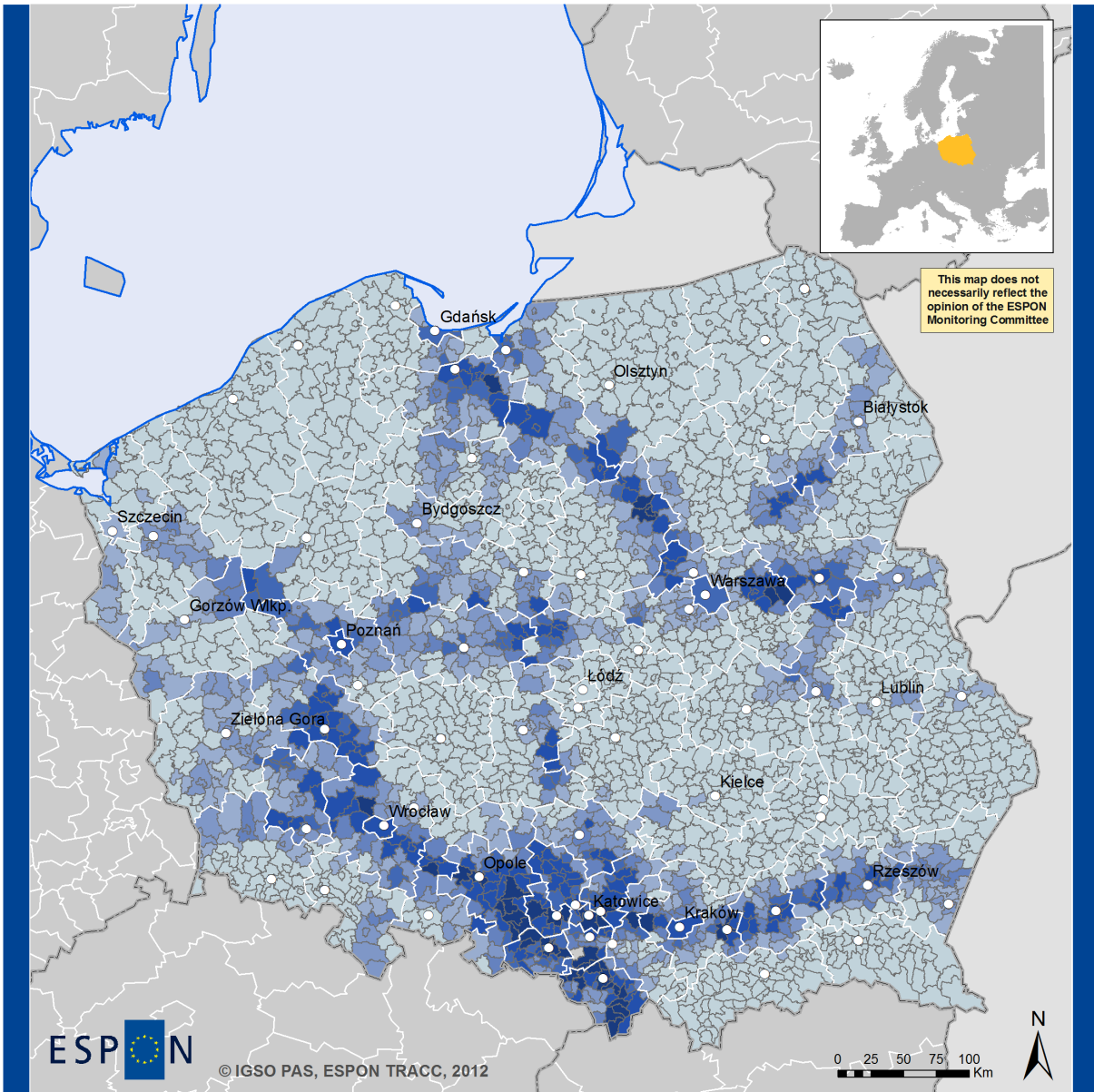


Figure 48. Absolute increase of potential accessibility to population by car with TEN-T projects




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Source: IGSO PAS, 2012
 Origin of population data: Local Data Bank, GUS, 2011
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Poland Case Study
Absolute increase of potential accessibility to population by public transport with TEN-T projects

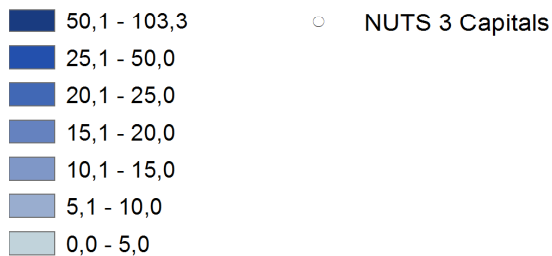


Figure 49. Absolute increase of potential accessibility to population by public transport with TEN-T projects

6 Conclusions

The analysis carried out in the area of Poland, as well as in the selected four zoom-in regions, allowed for identification of basic differentiations in terms of spatial accessibility in one of the new EU member states that is significantly backward in development of its transport infrastructure. Poland did not modernize its both road and rail infrastructure since the 80's of the 20th century until recently.

The first few years of a rapid economic growth of Poland (1994-2000) did not take advantage of for the expansion of the transport infrastructure. Consequently, when Poland entered the European Union in 2004, its transport infrastructure differed only marginally from that of 1989, and almost all plans, concerning future investment projects, were based on the expected European funds. At the same time, the basic gaps in the networks were so significant that despite the nominally largest (compared to other countries) expected transfers (both in the period 2004-2006, and in 2007-2013), it turned out impossible to realise all of the most urgent tasks using the structural funds. This entailed the necessity – to a higher degree than in other accession countries – of making a selection (among a long list of priority tasks) of these investment projects that would be supported.

In the above described conditions, a distribution of spatial accessibility (independently of the indicators used) still remains, to a large extent, a by-product of settlement network pattern, distribution of places of working and services of public utility (for example, health care and education). Influence of transport infrastructure itself is clearly discernible in public transport, which results from its uneven density (i.a., as a consequence of closing down many rail lines), and primarily from the quality of rail routes.

In road transport, despite many similarities, there is a slightly different situation. It results from the fact that Poland had had a relatively evenly developed and quite dense network of sealed roads even before the transition period. Simultaneously, there is a shortage of investment projects aimed at development of modern routes (motorways and express roads), which caused that accessibility has not been adequately improving due to new developments. Just the opposite, fast growth in car ownership caused a substantial overload of road network, road congestions, leading locally to deterioration in the accessibility level. Not until 2004, the development projects that were then undertaken caused a differentiation in spatial accessibility indicators in view of the state of infrastructure. There occurred a noticeable improvement in a selection of directions. A scale of that improvement (and thus scale of spatial differentiation) was limited due to a shortage of investment projects in the incoming road sections to major cities (including especially Warsaw), which was linked to spatial conflicts in suburbanization zones as well with environment protection functions.

At the same time, in the analyzed range, the findings were overlapped by socio-economic processes going on in Poland which had a spatial dimension. In the first place, this concerns internal and external migrations (changes in a distribution of population), and investments in health care.

Interpretation of the obtained results has to take into account the methodological assumptions that were adopted (see the annex below). Of particularly great significance are assumed fixed travel access time and by public transit, whose value is out of necessity slightly too great in the strongly urbanized areas, and sometimes too small as regards rural peripheral areas. This means that in reality (in respect to presented results): a) public transport is not so much competitive in the metropolitan areas, b) disparities in accessibility by public transport between urbanized units and rural units are even greater. The second methodological limitation is based on assuming a division into types of units (in terms of degree of urbanization) at the NUTS 3 level, which in Polish conditions (as compared to German units, units of that level comprise large areas) leads to a significant flattening of results.

Additionally, internal accessibility in the territory of Poland has understandably a different spatial distribution from that investigated at the European level. In reality, evaluation of the situation taking place in the particular local units, should take into consideration both kinds of indicators. This concerns especially units located along the German border, where transport linkages with central Poland are sometimes poor.

Accessibility to regional centres is in Poland conditioned by geographical and historical factors. Thereby it is much better in the south-central Poland and inferior in the north where population density is lower and cities/towns are sparse (especially in the Pomorze and Mazury regions). Only partially, it translated into the availability of public utility services (health care, education), since many of such functions is fulfilled in Poland by *poviat* centres, which are evenly distributed also in sparsely populated regions. Between some of the regional centres there are clearly visible internal peripheries. Existence of some of these peripheries is still tied to the borders left over from the historical period of the Partitions (for example, 19th century borders between Russian and Austrian rule between Rzeszów and Przemyśl and Lublin and Zamość or the prewar Polish-German border).

The obtained results have confirmed that there occurs acute spatial incompatibility between places of living and places of working throughout the entire territory of Poland. Concentration of places of working in major metropolises and in some medium-sized centres is markedly greater than concentration of population. This is a cause of large-scale traveling/commuting to work even from places lying far beyond what is conventionally perceived as the upper limit isochrone - 60-minute travel-time value. These travels in a considerable part are made by individual transport, which is entirely understandable after comparing of road accessibility indicators and those related to public transport.

New road investments (after 2004) to a large degree (on the basis of investigated indicators) have clearly become apparent during the analysis of potential accessibility to population (and also to medical doctors). A strongly positive effect is immediately perceptible in the long progression of constructed motorways and express roads (despite their formally lower technical standards and thus lower passing through speed adopted in a traffic model). In the first place, this involves road routes linking large demographic potentials, such as, for example, the A4 motorway between Wrocław, Upper Silesia and Kraków. The advantages are, however, observable also in the areas more sparsely populated, for example, between Gdańsk and Toruń (A1 motorway) as well as in those located to north-east of Warsaw (sections of express roads along the Via Baltica route). In the case of public transport, some of railway lines are also discernible as shown on the maps. In most of the cases, it is not a result of finalized investment projects, but of low technical speeds in the local non-trunk lines.

Within a Polish space, the analysis has revealed, also, a relatively satisfactory and evenly distributed development of public utility services, such as health care and secondary education. Despite that fact, disparities in accessibility to different public utility institutions (hospitals, medical doctors, schools) in the immediate vicinity of places of residence have become apparent (in the relevant isochrones). Concentration of medical doctors is clearly greater than concentration of population, which results in availability of better opportunities in terms of health care in large metropolitan areas. Also, as regards educational opportunities, metropolises and medium-sized centres are in a markedly better situation, since they are at disposal of a wider selection of educational institutions.

All the analyzed indicators have shown deficiencies and investment neglect of public transport. Such unfavourable picture is partly a consequence of the methodology that was adopted, but despite these shortcomings, it, to a larger extents, accurately reflects the reality, especially in the peripheral areas and those located away from the main rail lines. The better situation is noted in the intermediate vicinity of some of major centres. In external zones of metropolises as well in rural and peripheral areas, public transport is absolutely non-competitive in relation to individual

transport. This concerns, to a larger degree, accessibility to places of working (flexible approach in searching for jobs above a 60-minute isochrone), and, to a slightly smaller degree, accessibility to services that are concentrated in the historically established centres, frequently in the vicinity of main railway nodes.

Concerning accessibility, strong internal diversification has been revealed by a comprehensive analysis of four zoom-in regions. It is characteristic that the eastern Poland, perceived traditionally as the most problem areas (represented in the analysis by the Krośnieński and Przemyski sub-regions) have gained, with regard to some indicators, better values than the Zachodniopomorskie voivodeship located in the north-western Poland. The results of analysis conducted in zoom-in regions were influenced by factors such as their size and internal pattern of settlement network (more polycentric units have turned out better).

The study on the impact of investment projects that are envisaged within the framework of the currently effectual TEN-T network has attested to their significant potential shown in the previous numerous EU studies (for example, the Fifth EU Cohesion Report) in improvement of accessibility both in road as well as public (rail) transport. In particular, it needs to be stressed that there is prime necessity for development of road infrastructure in following directions: in the Warsaw-Upper Silesia direction (south section of the A1 motorway) – which was proved by a considerable improvement in accessibility, Gdańsk-Poznań-Wrocław (the S5 express road), and from Warsaw to regional centres located in the eastern Poland (the S8 and S17 express roads to Lublin and Białystok). The need of investments in railway infrastructure along the axis Wrocław-Rzeszów has become more apparent.

Annexes

Annex 1 References

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Annex 2 Database

Network data (input)

- node-link data of road network in 2011
- node-link data of public transport containing two sub-data-sets of railway network and train stations in 2011 and node-link data bus network and bus stops in 2011.
- node-link data of planned road network including road TEN-T projects
- node-link data of planned public transport network including railway TEN-T projects

Statistical data (input)

- population in 2010,
- employment in 2010,
- hospital with emergency units in December 2010 / January of 2011,
- health care facilities in 2010,
- secondary schools in 2010.

The employment data used for analysis (LAU-2 level) was estimated based on no. of persons employed according to main workplace (data available at LAU-2 level only for economic entities employing more than 9 persons) and for the total employment in NUTS-2 units (voivodeships).

The data for health care facilities (i.e. no. of medical doctors) were estimated based on available data for LAU-1 units using ratio per 1000 inhabitants.

All data, including estimated ones, were aggregated from 2479 LAU-2 units, into 2321 transport districts (according to the location of transport nodes).

Regional centres have been defined as a main city of each NUTS-3 units (the “capital” of NUTS-3 unit) supplemented by cities with more than 50 000 inhabitants (86 cities in total).

In case of hospitals with emergency units the address database were used. The data set has been transformed into coordinate locations by means of geocoding, using the MapInfo geocoding service.

Accessibility indicators (result)

- travel time to next regional centre, by car and public transport
- jobs accessible within 60 minutes of travel, by car and public transport
- potential accessibility to population, by car and public transport
- travel time to next hospitals, by car and public transport
- higher secondary schools within 30 minutes of travel, by car and public transport
- potential accessibility to medical doctors, by car and public transport

The indicators (result data) have been calculated at LAU-2 level regional units (municipalities, gminas). The results have been obtained for private and public transport based on contemporary state of transport infrastructure development and separately including the planned TEN-T project involvement

Annex 3 Accessibility model used

Accessibility by car

The speeds assumed were adjusted down for driving impediments. The model includes 14 categories of road in Poland (Komornicki et. al. 2012; Rosik 2012). Then logit functions were used and in this way the average speed in Poland was calculated for parts of the road network taking account of traffic regulations and some other variables influencing the speed of vehicles. For each road category and for each variable influencing the speed of travel different parameters were applied in the logit functions producing the appropriate speed-limit-related reductions of the travel speed. In general duration of travel with road transport in Poland was estimated on the basis of the traffic velocity model for more than 12 000 road segments, including local – county and municipality – roads. The velocity model for Poland was elaborated under the assumption of influence of various variables on the speed of vehicles, including:

- road quality category,
- road width,
- population number in the buffer of 5 km in the vicinity of a given segment,
- overbuilt areas,
- terrain relief.

Travel times within the transport districts were estimated by equating the area of the district with that of an equivalent circle and assuming that the average distance travelled inside the transport district is equal half of the radius. Therefore the approximation of self-potential when calculating the potential accessibility indexes is based on the internal travel time. The internal travel time is calculated with the use of the formula:

$$t_{in} = \frac{0.5 \sqrt{\frac{F}{\pi}}}{v_{in}} \times 60$$

where t_{ii} stands for an internal travel time, S – for a surface of unit i and $\overline{v_{ii}}$ – for an average travel speed within a unit i , which is assumed to be 20 km/h.

Accessibility by public transport

For Polish case study we completed the dataset containing rail connections, including travel times between railway stations using different types of railway connections (i.e. express, as well as fast and slow, regional trains). It allows us to connect approx. 30% of all LAU-2 nodes (*gminas* – municipalities). In Poland there is no possibility to obtain the complete dataset concerning bus transport at the national nor at the regional level. In order to conduct the planned analysis, we prepared public transport network using estimation of travel times between LAU-2 nodes. Using GIS software (TransCad) we built polyline layer, where each polyline connects nodes via road network. We decided to select the fastest path, in order to avoid the use of local roads instead of main ones, even there the length of the trip is slightly longer. To make the network more ‘realistic’ we had to select which nodes (i.e. LAU-2 municipalities) should be connected, as the ‘real’ public transport does not allow to travel between all municipalities directly. Moreover, our aim was to get as simply network as it is possible, as the lower number of edges means the fastest final calculations.

Finally we introduced four-stages procedure:

First of all, we built network which allowed to reach all *powiats* (LAU-1 nodes) from all *gminas* (LAU-2 nodes) located within the area. We created a set of ‘spider graphs’ composed of 1986 polylines in total providing to one of the 335 LAU-1 nodes. There does not exist connections between particular sub-networks.

Secondly, we generated direct connections between all pairs of local centres (LAU-1, *powiats*). To simplify the network, we checked all the sub-network, and selected edges connecting adjacent LAU-1 nodes to the final database. Ultimately the sub-network consist of 1320 edges after very detailed verification.

The third sub-network contains of the edges which connect (directly) the LAU-2 nodes, which are located outside the railway network, to train stations. We decided that all LAU-2 nodes would be connected to the nearest train station. In case there are more than one train station located in the proximity of a node (LAU-2) we decided to add also those of the connections which comply with following conditions:

$Length_i < 40$ km, and $Length_i \leq 1,33 * Length_{MINi}$

where $Length_i$ is the distance between municipality i and investigated train station and $Length_{MINi}$ is the distance between municipality i and the closest train station.

In consequence, we received the sub-network that consists of 2845 original edges (part of the edges were the same as in one of the previous sub-networks. i.e. LAU-1 to LAU-1 or LAU-2 to the proper LAU-1). The last step was to generate road-rail connectors, where needed (778).

Finally we got the network of public transport that consists of 8656 edges. It connects all of 2321 LAU-2 nodes. Estimated travel speeds were randomly tested and verified. Finally following parameters in relation to travel speed and time were used:

- for rail: real travel times (based on timetable)
- for estimated bus transport: 30 km/h
- for rail-LAU2 connectors: 15 minutes for distances up to 1,5 km, and proportionally up to 30 minutes for the longer ones (maximum distance: 6 km approx.); it allowed to include both: time spend on the change of transport mode, as well as time needed to reach rail station located outside a municipality centre (were needed).

Accessibility calculations

The travel time between any pair of communication regions (municipalities) was calculated by applying the method of identifying the shortest travel routes according to Dijkstra's algorithm. Eventually the potential accessibility of a municipality was calculated using the following index:

$$A_i = M_i \exp(-\beta t_{ii}) + \sum_j M_j \exp(-\beta t_{ij})$$

where:

A_i – accessibility of a municipality i ,

M_i – own mass (population or number of medical doctors) of a municipality i ,

M_j – mass (population or number of medical doctors) of a municipality j ,

t_{ii} – time of an internal trip within a municipality i ,

t_{ij} – travel time between the municipalities i and j .

The parameter β determines the slope of the distance decay effect. In this model, the value 0.034657 was used for potential accessibility to population and the value 0.046210 for potential accessibility to medical doctors in the calculation of the final maps.

TEN-T projects

The effect of TEN-T projects is calculated on the basis of few assumptions. First of all, the travel speed on all new express roads and motorways is calculated under the assumption of influence of various variables on the speed of vehicles on each road section including:

- road category (motorway or expressroad)
- population number in the buffer of 5 km in the vicinity of a given segment, overbuilt areas and terrain relief (to a lesser extent).

The average speed taking into account the above mentioned conditions is on express roads between 100-120 km/h and on motorways between 120-140 km/h. The maximum speed allowed for a car in Poland equals 120 km/h on express road and 140 km/h on motorway. The traffic on most motorway and express road sections in Poland is still below 25,000 vehicles/24h and for this reason such high speeds are reasonable.

For public transport investment in the railway system new sections will give significant speed improvements. However, there is no TEN-T project which will lead to high speed railway section. The new modernized railway lines will allow to travel with at least 140 km/h which is a significant change comparing with the actual speeds but not sufficient for the needs of the modern society.

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