

European Accessibility and Peripherality: Concepts, Models and Indicators

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Stockholm, Sweden
2002

Preface

As is normally the case, accessibility to the centre differs markedly from that to the periphery. This report concludes the work done on a number of studies applying a European perspective to accessibility, while at the same time reviewing their methodologies. New data on real travel costs is presented, and a special focus is put on the correlation between accessibility and migration in the Nordic countries.

The paper was written at the request of a working group under the Nordic Committee of Senior Officials for Regional Policy. The authors expect in future to continue the work undertaken in this pilot study by studying accessibility in different peripheral regions across Europe.

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Stockholm, September 2002

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1. Introduction

As many such as Keeble et al. (1988) have pointed out "peripherality is also synonymous with relative accessibility or inaccessibility to economic activity". Accessibility is the main "product" of a transport system. It determines the locational advantage of an area (i.e. a region, a city or a corridor) relative to all areas, including itself. Indicators of accessibility measure the benefits that the households and firms in an area enjoy from the existence and use of the transport infrastructure relevant for their area

The important role of transport infrastructure for spatial development in its most simplified form implies that areas with better access to the locations of input materials and markets will, *ceteris paribus*, be more productive, more competitive and hence more successful than more remote and isolated areas (see Linneker, 1997). This relationship has been taken up in the European Spatial Development Perspective which gives improvements in accessibility a high priority as a policy target: "Good accessibility of European regions improves not only their competitive position but also the competitiveness of Europe as a whole" (ESDP 1999, 69).

However, the relationship between transport infrastructure and spatial development is becoming ever more complex. There are of course a number of successful regions in the European core that confirm the theoretical expectation that location matters. However, there are also centrally located regions suffering from industrial decline and high unemployment. On the other side of the spectrum the poorest regions, as theory would predict, are at the periphery, but there also exist prosperous peripheral regions such as those in the Nordic countries. To make things even more difficult, some of the economically fastest growing regions are among the most peripheral ones.

On the other hand, the European Commission seems to have a very simple, traditional view on the question of central and peripheral regions in Europe as expressed in the latest Cohesion Report (see Figure 1, top). Although based on a detailed study with a very broad range of accessibility indicators for NUTS 3 regions by car and lorry (see for an example Figure 1, bottom), the categories describing relative location in Europe are collapsed into three: central, other and peripheral. Whether this reflects the reality and needs of the European periphery and whether this is an appropriate starting point for regional policy is thus rather questionable.

The objective of this report is to go beyond this circular approach to define peripheral regions. In so doing the report will summarise several studies in which the authors were previously involved. The report begins by introducing the basic accessibility concepts (Chapter 2). After that, the existing European accessibility model is presented (Chapter 3). The main part of the report deals with the discussion of selected aspects of accessibility concepts and indicators (Chapter 4). This is followed by an initial analysis of some potential drawbacks of peripheral regions, such as the high travel costs to participate in European affairs and the relatively high degrees of out-migration (Chapter 5).

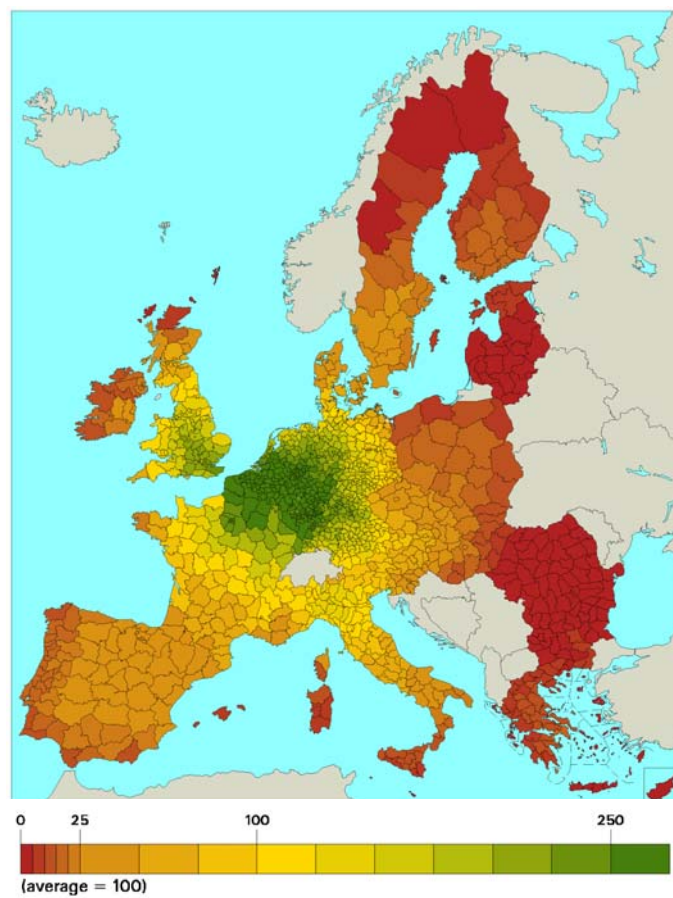
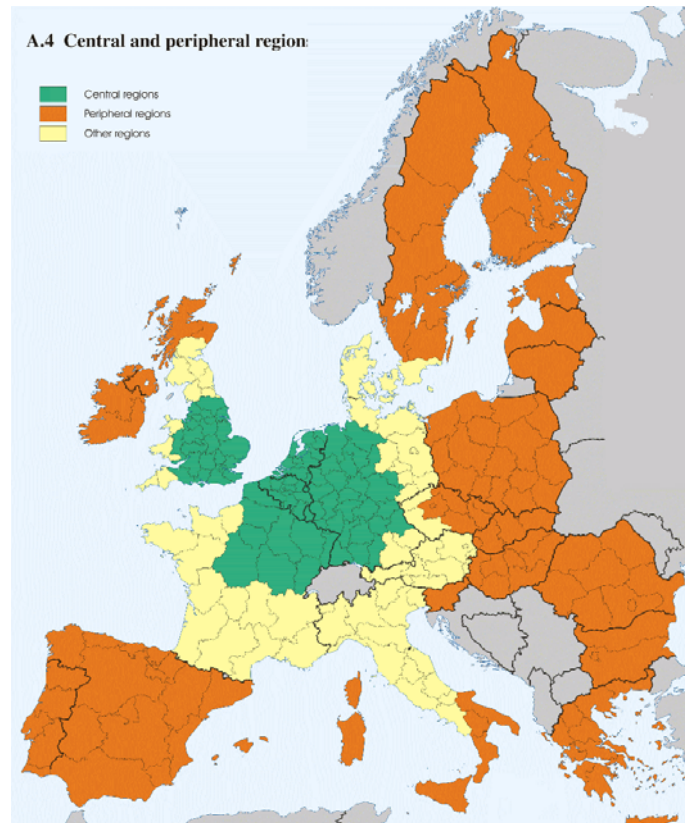


Figure 1. Peripherality in the 2nd Cohesion Report (top, European Commission, 2001), input for the 2nd Cohesion Report (bottom, Schürmann and Talaat, 2000).

2. Accessibility concepts

The task of the transport infrastructure is to enable spatial interaction, i.e. the mobility of persons and goods for social, cultural or economic activities. In the context of spatial development, the quality of transport infrastructure in terms of capacity, connectivity, travel speeds etc. determines the quality of locations relative to other locations, i.e. the competitive advantage of locations which is usually measured as accessibility. Investment in transport infrastructure leads to changing locational qualities and may induce changes in spatial development patterns.

There are numerous definitions and concepts of accessibility. A general definition is that "accessibility indicators describe the location of an area with respect to opportunities, activities or assets existing in other areas and in the area itself, where 'area' may be a region, a city or a corridor" (Wegener et al., 2002). Accessibility indicators can differ in complexity:

- Simple accessibility indicators take only transport infrastructure in the area itself into account. This is then measured as the total length of roads, motorways or rail lines, number of railway stations or motorway exits or as travel time to the nearest nodes of high-level networks. These indicators may express important information about the area itself, but they do not reflect the fact that many destinations of interest are outside the area.
- More complex accessibility indicators take account of the connectivity of transport networks by distinguishing between the network itself and the activities or opportunities that can be reached by it. These indicators always include in their formulation a spatial impedance term that describes the ease of reaching other such destinations of interest. Impedance can be measured in terms of travel time, cost or inconvenience.

2.1 Generic accessibility indicators

In this report, the more complex accessibility indicators are addressed in which, in more general terms, accessibility is a construct of two functions, one representing the activities or opportunities to be reached and one representing the effort, time, distance or cost needed to reach them:

$$A_i = \sum_j g(W_j) f(c_{ij})$$

where A_i is the accessibility of area i , W_j is the activity W to be reached in area j , and c_{ij} is the generalised cost of reaching area j from area i . The functions $g(W_j)$ and $f(c_{ij})$ are called *activity functions* and *impedance functions*, respectively. They are associated multiplicatively, i.e. are weights to each other. That is, both are necessary elements of accessibility. A_i is the total of the activities reachable at j weighted by the ease of getting from i to j .

These more complex accessibility indicators can be classified by their specification of the destination and the impedance functions (Schürmann et al., 1997, Wegener et al, 2002; see Table 1):

- Travel cost indicators measure the accumulated or average travel cost to a pre-defined set of destinations, for instance, the average travel time to all cities with more than 500,000 inhabitants.
- Daily accessibility is based on the notion of a fixed budget for travel in which a destination has to be reached to be of interest. The indicator is derived from the example of a business traveller who wishes to travel to a certain place in order to conduct business there and who wants to be back home in the evening (Törnqvist, 1970). Maximum travel times of between three and five hours one-way are commonly used for this indicator type.

Table 1. Generic accessibility indicators.

Type of accessibility	Activity function $g(W_j)$	Impedance function $f(c_{ij})$
<i>Travel cost</i> Travel cost to a set of activities	$W_j \mid \begin{cases} 1 & \text{if } W_j \geq W_{\min} \\ 0 & \text{if } W_j < W_{\min} \end{cases}$	c_{ij}
<i>Daily accessibility</i> Activities in a given travel time	W_j	$\begin{cases} 1 & \text{if } c_{ij} \leq c_{\max} \\ 0 & \text{if } c_{ij} > c_{\max} \end{cases}$
<i>Potential</i> Activities weighted by a function of travel cost	W_j^α	$\exp(-\beta c_{ij})$

- Potential accessibility is based on the assumption that the attraction of a destination increases with size, and declines with distance, travel time or cost. Destination size is usually represented by population or economic indicators such as GDP or income.

Each of the different accessibility types can be seen to have their own advantages and disadvantages. Travel time indicators and daily accessibility indicators are easy to understand and to communicate though they generally lack a theoretical foundation. Potential accessibility is founded on sound behavioural principles but contain parameters that need to be calibrated and their values cannot be expressed in familiar units.

From the three basic accessibility indicators, an almost unlimited variety of derivative indicators can be developed (cf. Ruppert, 1975), the most important ones being multi-modal, inter-modal and interoperable accessibility. In all three cases the equations presented above remain valid; what changes is the way in which transport costs are calculated.

Modal accessibility indicators are usually presented separately in order to demonstrate differences between modes. Or, they may be integrated into one indicator expressing the combined effect of alternative modes for a location. There are essentially two methods of integration. One is to select the fastest mode to each destination, which in general will be air for distant destinations and road or rail for shorter distances, and to ignore the remaining modes. Another way is to calculate an aggregate accessibility measure combining the information contained in the modal accessibility indicators by a 'composite' generalised travel cost. This is superior to average travel costs across modes because it makes sure that the removal of a mode with higher costs does not result in a – false – reduction in aggregate travel cost.

Inter-modal accessibility indicators take account of inter-modal trips involving two or more modes. Inter-modal accessibility indicators are potentially most relevant for logistic chains in freight traffic with different possible combinations of freight modes and terminals such as rail freight with feeder transport by lorry at either end. Inter-modal accessibility indicators in passenger travel involve mode combinations such as rail-and-fly or car access to railways.

2.2 Dimensions of accessibility indicators

Accessibility indicators may be sensitive to the following dimensions: origins, destinations, impedance, constraints, barriers, types of transport, modes, spatial scale, equity and dynamics (Wegener et al., 2000; 2002).

- *Origins*: Accessibility indicators may be calculated from the point of view of different population groups such as social or age groups, different occupations such as business travellers or tourists, or different economic actors such as industries or firms.
- *Destinations*: Accessibility indicators may measure the location of an area with respect to opportunities, activities and assets such as population, economic activities, universities or tourist attractions. The activity function may be rectangular (all activities beyond a certain size), linear (of size) or non-linear (to express agglomeration effects).
- *Spatial impedance*: The spatial impedance term may be a function of one or more attributes of the links between areas such as distance (Euclidean or network distance), travel time, travel cost, convenience, reliability or safety. The impedance function applied may be linear (mean impedance), rectangular (all destinations within a given impedance) or non-linear (e.g. negative exponential).
- *Constraints*: The use of the links between areas may be constrained by regulations (speed limits, access restrictions for certain vehicle types or maximum driving hours) or by capacity constraints (road gradients or congestion).
- *Barriers*: In addition to spatial impedance the non-spatial, e.g. political, economic, legal, cultural or linguistic barriers between areas or non-spatial linkages between areas such as complementary industrial composition may also be considered
- *Types of transport*: Only personal travel or goods transport, or both, may be considered
- *Modes*: Accessibility indicators may be calculated for road, rail, inland waterways or air. Multi-modal accessibility indicators combine several modal accessibility indicators. Inter-modal accessibility indicators include trips by more than one mode.
- *Spatial Scale*: Accessibility indicators at the continental, transnational or regional scale may require data of different spatial resolution both with respect to area size and network representation, intra-area access and intra-node terminal and transfer time.
- *Equity*: Accessibility indicators may be calculated for specific groups of areas in order to identify inequalities in accessibility between rich and poor, central and peripheral, urban and rural, nodal and interstitial areas.
- *Dynamics*: Accessibility indicators may be calculated for different points in time in order to show changes in accessibility induced by transport infrastructure investments or other transport policies, including their impacts.

3. European accessibility models

Over the last decades a vast number of accessibility studies addressing European core-periphery issues have been published. This chapter will briefly review the most important European accessibility models; the selection follows that in a number of more detailed reviews (Bruinsma and Rietveld, 1998; Wegener et al., 2000; 2002). This overview starts with a summary of the European accessibility models with respect to their dimensions (see Chapter 2.2) and then goes on to discuss their main findings with respect to European disparities in accessibility.

Most accessibility studies have a regional or national focus, but often not a European dimension. However, there are a growing number of accessibility models that address European-wide accessibility and thus European peripherality. This section will briefly introduce European accessibility models developed in the last two decades and will try to classify and compare the accessibility indicators used by applying the dimensions of accessibility presented in the previous chapter (see Table 2 and 3). European accessibility models that address urban agglomerations only (e.g. Bruinsma and Rietveld, 1993, or Cederlund et al., 1991; Erlandsson and Törnqvist, 1993) are not presented because they do not contribute to the question of the peripherality of rural areas. The order in which the models are presented is strictly chronological.

Keeble et al. (1982, 1988) were commissioned by DGXVI of the European Commission to analyse economic core-peripherality differences between the regions of the Community and to investigate whether any differences can be explained by relative location. For this purpose, they developed a gravity potential model with regional GDP as destination activity and road distance costs as impedance. The results are expressed as an Economic Potential Index and are presented in map form as contour lines.

The *Bundesforschungsanstalt für Landeskunde und Raumordnung* (Lutter et al., 1992, 1993) in a study for DG Regio of the European Commission calculated the accessibility of NUTS-3 regions in the then twelve Member States of the European Community as average travel time by inter-modal transport (road, rail, air) to 194 economic centres in Europe. In the same study they also used other destinations such as the next three agglomerations, the next high-speed train stop or the next airport. In addition, they calculated a daily accessibility indicator as the number of people that can be reached in three hours using the fastest connection. Modes considered included road, rail and air with and without planned infrastructure investments (new motorways, high-speed rail lines and more frequent flight connections).

Spiekermann and Wegener developed three-dimensional surfaces of daily and potential rail accessibility for Europe using raster-based GIS technology (Spiekermann and Wegener, 1994; 1996; Vickerman et al., 1999), road and air accessibility were added later (Schürmann et al., 1997; Fürst et al., 2000). The quasi-homogenous accessibility surface was achieved by sub-dividing Europe into some 70,000 square raster cells of 10 km width and calculating accessibility indicators for each raster cell with respect to all other raster cells. The population of raster cells was estimated by allocating the population of NUTS-3 regions to raster cells with the help of a hypothetical negative-exponential gradient of population density around population centres. Access travel time from each raster cell to the nearest network node was approximated using an average travel speed of 30 km/h.

In the UTS (Union Territorial Strategies) study, Chatelus and Ulled (1995) developed several accessibility indicators for the evaluation of trans-European networks at the level of NUTS-2 regions in the EU plus Norway. One of them, the FreR(M) indicator, measured the average cost to reach a market area of a certain population size by lorry. The impedance term is generalised road transport cost including the cost of the driver's time, the cost per kilometre and a fixed cost component. The CON(T) indicator accumulated population of NUTS-2

regions of EUR15 plus Norway and Switzerland reachable within a maximum travel time of three hours by any combination of car, rail and air, with transfer times between modes explicitly considered. The CON(T) index was used to assess transport infrastructure scenarios with respect to the criteria competitiveness, cohesion and sustainability. The FreR(T) index, a freight accessibility indicator expressing the size of the market that can be reached in a certain travel time accumulates the population that can be reached in one, two or three days by the fastest connection using road, rail or combined traffic with driving time restrictions for lorry drivers observed.

Gutiérrez et al. (1996) and Gutiérrez and Urbano (1996) calculated average travel time by road and rail from about 4,000 nodes of a multi-modal European transport network to 94 agglomerations with a population of more than 300,000 with and without planned infrastructure improvements. Road travel times included road and car ferry travel times modified by a link-type specific coefficient and a penalty for crossing nodes representing congested population centres. Rail travel times included time table travel time plus road access time and penalties for changes between road and rail (60 minutes), rail and ferry (180 minutes) and the change of rail gauge between Spain and France (30 minutes).

Table 2. Dimensions of European accessibility models

Authors	Generic Indicator type	Origins	Destinations	Impedance	Type of transport	Modes	Spatial scope
Keeble et al. (1982; 1988)	Potential	NUTS 2 centroids	GDP in NUTS 2 regions and in non-EU countries	Road distance	-	Road	EU9 EU12
Lutter et al. (1992, 1993)	Travel cost Daily	NUTS 3 centroids	194 Centres next 3 agl. airports etc.	Travel time	Personal	Road rail air inter-modal	EU12
Spiekermann and Wegener (1994, 1996)	Daily potential	10 km raster cells	Population in 10 km raster cells	Travel time	Personal	Rail	pan-Europe
Chatelus and Ulied (1995)	Travel cost Daily	NUTS2 centroids	Population in NUTS2 regions	Travel cost	Personal freight	Road rail air inter-modal	EU15, Norway, Switzerland
Gutiérrez and Urbano (1995, 1996)	Travel cost	4000 nodes	94 agglomerations	Travel time	Personal	Road rail	EU12
Copus (1997, 1999)	Potential	NUTS2 / NUTS 3 centroids	GDP, population, workforce in NUTS 2 / NUTS 3 regions	Travel time	Personal	Road	EU15, candidate countries, Norway, Switzerland
Wegener et al., (2000, 2002)	Potential	NUTS 3 centroids	Population and GDP in 10 km raster cells	Travel time	Personal	Road rail air	EU15
Schürmann and Talaat (2000)	Potential	NUTS 3 centroids	GDP, population, workforce in NUTS 3 regions	Travel time	Personal freight	Road	EU15, candidate countries
Spiekermann et al., (2002)	Potential	NUTS 3 centroids	Population in 10 km raster cells	Travel time	Personal	Multi-modal (road, rail, air logsum)	EU15

In studies for the Highlands and Islands European Partnership Programme and for DG Regio of the European Commission, Copus (1997, 1999) developed "peripherality indicators" for NUTS-2 and NUTS-3 regions based on road-based potential measures of the Keeble type. The model takes account of different average speeds for different classes of road, realistic ferry crossing and check-in times, EU border crossing delays and statutory drivers' rest breaks. Accessibility is presented as a peripherality index derived as the inverse standardised to the interval between zero (most central) and one hundred (most peripheral).

In a report of the Study Programme on European Spatial Planning for DG REGIO, Wegener et al. (2000; 2002) proposed reference indicators describing the geographical position of European NUTS 3 regions. Besides geographical, physical and cultural indicators, three accessibility indicators were proposed. The first two measure accessibility by road and rail to population, the last one, accessibility by air, to economic activity (expressed by gross domestic product, or GDP). Accessibility to population is seen as an indicator for the size of market areas for suppliers of goods and services; accessibility to GDP as an indicator of the size of market areas for suppliers of high-level business services. Accessibility is presented as index in which the average European accessibility serves as a reference.

Schürmann and Talaat (2000) produced a background report for the latest Cohesion Report of the European Commission (2001) in which an index of peripherality of the potential type was implemented in a geographical information system. Potential type indicators are calculated for passenger or freight transport by road using GDP, population or labour force as destination activity. The indicators are calculated for NUTS 3 regions and for the equivalent regions of the candidate countries as well as for Switzerland and Norway. Aggregation procedures for NUTS 2, 1 and 0 are offered by the system. The peripherality index is presented in two ways: either standardised on as the European average (as in Wegener et al., 2000) or to an interval between 0 and 100 (as in Copus, 1997, 1999).

Most recently, Spiekermann et al., (2002) developed a multi-modal accessibility indicator, i.e. an indicator that aggregates over modes and is thus capable of integrating the contributions of different transport modes to the degree of centrality or peripherality. The indicator is a logsum accessibility potential aggregating over road, rail and air. Multi-modal indicators are considered to have much more explanatory power with respect to regional economic performance than any accessibility indicator based on a single mode only (Fürst et al., 2000). The indicator is presented for NUTS 3 regions with a focus on the differentiation of peripheral areas. In addition, a national peripherality index has been developed for which only national destinations were considered.

The European accessibility models yield a wide range of approaches with respect to dimensions of accessibility. They differ in many respects, but there are also some commonalities:

- More than half of the models use a potential type indicator, the remaining use travel costs or daily accessibility indicators. A few models are able to calculate different types.
- Origins are usually NUTS-2 or NUTS-3 centroids, very few studies have a more detailed representation of space.
- The destination activities are usually population or GDP for the potential type models, and a pre-defined set of agglomerations for the travel cost indicators.
- Nearly all models use travel time as their impedance term, only a few apply travel costs.
- Models that consider freight transport use statutory drivers' rest breaks as constraints.
- Barriers are mainly in the form of border delays, only Keeble et al. use trade barriers.
- Nearly all models are based on personal travel, only a few consider freight transport.

- Half of the models consider one mode only, in most cases road. The other models have networks for different modes, however, only two use inter-modal travel times.

Table 3 summarises the main results of the accessibility models with respect to spatial disparity and its changing pattern over time. All models show a clear core-periphery pattern; some also show that within the core or within the periphery large disparities of accessibility do exist. The models however give very different answers as regards the changing pattern of accessibility over time. Some models, those working with travel cost indicators, support the case for public investment in infrastructure by demonstrating increased cohesion. Other models, mainly of the daily or potential type, are much more cautious or even forecast increased regional disparities as an outcome of transport infrastructure investments.

Table 3. Equity and dynamic statements of European accessibility models

Authors	Spatial disparities	Changing pattern through time
Keeble et al. (1982; 1988)	Clear core-periphery pattern	Disparities have increased in past periods
Lutter et al. (1993)	Existing, but scope depends on destination activities considered	Travel time benefits for peripheral regions, daily accessibility increases in central regions
Spiekermann and Wegener (1994, 1996)	Clear core-periphery pattern plus clear centre-hinterland disparities in all European countries	Increasing disparities induced by TEN
Chatelus and Ulied (1995)	Clear core-periphery pattern	Decreasing disparities
Gutierrez and Urbano (1995, 1996)	Clear core-periphery pattern	Decreasing disparities induced by TEN
Copus (1997, 1999)	Clear core-periphery pattern	Dynamics not considered
Wegener et al., (2000, 2002)	Different core-periphery patterns for different transport modes	Increasing or decreasing disparities is an outcome of the indicator chosen
Schürmann and Talaat (2000)	Clear core-periphery pattern for road transport	Improvements mainly for EU candidate countries
Spiekermann et al. (2002)	Clear core-periphery pattern, but very different degrees of peripherality; high similarity of peripherality in national and European context	Dynamics not considered

An overall assessment of the existing accessibility models is difficult. The general tendency is that none of the models is really able to address all relevant issues. Most models focus on personal transport and ignore freight transport although freight transport may be more relevant for peripheral regions. However, empirical work has shown that road accessibility by using car or trucks is very highly correlated and that car accessibility can be used as a proxy for truck accessibility. Most models often have an implicit relation to only certain sectors of the economy, i.e. by concentrating on personal transport the models are closely related to the service sector thus neglecting the fact that transport has differential relations with different sectors (see Vickerman, 1999).

To conclude, despite the vast range of models, there has as yet been no model presented in the literature that would match all requirements for the different dimensions. Models that are superior in a certain dimension are often behind in others. There is no model available that would be able to calculate accessibility for a spatially detailed representation of pan-Europe for personal and freight transport for all transport modes including multi- and inter-modal trips for different indicator types and destination activities and that has a database that allows assessments for different points in time, i.e. past, current and future accessibility patterns.

4. Discussion of accessibility indicators

This chapter will discuss some aspects and dimensions of accessibility indicators in more detail. The objective is to assess the effects of changing the type of indicator or the dimensions of indicators with respect to resulting accessibility and peripherality patterns. The discussion is predominantly based on a set of examples from earlier studies. Table 4 summarises the different accessibility indicators used for this analysis, all of which are presented in Figures 2-15.

Table 4. Accessibility indicators presented in Figures 2-15

Topic	Figure	Generic Indicator type	Mode	Origin	Destination	Destination activity	Year
Generic type of accessibility indicator	2	Travel cost	Rail	Raster cells	Cities > 250,000	n.a.	2010
	3	Daily accessibility	Rail	Raster cells	Raster cells	Population	2010
	4	Potential accessibility	Rail	Raster cells	Raster cells	Population	2010
Transport mode	5	Potential accessibility	Road	NUTS 3 centroids	Raster cells	Population	1996
	6	Potential accessibility	Rail	NUTS 3 centroids	Raster cells	Population	1996
	7	Potential accessibility	Air	NUTS 3 centroids	Raster cells	Population	1996
	8	Potential accessibility	Multi-modal (logsum road, rail, air)	NUTS 3 centroids	Raster cells	Population	2000
Spatial resolution	9	Potential accessibility	Road	NUTS 0, 1, 2, 3 centroids	NUTS 3 centroids	Employment	2000
	10	Potential accessibility	Rail	NUTS 5 centroids	Raster cells	Population	2000
	11 top	Daily accessibility	Air	Raster cells	Raster cells	Population	2000
	11 bottom	Daily accessibility	Rail	Raster cells	Raster cells	Population	2000
Destination activity	12 top	Daily accessibility	Rail	Raster cells	Raster cells	Population	1993
	12 bottom	Daily accessibility	Rail	Raster cells	Raster cells	GDP	1993
	13	Potential accessibility	Multi-modal (logsum road, rail, air)	NUTS 3 centroids	Raster cells	Population of origin/ country only	2000
Dynamic	14 top	Potential accessibility	Rail	Raster cells	Raster cells	Population	1993
	14 bottom	Potential accessibility	Rail	Raster cells	Raster cells	Population	2010
	15 top	Daily accessibility	Road	Raster cells	Raster cells	Population	Change 1996-2016
	15 bottom	Daily accessibility	Rail	Raster cells	Raster cells	Population	Change 1996-2016

4.1 Generic types of accessibility indicators

This section presents the basic similarities and differences between the different types of accessibility indicators as defined in Table 1. The examples have all been calculated with the same accessibility model for 10x10 km raster cells (Schürmann et al., 1997):

- As an example for the travel cost indicator type, Figure 2 shows average rail travel times to large cities in 2010 (192 cities with a population of more than 250,000). The European average of all average travel times will be about 22 hours. The shortest average travel times, to be found in Germany and Austria, are about 12 hours, the longest are nearly 50 hours. Not surprisingly, regions at the periphery of the European Union, in particular at the Nordic periphery, and in parts of Eastern Europe have the longest average travel times. The increase in average travel times from the core to the periphery is smooth and there are no great differences between neighbouring regions.
- As an example of the daily accessibility indicator type, Figure 3 presents daily accessibility by rail to population in 2010. Daily accessibility has been defined as the number of persons that can be reached from a location by a return trip during a single working day. Here five hours one-way door-to-door travel time was assumed to be the maximum, allowing five hours of activities at the destination. Significant disparities in accessibility appear. The highest daily accessibility values for more than 100 million persons to be reached are found in France, southern England, Belgium and the Netherlands, Germany, Switzerland, Austria and northern Italy. There is a sharp decline from these areas towards the Nordic countries, eastern and south eastern Europe, southern Italy, the Iberian Peninsula and Scotland and Ireland. However, even in the high-accessibility regions there are large differences in daily accessibility between city centres and their hinterlands as accessibility decreases from the nodes in the high-speed rail network to the more remote locations.
- As an example for the potential indicator type, Figure 4 shows potential accessibility by rail to population in 2010. The overall pattern of central and peripheral areas is similar to that generated by the daily accessibility indicator. Visible once again here are the major European rail corridors. However, the distinction between neighbouring regions is less pronounced.

The main findings with respect to the generic type of accessibility indicators are:

- The travel cost indicator type shows a clear core-periphery pattern, but it is not able to distinguish between neighbouring regions, because the large number of destinations and their spatial distribution has an equalising effect on average travel times. In addition, TEN infrastructure investments will lead to a decrease of average travel times everywhere. Thus, the spatial distribution of shortest and longest average travel times will not change. Hence, this indicator type is not too useful for bringing out different degrees of peripherality and their change over time. However, if only one destination or origin is used (e.g. in the form of isochrone or isocost maps), the indicator may deliver interesting insights.
- The daily accessibility indicator type shows a clear core-periphery pattern and is also able to distinguish very clearly between neighbouring regions in both types of areas, central and peripheral. This indicator shows results in the most clearly expressed disparities between regions. Daily accessibility indicators are also very sensitive regarding investments in infrastructure that result in overall benefits for regions, but also in very localised or regionalised changes of indicator values. The shortcoming of this indicator type is that it does not fully reflect human behaviour, because destination activities that are five hours travel time apart are given the same importance as those nearby.
- The potential accessibility indicator type shows similar results as the daily accessibility indicator. Potential indicators lead to a slightly less polarised spatial pattern. However, this depends to some degree on the estimated parameters of the potential model. The advantage of the potential indicator type is the incorporation of human behaviour, because destination activities are weighted as regards their ease of reach in terms of travel time or costs.

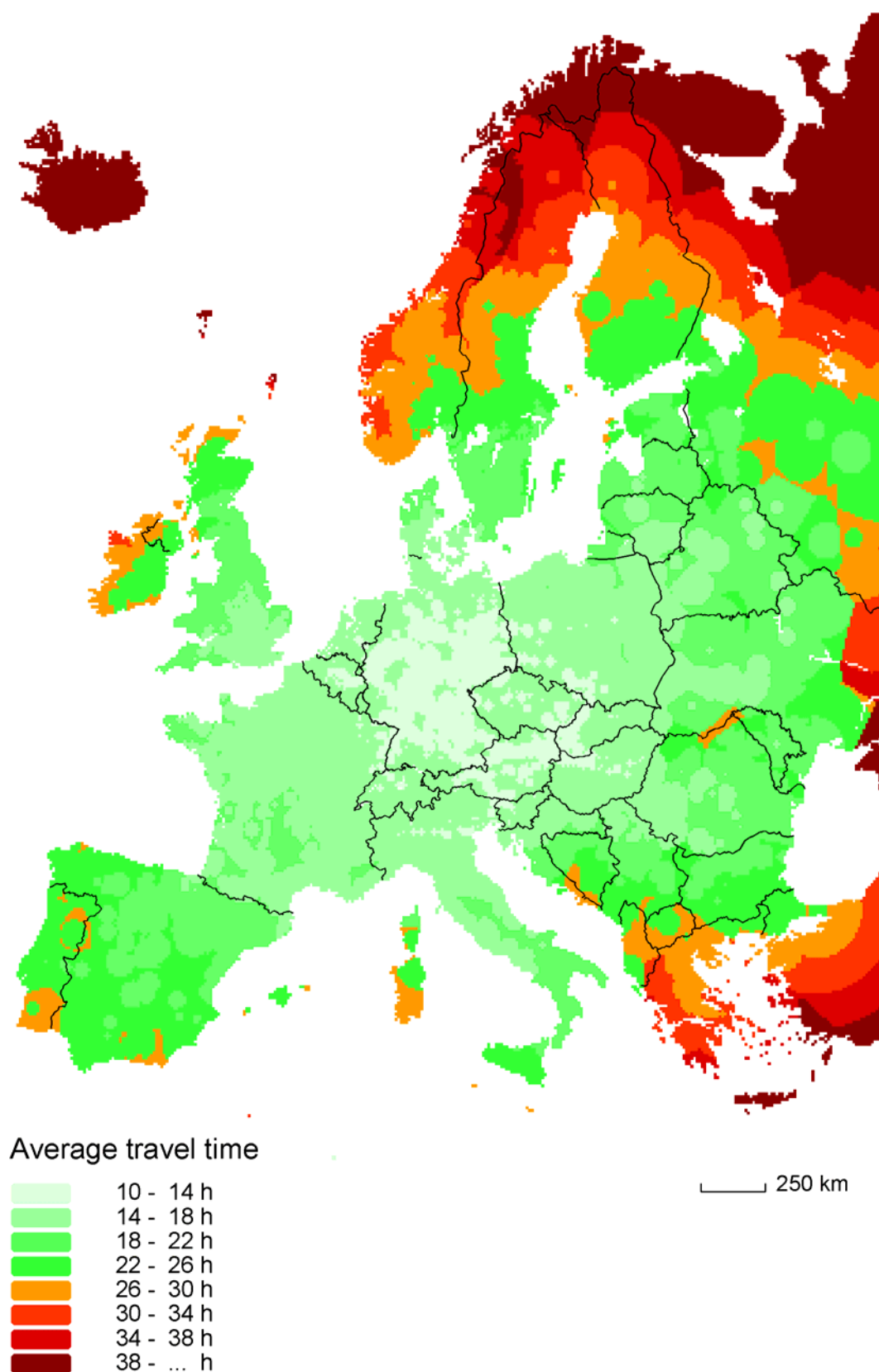


Figure 2. Generic type of accessibility indicator: Travel cost (Schürmann et al., 1997).

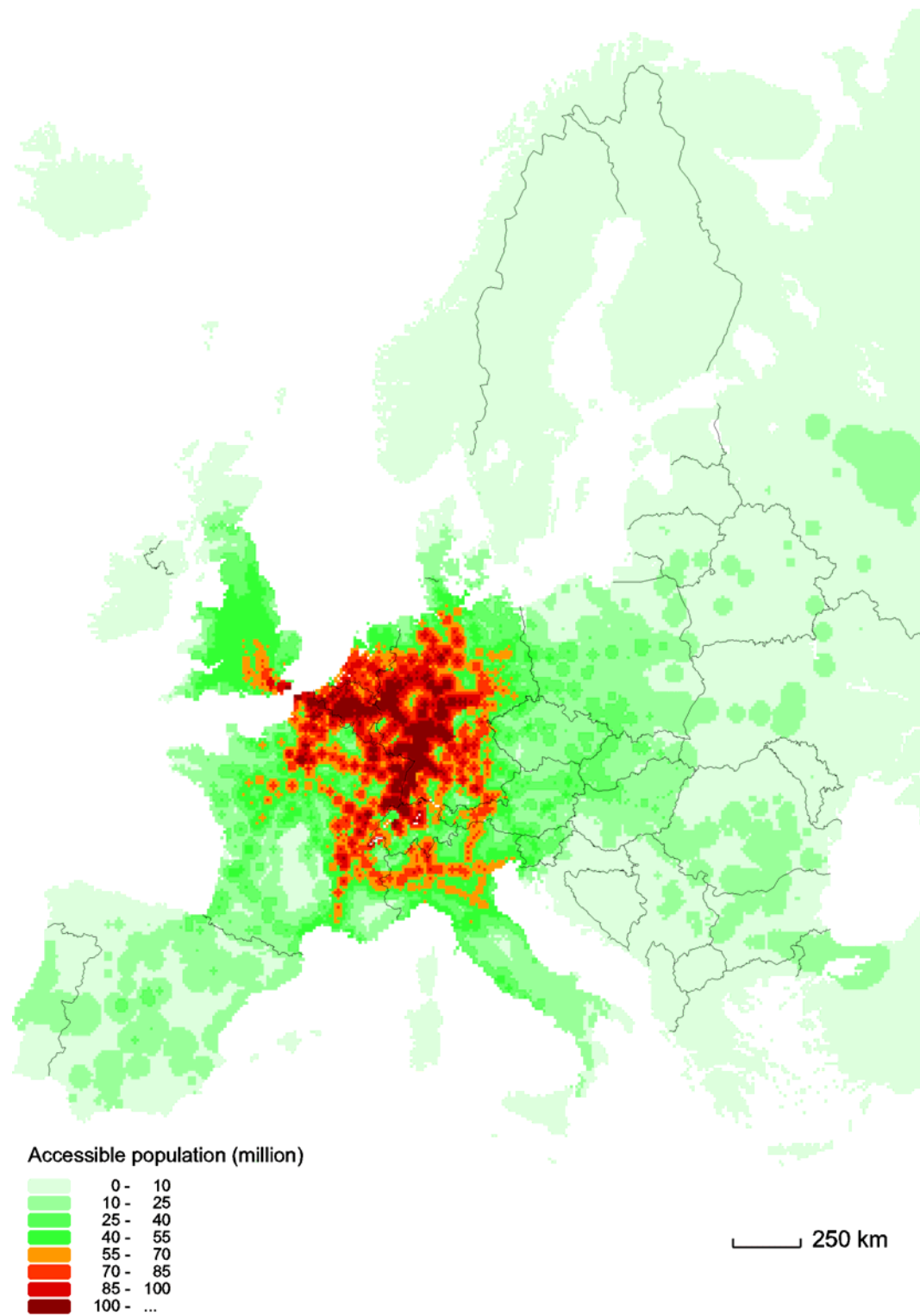


Figure 3. Generic type of accessibility indicator: Daily accessibility (Schürmann et al., 1997).

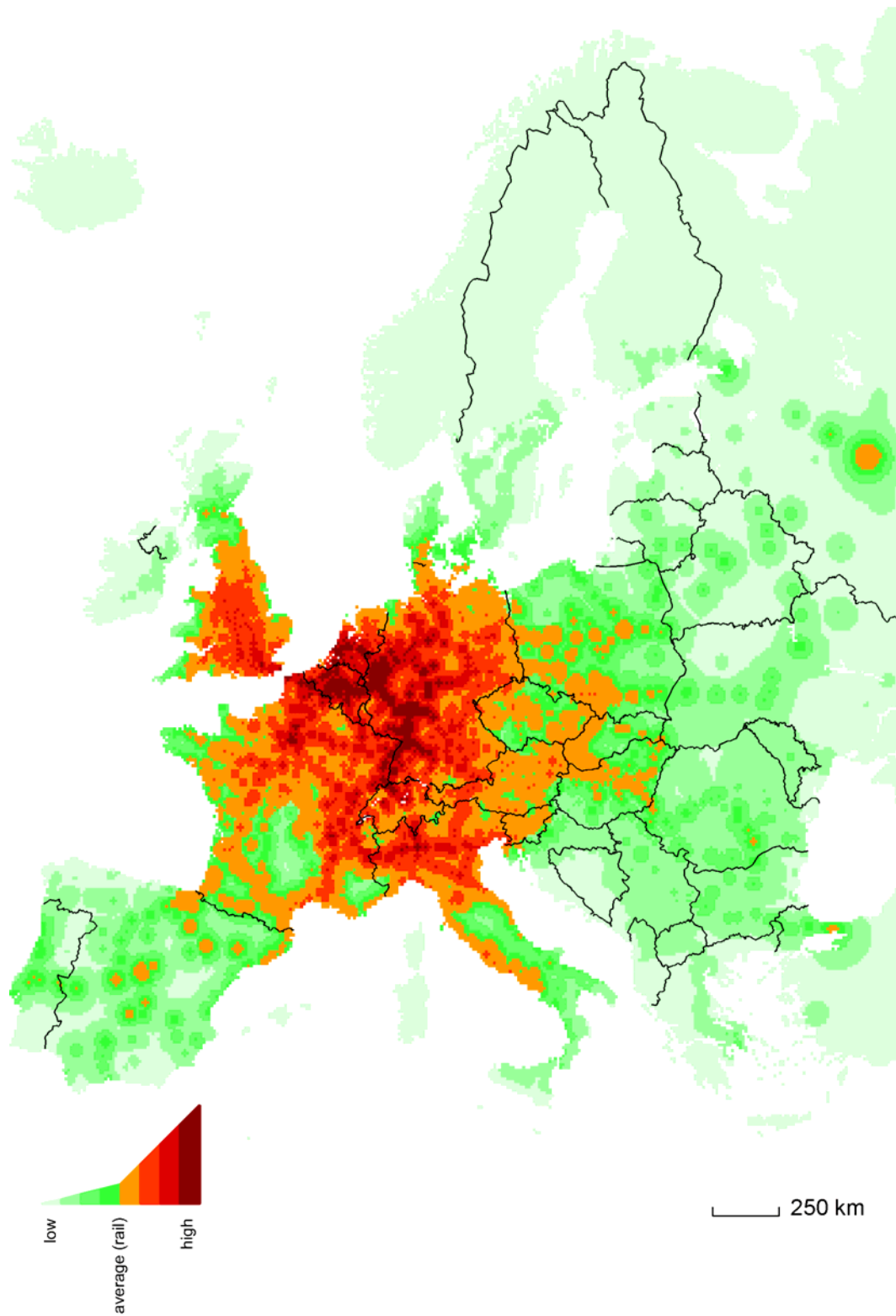


Figure 4. Generic type of accessibility indicator: Accessibility potential (Schürmann et al., 1997).

4.2 Transport mode

This section presents the basic similarities and differences with respect to the accessibility dimension transport mode. The examples are accessibility potentials for centroids of NUTS 3 regions and are standardised on the European Union's average. In order to include Norway, the indicators have been re-calculated with an existing model (Spiekermann et al., 2002).

- Figure 5 shows the spatial distribution of accessibility by road using population as destination activity. Road accessibility shows the common core-periphery picture for Europe. The highest accessibility can be found in German, Dutch, Belgian and northern French regions. The lowest values of less than 25 percent of the EU average are in nearly all Nordic, Irish, and Greek regions as well in some Scottish, Portuguese, Spanish and southern Italian regions.
- Figure 6 shows accessibility by rail using population as destination activity. The overall picture is similar to that for roads. However, there are a few important differences. The areas of highest accessibility are more closely confined to the regions belonging to major rail corridors. In the peripheral areas, some regions in southern Europe change category as compared to road, whereas the northern regions remain in the lowest category.
- Figure 7 shows accessibility by air using population as destination activity. The resulting accessibility pattern is very different from the two previous maps. Above average values can be found in regions that have a major international airport regardless of whether they are in the core of Europe or in more remote locations. This is also true for northern regions. Copenhagen and Malmö are even classified as being central. Nevertheless, airport regions in the central EU areas have higher values than airport regions in other parts. The hinterland of the airports is very narrow, something that is being demonstrated by a steep decline in accessibility values when moving away from the airport.
- Figure 8 shows multi-modal accessibility, i.e. a logsum accessibility potential aggregating over road, rail and air travel times. Regions with high accessibility are mainly located in an arc stretching from Liverpool and London via Paris, Lyon, the Benelux regions, along the Rhine in Germany to Northern Italy. However, some agglomerations in more remote areas such as Madrid, Barcelona, Dublin, Glasgow, Copenhagen, Malmö, Göteborg, Oslo, Rome and Naples are also classified as being central, or at least intermediate or above average because their international airports improve their accessibility. At the same time the European periphery begins in regions that are usually considered as being central. Several regions in Germany, Austria and France are peripheral, some are even extremely peripheral. Many regions in Portugal, Spain, Ireland, Scotland, Wales, Sweden, Finland, Norway, southern Italy and Greece are very peripheral or even extremely peripheral. Those regions do not have good access to international flight services.

The main findings with respect to transport modes are:

- Accessibility by road is the indicator to be used in order to reproduce the traditional core-periphery pattern in Europe. Investments in road infrastructure do not change this pattern.
- Accessibility by rail gives a somewhat different picture. Due to the concentration of rail, in particular high-speed rail, in only a couple of transport corridors, rail accessibility is more polarised between regions having good rail connections and those not having such connections. Investments in high-speed rail infrastructure will strengthen this picture.
- Accessibility by air is completely different. The map of Europe is converted into a patchwork of regions with high accessibility surrounded by regions with low accessibility. Low accessibility is however no longer a concern solely for those in the 'traditional' European periphery, but now also is a major worry for regions located in the European core.
- Multi-modal accessibility has major advantages over single mode indicators, because it aggregates over all modes. If a single indicator is required to assess the European territory in terms of peripherality, multi-modal or inter-modal accessibility should be chosen.

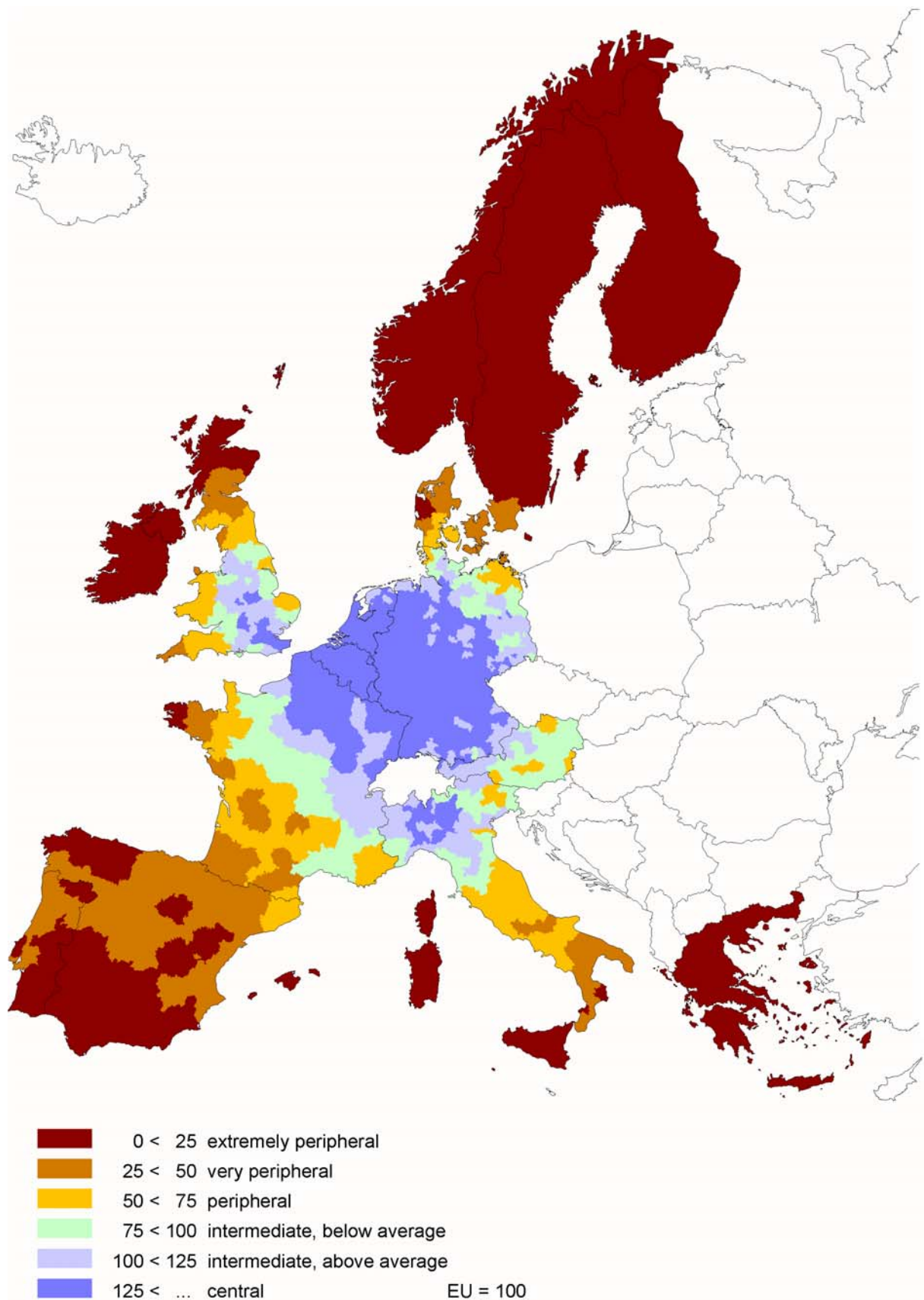


Figure 5. Transport mode: Road.

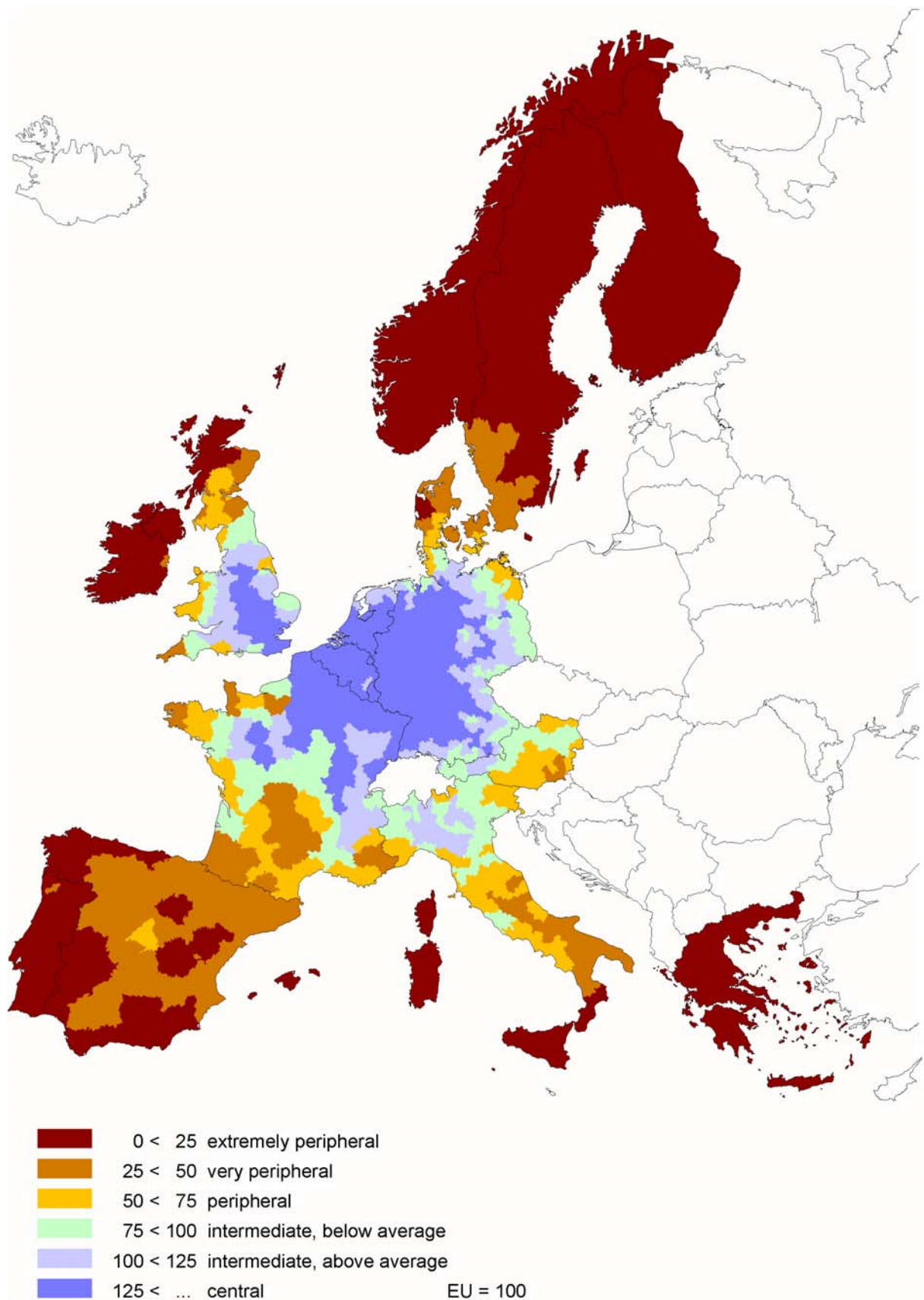


Figure 6. Transport mode: Rail.

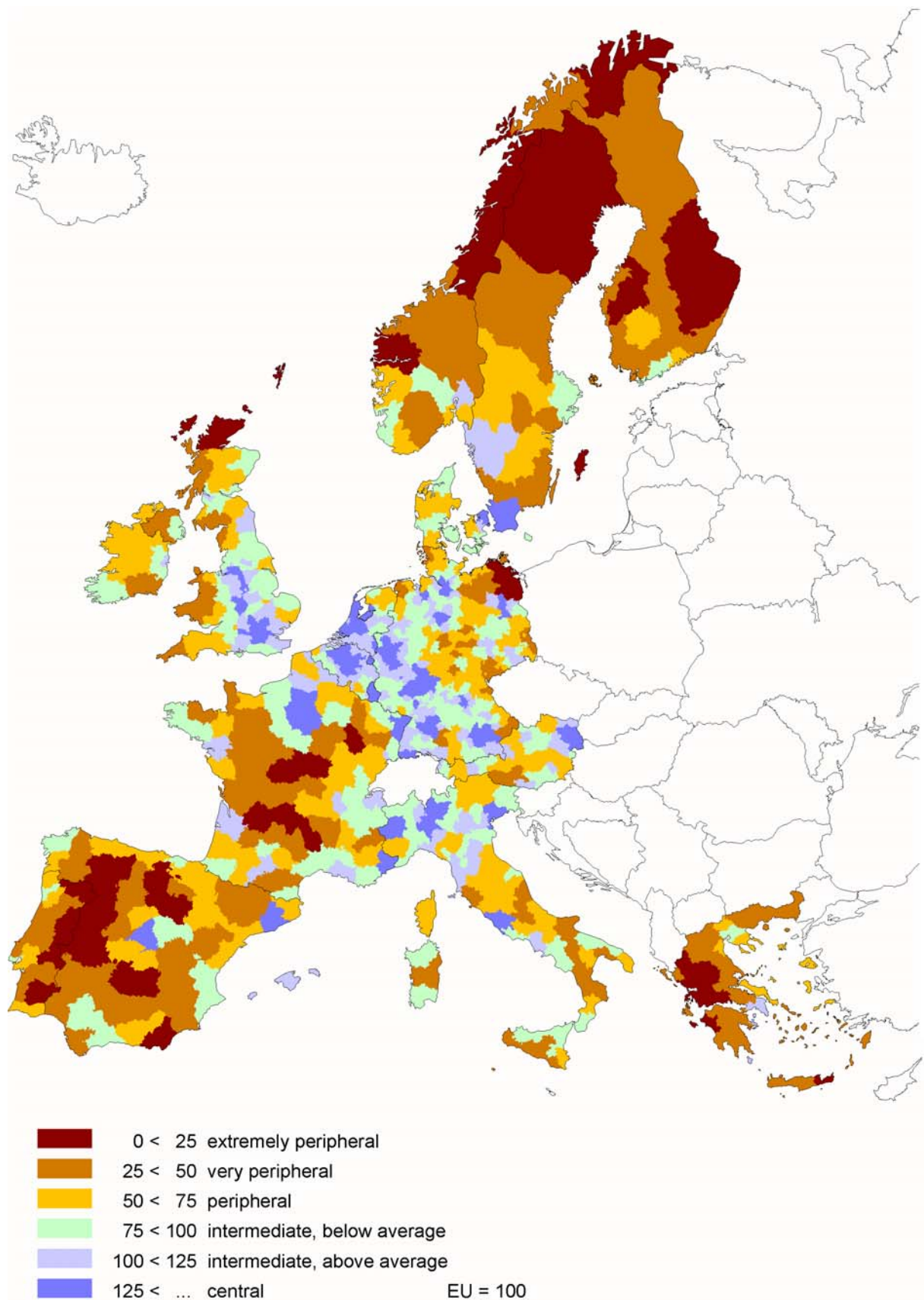


Figure 7. Transport mode: Air.

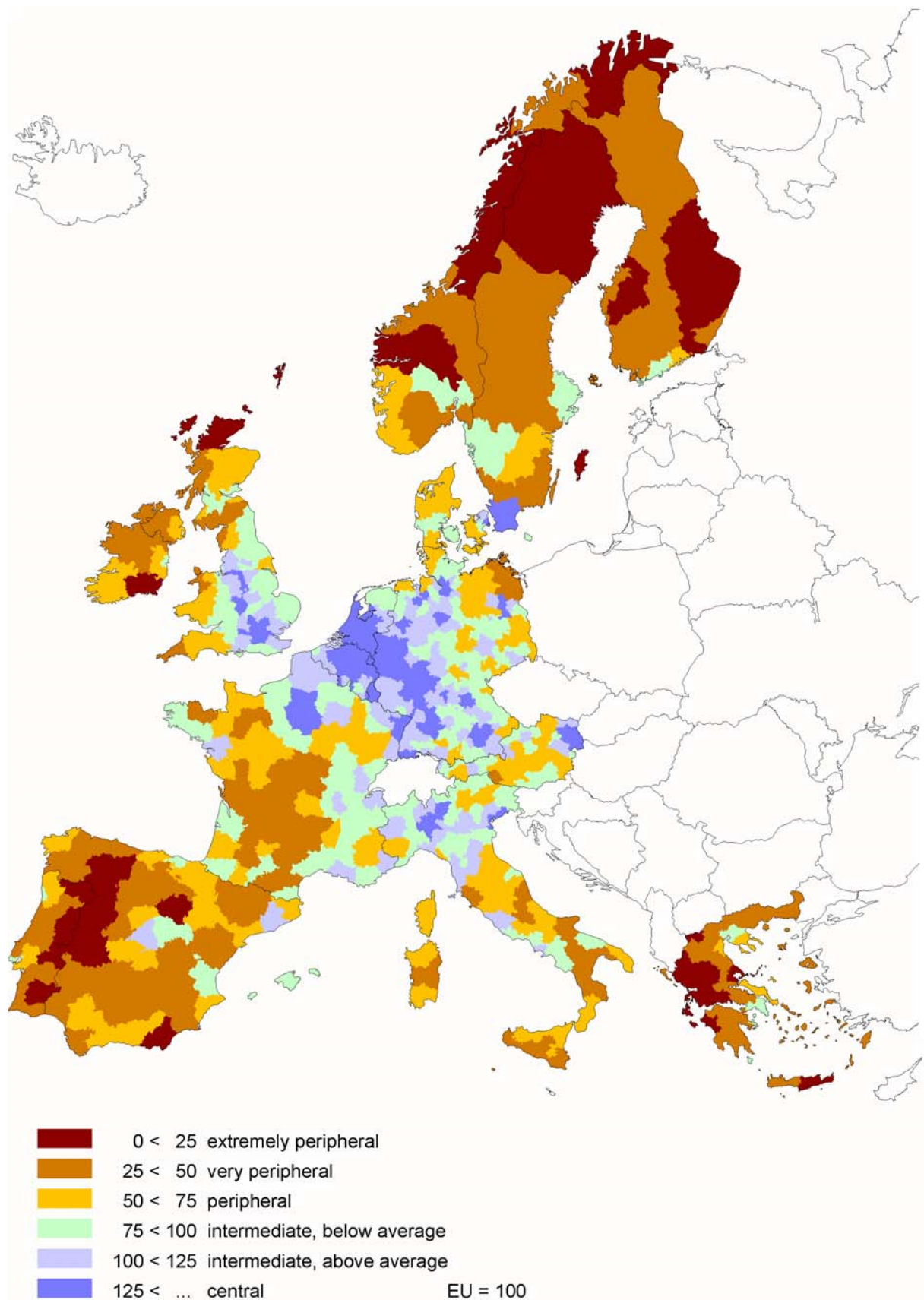


Figure 8. Transport mode: Multi-modal logsum road, rail, air.

4.3 Spatial resolution

This section presents the basic similarities and differences with respect to the accessibility dimension spatial resolution. The examples here have been calculated with different accessibility models (Schürmann and Talaat, 2000; Spiekermann et al., 2001; Hanell et al., 2000), for different spatial areas and also with different indicator types, and thus they are not directly comparable. However, an interpretation of the basic differences when looking at different spatial resolutions is possible:

- Figure 9 shows accessibility potential to employment by car for NUTS 0, 1, 2 and 3 regions in the European Union. As the transport mode is road, all four figures represent the traditional core-periphery pattern in Europe (see previous section), even at the level of NUTS 0. The increase in spatial resolution results in a more detailed spatial pattern. Thus a spatial differentiation within the central and peripheral regions becomes visible. In particular it becomes obvious that there are regions in the core of Europe, mostly rural, that are much less central than the agglomerations.
- Figure 10 shows accessibility potential to population by rail for NUTS 5 regions, i.e. municipalities, for the urban agglomerations of Lille, Brussels and Antwerp. The indicator values are standardised on the European Union's average and allow a direct assessment of the locational advantage or disadvantage of small territories within Europe. It can be seen that even in an area belonging to the most central parts of Europe, there are strong differences in terms of accessibility. Whereas the major cities have indicator values of more than twice the European average, there are municipalities at the fringe of the agglomerations that only score around the European average.
- Figure 11 shows daily accessibility to population by air and rail for 10x10 km raster cells of the Baltic Sea Region. The accessibility values of the raster cells are presented in three-dimensional surfaces in which the elevation and the colour indicates the number of persons that can be reached within five hours travel time. The map for air accessibility shows the dominant position of the major airport hubs in the region, other national and regional airports appear as modest hills. The beneficial area in terms of the daily accessibility of an airport is rather limited and is shown by the very narrow base of the peaks. The map for rail is rather different, showing highest values in Germany, Poland, and St. Petersburg; the latter because of its own huge population base; and much lower values for the southern parts of the Nordic countries and extremely low values for the northern parts.

The main findings with respect to spatial resolution are:

- If the regional level considered is aggregated, the more detailed information and spatial differentiation of a more detailed regional system will be lost. At the same time the extreme maximum and minimum indicator values are wiped out, thus suggesting a less polarised picture for central and peripheral areas in Europe. Because this is particularly true for NUTS 0 and 1, those regional systems are much less suitable for peripherality analysis than NUTS 2 or in particular NUTS 3 or NUTS 5.
- The examples for NUTS 5 and for the 10x10 km raster cells have shown that it is possible and indeed feasible to go very much further into spatial detail. In particular for transport modes that do not serve the territory equally such as rail and air, spatial detail results in an enormous spatial variation.
- Very high spatial resolution as shown in the raster cell examples allows visual representation of accessibility in three-dimensional surfaces that are easily communicated to a wider political and/or public audience.

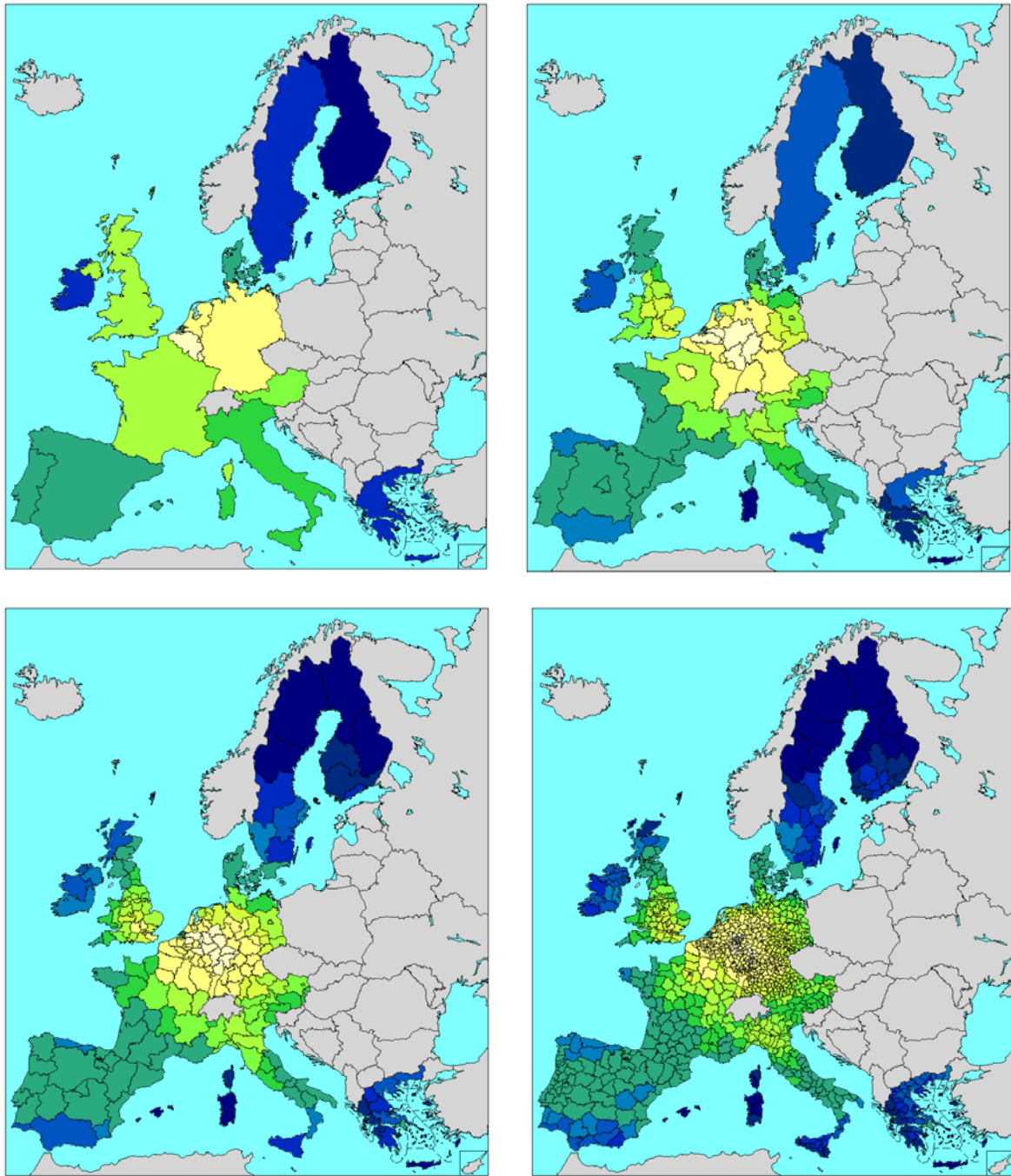


Figure 9. Spatial resolution: NUTS 0, 1, 2, 3 (Schürmann and Talaat, 2000).

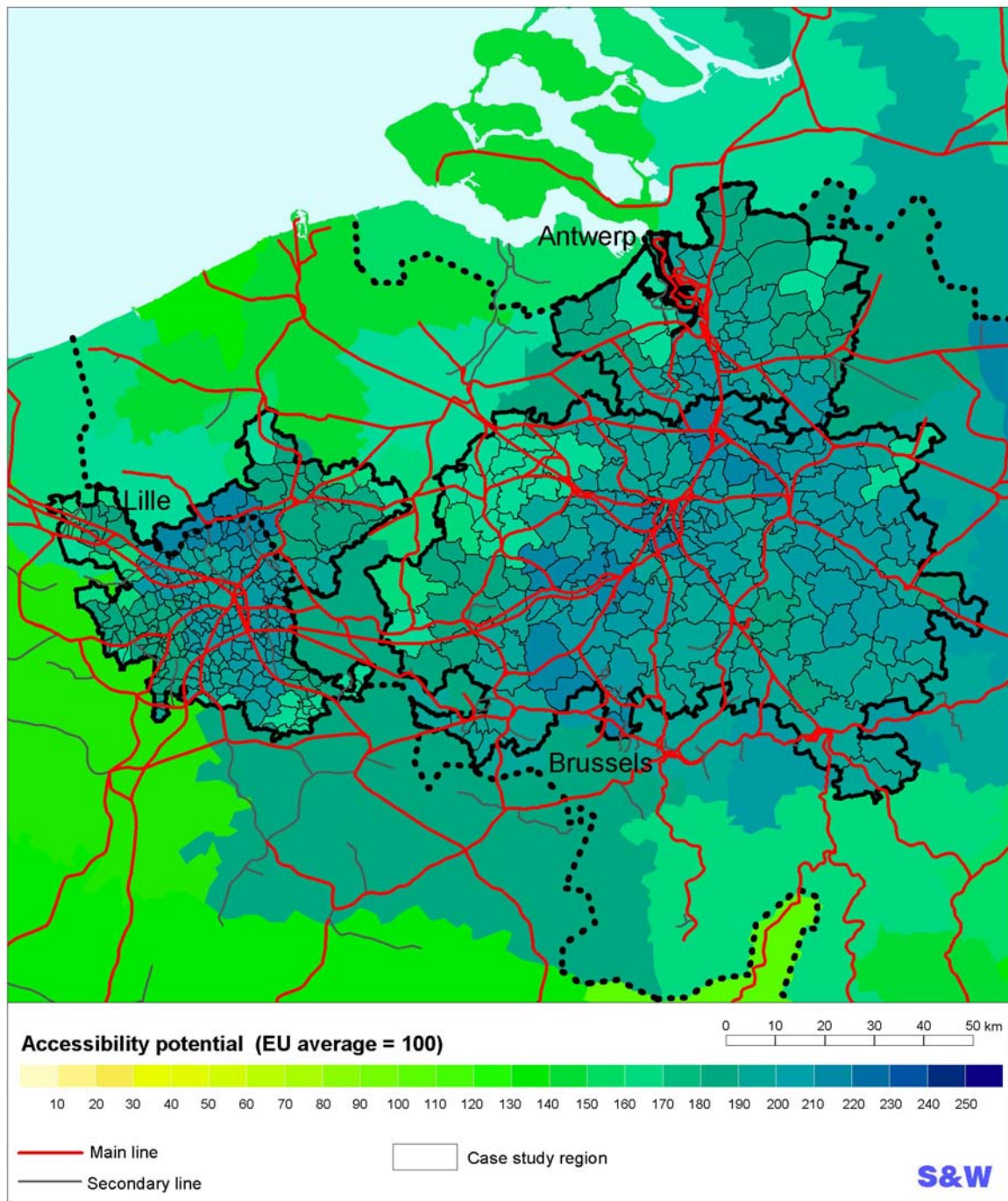


Figure 10. Spatial resolution: Municipalities (Spiekermann et al., 2001).

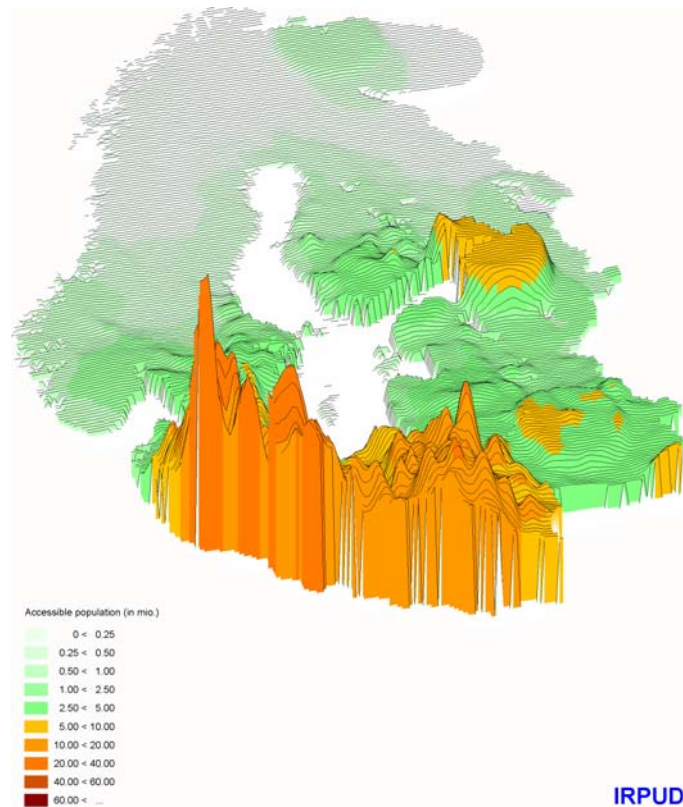
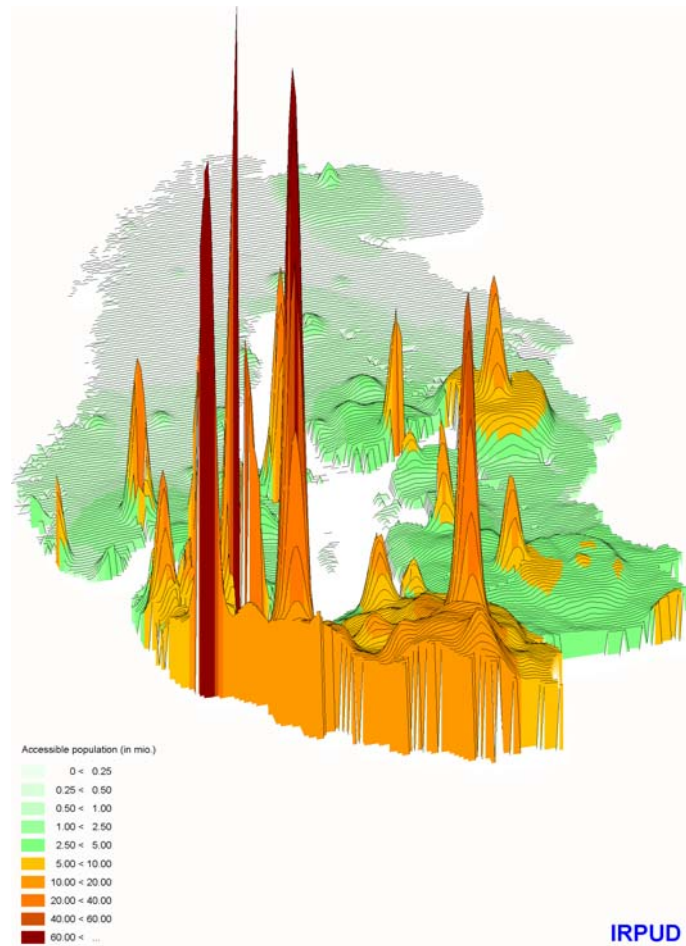


Figure 11. Spatial resolution: Raster cells 10x10 km, air (top), rail (bottom) (Hanell et al., 2000).

4.4 Destination activities

This section presents the basic similarities and differences with respect to the accessibility dimension destination activities. The examples have been calculated with different accessibility models (Schürmann et al., 1997; Spiekermann et al., 2002), for different spatial areas and also with different indicator types, and are thus not directly comparable. However, an interpretation of the basic differences when looking at different destination activities is possible:

- Figure 12 (top) shows daily accessibility by rail to population for 10x10 km raster cells. The highest daily accessibility values are found in France, southern England, Belgium and the Netherlands, Germany, Switzerland, Austria and northern Italy. There is a sharp decline from these areas towards the Nordic countries, eastern and south eastern Europe, southern Italy, the Iberian Peninsula and Ireland. However, even in the high-accessibility regions there are large differences in daily accessibility between city centres and their hinterlands.
- Figure 12 (bottom) shows daily accessibility now having GDP as destination activity. On the surface these seem similar to those for population, but disparities in local accessibility have now become more pronounced. Because economic production is highly concentrated in north western Europe, the 'mountains' of highest accessibility appear even higher than for population. This is mainly because of the much sharper decline in accessibility to GDP towards Eastern Europe. Here, the accessibility surface is nearly flat indicating the separation caused by the combined effect of low GDP and poor transport infrastructure. Even large agglomerations such as Moscow almost disappear because of the low levels of economic welfare.
- Figure 13 presents the results for a potential type, multi-modal indicator in which the destination activities are restricted to the national population of the origin zone, i.e. a national peripherality indicator. The results are standardised on the average of each respective country. The map has to be compared with Figure 8, which is calculated with the same model, but in which the limitation to national destination is not applied. By definition, each country has central and peripheral areas now. However, looking at the general distribution, the spatial structure is very similar to the European structure: regions that are peripheral in the European context are also peripheral in the national context. A few exceptions are those regions in the Benelux countries and along the western German border that are peripheral in the national but central in the international context.

The main findings are:

- The variation of the destination activity is not so important as one may expect with respect to the overall picture of core and periphery in Europe. The main difference is that the replacement of population by GDP leads to increased disparities between the EU member states and the candidate countries. For the regions of the European Union, correlation analysis has shown very high similarities between population and GDP used as destination activities (Schürmann et al., 1997). However, slight differences do appear. For the more central regions accessibility to GDP is slightly higher than to population, whereas for the more remote regions the opposite is true. This means that GDP as destination activity increases the disparities in accessibility because of the uneven distribution of GDP per capita in the European Union.
- The restriction of the destinations as presented in the example of the national peripherality index is debatable. On the one hand it results in some interesting observations; on the other hand, it does not reflect the growing interaction across national borders. If one is interested in the incorporation of border effects in accessibility modelling, a better way to investigate this is to include political and cultural barrier effects in the impedance component of the accessibility model (see Fürst et al., 2000).

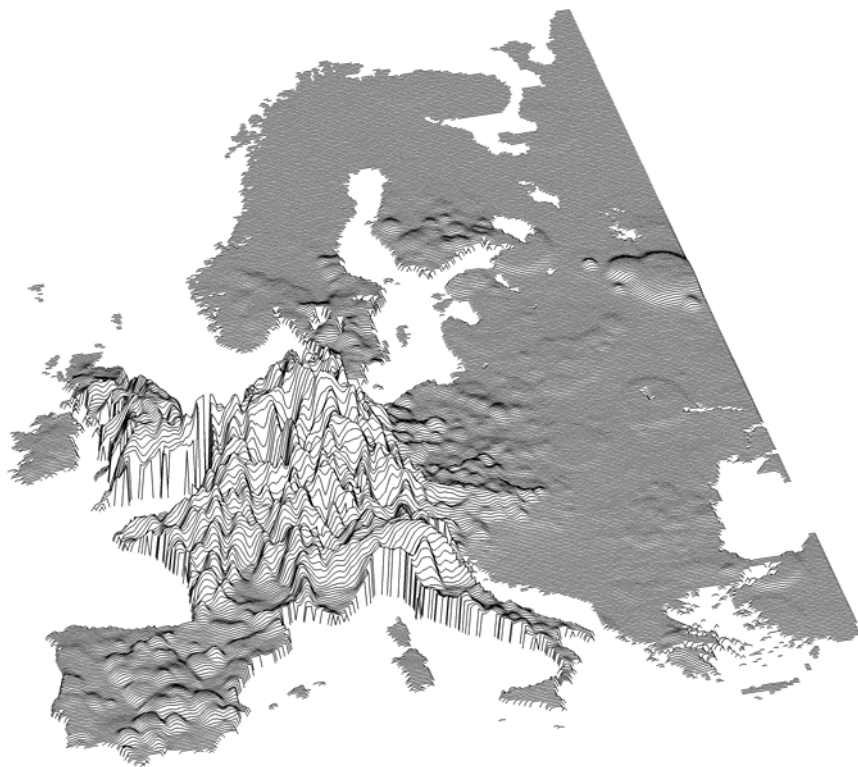
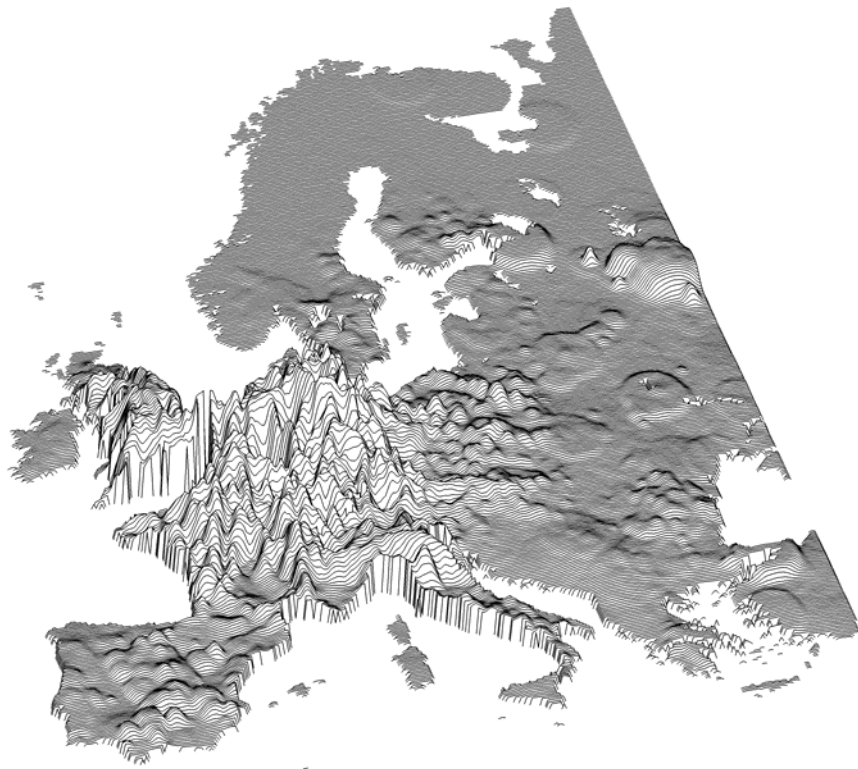


Figure 12. Destination activities: Population (top) and GDP (bottom) (Schürmann et al., 1997)

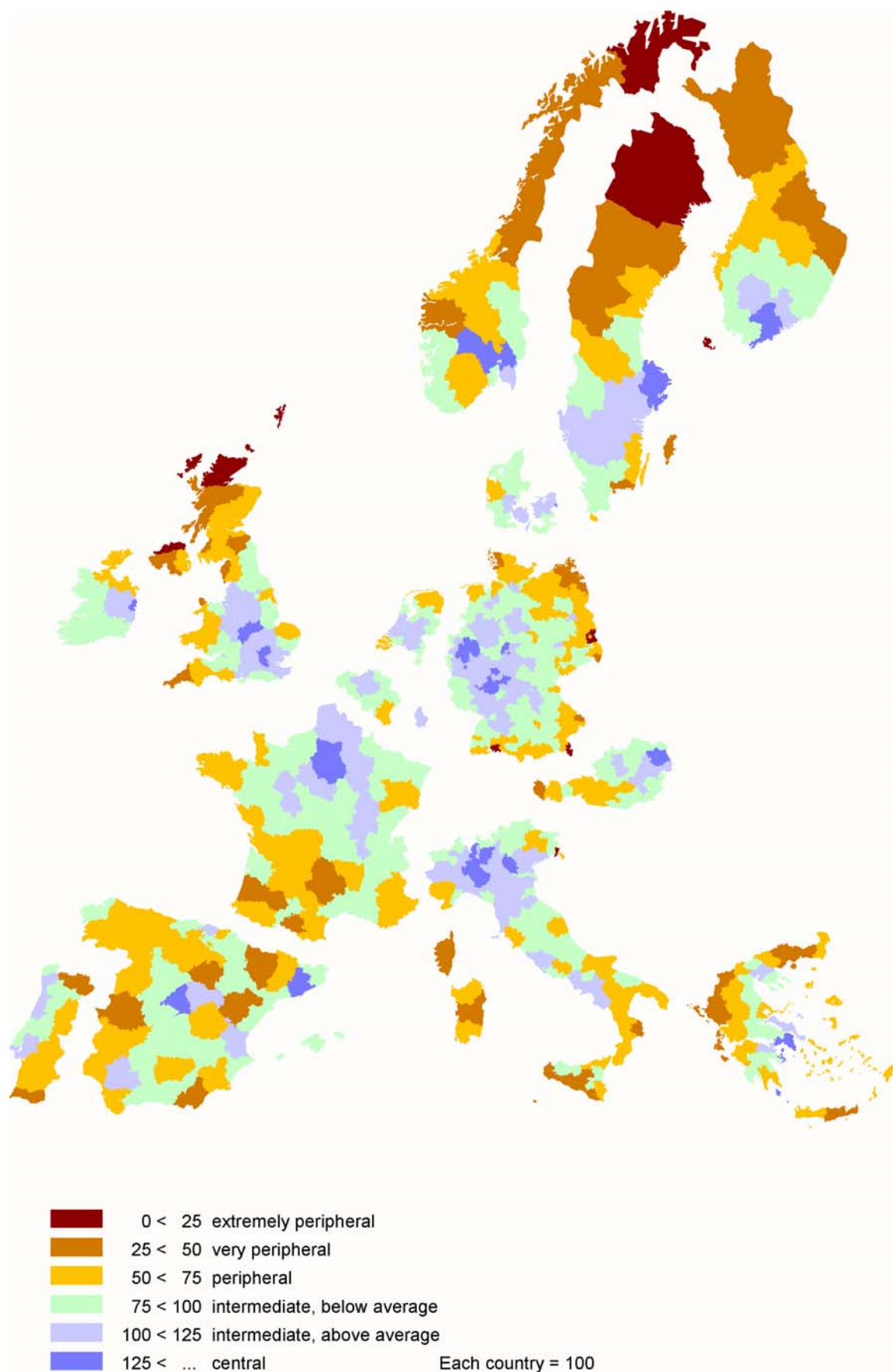


Figure 13. Destination activities: National Population (Spiekermann et al., 2002)

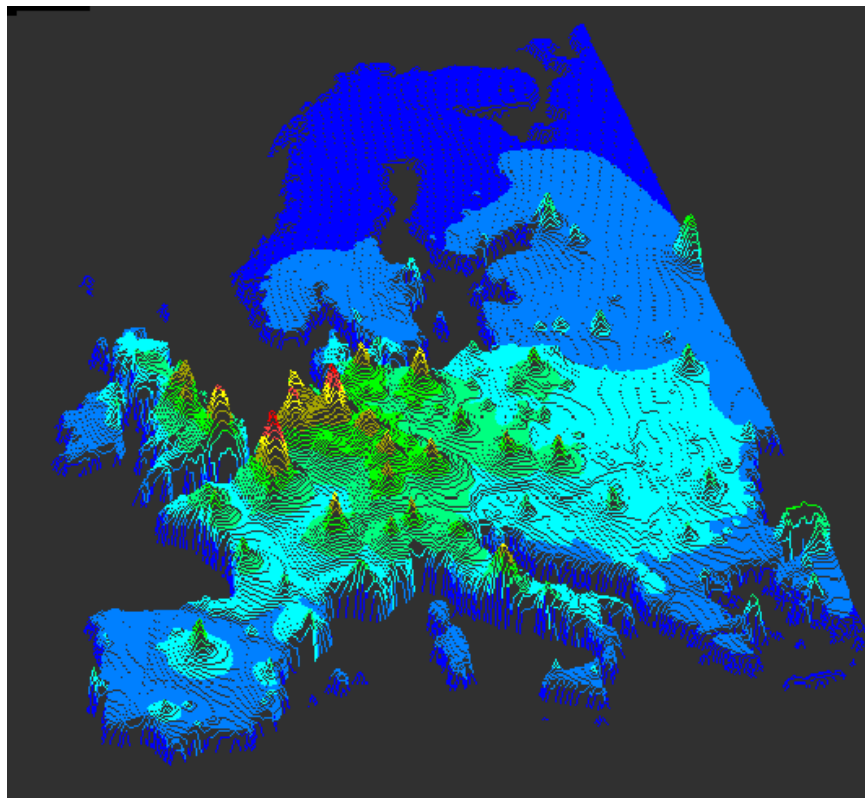
4.5 Dynamics

This section presents basic findings with respect to the accessibility dimension dynamics. The examples have been calculated with slightly different accessibility models (Spiekermann and Wegener, 1996, Hanell et al., 2000), for different spatial areas and also with different indicator types, and are thus not directly comparable, though they do allow clear statements:

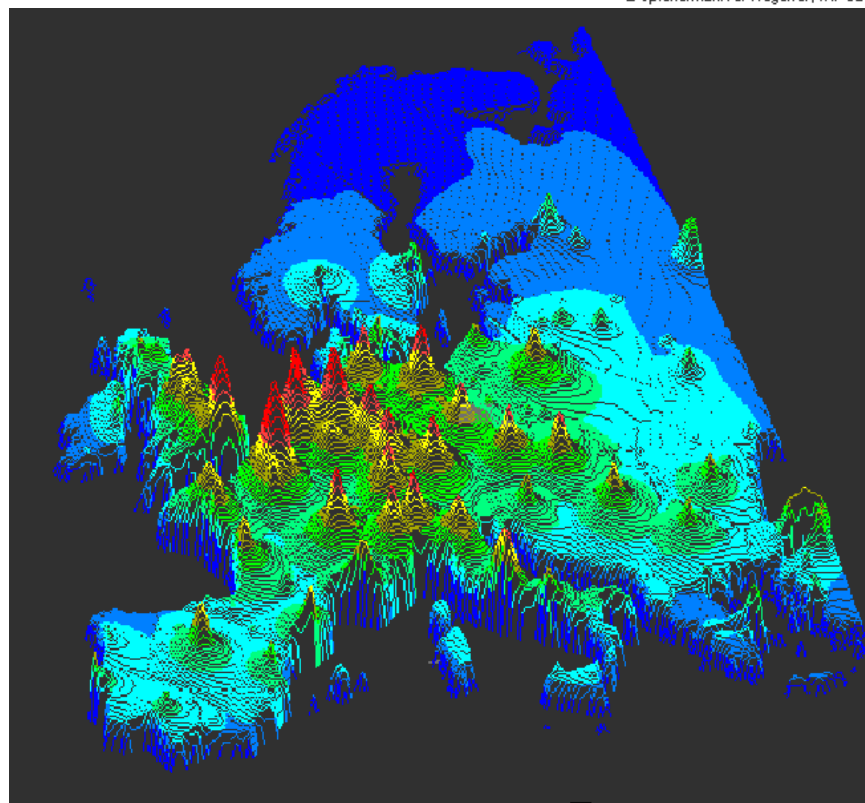
- Figure 14 shows accessibility potential to population for 10x10 km raster cells for Europe. The upper part shows the distribution of accessibility for 1993, the lower part for 2010 assuming that large parts of the TEN programme will have been implemented by then. Comparing the two surfaces, the overall accessibility pattern seems not to be that different. However, only now does the polarising effect of the new network become apparent. Only urban regions that are also nodes of the network have benefited, while the regions in between have not. Moreover, the differences in accessibility between cities in the core and the periphery have become larger, because the growth of cities in the centre is several times higher. The growth in accessibility for cities at the periphery is hardly visible, whereas the peaks in the economic core areas of Europe have become much more pronounced.
- Figure 15 shows daily accessibility to population for 10x10 km raster cells for the Baltic Sea Region. Presented here we see only the absolute changes between 1996 and 2016, i.e. the net effect of infrastructure investments in road (top) and rail (bottom) according to the TEN and TINA outline plans. Both maps show very similar results. The highest increases will occur in those areas that already had high values in 1996. Growth in accessibility will primarily take place along the improved transport corridors such as the Nordic Triangle or the *Via Baltica*. The changes in accessibility will not however lead to a reduction of the disparities in accessibility across the region.

The main findings with respect to dynamics are:

- Accessibility and peripherality are not static indicators. Depending on the definition of the indicator they may be very sensitive to changes in the transport system. In particular, investments that introduce a new level of transport service such as those in the high-speed rail network will lead to increased accessibility indicator values and may change the spatial pattern of central, intermediate and peripheral regions. Moreover, investments that remove a bottleneck to transport and communications such as the Channel Tunnel or the Øresund link result in increased accessibility values, however, in such cases the area of impact is surprisingly narrow.
- A combination of changing the accessibility indicator dimensions transport mode and the being considered will deliver significant insights as regards what investments in which transport modes may change the relative position of an area in the European context. For this purpose, difference maps as presented in the example for the Baltic Sea Region are of great value.



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Figure 14. Dynamics: Accessibility 1993 (top) and 2020 (bottom) (Spiekermann and Wegener, 1996)

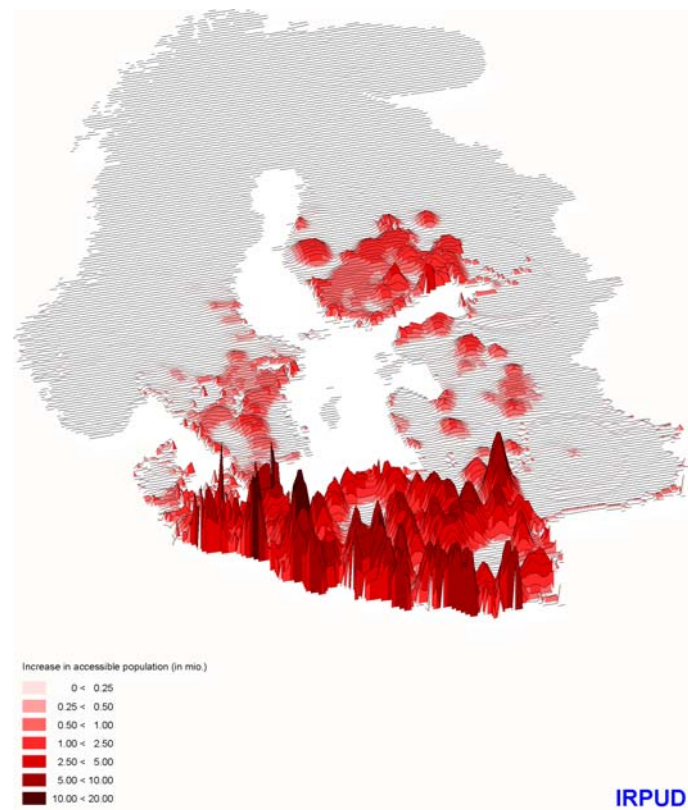
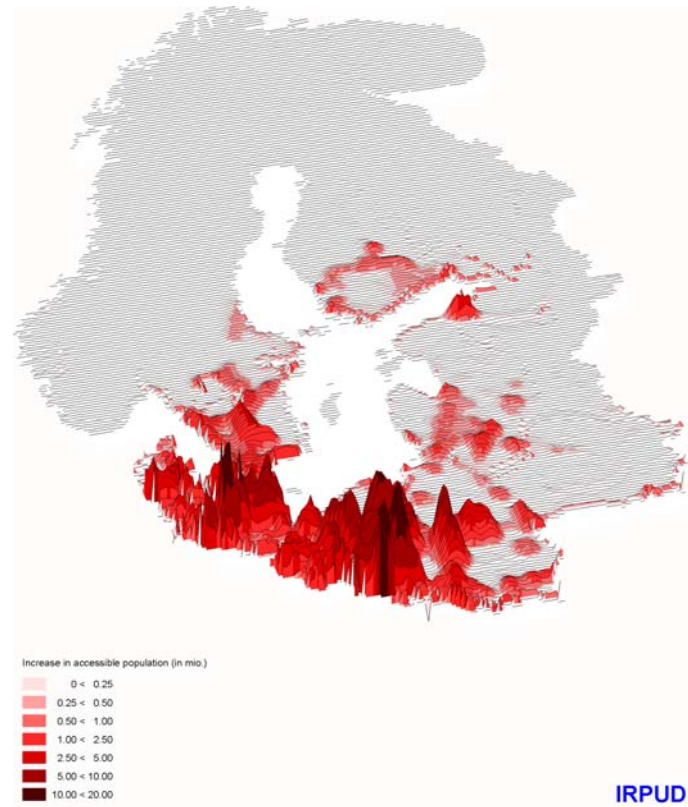


Figure 15. Dynamics: Absolute change 1996-2016, road (top), rail (bottom) (Hanell et al., 2000)

5. Peripheral drawbacks

Peripherality is often associated with a number of disadvantages. Very often a relatively poor regional economic performance is viewed as the outcome of low accessibility to the main European markets. Previous work has shown that a relationship exists between accessibility and economic performance in terms of GDP per capita or GDP per worker; however, the correlation at NUTS 3 level is relatively low, with an r^2 of between 0.23 and 0.31 (Spiekermann et al., 2002). At the same time, the Nordic regions have higher economic outputs than other European regions with similar low levels of accessibility. However, this seems to be based on national assets and policies in the fields of education, R&D and innovations, all of which seem to overcome the disadvantage of remote location to a certain degree.

The Nordic regions however face other disadvantages due to their remote location. They have to deal with extremely high travel costs to participate in European integration. Several regions face relatively high degrees of population loss due to negative net-migration rates. The latter will have a serious impact on the ability to provide basic services in those regions and thus also on the long-term viability of those areas. This chapter will present a brief analysis of these two issues as regards the Nordic regions.

5.1 Travel costs

The survey presented in this section aims to illustrate the spatial dependence and structure of travel time and costs in Europe by means of a real life example. A one-day meeting during the week involving parties from countries from across Europe is assumed to take place on Tuesday, 10 September 2002, and lasts from 11 am until 17 pm (six hours). It is supposed to be attended by 35 participants coming from three general groups of European locations. Group 1 comprises the seventeen capitals of the EU/EEA territory. Group 2 includes eight selected non-capital towns of the EU/EEA territory, namely Aalborg (DK), Inverness (UK), Las Palmas (ES), Luleå (S), Marseilles (F), Palermo (I), Rovaniemi (FI) and Tromsø (N). Group 3 comprises the ten capitals of the candidate countries. As potential meeting places four venues in central Europe (Brussels, Frankfurt, London and Paris) and two locations in peripheral Europe (Madrid and Stockholm) were selected.

Two months in advance of the meeting a travel agency calculated travel times and cost for every participant and potential meeting place.

- *Travel time* is the total time required to attend the meeting, i.e. a round trip from home or office and back for the participant. Travel time includes the time taken to approach the terminal and to check in, time for train and/or air journey, time to approach the meeting location and time for the meeting itself (six hours), and, if necessary time for an overnight stay. However, real flight and train timetables have been used which regularly extends the travel time with time spent waiting for the next possible departure etc. The time taken to approach the terminal/meeting location has been set to 90/60 minutes for flight and 30/30 minutes for train connections.
- *Travel costs* comprise costs for transport, an estimated amount for the travel time of the participants and costs for required overnight stays. Transport costs include expenditures for long-distance train and/or flight tickets with an option of switching between the modes in order to keep the total travel time (see depiction below) as short as possible. Costs for local transport are excluded. The value of each traveller's time is charged as Euro 500 for a working day, while overnight stays cost a further Euro 105.

Table 5 reveals London to be the optimal venue requiring the lowest total travel budget (EUR 58,942) as well as the lowest total travel time (729 hours). However, the other three central

European venues looked at cause additional costs of only between 2-5%. With a venue in peripheral Europe the total expenditures significantly increase, even if a venue such as Stockholm may be more easily accessible from some candidate countries. Thus Stockholm causes 20% additional costs and Madrid exceeds the London budget by 50%. Similar differences are even true for travel times.

Table 5. Total meeting travel times and expenditures.

Venue	Travel time (h)		Travel costs (Euro)				
	Total	Proportion	Total	Proportion	Accommodation	Tickets	Value of time
London	729	-	58,942	-	840	37,602	20,500
Paris	761	+5%	61,188	+4%	1,365	36,823	23,000
Brussels	776	+6%	61,770	+5%	1,155	38,615	22,000
Frankfurt	768	+5%	60,188	+2%	1,050	37,138	22,000
Stockholm	899	+22%	70,895	+20%	2,250	39,875	28,500
Madrid	1,117	+53%	88,547	+50%	4,095	48,452	36,000

Bearing in mind the physical distances the participants have to cover, air transport was obviously the first choice of most participants. Thus, travel costs clearly reflect the organisation of air traffic in hubs (Figure 16). Participants from EU/EEA capitals (group 1) generally enjoy similar low expenditures for a central European venue but expenditures for participants from remote EU/EEA capitals can easily double when choosing a venue in peripheral Europe. In the case of Brussels only Athens and Reykjavik stand out with their time-cost proportion. Attending the meeting from a non-capital town of the EU/EEA territory (group 2) significantly increases expenditures that are often comparable to the higher expenditures of a participant from a capital town of the candidate countries (group 3). The travel costs of participants out of group 2 and 3 regularly lie close to double those of group 1. At the moment, the capital towns of the candidate countries have to suffer relatively bad accessibility to the European centre, particularly taking into consideration their moderate physical distances. This holds true particularly for the capitals of the Baltic States (Tallinn, Riga and Vilnius), and not only in the depicted case of Brussels. The choice of London as a venue clearly reduces the high expenditures of several participants getting more of them close to the time-cost proportion of participants from EU/EEA capitals. In contrast with Madrid as the host venue costs spiral, though this was to be expected.

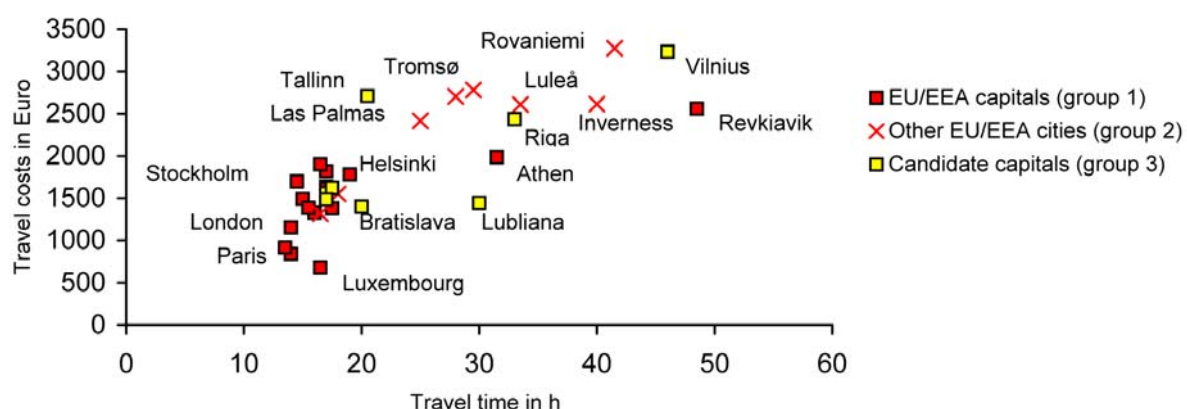


Figure 16. Time-cost proportion for the venue of Brussels

Travel time and travel costs rise more or less simultaneously according to the pattern depicted above as can also be observed in Figure 17. Therefore participants from non-capital towns of the EU/EEA territory (group 2) as well as participants from capital towns of the candidate countries (group 3) are often at a double disadvantage. This appears to be even more so in remote parts of the EU/EEA such as the Nordic countries, Spain or Scotland. Participants from for instance Luleå, Inverness, Rovaniemi, Tromsø, Vilnius or Riga often have to spend significantly more travel time and travel money than participants from the EU/EEA capitals, particularly when attending a meeting held at a central European location.

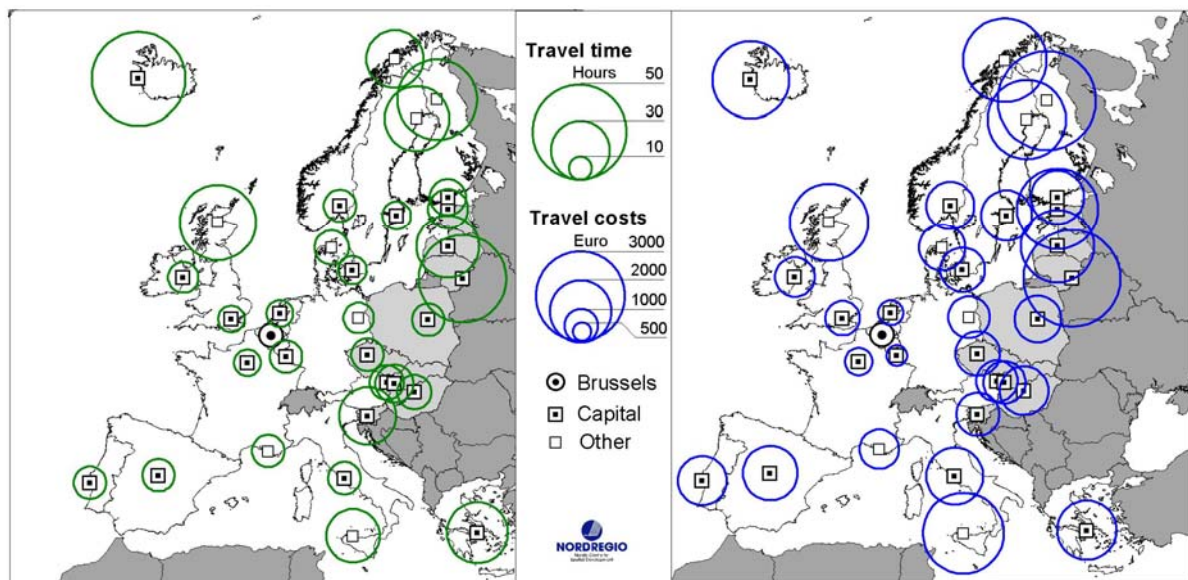


Figure 17. Travel time (left) and travel cost (right) for a 6h meeting in Brussels.

Due to its selective focus on location and time, the survey presented here can only give a snapshot of the spatial distribution of real travel time and travel costs in Europe. Of course, developments in the extremely dynamic flight market such as new flight services or new tariff structures may lead to significant changes in the picture. Notwithstanding this however the overall result will remain the same. European business meetings held in the central European agglomerations see those participants from the European periphery face serious disadvantages in terms of travel time and cost.

5.2 Population loss

Many regions in the Nordic countries are facing serious population loss due to the fact that more people are leaving the regions than can be attracted to settle in them. There is a strong correlation between the size of the population of a municipality or a region and its net-migration rate (Hanell et al., 2002). Moreover, there is a significant correspondence between the degree of peripherality and the net-migration rate. Figure 18 presents the correlation between relative location (expressed as European multi-modal accessibility potential, as presented in Figure 8, but standardised now to the Nordic regions) and the net-migration rate (1995-1999). It can be seen that the Danish regions are highest in accessibility and nearly all of them have higher in-migration than out-migration. The distribution of Finnish, Norwegian and Swedish regions in the diagramme are very similar. Most regions have low accessibility values and net-migration losses; some have net-migration gains where roughly every second region scores relatively well on accessibility values. The correlation coefficient is $r^2 = 0.41$, thus clearly higher than for the correlation between accessibility and economic variables.

Figure 19 adds a spatial component to the analysis. It presents the regional net-migration rates in the late 1990s, the current regional accessibility values, and, the relationship between both indicators for the Nordic regions. Net-migration losses are mainly to be found in the northern regions, but also in southern parts of Sweden and Finland. The highest population gains due to migration can be found in the agglomerations. Moreover, these are the same regions that show the highest accessibility, mainly because of their good air connections. Accessibility decreases towards the north, however, there are also regions of low accessibility in-between. The lower map relates the two variables. A very clear pattern thus emerges: Low accessibility comes with out-migration, whereas relatively high accessibility is linked to net-migration gains in the Nordic agglomerations and with losses in the more rural areas.

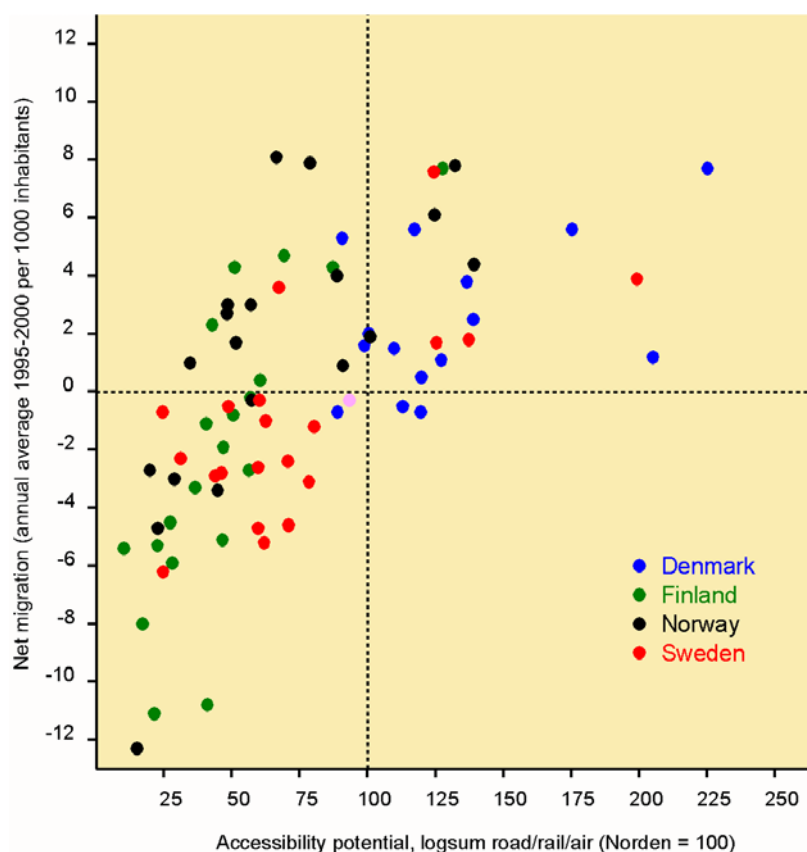
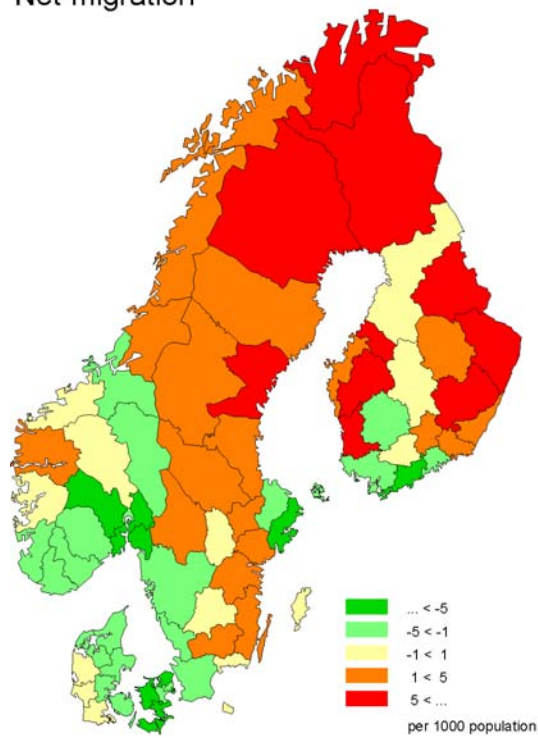
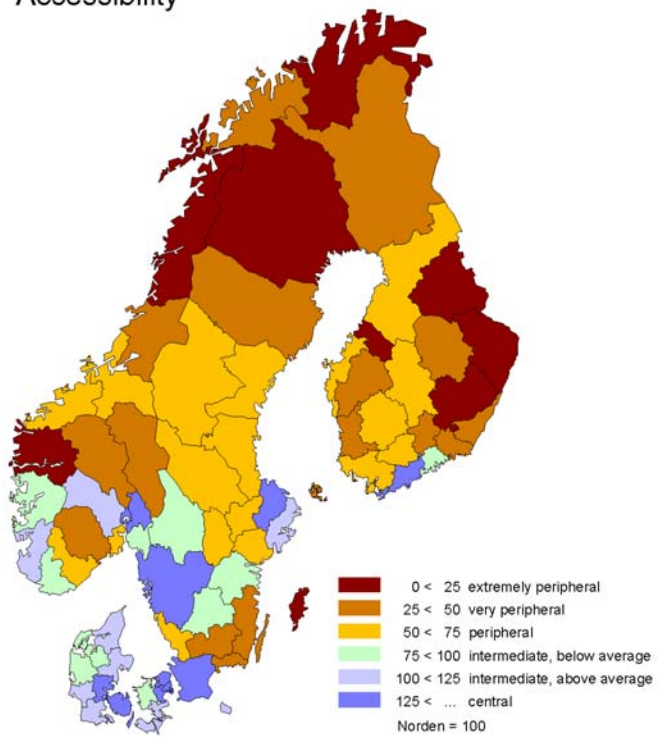


Figure 18. Correlation of net-migration and accessibility of Nordic regions.

Net-migration



Accessibility



Net-migration v. accessibility

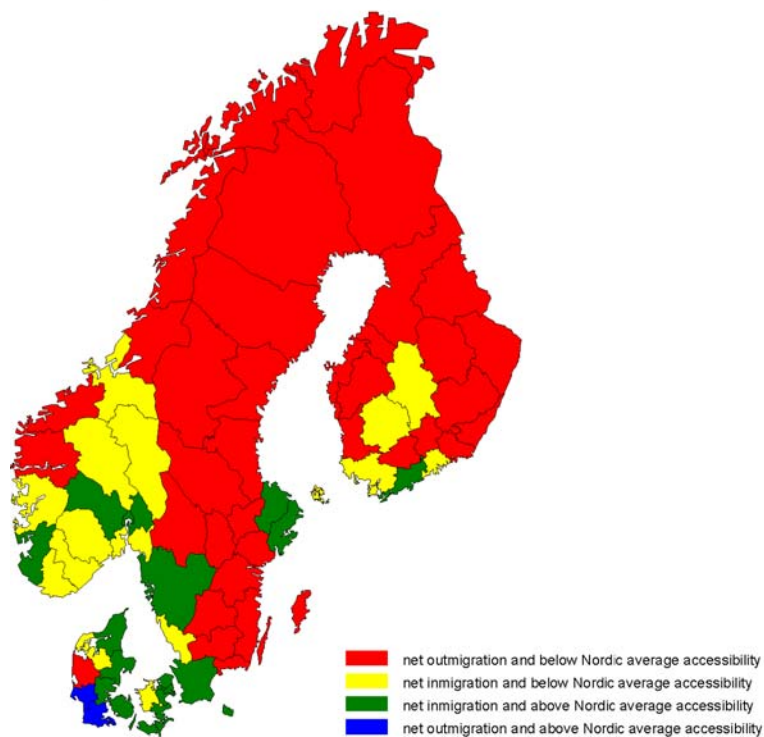


Figure 19. Spatial relationship of net-migration and accessibility of Nordic regions.

6. Conclusions

The purpose of the report was to present an overview on the accessibility and peripherality concepts, models and indicators currently discussed in the European context. In the report, peripherality is considered to be identical to low accessibility. Accessibility is a very broad term used very differently, and for different purposes. Accessibility concepts range from very simple indicators to sophisticated indicators and models used in regional science.

Different European accessibility models and their basic results have been presented in this report. In addition, selected issues such as the type of accessibility indicator and different dimensions of accessibility have been discussed in order to identify appropriate ways to define different degrees of peripherality and their development over time.

One of the main findings is that accessibility models are mostly concerned with measuring the accessibility of the large European centres and with differentiating between the European core and remote regions. There are very few examples in which the European periphery is differentiated internally with respect to accessibility.

Consequently, there are even less examples in which different degrees of Nordic peripherality, e.g. of low accessibility, are related to regional economic performance or to other factors that may explain spatial development processes. The report discusses two examples of Nordic peripheral drawbacks due to low accessibility. It was demonstrated that peripheral regions face major economic disadvantages in terms of travel costs compared to central European areas. It was also shown that there is a relatively high correlation between low accessibility and problematic demographic developments in the form of net-migration losses.

This lack of knowledge concerning peripheral areas in Europe includes the Nordic countries, and in particular Norway and Iceland. Therefore, it is recommended that we need to increase the knowledge base regarding peripheral areas and their accessibility. The Nordic countries should set up a system of accessibility indicators for municipalities, i.e. NUTS 5 regions, given that the available indicators for NUTS 3 regions do not reflect the huge differences within those regions in the North. Such accessibility indicators could have significant political relevance and could be used in different regional policy contexts in the Nordic Countries and in the European Union. Such indicators should include:

- Accessibility indicators that could be used to develop a new indicator for eligibility for EU Structural Funds beyond 2006.
- Accessibility indicators that could be used for the ratification of national regional policy, e.g. investment aid.
- Accessibility indicators that could be used as part of a spatial monitoring system for the Nordic countries.

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