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Accessibility Analysis of the Baltic Sea Region

Final Report

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1. Introduction

Currently, the Baltic Sea Region Transnational Programme 2007-2013 is under preparation. One of the topics considered very important by the Joint Programming Committee and its drafting teams is accessibility. In the first draft of the programme "Internal and external accessibility of the BSR" is one of the four priorities (BSR JPC, 2006). This study has been commissioned to support the ongoing analysis of the socio-economic situation in the BSR with maps and interpretations on accessibility.

The objective of this study is to provide an up-to date picture of the accessibility situation of the BSR through a set of appropriate indicators. The study is organised along a number of different accessibility indicators which were partly based on the indicators developed in the transport-oriented studies of the ESPON 2006 Programme. Following the terms of reference for this study, seven accessibility indicators have been elaborated for the BSR:

- Car travel times to rail stations
- Car and rail travel times to commercial airports
- Lorry travel times to transport terminals
- Car and rail travel times to large cities
- Travel times between BSR cities
- Multimodal potential accessibility to population and GDP
- Mobile telephone penetration and internet access

Each accessibility issue is presented in at least one core map showing the indicator values for the BSR and its neighbouring regions and includes a description of the indicator, the data used and an analysis and interpretation of the results.

The analysis was carried out for the territory of the BSR including the eligible areas in Russia and Belarus. In order to allow a straightforward interpretation of the indicators not only in the BSR context but also in the wider European context, the neighbouring territories were included in the analysis. The analysis was mainly conducted at the NUTS-3 level for the territory of the European Union and corresponding spatial units for non-EU member states. Selected indicators were calculated and are presented at even smaller units (raster cells of 2x2 km), but were also aggregated to the NUTS-3 level. The indicators on mobile telephone penetration and internet access were not available at regional level and are therefore presented at national level for which the data exists.

The report has the following structure. First, a classification of accessibility indicators is given (Chapter 2). Then, the database used and further developed for this study is presented (Chapter 3). The main part of the report is the presentation and discussion of the different accessibility indicators in Chapter 4. Finally, the findings are summarised and related to the Baltic Sea Region Transnational Programme.

2 Accessibility Indicators

The task of 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. Investments in transport infrastructure lead to changing locational qualities and may induce changing 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 measured then as 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 express important information about the area itself, i.e. about the transport infrastructure endowment, but do not reflect 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 include in their formulation always a spatial impedance term which describes the ease of reaching destinations of interest. Impedance can be measured in terms of travel time, cost or inconvenience.

The more complex accessibility indicators are 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:

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

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_{ij}) 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*.

The more complex accessibility indictors can be classified by their specification of the destination and the impedance functions (Schürmann et al., 1997, Wegener et al, 2002):

- 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.

- 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.

The different accessibility types all have advantages and disadvantages (Spiekermann and Neubauer, 2002). Travel time indicators and daily accessibility indicators are easy to understand and to communicate but lack partly 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.

In this study, sample indicators for all types of accessibility indicators were developed for the BSR. Infrastructure endowment indicators are represented by access times to rail stations, airports and terminals, but also by the mobile phone penetration and internet access indicators. Travel cost indicators are represented by travel times to larger cities. Daily accessibility indicators are represented by travel times between the BSR cities. Finally, the potential accessibility indicator type is represented by multimodal potential accessibility to population and GDP.

3. Database

The calculation of the different accessibility indicators for this study is facilitated by the availability of a detailed GIS database of trans-European transport networks, covering all countries of Europe and including all modes of transport.

The RRG GIS Database (RRG 2006) which is utilised for this study provides digital data for 38 countries in Europe (all countries of the European Union as well as Switzerland, Norway, Iceland, Albania, Rumania, Bulgaria, the European part of Turkey, countries of former Yugoslavia and the countries of the European part of the former USSR) in standard GIS format. This includes information on the pan-European road and rail networks, including railway stations; information on inland waterway networks, ferry routes and short sea shipping routes, including inland ports and seaport; information on European airports and flight connections; information on administrative boundaries for all countries at different spatial levels (NUTS 0 – 3, boundaries of cooperation areas etc.), and on city locations of all European cities with more than 50,000 inhabitants. The different categories of the database are stored as individual layers in the GIS database.

The GIS database is utilised to calculate the various accessibility indicators, and is also been used to illustrate the indicator results in map form at various spatial levels. The relevant layers of this database used for the present accessibility study are:

(i) Road network layer

The road network layer includes all TEN and TINA roads, E-roads, motorways and highways, dual-carriageway roads, as well as other trunk roads and other important national roads and road ferries. For many regions in Europe, also secondary and regional roads are available. Figure 1 illustrates the trunk road network in the BSR. The TEN and TINA road outline plans are also coded in this database. Information on the TEN and TINA links and outline plans are taken from different recent EC publications (European Communities 1996; European Commission 1995; 1998; 1999; 2002a; 2002b; 2003; 2004a; 2004b; 2005; HLG 2003; TINA Secretariat 1999; 2002).

(ii) Railway network layer

The railway network layer includes all railway lines under operation today, including all sections of the TEN and TINA rail networks and all sections of the *Dedicated Rail Freight Network*, as specified by recent EC documents. In addition, new planned railway lines based on the TEN and TINA outline plans, and selected railway links currently closed for operation are also included as well as rail ferries; however, some privately owned railway tracks are not included in the database. Along with the rail links, also the railway stations are coded (Railfaneurope.net 2004). The railway links and stations are visualised in Figure 2. Based on web-based timetable information systems of the respective national railway companies, rail travel times have been updated to reflect the train services in 2006.

(iii) Airports and flight networks

All airports of Europe offering scheduled flight services are covered by the RRG GIS Database,. A database on flight routes for scheduled flights in spring 2006 between these airports was developed based on information provided by OAG (OAG 2004; 2005a; 2005b; 2006). The information coded includes flight times and frequencies Figure 3 shows the airports classified by the number of destinations reached by direct flights and the air network classified by frequency of flight services.

(iv) Intermodal terminals

Intermodal terminals are defined as infrastructure facilities where containers, semitrailers, trailers and lorries and railway carriages can be transhipped from one mode to the other, e.g. from roads to railways (“rolling road trains”, “iron highways”) or from road or rail to ships. Intermodal terminals are represented in the RRG GIS database by seaports and inland ports for the whole of Europe (Binnenschiffahrts-Verlag 1995; 1997; UN 1994), and by dedicated intermodal container terminals (ICT) and combined road/rail transhipment terminals. The combined transport stations were derived from the database of the *International Union of Combined Road-Rail Transport Companies* (UIRR, 2006). This database includes the location of combined transport stations for several countries such as Austria, Belgium, Czech Republic, Denmark, France, Germany, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, and Switzerland and the UK; however, the three Baltic countries, Finland, Belarus and Russia are not included. Another limitation of the UIRR database is that it only contains terminals of its members, which means that even for the countries considered a full coverage of all Intermodal terminals is not available. Therefore, for Germany also Intermodal terminals of the *Deutsche Umschlaggesellschaft Schiene-Straße* (DUSS, 2006) were coded. Again, this data source only includes those terminals operated by DUSS, and thus is not providing a full picture of all terminals.

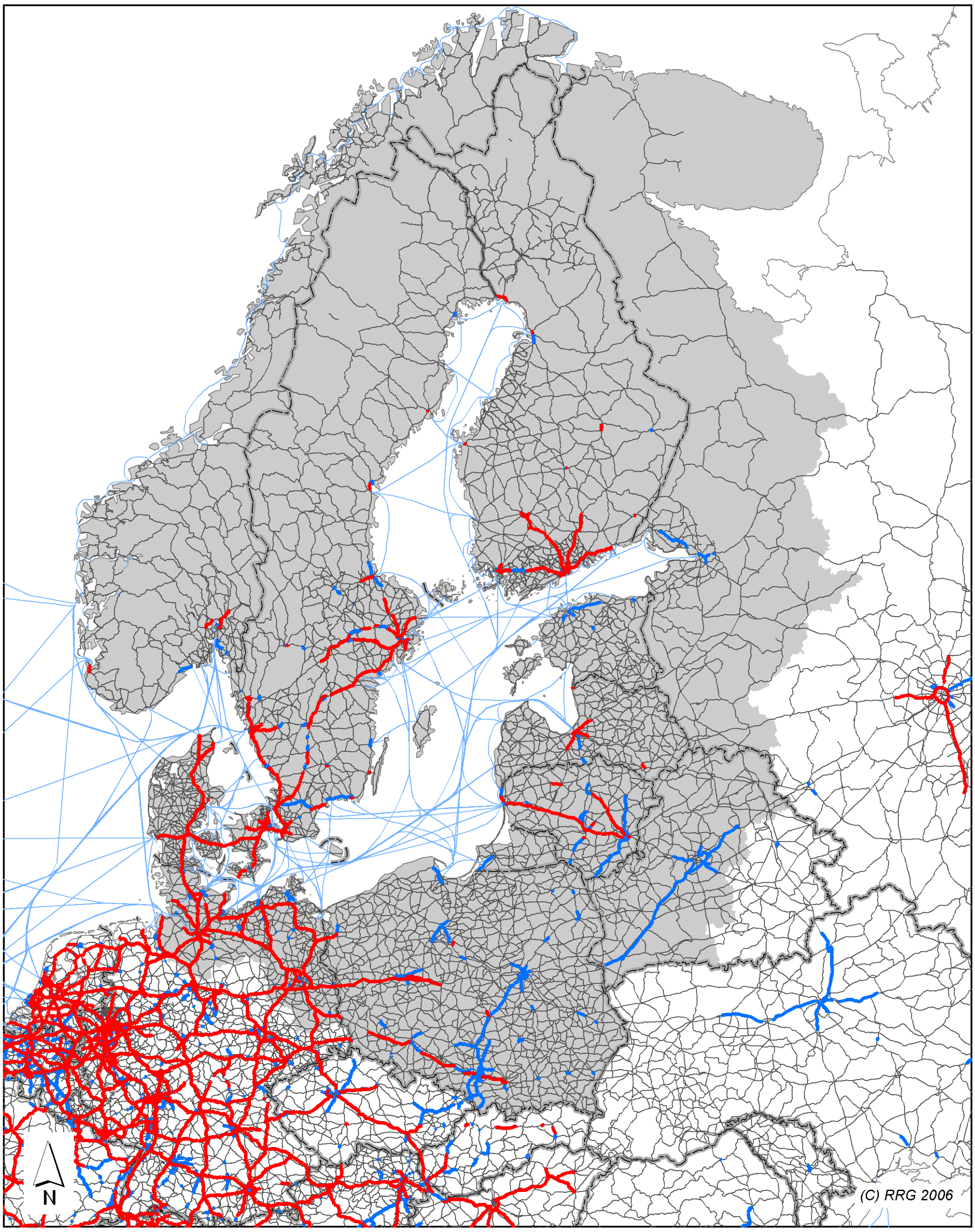
The geographical location of the intermodal terminals used for the accessibility calculations is illustrated in Figure 4.

(v) Cities in Europe and region boundaries

The RRG GIS Database contains also different point layers representing all cities in Europe with more than 50,000 inhabitants and polygon layers representing boundaries of administrative and statistical regions based on the NUTS system of regions (Eurostat 1999a; 1999b; 2004). The city locations (‘city centres’) will be used as the reference co-ordinates to calculate a number of accessibility indicators as described in the next chapter. In the BSR also smaller cities with less than 50,000 inhabitants are included if they host facilities for higher education (universities, polytechnics). It has to be noted that smaller cities have different functional roles in national urban systems in the northern part of the BSR compared with cities of that size in the southern part. Figure 5 shows the urban system of the BSR.

(vi) Regional socio-economic data

The database contains also the development of regional GDP and population. This information was updated in order to use the latest available data for the study (Eurostat, 2006b).



Trunk Road Network in the Baltic Sea Region (2006): Link Category

- Motorways
- Highways (dual-carriageway roads)
- Other trunk roads
- Ferry routes, shipping routes
- Co-operation area 2007-2013
- Country boundaries

Source(s):
RRG (2006) - RRG GIS Database

Figure 1. Road network database.

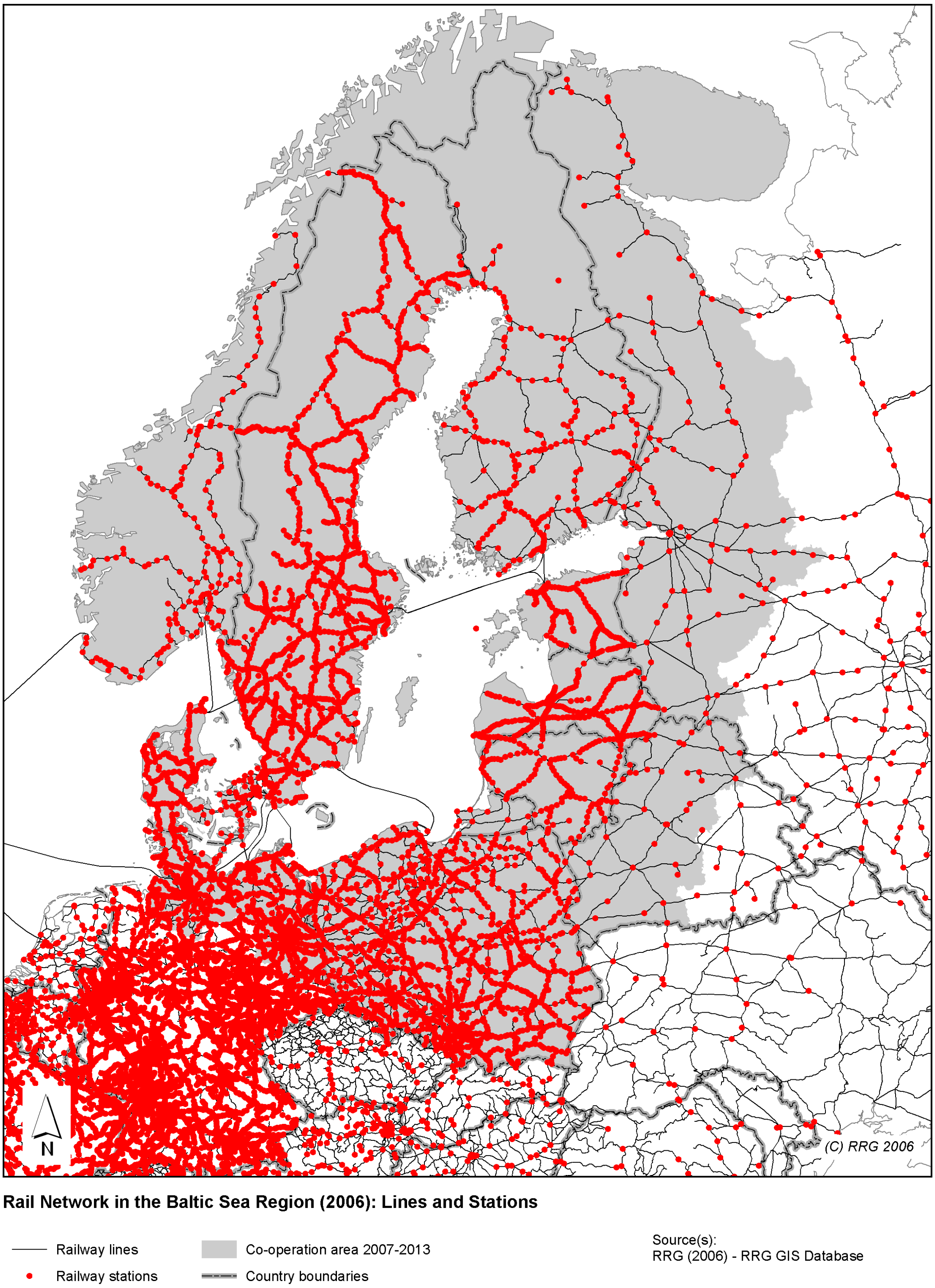
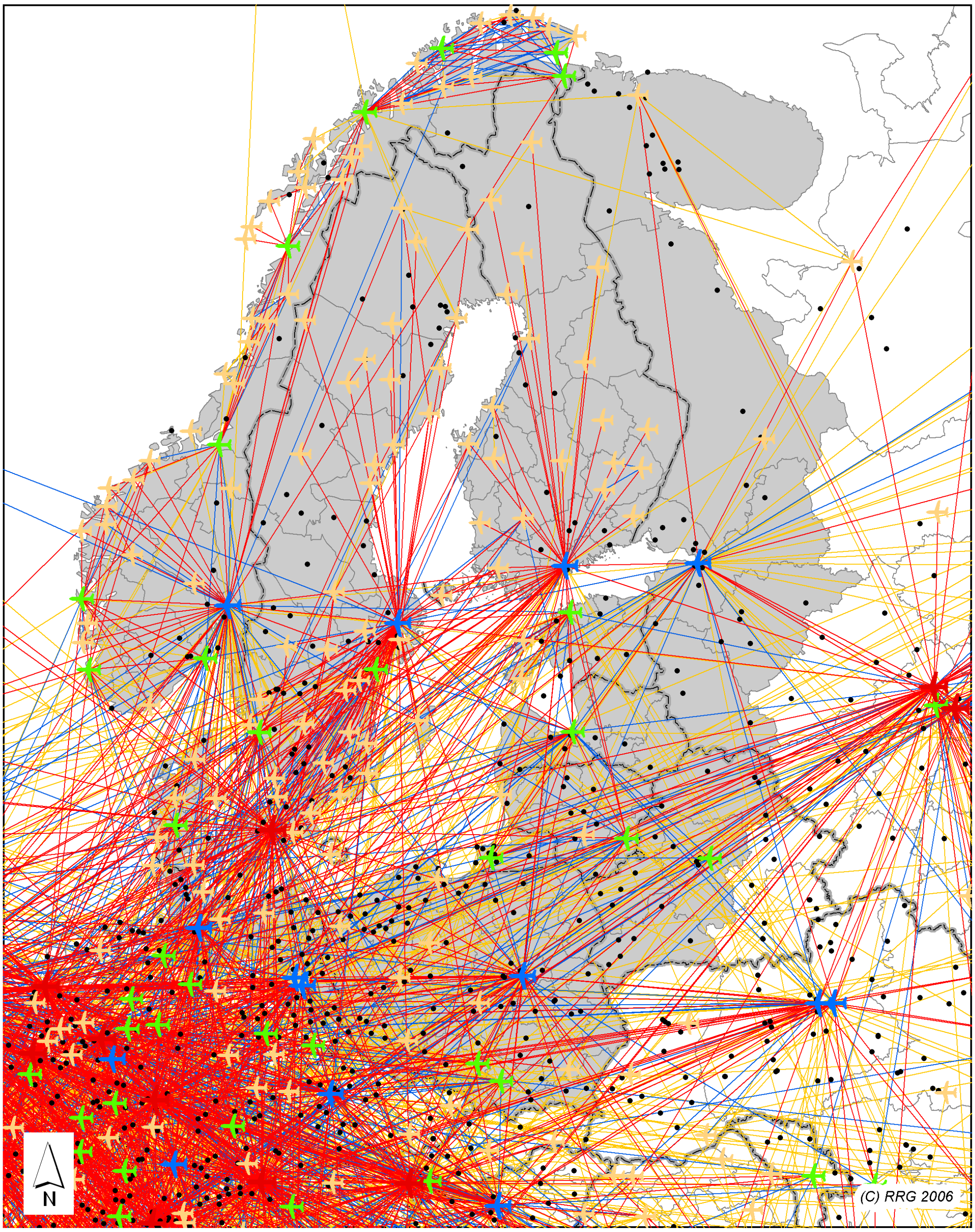


Figure 2. Rail network database.



Airports in the Baltic Sea Region and Flight Routes

Number of direct destinations
- No destination served
- 1 - 10
- 11 - 50
- 51 - 100
- 100 < ...

Flight routes
- Several daily flights
- One daily flight
- Non-daily flights

- Co-operation area 2007-2013
- Country boundaries
- NUTS-3 regions / equivalent regions

Source(s):
OAG (2006)

Note:
Number of destination counted as number of direct regular flights (no charter flights, no exceptional flights).

Figure 3. Air network database.

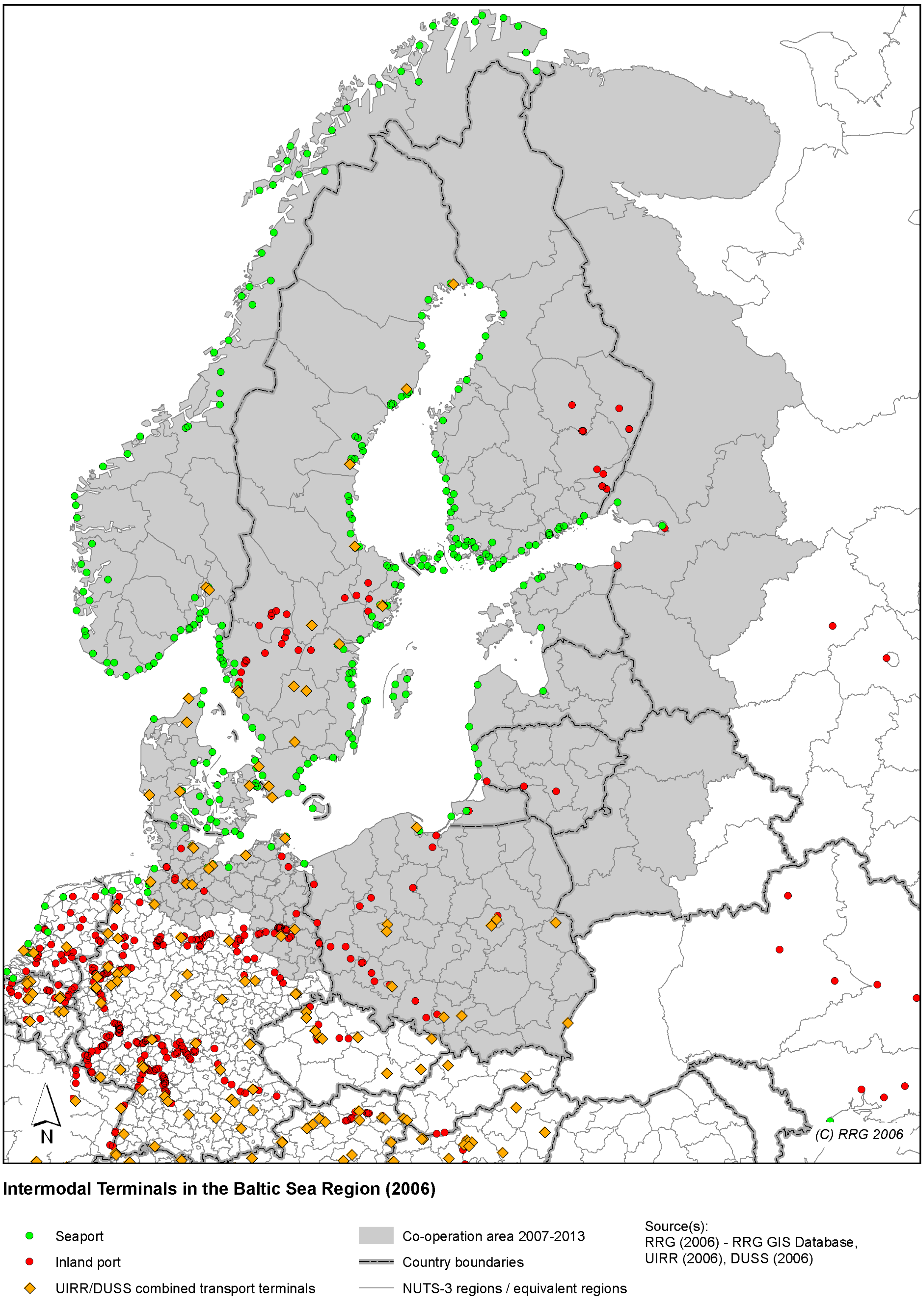


Figure 4. Intermodal transport terminal database.

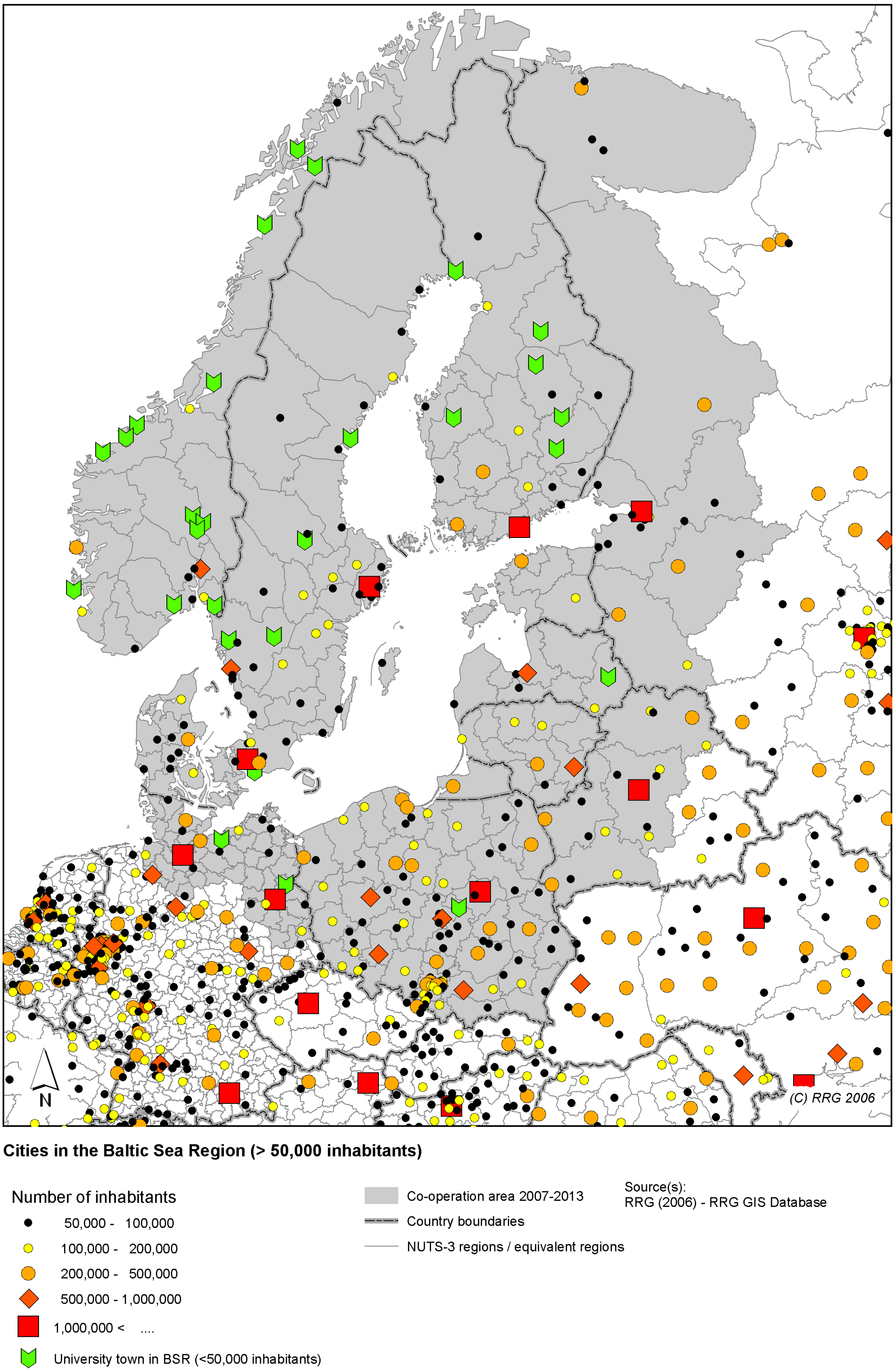


Figure 5. BSR urban system.

4. New Accessibility Indicators for the BSR

In this chapter the main results of the study, the new accessibility indicators for the BSR are presented. First, the transport infrastructure and ICT endowment indicators are presented. Then, the selected representatives for the accessibility types travel cost, daily accessibility and potential accessibility follow.

4.1 Car Travel Times to Rail Stations

This accessibility indicator is of the endowment type. It shows the access time by car to rail stations. Information on the importance – or hierarchy – of railway stations is not available for all countries. Also information on the frequency of rail services is not included, which means that the surrounding of a train station which has only one or two trains per day is coloured the same way as the surrounding of a train station with frequent services. Due to lack of data, for some countries outside the BSR only a selection of most important railway stations are taken into account as destinations, while for the remaining countries all railway stations are used for the analysis.

Access time to railway stations is calculated as the car travel time from each raster cell to the next station. A raster system with a cell size of 2x2 km is applied. In a second step the information at the raster cell level is aggregated to NUTS-3 regions by calculating the average of all raster cells belonging to a region, in order to facilitate comparison with other regional accessibility indicators.

The indicator results are illustrated in Figure 6 at raster cell level and Figure 7 at NUTS-3 level. Apparently Denmark, Germany and Poland as a whole stand out with very good rail access, as from all parts of the countries the next railway station can be reached within 45 minutes, in many parts even in less then 30 or 15 minutes. In other countries of the BSR the railway corridors become visible with good access times to the next rail stations, but regions outside these corridors experience medium to long access times, e.g. in parts of Finland and Russia with access times of 90 to 150 minutes. Areas in western and northern Norway, in northern Sweden and Finland and also areas in the remote parts of Russia do not have rail infrastructure leading to access times of more than three hours.

The aggregation of the data to NUTS-3 regions leads to the recognition of some general spatial patterns (Figure 7). In Denmark and Germany the whole countries show very good access to rail stations, i.e. very short access times. In Poland a divide between western (very good access) and eastern Poland (relatively good access) can be observed. For Sweden and Finland clear south-north gradients can be seen, with good and very good access in the southern parts of the countries and poor access in the northern regions. Belarus and the southern parts of Russia show medium to good access to rail stations, while the access times increases going further north with extremely poor access in the Murmansk region. The three Baltic countries in general have a good access to rail stations due to the relative high station density while at the same time representing relative small territories, with the exception of Lääne-Eesti, a NUTS-3 region comprising also many islands. Finally, Norway is the country with the greatest disparities in access to rail stations: While the Oslo area experiences very good access, the two northernmost regions of Troms and Finmark have extremely poor access to stations.

Table 1 gives aggregate results at country level. Norway and Russia turn out to have longest average access times with 120 and 114 minutes, respectively. Both countries also experience the longest maximum access times with more than 600 minutes. Consequently also the standard deviation is highest in these countries. Denmark, Germany and Poland are at the other end of the spectrum with average access times of less than 26 minutes. Notably, Latvia and Lithuania also rank high with mean travel times of 24 and 26 minutes, respectively, and small standard deviations demonstrating a rather even level of access to rail stations throughout these two countries.

*Table 1. Car travel time to rail stations.**

Country	Average travel time (min)	Standard deviation travel time (min)	Maximum travel time (min)
Belarus **	43	18	149
Denmark	20	21	200
Estonia	49	62	268
Finland	76	65	366
Germany **	12	7	96
Latvia	24	14	75
Lithuania	26	12	67
Norway	120	107	604
Poland	19	10	123
Russia **	114	120	678
Sweden	49	49	373
BSR area	*70*	*86*	*678*

[*] *statistics calculated are based on raster cells*
*** only those parts of the countries considered which are eligible under BSR Programme*

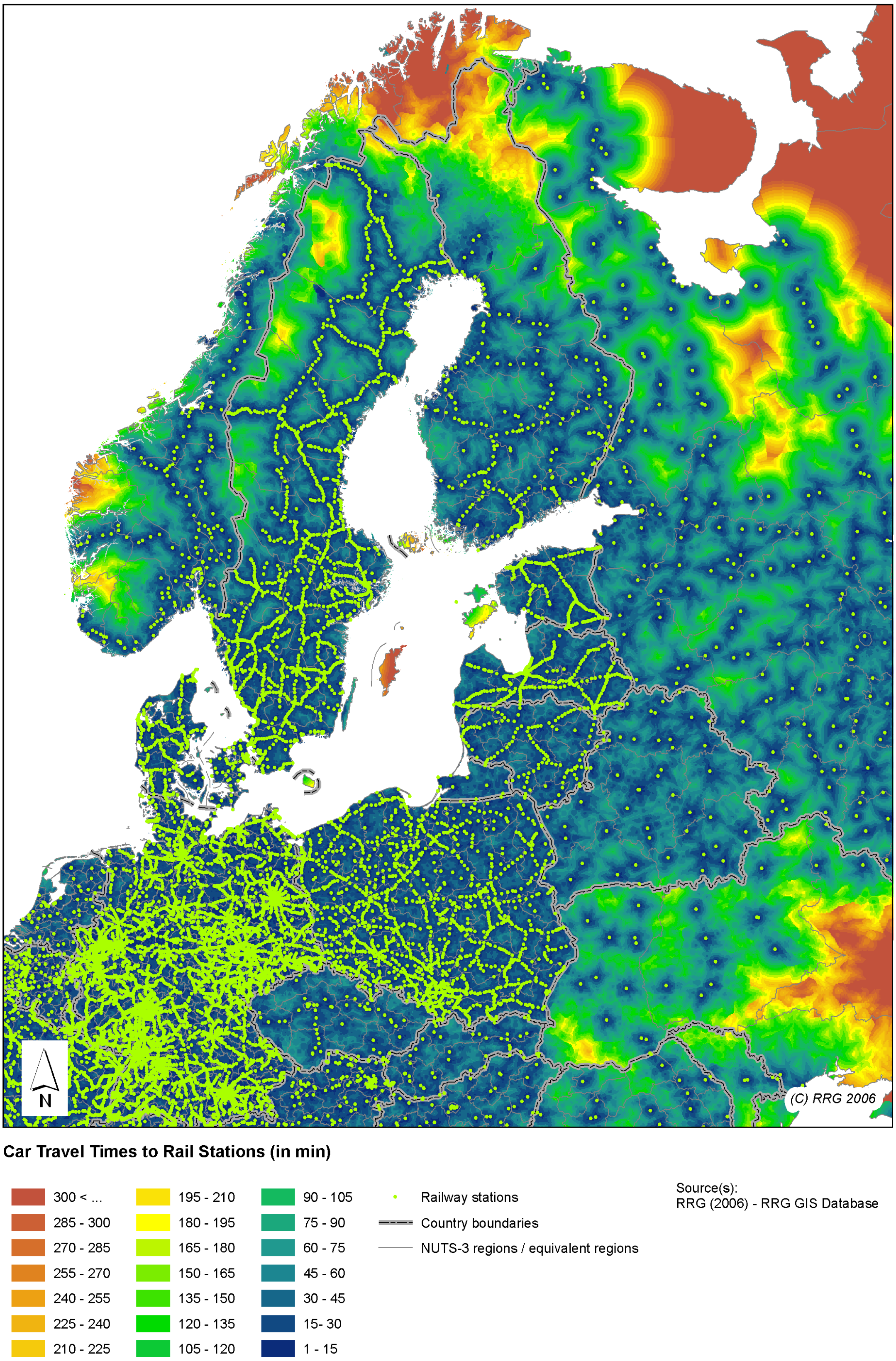
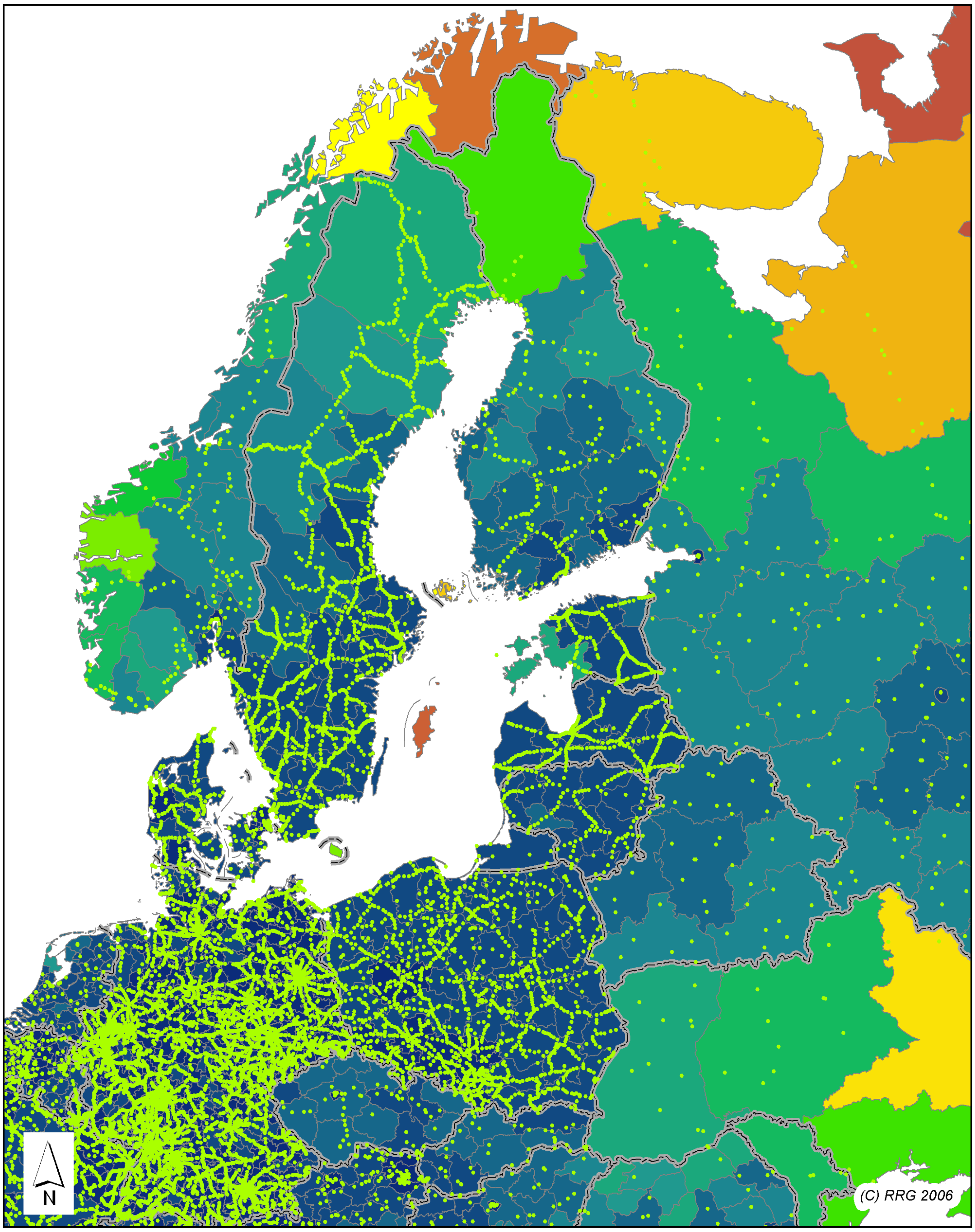


Figure 6. Car travel time to rail stations (raster level).



Car Travel Times to Rail Stations (NUTS-3) (in min)

300 < ...	195 - 210	90 - 105	Railway stations
285 - 300	180 - 195	75 - 90	Country boundaries
270 - 285	165 - 180	60 - 75	NUTS-3 regions / equivalent regions
255 - 270	150 - 165	45 - 60	
240 - 255	135 - 150	30 - 45	
225 - 240	120 - 135	15 - 30	
210 - 225	105 - 120	1 - 15	

Source(s):
RRG (2006) - RRG GIS Database

Note:
NUTS-3 travel time calculated as average over NUTS-3 region raster cells.

Figure 7. Car travel time to rail stations (NUTS-3 level).

4.2 Car and Rail Travel Times to Commercial Airports

The second accessibility indicator is also of the endowment type. The concept is similar to the previous one. The indicator shows access times to commercial airports.

Both, car and rail travel times are calculated for this analysis. All airports that offer scheduled flights are included in the list of destinations (see Figure 3). Again, the base calculation is done on a 2x2 km raster grid; results are aggregated in a second step to NUTS-3 regions. The indicator results are illustrated in Figures 8 to 11 for both road and rail modes for the two spatial levels.

In general, there are great disparities within all countries in the access times to commercial airports for both modes. Even in Germany with a relative high number of airports and good overall transport infrastructure there are regions with travel times of more than two hours to the next commercial airport, while there are other parts of the country with very good access with access times less than 15 minutes. Comparing the results for road and rail it is obvious that in most areasy the access times for rail are longer than for road: the 15 and 30 and 45 minute isochrones for the rail mode are significant smaller in all countries compared to their counterparts for road. These effects are most pronounced in the Baltic countries, in Poland and Belarus, as well as in many parts of Russia and also in Finland. The rather even distribution of commercial airports in the Nordic countries illustrates the importance of airports for travel in those areas. There is no south-north gradient in the access time to airports, however, at the raster level (Figures 8 and 10) there are greater disparities within a region than between them.

This is also reflected in the aggregated maps at NUTS-3 level (Figures 9 and 11). While the NUTS-3 regions hosting an airport and also smaller NUTS-3 regions close to airport regions experience very good access levels, NUTS-3 regions without any airport and NUTS-3 regions with a great territory do have intermediate levels of access to airports. NUTS-3 regions with poor and extremely poor levels of access can only be found in Eastern Europe (eastern parts of Poland, as well as Estonia, Belarus, and Russia). Due to the relative dense system of regional airports in the northernmost regions of Norway, Sweden and Finland, these regions have generally higher access levels as many parts of the Baltic countries and as many regions in Eastern Europe.

These findings are also reflected at national level (Table 2). In general, the average travel times, standard deviations and maximum travel times are higher for rail compared to road in all countries except for Denmark, Norway and Sweden, and to some extent also Finland and Poland where rail access is in a similar range as road access. Moreover, the summary results for both modes for the Nordic countries are generally better than for many other countries (such as Estonia, Latvia, Poland, Belarus, Russia) due to the huge differences in airport endowment. The average access level to airports by car is best in Germany. However, the BSR area in Germany is ranked lower than Sweden, Poland, Finland, Norway and Denmark considering access by rail. This also reflects that the rail network in northeast Germany is relatively weak, and that the airports are not directly linked to the rail network.

Table 2. Car and rail travel rimes to commercial airports.[*]

Country	Road			Rail		
	Average travel time (min)	Standard deviation travel time (min	Maximum travel time (min)	Average travel time (min)	Standard deviation travel time (min	Maximum travel time (min)
Belarus **	199	90	503	402	178	1006
Denmark	83	43	218	86	39	209
Estonia	131	62	321	168	71	330
Finland	101	51	397	122	72	453
Germany **	72	30	221	145	59	443
Latvia	164	66	342	207	74	515
Lithuania	90	35	213	155	78	396
Norway	110	60	327	117	64	382
Poland	132	54	339	139	60	396
Russia **	335	164	801	669	328	1602
Sweden	111	63	334	112	61	338
BSR area	*167*	*132*	*801*	*334*	*263*	*1602*

[*] *statistics calculated based on raster cells:*
*** only those parts of the countries considered which are eligible under BSR Programme*

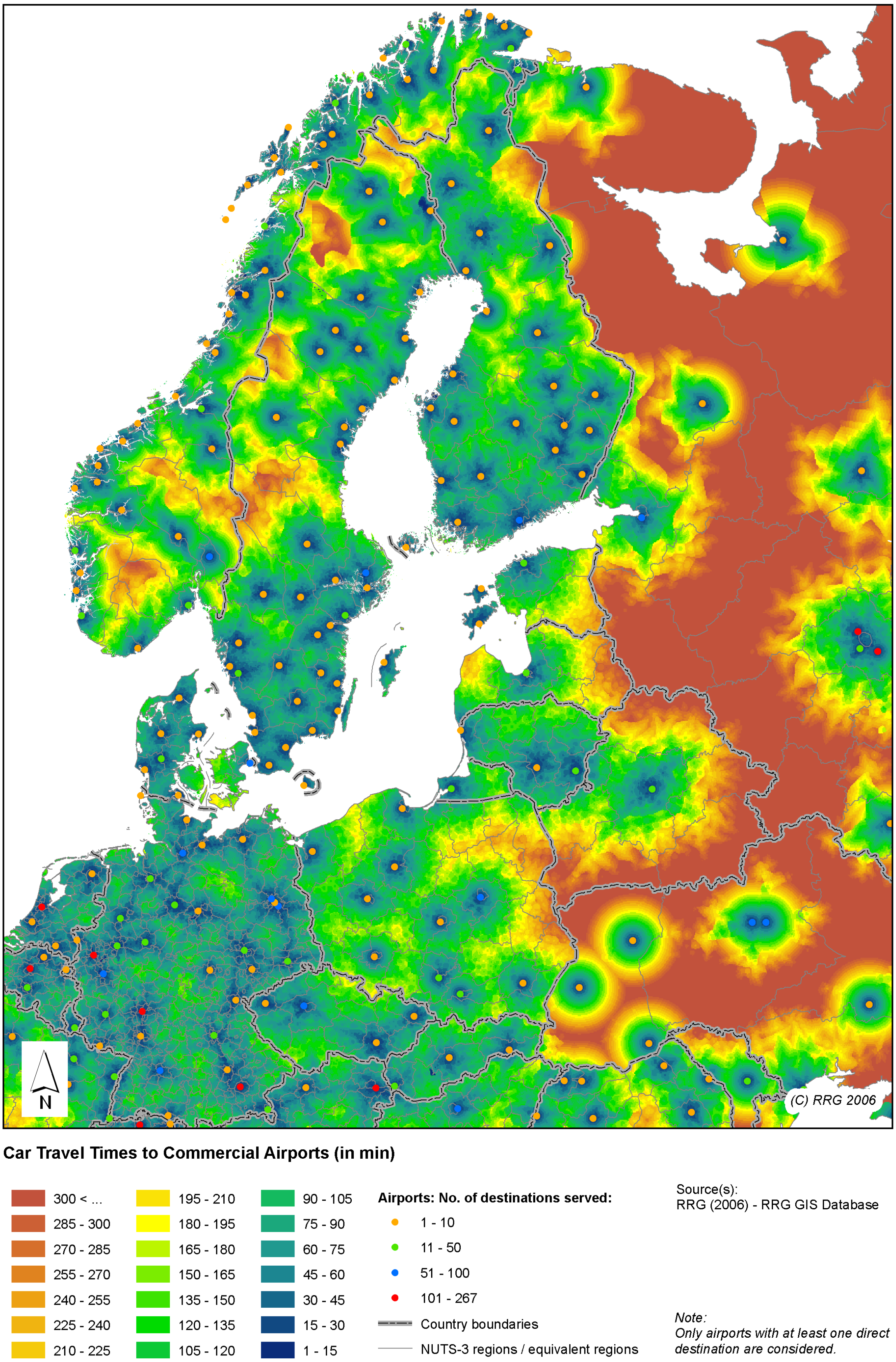


Figure 8. Car travel times to commercial airports (raster level).

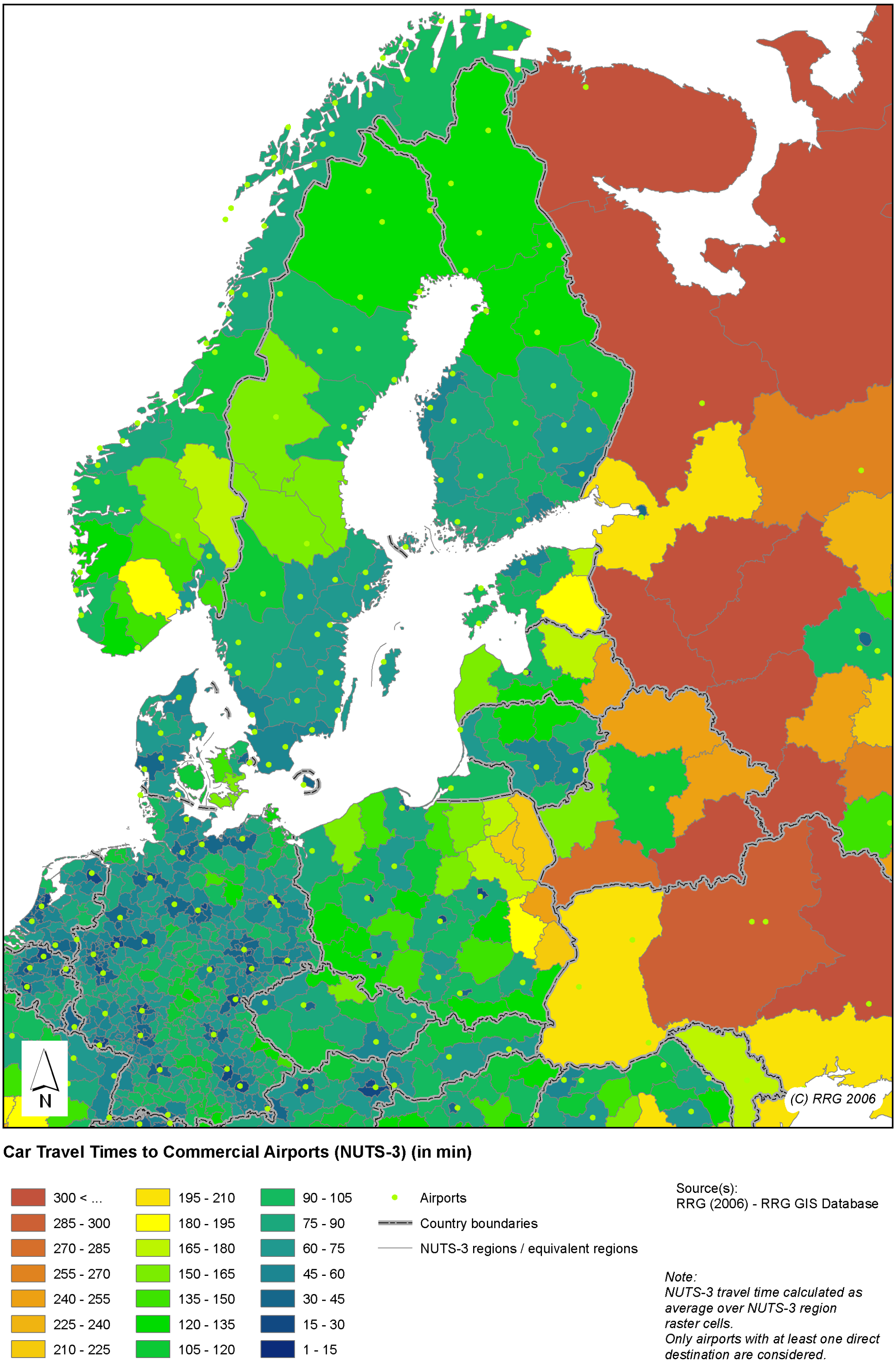


Figure 9. Car travel times to commercial airports (NUTS-3 level).

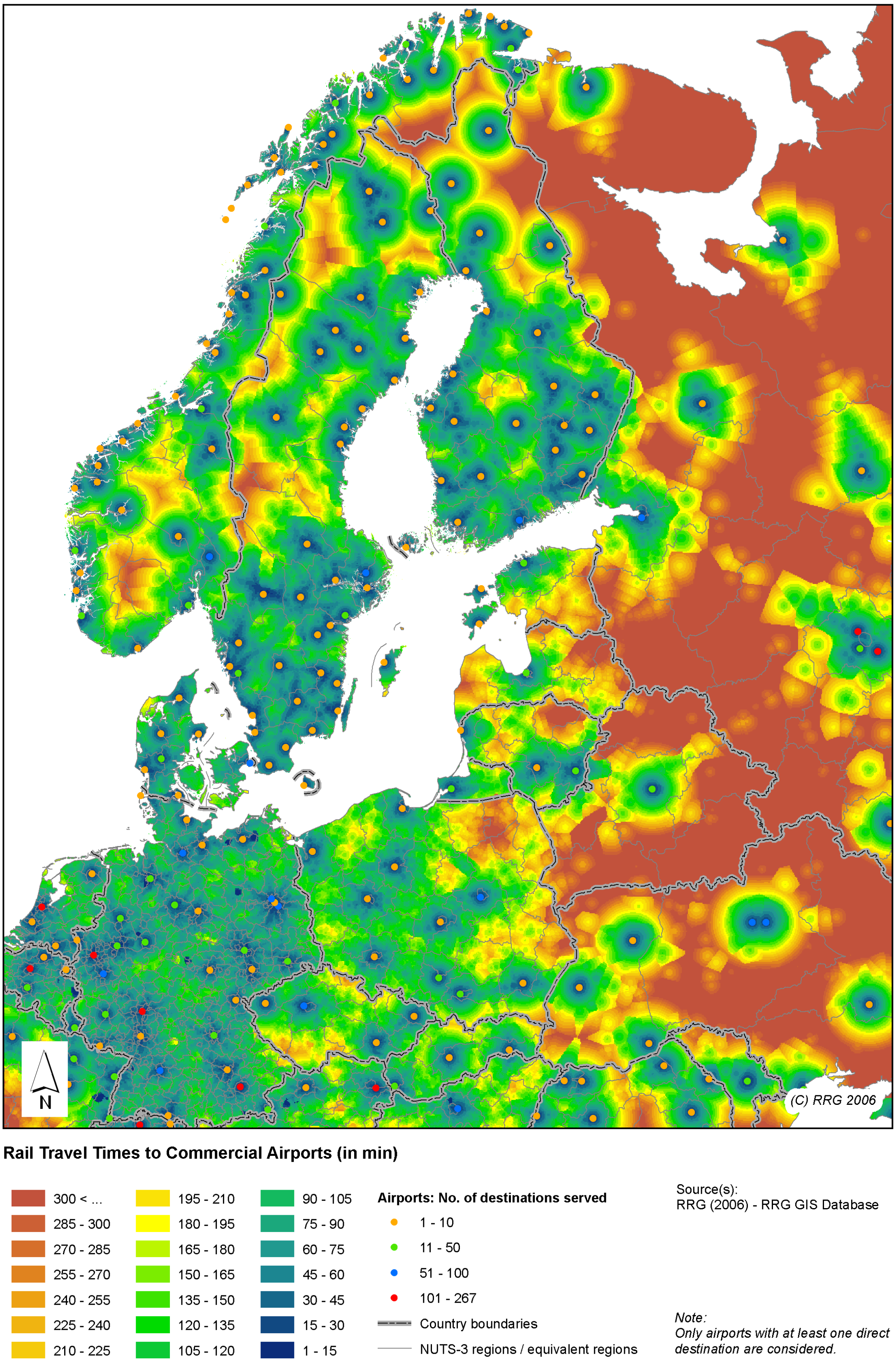
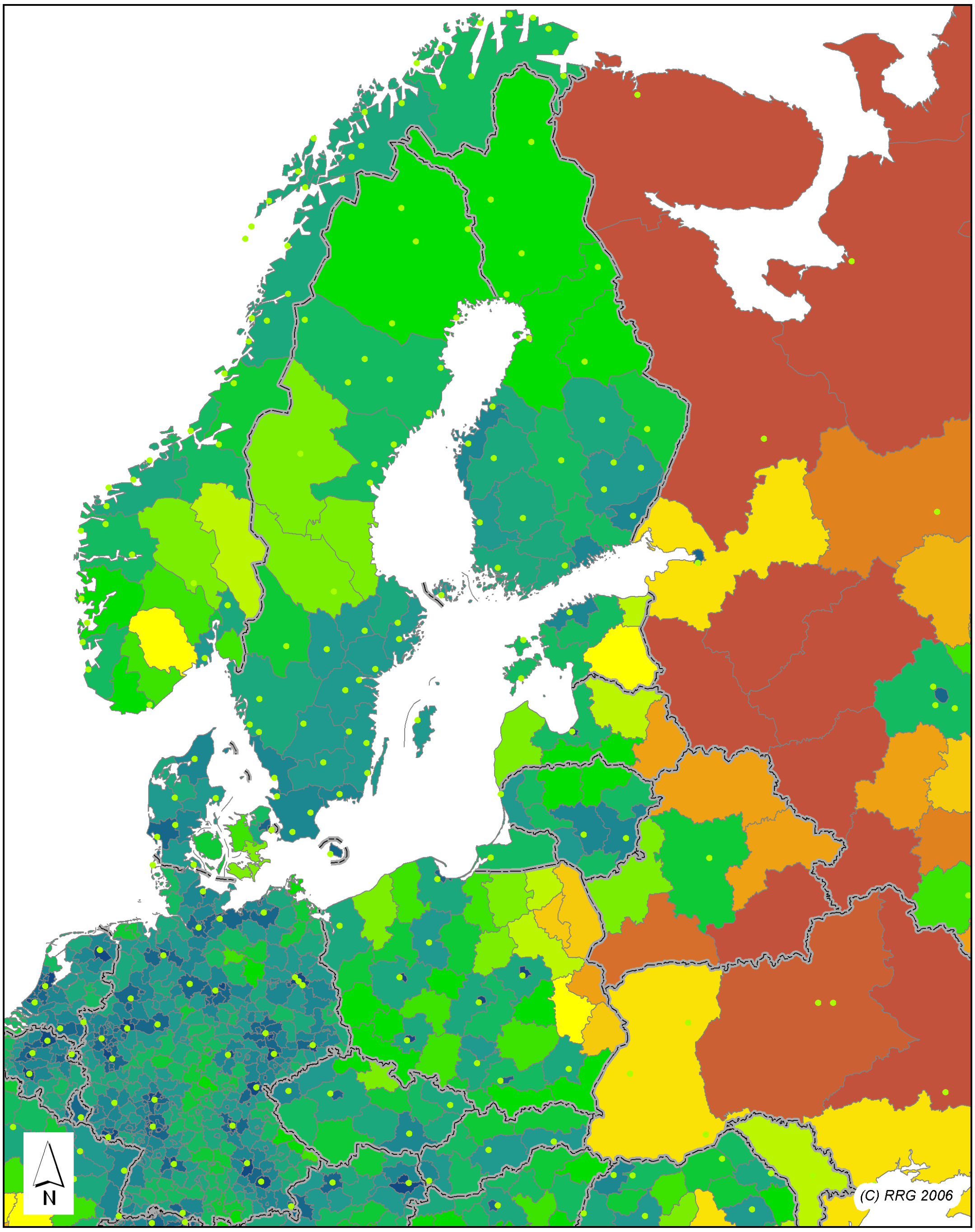


Figure 10. Rail travel times to commercial airports (raster level).



Rail Travel Times to Commercial Airports (NUTS-3) (in min)

300 < ...
285 - 300
270 - 285
255 - 270
240 - 255
225 - 240
210 - 225
195 - 210
180 - 195
165 - 180
150 - 165
135 - 150
120 - 135
105 - 120
90 - 105
75 - 90
60 - 75
45 - 60
30 - 45
15 - 30
1 - 15

Airports
Country boundaries
NUTS-3 regions / equivalent regions

Source(s):
RRG (2006) - RRG GIS Database

Note:
NUTS-3 travel time calculated as average over NUTS-3 region raster cells.
Only airports with at least one direct destination are considered.

Figure 11. Rail travel times to commercial airports (NUTS-3 level).

4.3 Lorry Travel Times to Transport Terminals

The third accessibility indicator of the endowment type gives a measure for freight transport. The indicator shows freight transport times to transport terminals based on lorry travel times. Similar to the previous indicators, the first map presents the indicator results at the 2x2 km raster level (Figure 12), while the following map illustrates the aggregated results at NUTS-3 level (Figure 13).

The results at raster level show very distinct patterns of access times (Figure 12): Coastal regions having seaports experience very good and good access times to transport terminals, and also regions along important inland waterways have good access, while the other parts of the BSR face long access times to such terminals. As a consequence, a clear gradient in the access quality from harbour regions to the hinterland is visible, which holds particularly true for the three Nordic countries, but to some extend also for Germany and Denmark. As far as Norway, Sweden and Finland are concerned, this reflects the great importance of harbour facilities for (goods) transport even in the northernmost parts of the country, in particular for ferry services and short sea shipping services. Poland and the Baltic states mark a contrast to these countries. Although they have a number of important harbours as well, the density of harbours and so the density of such transport terminals is much lower than in the other countries so that only small portions of the coastal areas benefit in terms of access times.

The NUTS-3 level map (Figure 13) is replicating the raster results in a somewhat smoothed way. Again, the coastal NUTS-3 regions stand out with good access times to transport terminals compared to mainland regions. However, as the NUTS-3 regions in northern Finland and northern Sweden have rather large territories with substantial amount of areas far away from the sea, the aggregated results for these areas give only medium to even poor access times although those regions have substantial numbers of seaports. Apart from the northernmost regions of Norway, Sweden and Finland, the longest access times are in the eastern parts of Poland, Belarus and Russia with the exception of the Kaliningrad and St. Petersburg areas.

However, in case of the northern parts of the Baltic Sea it is important not only to analyse the landside access to the transport terminals but also to mention the seaside access to the harbours, as the duration and extent of the ice coverage is hampering the usage of the ports. The ice season in the most northern part of the Baltic Sea lasts for six months and in the central parts 2-3 weeks, thus making all Finnish harbours, so as many Swedish ports ice bound during normal winters. Finland is the only country in the world of which all ports are ice bound during winter. Figures 12 and 13 are illustrating these phenomena by showing the ice coverage in the Northern parts of the Baltic Sea, the Gulf of Bothnia and the Gulf of Finland as of 16 March 2005, derived from information provided by the Finnish Institute of Marine Research (2005). At that day the extent of the ice coverage in the northernmost parts of the Baltic Sea was about 177,000 km^2. Although the maximum extend of the ice coverage is varying from year to year and week to week, it is obvious that all Finnish ports, all ports of northern Sweden, as well as all seaports in Estonia and along the Russian coast are frozen. On average the Baltic Sea starts to freeze at October / beginning of November each year, while the ice remains until April or even May, depending on the actual climatic conditions and on the lat/long position. During this period any shipping service can only be ensured through icebreakers which keep open certain channels to dedicated ports. However, although icebreakers are widely operating, free movements of cargo vessels are very limited during winter times, as only small channels through the ice are kept open, so that the seaside access to harbours is restricted.

Table 3 summarises the indicator results by country. Germany and Denmark show the shortest average travel time, followed by Lithuania. Compared to the rather good impression on the raster map, the average results for Finland, Norway and Sweden are somewhat poorer reflecting the overall size of their territories with rather great disparities between the most and least accessible parts of the countries (see for example Finland with 146 minutes on average and 558 minutes at maximum with a standard deviation of 106 minutes).

*Table 3. Lorry travel rime to transport terminals.**

Country	Average travel time (min)	Standard deviation travel time (min	Maximum travel time (min)
Belarus **	302	104	623
Denmark	52	29	152
Estonia	112	72	310
Finland	146	106	558
Germany **	50	25	168
Latvia	152	82	354
Lithuania	97	44	284
Norway	114	79	400
Poland	116	55	314
Russia **	461	273	1641
Sweden	140	101	467
BSR area	*211*	*205*	*1641*

* *statistics calculated based on raster cell:*
*** only those parts of the countries considered which are eligible under BSR Programme*

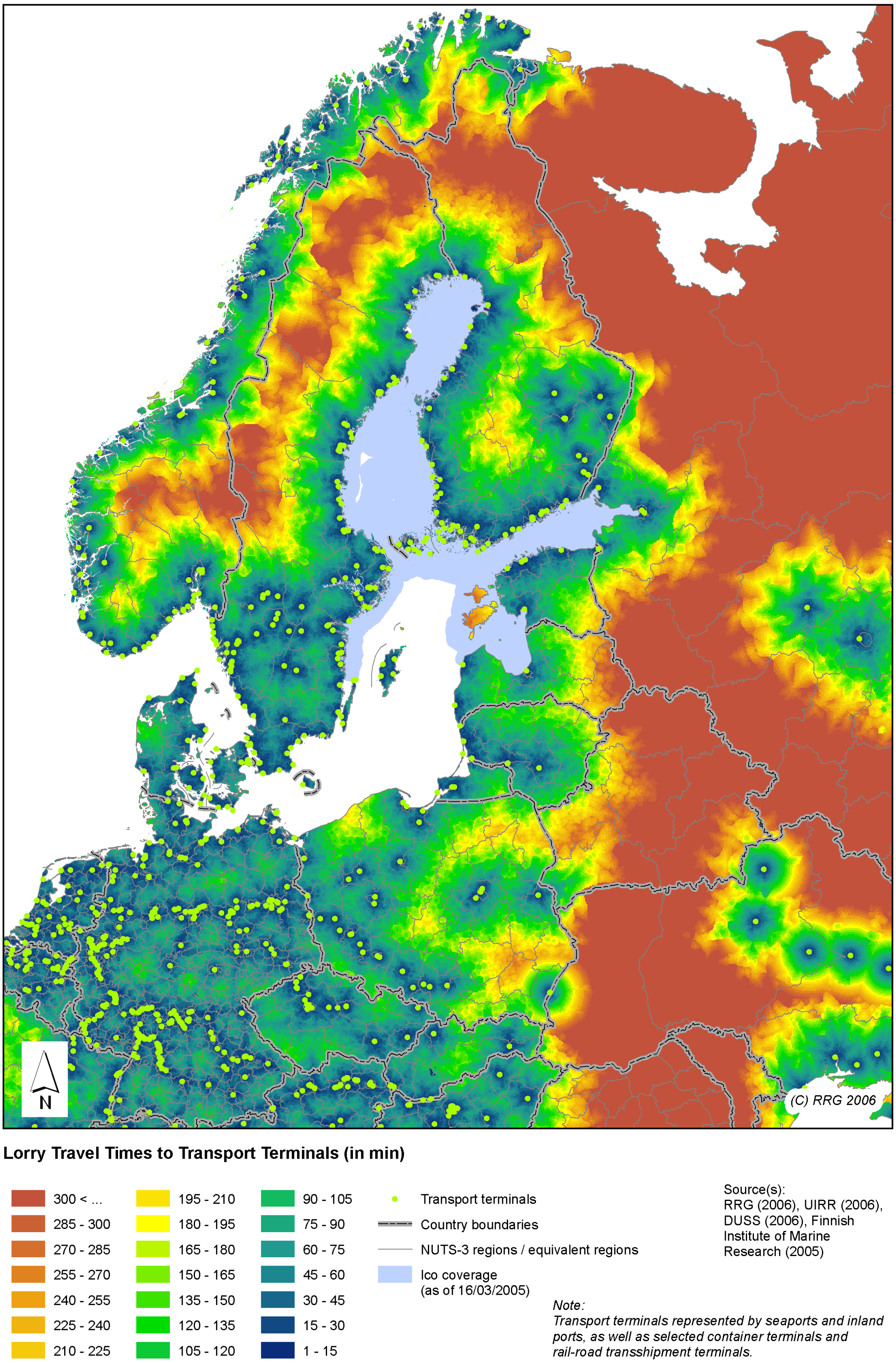


Figure 12. Lorry travel times to transport terminals (raster level).

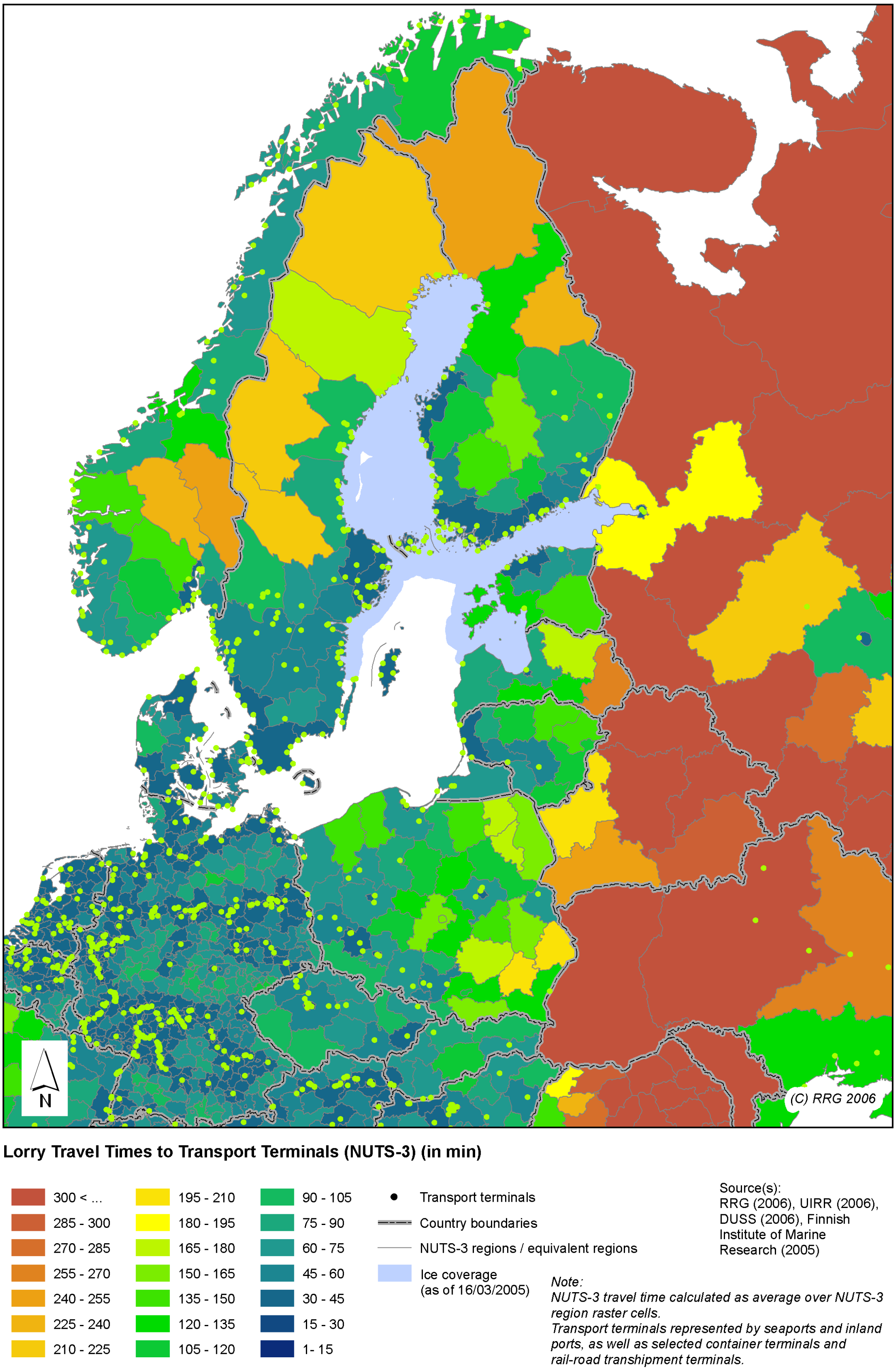


Figure 13. Lorry travel times to transport terminals (NUTS-3 level).

4.4 Mobile Telephone Penetration and Internet Access

This group of endowment indicators is different from the other accessibility indicators in two respects. First, instead of being concerned with transport it addresses the spatial diffusion and the adoption of new communication technologies. Second, whereas the other indicators are calculated by utilising spatial databases and accessibility models, the indicators of this group are coming from collected data which automatically leads to the issue of data availability, particularly at the regional level. Here, the problem is that there is almost no (regionalised) information available on the information society, However, at the same time the main differences in ICT endowment are to be observed between countries, the regional spread then follows the classical way from the national centres to the periphery (Richardson et al., 2005; ESPON 1.2.3, 2006)

For this indicator group two maps are presented, one addressing the mobile telephone penetration and one addressing access to the internet taking the fastest available technology, broadband connection, as example.

Figure 14 shows the mobile phone penetration rate for the BSR and other European countries for the year 2004. Most countries of the BSR do have more than 800 mobile phones per 1,000 inhabitants; in Norway and Sweden there are already more mobile phones than inhabitants. Poland and Latvia fall behind having only about 600 mobile phones per 1,000 persons; Russia has a mobile penetration rate of about 500 and Belarus of 250, but both countries experienced an enormous growth during the last couple of years . Table 4 gives more information by providing past data on mobile phone penetration. Almost ten years ago, the Nordic countries were the early adapter of this new communication technology with penetration rates of between 300 and 400, whereas Germany had only 100 and the eastern countries of the BSR only between twenty and forty mobile phones per 1,000 population. The exception in the eastern BSR is Estonia with already a penetration rate of 100 in 1997 and of almost 1,000 per 1,000 population in 2004. Given this temporal spatial development of the introduction of a new technology, it can be expected that in most countries the saturation level has already been reached and that the countries currently lagging will catch up very soon.

Table 4. Mobile phone penetration rate

Country	Mobile phones per 1,000 inhabitants		
	1997	2000	2004
Belarus	:	5	249
Denmark	270	630	957
Estonia	100	407	967
Finland	410	721	863
Germany	100	586	858
Latvia	30	169	673
Lithuania	40	150,	829
Norway	380	750	863
Poland	20	175	603
Russia	:	24	517
Sweden	360	718	1026

Source: Eurostat (2006b) for 1987; World Bank (2006) for 2000 and 2004

Table 5 presents broadband connection available at home. There are clear disparities in availability of fast internet access. Again, the Nordic countries are early adapters of the new technology; up to nearly 40 percent of the households have broadband at home. Germany and Estonia do follow with every fifth having broadband at home. In Poland, Latvia and Lithuania less than ten percent of the households do have fast internet access in their place of living. Table 5 gives also information on the spatial diffusion of broadband based on population density. In all countries the highest shares of broadband connection at home can be found in the densely populated areas, the lowest in the rural areas. However, it can also be seen that the share of households in the rural areas of more advanced countries are clearly higher than in the urban areas of less advanced countries with respect to the provision of broadband internet access.

Table 5. Broadband connection at home

Country	Percent of households (2004)			
	All	Densely-populated areas	Intermediate areas	Thinly populated areas
Belarus	:	:	:	:
Denmark	36	41	40	26
Estonia	20	33	n/a	15
Finland	21	25	18	12
Germany	18	29	18	13
Latvia	5	9	2	2
Lithuania	4	7	n/a	1
Norway	30	43	34	23
Poland	8	12	0	1
Russia	:	:	:	:
Sweden	:	:	:	:

Source: Eurostat (2005)

Figure 15 presents the spatial distribution of broadband subscribers per 1,000 population by country. Table 6 adds information on the temporal development depict enormous growth rates during the last couple of years in almost all countries. .

Table 6. Broadband subscription

Country	Broadband subscribers per 1,000 population		
	2000	2004	2005
Belarus	0.0	0.0	:
Denmark	10.6	168,8	250.0
Estonia	12.7	103.1	:
Finland	3.9	149.6	225.0
Germany	3.2	83.6	130.0
Latvia	0.1	16.9	:
Lithuania	0.0	37.5	:
Norway	5.2	87.4	219.0
Poland	0.0	32.7	24.0
Russia	0.0	0.9	:
Sweden	9.3	152.7	203.0

Source: World Bank (2006) for 2000 and 2004; OECD (2006) for 2005

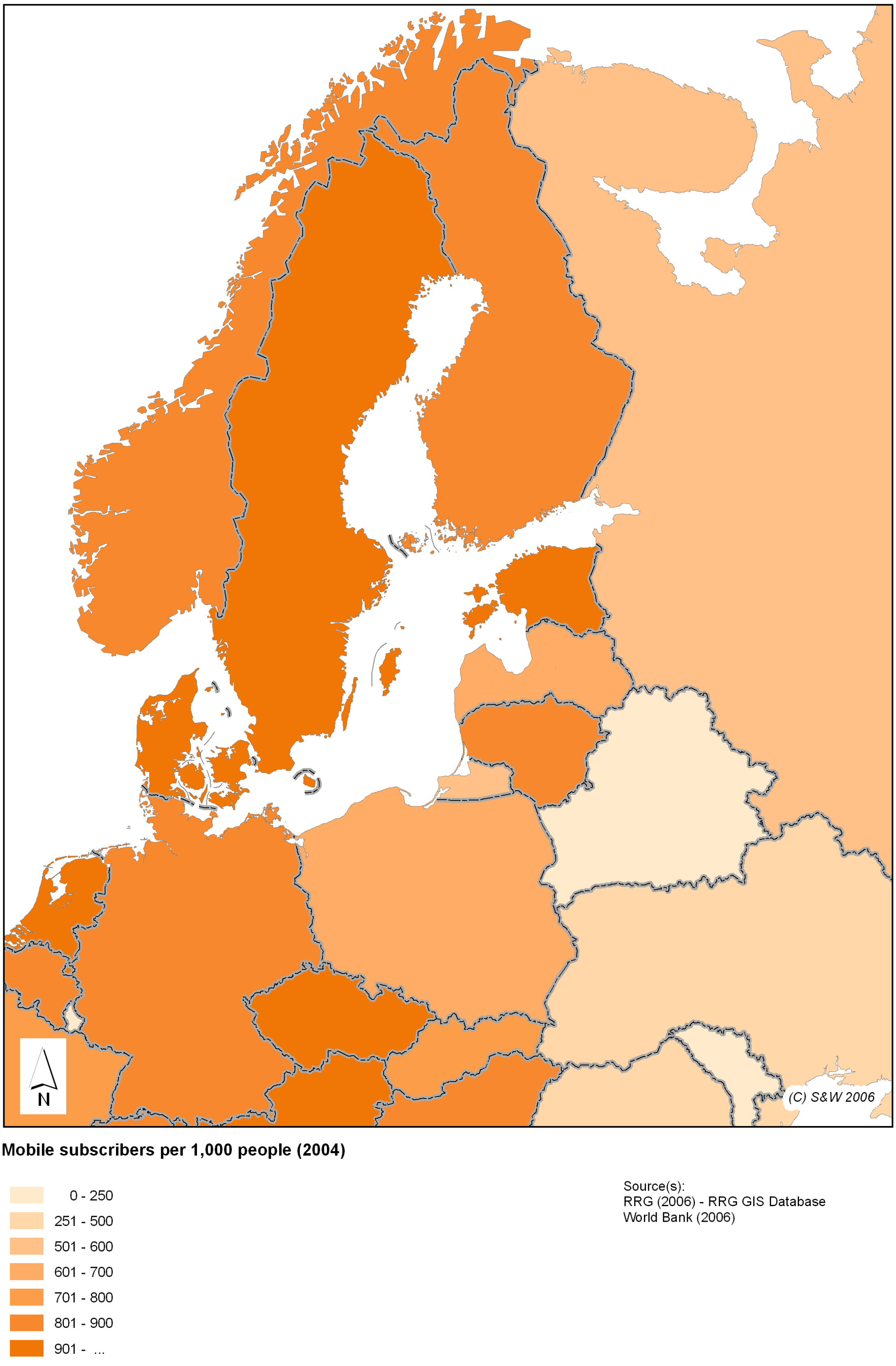
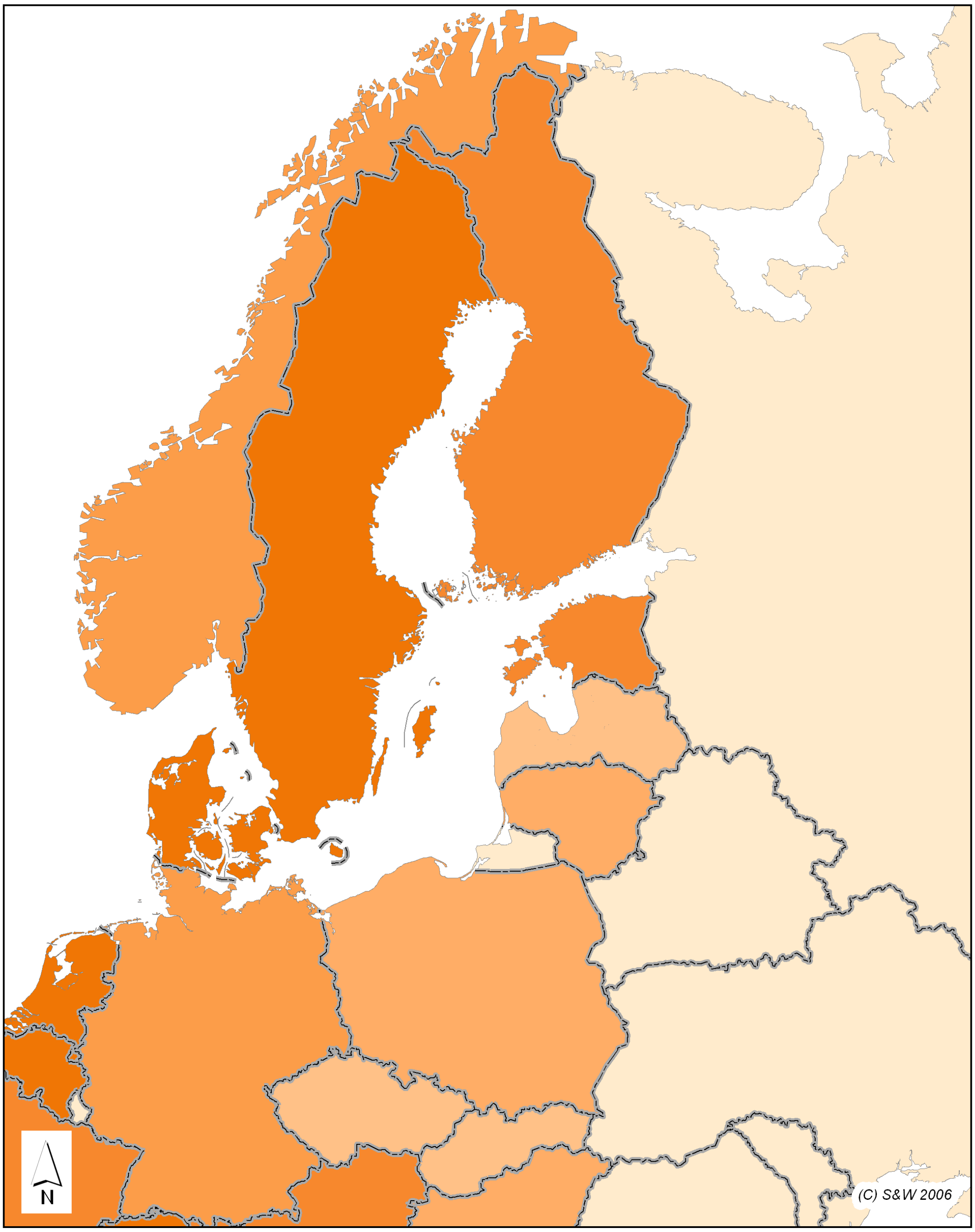
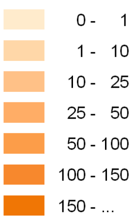


Figure 14. Mobile phone penetration.



Broadband subscribers per 1,000 people (2004)



Source(s):
RRG (2006) - RRG GIS Database
World Bank (2006)

Figure 15. Broadband penetration.

4.5 Car and Rail Travel Times to Large Cities

This indicator belongs to the travel cost indicators of the more complex group of accessibility indicators. It shows travel times to reach the next city. In BSR all cities with more than 50,000 inhabitants as well as smaller university cities are considered, while outside the BSR all cities with more than 100,000 inhabitants are taken into account.

The indicator is calculated separately for car and rail travel times. Again, a series of maps (Figures 16 to 19) is produced showing the results at raster level and at NUTS-3 level for both car and rail. It has to be noted that rail travel times include car access time to the next rail station; and in case there is no rail station, the time indicated might be only a car ride calculated with a very low average speed. The maps show travel times in classes of fifteen minutes going up to more than five hours. However, it should be taken into account when interpreting the results that travel times of more than three hours (indicated in yellow and red) mean that those areas practically do not have good car or rail access to a larger city which might be caused by a lack of cities in that part of the BSR or by a lack of appropriate transport infrastructure and services.

At raster level very distinct patterns emerge (Figures 16 and 18). For Germany and Poland, as the two countries with the highest density of regional cities, most of their territories experience very good access of less than 75 minutes to the next city, often even less than 45 or less than 30 minutes. Belarus and Lithuania both also have several regional cities and so great parts of their territory also have good access to them, while the other two Baltic countries have only few regional cities, so that consequently most of their territory experiences medium access quality. Greatest contrast between areas with good access and areas with poor access can be found in the Nordic countries and in Russia, but with individual patterns each. In Finland the regional cities are concentrated in the southern and eastern parts of the country, but they are located in such a manner that their service areas do not overlap. Areas between these service areas experience travel times of more than two hours. In Sweden the situation is somewhat different: The situation in southern Sweden can be compared with southern Finland including areas with good access quality and intermediate areas with rather medium or poor access quality.

However, the situation is changing drastically north of the Malaren Sea where regional cities can only be found scattered along the Baltic Sea coast. Consequently most of the territory has very long access times of more than three hours to the next regional city for both road and rail. This basically is also describing the situation of the whole of Norway, where the few regional cities are scattered along the coastlines, leading to good access times around these cities but poor or even very poor access times in between the fjords. The main difference between the car and rail modes is that for rail the rail corridors with shorter travel times are more pronounced while for the car the isochrones extend much more in all directions. Moreover, the railway isochrones are generally smaller than those for the cars.

These distinct patterns are also reflected at NUTS-3 level (Figures 17 and 19). In general, most of the regions in Germany, Poland and also Denmark have short access times. Most of the regions in the Baltic countries have intermediate access times, while for Sweden and Finland again a south-north gradient can be observed with good access qualities in the south and rather poor qualities in the north. Norway in general has only medium to poor access times to regional cities with the exception of the Oslo and Molde areas. Substantial differences between the accessibility patterns for cars and railways cannot be recognised, except that for the latter one the differences (disparities) between the least and best accessible regions are somewhat more pronounced.

Tables 7 and 8 aggregate the information of the maps by country. Comparing both road and rail modes, it is obvious that the average travel times for rail is higher than for road for all countries, and so are the maximum travel times and also the standard deviations. However, the overall results for the BSR (118 minutes travel time for cars on average and 143 minutes for rail) are to a large degree determined only by Norway and Russia, being the only two countries with average travel times below the BSR average. The differences between rail and road access are also visible in the share of the national territories that have access to the next city within two hours; for road almost all countries have more than 90 percent in this travel time class, for rail only Denmark, Germany and Poland.

*Table 7. Car travel times to large cities. **

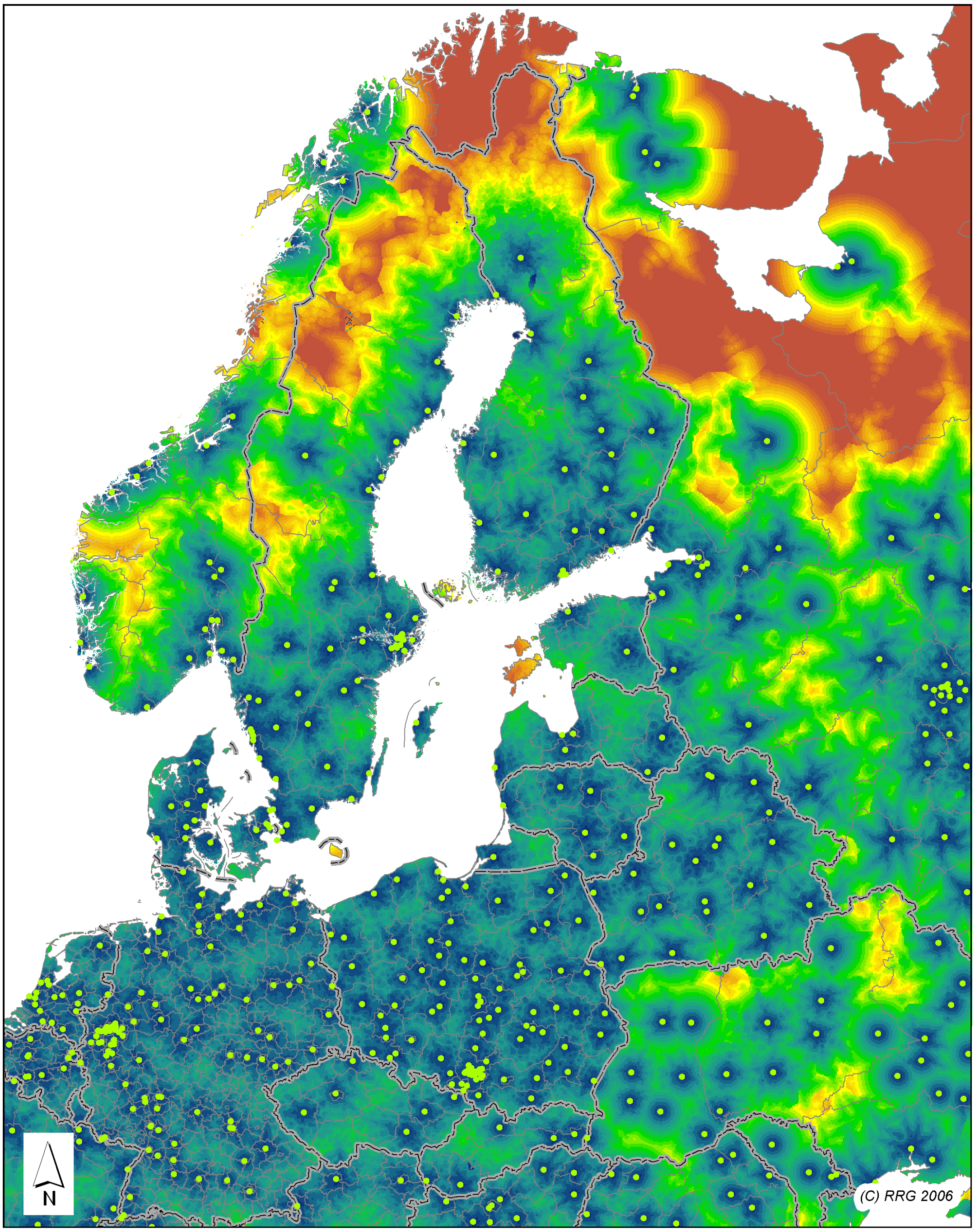
Country	Travel times			Share of territory with travel time (%) of			
	Average travel time (min)	Standard deviation travel time (min	Maximum travel time (min)	< 2h	2h < 3h	3h < 4h	> 4h
Belarus **	56	24	163	99.3	0.7	0.0	0.0
Denmark	48	32	235	98.5	0.1	1.4	0.0
Estonia	91	65	302	89.7	1.9	2.4	6.0
Finland	108	78	417	68.2	14.0	8.1	9.7
Germany **	38	15	124	99.9	0.1	0.0	0.0
Latvia	66	27	143	99.1	0.9	0.0	0.0
Lithuania	50	18	126	99.9	0.1	0.0	0.0
Norway	159	113	571	42.9	26.4	13.1	17.6
Poland	42	18	128	99.9	0.1	0.0	0.0
Russia **	183	129	645	42.0	17.7	11.0	29.3
Sweden	117	81	410	56.8	18.1	14.0	11.1
BSR area	*118*	*103*	*645*	*65.8*	*13.2*	*8.2*	*12.8*

** statistics calculated based on raster cells:*
*** only those parts of the countries considered which are eligible under BSR Programme*

*Table 8. Rail travel times to large cities. **

Country	Travel times			Share of territory with travel time (%)			
	Average travel time (min)	Standard deviation travel time (min	Maximum travel time (min)	< 2h	2h < 3h	3h < 4h	> 4h
Belarus **	76	35	213	89.1	10.6	0.3	0.0
Denmark	56	35	230	95.2	3.5	1.3	0.0
Estonia	109	54	337	62.7	28.7	7.5	1.1
Finland	147	128	594	58.5	13.6	6.5	21.4
Germany **	48	24	142	99.7	0.3	0.0	0.0
Latvia	107	53	236	58.7	31.6	9.7	0.0
Lithuania	80	34	171	85.3	14.7	0.0	0.0
Norway	181	142	682	37.8	24.4	16.4	21.4
Poland	53	26	144	99.2	0.8	0.0	0.0
Russia **	220	141	691	29.6	18.4	14.4	37.6
Sweden	131	90	426	51.8	16.1	15.8	16.3
BSR area	*143*	*123*	*691*	*57.2*	*15.1*	*9.9*	*17.8*

** statistics calculated based on raster cells:*
*** only those parts of the countries considered which are eligible under BSR Programme*



Car Travel Times to Large Cities (in min)

300 < ...
285 - 300
270 - 285
255 - 270
240 - 255
225 - 240
210 - 225
195 - 210
180 - 195
165 - 180
150 - 165
135 - 150
120 - 135
105 - 120
90 - 105
75 - 90
60 - 75
45 - 60
30 - 45
15 - 30
1 - 15

Cities
Country boundaries
NUTS-3 regions / equivalent regions

Source(s):
RRG (2006) - RRG GIS Database

Note:
In BSR: all cities > 50,000 inhabitants plus cities with facilities for higher education (universities, polytechnics)
Outside BSR: all cities > 100,000 inhabitants

Figure 16. Car travel times to large cities (Raster level).

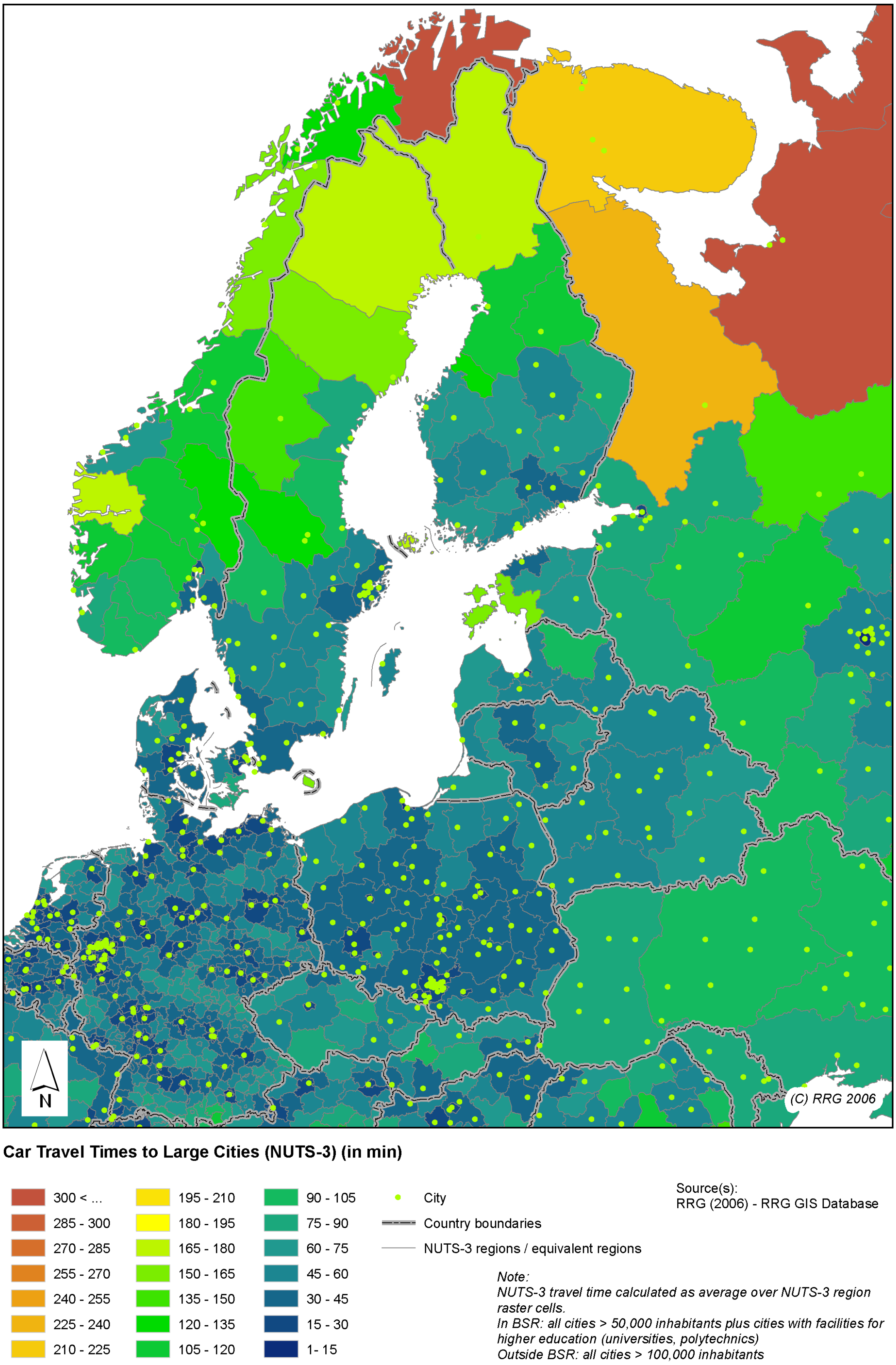


Figure 17. Car travel times to large cities (NUTS-3 level).

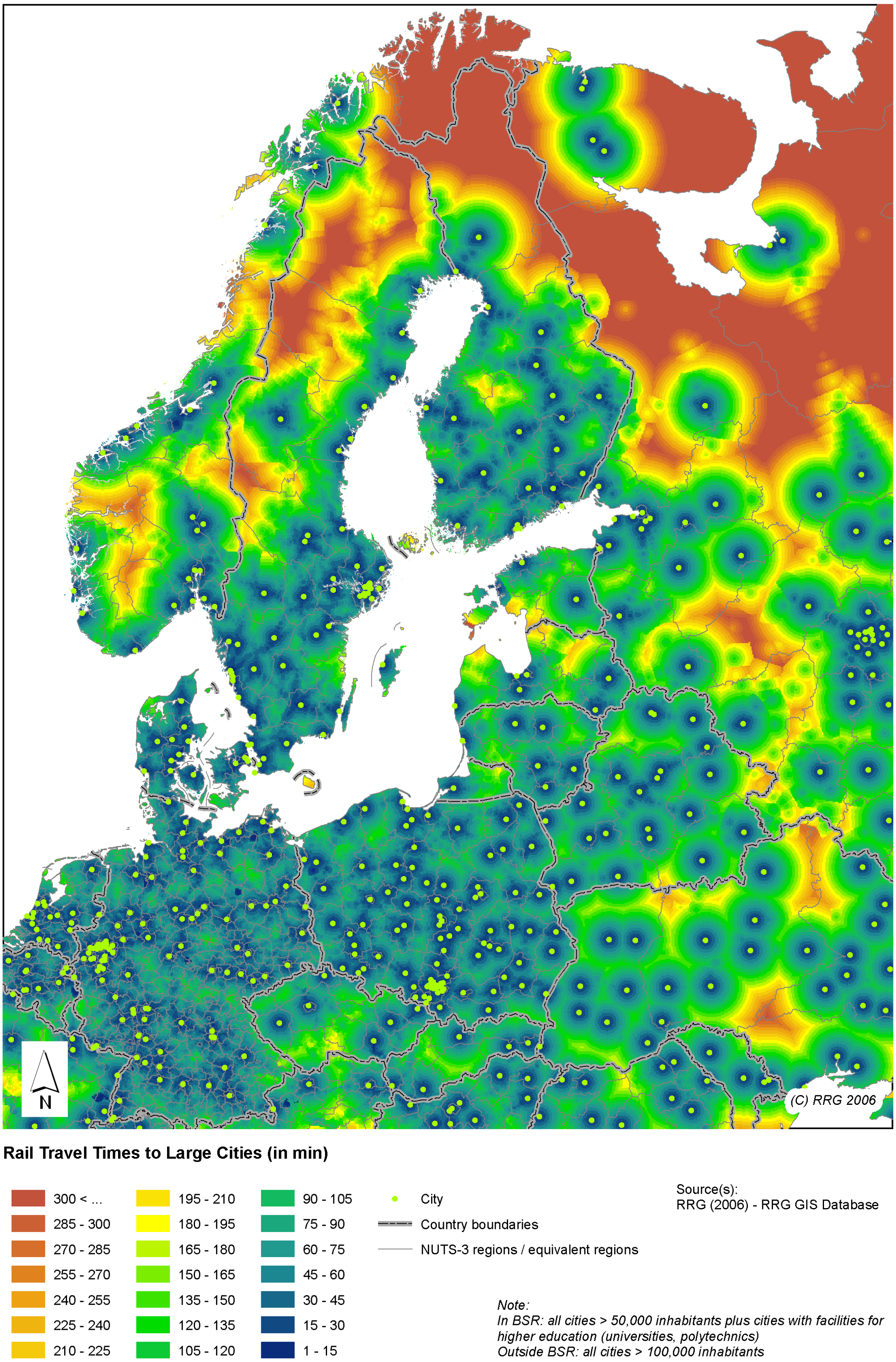


Figure 18. Rail travel times to large cities (raster level).

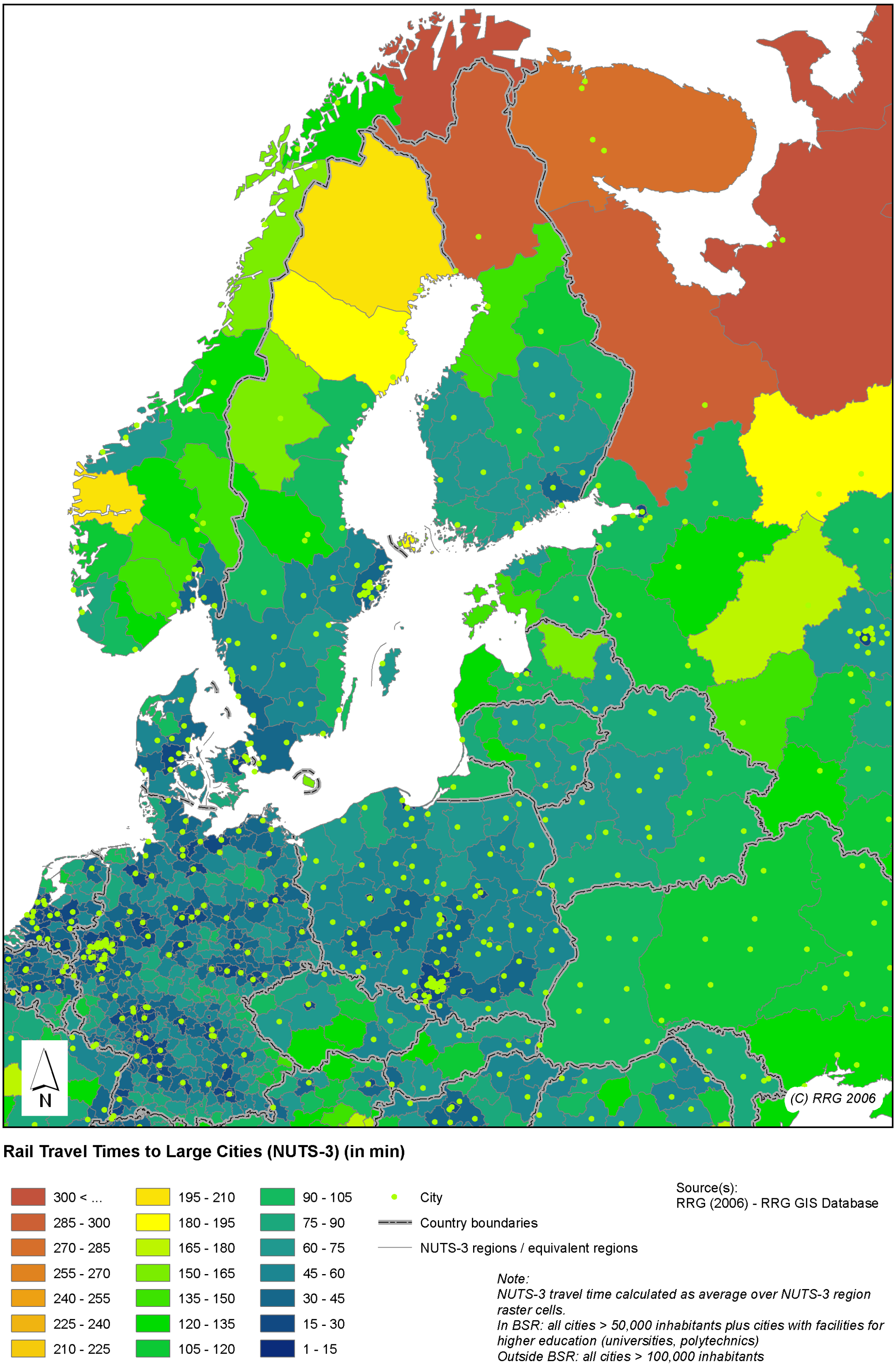


Figure 19. Rail travel times to large cities (NUTS-3 level).

4.6 Travel Times between BSR Cities

The indicator "Travel time between BSR cities" belongs to the group of daily accessibility indicators. It shows the travel time relationships between the main urban centres in the BSR. So, conceptually, there is a fundamental difference to the previous indicator which displays travel times to the next city, i.e. in this way also shows the service areas of the cities, whereas the indicator in this section shows the connectivity of the Baltic urban system. The indicator will display whether the current BSR transport services are in line with the spatial structure of the urban system or not.

For this indicator a map type has been developed that is based on current road, rail and air travel times between the BSR cities of more than 50,000 inhabitants; to reflect the peculiarities of the BSR urban system also university towns with less than 50,000 inhabitants are included. This indicator follows the idea developed in ESPON 1.2.1 (Mathis et al., 2005) to display travel times between cities if the travel time is below a certain threshold. Based on the network infrastructure database (see Chapter 2), a dataset was developed that contains the road, rail and air travel times between all BSR city centres, i.e. the access times to the rail and air networks were included. Two travel time thresholds were defined. First, travel times below 3 hours one way indicate a potentially very close relationship between cities, because it is relatively easy to make a journey back and forth within one day. A travel time below 5 hours one way is taken as the second threshold, because even with this longer duration of the journey, it is still possible to do a, however less convenient, roundtrip in one day.

Figures 20 to 23 show the results of this urban connectivity indicator for the three modes road, rail and air and eventually for an overlay of the three modes, i.e. the fastest mode. All four maps show remarkable features of the BSR urban system.

Figure 20 displays the connectivity of cities by road. Not surprisingly, a large number of connections below 3 hours are to be found where the density of cities is higher, i.e. mainly in Poland and the BSR areas in Germany. But whereas Poland displays an urban system more evenly distributed over the territory leading to a narrow mesh of potential connections, this part of Germany is dominated by the two cities of Berlin and Hamburg. North-eastern Poland, Lithuania, Latvia and Belarus show a regular pattern of connections in a less dense urban system, however, because of the road quality, the travel times are more often in the range of three to five hours. Denmark and the southern areas of Sweden and Finland have also less dense urban networks, but travel times are more often below three hours. Connected urban system in Norway are only in the Oslo area, the same is true for the Russian parts of the BSR in which road connected urban systems are only visible in the St. Petersburg area. Estonia has only very few cities in the category defined which are connected by travel times of up to five hours.

Figure 21 shows the rail connectivity of cities. At a first view, the map looks very similar to the one for road. However, there are important differences. In many parts of the BSR including Poland, eastern Germany, Lithuania and Belarus there a substantial less connections between cities with travel times below three hours. On the other hand, in Sweden and Finland the number of connections with less than three hours travel time is higher than for road.

Figure 22 shows air connectivity of the BSR cities. The picture is completely different from the two previous ones: Whereas they show spatial structures of connectivity structures dominated by regional urban systems; now, air connectivity is dominated by larger distances within the travel time thresholds. However, the emerging urban relationships are primarily nationally dominated, in particular in the Nordic countries and in Poland. With few exceptions, only the capitals plus St. Petersburg, Hamburg and Gothenburg are offering a reasonable amount of linkages to other countries, but here again, mostly to the capitals. Thus, there are two overlapping urban spatial systems: the international network of capitals and the national star like network of the capitals and more remote smaller cities.

Figure 23 eventually shows the connectivity of the BSR urban system by all modes, i.e. if one mode offers travel times below the thresholds the corresponding line is drawn on the map. The emerging pattern is the sum of the individual modal patterns. The overlay results in a C-shaped arc of fairly good connected cities starting in St. Petersburg and going via Helsinki, Stockholm, Copenhagen, Hamburg and Berlin to Warszawa. Two specific characteristic are visible. First, the eastern parts of the BSR comprising the Baltic States, Belarus and parts of the Russian BSR area show relatively low densities of connecting potential based on both, less cities and less high-quality transport connections. Secondly, the Baltic Sea as such is still visible as an important barrier to travel in this part of Europe; only very few connections across it show travel times of less than three hours. However, there are numerous connections with travel times of less than five hours across this natural barrier.

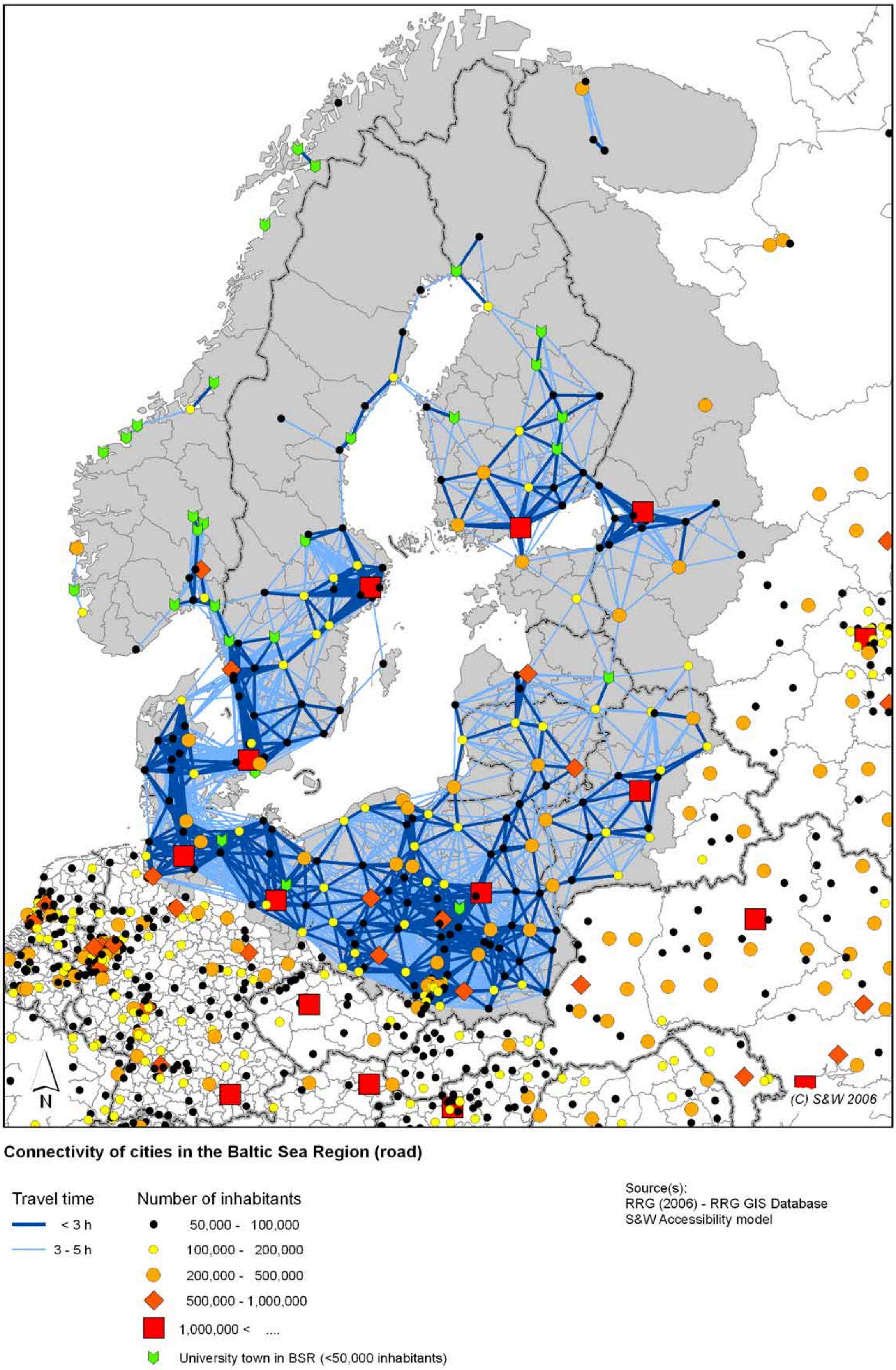
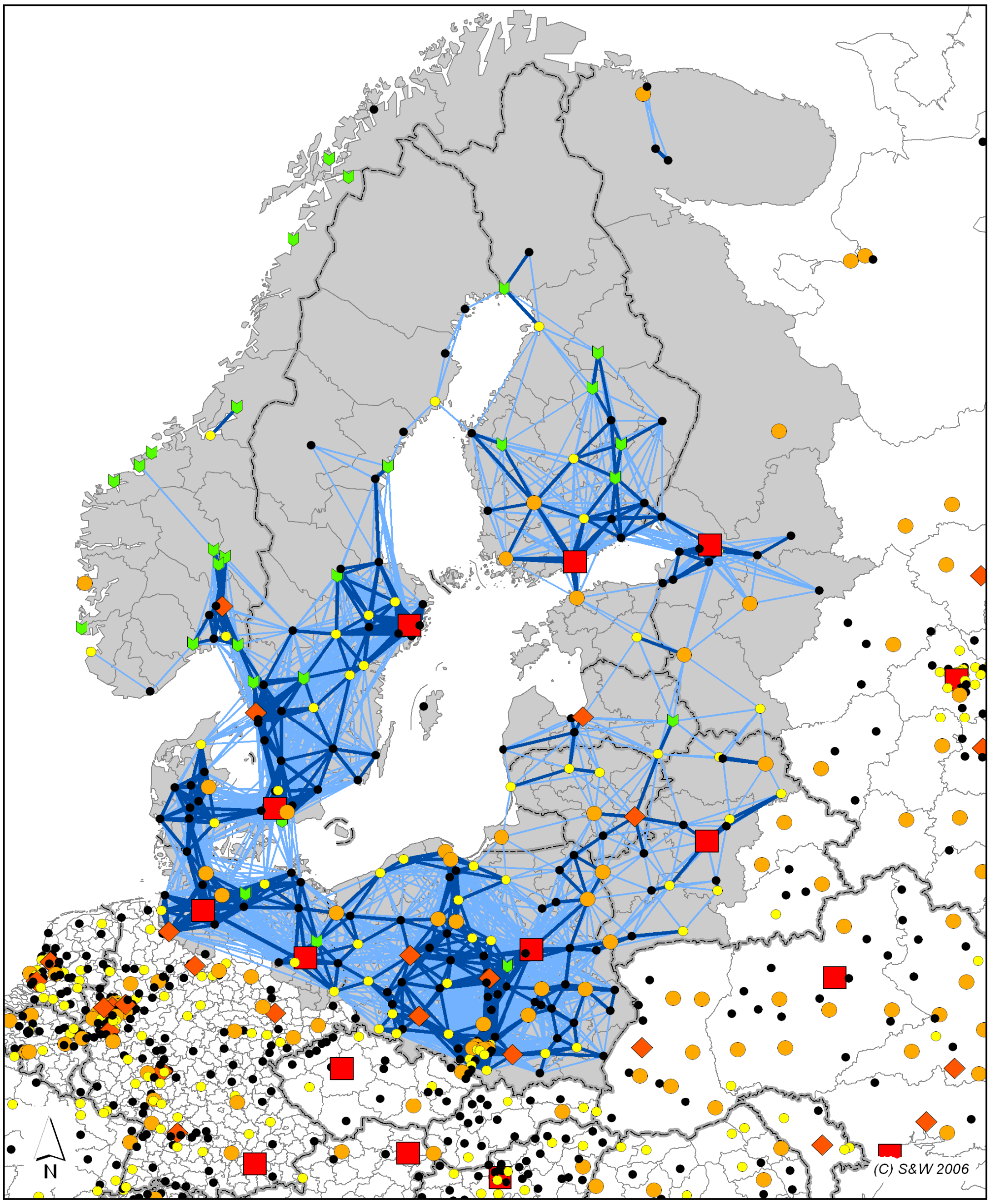


Figure 20. Road connectivity of BSR urban network.



Connectivity of cities in the Baltic Sea Region (rail)

Travel time
< 3 h
3 - 5 h

Number of inhabitants
50,000 - 100,000
100,000 - 200,000
200,000 - 500,000
500,000 - 1,000,000
1,000,000 < ....
University town in BSR (<50,000 inhabitants)

Source(s):
RRG (2006) - RRG GIS Database
S&W Accessibility model

Figure 21. Rail connectivity of BSR urban network.

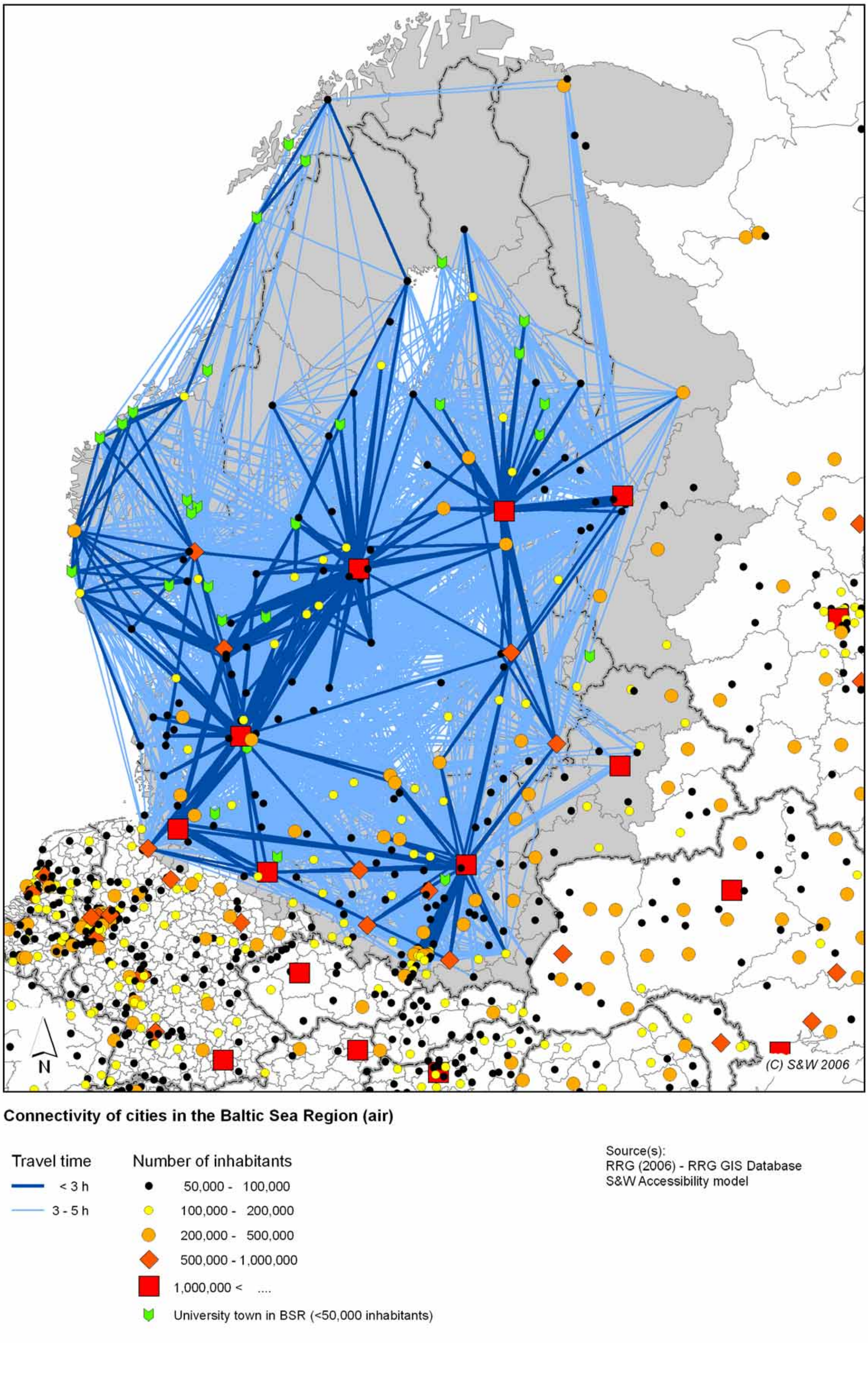


Figure 22. Air connectivity of BSR urban network.

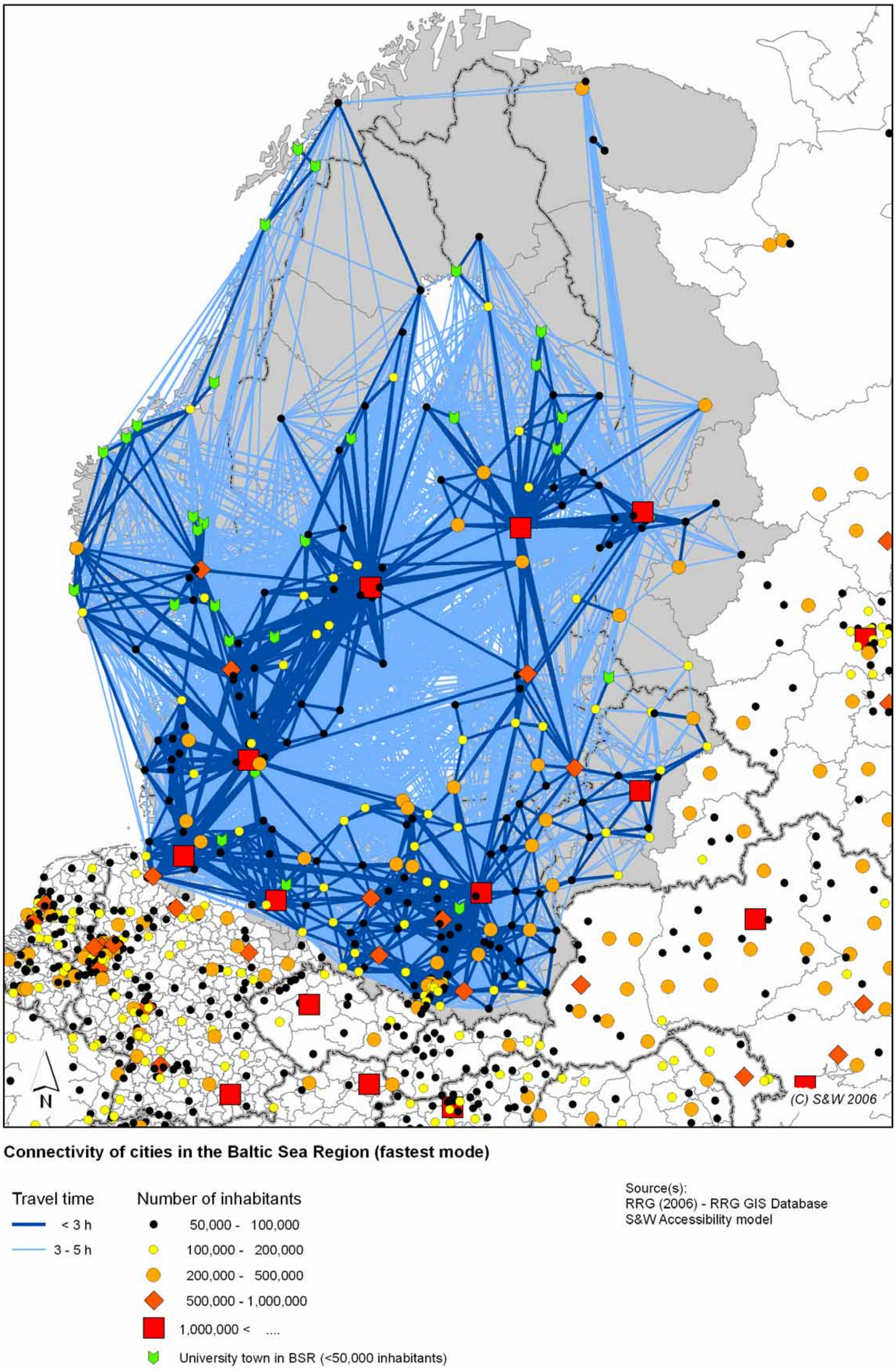


Figure 23. Fastest mode connectivity of BSR urban network.

4.7 Multimodal Potential Accessibility

The last accessibility indicator belongs to the potential accessibility type in which the attraction of a destination increases with size and declines with distance, travel time or cost. Two multimodal potential accessibility indicators were developed for this study. one uses population as destination activity as most common in accessibility studies and the other uses GDP as destination activity. Accessibility of a place following this concept is then the sum of all destination activities weighted by the travel time or cost to go there.

The two multimodal potential accessibility indicators were developed with the accessibility model specification of the ESPON 1.2.1 project (Mathis et al., 2005, Spiekermann & Wegener, 2006) of which the modal indicators reflecting the situation in the year 2001 were published in the 3rd Cohesion Report (European Commission, 2004c). Multimodal means that road, rail and air travel times between regions are aggregated and used in one combined indicator. For this study, the network database was updated to the year 2006. This includes the construction of new roads and motorways, current rail and air time table information and also the integration of several regional airports served by low-cost airlines. The population and GDP database was updated as well to the most recent year for which data is available.

Figures 24 to 26 show the current potential accessibility by using population as the destination activity of interest. Figure 24 illustrates the spatial distribution of high and low accessibility by using the population of all European regions as destinations. The indicator values mapped are standardised to the population-weighted average of the BSR. Regions with highest accessibility values in Europe are to be found outside the BSR in western parts of Germany and the Benelux country. However, the regions of Hamburg, Berlin, Copenhagen/Malmö and Warszawa including their hinterland mark visible peaks of accessibility in the BSR. Capital regions of other BSR countries do have clearly above BSR average accessibility, however, values are much lower than the more central located capital regions and are in the range of the more rural regions in Germany. In most countries, accessibility clearly goes down when moving away from the capital cities. Regions in Russia have lowest accessibility followed by the regions of the Northern periphery.

Figure 25 shows multimodal potential accessibility in which only the BSR area is considered to be of interest, i.e. the population of outside regions is neglected. Thus, the map shows which European regions have good access to the BSR market. The overall spatial pattern of accessibility within the BSR is very similar to the European-wide accessibility, but the disparities are less pronounced because the focus is less on pan-European relationships. However, also regions outside the BSR have fairly good accessibility to the BSR which is partly higher than in several BSR regions; this means that the BSR market could also be easily served from outside the area.

Figure 26 relates the two previous maps by showing which contribution the accessibility to the BSR makes to the European accessibility of the regions. Highest shares are of course located in BSR regions, but there is a distinct spatial pattern. The northern and western accessibility values are only to a low degree constituted by BSR destinations, i.e. the orientation of those regions can be much more easily directed outwards the BSR. For the eastern areas of the BSR, the BSR is important. This is particular true for two types of regions. The first one consist of rural regions; here, without good international connections, the relatively low accessibility is mainly based on national destinations. The second type consists of regions with a large number of inhabitants such as the regions around St. Petersburg and Brest. Here, the huge self-potential with a lack of sufficient international connections leads to very high degrees of dependencies of the accessibility indicator values on the local and regional destinations. Outside the BSR the BSR is hardly important for the accessibility potential; outside the European territory shown on the map the contribution of the BSR to the accessibility potential of the regions is clearly below ten percent.

A similar series of multimodal potential accessibility maps is presented in Figures 27 to 29; for these maps the destination activity is GDP. Comparing the map with all European GDP as destination activity (Figure 27) with the corresponding map for population (Figure 24), a rather similar pattern of high and low accessibility within the BSR area is visible. However, there are some slight shifts of regions in both directions compared to the BSR average; towards higher accessibilities in the Nordic countries and in Germany and towards lower accessibility in the eastern BSR. However, the most significant difference is that the BSR falls behind the clearly increased accessibility in western Europe. Here, the combined effect of good economic performance and good infrastructure and transport services lead to very pronounced increase in accessibility potential based on GDP and thus to an increased gap in accessibility to the BSR.

The pattern of Figure 28 is even more pronounced when looking at accessibility to BSR GDP only. Now, the Nordic countries and Germany are clearly visible as areas of high accessibility potential. Most of non-BSR regions in Germany and other European countries have higher accessibility to BSR GDP than regions located in the eastern BSR. On the other hand, the GDP of the BSR contributes in general to a much lesser degree to the accessibility potential of the BSR regions than shown for population (Figure 29); this is particular true for the eastern parts of the area which still have the obstacles of relatively low economic performance and transport infrastructure and services.

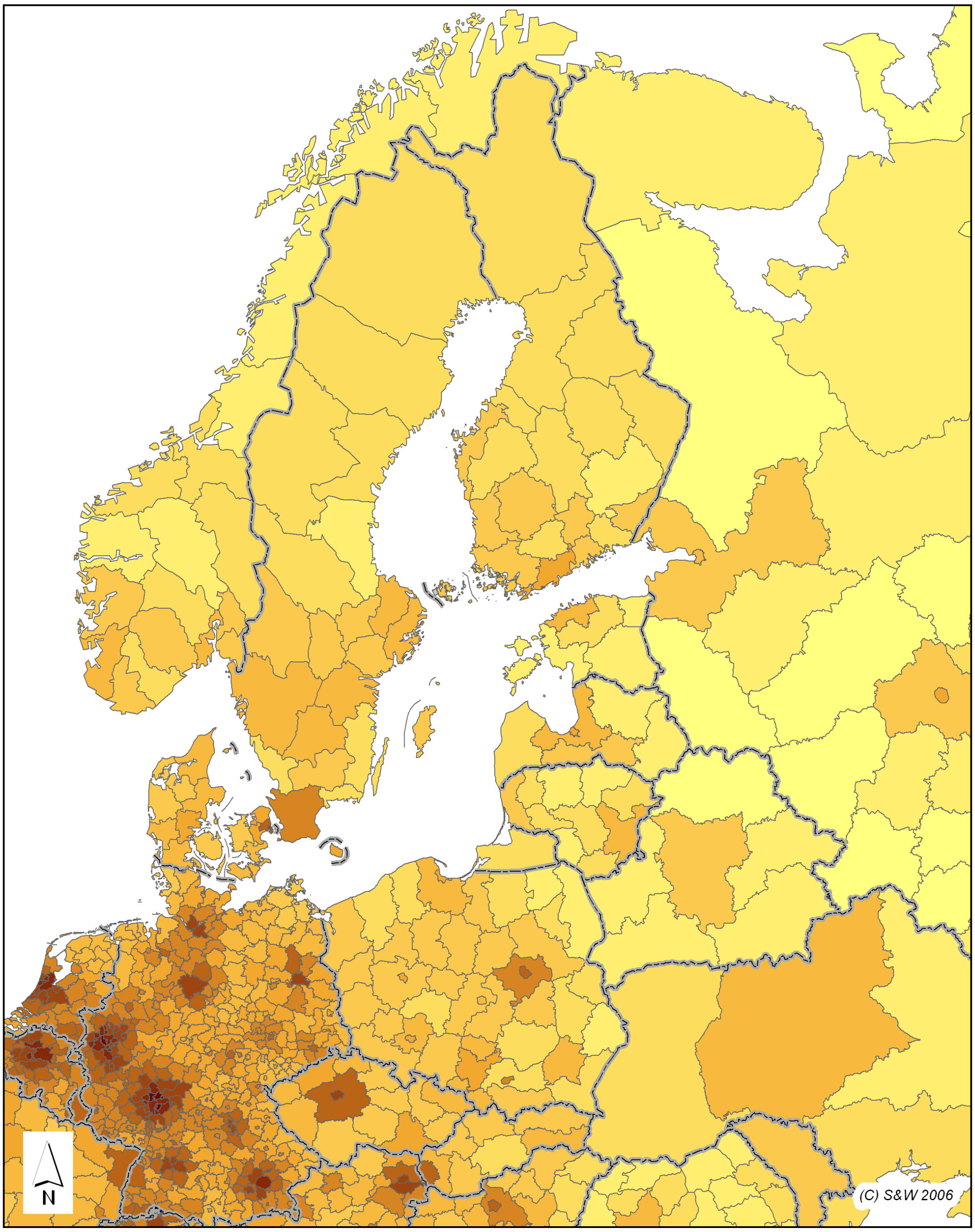
Table 9 gives aggregates of accessibility by country and confirms at this level of aggregation that disparities in accessibility are larger when looking at all European destinations compared to BSR destinations only and that disparities in potential accessibility to GDP are much larger compared to using population as destination activity.

Applying the concept of multimodal potential accessibility to the BSR with data for 2006 does not lead to a very distinct picture from that presented in earlier studies. The changes in the road and rail infrastructure of the last couple of years were to small to dramatically change the spatial pattern of accessibility. However, the intensified use of regional airports and the large expansion of the low-cost carrier and their flight services have changed the position of several individual regions. The replacement of population by GDP as destination activity leads to much higher disparities in accessibility in the BSR, because then the countries with lower GDP which mostly have already a lower quality of the transport infrastructure are downgraded in terms of accessibility.

Table 9. Multimodal potential accessibility

Country	Destination activity			
	European population	BSR population	European GDP	BSR GDP
Belarus *	44	52	34	30
Denmark	128	105	150	164
Estonia	66	69	68	78
Finland	87	84	92	111
Germany *	169	131	194	183
Latvia	88	84	88	86
Lithuania	73	75	73	70
Norway	77	60	92	95
Poland	96	105	87	80
Russia *	80	110	60	68
Sweden	100	87	117	134
BSR area	*100*	*100*	*100*	*100*

** only those parts of the countries considered which are eligible under BSR Programme*



Multimodal potential accessibility to European population (BSR = 100)

3 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275

Country boundaries
NUTS-3 regions / equivalent regions

Source(s):
RRG (2006) - RRG GIS Database
S&W Accessibility Model

Figure 24. Multimodal potential accessibility to European population.

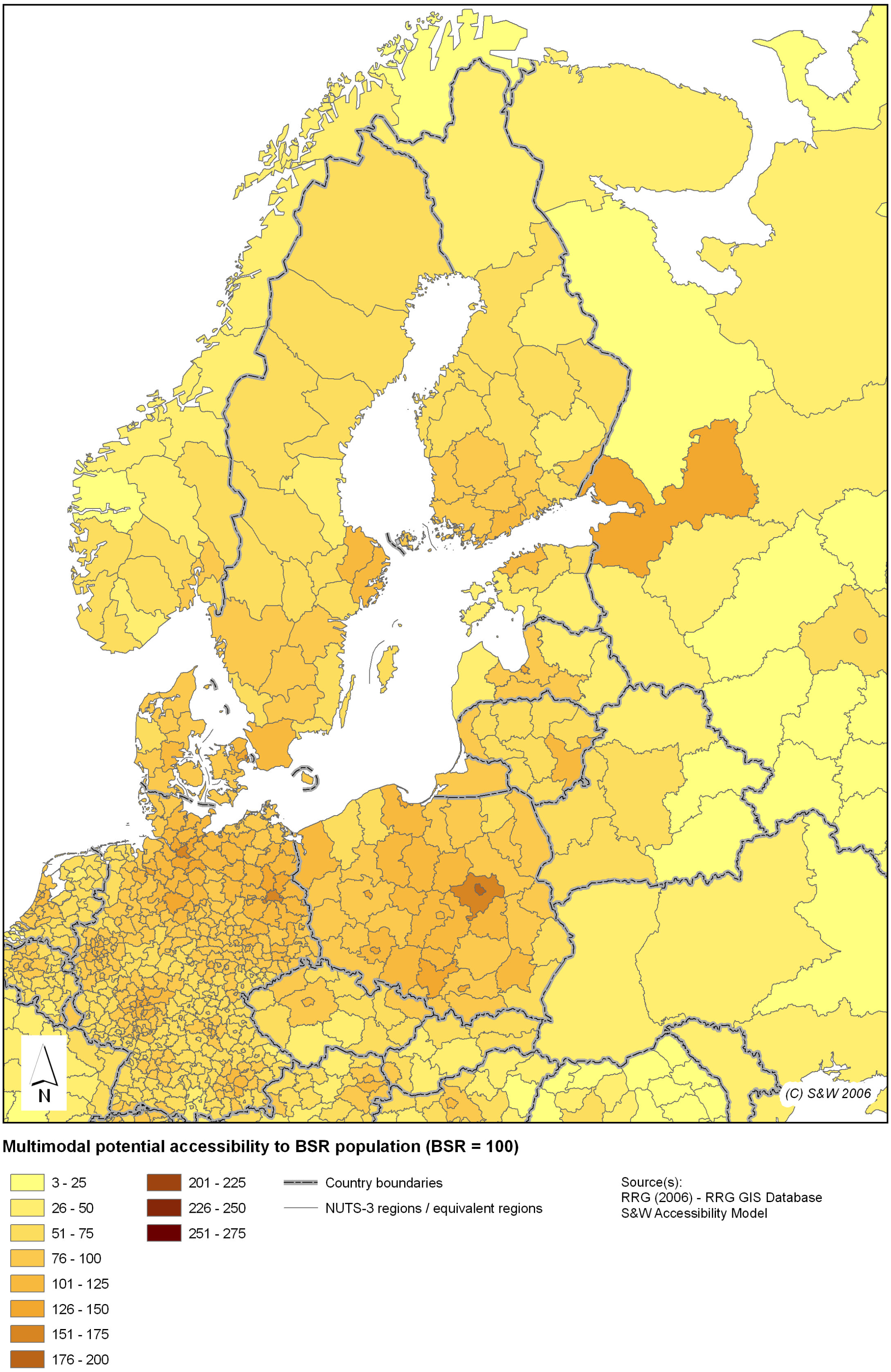


Figure 25. Multimodal potential accessibility to BSR population.

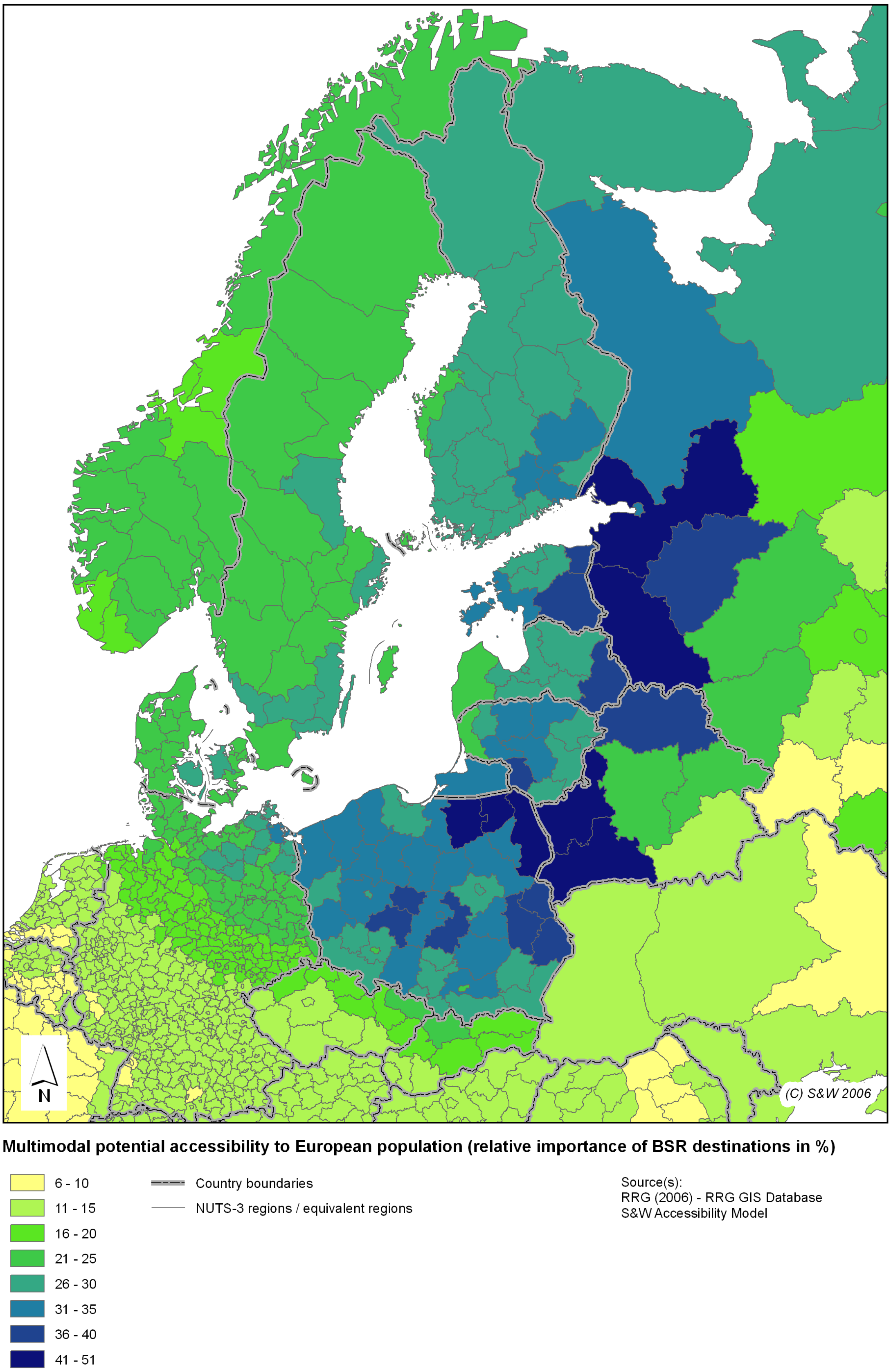


Figure 26. Contribution of BSR destinations to European accessibility (population).

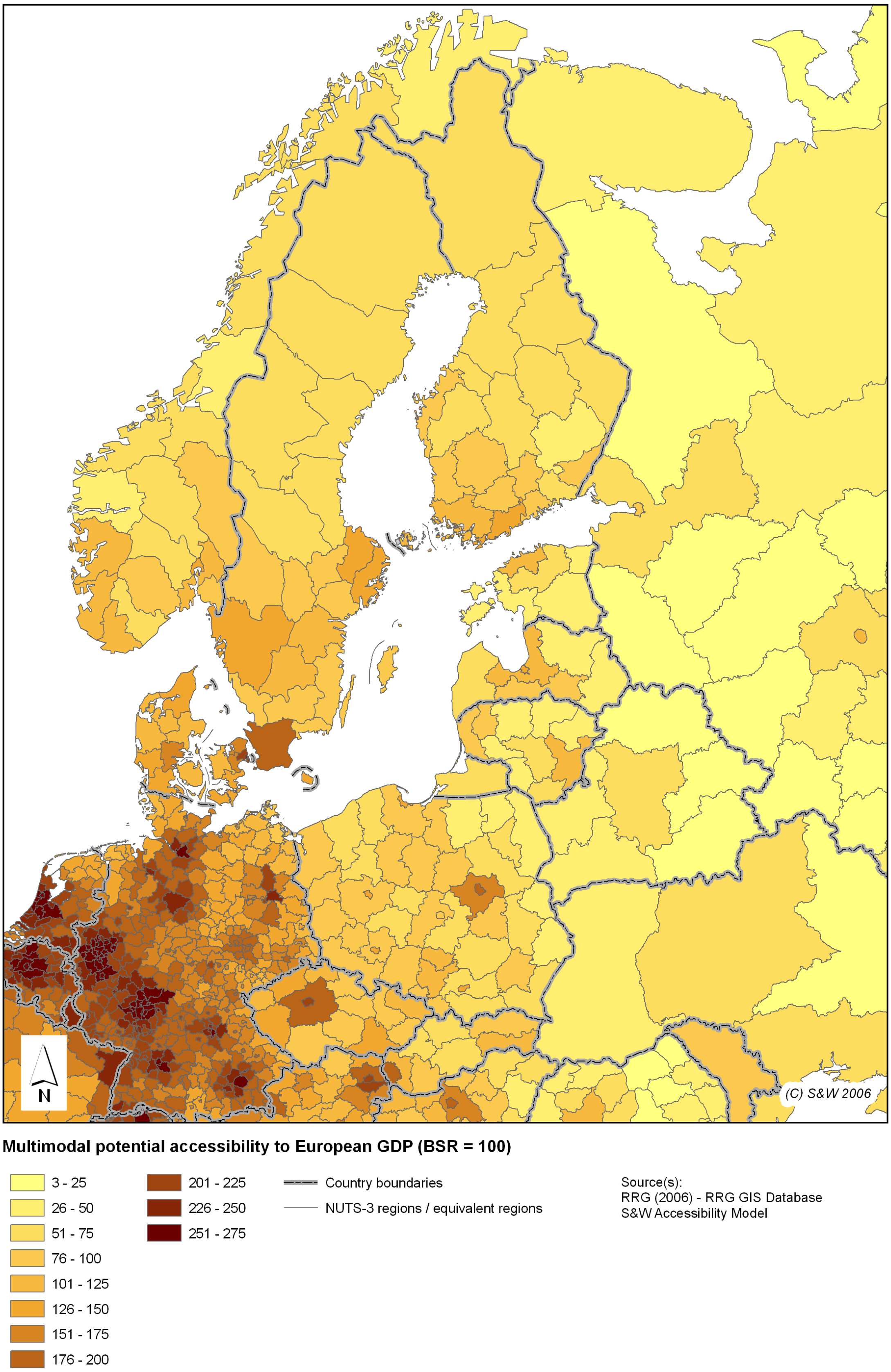


Figure 27. Multimodal potential accessibility to European GDP.

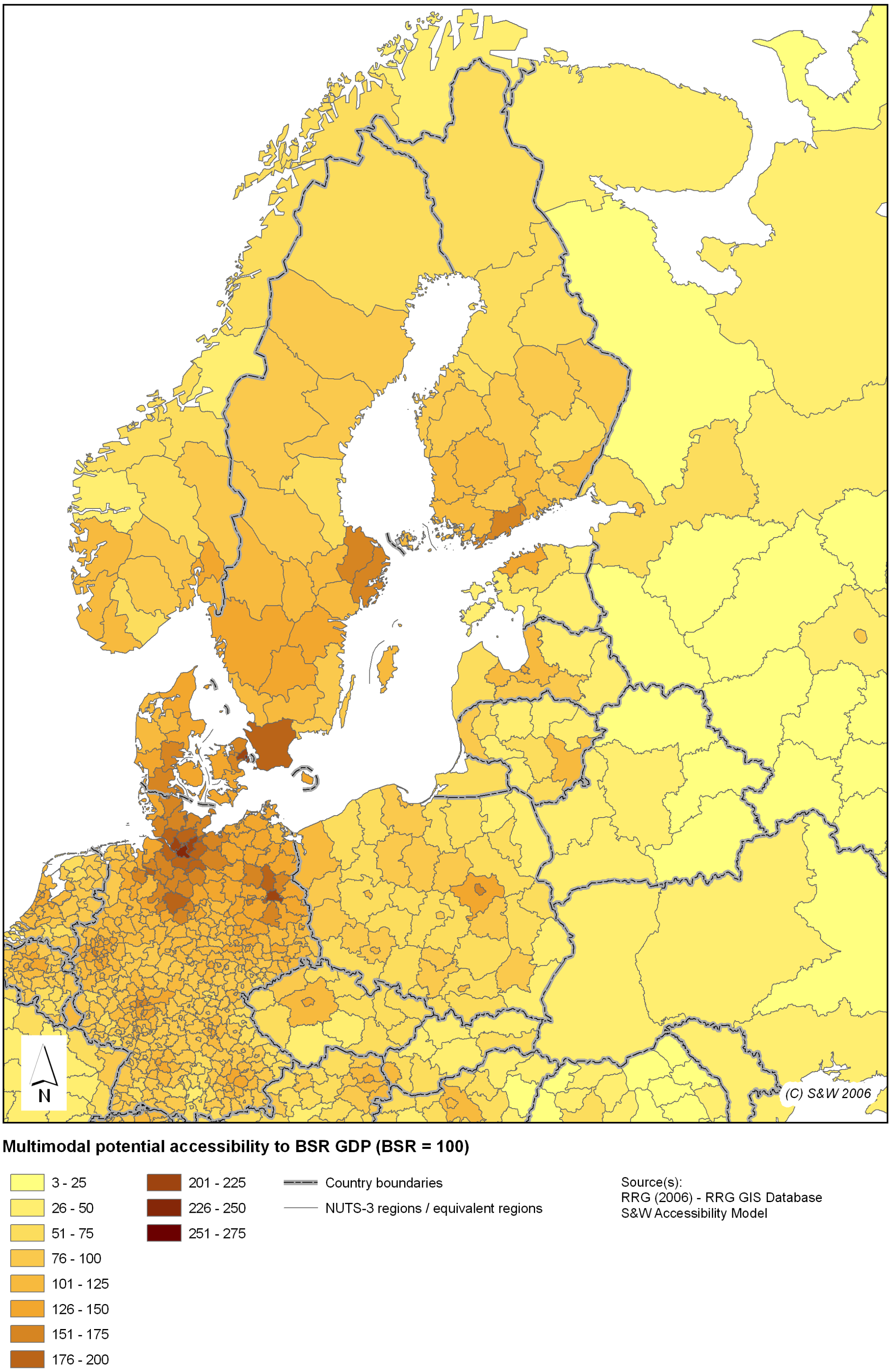
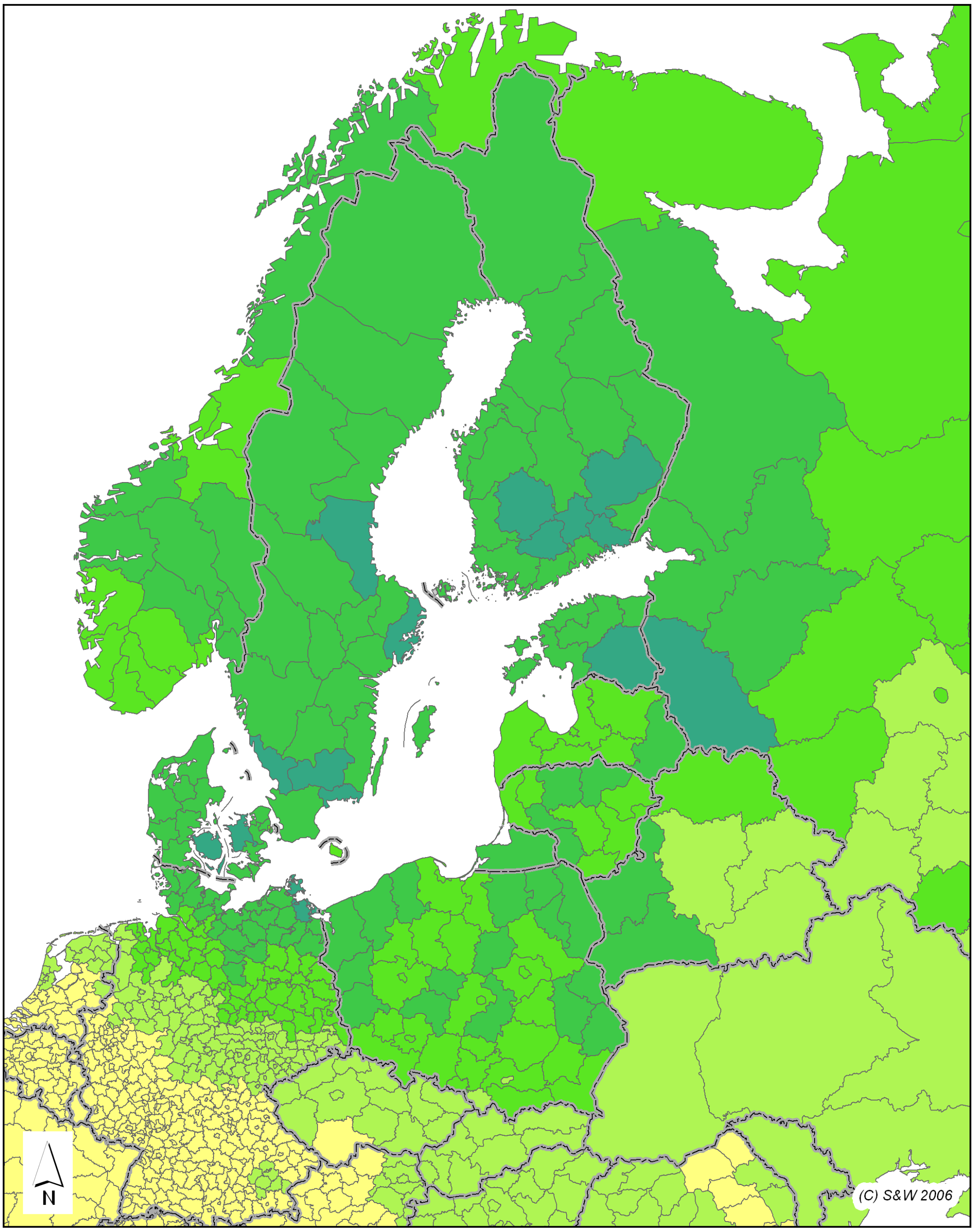


Figure 28. Multimodal potential accessibility to BSR GDP.



Multimodal potential accessibility to European GDP (relative importance of BSR destinations in %)

- 6 - 10
- 11 - 15
- 16 - 20
- 21 - 25
- 26 - 30
- 31 - 35
- 36 - 40
- 41 - 51

Country boundaries
NUTS-3 regions / equivalent regions

Source(s):
RRG (2006) - RRG GIS Database
S&W Accessibility Model

Figure 29. Contribution of BSR destinations to European accessibility (GDP).

5 Conclusions

The analysis of current accessibility pattern in the BSR provided in this report allows to assess the potentials and obstacles of the BSR in the light of different indicators, allows to see internal differentiations and disparities including those between urban and rural areas, and allows to compare the accessibility of the BSR with other parts of Europe. Finally, the interpretation of the results allows to draw some conclusions concerning policy measures such as the allocation of programme resources and subsequent investments.

Transport infrastructure endowment

Already the presentation of the transport infrastructure networks in Chapter 3 has shown the huge disparities in infrastructure endowment and transport services in the BSR. In general, road and rail networks are much more developed in the western parts of the BSR compared to the eastern areas but also compared to the northern periphery. Motorways and modern railways prevail in Germany, Denmark, southern Sweden and parts of Poland. Airports offering highest numbers of destinations are located at the national capitals of the Nordic countries, Germany and Poland and in St. Petersburg. However, in several of those countries there are additional airports serving up to fifty destinations, figures that are also reached nowadays by the capital airports of the Baltic States. Intermodal transport terminals are mostly located at the Baltic Sea or at main railway corridors in the western part of the BSR.

Accordingly, access times to those infrastructure facilities differ clearly between the different parts of the BSR. Countries with lower transport infrastructure endowment do face longer access times to rail stations, airports or intermodal terminals. Highest access times are often to be found in the Russian part of the BSR and in Belarus followed by the Baltic States, this is particular true for freight transport. However, in the Nordic countries access time to rail are often very high. On the other hand, those countries do have fairly good access time to airports which are partly much shorter than in more densely populated countries. This is a direct consequence of the systems of regional airports in those countries with feeder service to the national capitals.

ICT endowment

The way towards an information society in the BSR was reflected with indicators on mobile phone penetration and broadband access to the internet. It could be shown that nowadays on average almost every person owns a mobile telephone and that the saturation level of this equipment seems to be reached already. The few exceptions from this can be considered as being of temporal nature; it can be expected that the gap to the other countries will be closed in the very near future.

The picture on broadband access to the internet at home is very different. First, the availability to households is even in advanced countries much below fifty percent which is probably still far away from demand. Nevertheless, there are spatial disparities in the diffusion of this technology visible in two respects, between countries and within all types of countries between urban and rural regions.

Access to next larger city

The access times from the territory to the next larger city are primarily determined by the spatial distribution of cities in the BSR. Consequently, countries with higher densities of medium-sized and large cities have lower average travel times to reach the city centres. This is supported by the analysis showing Germany, Poland and Denmark with reasonable short access times and the northern countries and Russia with highest average travel times to cities.

Connectivity of urban system

The degree of connectivity of the BSR urban system has been analysed on the basis of travel times by road, rail and air transport between all cities of the area. Based on road and rail transport, the connected urban system is in most countries very nationally oriented showing higher degrees of connectivity in countries with higher densities of cities and modern transport infrastructure. Comparing rail with road connectivity it is remarkable that the urban systems in the Nordic countries are better served by rail whereas in the eastern parts of the BSR at generally lower levels of connectivity road is providing better connectivity for the cities. Looking at air connectivity, larger distances between cities can be overcome in the given travel times. But nevertheless, the connected urban system is to a high degree dominated by national linkages which are then overlaid by a system of well connected capital cities. Looking at the three modes together, the urban system is well connected along the Baltic Sea coast in an arc stretching from St. Petersburg via Helsinki, Stockholm, Copenhagen, Hamburg, Berlin to Warszawa; thus leaving an area of less connected cities in the Baltic states and Belarus and beyond and still seeing the Baltic Sea as a barrier to travel between cities of the BSR.

Potential accessibility

The potential accessibility indicator is theoretically most secured as it is based on human behaviour with respect to spatial interaction. The indicator expresses the degree of opportunities a location might have from the existence of transport infrastructure and services connecting to the activities or facilities of interest.

The analysis of multimodal potential accessibility has shown the large disparities existing in the BSR. The German parts of the BSR and Denmark, parts of Poland and Sweden have highest accessibility to population; looking at GDP Poland falls back. The Baltic States, Belarus, Russia and the northern peripheral areas have lowest accessibility within the BSR and thus also within Europe as a whole. Disparities are much higher when looking at GDP based accessibility, the east-west divide becomes much more pronounced and in particular the gap to other European regions is increasing.

Considering only the BSR area as destination of interest, the spatial pattern remains similar for population based accessibility and disparities within the BSR are somewhat lower. Looking only at the accessibility based on GDP generated in the BSR disparities are higher than for population. The contribution of the BSR destinations to the European accessibility differs between GDP and population. For GDP the contribution of the BSR destinations is much lower, i.e. the accessibility potential is much more depending on connections to regions outside the BSR. For population the share is higher and the disparities are larger. In particular there are regions in the eastern part of the BSR, rural as well as huge agglomerations, which are very much dependent on the contribution of the BSR destinations.

Need for intervention at the transnational Baltic Sea Region level

The analysis has shown that the BSR is characterised by huge disparities in accessibility: parts of the regions are almost at European peak values for certain indicators, parts of the region are about European average and several parts, in particular in the northern and eastern areas belong to the most lagging areas of Europe in terms of transport infrastructure endowment and accessibility. It has also been shown that the connectivity provided by the transport system is to a large degree very nationally oriented, thus lacking transnational components which are important for the integration of the BSR. This clearly marks important deficits in competitiveness and territorial cohesion of the BSR.

The main strategic objective of the BSR Interreg Programme under preparation is "to strengthen competitiveness of the Baltic Sea Region, its territorial cohesion and sustainability of its development by connecting potentials over the administrative borders" (BSR JPC, 2006, 15). Seen in the light of the results of this study, all major elements of the strategic objective, competitiveness, territorial cohesion and sustainability, call for interventions in the field of accessibility related policy measures; the major strategy stated, connecting potentials, directly calls for the improvement of linkages within the BSR and with areas outside.

Consequently, the planned priority of the programme, "Improving External and Internal Accessibility," is of crucial importance for the success of the transnational strategy as a whole. There are two major directions of support planned in the draft programme. The first is to directly enhance through transport and ICT measures accessibility and socio-economic growth. The second direction of support is to relate transport and ICT related measures with the development of existing of the creation of new strategic development zones. The first direction of measures is directly backed-up by the findings of this study. The second direction of measures was not in the focus of this study, but it reflects the important linkage of transport related measures with spatial development measures.

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