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INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEM

Term Paper

RAILWAYS IN EUROPE

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INTRODUCTION

BACKGROUND

The following paragraphs are extracted from Microsoft Encarta encyclopedia [3], explaining the history of railways in Europe.

Railway, a means of mass transport in vehicles running on parallel rails. By the 18th century workers in several European mining areas had discovered that movement of a loaded wagon was easier if its wheels ran on, and were guided by, a crude track of metal plates, because friction was thereby reduced. The wagonways served only to move goods from their source to the nearest waterway, then the principal means of bulk transport. The onset of the Industrial Revolution in early 19th-century Europe demanded more efficient means of moving raw materials to the new factories and finished goods from them. The solution was pioneered by Richard Trevithick, a Cornish engineer. In 1804 he successfully adapted the steam engine, to drive a wheeled locomotive that hauled wagons at the Pen-y-Darren ironworks, South Wales. Two decades elapsed, during which cast-iron rails were developed to withstand the weight of a steam locomotive and traction power for haulage of trains, as opposed to one or two wagons, was secured by mounting a steam locomotive on two or more driven axles with their wheels coupled by rods. The world's first public steam railway, the Stockton & Darlington in north-east England, engineered by George

Stephenson, was opened in 1825. For some years this railway carried only freight and also made some use of horses. The first public railway to carry both passengers and freight, and to be worked entirely by steam locomotives, was the Liverpool & Manchester, opened in 1830. This too was engineered by George Stephenson, now with the assistance of his son Robert Stephenson.

From the mid-1830s onward inter-city railway construction developed rapidly in Britain and Continental Europe. The British railways were all built by private enterprise with minimal government intervention, but in Continental Europe most construction was controlled, and in some cases undertaken, by national or state governments. This established (except in Britain) a European tradition of the railway as a public enterprise, and of government obligation to fund at least in part the upkeep and expansion of national railway infrastructure. Government involvement was concerned to avoid wasteful duplication of competing railways on the most lucrative routes—as happened in Britain—and to ensure that railways spread in a way that best served the social and economic development of the state or country concerned.

Railway construction spread so rapidly in the 1840s that by the end of the decade 10,715 km (6,658 mi) of route had been built in Britain, 6,080 km (3,778 mi) in the German states, and 3,174 km (1,972 mi) in France. Everywhere else in Central and Western Europe, except Scandinavia and the

Balkans, railway building had begun. Passenger travel by train was soon popular, but until the second half of the 19th century the rapid European railway expansion was driven chiefly by the hunger of newborn industry for freight transport, and the railway's ability to supply it at rates ensuring attractive profits for investors. By 1914 today's European rail network was almost wholly in place, Scandinavia excepted, following completion of the great transalpine rail tunnels: the Mont Cenis (or Fréjus) from France to Italy in 1871; the St Gotthard in Switzerland in 1881; the Arlberg in Austria in 1883; and in Switzerland, the Simplon in 1906, and the Lotschberg in 1913.

In Western Europe, population centres are much more closely spaced; there, modernization of track and signalling, plus new traction technology, have enabled sustained running speeds of 160 or even 200 km/h (100 to 125 mph). This has kept trains on historic main lines competitive in speed with planes and private cars for inter-city journeys of up to about 400 km (250 mi). These inter-city trains have been helped to retain enough traffic for viability by great improvements in comfort: advances in running gear and elimination of rail joints by long-welding has made passenger carriages very smooth-riding; and interiors are often air-conditioned and sound-insulated. Passenger service viability over more than 400 km (240 mi) has demanded technological developments permitting operation at much higher speeds. After the first new Japanese Bullet Trains had proved this possible in the mid-1960s, the French perfected their TGV (Train à Grande Vitesse, or High-Speed Train). The first new TGV railway, from Paris south to Lyons, was completed in 1983, carrying trains able to run continuously at 270 km/h (168 mph). By 1994 four more TGV lines had been completed, which extended high-speed train service from Paris to northern and western France, and deeper into the south; on these the continuous speed was lifted to 300 km/h (186 mph).

In a special test in May 1990, a TGV raised the world rail speed record to 515.3 km/h (320.3 mph), and the French aim to make 350 km/h (217.5 mph) the everyday TGV speed before long. New TGV lines, from Paris to the east and south from Lyons to the Mediterranean coast and the Spanish border, are certain to be built in the late 1990s. Spain adopted French TGV technology for its first high-speed line, a 300-km/h (180-mph) route from Madrid to Seville, and will soon build a second from Madrid to Barcelona. The Italians and Germans have developed their own technology for the new high-speed inter-city railway lines they have already built and are extending. The European Union aims to see these new national lines interconnected to enable uninterrupted international high-speed rail travel. The first non-European country other than Japan to decide to build a new high-speed inter-city passenger railway is South Korea, which is to employ French TGV technology in its project to link the capital, Seoul, in the north-west of the country with Pusan in the south-west.

STATEMENT OF THE PROBLEM

There are thousands of miles of railways used in European countries wither in or intra countries. The following questions are raised:

- What is the total population in Europe?
- What is the total area of Europe?
- How long is the total railway in Europe?
- How many railway stations in Europe?
- What is the population of each country?
- What is the area of each country?
- How long is the railway in each country?
- How many railway stations in each country?
- What is the relation between railways length to population of each country?
- What is the relation between railways length to the area of each country?
- What is the relation between railways length to the number of railway stations in each country?

Above questions are the problems under investigation by this term paper.

<u>SCOPE, LIMITATIONS AND DIFFICULTIES</u>

This study is limited to the following:

- The study is done on Europe and European countries.
- The data used is limited to data supplied by ESRI Data and Maps for ARCGIS 8.1.

During the use of the ARCGIS 8.1 I have experienced the following difficulties due to not being expert with the software:

- I was unable to draw more than one layout view in the project and hence I have utilized one layout view in doing the three output drawing of this project.
- I came up around this difficulty be making features visible and/or invisible in each drawing depending in the need of showing such feature.
- Another difficulty I have faced is doing analysis from data found in more than one attribute table. Such expertise need someone who is utilizing this software to its limit, not to someone who only went through the software exercise an in my case.
- I came up around this difficulty by doing small calculation from within each table utilizing functions such as SUM and COUNT and then exporting the required data to excel sheet. By such method I have placed all extracted output data in one Excel sheet and perform all of the required calculation and charting outputs by Excel software which I have more experience with.

OBJECTIVES

The objective of this term paper is to calculate the following:

1. Total population in Europe.
2. Total area of Europe.
3. Total length of Railways in Europe.
4. Total number of railway stations in Europe.
5. Total population in each country.
6. Total area of in each country.
7. Total length of Railways in each country.
8. Total number of railway stations in each country.
9. The resultant of dividing total population by linear kilometers of railways in each country.
10. The resultant of dividing total area by linear kilometers of railways in each country.
11. The resultant of dividing total linear kilometers of railways by number of railway stations in each country.

PROJECT TOOLS

The tools used for making the study and reports for this term paper are:

- ARCGIS 8.1 software.
- ESRI Data and Maps for ARCGIS 8.1.
- Microsoft Excel 2003
- Microsoft PowerPoint 2003

PROJECT DATA

The study was based on data available from ESRI as "ESRI Data and Maps for ARCGIS 8.1". The following is the hierarchy of the utilized data sets and feature classes:

- ESRI Data & Maps\europe\basemap
    - Country.sdc
        - Country Level Political Map.lyr
    - Prov1.sdc
        - Level 1 Province Areas.lyr
    - Rr_stns.sdc
        - Railway Stations.lyr
    - Rails.sdc
        - Railways.lyr
- ESRI Data & Maps\europe\demograph
    - Country.sdc
        - country

ANALYSIS

Analysis of data was done in the four following stages:

1. Drawing stage
2. Attributes processing and analysis stage
3. Output formulation stage
4. Output Presentation Stage

1. DRAWING STAGE

In this stage the related maps are drawn to a scale that make features better presented. A3 size paper size was selected so that features can be more visible and presentable. The format of the page was set so that same format can be utilized in all other drawings. Three maps were drawn in a scale of 1:25,000,000. Main title for all drawings was selected as the title of this term paper "RAILWAYS IN EUROPE" and was placed to the bottom of each map with horizontal alignment. The title was accompanied with a number showing the page number divided by the total pages number. Maps titles were presented on the left of each page with vertical alignment. The scale was shown at the bottom right hand on each drawing and legends were shown at the top left hand side of each drawing as applicable. The same view of European countries was utilized in each map adding to it features specifically available for each drawing. The three presented maps were as per the following:

1. Europe Political Map: showing European countries map with country titles.
2. Europe Railway Stations: showing European countries and railways stations locations.
3. Europe Railways: showing European countries map and railways running in the whole continent.

See Railway in Europe maps numbers 1, 2 and 3 in the APPINDEX.

2. ATTRIBUTES PROCESSING AND ANALYSIS STAGE

In this stage the related attribute tables were studied to select data that would be used in this study. Then, selected data was analyzed in order to present them in a suitable format. In this stage four attribute tables were selected, processed and analyzed. The following summarize analysis and processing work done to each table:

1. Countries Area Data: taken from ESRI Data & Maps\europe\basemap, data set:Country.sdc, Feature class: Level 1 Province Areas.lyr attributes table. This data is listing the square kilometers for each province in each country. This study is requiring the total area for each country, hence, for each country the **SUM** function was utilized to sum all the square kilometers for each province in order to achieve the required output.

2. Countries Population Data: taken from ESRI Data & Maps\europe\basemap, data set:country.sdc, Feature class: country.lyr attributes table. This data is listing the total population for each country, which can be used directly for this study.

3. Railway stations Numbers Data: taken from ESRI Data & Maps\europe\basemap, data set: Rr_stns.sdc, Feature class: Railways Stations.lyr attributes table. This data is listing the railway stations names found in each province in each country. This study is requiring total numbers of railway stations; hence, for each country the **COUNT** function was utilized to count number of railway stations.

4. Railways Length Data: taken from ESRI Data & Maps\europe\basemap, data set: Rails.sdc, Feature class: Railways.lyr attributes table. This data is listing all railways segments length in all of Europe. This study is requiring total linear kilometers of railway, hence, for each country the **SUM** function was utilized to sum all of the linear kilometers of railways in order to achieve the required output

By end of this stage a single Excel table was constructed containing countries record with the following attributes:

- Country title
- Population
- Area in square kilometers
- Length of railways
- Number of railway stations

See table 1 in the APPENDIX.

3. OUTPUT FORMULATION STAGE

In this stage the required output data was formulated based on the single table constructed previously. The following calculated fields were added to the output table:

- Population per linear kilometers of railways of each country. This is a calculation field where total population is divided by total linear kilometers of railways.
- Square kilometers of country area per linear kilometers of railways. This is a calculation field where a total square kilometers of country area is divided by total linear kilometers of railways.
- Railway stations per linear kilometers of railways for each country. This is a calculation field where total numbers of railway stations are divided by total linear kilometers of railways.

See table 2 the APPENDIX.

4. OUTPUT PRESENTATION STAGE

In this stage the calculated output is presented in graphical format. Due to the fact that Iceland in chart numbers 2 and 3 were showing out of scale bars, it was deleted from those two charts in order to have better visualization of presented data.

See charts 1, 2 and 3 in the APPENDIX.

SUMMARY AND CONCLUSION

It was discovered that Russia is having the biggest population of 114,752,000 while Iceland is having the smallest population of 275,264. Biggest area of 3,953,708 km^2 is owned by Russia while smallest area is Luxembourg of 2,569 km^2. Longest railways were running on Russia with 61,741 km while the shortest is running by Iceland with 102 km. Germany is scoring number one in railway stations numbers by having 6,967 railway stations and Iceland is scoring the lowest with only one railway station.

From the output calculations the Netherlands is providing one kilometer of railways per 6,044 persons while Sweden is providing one kilometer of railways for every 644 persons. Iceland is building one kilometer of railways for every 1,021 km^2 of land area while Switzerland, Czech and Germany are building one kilometer of railways for every 8 km^2 of their land. Finally, Iceland is providing one railway station for every 102 linear kilometers of railway while Austria is providing one railway station every 3 linear kilometers of railway.

For the whole continent of Europe, total population is 749,562,932 persons, total area is 10,694,912 km^2, total linear kilometers of railways is 371,962 km and total numbers of railway stations is 48,648. In average, one linear kilometer of railway is provided for every 2,225 persons, one linear kilometer of railway is built for every 54 square kilometers of Europe area and one railway station is provided for every 11 linear kilometer of railway.

REFERENCES

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Stan Aronoff (1989) *GIS: A Management Perspective*, WDL Publications, Ottawa, Canada

T. Ormsby; E. Napoleon; R. Burke; C. Grossel and L. Feaster (2001) *Getting to Know ArcGis Desktop*, ESRI Press, Redlands, California, USA

APPENDIX

Data Extracted from Data Attribute Tables				
Country Name	**Population** (persons)	**Area** (km^2)	**Railways** (liner km)	**Stations** (numbers)
Austria	8,108,036	83,230	5,854	1,741
Albania	3,083,519	28,920	558	41
Belgium	10,239,085	30,276	3,067	547
Bulgaria	8,190,876	110,997	4,593	805
Bosnia and Herzegovina	4,377,071	51,157	3,151	221
Belarus	9,987,400	204,784	5,664	830
Switzerland	7,123,537	40,899	4,953	1,781
Czech Republic	10,278,098	77,929	10,114	2,724
Germany	82,037,011	353,516	41,708	6,967
Denmark	5,313,577	44,705	2,642	478
Spain	39,326,731	510,507	16,766	1,124
Estonia	1,370,052	44,946	1,119	179
France	58,520,595	545,558	34,569	3,208
Finland	5,171,302	341,825	6,405	225
United Kingdom	59,259,216	243,098	15,745	2,645
Greece	10,521,669	133,753	2,727	387
Hungary	10,043,224	92,227	7,914	1,699
Croatia	4,381,352	56,265	2,967	527
Italy	57,679,895	302,076	19,520	3,300
Irish Republic	3,744,700	69,491	1,870	130
Iceland	275,264	104,590	102	1
Luxembourg	384,700	2,569	241	64
Lithuania	3,490,800	64,043	2,245	250
Latvia	2,397,557	63,885	2,438	381
Moldova	3,635,000	33,627	1,131	185
Macedonia	2,032,130	25,398	835	101
Norway	4,478,497	404,020	4,359	534
Netherlands	15,863,950	35,409	2,625	389
Portugal	9,979,450	92,982	3,626	369
Poland	38,644,211	307,738	28,457	3,352
Romania	22,458,022	236,271	12,461	2,099
Russia	114,752,000	3,953,708	61,741	3,988
Sweden	8,882,792	452,114	13,792	789
Slovakia	5,398,657	48,457	3,767	956
Slovenia	1,990,094	20,127	1,293	272
Turkey	56,473,051	789,629	8,241	817
Ukraine	49,036,303	592,074	27,234	3,804
Serbia and Montenegro	10,633,508	102,113	5,468	738
Totals	**749,562,932**	**10,694,912**	**371,962**	**48,648**

Table1: Data extracted from attributes tables

Calculated Data			
Country Name	**1** (person per km)	**2** (km2 of area per km)	**3** (km per station)
Austria	1,385	14	3
Albania	5,530	52	14
Belgium	3,338	10	6
Bulgaria	1,783	24	6
Bosnia and Herzegovina	1,389	16	14
Belarus	1,763	36	7
Switzerland	1,438	8	3
Czech Republic	1,016	8	4
Germany	1,967	8	6
Denmark	2,011	17	6
Spain	2,346	30	15
Estonia	1,225	40	6
France	1,693	16	11
Finland	807	53	28
United Kingdom	3,764	15	6
Greece	3,858	49	7
Hungary	1,269	12	5
Croatia	1,477	19	6
Italy	2,955	15	6
Irish Republic	2,003	37	14
Iceland	2,687	1,021	102
Luxembourg	1,596	11	4
Lithuania	1,555	29	9
Latvia	984	26	6
Moldova	3,213	30	6
Macedonia	2,433	30	8
Norway	1,027	93	8
Netherlands	6,044	13	7
Portugal	2,752	26	10
Poland	1,358	11	8
Romania	1,802	19	6
Russia	1,859	64	15
Sweden	644	33	17
Slovakia	1,433	13	4
Slovenia	1,539	16	5
Turkey	6,853	96	10
Ukraine	1,801	22	7
Serbia and Montenegro	1,945	19	7
Averages	**2,225**	**54**	**11**

1: Number of persons per Linear KM of railway;
2: Square KM of country area per linear KM of railway
3: Linear KM of railway per number of railway stations

Table2: Calculated Data

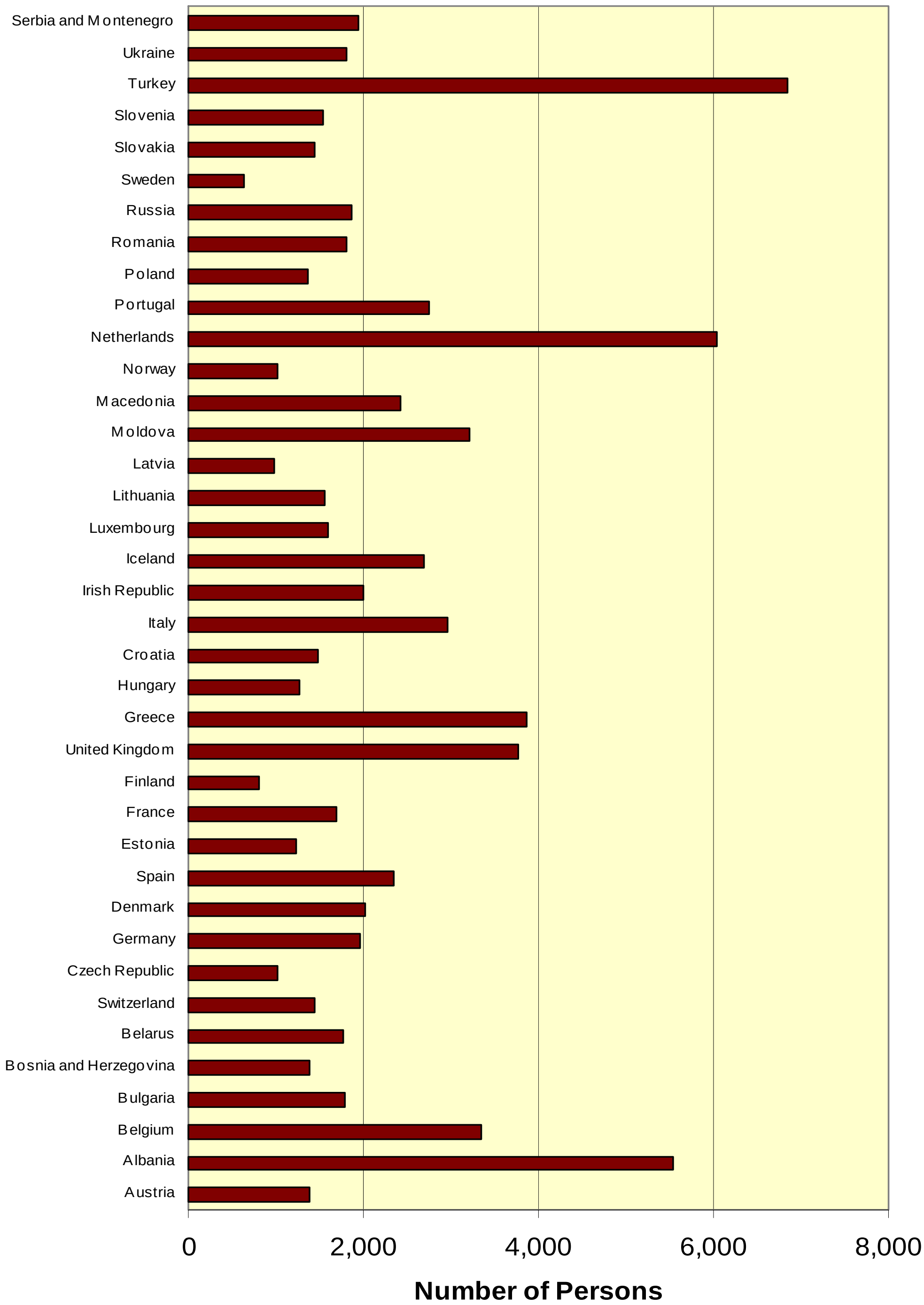

Chart 1: Number of persons per linear kilometer of railway

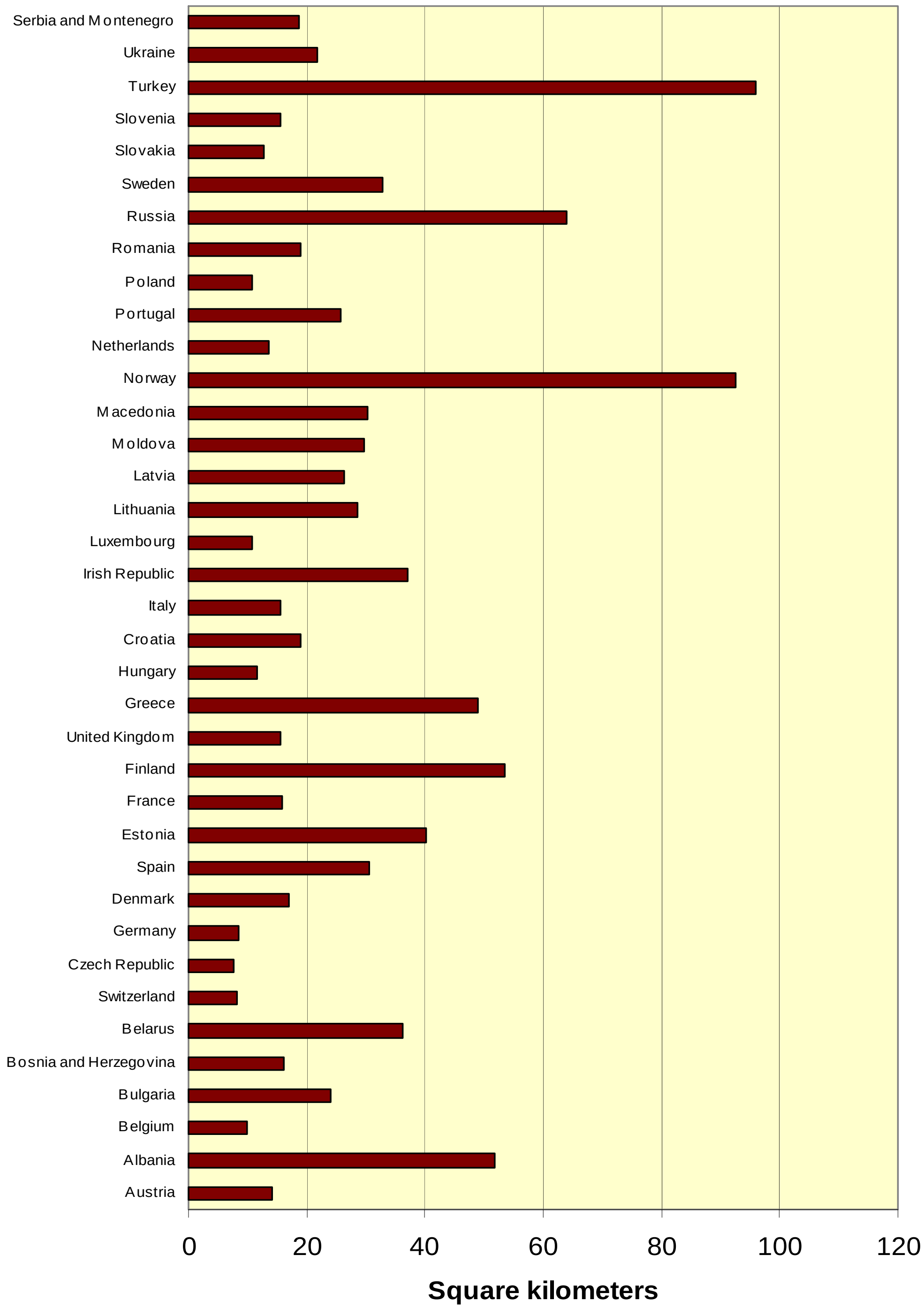

Chart 2: Square kilometers of area per linear kilometer of railway

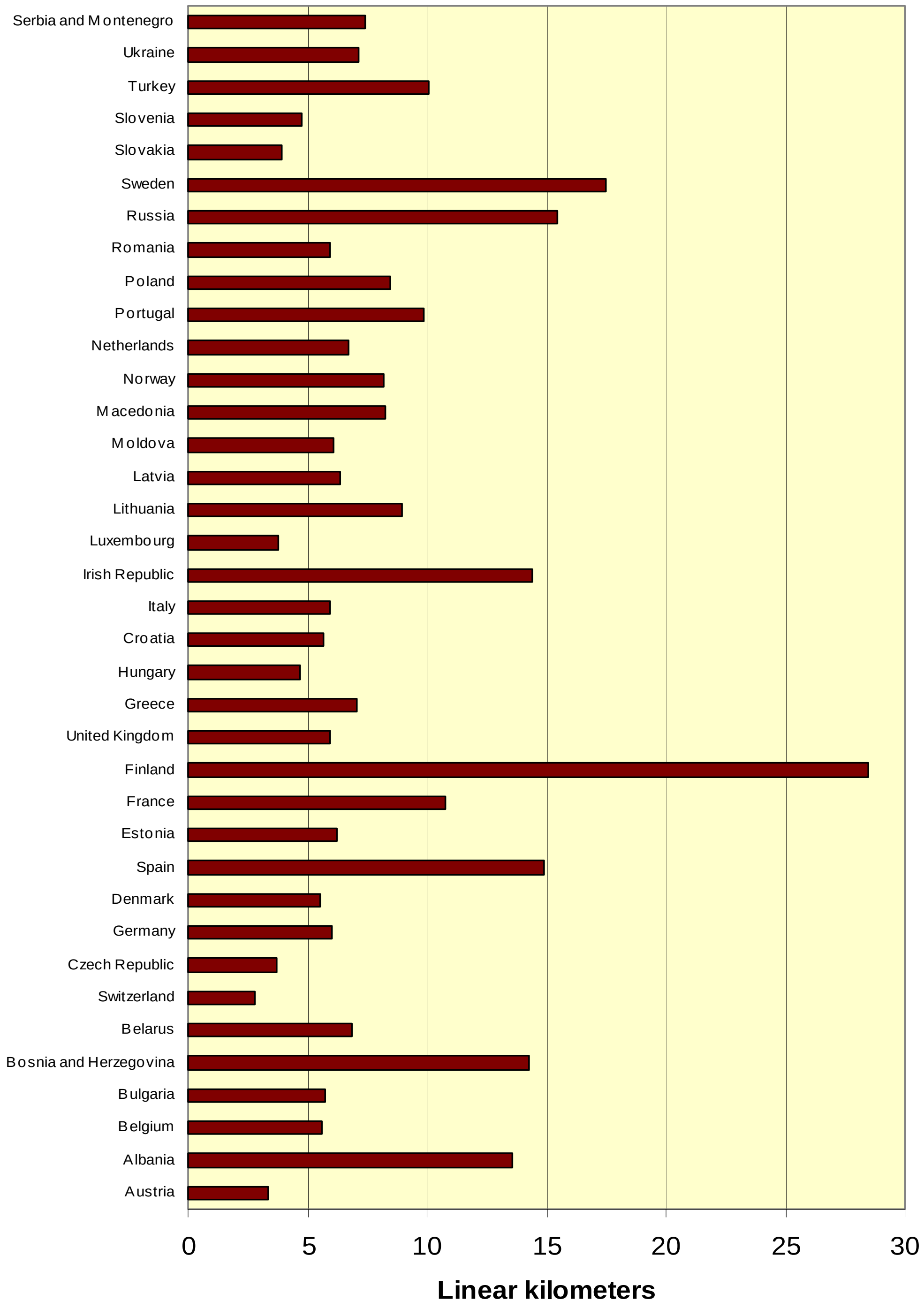

Chart 3: Linear kilometer of railway per railway station