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Disclaimer:

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The report content reflects the views of the author and not necessarily those of the PA1b coordinators and Steering group members.

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This document is prepared by the SLOMAN, Company for Consulting & Engineering, Ltd, Slovenia.

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PREFACE

Dear Reader,

We are pleased to share with you the first brochure dedicated to roads in the Danube region, which features overview of present road infrastructure.

Transport generates unusually considerable economic advantages. The most obvious are the saving of time, the cost cutting of transport, the extension of the area of influence for doing business and leisure activities. Road transport is major transport mode since its share represents roughly 75% - 80 % of all transport. Forecasts are indicating that traffic on our roads will continue to grow across the short, medium and long term. Therefore, it is essential that we continue to develop road infrastructure, with particular focus on maintenance, construction of missing links, enhanced traffic flows by building smart motorway network and on modernization of secondary and tertiary networks.

The purpose of this brochure is to better understand and to present state of play of the Roads in the Danube region. The ability to make overview of roads in the 14 Danube region countries and an effort made to compare them on a variety of indicators should help to assess gaps between countries and agree on future joint activities to address the most challenging issues. At the same time, it can be used for further discussions and policy developments related to the road infrastructure at macro-regional, regional, national and local level hence make long-lasting contributions to improvement of roads and consequently to more efficient mobility of peoples and goods.

It is hoped that this report will trigger further research on the Danube region roads and will lead to improved and more accurate next version of the publication concerning our roads.

We wish you a pleasant reading.

EUSDR Priority Area 1b coordinators:

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1.1 THE DANUBE MACRO-REGION

The Danube Region is a functional area defined by its river basin[1]. The area covered by the Danube macro-region stretches from the Black Forest (Germany) to the Black Sea (Ukraine-Romania-Bulgaria) and is home to around 113 million inhabitants in 14 countries: Austria, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Germany (Baden-Württemberg and Bayern), Hungary, Montenegro, Moldova, Romania, Serbia, Slovakia, Slovenia and Ukraine (Odessa - Ivano Frankivska – Chernovitsi – Zakarpatya oblast).

The Danube Region has many opportunities. It has many areas of outstanding natural beauty, a rich history, heritage and culture. There is immense development potential, many creative ideas and a quality labor force.

Good connections are key for the Danube Region, either internally or to other European and global regions. No part should remain peripheral. Transport and energy infrastructures have many gaps and deficiencies, due to insufficient capacity, quality or poor maintenance. Better connections among people are also needed, especially through culture and tourism.

Effective improvements need coordinated planning, funding and implementation. Market failures, due to externalities, are strikingly evident in lack of investments across borders. Large projects need to be identified and implemented sustainably and efficiently, with shared costs and benefits. The more users, the more efficient investments become, with significant economies of scale.

Main issues: Road, rail and air infrastructure is often inefficient or simply missing, especially cross-border connections. Implementation of multimodal TEN-T core network corridors, including their extension to the neighbouring coutries and the Rail Freight Corridors according to Regulation (EC) No 913/2010 must be on time (by 2030). The Transport Community Treaty proposed in 2008 and signed by all parties in the second half of 2017 provides for better integration of the Western Balkans Region[2]. Multimodality and interoperability, exploiting the potential of the river as a core element in modern logistics, are crucial. North-south connections are also needed.

[1] Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and The Committee of the Regions, European Union Strategy for Danube Region, COM (2010) 715 final, Brussels, 8.12.2010,
[2] Great part of Western Balkans is part of the Danube macro-region

1.2 ROADS IN THE DANUBE MACRO-REGION

From all aspects the Danube Region is very heterogeneous with significant differences in size and growth of the economies, unemployment and welfare, where the less developed countries lag behind the wealthier ones. This is valid also for the national and transnational road networks.

One may tentatively distinguish roads of the Upper Danube, Central Danube and Lower Danube region. Taking into account the World Economic forum[3] "The Global Competitiveness Report 2016–2017, 2nd pillar: infrastructure" the quality of roads in the Danube countries in comparison to the 138 World countries (out of 193[4]) is as follows: Austria ranked 8, Germany[5] ranked 16, Croatia ranked 18, Slovenia ranked 52, Slovakia ranked 64, the Czech Republic ranked 65, Hungary ranked 69, Bulgaria ranked 94, Montenegro ranked 102, Serbia ranked 115, Bosnia and Herzegovina ranked 116, Romania ranked 128, Moldova ranked 132 and Ukraine[6] ranked No. 134.

In spite of possibility to look at other available data and documents it is clear that countries of Upper Danube (in particular Germany and Austria) have better developed and maintained road network, in comparison to the Central and Lower Danube countries. It is also obvious that most of the Danube macro-region countries are still developing their road networks.

Regardless of above mentioned differences, most countries face similar problems, mostly linked with lack of resources available for maintenance, upgrading, modernization, construction of missing links and the elimination of road network bottlenecks.

[3] https://www.weforum.org/reports/the-global-competitiveness-report-2016-2017-1/
[4] https://www.countries-ofthe-world.com/all-countries.html
[5] Germany: No separate data available for Baden-Wuerttemberg and the Free State of Bavaria.
[6] Ukraine: No separate data for regions that are part of the Danube macro-region.

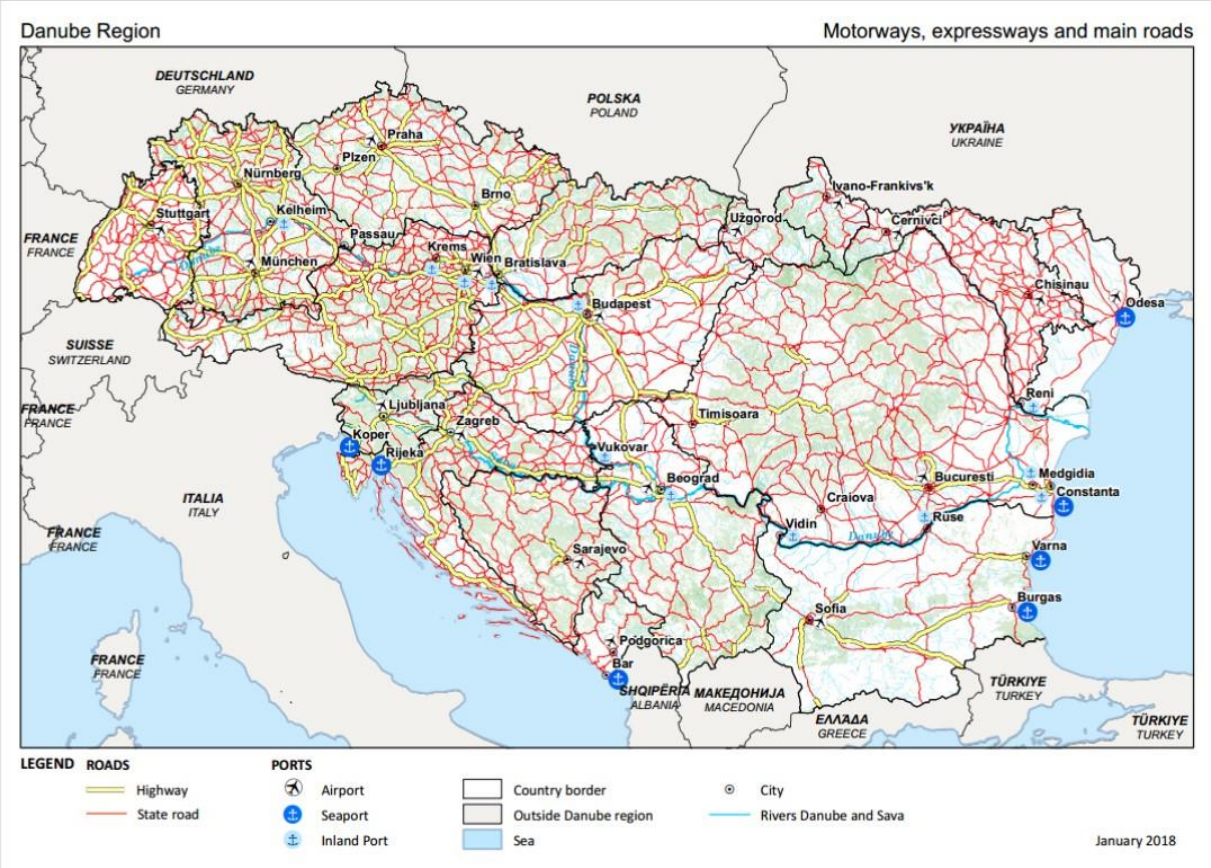

Figure 1: Motorways (4-lanes or more) and state roads of the Danube region

1.2.1 Early roads[7]: Roman road system and the Danube region

Roman road system was an outstanding transport network of the ancient Mediterranean world. It extended from Britain to the Tigris-Euphrates river system (present Middle East) and from the Danube River to Spain and northern Africa. In all, the Romans built around 80.000 km of hard-surfaced roads, primarily for military reasons. The Roman roads were remarkable for their straightness, solid foundations, a slightly arched surfaces facilitating drainage, and use of concrete made from volcanic ash and lime.

Among many structures of that time is Trajan's Bridge[8] (Romanian: *Podul lui Traian*; Serbian: Trajanov Most) the first bridge to be built over the lower Danube. For more than 1.000 years it was the longest arch bridge in both total and span length. The bridge was constructed in 105 AD by instruction of Emperor Trajan for the deployment of Roman troops during the conquest of Dacia (present Romania). Despite deterioration from neglect these roads continued to serve Europe, including the Danube region throughout the Middle Ages and many fragments of the system survived until today. For the most of the Danube region countries, Roman roads were the first man made concrete routes.

[7] The world's oldest known paved road was constructed in Egypt some time between 2600 and 2200 BC
[8] https://en.wikipedia.org/wiki/Trajan%27s_Bridge

Figure 2: The Roman Empire 125 AD (Source Internet[9])

1.2.2 Modern Roads

In term of length, most of the national secondary and tertiary roads are single carriageway (one lane for each direction) and paved with bitumen (asphalt) or concrete, while the main roads are slowly, yet continuously upgraded into four-lane roads (i.e. motorways, highways or expressways).

While more and more primary roads are motorways and expressways with a dual carriageway and are constructed mainly for the transnational long distance travel and/or to link major conurbations. Motorways are major roads that features two or more traffic lanes in each direction, with opposing traffic separated by a median strip, elimination of level crossings, controlled entries and exits and advanced designs eliminating steep grades, sharp curves and other hazards and inconveniences to driving. Motorways have been constructed in a way that they are passing near but not through large urban centers (cities), on more or less direct lines between desired places. Their advantages include high speed, comfort and convenience for drivers and passengers, lower vehicle operating costs and greater safety, thus contributing to more environment friendly movement of vehicles.

Many of new motorways are toll roads, although that is not an essential, feature.[10] At present Danube region countries have many different schemes for road tolls. Some have

[9] https://commons.wikimedia.org/wiki/File:Roman_Empire_125_map.png
[10] https://www.britannica.com/technology/Autobahn-German-highway

tolls (péage, eTolls) that are distance-based charges for all categories of vehicles, while others have time-based charges (vignettes) for cars and/or trucks.

While Italy was the first to start construction of "autostrada" (1924), second and the most known for motorways is Germany[11] (the first 18 km were built in 1932). Since then motorways were constructed in almost all European countries. Today length of motorways constructed in the Danube region alone reaches almost 13.000 km.

Modernising and upgrading Danube region's road transport infrastructure to meet modern standards and EU requirements also means improving road safety.

1.2.3 E-Road network

The United Nations Economic Commission for Europe (UNECE) first major act to improve transport was a joint UN declaration no. 1264 "the Declaration on the Construction of Main International Traffic Arteries", signed in Geneva on 16 September 1950. It defined the first E-road network. The declaration was amended several times before November 15, 1975, when it was replaced by the European Agreement on Main International Traffic Arteries (AGR)[12], which set up a route numbering system and improved standards for roads. The network is numbered from E 1 up and its roads cross national borders. North-south routes have odd numbers, while east-west routes have even numbers. Numbers count upward from west to east and from north to south, with some exceptions.

The AGR considers three types of roads: motorways, express roads and ordinary roads. They are classed as follows:

1. Motorways:

Motorway means a road specially designed and built for motor traffic, which does not serve properties bordering on it, and which:

(i) Is provided, except at special points or temporarily, with separate carriageways for the two directions of traffic, separated from each other by a dividing strip not intended for traffic or, exceptionally, by other means;

(ii) Does not cross at level with any road, railway or tramway track, or footpath; and

(iii) Is specially sign-posted as a motorway.

2. Express roads:

An express road is a road reserved for motor traffic accessible from interchanges or controlled junctions only and which:

(i) Prohibits stopping and parking on the running carriageway(s); and

[11] Germany's autobahn network has a total length of about 12,993 kilometers (8,073 mi) in 2016, which ranks it among the most dense and longest controlled-access systems in the world. Longer similar systems can be found in the United States (77,017 kilometer and in China (123,000 kilometers. https://en.wikipedia.org/wiki/Autobahn

[12] ECE/TRANS/SC.1/2016/3/Rev.1

(ii) Does not cross at level with any railway or tramway track, bicycle path or footpath.
3. Ordinary roads:
An ordinary road is one open to all categories of users and vehicles. It may have a single carriageway or separate carriageways.
International roads should preferably be motorways or express roads.

E-road network is supposed to be regularly updated.

It goes without saying that all main Danube region roads are part of the E-road network.

1.2.4 UNECE - Trans-European Motorways (TEM) Project

The UNECE Trans-European Motorways (TEM) Project is a sub-regional cooperation among Central, Eastern and South Eastern European countries. TEM was established in 1977. Initial financial support was provided by the United Nations Development Programme (UNDP), while the executing agency is UNECE. There are 15 member countries: Armenia, Austria (associate member), Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Georgia, Hungary, Italy, Lithuania, Poland, Romania, Slovakia, Slovenia and Turkey.
Main aim of the TEM project is to ensure seamless connections throughout Europe, including access to markets. Central to this work is the TEM Master Plan[13] (2012) which sets out the priority infrastructure needs, the backbone networks and a realistic investment plan to develop them.

Out of 14 Danube region countries, 9 are also members of the TEM project, while three have observer status (Montenegro, Serbia and Ukraine).

1.2.5 The EU TEN-T Core and Comprehensive network

The Trans-European Transport Networks (TEN-T)[14] are a planned set of road, rail, air and water transport networks in the European Union. The TEN-T networks are part of a wider system of Trans-European Networks (TENs), including a telecommunications network (eTEN) and a proposed energy network (TEN-E or Ten-Energy).
In 1990, the Commission adopted a first action plan on trans-European networks. Following the coming into force of the Maastricht treaty in 1993, the TEN-T became one of the key instruments for cohesion and growth within the European Union. Based on these competences, the Essen European Council in 1994 endorsed the so-called "Essen List" including the 14 projects that were supposed to contribute most to European integration.

[13] http://www.unece.org/transport/areas-of-work/ter/about-us/tem-and-ter-master-plan.html
[14] https://en.wikipedia.org/wiki/Trans-European_Transport_Networks

This list of priority projects was later included in the Community Guidelines for the development of the Trans-European Transport Network (TEN-T) that was adopted by the European Parliament and Council in 1996. The first financial regulation for the TEN-T was adopted in 1995.[15]

The new legal basis for the development of the trans-European transport network (TEN-T) which has been adopted in December 2013 marks the beginning of a new era in Europe's transport infrastructure policy. TEN-T Core Network Corridors are the backbone of the new EU transport policy.
Compared to the past approach, the main innovation of the new TEN-T policy lies in the definition of an integrated, multimodal core network which shall be developed until 2030 by Member States and relevant stakeholders. This core network links major nodes (urban nodes, ports, airports and other transport terminals) through key rail, road, inland waterway, maritime and air transport connections.
The core network shall be completed, i.e. a full network shall be in function, missing links between Member States will have been completed and bottlenecks that hamper free flows of transport, thereby causing high cost to the economy will have been removed.
Core network corridors play a key role in the coordinated implementation of the new TEN-T policy. The corridors are based on three pillars:
• enhancing cross-border connections and removing bottlenecks;
• integrating different transport modes (multi-modality);
• promoting technical interoperability.

The Connecting Europe Facility (CEF)[16] for Transport is the funding instrument to realize European transport infrastructure policy. It aims at supporting investments in building new transport infrastructure in Europe or rehabilitating and upgrading the existing one.
TEN-T policy objectives foresee:

- completion by 2030 of the Core Network, structured around nine multimodal Core Network Corridors[17].
- completion by 2050 of the Comprehensive Network in order to facilitate accessibility to all European regions

CEF Transport focuses on cross-border projects and projects aiming at removing bottlenecks or bridging missing links in various sections of the Core Network and on the Comprehensive Network (link), as well as for horizontal priorities such as traffic management systems.
CEF Transport also supports innovation in the transport system in order to improve the use of infrastructure, reduce the environmental impact of transport, enhance energy efficiency and increase safety.

[15] http://www.green-ten-t.eu/history/
[16] https://ec.europa.eu/inea/en/connecting-europe-facility
[17] Note: revision of TEN-T is foreseen in 2023

The total budget for CEF Transport is €24.05 billion for the period 2014-2020. INEA is responsible for implementing €22.4 of the CEF Transport budget in the forms of grants during the same period.

These projects are technically and financially managed by the Innovation and Networks Executive Agency (INEA), which is the successor of the Trans-European Transport Network Executive Agency (TEN-T EA) created by the European Commission in 2006. INEA started its activities on 1 January 2014 in order to implement the following EU programmes:

- Connecting Europe Facility (CEF)
- Parts of Horizon 2020 – Smart, green and integrated transport + Secure, clean and efficient energy
- Legacy programmes: TEN-T and Marco Polo 2007-2013

INEA's main objective is to increase the efficiency of the technical and financial management of the programmes it manages.

The Danube region road netwotks:
The Danube region road network consists of three transport systems that are in process of merging. These are:

- TEN-T network (within the EU Member States), further divided into:
    - Core network, including Core Network Corridors and
    - Comprehensive network.

  The comprehensive network role is to provide access to CNC. It is worth to mention that 6 out of 9 TEN-T CNC cross the Danube Macro Region.
- Western Balkan network[18] (Bosnia & Herzegovina, Montenegro and Serbia are also part of the Danube region) and
- Eastern Partnership network (parts of this network are represented also by two Danube region countries: Moldova and Ukraine).

Typical for all three networks (all composed of multimodal corridors) is that the road mode takes a lion share of transport, both passengers and freight, when compared to the rail mode. It is therefore imperative to pay special attention to maintenance and further road infrastructure developments while taking fully in line sustainable planning, green procurement and use of the latest construction techniques and environmentally friendly materials, where available and whenever possible.

[18] Western Balkans countries are: BiH, Montenegro, Serbia, Albania, Kosovo (under UN resolution) and FYROM. Network monitoring and planning is part of SEETO tasks.

1.2.6 ITS deployment on the Danube Region Road Network[19]

In road transport, intelligent transport systems (ITS) have been developing for over 20 years. Some applications are now widespread and well-known. For example, several millions of cars and trucks are equipped with on-board navigation systems that are able to consider real-time traffic and travel information.
The potential of intelligent transport systems (ITS) can only be achieved if their deployment in Europe evolves from the limited and fragmented scenario of today into an EU-wide one. Same goes for the Danube macro-region.

ITS can contribute to the main transport policy objectives. Also the links between modes, e.g. public transport, are becoming increasingly important. The goal should also be a reduction of congestions through better management. New assistance systems and information services for drivers are making driving a more comfortable experience.

ITS contributes that road fatalities are decreasing. There are still more than 25.000 deaths on EU roads each year. New in-vehicle safety and driver assistance systems can intervene before an accident happens. As more than 90 % of all accidents are caused by human error, this is a much-needed development. Once implemented in all countries eCall (automatical calling the emergency services and transmitting location data from the accident scene) would drastically cut the response time of the emergency services. In addition, connected and automated driving technologies will significantly improve traffic flows, reduce the incidence of critical situations, optimize the handling of corresponding scenarios, relieve the pressure on drivers and the environment and support jobs and growth.
Main challenge in ITS deployment remains interoperability. For example, interoperability is of utmost importance with electronic fee collection systems. ITS enables charging road vehicles can be flexible (according to vehicle type and/or emissions category).

Innovation for more efficiency and sustainability is also one of main objectives of the White Paper on transport: Roadmap to a single European transport area - Towards a competitive and resource -efficient transport system[20]. While advanced road traffic management and information systems are used in many places throughout Europe, regional and national ITS services still form a fragmented patchwork. Trans-European Network for Transport (TEN-T), backed up by a new financing instrument, the Connecting Europe Facility (CEF) supports its development, including the deployment of EU-wide ITS services.

The EU also aims to create a single market for ITS services. This includes the development of technical standards to ensure interoperability and a stable basis for investment decisions, as

[19] https://ec.europa.eu/transport/themes/its/road/deployment_en
[20] https://ec.europa.eu/transport/themes/strategies/2011_white_paper_en

well as the necessary legal and organizational framework for the deployment of ITS services (ITS Action Plan and ITS Directive[21]). The main targets for ITS deployment are to: decrease traffic fatalities by 25 %, decrease traffic congestion by 25 % and decrease CO_2 emissions by 10 %.

The Danube region countries could start joint efforts for speedy deployment by common Master plan for ITS deployment. So far Roadmap for the Deployment of ITS in the Danube Region[22] was elaborated that shows the harmonized access to public transport data, access to dynamic road data, as well as the provision of multi-modal travel information is of high priority in the Danube Region.

1.2.7 A display of some of the basic data about roads in the Danube region presented in charts

This brochure charts contain the following data:

- Kilometers of roads per million inhabitants
- Kilometers of roads per km^2 of the land area
- Kilometers of motorways per million inhabitants
- Kilometers of motorways per km^2 of the land area
- Average annual daily traffic (AADT) on motorways in the year 2016 (2015[1])
- Traffic safety – number of killed persons per million inhabitants in road accidents in year 2014 (2016[1], 2017[2])
- Gross investment spending in road infrastructure in mio EUR/year 2013 (2016[1],2017[2]) per mio inhabitants
- Maintenance expenditures in road infrastructure in EUR/year 2013 (2016[1],2017[2]) per km of road network (length of all roads)

Charts below show a quick overview of the few important parameters that are important at describing a road network. On the charts one can compere different parameters between counties.

[21] https://ec.europa.eu/transport/themes/its/road/action_plan_en
[22]http://www.smart-mobility.at/en/news/latest-news/newsdetails/?tx_news_pi1%5Bnews%5D=121&cHash=445d9aec26f3e40a7e833a955defbcbf

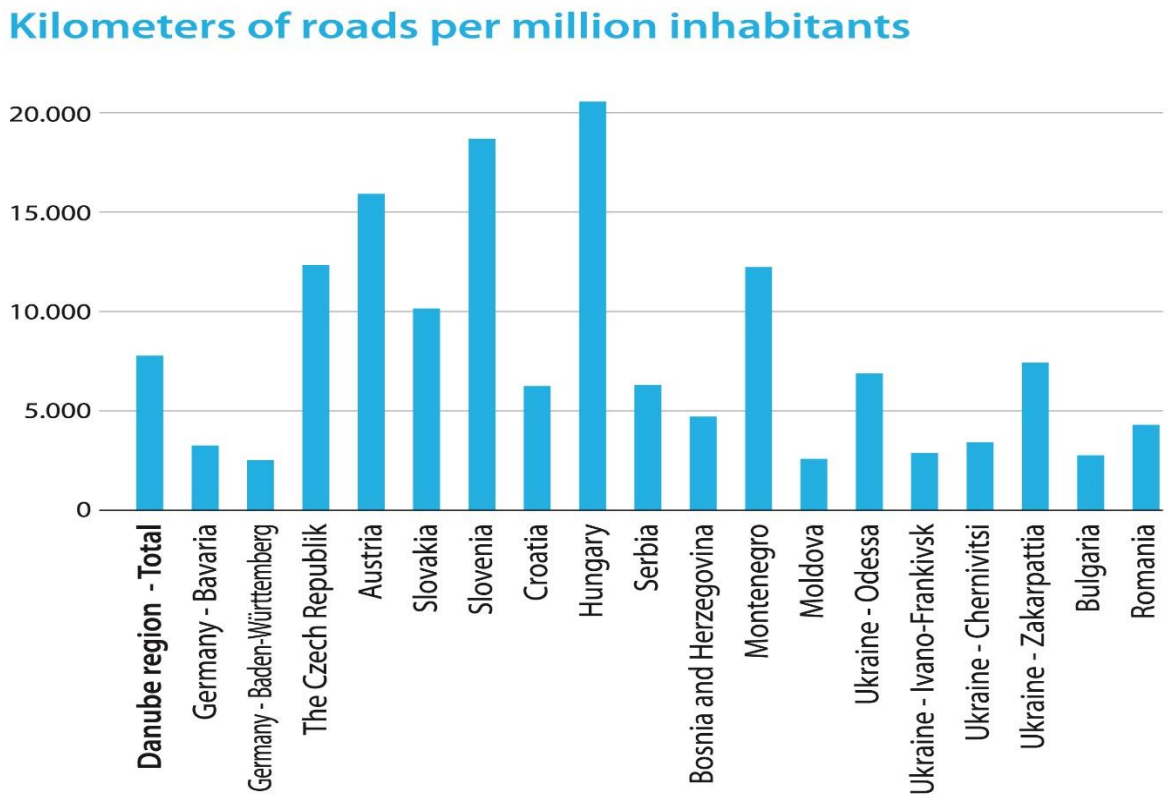

Figure 3: Kilometers of roads per million inhabitants

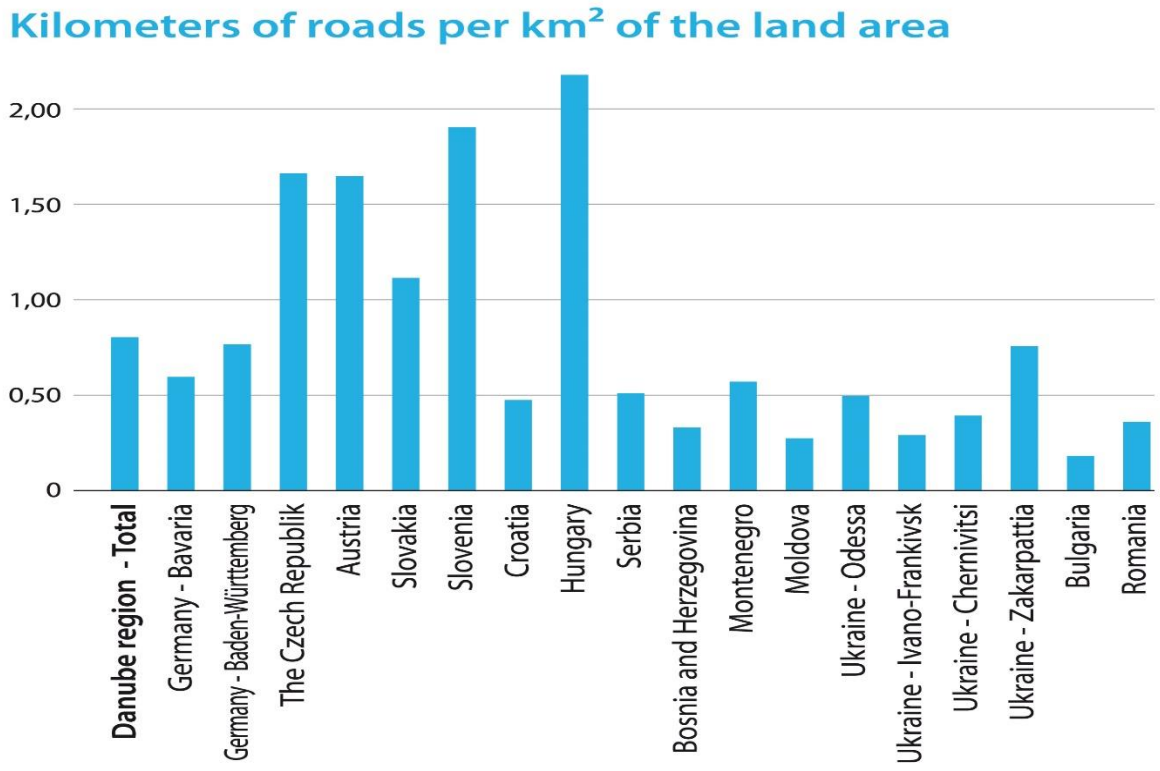

Figure 4: Kilometers of roads per km^2 of the land area

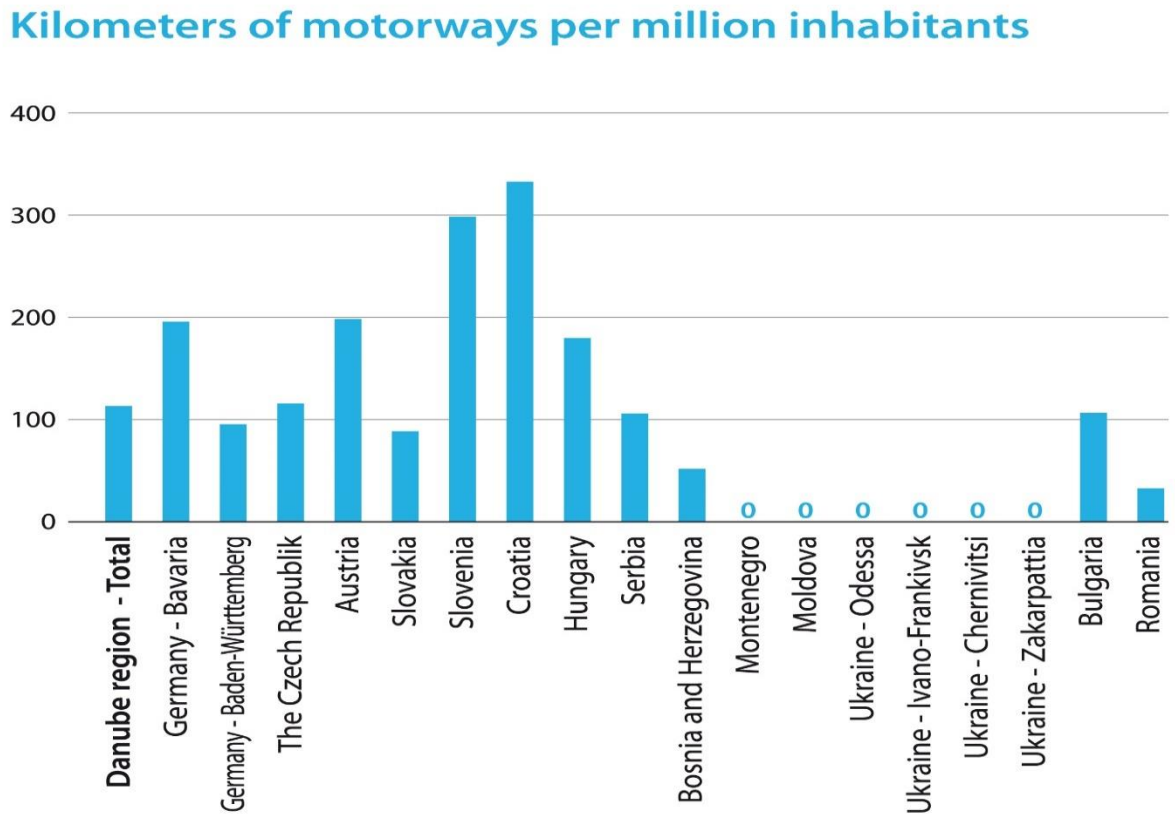

Figure 5: Kilometers of motorways per million inhabitants

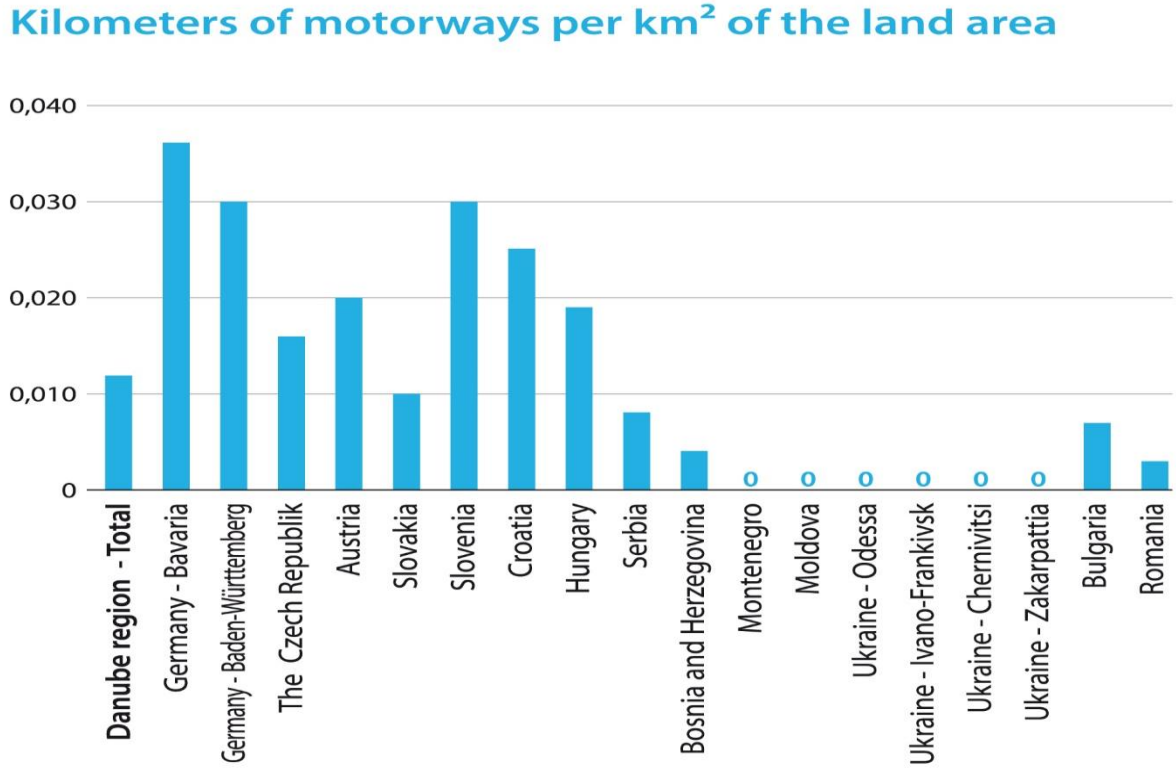

Figure 6: Kilometers of motorways per km2 of the land area

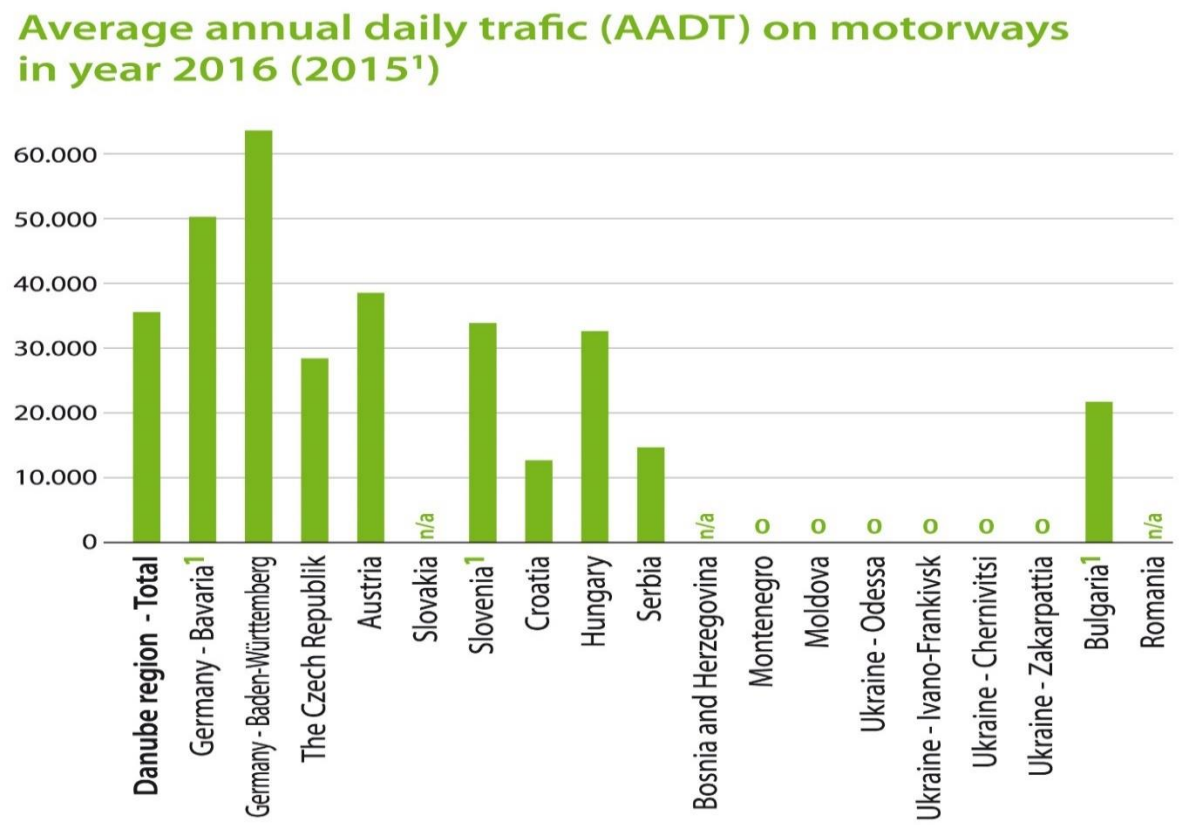

Figure 7: Average annual daily traffic (AADT) on motorways in the year 2016 (2015[1])

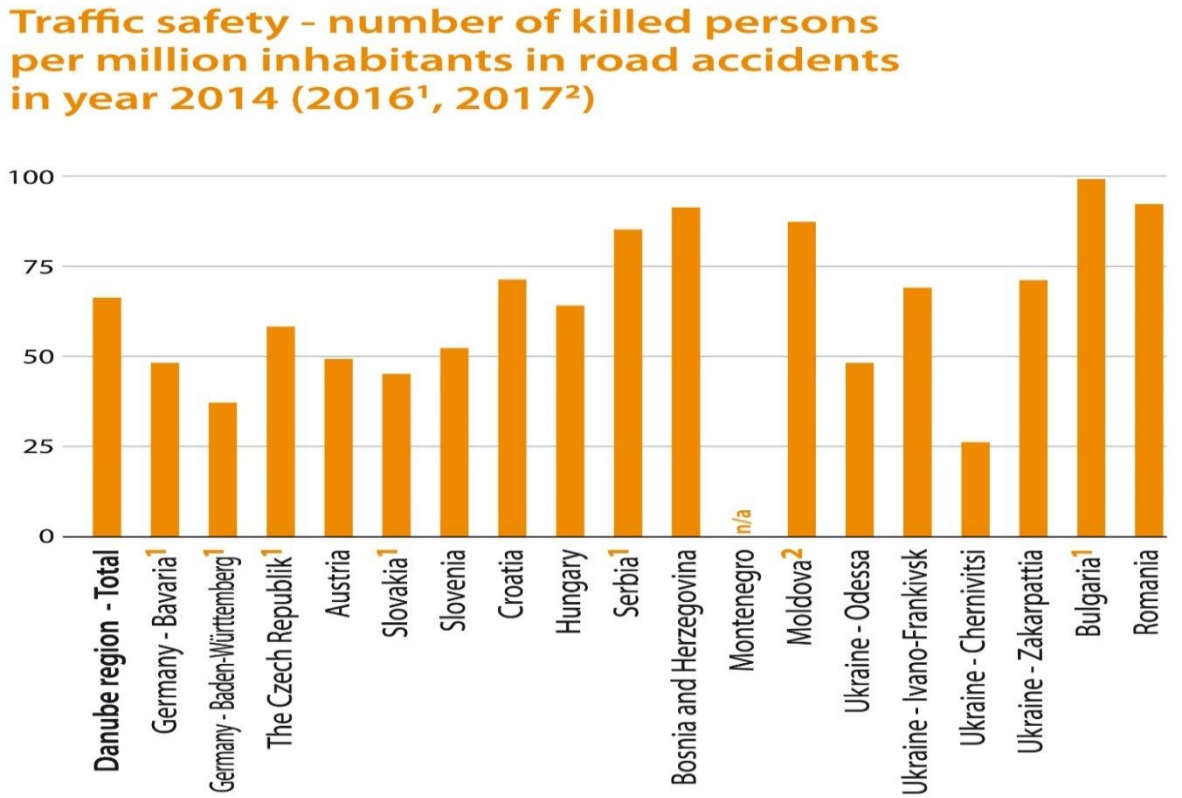

Figure 8: Traffic safety – number of killed persons per million inhabitants in road accidents in year 2014 (2016[1], 2017[2])

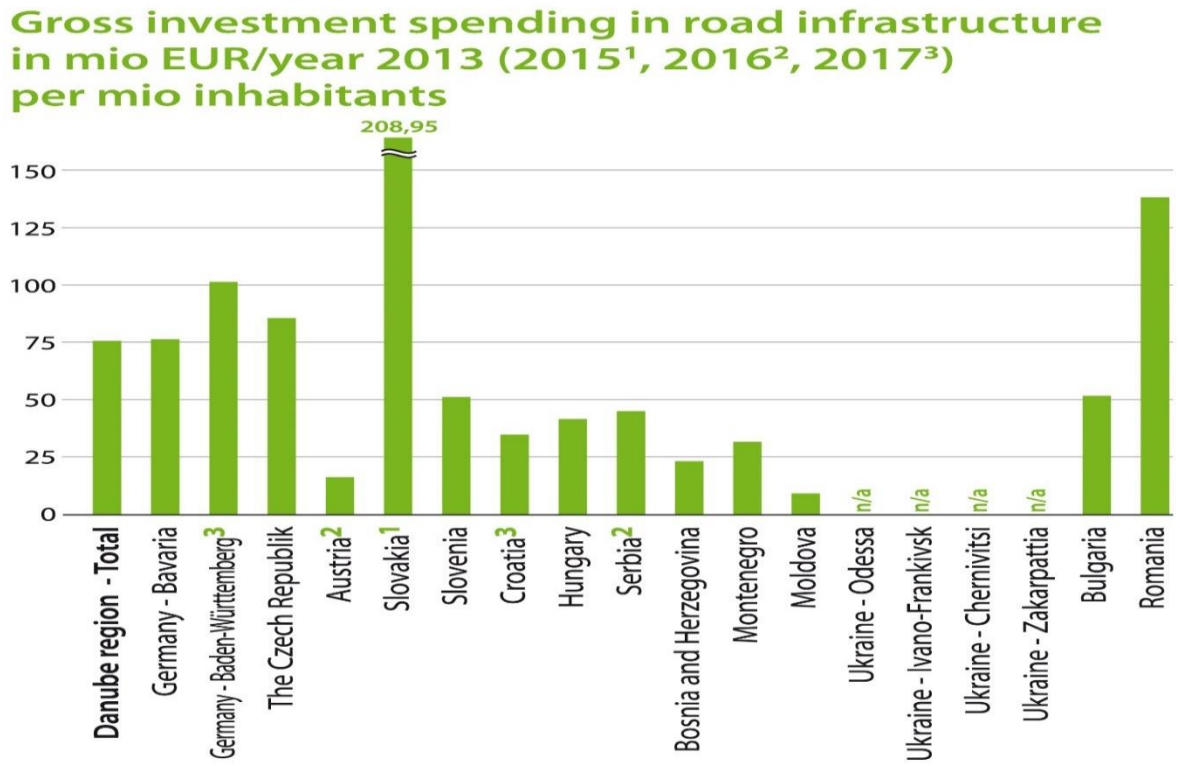

Figure 9: Gross investment spending in road infrastructure in mio EUR/year 2013 (2016[1],2017[2]) per mio inhabitants

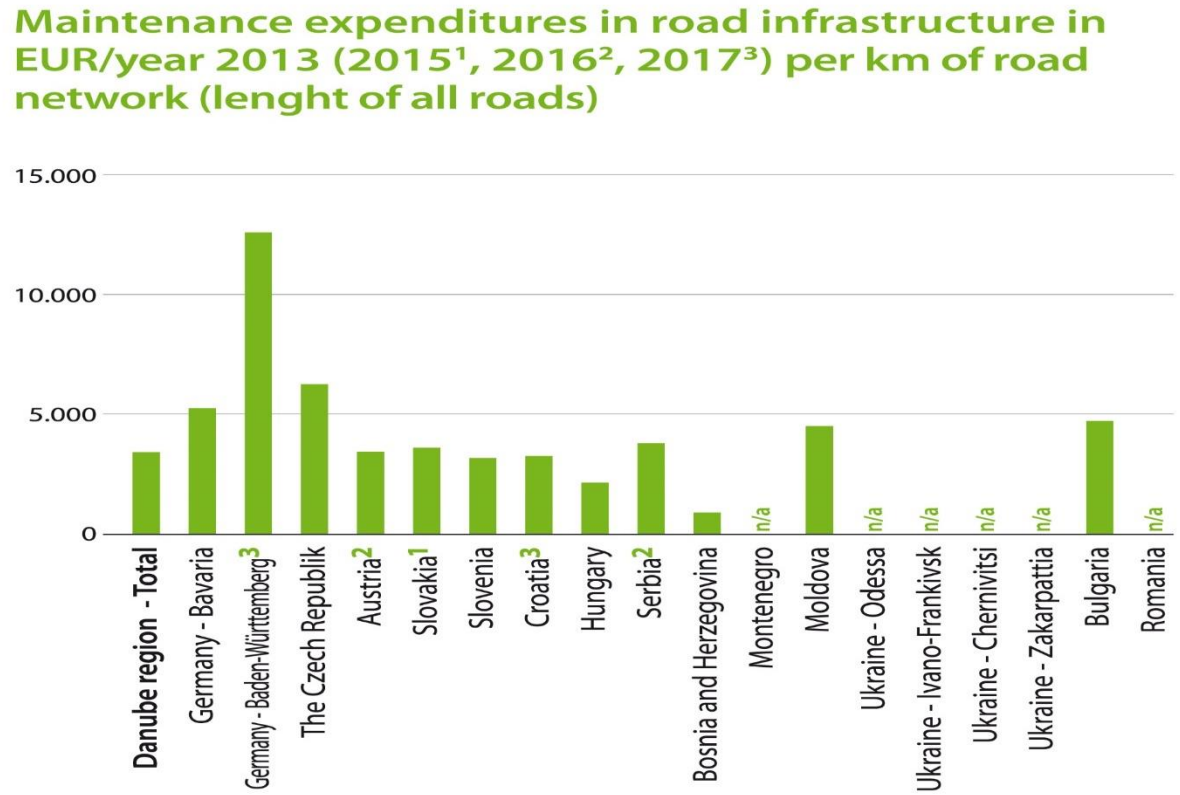

Figure 10: Maintenance expenditures in road infrastructure in EUR/year 2013 (2016[1],2017[2]) per km of road network (length of all roads)

2 REGION DESCRIPTIONS IN THE DANUBE REGION

2.1 AUSTRIA

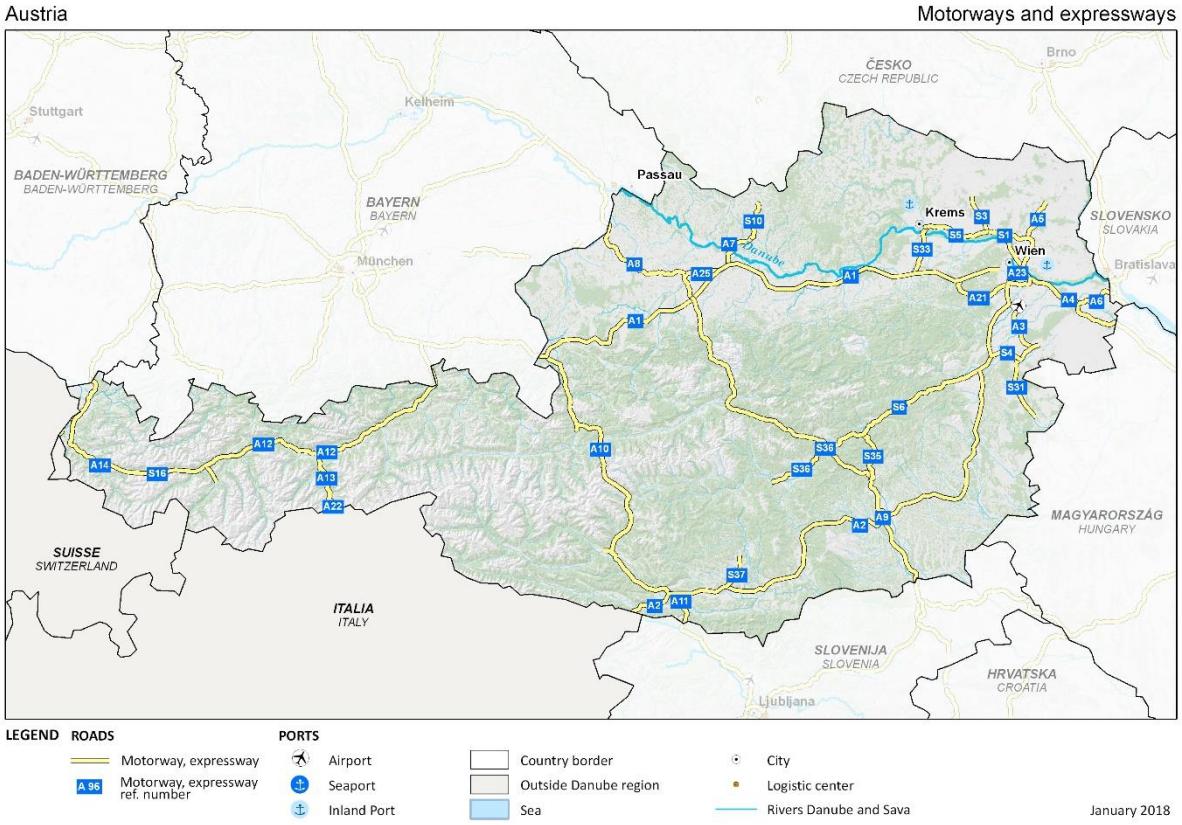

Figure 11: Motorway map of Austria

Austria is a country situated in central Europe. Most of its territory lies on the right side of the Danube river. Austria borders Slovenia and Italy on the south, Hungary on the southeast, Slovakia on the east, the Czech Republic and Germany on the north, Switzerland and Liechtenstein on the west. The landscape in mostly Alpine, only 32 % of the country is below 500m[23]. Austria has 83.879 km^2 of land area and 8.690.076 inhabitants with 40.200 euro per capita GDP.

Austria has good connections with majority of neighbouring countries. Only the missing motorway section with the Czech Republic should be addressed in short term period. Road network consists of 1.719 km of motorway and 138.208 km of all the roads. Traffic safety has improved over the past 10 years. There were 44 % less fatal accidents (deaths) recorded on the roads–between 2005 and 2014. A steady flow of investments into maintenance and expansion of road network, missing sections and bottlenecks is being made.

[23] https://en.wikipedia.org/wiki/Austria

2.2 BOSNA AND HERCEGOVINA

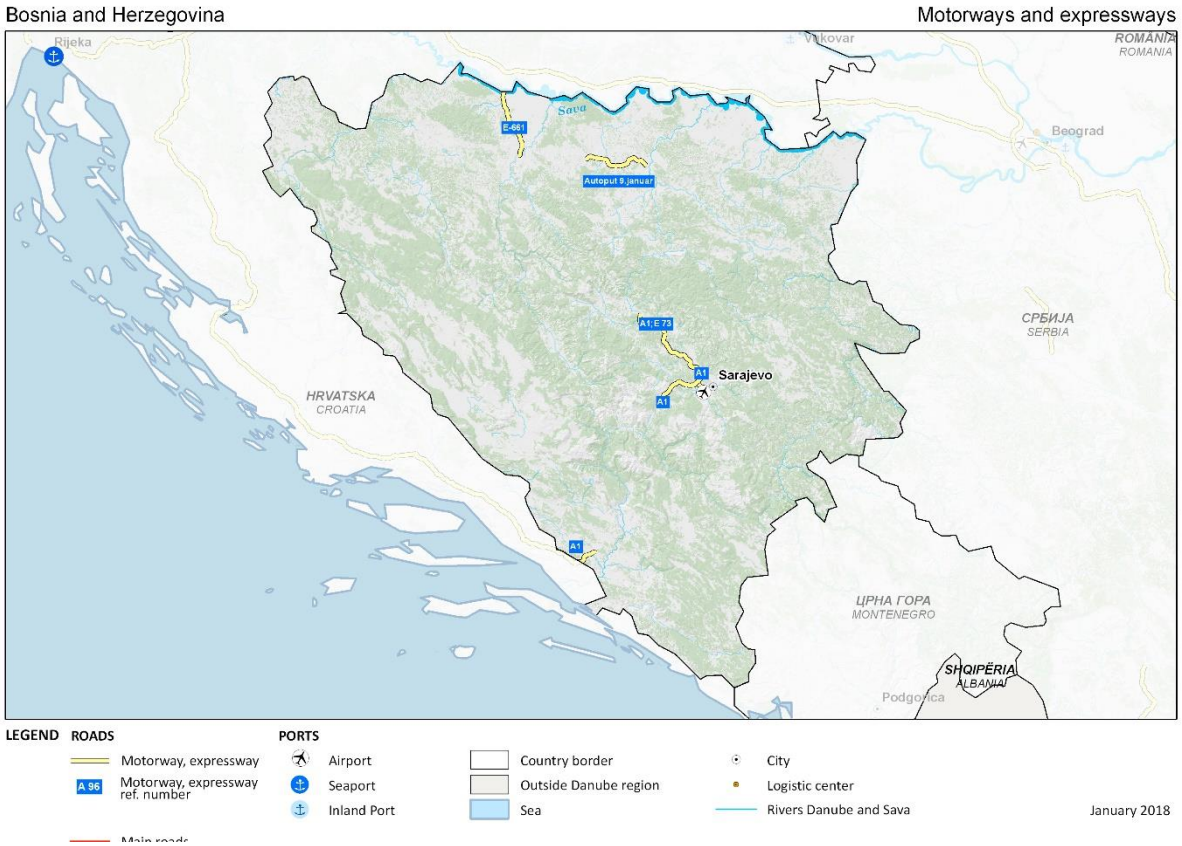

Figure 12: Motorway map of Bosna and Hercegovina

Bosnia and Herzegovina is situated in the Balkan peninsula in south-eastern Europe. It has borders with Croatia in the north, west and southwest, Serbia and Montenegro on the east. It is located on the right side of the Sava river. Sava is a tributary that joins the Danube river in Belgrade. Its terrain is mostly mountainous in the east and center of the country, the northwest in mostly hilly and flatlands can be found mainly in the northeast.

Bosnia and Herzegovina recently started construction of its motorways. So far 183 km are put into operation. Regardless short motorway network, its traffic safety has improved significantly in the last years. There were 44 % less fatal accidents (deaths) recorded on the roads–between 2005 and 2014. For this kind of trend to proceed, focus should be on connecting neighboring countries with motorways, since quality road network brings many benefits to the region.

2.3 BULGARIA

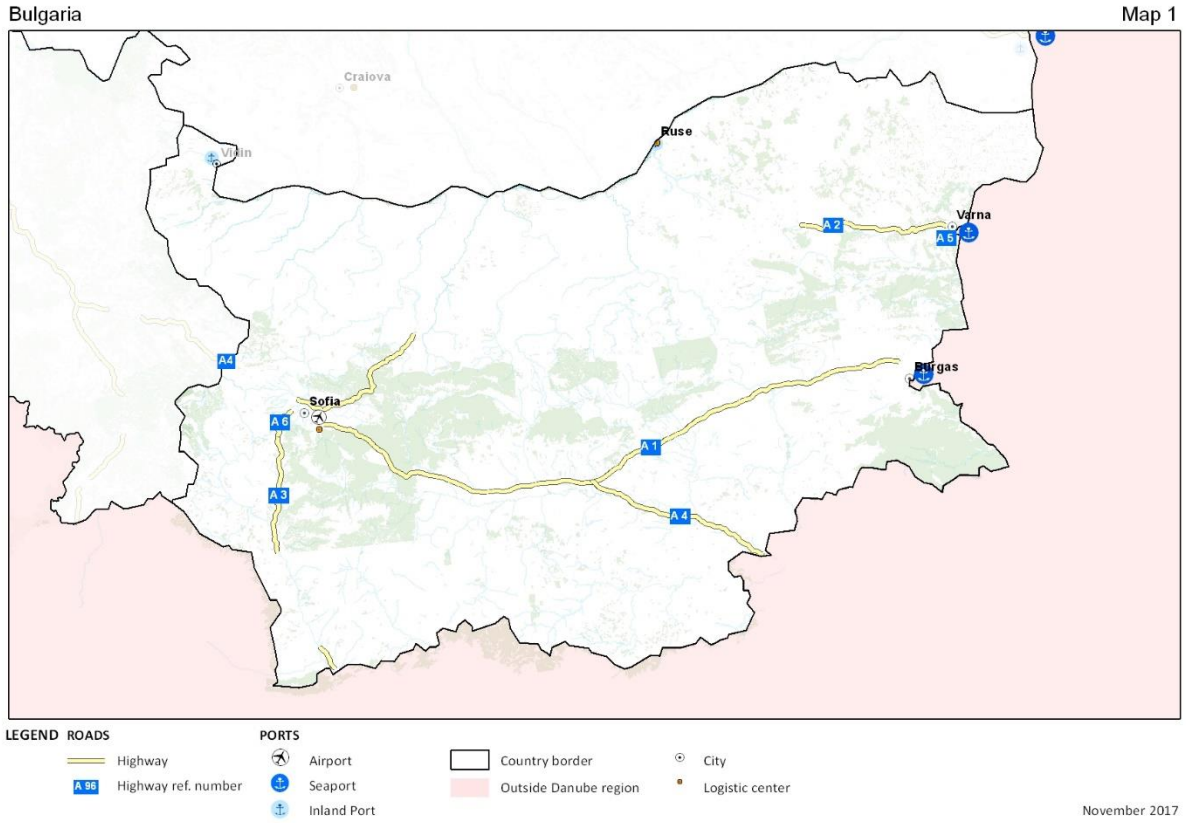

Figure 13: Motorway map of Bulgaria

Bulgaria is situated in southeastern Europe. It has borders with Romania on the north, Serbia on the northwest, FYR Macedonia on the west, Greece on the southwest and south, Turkey on the southeast and the Black sea on the east. It is located on the right side of the lower part of the Danube river. Its terrain is diverse. On the west is a part of Balkan Mountains in the middle Tracian plain and on the north-northeast Danubian plains.

Total length of the national road network in Bulgaria is 19.902 km. Motorways account for only 740 km of the total length. Despite the low percent of motorways, there were 31 % less fatal accidents (deaths) recorded on the roads–between 2005 and 2014. Due to the insufficient investments compared to the needs, there has been no significant improvement in the overall condition of the roads, despite the measures taken in recent years.

Focus in the future should be on connecting neighbouring countries with motorways, because quality road network brings many benefits to the region. Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

2.4 CROATIA

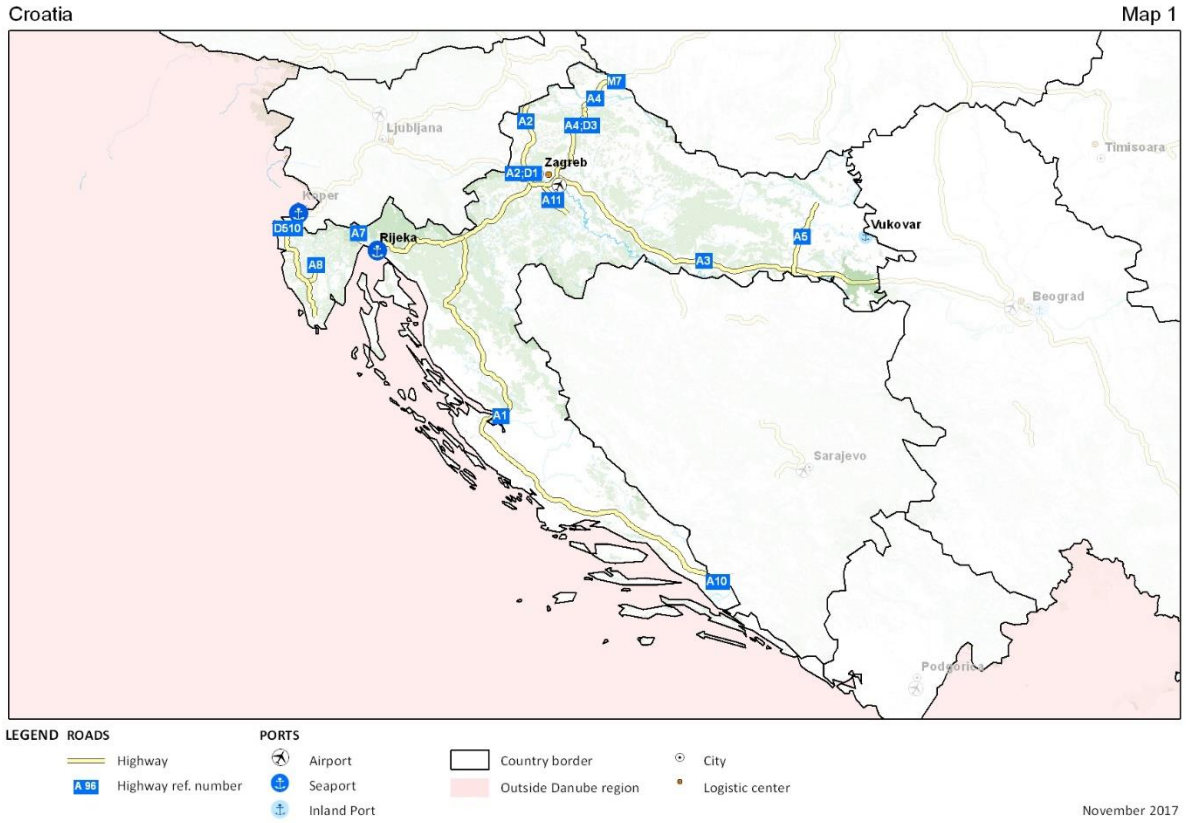

Figure 14: Motorway map of Croatia

Croatia is situated in the north of the Balkan region – southeast Europe, on the right side of Danube river basin. Its borders are to the northwest Slovenia, on the west Adriatic Sea and the sea border with Italy, on the southeast Bosna and Herzegovina and Montenegro, on the east Serbia and on north Hungary. Croatia consists of Dinaric Alps on the west, hilly northern parts of Hrvatsko Zagorje and a part of Pannonian basin in the east. Croatia has over 5.800 km of shore line on the Adriatic Sea.

Croatia's road network consists of 26.865 km of all roads of which 1.417 are motorways. Croatia has with great intensity completed most of her motorway network in the past decade. The construction of motorways contributed to better road safety. There were 48,74 % less fatal accidents (deaths) recorded on the roads between 2005 and 2014.

2.5 THE CZECH REPUBLIC

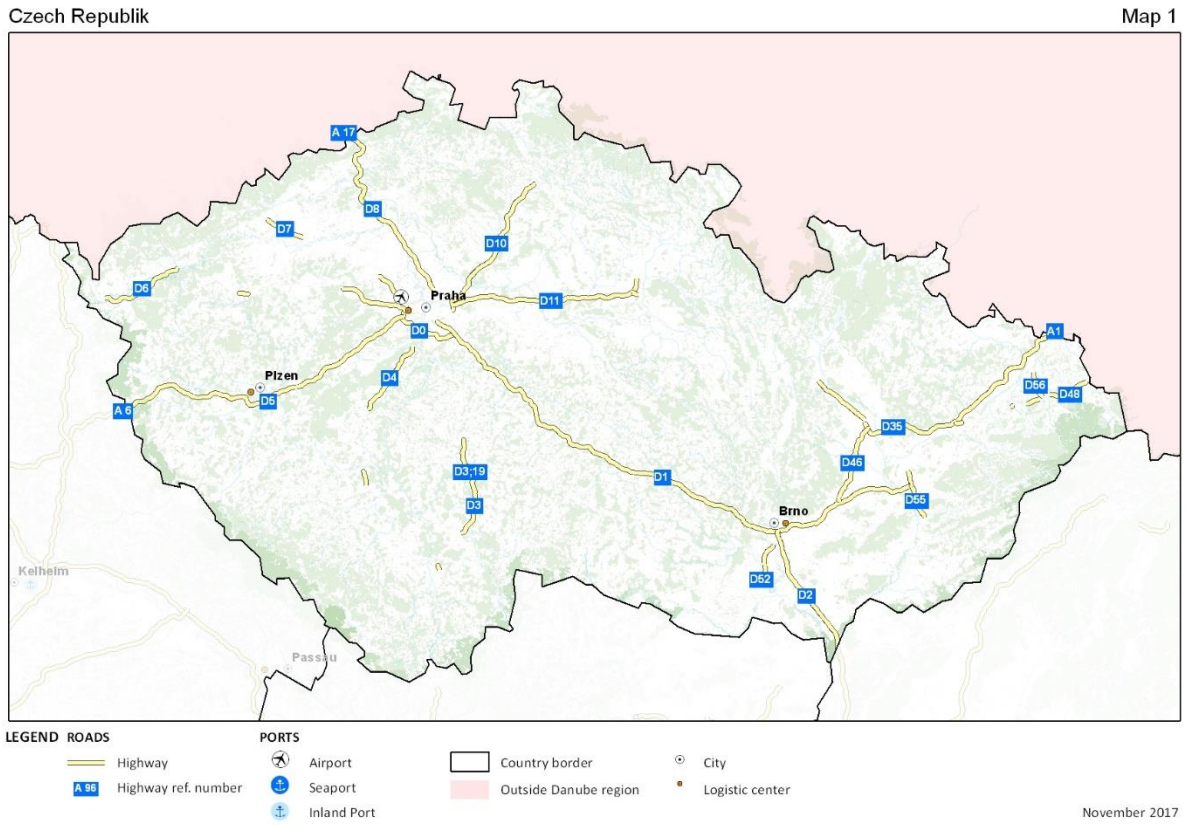

Figure 15: Motorway map of the Czech Republic

The Czech Republic is a country situated in central Europe on the left side of the Danube river. On the northwest and west it shares a border with Germany. In the south it has a border with Austria, at southeast it borders Slovakia and on the northeast it borders Poland. Its geography is of mainly hilly, the highest point is Snežka mountain (1.603 m).

The Czech Republic has a GDP, 16.763 euro per capita and an area of 78.868 km^2. It has 130.676 km of all roads, with a low length of motorways, only 1.223 km. Motorway connection with Austria is missing. Traffic safety has improved over the past 10 years. In 2016 there were 50 % less fatal accidents (deaths) on the roads (611) in comparison to 2007 (1 222). Traffic intensities are highest around the capital Prague as well as on the connection between Prague and Brno and between Brno and Ostrava. Taking into account the average growth in daily traffic on main roads, being over 5 % during the past few years, quite a number of road sections are prone to upgrading to motorway or express-road standard.

2.6 GERMANY - BADEN WÜRTTEMBERG

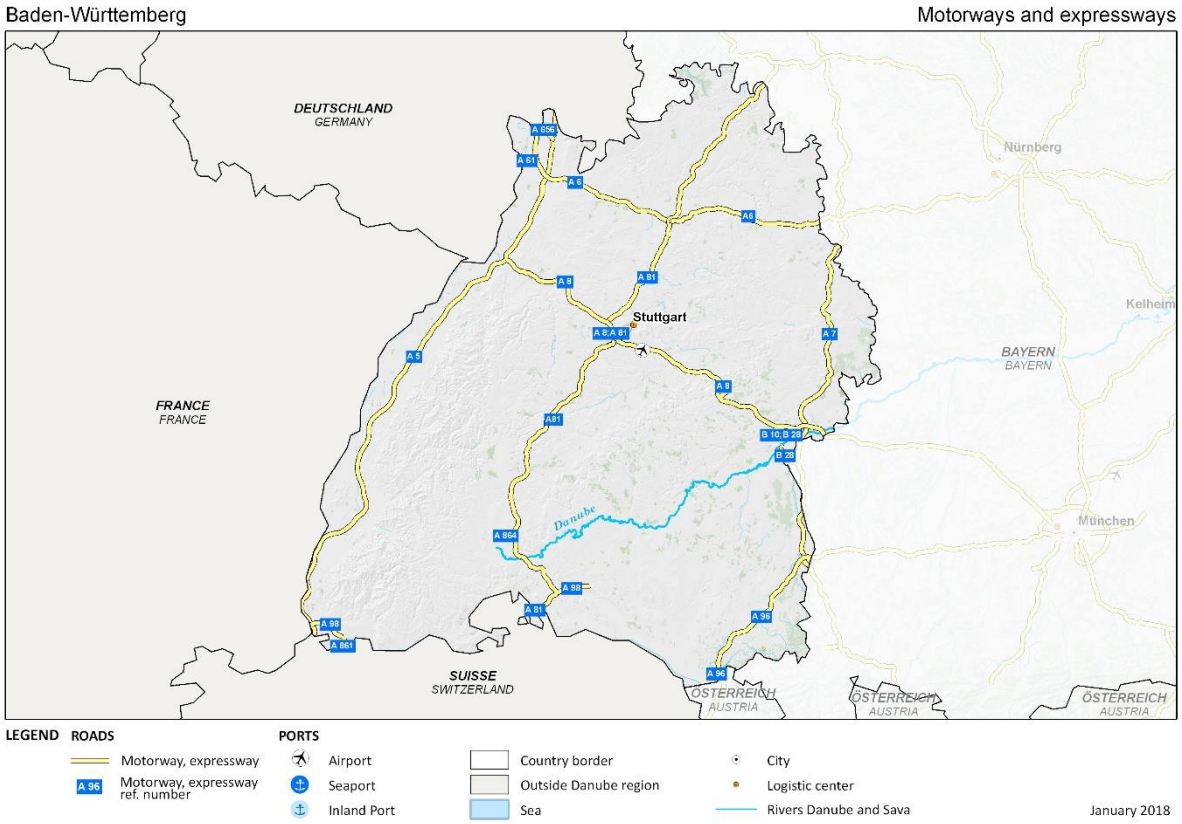

Figure 16: Motorway map of Baden Wuertemberg

Baden Wuertemberg is a federal state in Germany, with 10.879.618 inhabitants. It is situated at the upper Danube region in southwest of Germany at the border with France and Switzerland. In the southwest lies the Black Forest (Schwarzwald) and in the south there are the foothills of the Alps. The Danube river originates at Donaubach spring (Donaueschingen) in the Black Forest.

Regarding its size and population, it is the third largest state in Germany[24]. Hand in hand goes its high GDP, 43.843 euro per capita and its good road network connectivity. The state has 27.421 km of all roads on 35.677 km^2 of land area. In the last 10 years it was 37,01 % less fatal road accidents recorded (2016 in comparison to 2006).

[24] https://en.wikipedia.org/wiki/Baden-W%C3%BCrttemberg#Geography

2.7 GERMANY – BAVARIA

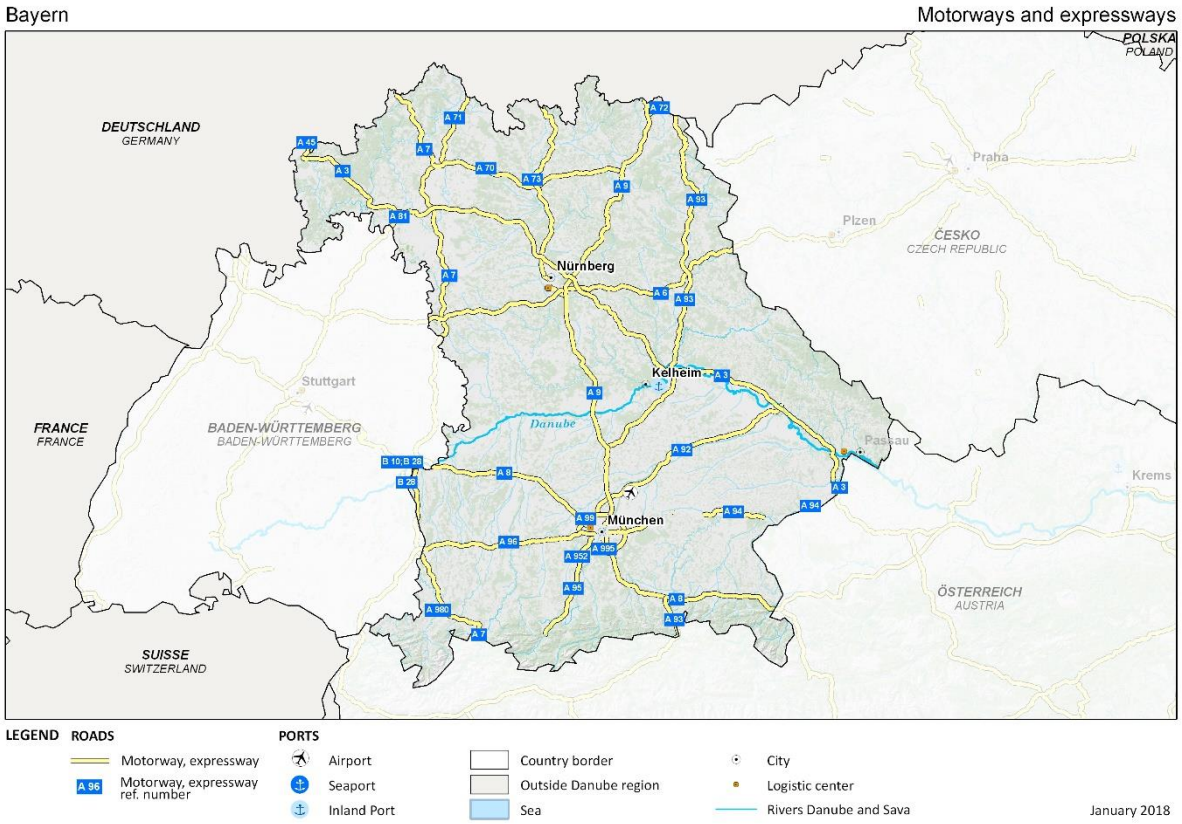

Figure 17: Motorway map of Bavaria

The Free State of Bavaria is a German federal state located in the south east of Germany. It borders Baden Wuertemberg on the west, Switzerland on the southwest, the Czech Republic on the east and Austria on the south. Bavaria is the largest German state according to land area and the second largest according to population[25]. The Danube river flows directly through the center of the state. The southern part of Bavaria lies in the foothills of Alps, the rest of Bavaria is hilly and flat.

Bavaria has a high GDP, 44.225 euro per capita and a good road network distribution. With 41.895 km of all roads, out of which 2.515 are motorways, it is one of the most branched network in the Danube basin. Despite good network, investments in expansions are needed, especially at major cities. Traffic safety has improved over the past 10 years. In 2016 there were 32 % less fatal accidents (deaths) on the roads in comparison to 2006.

[25] https://en.wikipedia.org/wiki/Bavaria

2.8 HUNGARY

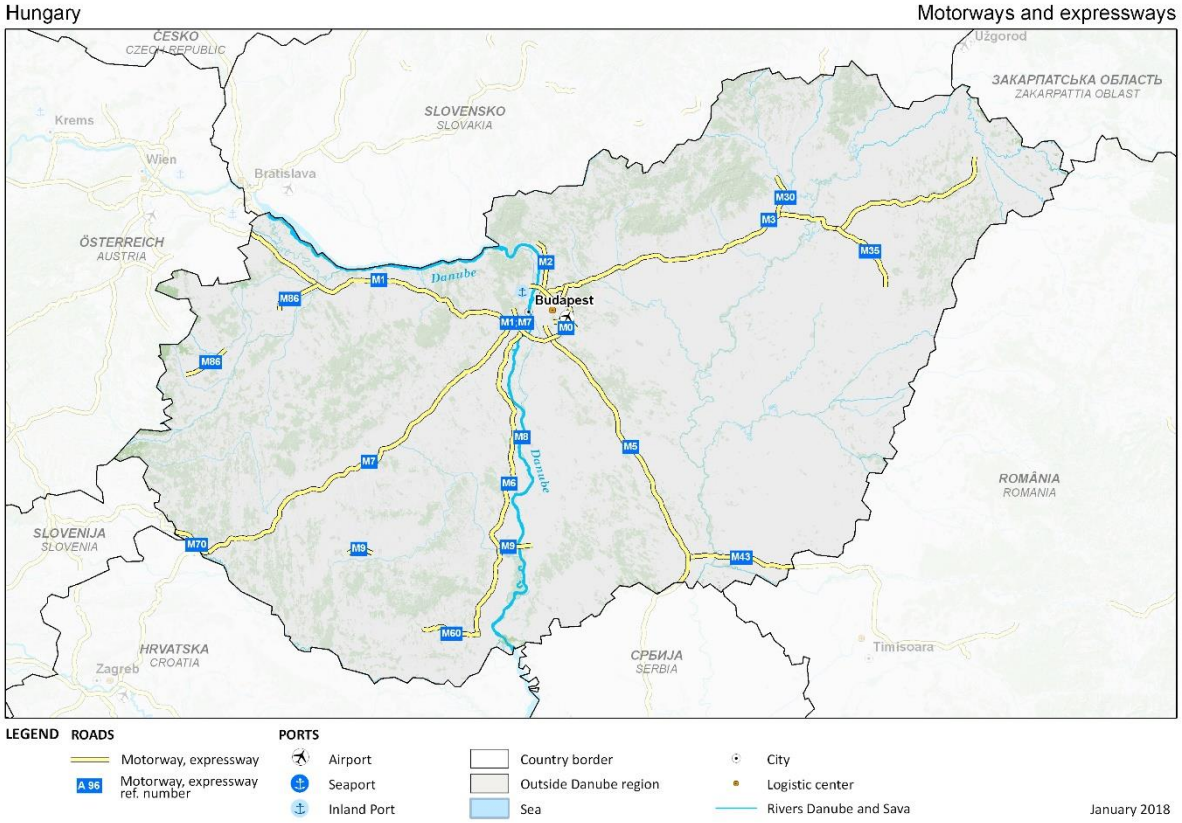

Figure 18: Motorway map of Hungary

Hungary is situated in central Europe. The Danube river crosses Hungary through its capital Budapest. Hungary borders Slovakia on the north, Austria on the northeast, Slovenia on the west, Croatia on the southwest, Serbia to the south, Romania to the east and Ukraine on the northeast. Hungary is mostly a flat country. The terrain ranges from flat to rolling plains.

The density of public roads is one of the highest in the EU. Seven out of 8 major motorways start from Budapest and all of them link up with the European road network. Hungary's s road network has a total of 203.309 km of all roads, out of which 1.767 km are motorways. The motorway network has been upgraded and extended over the last few years through reconstruction of four-lane sections, which covered only a part of the country. It has been estimated that the improvement of the motorway network and four lane motorways linking all the major cities in Hungary will result in an approximately 40 % decrease of driving times on the main inter-city routes (Hungarian Transport Administration, 2013). It can also result to better safety. There were 51,02 % less fatal accidents (deaths) recorded on the roads between 2005 and 2014.

2.9 MOLDOVA

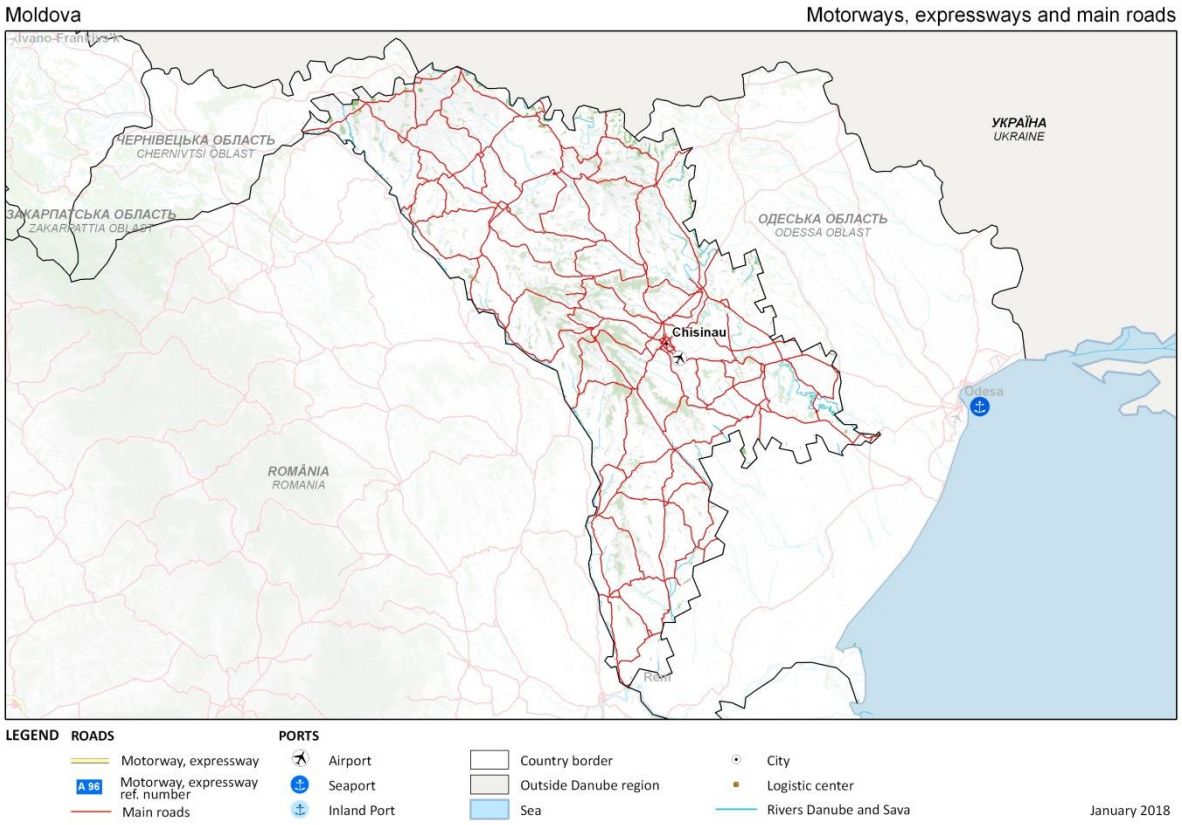

Figure 19: Main road map of Moldava

Moldova is a country with 33.846 km^2 of land, situated in Eastern Europe and a GDP 1.723 EUR per capita. It has borders with Romania in the west and Ukraine in the east. It is located on the left side of the lower part of the Danube river. Its terrain is mostly hilly.

Moldova has no motorways (no four lane roads), 2.627 km of national roads, 3.277 km of regional roads, 3394 other roads and 1.987 km of road without anti dust protection. Therefore, further development of national road network is necessary. Focus should be on connecting neighboring countries with motorways, because quality road network brings many benefits to the region. Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

2.10 MONTENEGRO

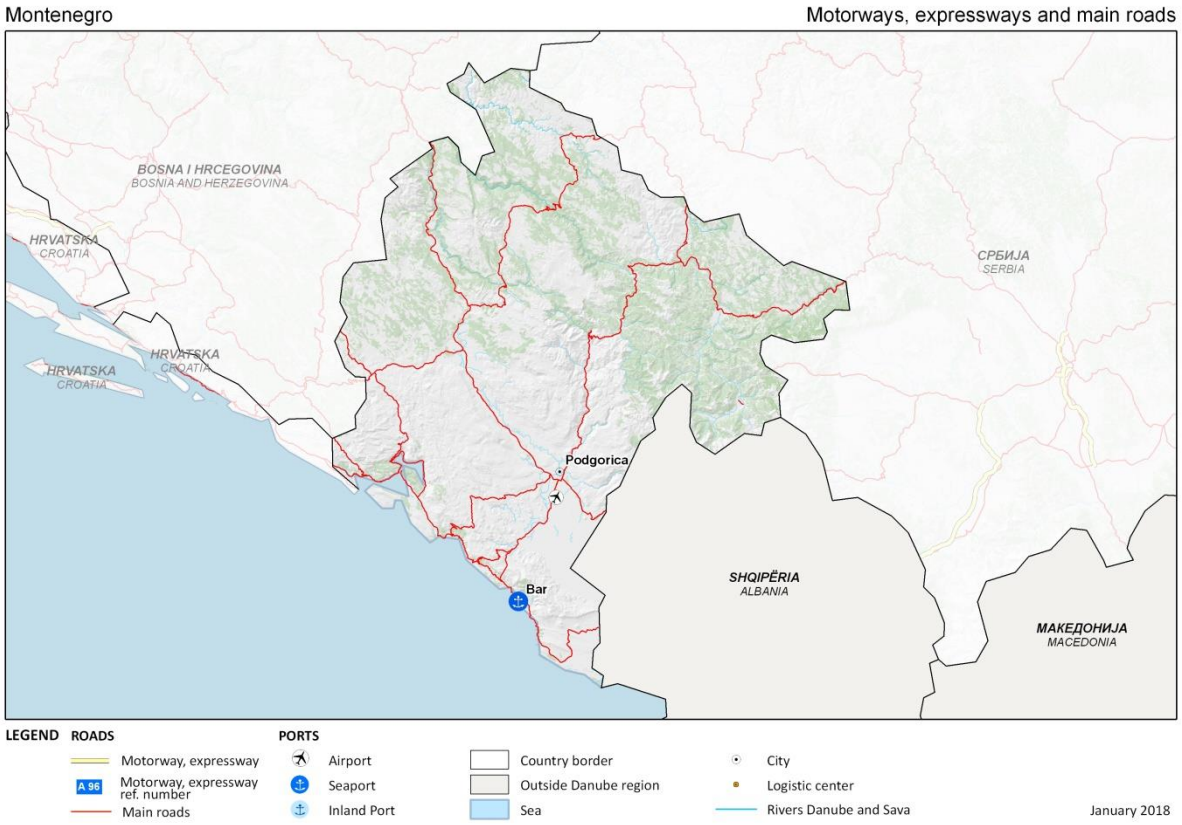

Figure 20: Main road map of Montenegro

Montenegro is situated in the Balkan peninsula in southeastern Europe. It has borders with Croatia on the west, Serbia on the northeast, Bosnia and Herzegovina on the west and Albania on the southeast. It is located on the right side of the middle part of the Danube river. Its terrain is mostly mountainous and only at the Adriatic Sea coastal area a small part of flatland can be found.

Montenegro has no motorways and a total length of the road network 7.965km. This could be the reason for low traffic safety. Between 2004 and 2007, Montenegro experienced a 40 % increase in road accidents and associated personal damages. The economic cost of traffic accidents in Montenegro is nearly 2 % of GDP.

Authorities have prioritized upgrading road safety equipment and practices in line with EU standards, and are taking steps to upgrade relevant signage and infrastructure. However, assistance is needed to build the technical and institutional capacity for relevant road agencies and implement investments and pilot projects.

2.11 ROMANIA

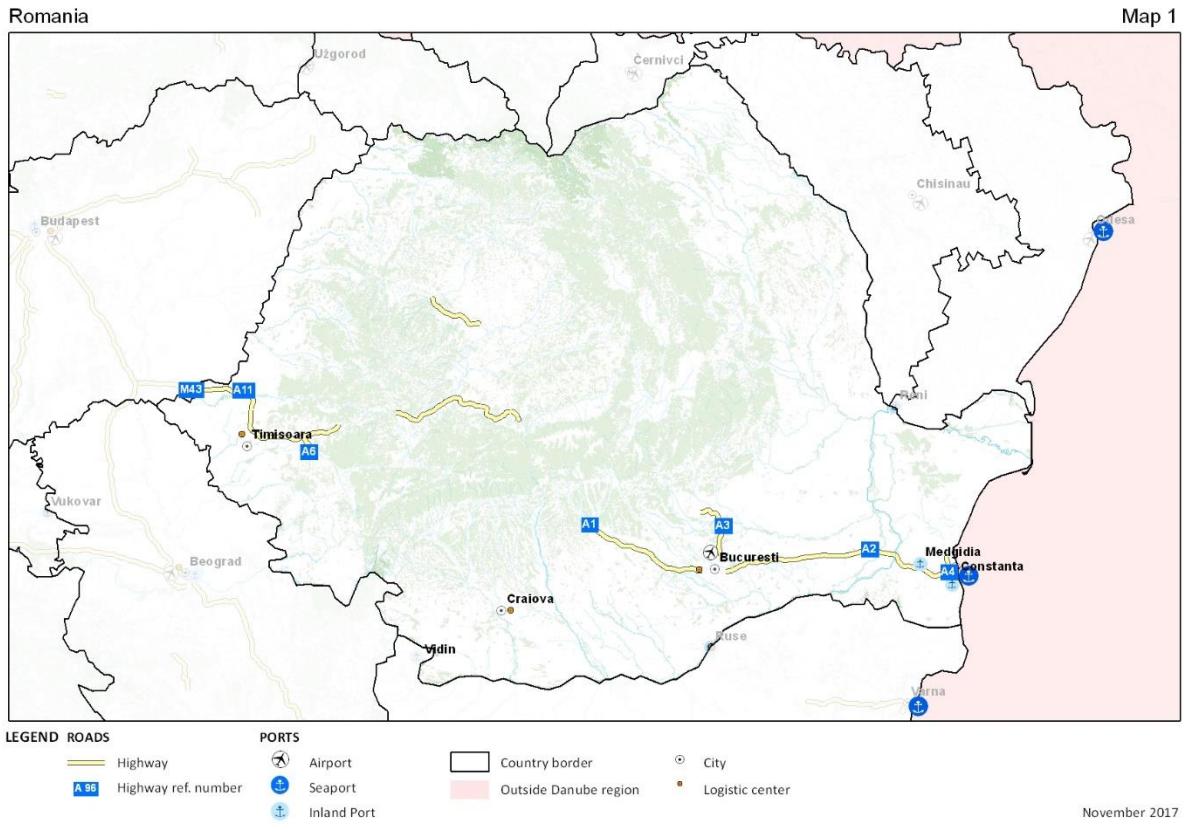

Figure 21: Motorway map of Romania

Romania is situated in southeastern Europe. It has borders with Hungary on the northwest, Serbia on the west, Bulgaria on the south, Moldova on the east and Ukraine on the southeast and north. It is located on the left side of the lower part of the Danube river. Its terrain is mostly mountainous in the center and flat in the south and southeast, where the Danube delta is situated. Romania has a long coast along the Black Sea.

In comparison to its size, Romania has a relatively short length of motorway network, 644 km. There were 31 % less fatal accidents (deaths) on the roads–between 2005 and 2014. Despite the fact that fatality level is decreasing, further development of national road network is necessary. Focus should be on connecting neighboring countries with motorways, since high-quality road network brings many benefits to the region. Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

2.12 SERBIA

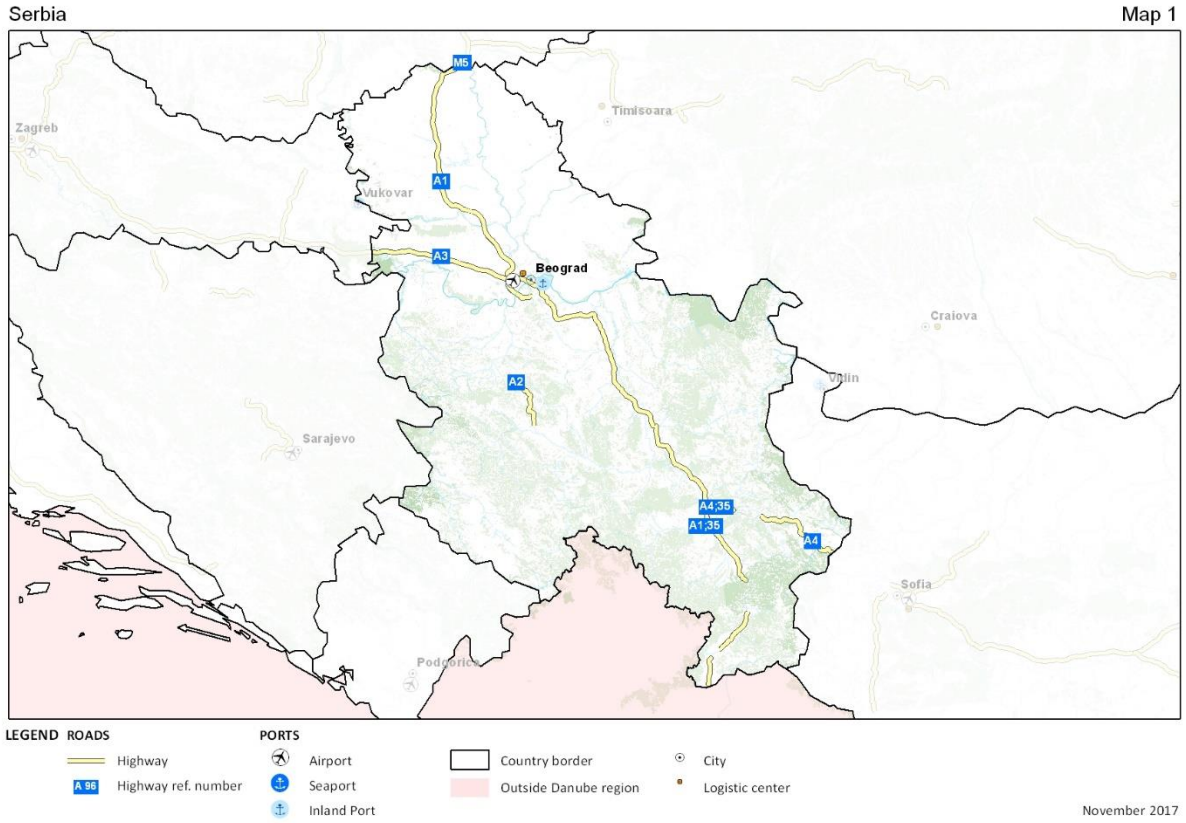

Figure 22: Motorway map of Serbia

Serbia is located in the central part of the Balkans in the southeast Europe. Its borders are with Hungary to the north, Romania to the east, Bulgaria to the southeast, FYR Macedonia to the south. The Danube river flows through the north of the country through the city of Novi Sad. North of Serbia's land is a part of the Pannonian Plain. The canter of Serbia is mostly hilly traversed by rivers. The south of the country is dominated by Dinaric alps.

Serbia's road network has a total of 45.009 km of all roads, out of which 603 km are motorways. It has a low density of motorways, therefore the connectivity with neighboring countries is inadequate. In the future connections with neighbouring countries (in particular Bosnia and Herzegovina, Montenegro and Romania) should be considered.

2.13 SLOVAKIA

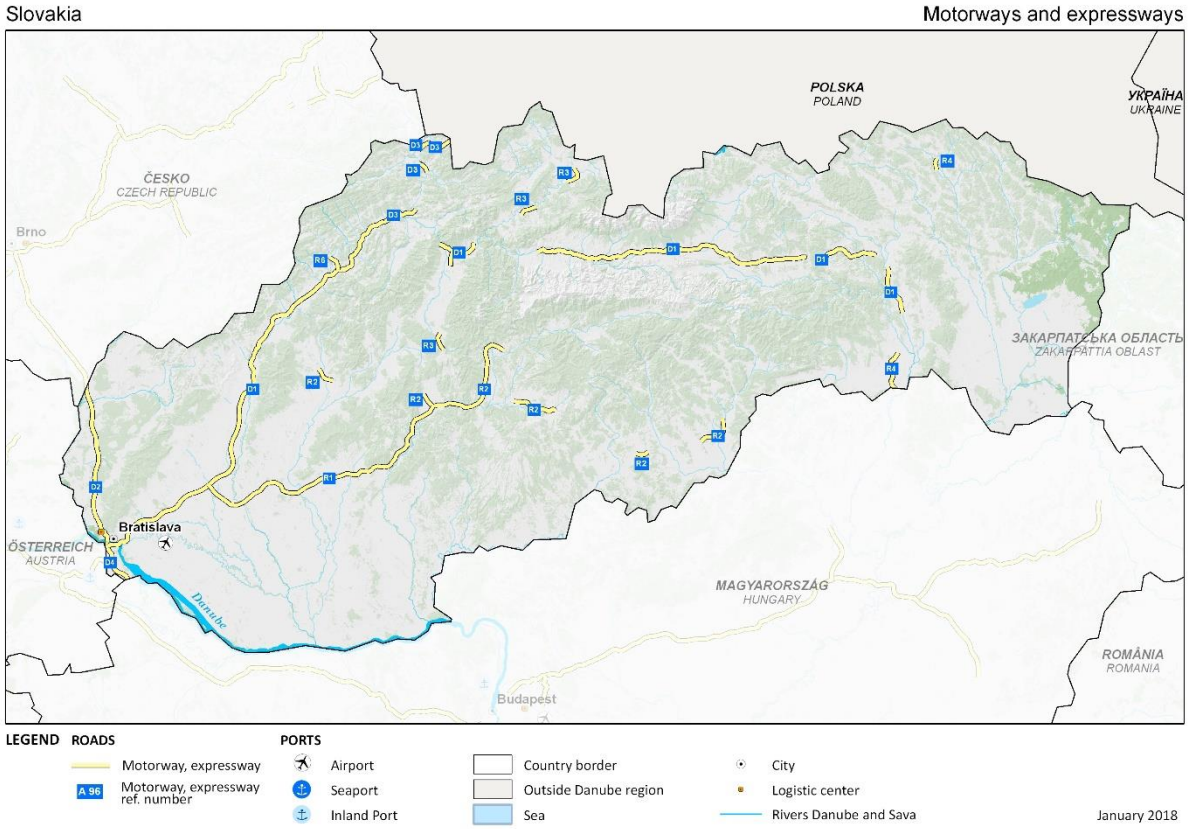

Figure 23: Motorway map of Slovakia

Slovakia is a country situated on the upper left side of the Danube region in central Europe and has been the EU member county since 1st May 2004. Most of the country on the north is dominated by Carpathian Mountains. While on the southwest the biggest Slovakian lowland – Danubian Lowland can be found. Its road network consists of 54.806 km of all roads, of which 420 km are motorways. Its road density is 10.100 km of roads per 1 million inhabitants. Motorway connections with Ukraine, Poland and Hungary should be improved in order to enable better connectivity.

In 2014, 259 persons died in road accidents. The death rate has fallen for 54% between the year 2006 and 2015. The decline of death rate and increase in road safety can be attributed to funds that were intended for investing and maintaining road infrastructure (564 million euros in the year 2013). Despite the expansion observed during the past decade, the Slovak motorway network is still underdeveloped, when compared to the EU average.

2.14 SLOVENIA

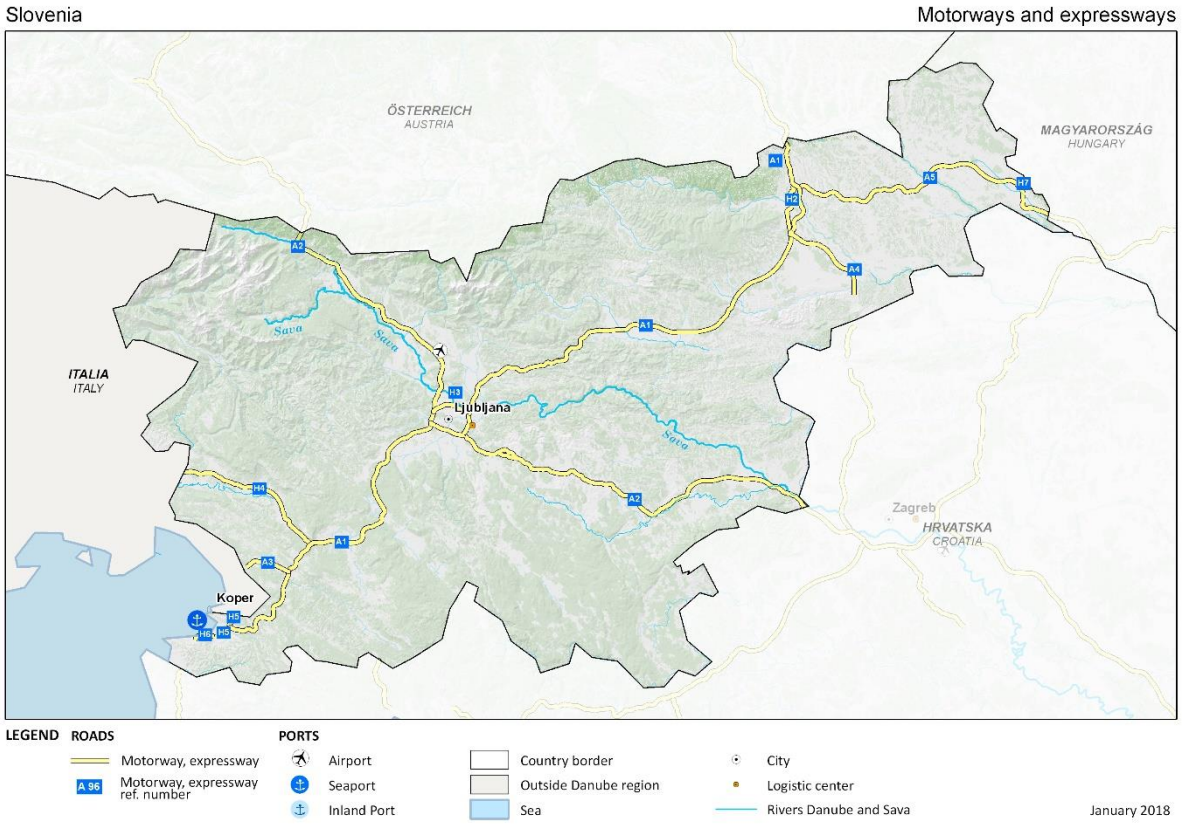

Figure 24: Motorway map of Slovenia

Slovenia is located in central Europe and borders Austria on the north, Italy on the west, Croatia on the east and Hungary on the north-eastern site. Its topography is mainly Alpine on north-northwest and hilly on south. On the east there is a lowland – Pannonian Plain through which the rivers Drava and Mura, tributaries of the Danube river, flow.
National transport development strategy has been focusing on expansion of the motorway network during the past decade. The national program for motorway construction led to expansion of the motorway network in the East – West direction and the North – South direction (Ministry of Infrastructure of Slovenia, 2014).

Slovenia has 38.779 km of all roads and 618 km of motorway. A well designed road network is also one of the reasons for decreasing death rate on roads. There were 58,14 % less fatal accidents (deaths) recorded on the roads between 2005 and 2014.

2.15 UKRAINE – CHERNIVITSI

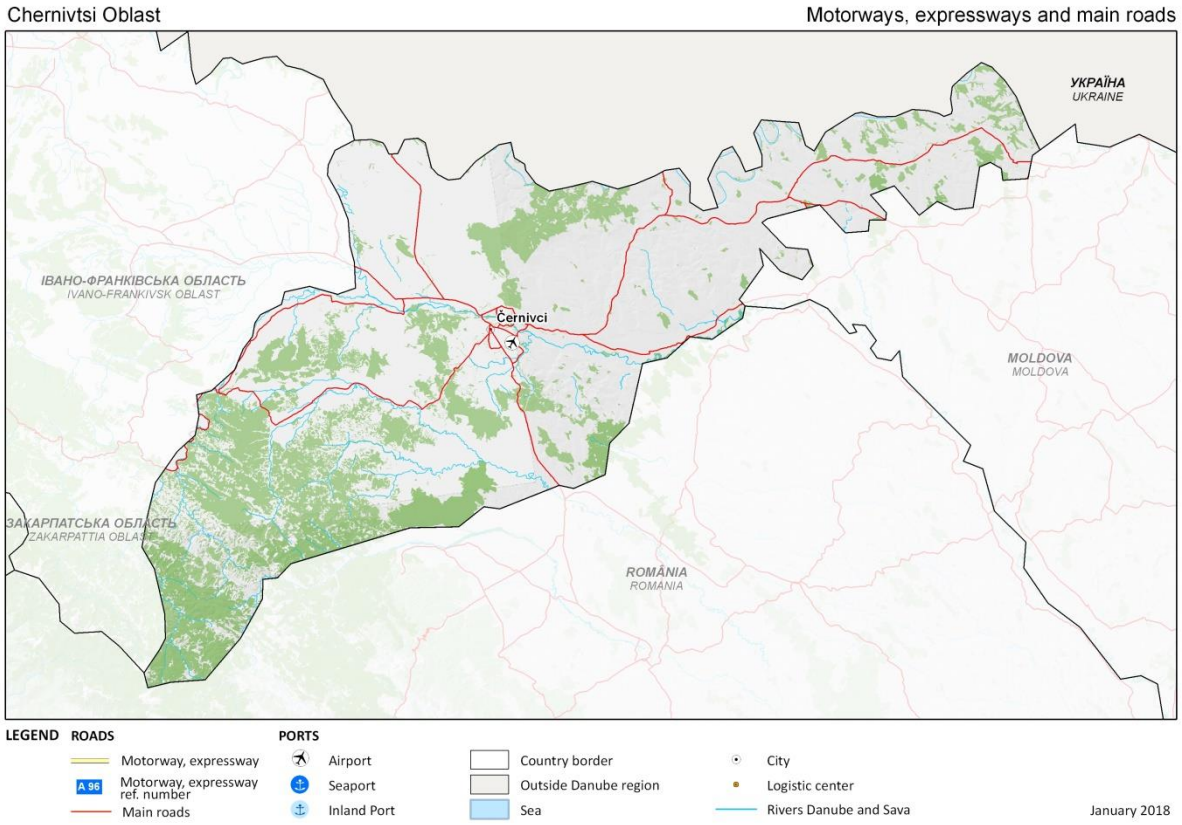

Figure 25: Main road map of Chernivitsi (Ukraine)

Chernivitsi region is situated in eastern Europe and is a part of western Ukraine. It has borders with Romania on the south, Moldova on the southeast and the rest is the border with Ukraine. It is located on the left side of the lower part of the Danube river. Its terrain is mountainous at the foothills of Carpathian on the west and flat in the east.

Chernivitsi region has no motorways and a total length of the road network is 3.204km. Therefore, further development of national road network is necessary. Focus should be on connecting neighboring countries with motorways, because quality road network brings many benefits to the region. Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

2.16 UKRAINE - IVANO FRANKIVSKA

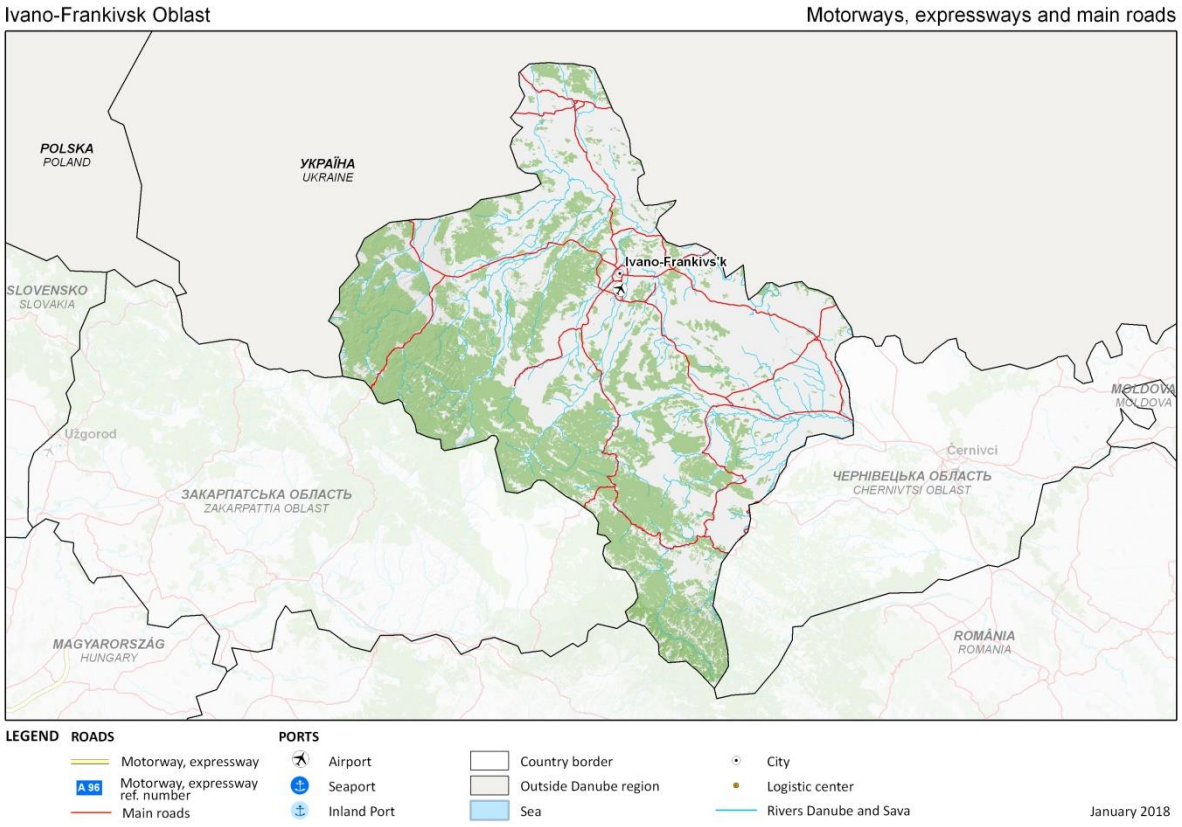

Figure 26: Main road map of Ivano Frankivska (Ukraine)

Ivano Frankivska region is situated in eastern Europe and is a part of western Ukraine. It has borders with Romania on the south and the rest is the border with Ukraine. It is located on the left side of the lower part of the Danube river. Its terrain is mountainous at the foothills of Carpathian on the west and flat in the east.

Ivano Frankivska region has no motorways and a total length of the road network is 4.110km. Therefore, further development of national road network is necessary. Focus should be on connecting neighboring countries with motorways, because quality road network brings many benefits to the region. Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

2.17 UKRAINE – ODESSA

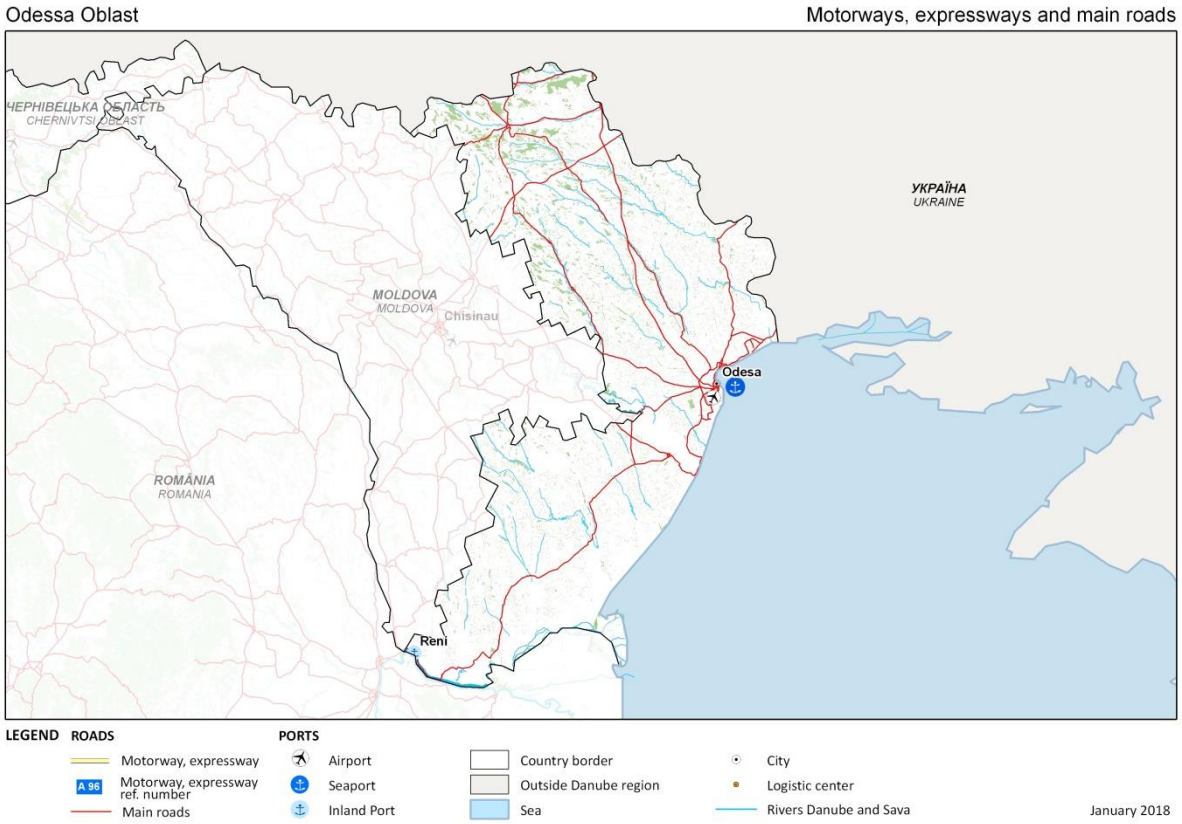

Figure 27: Main road map of Odessa (Ukraine)

Odessa region is situated in eastern Europe and is a part of southwestern Ukraine. It has borders with Romania on the south, Moldova on the west and Ukraine on the east. It is located on the left side of the lower part of the Danube river. Its terrain is mostly hilly. In Odessa region is the biggest Ukraine sea port – Port of Odessa.

Odessa has no motorways and a total length of the road network is 16.632 km. Therefore, further development of national road network is necessary. Focus should be on connecting neighboring countries with motorways, because quality road network brings many benefits to the region. Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

2.18 UKRAINE - ZAKARPATYA

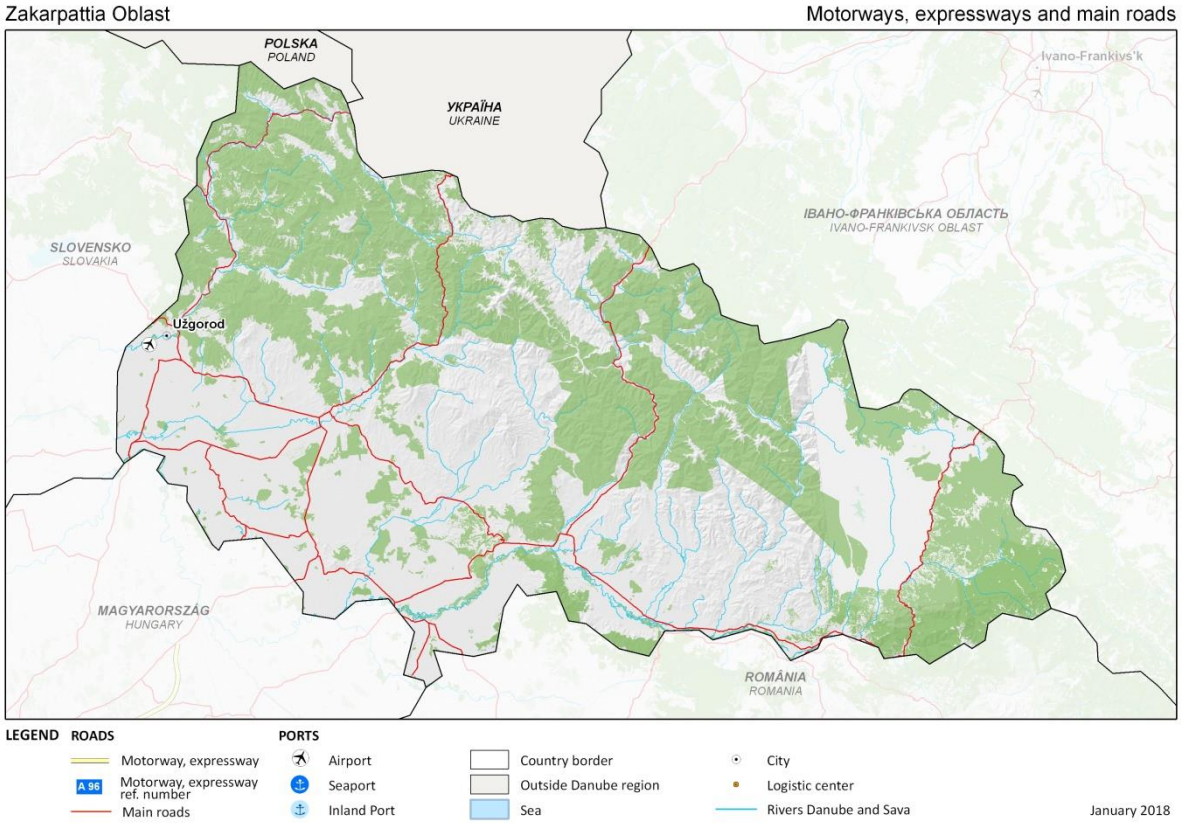

Figure 28: Main road map of Zakarpatya (Ukraine)

Zakarpatya region is situated in eastern Europe and is a part of western Ukraine. It has borders with Romania on the south Hungary on the west, Slovakia on the northwest, Poland on the north and Ukraine on the east. It is located on the left side of the lower part of the Danube river. Its terrain is mostly mountainous, because it is located in the Carpathian Mountains, a small part of the state on the west side, is a part of Pannonian flatland.

Zakarpatya region has no motorways and a total length of the road network is 9.613km. Therefore, further development of national road network is necessary. Focus should be on connecting neighboring countries with motorways, because quality road network brings many benefits to the region. Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

3 PAVEMENT MANAGEMENT SYSTEM

3.1 INTRODUCTION

Pavement Management and Pavement Management Systems (short PMS) became a standard approach in the asset management process of many road administrations in Europe. Especially on high level road infrastructure networks, like motorways and expressways, the use of PMS for the selection of maintenance treatments on section or object level but also for the assessment of strategic targets and requirements on network level is state of the art.

Nevertheless, the use of a holistic asset management approach for different types of roads is a big challenge for road administrations and the involved decision makers. The main objective of a PMS is the provision of a pragmatic and repeatable solution, which gives the road administration as well as the decision and policy makers the possibility to underline necessary investments into their road infrastructure networks.

3.2 ASSET MANAGEMENT AND PAVEMENT MANAGEMENT

The asset management process, which is schematically shown in the following Figure 29, gives an overview of a holistic asset management framework. The expectations of the different stakeholders (users, neighbors, road owners and operators, environment, etc.) define the requirements and specifications, which should be an integrative part of the maintenance policy and the strategic targets finally. To combine the strategic level with the technical requirements it is necessary to support the road administration from the communication and the organization point of view.

Thus, a PMS can be defined as a decision support tool, which enables to answer the different “maintenance questions” on the different levels.

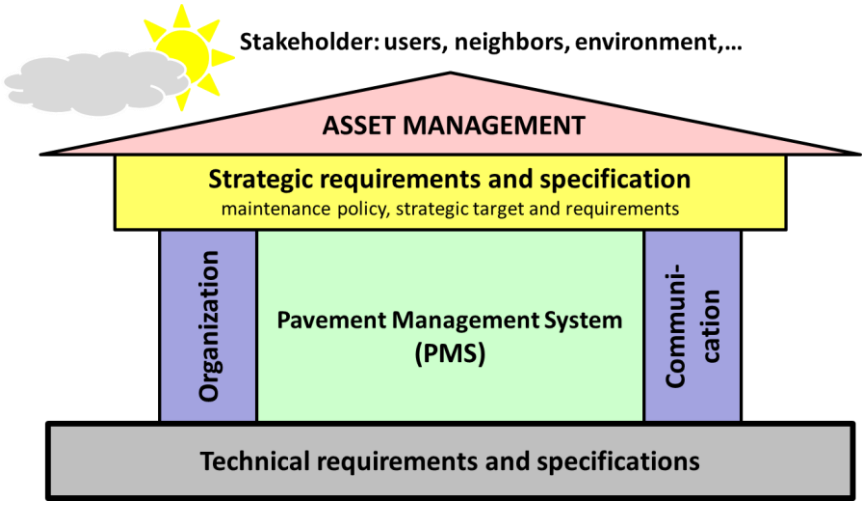

Figure 29: Schematic asset management framework

To guarantee a successful approach of a PMS, the pavement management process must be integrated into the holistic asset management solution, considering the following activities and tasks:

- Management of data and information (monitoring and collection, interoperability, data storage, data exchange, etc.)
- Analysis of data and information using future oriented analysis methods (life-cycle-assessment, life-cycle-cost-analysis, life-cycle-risk-analysis, etc.)
- Reporting of data and analysis results (reports, graphs, maps, web-sites, etc.)

An overview of the different tasks of a pavement management process can be taken from the following Figure 30.

Figure 30: Pavement management tasks (schematically, graph Deighton Associates Ltd.)

3.3 OBJECTIVES AND BENEFIT OF A PMS

For a successful PMS implementation, the effort needs to be compared with the objectives and finally the benefit of the practical solution. Based on long-term experiences of PMS application, the following list gives an overview of objectives, which can be achieved:

- Increase of efficiency based on a systematic and objective planning of maintenance treatments.
- The basis for a sustainable solution is the knowledge about the actual pavement construction, including different types of data, which are describing the pavement characteristics from the maintenance point of view.
- Integration and assessment of strategic targets into the maintenance process
- The PMS is still a technical approach, which should answer the following questions:
    - Which maintenance treatments on which road sections?
    - When is the best point of time for the maintenance treatments?
    - Where should it be done?
- Evaluation and estimation of asset value
- Provision of a basis for the realization of short- to long-term maintenance (investment) programs

By providing the results of a PMS, the benefit can be seen on different decision levels. On the technical level, the pavement management engineers should be able to use the objective recommendations as a basis for the definition of the maintenance treatments on the different road sections.

On the strategic or management level, the network level results enable to assess the achievement of strategic targets and requirements and to predict the future maintenance needs of the assessed networks. Especially the discussion of necessary investments can be carried out on an objective base, showing the consequences and the effects to the different stakeholders.

3.4 DATA COLLECTION AND INFORMATION

A key requirement for the successful use of a PMS is the availability of maintenance relevant data and information. Usually, the collection of the basic information causes the highest effort in the implementation phase, but also during the continuously use of the solution. Based on the experiences in many European countries, the minimum requirements for the availability of data return the following list:

- Inventory and network data
- Traffic data or road categorization (as basis for the prioritization)

- Pavement construction data: type of construction, average thicknesses of bound layers, year of placement of wearing course
- Condition data from condition measurements and/or visual inspections
- Results from investigations on project level
- Information about actual construction and maintenance program

With regard to the quality of the expected results, the pavement condition data are the decisive input for the pavement management analysis, where the quality of the results is strongly dependent on the quantity (density), accuracy and completeness of the collected information. As already mentioned, the condition inspections can be carried out either in form of visual inspections (by inspection teams directly on the road) or in form of condition measurements (by specific measuring devices on inspection vehicles). On low level roads, mainly visual inspection will be carried out in comparison to roads with higher traffic volume, where a repeatable process and a reduced disturbance of the road users recommends measuring vehicles. Independently from the type of inspection, the data should enable to assess the pavement construction from the safety, the comport and the structural point of view taking into account the following pavement performance indicators:

- Rutting
- Longitudinal evenness (roughness)
- Cracking
- Surface defects (potholes, raveling, etc.)
- Bearing capacity on roads with high HGV and/or under-designed pavement construction
- Skid resistance on high speed roads

It is recommended to homogenize the short inspection sections into homogeneous analysis sections, considering other information like pavement construction data, traffic volumes, etc. Nevertheless, the intensity of data collection should be brought in coincidence with the expected results. The collection of data, which will not be included in a following up analysis process, should be avoided (reduction of effort in time and costs).

3.5 PAVEMENT MANAGEMENT ANALYSIS

Based on the underlying information and data it is possible to apply different types of analysis. An estimation of actual and future (monetary) maintenance needs a prediction of the future condition and recommends the use of life-cycle procedures like LCA (life-cycle-assessment), LCCA (life-cycle-cost-analysis) or LCRA (life-cycle-risk-analysis). Although these methods require a more sophisticated approach, the benefit from the result point of view is much more significant (in comparison to a “worst-first” solution). Modern Pavement Management Systems like dTIMS^{TM} (Deighton Total Infrastructure Management System, Canadian origin) support any kind of life-cycle procedures under given local requirements (performance prediction models, maintenance treatment catalogue, etc.).

Based on long-term experiences, the requirements for a future oriented analysis can be summarized as follows:

- Definition of asset performance and custom deterioration curves
- Definition and assessment of treatment strategies
- Analysis of multiple budget or quality scenarios
- Optimization of recommendations
- Support of existing decision processes (work flows)
- Ability to forecast future pavement condition and performance
- Supports existing asset management and pavement management methodology

3.6 EXPECTATION ON RESULTS OF THE PAVEMENT MANAGEMENT APPROACH

The integration of the results of a pavement management analysis is a critical task in the decision process. Many road administrations execute pavement management analysis but do not include the results into their decision process to the possible extend. Especially, the control of target achievements of a given maintenance strategy (on network level) would help the decision makers to set the future (strategic and tactical) directions from a more holistic point of view. On project or section level, the results should support the engineers in planning their maintenance treatments from a life-cycle point of view. Of course, a PMS does not generate a maintenance construction program, it is a decision support tool, which helps the road managers and engineers in finding the best (optimum) solution under the given preconditions (technical and tactical). Subject to the level of application, the results can be summarized as follows:

- Section based results
    - Type, year and location of maintenance treatments
    - Treatment prioritization (as an output of the optimization process)
    - Basis for further investigation on project level
- Network level results (total network or sub-networks)
    - Condition distribution
    - Cost distribution to different types of maintenance treatments
    - Comparison of scenarios (budget, quality, level of service)
    - Treatment length distribution
    - Maintenance backlog (monetary and non-monetary)
    - Development asset value

Beside the use of PMS results in the decision process, the representation of the results is another critical task. Complex results need to be adjusted in an understandable and readable way, where the representation in form of graphs (diagrams, maps, strip-maps, etc.) is more successful than comprehensive reports (construction program map, see Figure *31*).

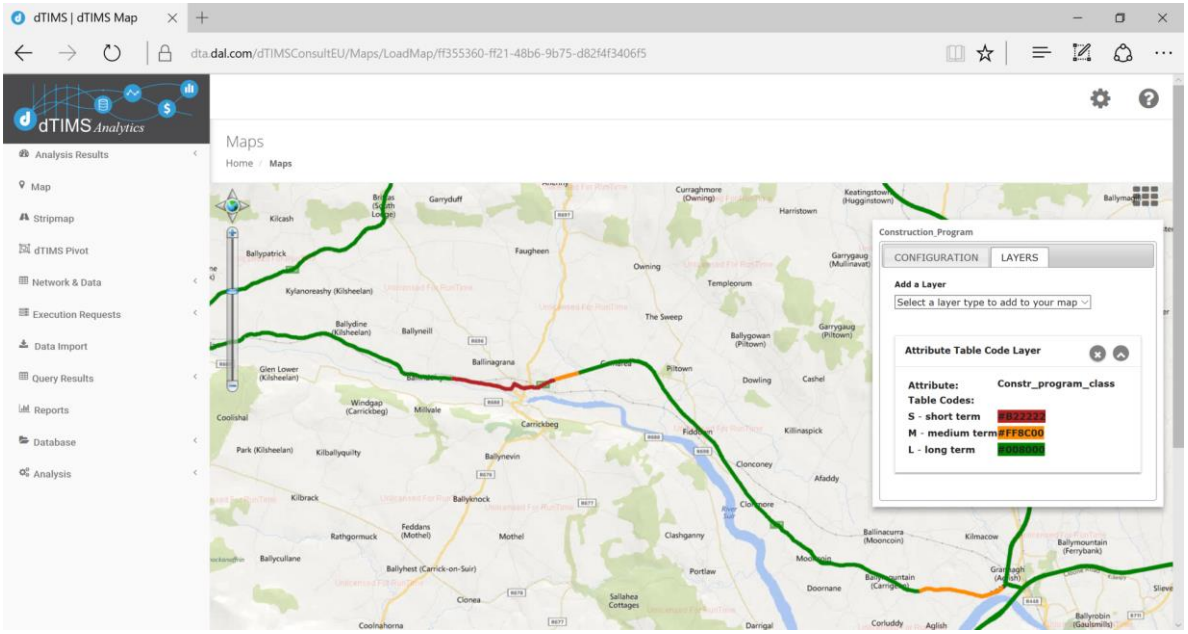

Figure 31: Recommended maintenance construction program on a map (dTIMS BA)

3.7 STATE OF THE ART PMS TECHNOLOGY

Within the last 20 years successful PMS implementation were mainly limited to engineering departments, using the system more as a planning instrument and not as a strategic decision support tool. In the meantime, the developments on the IT sector opened the PMS world for different types of users on the policy level, the management level but also on the public level. To see the actual pavement condition on a public website is unexceptional anymore. The implementation of a so called “3-tier IT-architecture”, where the whole solution is separated into a data-level, an application level and a presentation level (web based), is state of the art in information technology. The following Figure *32* shows the actual 3-tier architecture of dTIMS^{TM}.

If a solution will be insourced or outsourced is strongly dependent on the availability of the local IT-environment. By using the new technologies and possibilities, smaller road administrations can get access to high performance PMS without having an expensive on-site IT-environment available (key word: software as a service). This enables the road administration to manage their data, execute the analysis and prepare the results under the given preconditions by using high performance decision support tools.

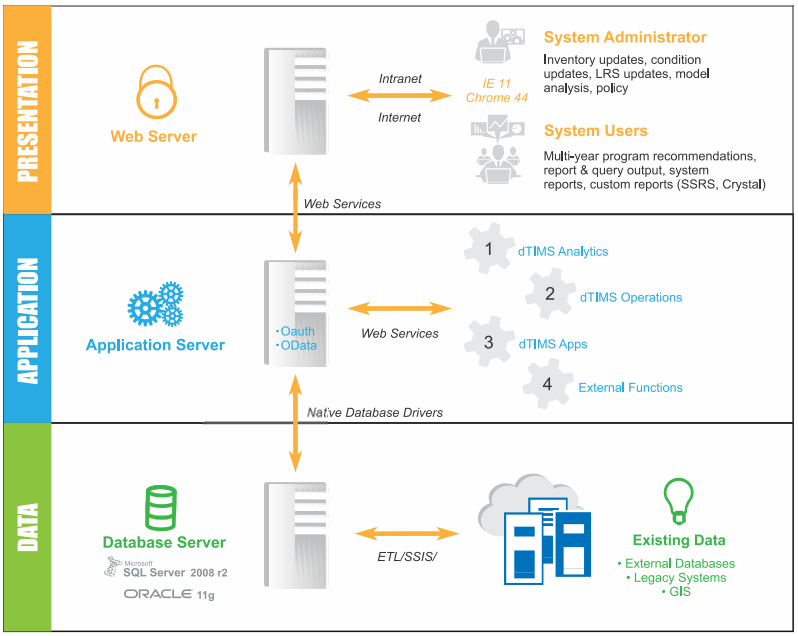

Figure 32: 3-tier architecture of asset management system dTIMS

3.8 MEETING THE OBJECTIVES IN PRACTICE

PMS solutions have been implemented on different types of roads and networks all over Europe. Especially in Austria and Germany the number PMS applications on state roads, regional roads and on community roads is increasing within the last years. In the meantime, the local road administrations see the benefit of using an objective PMS as a basis for the discussion with their local engineers and the financial departments. The following examples show, how a PMS can be used to support different road administrations. The following chapters show, how a PMS and the results of the analysis can be used in the decision process.

3.8.1 Allocation of maintenance funds

One of the main objectives of a pavement management approach is the repeatable and objective planning of maintenance investments and the allocation of funds to different regions, road categories or networks. By using a PMS, the road administration is able to show the different effects of distributing the maintenance funds in different ways. On different state road networks in Austria and on the national road network in Ireland a so called “cross regional analysis” has been used to define the distribution key for the different regions or sub-networks respectively. Besides basic funding of each single region or road category, a percentage of the maintenance funds will be used for distribution over the whole network, taking the maintenance needs from the total network point of view into account. In Ireland, a prototype of a management dashboard (dTIMS business intelligence) is used to show the effects on the different networks for the management level (see Figure 33). Each

manager, who has access to the site, can see for different scenarios the effects on the different networks, and is able to scroll down into the road section level.

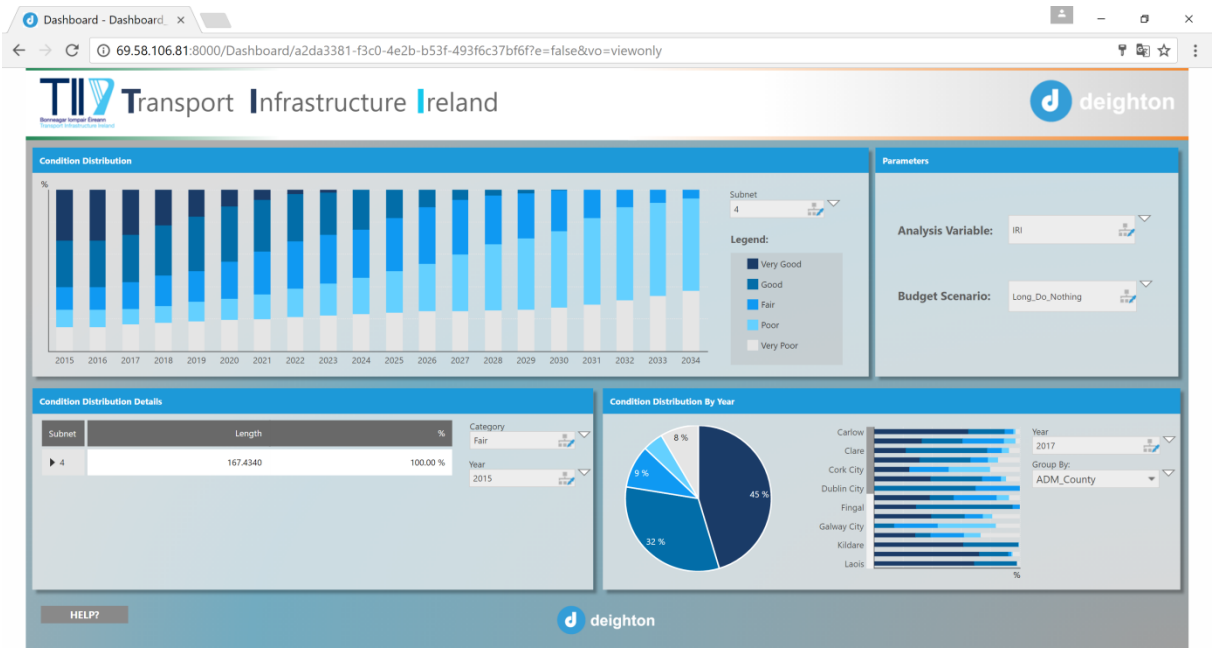

Figure 33: Screenshot of PMS dashboard (dTIMS BI, Ireland)

3.8.2 Development of pavement condition

Beside the distribution and allocation of funds on the different road networks, the development of the pavement condition over a given time period is an effective way to show the effects of the investments. The time-dependent change of the condition on a map is shown for a pre-selected budget scenario.

3.8.3 Basis for maintenance program

Beside the strategic use of the results, the recommendations of maintenance treatments on different road sections are easy to use as a basis for the maintenance program. Nevertheless, it is important to present these results in an understandable way and to give the users the possibility to review and adjust the treatment recommendations. The following Figure 34 shows the planned maintenance program for a preselected scenario of a community network in Austria on a map and the consequences in form of different condition distributions.

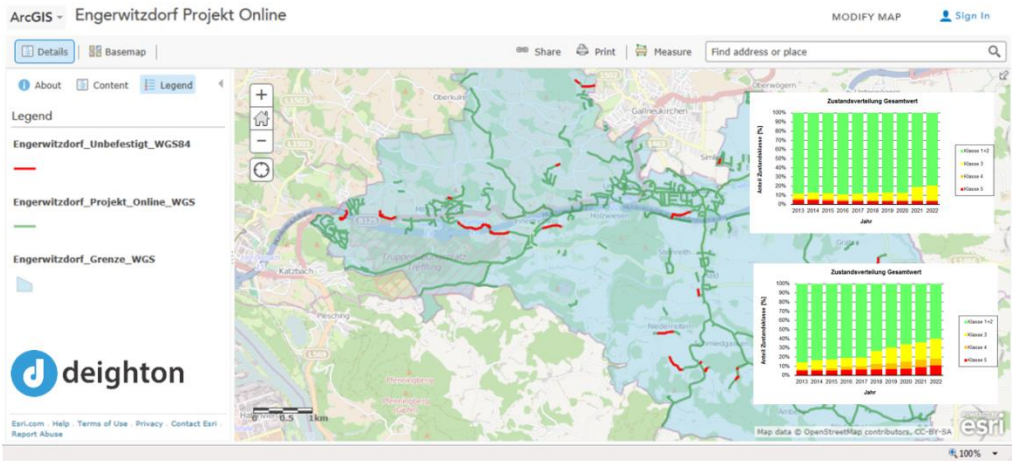

Figure 34: Maintenance treatment map for a community network in Austria

Detailed results from the life-cycle-analysis enable to assess different options (see Figure 35). This, of course, requires a basic knowledge in performance prediction and life-cycle-analysis, so that the specific information and results will be used mainly by the engineers.

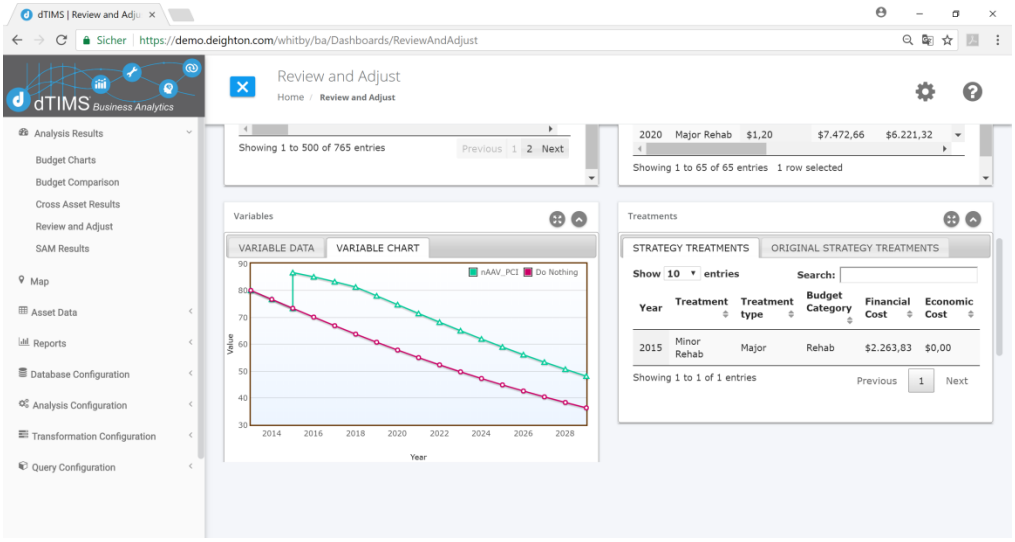

Figure 35: Review and adjust section based results from life-cycle analysis (dTIMS BA)

3.9 Implementation of PMS - Pavement Management System in different Danube region states

- **Baden** Wuerttemberg

In Baden Wuerttemberg a pavement management system was introduced on the motorways and as well on other state roads. It enables a monitoring of the condition of the carriageway and the preparation of reconstruction plans in a frequency of 4 years. Such systems provide efficient infrastructure management and long-term financial sustainability.

- **Bavaria - Road management**

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure. In Bavaria ~~a~~ computer-aided systems were introduced on national and also on state roads. It enables continuous monitoring of the condition of the carriageway and the preparation of reconstruction plans carriageway and the bridges. Such systems provide efficient infrastructure management and long-term financial sustainability.

- **Austria - Road management**

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

In Austria, a computer-aided system (e.g. DTIMS_CT or PMS) was introduced on the motorways and also on other state roads. It enables continuous monitoring of the conditions of the carriageways and the preparation of reconstruction plans. Plans are made on the basis of mathematical models which are based on collapse curves of the carriageway. Such systems provide efficient infrastructure management and long-term financial sustainability.

- **Slovakia - Road management**

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

In Slovakia Road Databank, department of Slovak Road Administration, is responsible for monitoring of the condition of the carriageway and the preparation of reconstruction plans. Pavement diagnostics is realized by special equipment technologically suitable for particular purpose supported by software tools especially developed for Information System of Road Network Model.

- **Slovenia - Road management**

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

In Slovenia, a computer-aided system (e.g. DTIMS_CT or PMS) was introduced on the motorways and also on other state roads. It enables continuous monitoring of the conditions of the carriageways and the preparation of reconstruction plans. Plans are made on the basis

of mathematical models which are based on collapse curves of the carriageway. Such systems provide efficient infrastructure management and long-term financial sustainability

- **Hungaria - Road management**

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

In Hungary, a computer-aided system (e.g. DTIMS_CT or) was introduced on the motorways and also on other state roads. It enables continuous monitoring of the conditions of the carriageways and the preparation of reconstruction plans. Plans are made on the basis of mathematical models which are based on collapse curves of the carriageway. Such systems provide efficient infrastructure management and long-term financial sustainability.

- **Bosnia and Herzegovina - Road management**

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

In Bosnia and Herzegovina, a computer-aided system (e.g. DTIMS_CT or) was introduced on the motorways and also on other state roads. It enables continuous monitoring of the conditions of the carriageways and the preparation of reconstruction plans. Plans are made on the basis of mathematical models which are based on collapse curves of the carriageway. Such systems provide efficient infrastructure management and long-term financial sustainability.

- **Moldova- Road management**

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure. In Moldova a computer-aided system (e.g. DTIMS_CT or PMS) is under implementation.

- **Ukraine: Odessa oblast -Road management**

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

3.10 Conclusion

On the basis of PMS review in individual countries of the Danube region it has been observed that the approaches vary. In some countries the system is well developed in some it is being implemented and in others they do not use it yet.

On this field of work, it would be very beneficial to all the countries of the Danube region if they could work together and try to unify the network to the best possible way. Especially it would be appropriate that good practices, from countries that already use the PMS, be implemented to the countries that do not have PMS.

Pavement management systems are the basis for road building planning, which ensures optimal use of founds and maximum satisfaction of road users.

4 DANUBE REGION ROADS - QUESTIONNAIRE

4.1 DESCRIPTION OF THE ENTIRE DANUBE REGION

1. Countries, federal lands and authorities in the region

The Danube region includes the following 18 countries, federal lands and authorities:

- **Baden Wuertemberg – Germany**
- **Bayern – Germany**
- **The Czech Republic**
- **Austria**
- **Slovakia**
- **Slovenia**
- **Croatia**
- **Hungary**
- **Serbia**
- **Bosnia and Herzegovina**
- **Montenegro**
- **Moldova**
- **Odessa - Ukraine**
- **Ivano Frankivska – Ukraine**
- **Chernovitsi – Ukraine**
- **Zakarpatya – Ukraine**
- **Bulgaria and**
- **Romania**

2. General data

- inhabitants/2016: **112.329.542**
- membership in the EU: **10 countries or federal lands and oblasts**
- GDP / 2016 in EUR million: **2.139.144**
- GDP per capita/ 2016 in EUR: **19.043**
- land area - km²: **1.091.925**
- km of roads per million inhabitants: **7.833**
- km of roads per km² of the land area: **0,806**
- km of motorways per million inhabitants: **117**
- km of motorways per km² of the land area: **0,012**

3. Description of the road network

- length of motorways – km: **13.107**
- length of main or national roads – km: **113.115**

- length of secondary or regional roads – km: **210.927**
- length of other roads – km: **513.953**
- total lengths of all roads – km: **879.917**
- length of national roads without anti-dust protection – km: **3.171**

Note: the categorization of roads is very different in the countries of the Danube Region. Therefore, we tried to unify the review as much as possible, and we combined individual categories, for example, in Germany we have federal and state roads combined into national roads. Some countries did not provide data for other roads. Therefore, this category as a common data is inaccurate.

4. Main features of the road network

According to road traffic, the Danube Region consists of very different countries. This includes, for example Germany and Austria, which have highly developed and highly traffic-laden road systems, and on the other, there are countries that are still developing their road network.

Average annual daily traffic (AADT) on motorways is 35.000 vehicles

The Danube region consists of three transport areas:

- TEN-T network
    - core and
    - comprehensive

- Western Balkan SEETO network and
- Strategic Eastern Partnership.

Through this region, the following European road corridors take place:

- ***Baltic – Adriatic Corridor****: Gdansk-Warsaw / Szczeczin-Poznan-Wroclaw – Katowice – Ostrava-Brno/Žilina-Bratislava – Vienna – Graz – Ljubljana/Klagenfurt – Koper/Trieste/Venice/Ravenna*
- ***Mediterranean Corridor****: Barcelona – Torino - Ljubljana – Zagreb – Budapest - Kiev – Sarajevo - Beograd*
- ***Orient - East Mediterranean Corridor:*** *Bremen – Hannover / Rostock/Hamburg – Berlin – Dresden – Prague – Brno – Bratislava/Vienna – Budapest – Timisoara – Sofia – Burgas/TR borders / Thessaloniki – Igoumenitsa/Athens – Patras*
- ***Scandinavian – Mediterranean Corridor:*** *Helsinki – Stockholm – Malmo – Berlin – Munich – Verona – Roma – Napoli*
- ***Rhine – Alpine Corridor:*** *Hamburg – Frankfurt – Basel – Zurich – Genoa*
- ***Rhine – Danube Corridor****: Strasbourg/Frankfurt/Mannheim – Stuttgart-Munich/Nuremberg – Prague – Brno – Zlín – Žilina – UA borders / Linz – Vienna – Bratislava –Budapest – Timisoara – Bucharest – Constanta*

Regarding spatial surroundings, socio-economic unity and spatial interactions, 9 functional regions are defined:

- South Germany and Western Austria
- Eastern Austria and Slovenia
- The Czech Republic and Slovakia
- Hungary
- Croatia and Bosnia and Herzegovina
- Montenegro and Serbia
- Bulgaria
- Western Romania and
- Eastern Romania, Moldova and Ukraine.

Some traffic directions are already very saturated and represent the main directions between north and south and east and west. In all countries, road transport is concentrated in the main cities.

In addition, there are very heavy traffic routes, linking southern ports to northern and eastern Europe. These are routes through Slovenia, Croatia, Austria, Germany, the Czech Republic, Slovakia and Hungary.

Also important are the traffic routes connecting the Black Sea ports with neighbouring countries such as Ukraine, Moldova, Romania and Bulgaria. Traffic is increasing on the corridor through Greece and Turkey, through Bulgaria, Serbia, Hungary, Croatia and Slovenia towards the north and west.

The development of tourism along the Adriatic coast also strengthens the road directions through Slovenia, Croatia, Bosnia and Herzegovina and Montenegro.

For Danube region personal transit traffic represents 2% to7%, while freight transport in transit represents to 5% - 20%. There are some differences between the countries of the so-called transit, while in others areas there are fewer differences.

The traffic loads of motorways and other roads vary greatly across countries. While there are already more than 10,000 vehicles per day in some of the most developed countries, AADT is less than 10,000 or less than 5,000 vehicles per day in the least burdened countries.

Most countries already have or are building their own motorway systems, which mostly collect tolls in various forms, such as manual collection, electronic pick-up, vignettes, etc. On other main and secondary roads, traffic loads across countries are very different. This is followed by the standard and quality of these roads.

5. Conditions of road surfaces

The condition of road surfaces and the structures on the roads is very different in each country. This depends mainly on the age of individual roads, traffic loads and investments in the maintenance of these roads.

In some countries the percent of good and very good road surfaces on national roads is over 50 % and in other countries is less than 30 %. Similarly, conditions are at road structures.

6. Missing sections, bottlenecks, dangerous sections

According to Transport study for the Danube macro-region (European Investment bank – may 2017), road transport physical bottlenecks are largely due to infrastructures not complying with technical standards. Capacity constraints also occur during specific time periods, especially nearby urban agglomerations and when traffic is mixed (i.e., long distance, regional and urban). This condition may exacerbate capacity limitations of urban ring roads or bypasses.

For the TEN-T CNCs crossing the Danube Macro-Region (notably, Baltic-Adriatic, Mediterranean Orient/East-Med and Rhine-Danube), the localization of current and future physical bottlenecks is provided by the relative studies that also identify the measures to address such limitations (e.g., upgrading or widening of transversal sections).

As regards the SEETO (**South East Europe Transport Observatory**) road network, the capacity analysis shows that the majority of the comprehensive network (i.e., 4.000 km) does not need immediate interventions, while 24% (i.e., 1.500 km) requires rehabilitation and the 16% (i.e., 1.100 km) upgrading and/or widening. The analysis of the Eastern Partnership countries road network level of service shows, that both Moldova and the 4 provinces of Ukraine have a relatively balanced Figure in terms of volume to capacity ratio.

On the TEN-T corridors, the following bottlenecks and missing sections of motorways and expressways are most critical:

- ***the Rhine-Danube Corridor***
  - *on the Bavarian motorway A8 south of Munich towards the German border of Austria*

- ***the corridor Rhine - Danube and Orient - East Mediterranean Corridor***
  - *in Austria on the A4 Fischamend - West Bruck - Neusiedl motorway towards the Hungarian border.*

- ***the Baltic – Adriatic Corridor and Orient - East Mediterranean Corridor***
  - *road cross-border section Brno (CZ) – Wien (Schwechat) (AT)*

- ***Orient - East Mediterranean Corridor***
  - *in Bulgaria, Struma - the border with Greece.*

On the comprehensive network, the missing sections and bottlenecks are most exposed on sections:

- *the Karawanks tunnel between Austria and Slovenia and*
- *in Hungary, the bypass Csorna in the direction to Austria or Slovenia.*

On the SEETO Corridor Vc on the extension of Mediterranean Corridor the following bottlenecks and missing sections of motorways and expressways are most critical:

- *in Bosnia and Herzegovina, section Tarčin - Konjic on the direction of Sarajevo towards the Adriatic coast*

On the SEETO Corridor X or extension of Orient - East Mediterranean Corridor the following missing section is:

- *in Serbia bypass Belgrade in the direction of Romania*

On the SEETO network are missing links:

- *in Serbia Belgrade - Pancevo in the direction of the Romanian border and*
- *in Montenegro, the bypass Podgorica in the direction towards the Adriatic coast.*

In the context of **the Strategic Eastern Partnership**, the following improvements to the road network are most important:

- *in Chernovtsi link Balti - Criva on the direction towards Moldova and*
- *in Odessa, the connection between Odessa and Rennes towards Romania.*

The construction of the Hajdusamson ring road in Hungary is important in **the national network.**

7. Traffic safety

According to the statistics available for the countries of the Danube Macro-Region, road safety shows a generalized improvement from 2006 to 2014 with respect to the number of accidents, casualties and injured persons.

In the Danube region, in the year 2016 (for some countries the figure for 2014) there were 7.525 killed persons in road accidents, or 67 killed persons per million inhabitants of the Danube region.

In general, the level of traffic safety in the countries of the Danube region is very different. This is also shown by the results of EuroRAP in which traffic safety was analyzed in individual countries of the Danube region (not all).

The European Road Assessment Programme (EuroRAP) is an international not for profit association set up in 1999 and registered in Belgium that is dedicated to saving lives through safer roads.

The program aims to reduce death and serious injury, through a program of systematic assessment of risk, identifying the major shortcomings that can be addressed by practical road improvement measures. It forges partnerships between those responsible for a safe road system (civil society, motoring organizations, vehicle manufacturers and road authorities) and aims to ensure that assessment of risk lies at the heart of strategic decisions on route improvements, crash protection and standards of route management.

Its Members are automobile and touring clubs, national and regional road authorities, and researchers. The program receives structural funding from the FIA Foundation, the International Road Assessment Programme (iRAP), and the European vehicle manufacturers' association (ACEA).

In this program there are 11 countries from the Danube Region: Austria, Bosnia and Herzegovina, Croatia, the Czech Republic, Germany, Hungary, Moldova, Montenegro, Serbia, Slovakia and Slovenia.

In countries where detailed crash and traffic data are available, EuroRAP risk maps give an objective view of where people are being killed or seriously injured on a road network and where their crash risk is highest. They capture the combined risk arising from the interaction of road

Star Ratings are based on road inspection data and provide a simple and objective measure of the level of safety 'built-in' to the roads for vehicle occupants, motorcyclists, pedestrians and bicyclists. 5-star roads (green) are the safest, and 1-star (black) are the least safe for users, vehicles and the road environment.

The traffic safety status is very different based on the results of the SENSoR project. Countries with a less developed road network have of vehicle occupant Star Ratings, which indicate that less than 20% of the roads have three or more stars. Countries with a developed network have such roads with more than 50% or even more than 70%.

8. The protection of the environment and the inhabitants.

Not surprisingly, transport-related environmental issues in the region are mostly caused by cars and trucks' air pollution emissions. Geographically concentrated in the most developed Western EU Member States, the trend of pollutant emissions has been generally decreasing over the period from 2005 to 2015 (according to ASTRA model and KNOEMA database).

From the legislative point of view, all Danube Macro-Region countries ratified the Convention on Environmental Impact Assessment in a Transboundary Context (i.e., ESPOO Convention) and the Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context (i.e., Kyiv Protocol).

9. Gross investment spending in road infrastructure

In 2013 (some data are in 2016 and 2017) **8.142** mio EUR were invested in Danube region national roads.

10. Maintenance expenditures in road infrastructure

In 2013, (some data are in 2016 and 2017) **3.409** mio EUR were used for the maintenance of Danube region state roads

11. Transport policy objectives

The majority of the identified future projects foresee the development of network sections which are already operating. This could imply an advantage, when compared to totally new ones as there would be:

- a lesser level of uncertainty when forecasting demand volumes,
- the chance to rely on previous estimations of investment and management costs and likely
- a more limited environmental impact (e.g., absence or low land acquisition needs and no interference with Natura 2000 and other designated sites at national level).

The development of existing road sections has been proposed not only to address future demand volumes, but also to tackle low technical standards and states of degradation of the infrastructures, which in turn influence the safety levels. Examples in this regard are the project to widen the A8 motorway from Munich to the German-Austrian border, the implementation phase of the third lane of the A4 motorway in Austria as well as the improvement of the M-14 road section from Balti to Criva in Moldova.

The construction of new road sections is a need, emerged, at location where heavy traffic is expected for the future and chiefly along strategic axes of the networks, or in correspondence of urban agglomerations, such as: the construction of dual-carriageway sections as continuation of the A5 North motorway in Austria, the construction of the Lot 3.2 of the Struma motorway in Bulgaria, the construction of two bypasses in Csorna and in Hajdúsámson in Hungary, the construction of section C of Belgrade bypass in Serbia and the bypass of Podgorica in Montenegro.

Two future road projects included in the list are worth investigating. From an investigation a development of a feasibility study should be done. Firstly, the new motorway section Belgrade-Pančevo-Vršac to the Romanian border that would overlap the extension of the Orient/East-Med CNC on the SEETO comprehensive network. Secondly, the project of the Odessa-Reni motorway which is a priority for Ukraine.

The distribution of the future projects in the transport network contexts is in line with the relevance of the CNCs that intersect the Danube Macro-Region; not surprisingly, the Rhine-Alpine and Scandinavian Mediterranean are marginal.

The identified future projects localized in the Western Balkans Functional Region are on sections of Corridors Vc and X, the recent extensions of the TEN-T Orient/East-Med and Mediterranean CNCs.

Four projects are on the TEN-T comprehensive network: the construction of the second tube of the Karawanks tunnel (an important cross-border section between Austria and Slovenia connecting the BalticAdriatic and the Mediterranean CNCs), the construction of the Csorna bypass section in Hungary and the construction of the Hajdúsámson bypass in Hungary.

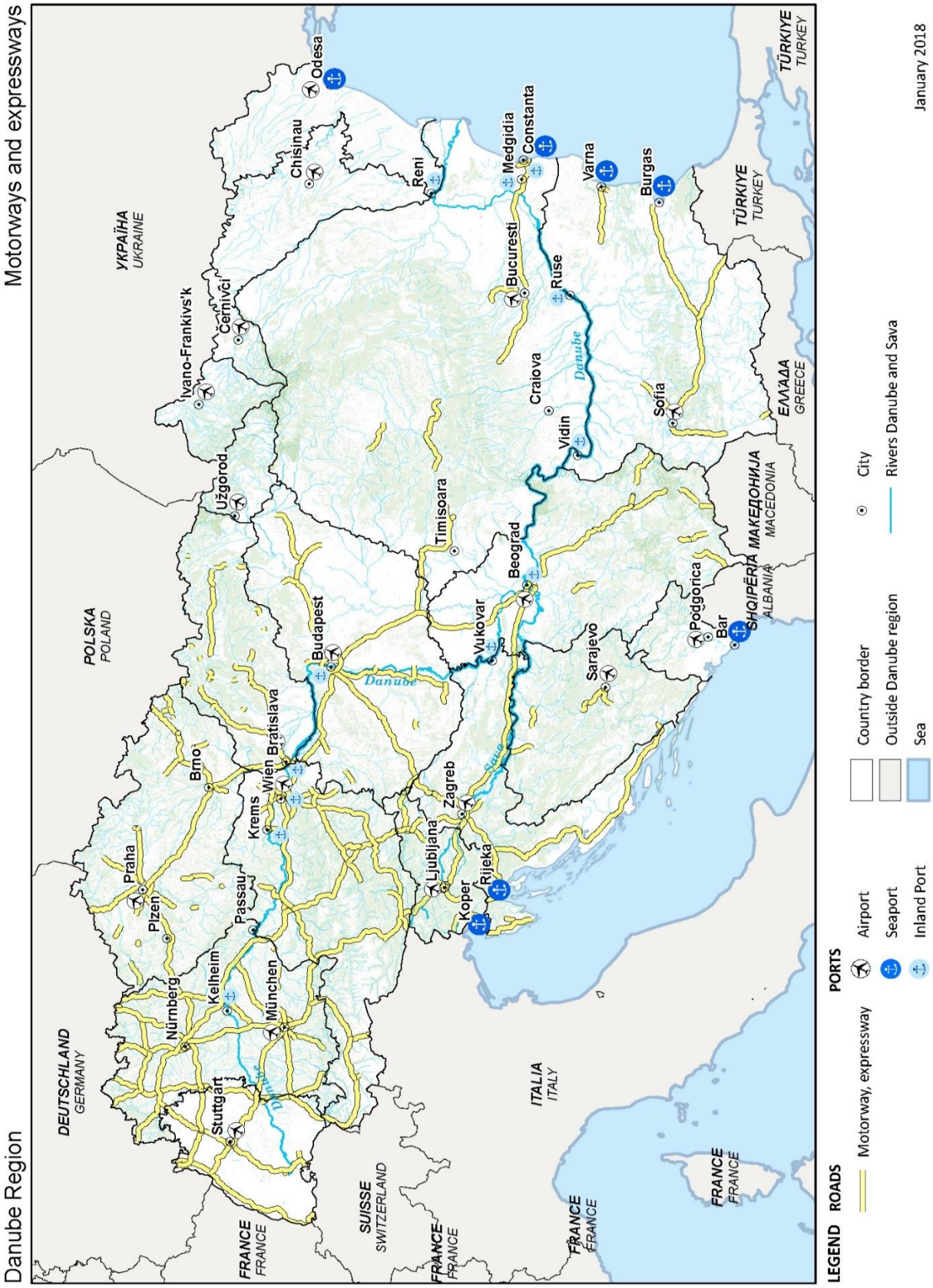

Figure 36: Motorway map of Danube region

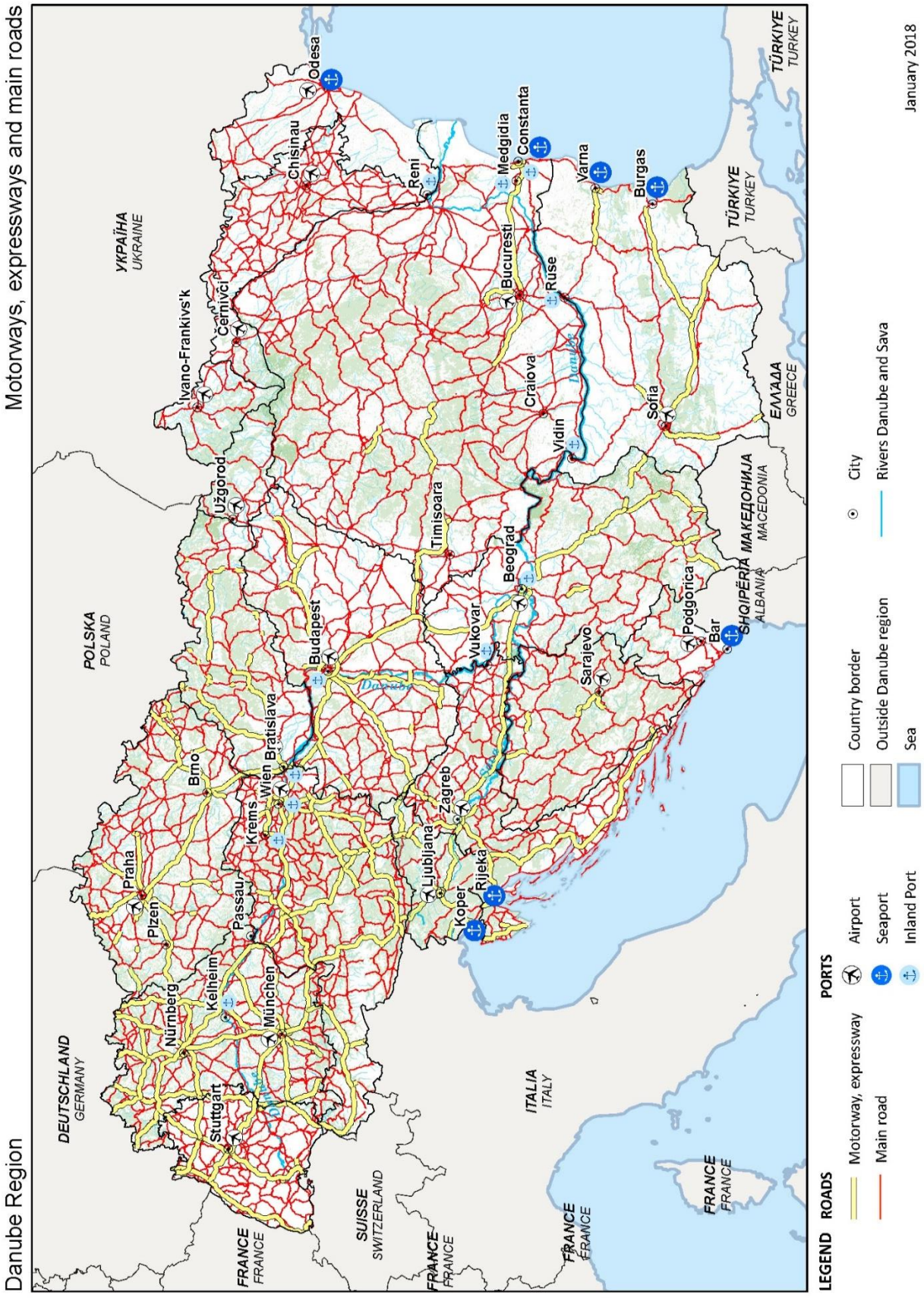

Figure 37: Main and motorway road map of Danube region

4.2 DESCRIPTION OF EACH COUNTRY, FEDERAL LANDS AND AUTHORITIES OF DANUBE REGION

The order of the countries follows the Danube River.

4.2.1 Danube Region roads: BADEN WUERTEMBERG

1. General data[26]

- Inhabitants / 2016: **10.879.618**
- Membership in the EU: **1.1.1958**
- GDP / 2016 in EUR million: **477.000**
- GDP per capita / 2016 in EUR: **43.843**
- Capital city: **Stuttgart**
- Land area - km²: **35.677**
- Km of roads per million inhabitants: **2.516**
- Km of roads per km² of the land area: **0,77**
- Km of motorways per million inhabitants: **97**
- Km of motorways per km² of the land area: **0,03**

2. Description of the road network[27][28][29][30][31]

- Length of motorways – km: **1.054**
- Length of main or national roads – km: **4.230**
- Length of secondary or regional roads – km: **10.043**
- Length of other roads – km: **12.094**
- Total lengths of all roads – km: **27.421**

3. Main features of the road network

3.1. Traffic

3.1.1. General traffic estimates:

[26] statistisches Landesamt
[27] Amtl. Langenstatistik Bundesautobahnen
[28] Amtl. Langenstatistik Bundesstrasen
[29] Amtl. Langenstatistik landesstrasen
[30] Amtl. Langenstatistik kreisstrasen
[31] Amtl. Langenstatistik

Traffic loads are large all over the whole state. The average daily traffic (ADT) on motorways is nearly 64.000 vehicles/day, with a percentage of heavy goods vehicles of about 16%. Especially the area of the capital Stuttgart is concerned of more than 150.000 v/d ADT on the motorways A 8 and A 81 each. The capital itself has only a few effective national roads where traffic concentrates on. Baden-Württemberg has pronounced characteristics of a transit corridors north – south and east – west. Traffic is both domestic and transit.

3.1.2. Average annual daily traffic (AADT)[32][33][34]

- Average annual daily traffic (AADT) on motorways: 63.771
- Average annual daily traffic (AADT) on main or national roads: 15.013
- Average annual daily traffic (AADT) on secondary or regional roads: 5.323

3.2. International road corridors:

- TEN-T corridors:
  - ***Rhine – Alpine Corridor****: Hamburg – Frankfurt – Basel – Zurich - Genoa*
  - ***Rhine – Danube Corridor****: Frankfurt – Munich – Praha - Vienna – Bratislava - Uzhhorod*
  - ***Mannheim/Karlsruhe*** *– Stuttgart – Munich (A5, A6, A8 A 81)*

3.3. Toll system

Trucks on motorways and expressways must pay a toll. Toll collection is via the satellite toll collection system.

3.4. Condition of road surfaces and structures

Condition of roads and road structures is as following:

- Condition of pavement structures on motorways and express roads in 2016 is:
  - good 65 %
  - marginal 30 %
  - poor 5 %

- Condition of pavement structures on national roads in 2016 is:
  - good 50 %
  - marginal 40 %
  - poor 10 %

[32] Bundesautobahnen
[33] Bundesstrasen
[34] Landesstrasen

- Condition of road structures on motorways and express roads in 2016 is:
    - good 90 %
    - marginal 10 %
    - poor 0 %

- Condition of road structures on national roads in 2016 is:
    - good 90 %
    - marginal 10 %
    - poor 0 %.

3.5. Speed Limits

- speed limits on other national roads: **no limit**
- speed limits on motorways: **50/100 km/h**

3.6. Traffic safety [35]

- Traffic safety - number of killed persons in road accidents in year 2016 were: **405**
- Traffic safety - number of killed persons per million inhabitants in road accidents in year 2016 were: **37**

Traffic safety has improved over the past 10 years. 37,01 % (complete Germany) less fatal accidents (deaths) were recorded in 2016, on the roads in comparison to 2006.

Traffic safety has always improved in the past. According to many circumstances Baden-Wurttemberg lays stress on special concerned persons (e.g. motorbike drivers in case of raised death rates; pedestrians bicycle drivers on urban roads).

Main causes of traffic accidents were

- Excessive speed
- Misuse the right of way
- Less distance to vehicles in front
- Wrong behavior (turn around, turn right/left)
- Misuse of alcohol and drugs

Based on EURORAP data research, some 75% of German motorway achieves the “low” risk rating. Similarly, 70% of German motorways score a 4- or 5- star rating with the main flaws being in run-off protection and junction layout.

While motorways and some dual carriageway federal motorways provide high safety standards, single carriageways need improvement. The lack of a median barrier, frequent

[35] Ministry of the Interior, Digitisation and Migration Baden - Wuerttemberg

obstacles (trees) near to the edge of the road and high legal speed limits contribute to severe accident damage and subsequently poor Star Ratings.

3.7. Main weaknesses on the road network

3.7.1. Missing sections

There are no sections missing, except some bypasses around villages and smaller cities. They will be implemented in the nearer future.

3.7.2. Bottlenecks

There are only three sections in the motorway network, which have to be considered in the next years. Planning's and preparations are still running for all of them.

1. A 5 Motorway junction Heidelberg to motorway junction Walldorf
2. A 8 Pforzheim/West to Pforzheim/East
3. A 8 Kirchheim/Teck-Ost to Merklingen

In additional, there are many measurements planed, to increase the motorways capacities, such as upgrading motorways or hard shoulder running.

3.7.3. Hazardous road sections

None of the motorways or national roads are hazardous or dangerous. Road duty and maintenance teams check the whole network daily. If accidents occur in a section, road authorities, police and road operators fulfil a safety quality audit. The same audit is mandatory to each new planning. According to this, motorways and national roads have a high level of safety and user-optimization and state of the art.

3.7.4. Inadequate protection of the environment and inhabitants

Most of roads are built with adequate protection against excessive noise pollution from road traffic for the living environment. At the crossings of state roads through settlements, protection is unregulated.

As a rule, measures are taken for the controlled drainage of water, from roads into the arrester through containers along motorways.

Wildlife crossings (ecoducts, green bridges) are built to allow land-based creatures to pass safely from one side of the road to another. On several motorway sections underpass tunnels (mainly for large animals) and tunnels and culverts (for amphibian and small mammals such as otters and hedgehogs) are also included.

3.8. Links with neighbouring countries

Baden Wuerttemberg motorway system is well connected with neighbouring countries France, Switzerland and Austria, as well as Rhineland-Palatinate, Hesse and Bavaria. Baden-Wurttemberg is working well together with all of them.

3.9. Protection of the environment and inhabitants from the impact of road traffic (noise, water)

The motorway system in particular is always built with many measures to protect the natural and living environment. Thus, most settlements along motorways and expressways are protected by active anti-noise protection measures. Especially on old motorways anti-noise measures are being constructed on sections where they were not built at the time of construction. On national roads, these measures are similar. The ministry of transport takes care that - where roads are passing towns and smaller settlements - inhabitants have to be protected against excessive noise.

Traffic management systems on motorways provide a huge level of free and undisturbed traffic flow, harmonized speed limits, incident warning and traffic information. Road users can adopt this information and change their mobility behavior. Because of this, we can notice a significant reduction of vehicle emissions, congestion and accidents.

3.10. Systems for informing users of individual transport systems

3.10.1. Notification by category of roads

Municipalities are responsible for informing about the situation on local/municipality roads.

3.10.2. Ways of informing

The traffic information center, managed by the traffic control center for motorway and national road networks, collects information of conditions on the state roads (all incidents) and daily traffic volume. This information is distributed to the police control center, the national access point (according to the delegated regulation 2015/962), the broadcasting companies, to the public via internet and app (android and iOS) and – in special cases – via newspaper.

3.11. Responsibility and operators

- Ministry responsible for road infrastructure: Ministry of Transport (Verkerhrsministreum)
- Motorway operators: Traffic Control Center Baden Wurttemberg
- Operators of other state roads: Road authorities in each rural district

4. Investing spending and maintenance expenditures

4.1. Gross investment spending in road infrastructure

In 2017, at least **1.100 mio EUR** was invested in motorways and national roads.

4.2. Maintenance expenditures in road infrastructure

In 2017, **350 mio EUR** were used for the maintenance of state roads, which is a quite high level.

5. The objectives of the transport policy and the future development of the road network

5.1. The goals of the transport policy

The vision of transport policy is defined as ensuring the sustainable mobility of the population and supplying the economy with the following objectives:

- improve mobility and accessibility,
- reduce travel times
- improve supply of the economy,
- increase road safety,
- reduce energy consumption,
- reduce emissions.

Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

5.2. The main priorities of road development

General measures are in areas such as:

- ensuring an adequate standard of existing road infrastructure, including road rehabilitation,
- provide a narrow network of roads for all purposes (long range traffic, urban areas, landscape areas)
- traffic safety,
- protection of the natural and living environment from the impact of road transport,

- improving accessibility to regional center,

The following major projects are planned on the road network:

- close gaps in the road (secondary) network
- remove bottlenecks in the motorway network

6. Road management

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

In Baden Wuerttemberg, a pavement management system was introduced on the motorways and as well on other state roads. It enables a monitoring of the condition of the carriageway and the preparation of reconstruction plans in a frequency of 4 years. Such systems provide efficient infrastructure management and long-term financial sustainability.

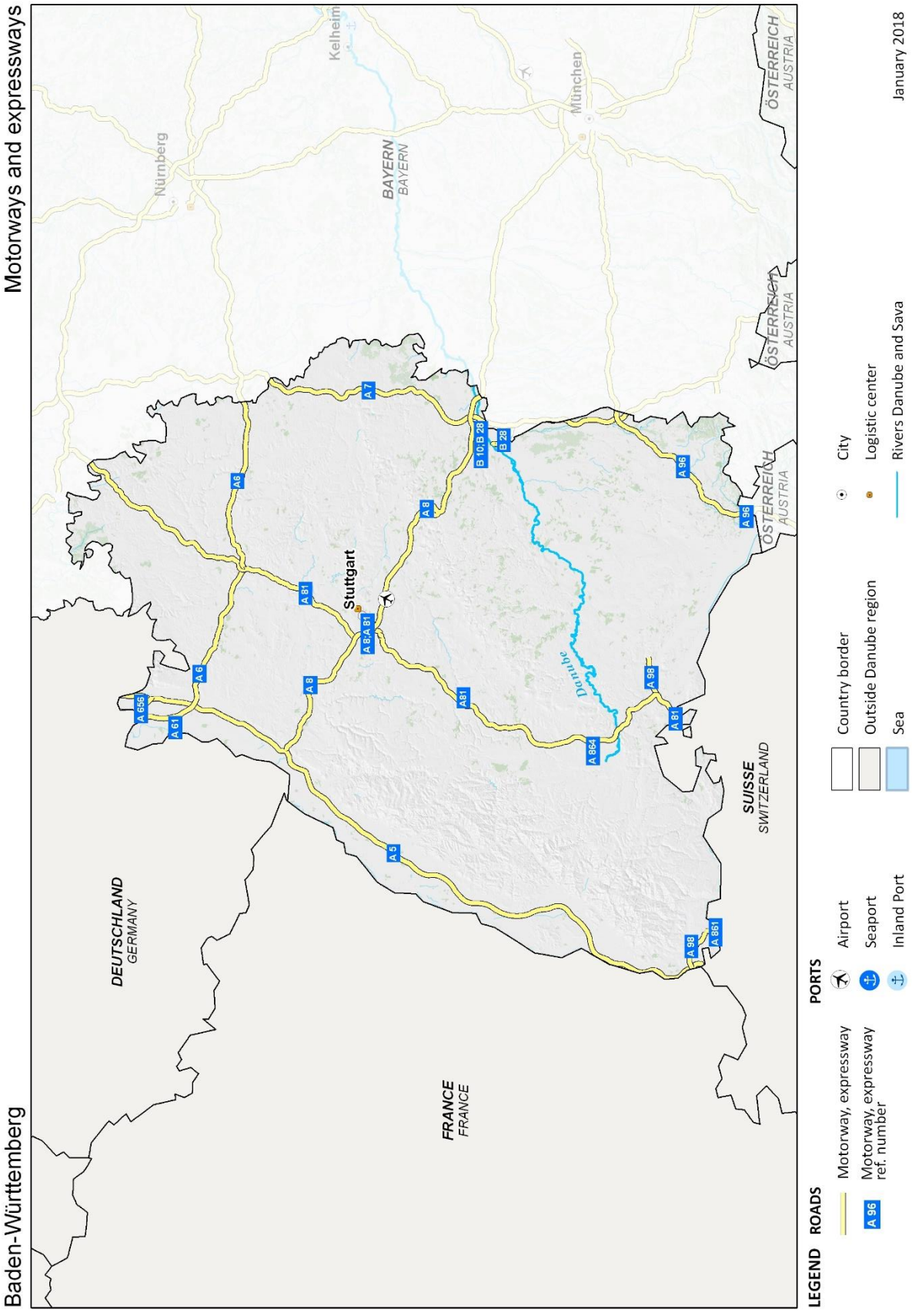

Figure 38: Motorway map of Baden-Wuerttemberg; Source: SLOMAN d.o.o.

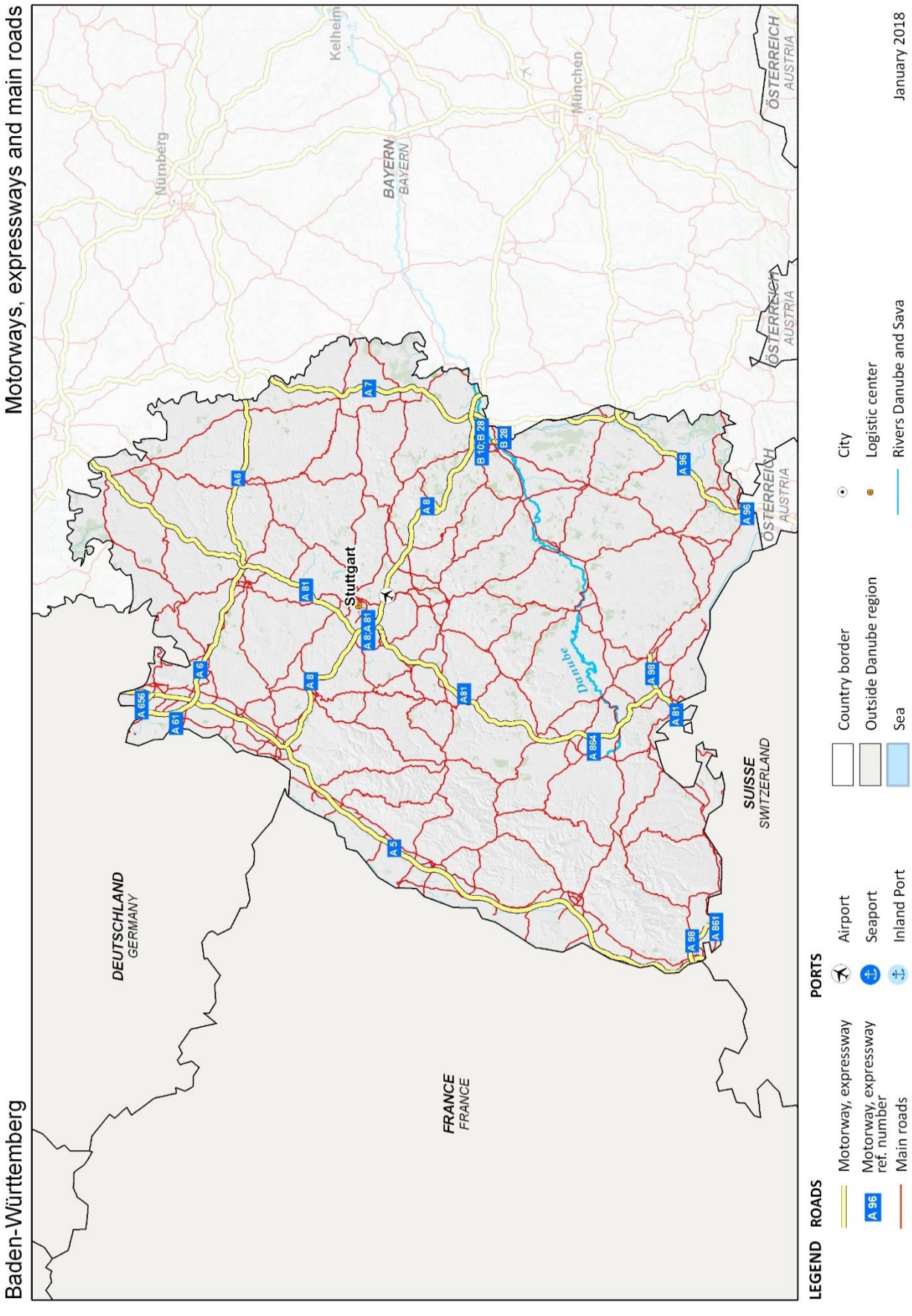

Figure 39: Motorway and main road map of Baden-Wuerttemberg

4.2.2 Danube Region roads: BAVARIA[36]

1. General data

- Inhabitants / 2015: **12.843.514**
- Membership in the EU: **1.1. 1958**
- GDP / 2016 in EUR million: **568.000**
- GDP per capita / 2016 in EUR: **44.225**
- Capital city: **Munich**
- Land area - km²: **70.550**
- Km of roads per million inhabitants: **3.262**
- Km of roads per km² of the land area: **0,59**
- Km of motorways per million inhabitants: **196**
- Km of motorways per km² of the land area: **0,036**

2. Description of the road network

- Length of motorways – km: **2.515**
- Length of federal and state roads – km: **20.531**
- Length of secondary or regional roads – km: **18.849**
- Total lengths of all roads – km: **41.895**

3. Main features of the road network

3.1. Traffic

3.1.1. General traffic estimates:

Traffic loads are large and concentrated in the areas of large cities like Munich and Nurnberg and in the direction of the transit corridor north – south and east - west. Traffic is both domestic and transit. Personal transit traffic is greatly increased during the summer tourist season.

3.1.2. Average annual daily traffic (AADT)

- Average annual daily traffic (AADT) on motorways: **50.074**
- Average annual daily traffic (AADT) on main or national roads: **13.794**
- Average annual daily traffic (AADT) on secondary or regional roads: **1.755**

[36] Bavarian Road Administration

3.2. International road corridors:

- TEN-T corridors:
    - ***Rhine – Danube Corridor****: Frankfurt – Munich – Praha - Vienna – Bratislava - Uzhhorod, and*
    - ***Scandinavian – Mediterranean Corridor****: Helsinki – Stockholm – Malmo – Berlin – Munich – Verona – Roma – Napoli*

- Other main international roads *(excerpt from European Road Network):*
    - ***E 43:*** *Würzburg – Ulm – Lindau – Bregenz – Chur – Bellinzona*
    - ***E 45:*** *Alta – Göteborg – Aarhus – Hamburg – Kassel – Nürnberg – München – Innsbruck – Bozen – Bologna – Neapel – Messina - Agrigento*
    - ***E 48:*** *Schweinfurt – Bayreuth – Karlsbad - Prag*
    - ***E 50:*** *Brest – Paris – Nürnberg – Prag – Rostow – Machatschkalla*
    - ***E 52:*** *Straßburg – Stuttgart – München - Salzburg*
    - ***E 60:*** *Brest – Mühlhausen – Zürich – Rosenheim – Salzburg – Wien – Budapest – Bukarest – Tiflis – Baku – Asgabat – Duschanbe – Irketscham*

3.3. Toll system

Trucks on motorways and expressways must pay a toll. Toll collection is via the satellite toll collection system.

3.4. Condition of road surfaces and structures

Condition of roads and road structures is as following:

- Condition of pavement structures on motorways in 2013 is:
    - good 74 %
    - marginal 11 %
    - poor 15 %

- Condition of pavement structures on national roads in 2016 is:
    - good 40 %
    - marginal 22 %
    - poor 38 %

3.5. Speed limits

- speed limits on motorways: **no limit**
- speed limits on other national roads: **50/100 km/h**

3.6. Traffic safety

- Traffic safety - number of killed persons in road accidents in year 2016 were: **616**
- Traffic safety - number of killed persons per million inhabitants in road accidents in year 2016 were: **48**.

Main causes of traffic accidents were unmatched speed and distraction.

Traffic safety has improved over the past 10 years. 32 % less fatal accidents (deaths) were recorded in 2016, on the roads in comparison to 2006.

Based on EURORAP data research, some 75% of German motorway achieves the “low” risk rating. Similarly, 70% of German motorways score a 4- or 5- star rating with the main flaws being in run-off protection and junction layout.

While motorways and some dual carriageway federal motorways provide high safety standards, single carriageways need improvement. The lack of a median barrier, frequent obstacles (trees) near to the edge of the road and high legal speed limits contribute to severe accident damage and subsequently poor Star Ratings.

3.7. Main weaknesses on the road network

3.7.1. Missing sections

In the following directions, there are missing sections of motorways:

- Motorway A 94, Munich – Passau (A 3)
- Federal Road B 15n, Landshut – Rosenheim

3.7.2. Bottlenecks

There are quite a few sections of roads or areas where traffic is already close to the limit capacity. These are in particular:

- Areas of Munich & Nuremberg
- Motorway A 3, Würzburg – Nuremberg
- Motorway A 6, Heilbronn – Nuremberg
- Motorway A 8, Munich – Salzburg (A)
- Motorway A 9, Holledau (A 93) – Munich

3.7.3. Inadequate protection of the environment and inhabitants

Most of roads are built with adequate protection against excessive noise pollution from road traffic for the living environment. At the crossings of state roads through settlements, protection is unregulated.

As a rule, measures are taken for the controlled drainage of water, from roads into the arrester through containers along motorways.

Wildlife crossings (ecoducts, green bridges) are built to allow land-based creatures to pass safely from one side of the road to another. On several motorway sections underpass tunnels (mainly for large animals) and tunnels and culverts (for amphibian and small mammals such as otters and hedgehogs) are also included.

3.8. Links with neighbouring countries

Bavarian motorway system is well connected with neighbouring countries Italy, the Czech Republic and Austria.

3.9. Protection of the environment and inhabitants from the impact of road traffic (noise, water)

Settlements are primarily protected by active anti-noise protection measures. On existing motorways there is a fundamental requirement for subsequent noise protection in the case of modification and expansion, in accordance with noise limits stipulated in regulations. In addition, measures for noise reduction can be retrofitted on a quasi-voluntary base even if there are no building measures, if certain noise limits are exceeded. On federal and state roads the procedure is analogous.

3.10. Systems for informing users of individual transport systems

3.10.1. Notification by category of roads

The Bavarian Road Administration is responsible for the traffic information for national and state roads.

Municipalities are responsible for informing about the situation on local/municipality roads.

3.10.2. Ways of informing

The traffic information center, managed by “Zentralstelle für Verkehrsmanagement (ZVM)”, collects information of conditions on the state roads (such as accidents or winter conditions) and daily traffic (such as road work sites or congestions). This information is transmitted to the public media and users of the road network.

3.11. Responsibility and operators

- Ministry responsible for road infrastructure:
- Motorway operators:
- Operators of other state roads:

4. Investing spending and maintenance expenditures

4.1. Gross investment spending in road infrastructure

In 2013, **986 mio EUR** were invested in national roads including **496 mio EUR** for the maintenance of the national roads.

4.2. Maintenance expenditures in road infrastructure

In 2013, **217 mio EUR**, were invested in state roads including **126 mio EUR** for the maintenance of state roads.

5. The objectives of the transport policy and the future development of the road network

5.1. The goals of the transport policy

The vision of transport policy is defined as ensuring the sustainable mobility of the population and supplying the economy with the following objectives:

- improve mobility and accessibility,
- improve supply of the economy,
- improve road safety and security,
- reduce energy consumption,
- reduce user and operator costs,
- reduce environmental burdens.

Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

5.2. The main priorities of road development

General measures are in areas such as:

- ensuring an adequate standard of existing road infrastructure, including road rehabilitation,
- traffic safety,
- protection of the natural and living environment from the impact of road transport,
- improving accessibility to regional center,
- preparedness for extreme weather events and
- road measures in individual parts of the country

The following major projects are planned on the road network:

- Motorway A 3, Expansion between Würzburg – Nuremberg (to be open for traffic in 2024)
- Motorway A 94, Munich – Passau (A 3), partially in construction ((to be open for traffic in 2022)

6. Road management

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

In Bavaria computer-aided systems were introduced on national and also on state roads. It enables continuous monitoring of the condition of the carriageway and the preparation of reconstruction plans carriageway and bridges. Such systems provide efficient infrastructure management and long-term financial sustainability.

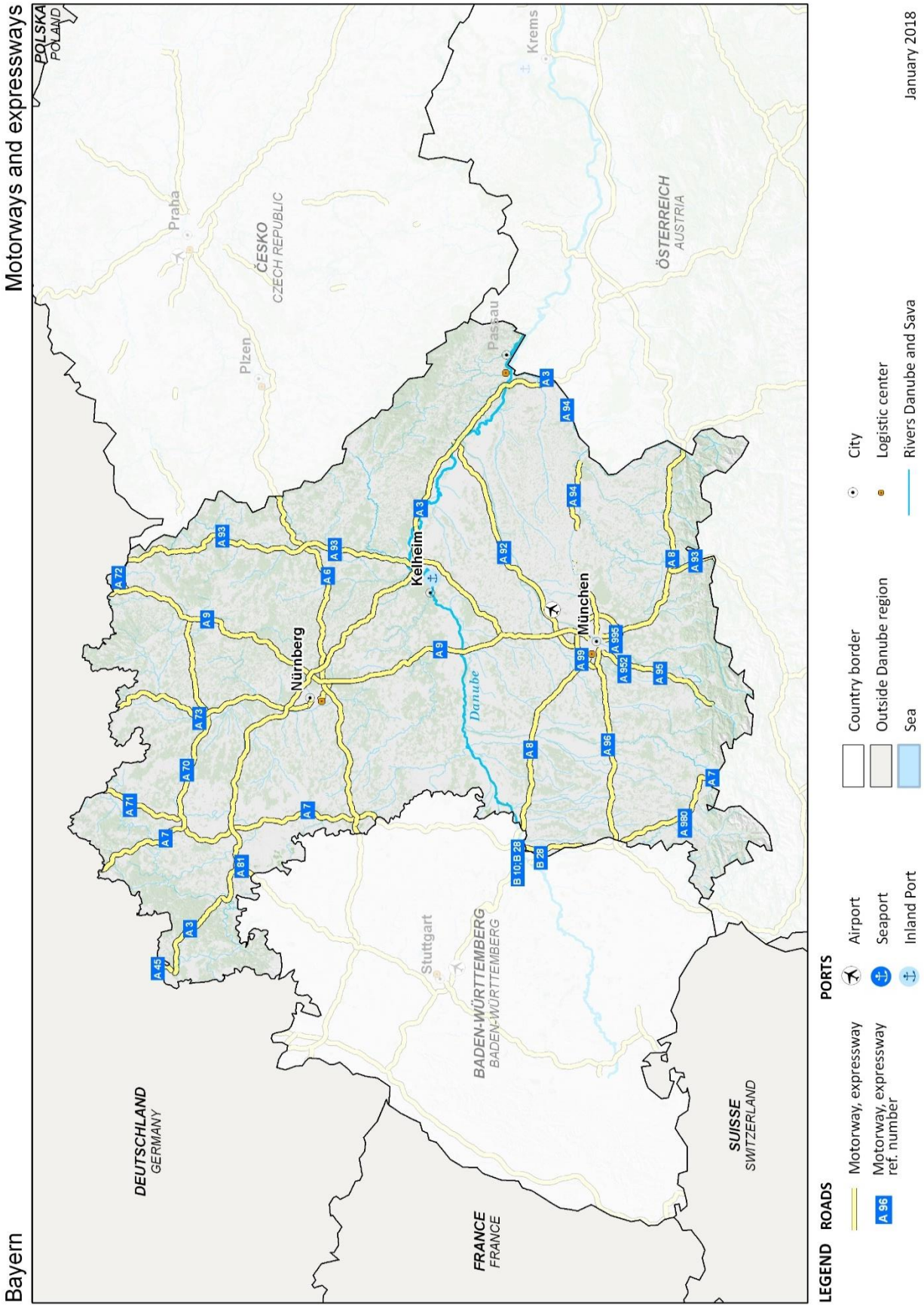

Figure 40: Motorway map of Bavaria; Source: SLOMAN d.o.o.

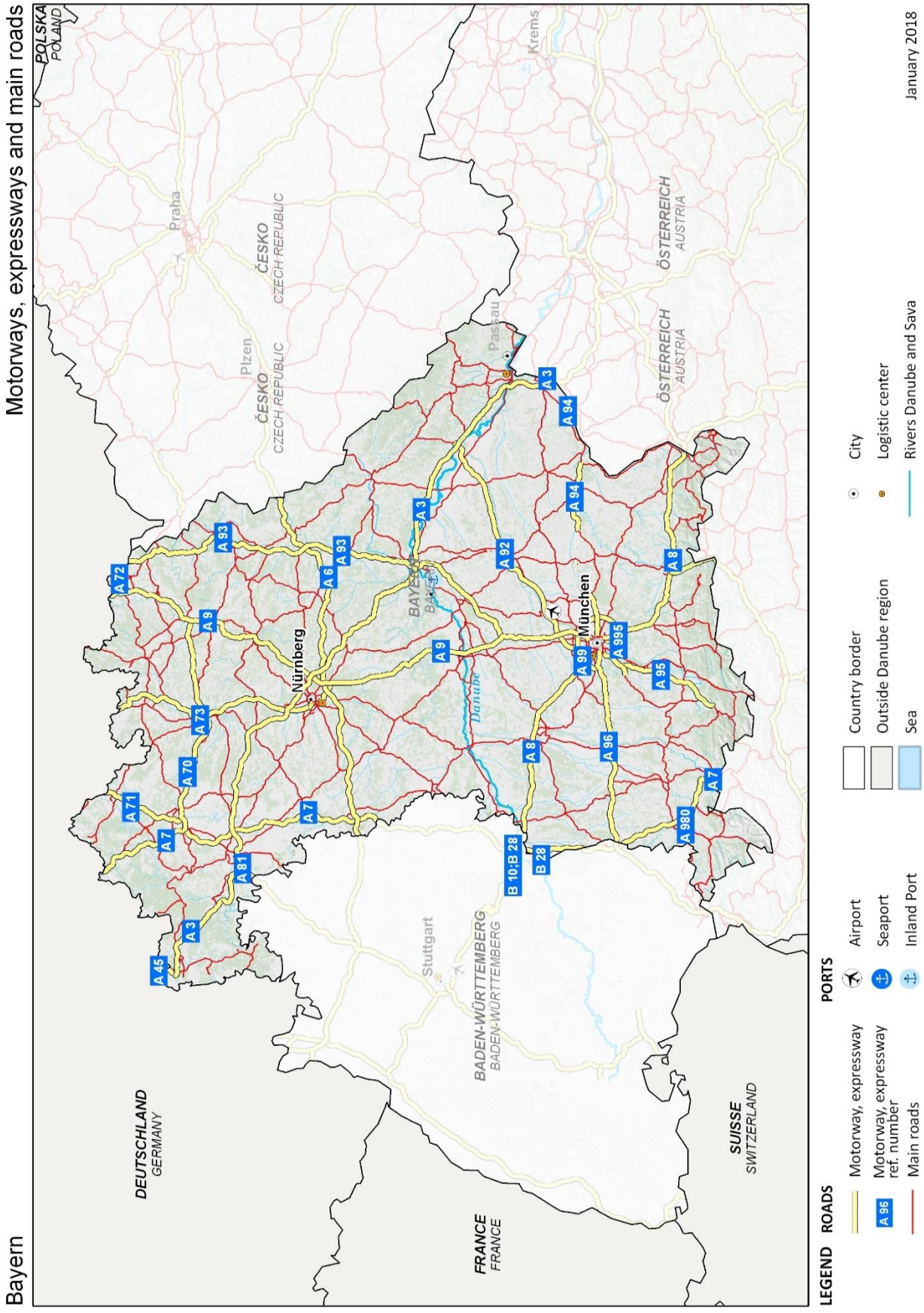

Figure 41: Motorway and main road map of Bavaria

4.2.3 Danube Region roads: THE CZECH REPUBLIK

1. General data[37]

- Inhabitants / 2016: **10.565.300**
- membership in the EU: **1.5.2004**
- GDP / 2016 in EUR million: **176.574,3**
- GDP per capita/ 2016 in EUR: **16.713**
- capital city: **Prague**
- land area - km²: **78.868**
- km of roads per million inhabitants: **12.368**
- km of roads per km² of the land area: **1,66**
- km of motorways per million inhabitants: **116**
- km of motorways per km² of the land area: **0,016**

2. Description of the road network

- length of motorways (2016) – km: **1.223**
- length of main or national roads (2016) – km: **5.807**
- length of secondary or regional roads (2016) – km: **48.727**
- length of other roads (2016) – km: **74.919**
- total lengths of all roads (2016) – km: **130.676**

3. Main features of the road network

3.1. Traffic

3.1.1. General traffic estimates:

Traffic loads are large and concentrated in the areas of large cities like Praha and Brno and in the direction of the transit corridor northwest - southeast and southwest - northeast. Traffic is both domestic and transit. Transit freight transport in tkm represents about 12 % while volume of goods transport in tones is about 6 %.

3.1.2. Average annual daily traffic (AADT)

- Average annual daily traffic (AADT) on all state roads: **2.594**
- Average annual daily traffic (AADT) on motorways: **28.165**
- Average annual daily traffic (AADT) on main or national roads: **8.506**
- Average annual daily traffic (AADT) on secondary or regional roads: **2 612 (673)**

[37] Official website of the European Union

3.2. International road corridors:

- TEN-T corridors:
  - ***Rhine – Danube Corridor****: Strasbourg/Frankfurt/Mannheim – Stuttgart-Munich/Nuremberg – Prague – Brno – Zlín – Žilina – UA borders / Linz – Vienna – Bratislava –Budapest – Timisoara – Bucharest – Constanta*

  - ***Orient - East Mediterranean Corridor****: Bremen – Hannover / Rostock/Hamburg – Berlin – Dresden – Prague – Brno – Bratislava/Vienna – Budapest – Timisoara – Sofia – Burgas/TR borders / Thessaloniki – Igoumenitsa/Athens – Patras*

  - ***Baltic – Adriatic Corridor****: Gdansk-Warsaw / Szczeczin-Poznan-Wroclaw – Katowice – Ostrava-Brno/Žilina-Bratislava – Vienna – Graz – Ljubljana/Klagenfurt – Koper/Trieste/Venice/Ravenna*

- Other main international roads:
  - ***Praha – Hradec Králové - Wroclaw***
  - ***Praha – České Budějovice - Linz***
    Praha – Karlovy Vary - Bayreuth

3.3. Toll system

Motorways and expressways, users must pay a toll:

- Personal vehicles must have an annual, monthly or 10 days' vignette
- Trucks on motorways and expressways must pay a toll. Toll collection is via the microwave system.

3.4. Speed Limits

- speed limits on motorways: **130 km/h**
- speed limits on other national roads: **50/90 km/h**

3.5. Traffic safety

  - Traffic safety - number of killed persons in road accidents in year 2016 were: **611**
  - Traffic safety - number of killed persons per million inhabitants in road accidents in year 2016 were: **58**

Traffic safety has improved over the past 10 years. In 2016 (611) there were 50 % less fatal accidents (deaths) on the roads (611) in comparison to 2007 (1.222).

Main causes of traffic accidents were: non-adaptation of speed to road traffic conditions, going into the opposite direction, designated driving.

The latest results from the Czech EuroRAP programme were launched in November 2011. Results show that head-on crashes and side impact crashes at intersections account for one-third of all road deaths in the Czech Republic. Over the past 5 years, 1,232 people have been killed hitting objects at the roadside – a quarter of all road fatalities. Every fourth fatality is a pedestrian or cyclist. In total 1.223km of motorways and 5,807km of main roads has been measured and mapped – the network on which nearly one-third of all fatal or serious crashes occur.

Safety ratings are available for 341 separate road sections. Latest results show that one-third of the network was rated as high or medium-high risk. Routes in Zlin region were rated as carrying higher risks of fatal or serious crashes.

3.6. Main weaknesses on the road network

3.6.1. Missing sections

In the following directions, there are missing sections of motorways or main roads:

- D0 Prague ringroad, northern and eastern part
- D35 Hradec Králové – Mohelnice
- D11 Hradec Králové – Trutnov – st. border
- D3 Praha – Tábor, České Budějovice – st. border
- D52 Pohořelice – Mikulov st. border
- D6 Řevničov – Karlovy Vary
- D49 Hulín – Zlín – st. border
- D43 Brno – Moravská Třebová

3.6.2. Hazardous sections[38][39]

Defining “high level of risk” is not straightforward – this is also the reason why there are several different methodologies for identification of black spots / hazardous locations / risk sites / critical sites, etc.

We can use general definition (Elvik, 2008): a hazardous road location is defined as a place within a road section with significantly high number of traffic crashes (a part of a road section which contains statistically significant cluster of traffic crashes). Then we can apply kernel density estimation method developed by CDV[40]. When we used data for the core road

[38] Bíl, M., Andrášik, R., Janoška, Z. (2013). Identification of hazardous road locations of traffic accidents by means of kernel density estimation and cluster significance evaluation. *Accident Analysis & Prevention*, 55, 265 - 273.

[39] Elvik, R. (2008). A survey of operational definitions of hazardous road locations in some European countries. *Accident Analysis & Prevention*, 40, 1830 - 1835.

[40] KDE+; Bíl et al., 2013; http://www.kdeplus.cz/en/

network (motorways and roads of 1st to 3rd class), we identified 0.67 % of length as hazardous (1429 hazardous locations, total length approx. 261 km).

Czech national railway operator SŽDC currently registers 7961 railway level crossings (RLCs). In terms of their securing, there are five categories, see figure. Almost 50% (3938 RLCs) of them are passive (with signs only, without lights and/or crossbucks).

3.6.3. Inadequate protection of the environment and inhabitants

Most of roads are built with adequate protection against excessive noise pollution from road traffic for the living environment. At the crossings of state roads through settlements, protection is unregulated.

As a rule, measures are taken for the controlled drainage of water from roads into the arrester through containers along motorways.

Wildlife crossings (ecoducts, green bridges) are built to allow land-based creatures to pass safely from one side of the road to another. On several motorway sections underpass tunnels (mainly for large animals) and tunnels and culverts (for amphibian and small mammals such as otters and hedgehogs) are also included.

3.7. Links with neighbouring countries

The Czechs motorway system is well connected with neighbouring countries Germany and Slovakia. Unfinished connections are with Poland (western part) and Austria.

3.8. Protection of the environment and inhabitants from the impact of road traffic (noise, water)

The motorway system in particular is built with many measures to protect the natural and living environment. Thus, most settlements along motorways and expressways are protected by active anti-noise protection measures. Especially on old motorways anti-noise measures are being constructed on sections where they were not built at the time of construction. On national roads, these measures are less frequent. Particularly where roads are passing towns and smaller settlements inhabitants are not protected against excessive noise.

3.9. Systems for informing users of individual transport systems

3.9.1. Ways of informing

The traffic information center, managed by **Road and Motorway Directorate of the Czech Republic,** collects information of conditions on the state roads (such as accidents or winter conditions) and daily traffic (such as road work sites or congestions). This information is transmitted to the public media and users of the national road network.

The Integrated Traffic Information System of the Czech Republic is comprised of three main parts:

1) Data collection subsystems

2) The National Traffic Information and Management Centre (NDIC) - processes and evaluates traffic information, monitors the traffic situation on a centralized basis, carries out central traffic management and control and provides the public with traffic-related information and data

3) Subsystems for providing traffic information

The National Traffic Information and Management Centre (NDIC) is a central technical, technological, operational and organizational point of the Integrated Traffic Information System of the Czech Republic (JSDI). It is an operational department run by the Road and Motorway Directorate, functioning on the 24/7 basis and collecting, processing, assessing, verifying and authorizing traffic information and data. This information and data serve as a basis on which the National Traffic Information and Management Centre operators regulate the traffic by means of variable traffic signs, traffic information devices, the Radio Data System – Traffic Message Channel or through the www.dopravniinfo.cz website and through relevant mobile phone applications.

The Police of the Czech Republic represents another important provider of information in frame of the Integrated Traffic Information System, gathering important information mainly through calls to the 158 emergency line or from its patrols.

According to the contract between private entities and the Road and Motorway Directorate of the Czech Republic, private entities have, in order to provide their clients with information services, the right to use information from the National Traffic Information and Management Centre and from the Integrated Traffic Information System.

Municipalities are responsible for informing about the situation on local/municipality roads.

3.10.2 Responsibility and operators

- ministry responsible for road infrastructure: **Ministry of Transport of the Czech Republic**
- motorway operators: **Road and Motorway Directorate of the Czech Republic**
- operators of other state roads: **regions and municipalities**

4. Investing spending and maintenance expenditures

4.1. Gross investment spending in road infrastructure

In 2013, **910** mio EUR were invested in national roads.

4.2. Maintenance expenditures in road infrastructure

In 2013, **822** mio EUR were used for the maintenance of state roads

5. The objectives of the transport policy and the future development of the road network

5.1. The goals of the transport policy

The vision of transport policy is defined as ensuring the sustainable mobility of the population and supplying the economy with the following objectives:

- improve mobility and accessibility,
- improve supply of the economy,
- improve road safety and security,
- reduce energy consumption,
- reduce user and operator costs,
- reduce environmental burdens.

Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

5.2. The main priorities of road development

General measures are in areas such as:

- ensuring an adequate standard of existing road infrastructure, including road rehabilitation,
- traffic safety,
- protection of the natural and living environment from the impact of road transport,
- improving accessibility to regional center,
- preparedness for extreme weather events and
- road measures in individual parts of the country

The following major projects are planned on the road network:

- D0 Prague ringroad, northern and eastern part
- D35 Hradec Králové – Mohelnice
- D11 Hradec Králové – Trutnov – st. border
- D3 Praha – Tábor, České Budějovice – st. border
- D52 Pohořelice – Mikulov st. border
- D6 Řevničov – Karlovy Vary
- D49 Hulín – Zlín – st. border

- D43 Brno – Moravská Třebová

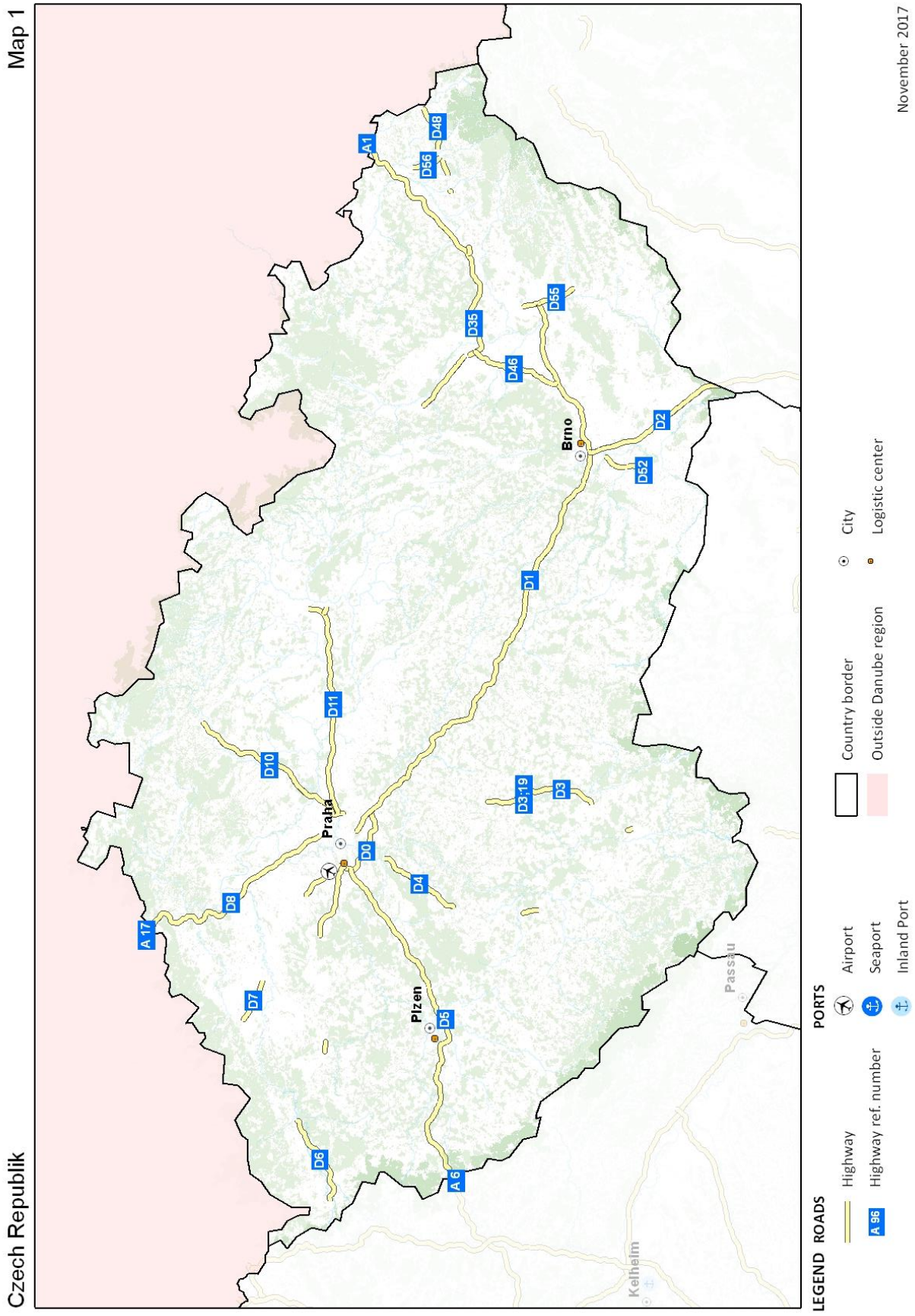

Figure 42: Motorway map of the Czech Republic; Source: SLOMAN d.o.o.

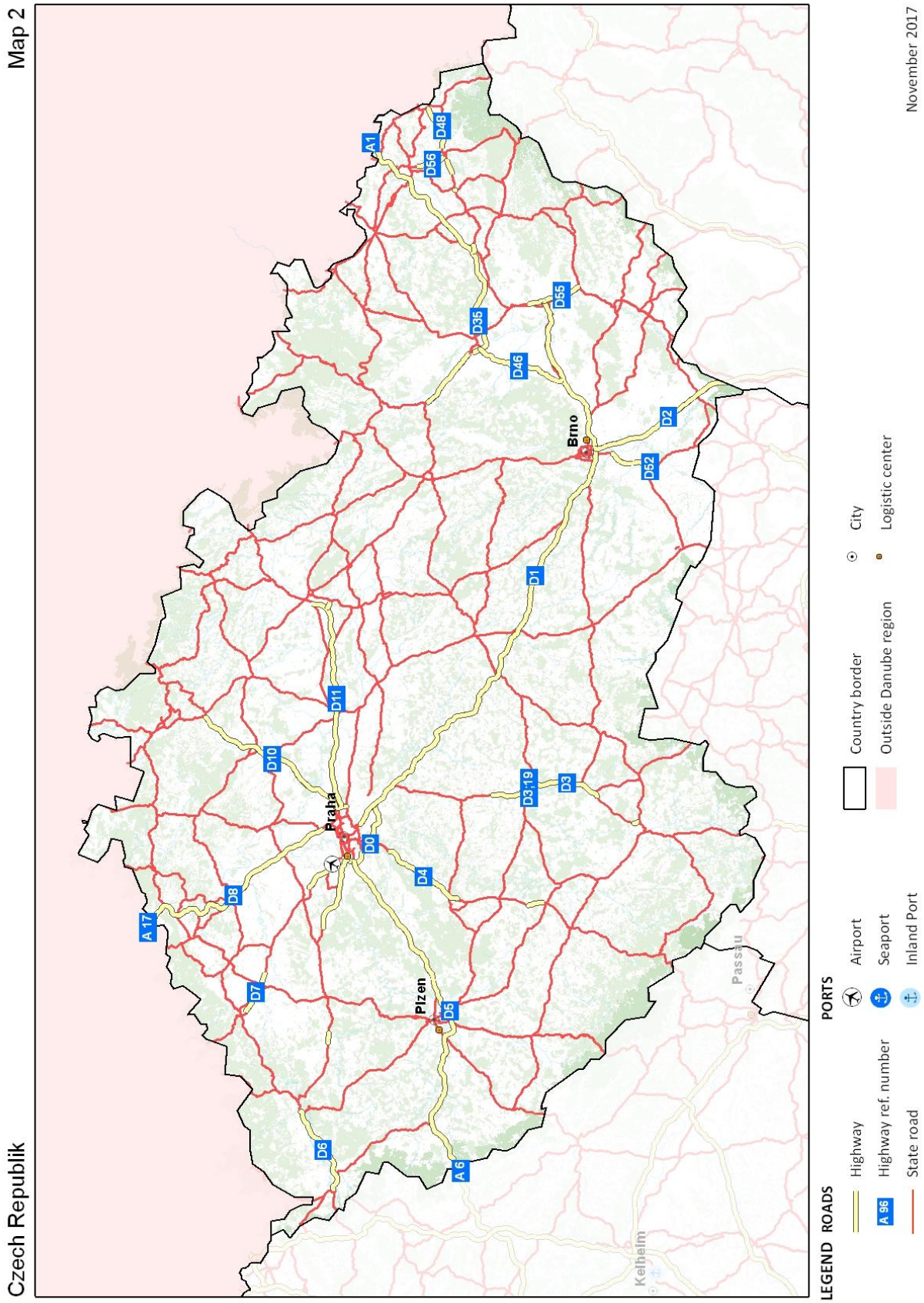

Figure 43: Motorway and main road map of the Czech Republic

4.2.4 Danube Region roads: AUSTRIA

1. General data[41]

- Inhabitants / 2016: **8.690.076**
- EU membership in the: **1.5.1955**
- GDP / 2016 in EUR million: **349.344**
- GDP per capita / 2016 in EUR: **40.200**
- Capital city: **Vienna**
- Land area - km²: **83.879**
- Km of roads per million inhabitants: **15.904**
- Km of roads per km² of the land area: **1,65**
- Km of motorways per million inhabitants: **198**
- Km of motorways per km² of the land area: **0,020**

2. Description of the road network[42]

- Length of motorways – km: **1.719**
- Length of main or national roads – km: **10.345**
- Length of secondary or regional roads – km: **23.681**
- Length of other roads – km: **102.463**
- Total lengths of all roads – km: **138.208**

3. Main features of the road network

3.1. Traffic

3.1.1. General traffic estimates:

Traffic loads are large and concentrated in the areas of large cities like Vienna, Graz, Salzburg, Innsbruck and in the direction of the transit corridors northwest – southeast, north - south and east - west. Traffic is both domestic and transit. Personal transit traffic is greatly increased during the summer tourist season. For Austria personal transit traffic represents 7%, while freight transport in transit represents 3%.

3.1.2. Average annual daily traffic (AADT)

- Average annual daily traffic (AADT) on motorways: 38.400

[41] Official website of the European Union
[42] BMVIT, 2016

3.2. International road corridors:

- TEN-T corridors:
  - ***Baltic – Adriatic Corridor****: Gdansk – Ravenna – Warsaw – Bratislava – Vienna - Ljubljana - Koper, Trieste, Venice – Ravenna*
  - ***Scandinavian – Mediterranean Corridor****: Helsinki – Stockholm – Malmo – Berlin – Munich – Verona – Roma – Napoli and*
  - ***Rhine – Danube Corridor****: Frankfurt – Munich – Praha - Vienna – Bratislava - Uzhhorod,*
  - ***Orient – East Mediterranean Corridor:*** *Hamburg/Rostock – Berlin – Dresden – Prague – Vienna/Bratislava – Budapest – Craiova – Sofia – Burgas/Athen*

3.3. Toll system

The entire primary road network (i.e. all motorways and expressways) is subject to tolling.

- The vignette system (toll sticker or digital vignette) applies to all vehicles with a maximum permissible weight up to and including 3.5 tons on all motorways and expressways, except certain road sections with tolls depending on mileage (i.e. certain tunnels and routes across the Alps). Vignettes are available either for ten days, two months or one year.
- Vehicles with a maximum permissible weight above 3.5 tons are subject to distance based charging on all motorways and expressways. The electronic toll system is operating multi-lane free-flow via DSRC 5.8 GHz microwave technology.

3.4. Condition of road surfaces and structures

Condition of roads and road structures is as following:

- Condition of pavement structures on motorways and express roads (national roads) in 2016 is:

CSI Safety Index

good (1,2)	44,3%
marginal (3)	47,4 %
poor (4,5)	8,1%

- Condition of road structures on motorways and express roads in 2016 is

SI Structural Index

good (1,2)	76,9 %
marginal (3)	8,8%
poor (4,5)	14,3%

3.5. Speed Limits

- Speed limits on other national roads: **50/100 km/h**
- Speed limits on motorways: **130 km/h**

3.6. Traffic safety [43]

- Traffic safety - number of killed persons in road accidents in year 2014 were: **430**
- Traffic safety - number of killed persons per million inhabitants in road accidents in year 2014 were: **49**

Traffic safety has improved over the past 10 years. There is **37** % less fatal accidents (deaths) on the roads-between 200**7 (691)** and 201**6 (430).**

Main reasons of traffic accidents were … (e.g. speeding, alcohol and poor infrastructure)[44].

- inattention/ distraction: 29%
- inappropriate speed: 28%
- neglecting right of way (also against pedestrians)/ red light: 14%

Based on EURORAP data research the results were also presented alongside those in the SENSoR project for South East Europe and this reinforces the generally low risk nature of Austrian motorways when compared with the more extensive networks assessed in neighbouring Hungary, Slovakia and Slovenia.

3.7. Main weaknesses on the road network

3.7.1. Missing sections

- A3 motorway between Eisenstadt and AT/H border
- A5 motorway - last remaining section Poysbrunn – AT/CZ border
- the second tunnel tube of the Karawanken tunnel (A11) to Slovenia
- A26 in Linz
- S1 expressway in the North-East of Vienna
- S3 expressway between Hollabrunn and Guntersdorf; section Guntersdorf – AT/CZ
- S7 expressway between Riegersdorf and Dobersdorf;
- S8 expressway to the Slovakian border),
- S10 expressway (planned between Freistadt and AT/CZ border; section Rainbach – AT/CZ border

[43] Road Statistics Yearbook 2016

[44] http://www.statistik.at/web_de/statistiken/energie_umwelt_innovation_mobilitaet/verkehr/strasse/unfaelle_mit_personenschaden/index.html

- S18 expressway to Swiss border

3.7.2. Hazardous road sections

On the website of ASFINAG a map is provided with accident black spots[45]

3.7.3. Inadequate protection of the environment and inhabitants

Most of roads are built with adequate protection against excessive noise pollution from road traffic for the living environment.

Air pollution caused by traffic is reduced by imposing speed-limits on selected motorway and expressway sections.

As a rule, measures are taken for the controlled drainage of water from roads into the arrester through containers along motorways.

Wildlife crossings (ecoducts, green bridges) are built to allow land-based creatures to pass safely from one side of the road to another. On several motorway sections underpass tunnels (mainly for large animals) and tunnels and culverts (for amphibian and small mammals such as otters and hedgehogs) are also included.

3.8. Links with neighbouring countries

Austrian motorway system is well connected with neighbouring countries Germany, Italy, Slovenia, Hungary and Slovakia. Missing motorway connections are expressway S3, S10 and motorway A5-to the Czech Republic, S8 to Slovakia, S18 to Switzerland as well as A3 and S7 to Hungary, which are currently under planning or under construction.

3.9. Protection of the environment and inhabitants from the impact of road traffic (noise, water)

The motorway and expressway system is built with many measures to protect the natural and living environment.
Thus, most settlements along motorways and expressways are protected by active anti-noise protection measures. Especially on old motorways and expressways anti-noise measures are being constructed on sections where they were not built at the time of construction.

On the motorways and expressways, as a rule, measures are taken for the controlled drainage of water from roadways into the water drain, through containers.

[45] https://www.asfinag.at/media/2240/ukrplusuhs_2014-2016.pdf

Air pollution caused by traffic is reduced by imposing speed-limits on selected motorway and expressway sections.

In general, motorways and expressways have been planned in the last decades with a lot of attention to the natural and living environment. The routes were chosen in such a way that they were as nicely as possible integrated into the environment and protected against the disturbing effects of traffic. Much attention was given to the road alignment, design of objects, tunnel portals, etc.

3.10. Systems for informing users of individual transport systems

3.10.1. Notification by category of roads

Based on the public authorization, traffic information on the state roads is entrusted to:

- ASFINAG for motorways and expressways (and main roads on regional level).

Municipalities are responsible for informing about the situation on local/municipality roads.

3.10.2. Ways of informing

The traffic information center, managed by ASFINAG for motorway networks, collects information of conditions on the state roads (such as accidents or winter conditions) and daily traffic (such as road work sites or congestions). This information is transmitted to the public media and users of the national road network. In addition, ASFINAG is a main contributor of the VAO (Austrian Traffic Information System), which provides multimodal real-time traffic information and routing services. Finally, a significant percentage of the Austrian motorway network is equipped with roadside ITS equipment.

3.11 Responsibility and operators

- Ministry responsible for road infrastructure: bmvit
- Motorway operators: ASFINAG
- Operators of other state roads: provinces

4. Investing spending and maintenance expenditures[46]

4.10. Gross investment spending in road infrastructure

In 2016, **154 mio EUR** were invested on motorways and express roads (national roads).

4.11. Maintenance expenditures in road infrastructure

In 2016, **471 mio EUR** were invested in the maintenance of motorways and express roads (national roads).

[46] Road Statistics Yearbook 2016

5. The objectives of the transport policy and the future development of the road network

5.10. The goals of the transport policy

The vision of transport policy is defined as ensuring the sustainable mobility of the population and supplying the economy with the following objectives:

- improve mobility and accessibility,
- improve supply of the economy,
- improve road safety and security,
- reduce energy consumption,
- reduce user and operator costs,
- reduce environmental burdens.

Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

5.2 The main priorities of road development

General measures are in areas such as:

- ensuring an adequate standard of existing road infrastructure, including road rehabilitation,
- traffic safety,
- protection of the natural and living environment from the impact of road transport,
- improving accessibility to regional centers,
- preparedness for extreme weather events and
- road measures in individual parts of the country

The following major projects are planned on the road network:

- construction of A3 motorway (planned between Eisenstadt and AT/H border)
- construction of A5 motorway (last remaining section Poysbrunn – AT/CZ border will be realized based on demand and EIA process on the Czech Republic side)
- construction of the second tunnel tube of the Karawanken tunnel (A11) to Slovenia
- construction of the A26 in Linz (total length 4,7 km)
- planning of S1 expressway in the North-East of Vienna (total length 22,5km)

- construction of S3 expressway (under construction between Hollabrunn and Guntersdorf; section Guntersdorf – AT/CZ border will be realized based on demand on the Czech Republic side)
- construction of S7 expressway (under construction between Riegersdorf and Dobersdorf; planned between Dobersdorf and AT/H border; total length 17,5km)
- planning of the S8 expressway to the Slovakian border (total length 34,0 km),
- construction of S10 expressway (planned between Freistadt and AT/CZ border; section Rainbach – AT/CZ border will be realized based on demand on the Czech Republic-side; total length 15,1km)
- planning of S18 expressway to Swiss border (total length 6,2 km)

6 Road management

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

In Austria, a computer-aided system (e.g. DTIMS_CT or PMS (Pavement Management System)) was introduced on the motorways and also on other state roads. It enables continuous monitoring of the conditions of the carriageways and the preparation of reconstruction plans. Plans are made on the basis of mathematical models which are based on collapse curves of the carriageway. Such systems provide efficient infrastructure management and long-term financial sustainability.

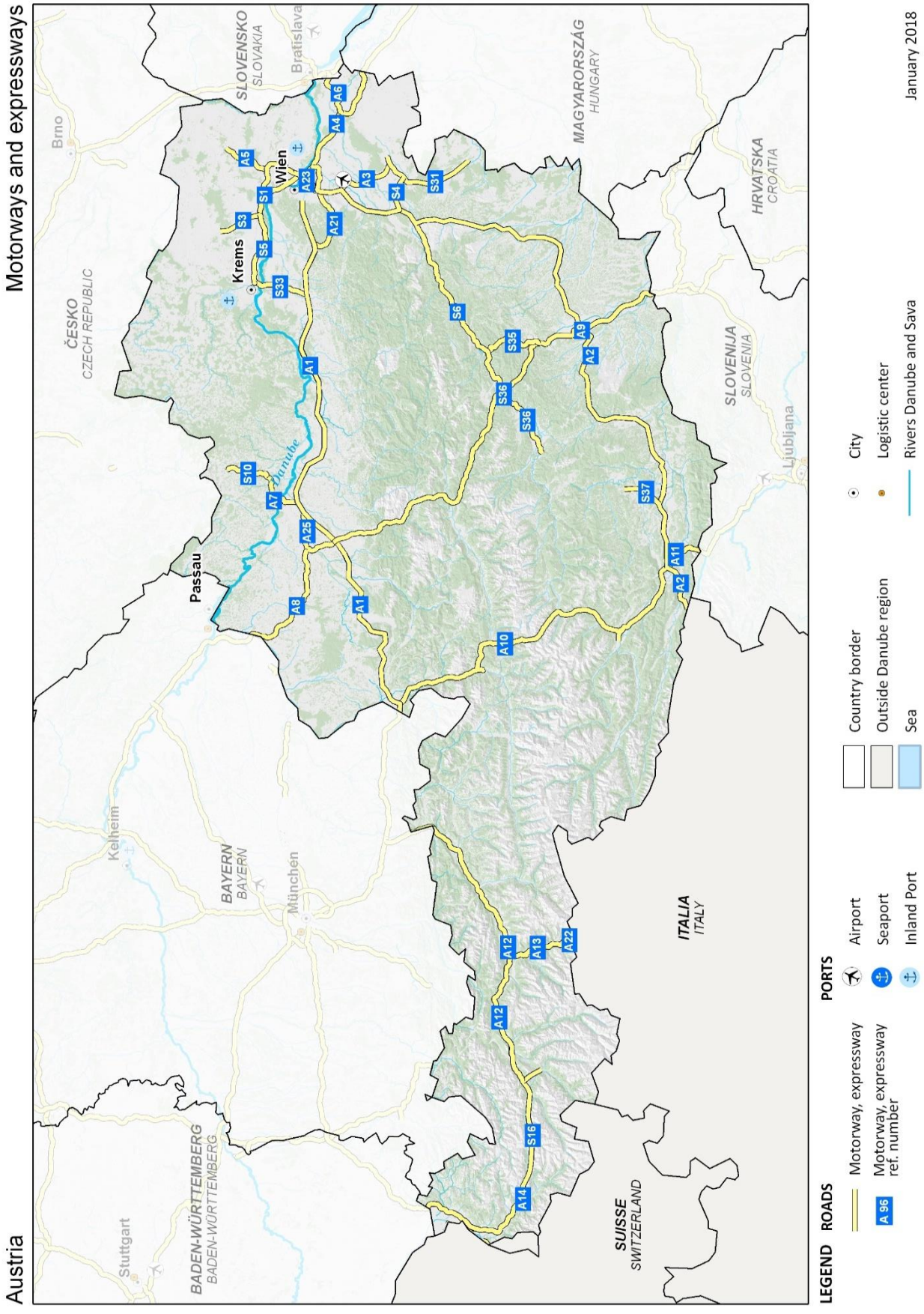

Figure 44: Motorway map of Austria; Source: SLOMAN d.o.o.

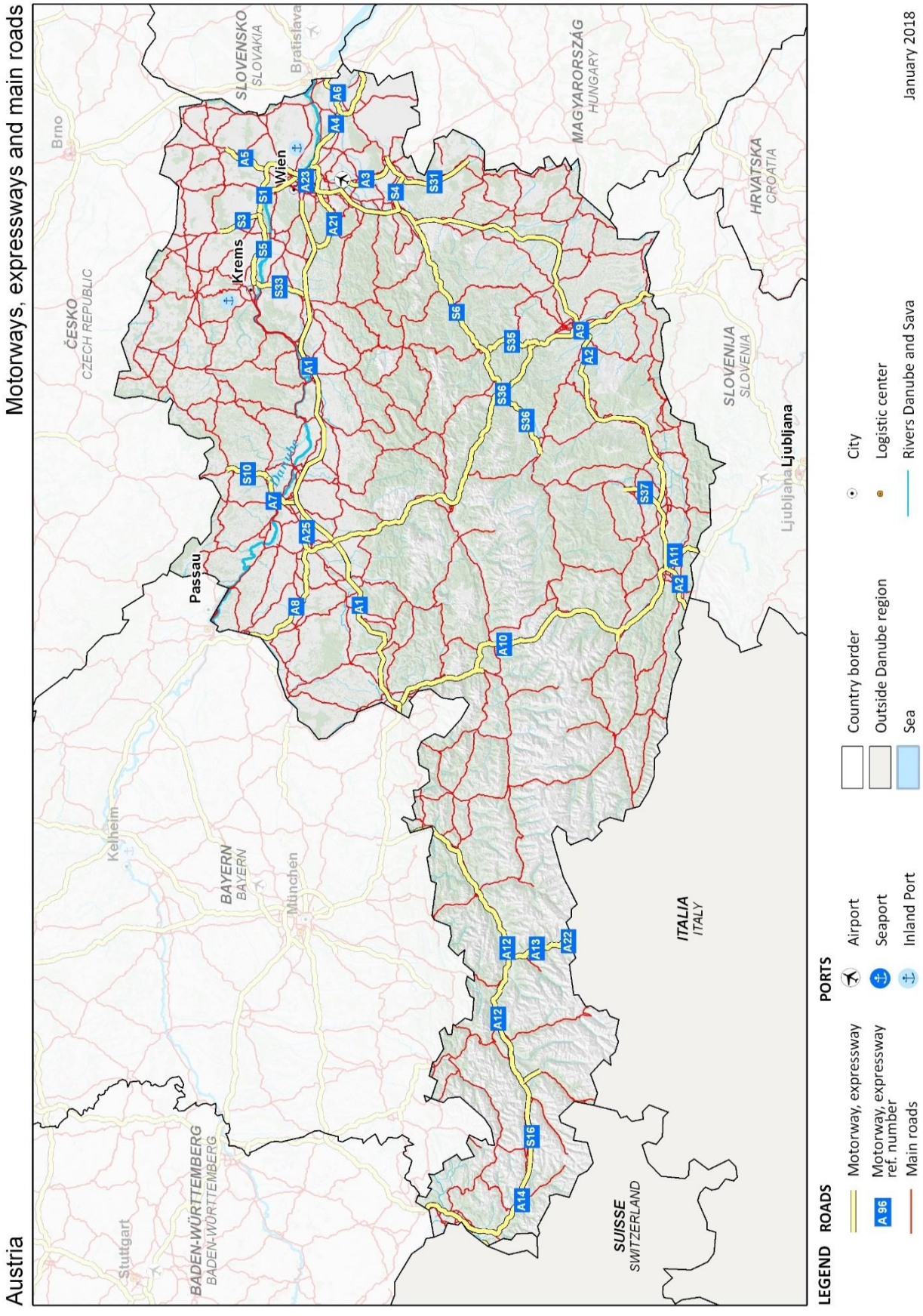

Figure 45: Motorway and main road map of Austria

4.2.5 Danube Region roads: SLOVAKIA

1. General data[47]

- Inhabitants / 2016: **5.426.252**
- membership in the EU: **1.5.2004**
- GDP / 2016 in EUR million: **80.958,0**
- GDP per capita / 2016 in EUR: **14.920**
- capital city: **Bratislava**
- land area - km²: **49.035**
- km of roads per million inhabitants: **10.111**
- km of roads per km² of the land area: **1,12**
- km of motorways per million inhabitants: **88**
- km of motorways per km² of the land area: **0,01**

2. Description of the road network[48]

- length of motorways and (2013) – km: **480**
- length of main or national roads (2013) – km: **3.538**
- length of secondary or regional roads (2013) – km: **13.996**
- length of other roads (2013) – km: **36.852**
- total lengths of all roads (2013) – km: **54.866**

3. Main features of the road network

3.1 Traffic

3.1.1 General traffic estimates:

Traffic loads are large and concentrated in the area of capital city Bratislava and in the direction of the transit corridors northeast – southwest, northeast – southwest and west – east. Traffic is both domestic and transit. For personal transit traffic represents 1,2 %, while freight transport in transit represent 3,9 %.

Volume of cross-border transport is very low in comparison to inland transport but impact on traffic load is enormous. Therefore, planning and constructing of new bypasses is crucial for most of the larger cities in Slovakia.

3.2. International road corridors:

[47] Official website of the European Union
[48] Eurostat, IRF 2013

- TEN-T corridors:
  - ***Rhine – Danube Corridor****: Frankfurt – Munich – Praha - Vienna – Bratislava - Uzhhorod,*
  - ***Baltic – Adriatic Corridor****: Gdansk – Ravenna – Warsaw – Bratislava – Vienna - Ljubljana - Koper, Trieste, Venice – Ravenna and*
  - ***Orient - East Mediterranean Corridor****: Rostock – Praha – Bratislava – Budapest – Beograd – Sofia - Athens*

- Other main international roads:
  - Already constructed:
    R1 Trnava - Nitra – Zvolen - Banská Bystrica (170 km)
    R4 Košice – Milhosť / border with Hungary(14.2 km)

3.3. Toll system

On motorways and expressways, users must pay a toll:

- From 1 December 2015 personal vehicles must have an annual, 30 days or 10 days electronic vignette[49]
- Trucks on motorways and expressways must pay a toll. From 1 January 2010 toll collection is via the GPS satellite system.[50]

3.4. Condition of road surfaces and structures[51]

Condition of roads and road structures is as following:

- Condition of pavement structures[52] on motorways and express roads in 2016 is:
  - good 97,9 %
  - marginal 1,6 %
  - poor 0,5 %

- Condition of pavement structures on national roads[53] in 2016 is:
  - good 70 %
  - marginal 13,4 %
  - poor 16,6 %

- Condition of road structures[54] on motorways and express roads in 2016 is:
  - good 93,3 %
  - marginal 5,3 %
  - poor 1,4 %

[49] https://www.eznamka.sk/selfcare/home/#text-BasicInfo2
[50] https://www.emyto.sk/en
[51] http://www.cdb.sk/files/output/rdb_2017/index.html
[52] under the term "*condition of pavement structures"* we understand "rutting"
[53] under the term "national roads*"* we understand "1st class roads"
[54] under the term "*condition of road structures"* we understand "longitudinal unevenness/IRI"

- Condition of road structures on national roads in 2016 is:
    - good 50,4 %
    - marginal 26,4 %
    - poor 23,2 %.

3.5. Speed Limits

- speed limits on motorways: **130 km/h**
- speed limits on other national roads: **50/90 km/h**

3.6. Traffic safety

- Traffic safety - number of killed persons in road accidents in year 2016 were: **242**
- Traffic safety - number of killed persons per million inhabitants in road accidents in year 2014 were: **45**

Traffic safety has improved over the past 10 years. In 2016 there were 242 fatal accidents (deaths) on the roads, which is 56 % less in comparison to 519 fatal accidents in 2006. Decreasing trend of fatal accidents has been established through the implementation of several measures in various areas, from the construction of the motorway network, modernization of 1st class roads, awareness campaigns to adopting EU strategies for traffic safety. Ministry of Transport and Construction of Slovak Republic is coordinating activities listed in National road safety strategy in years 2011 – 2020 (BECEP)[55] which is based on EU road safety action plans.

Main causes of traffic accidents were lost of concentration due to using of mobile devices, speeding, wrong overtaking, wrong turning, violation on pedestrian regulations, wrong line in the lanes, etc.

Based on EURORAP data research the results as part of the SENSoR project, inspections of 1,866km were carried out, 67% of which were single carriageways and Star Ratings were produced.

A quarter of vehicle occupant Star Ratings achieved 3-star or higher.

3.7. Main weaknesses on the road network

3.7.1. Missing sections

There are 48 km of motorways under construction within main motorway D1 between the capital city of Bratislava and Košice city as part of Rhine – Danube Corridor. Last missing

[55] https://ec.europa.eu/transport/road_safety/useful-links/policy-orientation_en

section of D1 which is not under construction is the section Turany – Hubová. It´s planning is coming to an end. In May 2017 EIA and Ministry of Environment of the Slovak Republic issued an acceptance opinion for variant 2 (out of 4) which counts with two tunnels. Construction works are expected to start in 2021.

Missing sections with length of 26 km are also on motorway D3 Žilina – Čadca – Skalité/Zwardon, border with Poland which is part of Baltic – Adriatic Corridor. Three sections are under preparation and one is under construction with planned date of opening in 12/2020. Whole D3 motorway is planned to be operated in 2023 – 2026 (depends on terms of financing and results of preparation process).

Very important for the capital city of Bratislava and south-west region of Slovakia is D4 motorway and R7 expressway project which foresees the construction of the southern part of Bratislava ring road and part of the southern expressway network, linking the west and the east part of Slovakia. D4R7 project is under construction and planned opening for traffic is summer 2020.

3.7.2. Bottlenecks

There are quite a few sections of roads or areas where traffic is already close to the limit capacity. These are in particular:

There are 48 km of motorways under construction within main motorway D1 between the capital city of Bratislava and Košice city as part of Rhine – Danube Corridor. Last missing section of D1 which is not under construction is the section Turany – Hubová. It´s planning is coming to an end. In May 2017 EIA and Ministry of Environment of the Slovak Republic issued an acceptance opinion for variant 2 (out of 4) which counts with two tunnels. Construction works are expected to start in 2021.

Missing sections with length of 26 km are also on motorway D3 Žilina – Čadca – Skalité/Zwardon, border with Poland which is part of Baltic – Adriatic Corridor. Three sections are under preparation and one is under construction with planned date of opening in 12/2020. Whole D3 motorway is planned to be operated in 2023 – 2026 (depends on terms of financing and results of preparation process).

Very important for the capital city of Bratislava and south-west region of Slovakia is D4 motorway and R7 expressway project which foresees the construction of the southern part of Bratislava ring road and part of the southern expressway network, linking the west and the east part of Slovakia. D4R7 project is under construction and planned open for traffic is summer 2020.

3.7.3. Hazardous road sections

- More than 100 road crossings need improvements to increase road safety,
- 1 119 km (33 %) of state roads are rated at a high level of risk (2016)

- 141 are passively protected level crossings of roads and railways (with only traffic sign)

Dangerous places are primarily on the roads:

- (name road sections and number)
- D1 Bratislava motorway (Port bridge, road crossings Galvaniho and Gagarinova)
- D1 Trenčín – Zamarovce
- D1 Važec – Poprad
- R1 Trnavá Hora - Zvolen
- road I/51 Trnava – Senica – Holíč
- road I/61 Trenčín – Dubnica nad Váhom - Beluša
- road I/64 Nitra – Prievidza
- road I/18 Žilina – Vrútky
- road I/11 Žilina – Kysucké Nové Mesto – Čadca – Svrčinovec

3.7.4. Inadequate protection of the environment and inhabitants

Most of roads are built with adequate protection against excessive noise pollution from road traffic for the living environment. At the crossings of state roads through settlements, protection is unregulated.

As a rule, measures are taken for the controlled drainage of water from roads into the arrester through containers along motorways.

Wildlife crossings (ecoducts, green bridges) are built to allow land-based creatures to pass safely from one side of the road to another. Slovakia needs to increase effort in this area of environment protection. There are only three ecoducts in Slovakia. Last one which was completed in February 2016 is situated in location of Moravský Svätý Ján on D2 motorway Bratislava – Brno. Next green bridge is planned on D3 motorway in Svrčinovec location.

From long time perspective it is also important to focus on use of alternative fuels. Ministry of Transport and Construction of the Slovak Republic in cooperation with National Motorway Company has created the conditions for using alternative fuels by elaborating document *"The conception for placing resting areas on motorways in Slovak Republic"* which is focused also on building charging stations for electro mobiles.

3.8. Protection of the environment and inhabitants from the impact of road traffic (noise, water)

The motorway system in particular is built with many measures to protect the natural and living environment. Every constructor of new infrastructure project has obligation to submit an analysis that planned construction is environmentally friendly and impact on the environment, traffic participants and others is minimized.

Thus, most settlements along motorways and expressways are protected by active anti-noise protection measures. Especially on old motorways anti-noise measures are being constructed on sections where they were not built at the time of construction. On national roads, these measures are less frequent. Particularly where roads are passing towns and smaller settlements inhabitants are not protected against excessive noise.

In order to effectively manage and eliminate the noise of road traffic there have been elaborated strategic noise maps which evaluate noise situation and noise limits around agglomeration, motorways, express roads and chosen 1st class roads. These maps are updated every five years.

3.9. Links with neighbouring countries

Slovak motorway system is well connected with neighbouring countries the Czech Republic and Austria. Unfinished connections are with Poland, Ukraine and Hungary. Missing links with Poland within D3 Žilina – Kysucké Nové Mesto – Čadca in length of 26 km are under construction or under preparation. Connection with Hungary is strengthening by new R7 project Bratislava – Dunajská Lužná – Holice in length of 32 km. Motorway connection between Košice city and Ukraine state border in length of 74 km is under EIA process.

3.10. Systems for informing users of individual transport systems

3.10.1. Notification by category of roads

Based on the public authorization, traffic information on the state roads is entrusted to:

- NDS (National Motorway Company) for motorways and expressways (https://www.ndsas.sk/en).
- SSC (Slovak road administration) for 1st class roads. (http://www.ssc.sk/en/about-us.ssc http://www.cdb.sk/sk/dopravne-informacie-rds-tmc/Vysielanie-RDS-TMC.alej http://www.zjazdnost.sk/map/view.html.)

Municipalities are responsible for informing about the situation on local/municipality roads.

3.10.2. Ways of informing

The traffic information center for state roads, on behalf of two state road operators in the Slovak Republic (NDS which operates motorways and expressways and SSC which operates 1st class roads), collects information of conditions on the state roads (such as accidents or winter conditions) and daily traffic (such as road work sites or congestions). This information is transmitted to the public media and users of the national road network.

From 10.1.2017 new web portal odoprave.info[56] provides overall information about all traffic related services and the current traffic situation in Slovakia. The ordinary users and experts are informed about the general traffic situation, but mainly about traffic restrictions, traffic accidents and current traffic conditions on the roads. The contributors can report traffic events directly to the portal. All reported traffic events are processed by NDIC operator.

4. Investing spending and maintenance expenditures

4.1. Gross investment spending in road infrastructure

In 2015, **1.133,8 mio EUR** were invested in the national road network

4.2. Maintenance expenditures in road infrastructure

In 2015, **201,00 mio EUR** were used for the maintenance of state roads.

5. The objectives of the transport policy and the future development of the road network

5.1. The goals of the transport policy

The vision of transport policy is defined as ensuring the sustainable mobility of the population and supplying the economy with the following objectives:

- improve mobility and accessibility,
- improve supply of the economy,
- improve road safety and security,
- reduce energy consumption,
- reduce user and operator costs,
- reduce environmental burdens.

Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

5.2. The main priorities of road development

General measures are in areas such as:

[56] https://odoprave.info/wps/portal/pub/Home/dopravna-situacia

- ensuring an adequate standard of existing road infrastructure, including road rehabilitation,
- traffic safety,
- protection of the natural and living environment from the impact of road transport,
- improving accessibility to regional center,
- preparedness for extreme weather events and
- road measures in individual parts of the country

The following major projects are planned on the road network:

- construction of missing links of D1:
  Hričovské Podhradie - Lietavská Lúčka (11.3 km, to be open for traffic in 10/2018)
  Lietavská Lúčka – Višňové – Dubná Skala (13.5 km, to be open for traffic in 12/2019)
  Hubová – Ivachnová (15.3 km, to be open for traffic in 12/2021)
  Prešov, west – Prešov, south (7.87 km, to be open for traffic in 6/2021)
- motorway bypass of Košice city
  D1 Budimír – Bidovce (14.4 km, to be open for traffic in 12/2019)
- construction of missing links of D3:
  Čadca, Bukov – Svrčinovec (5.67 km, to be open for traffic in 12/2020)
  Žilina, Brodno – Kysucké Nové Mesto (under planning)
  Kysucké Nové Mesto – Oščadnica (under planning)
  Oščadnica – Čadca, Bukov (under planning)
- construction of D4, the Bratislava motorway ring (27 km, to be open for traffic in 6/2020)
- construction of motorway R7 Bratislava – Dunajská Lužná – Holice (32 km, to be open for traffic in 12/2019)
- extension of D1 Bratislava – Senec – Trnava from four lanes to six lanes

6. Road management

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

In Slovakia Road Databank, department of Slovak Road Administration, is responsible for monitoring of the condition of the carriageway and the preparation of reconstruction plans. Pavement diagnostics is realized by special equipment technologically suitable for particular purpose supported by software tools especially developed for Information System of Road Network Model.

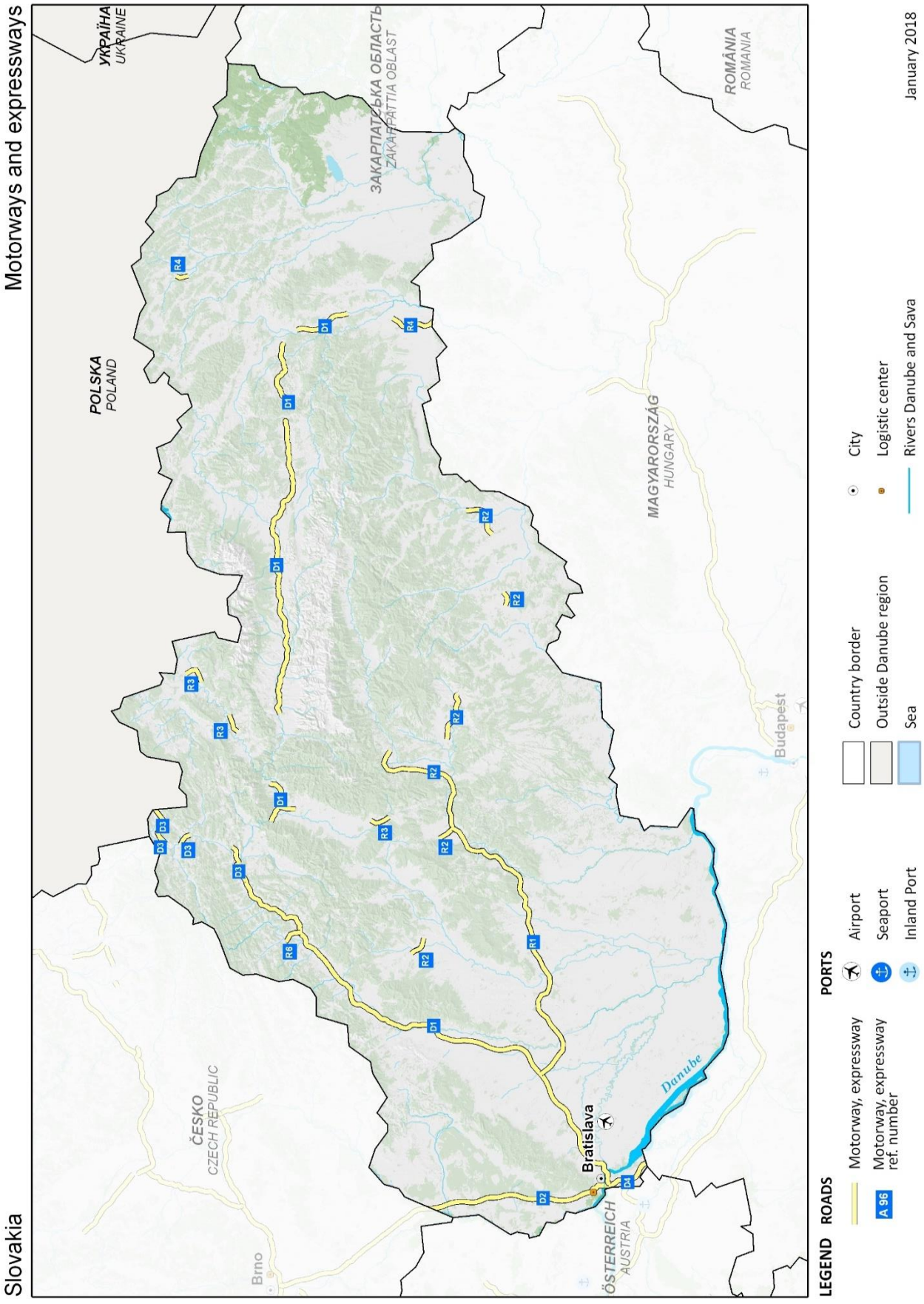

Figure 46: Motorway map of Slovakia; Source: SLOMAN d.o.o.

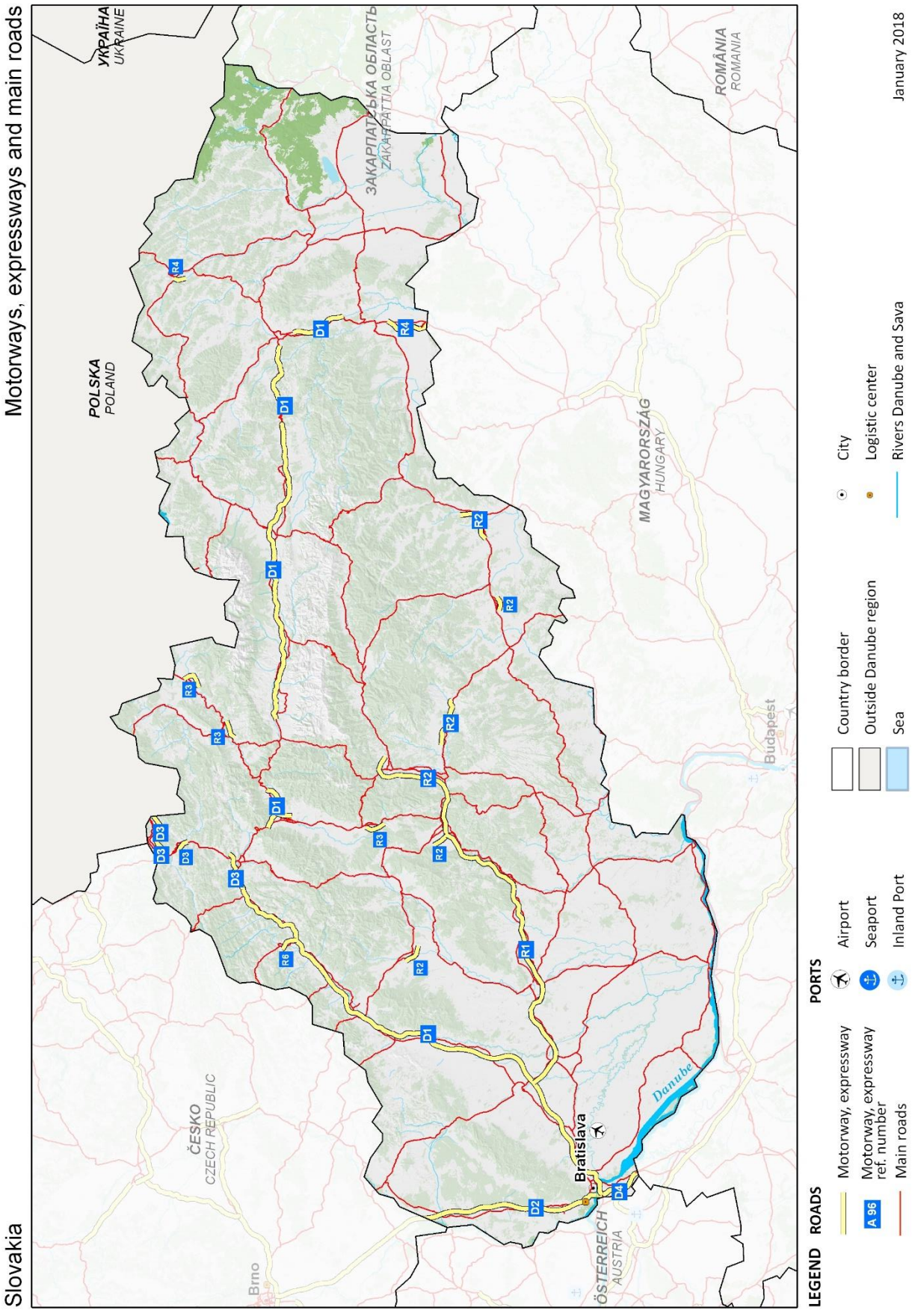

Figure 47: Motorway and main road map of Slovakia

4.2.6 Danube Region roads: SLOVENIA

1. General data[57]

- Inhabitants / 2016: **2.064.188**
- membership in the EU: **1.5.2004**
- GDP / 2016 in EUR million: **39.769,1**
- GDP per capita / 2016 in EUR: **19.266**
- capital city: **Ljubljana**
- land area - km²: **20.273**
- km of roads per million inhabitants: **18.787**
- km of roads per km² of the land area: **1,91**
- km of motorways per million inhabitants: **299**
- km of motorways per km² of the land area: **0,030**

2. Description of the road network[58]

- length of motorways (2014) – km: **618**
- length of main or national roads (2014) – km: **807**
- length of secondary or regional roads (2014) – km: **5.112**
- length of other roads (2014) – km: **32.242**
- total lengths of all roads – km: 2014): **38.779**
- length of national roads without anti-dust protection (2016) – km: **293**

3. Main features of the road network

3.1.1 General traffic estimates:

Traffic loads are large and concentrated in the area of the capital city of Ljubljana and in the direction of the transit corridor northeast – southwest (Koper/border with IT – Ljubljana – Maribor – border with AT/border with HU). Traffic is both domestic and transit. Personal transit traffic is greatly increased during the summer tourist season. Transit traffic through Slovenia is greatly increased during the summer tourist season. For Slovenia personal transit traffic represents 7%, while freight transport in transit represents 3%.

3.1.2. Average annual daily traffic (AADT)[59]

- Average annual daily traffic (AADT) on all state roads (2015): **5.574**
- Average annual daily traffic (AADT) on motorways (2017): **33.834**
- Average annual daily traffic (AADT) on main or national roads (2015): **7.532**
- Average annual daily traffic (AADT) on secondary or regional roads (201): **2.375**

[57] Official website of the European Union
[58] DRSI 2016
[59] DRSI 2015

3.2 International road corridors:

- TEN-T Core Corridors:
    - ***Baltic – Adriatic Corridor****: Gdansk – Ravenna – Warsaw – Bratislava – Vienna - Ljubljana - Koper, Trieste, Venice - Ravenna*
    - ***Mediterranean Corridor****: Barcelona – Torino - Ljubljana – Zagreb – Budapest – Kiev, including indicative extension to Sarajevo and Belgrade*

- Apart of TEN-T core corridors sections, other Slovenian motorways are part of the TEN-T comprehensive network:
    - *Already constructed: Ljubljana - Jesenice – border with AT (direction Salzburg)*
    - *Under construction: Maribor - Ptuj – Gruškovje/ border with CRO (direction Zagreb).*
    - *Planned new motorway: Postojna – Jelšane (border with CRO; direction Rijeka)*

3.3 Toll system

Motorways and expressways users must pay a toll:

- Use of annual, monthly or weekly (7 days) vignette is mandatory for all Personal vehicles. Vignette tolling system is intended for vehicles with the maximum permissible weight up to 3.500 kg, regardless of the maximum weight of the trailer.
- The trucks (vehicles with the maximum permissible weight over 3.5 tones) pay a toll with manual collection or toll collection system without stopping at toll stations. The system is a combination of an open and closed toll system. From 1 January 2018, the toll collection for trucks will be a microwave toll collection system without stopping.

3.4 Condition of road surfaces and structures[60]

Conditions of roads and structures on the roads are on the basis of regular monitoring is as following:

- Condition of pavement structures on motorways and express roads in 2016:
    - good 44 %
    - marginal 24 %
    - poor 32 %

- Condition of pavement structures on national roads in 2016:
    - good 30 %
    - marginal 10%
    - poor 60%

[60] DRSI 2016

- Condition of road structures on national roads in 2016:
    - good 21%
    - marginal 36%
    - poor 43%.

3.5 Speed Limits

- speed limits on motorways: **130/100 km/h**
- speed limits on other national roads: **50/90 km/h**

3.6 Traffic safety[61]

- Traffic safety - number of killed persons in road accidents in year 2014 were: **108**
- Traffic safety - number of killed persons per million inhabitants in road accidents in year 2014 were: **52**

There were 58,14 % less fatal accidents (deaths) on the roads between 2005 and 2014.

Based on EURORAP data research, Slovenia's high quality motorway network, financed by vignette, is among the most modern in Europe. The motorway death and serious injury rate on the 770km of Slovenian motorways is about 7 times lower than on other main and regional roads.

As part of the SENSoR project, inspections of 3,537km were carried out, 78% of which were single carriageways and Star Ratings were produced.

Just under half of vehicle occupant Star Ratings achieved 3-star or higher.

Traffic safety is gradually improving. In the last ten years, the number of road fatalities has almost halved. Significant improvements occurred through the introduction of related measures in various areas, from the construction of the motorway network and the introduction of vignette tolls, to changes in legislation on rules that considerably more rigorously deal with infringements due to non-compliance with speed limits, driving under the influence of alcohol, illicit drugs or psychoactive substances. Important are also road safety measures introduced at the level of municipalities and the influence of the media and non-governmental organizations.

The reasons of traffic accidents were variety, for example, traffic participants, road infrastructure, vehicles and the like.

[61] DRSI 2014

3.7 Main weaknesses on the road network

3.7.1 Missing sections

On the main motorway system, the last section between Ptuj (Hajdina) and Gruškovje/border with CRO (direction Zagreb) is under construction, as part of the Pyhrn motorway. It is to be opened for traffic in 2018.

The so called "3rd development axis" between Holmec (Austrian border) – Dravograd / Slovenj Gradec – Velenje - Celje - Novo mesto – Metlika / Črnomelj - Vinica (border with the Republic of Croatia) is under preparation. On several sections design documents are in preparation, while works are expected in 2019 or later.

Several bypasses to avoid built-up areas, towns or villages are missing as well, for example around tourist town of Bled, the northern bypass of town Škofja Loka, etc.

There is still lack of progress in relation to planning of new "3.a development axis" which runs from Ljubljana - Kočevje - border with the Republic of Croatia and on the 4th development axis Jeprca (near Ljubljana) - Škofja Loka - Tolmin - Kobarid - border with the Republic of Italy.

There are some missing connections of roads to the motorways.

Some of the bypass settlements are planned.

A construction of a new main road Hrastnik - Zidani most near the Sava River is also being planned.

3.8.2. Bottlenecks

There are quite a few sections of roads or areas where traffic is already close to the limit of traffic capacity. These are in particular:

- Ljubljana motorway ring and main roads entering the city Ljubljana
- the missing section of Pyhrn motorway between Maribor and border with Croatia (section Draženci – Gruškovje)
- western part of Maribor
- tourist road Koper – Dragonja
- an important economic road Velenje - Arja vas
- The area of Kranj
- The area of Novo mesto
- The area of Murska Sobota
- The area Ptuj and
- motorway Postojna - Pivka - Jelšane (border with the Republic of Croatia)

3.8.3. Hazardous sections

There are still too many dangerous points on Slovenian road network.

- More than 100 crossings from the point of view of safety are arranged inappropriate
- 655 km (15 %) of state roads rated at a high level of risk
- 490 passively protected level crossings of roads and railways (only traffic sign)

Dangerous places are primarily on the roads:

- Postojna – Jelšane/border with CRO (direction towards Rijeka; Adriatic Sea)
- Arja vas (near Celje) – Velenje (northern part of 3rd Development Axis),
- Novo mesto – Metlika (southern part of 3rd development axis),
- Logatec - Idrija - Tolmin – Kobarid and
- Ljubljana – Kočevje (part of 3.a development axis).

3.8.4. Inadequate protection of the environment and inhabitants

Most of roads are built with adequate protection against excessive noise pollution from road traffic for the living environment. At the crossings of state roads through settlements, protection is unregulated.

As a rule, measures are taken for the controlled drainage of water from roads into the arrester through containers along motorways.

Wildlife crossings (ecoducts, green bridges) are built to allow land-based creatures to pass safely from one side of the road to another. On several motorway sections underpass tunnels (mainly for large animals) and tunnels and culverts (for amphibian and small mammals such as otters and hedgehogs) are also included.

3.9. Links with neighbouring countries

Slovenian motorway system is well connected with neighbouring countries Italy, Austria, Hungary and Croatia. There are only missing links with Croatia, such as Postojna - Rijeka and Koper - Dragonja. The future third development axis in the north will enable connection to Austria via Dravograd or Holmec towards Klagenfurt and in the south via Metlika to Karlovac.

3.10. Protection of the environment and inhabitants from the impact of road traffic (noise, water)

The motorway system was built with many measures to protect the natural and living environment. The routes were chosen so that they were as nicely integrated into the environment and secured against the disturbance of traffic effects. Much attention was given to the design of objects, tunnel portals, etc.

Thus, most settlements along motorways and expressways are protected by active anti-noise protection measures. Especially on old motorways anti-noise measures are being

constructed on sections where they were not built at the time of construction. As a rule, active anti-noise measures have been built.

On national roads, these measures are less frequent. Particularly in the course of the settlements, the inhabitants at these roads are not protected against excessive noise.

Noise monitoring for sections of main and regional roads, where the traffic density in 2011 exceeded 3 million vehicles (178 sections of roads with a total length of 637 km were considered) was carried out. The results showed that the most traffic loaded roads most often run through settlements and larger settlements. Road sections with the most overburdened inhabitants take place in the settlements of Maribor, Ljubljana, Velenje, Jesenice and Piran.

Municipalities in which overwhelming majority of citizens are on the national roads are Maribor (7,697), Ljubljana (6,587), Velenje (4,494), Jesenice (5,858) and Celje (2,569). In the territory of Slovenia, the population is the most heavily burdened by national roads in the evening between 18 and 22 hours. In the past, a number of overburdened buildings have already been implemented noise protection measures. Passive noise protection has generally been carried out (active noise protection in most cases proves to be unjustified, due to a large financial contribution and low effectiveness-PHO shutdown due to driveway).

Noise measures on existing roads are carried out in accordance with the adopted operational program, which includes rehabilitation of the most burdened buildings in the territory of Slovenia.

On the motorways, as a rule, measures are taken for the controlled drainage of water from roadways into the water drain, through containers. In general, motorways have been planned in the last decades with a lot of attention to the natural and living environment. The routes were chosen in such a way that they were as nicely integrated into the environment and protected against the disturbing effects of traffic. Much attention was given to the design of structures, tunnel portals, etc.

3.11. Systems for informing users of individual transport systems

3.11.1 Notification by category of roads

Based on the public authorization, traffic information on the state roads is entrusted to:

- DRSI (Slovenian Infrastructure agency) for certain motorways and main and regional road
- DARS (Motorway Company in the Republic of Slovenia) for motorways.

Municipalities are responsible for informing about the situation on local/municipality roads.

3.11.2. Ways of informing

The traffic information center for state roads, on behalf of the two state road operators in the Republic of Slovenia (DRSI, which manages some expressways, main and regional roads, and DARS d.d., which operates motorways and four-lane expressways) collects information of conditions on the state roads (such as accidents or winter conditions) and daily traffic (such as road work sites or congestions). This information is transmitted to the public media and users of the national road network.

3.12. Responsibility and operators

- responsible for information on traffic on motorways: **Motorway Company in the Republic of Slovenia d.d. (DARS d.d.)**
- responsible for information on traffic on state roads: **Slovenian Infrastructure Agency** (**DRSI)**
- responsible for information on traffic on other roads: **municipalities**

4. Investing spending and maintenance expenditures[62]

4.1. Gross investment spending in road infrastructure

In 2013, **104 mio EUR** were invested in national roads.

4.2. Maintenance expenditures in road infrastructure

In 2013, **123 mio EUR** were used for the maintenance of state roads.

5. The objectives of the transport policy and the future development of the road network

5.1. The goals of the transport policy

The vision of transport policy is defined as ensuring the sustainable mobility of the population and supplying the economy with the following objectives:

- improve mobility and accessibility,
- improve supply of the economy,
- improve road safety and security,
- reduce energy consumption,
- reduce user and operator costs,
- reduce environmental burdens.

[62] DRSI 2016

Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

5.2. The main priorities of road development

General measures are in areas such as:

- ensuring an adequate standard of existing road infrastructure, including road rehabilitation,
- traffic safety,
- protection of the natural and living environment from the impact of road transport,
- improving accessibility to regional centers,
- preparedness for extreme weather events and
- road measures in individual parts of the country

The following major projects are planned on the road network:

- construction of the Pyhrn motorway in Slovenia between Maribor and Gruškovje/ border with Croatia (the last section Draženci – Gruškovje, 14 km, to be open for traffic in 2020)
- upgrading of the second tube of the Karavanke tunnel (under planning)
- Construction of the 3. development axis border with the Republic of Austria - Dravograd - Velenje - Celje - Novo mesto - Metlika - border with the Republic of Croatia - (under planning)
- Extension of the Ljubljana motorway ring with connecting directions in six-carriageway (under planning)
- Construction motorway between Postojna to border with the Republic of Croatia - direction Rijeka - (under planning).

6. Road management

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

In Slovenia, a computer-aided system (e.g. DTIMS_CT or PMS (Pavement Management System)) was introduced on the motorways and also on other state roads. It enables continuous monitoring of the conditions of the carriageways and the preparation of reconstruction plans. Plans are made on the basis of mathematical models which are based on collapse curves of the carriageway. Such systems provide efficient infrastructure management and long-term financial sustainability

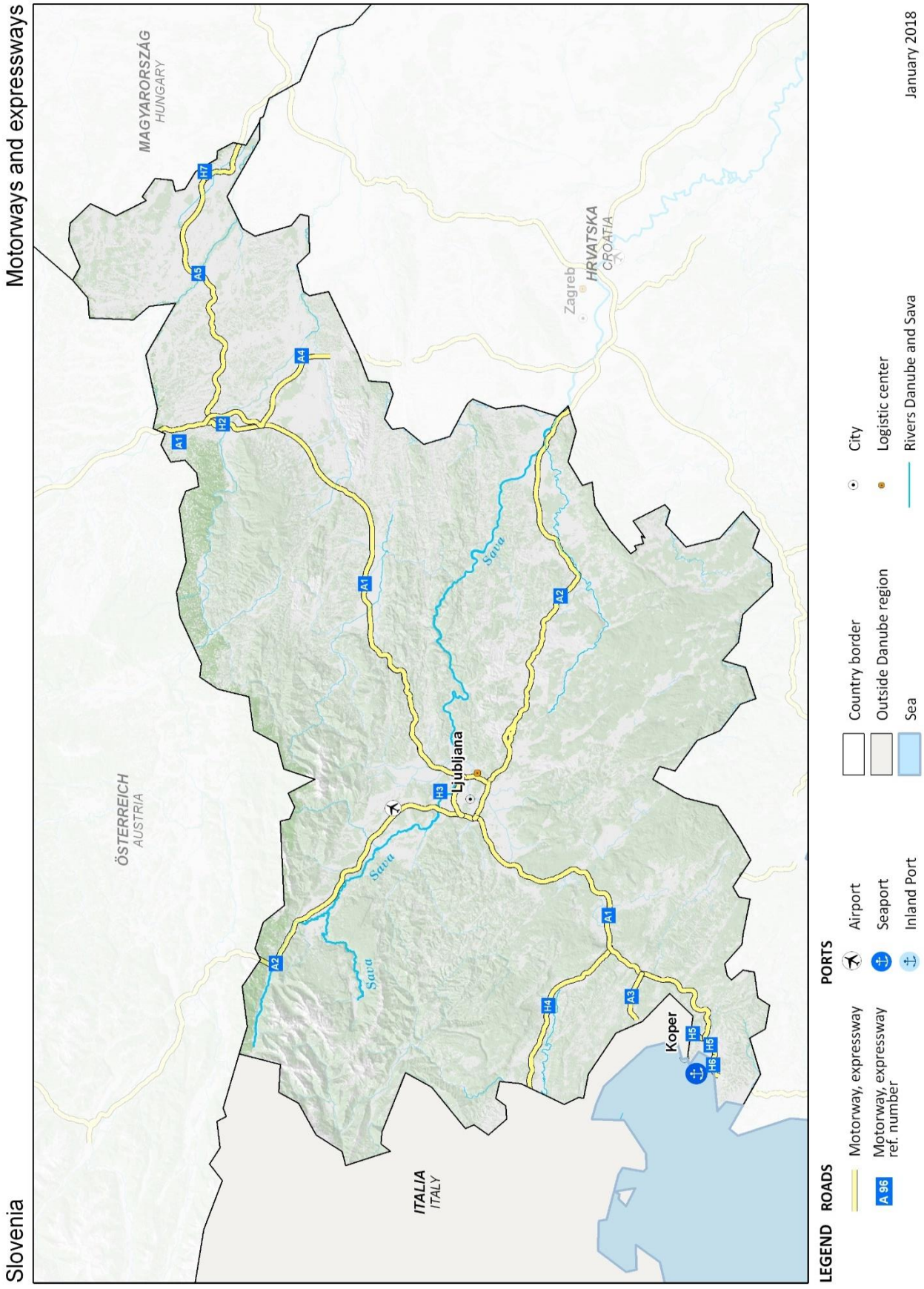

Figure 48: Motorway map of Slovenia

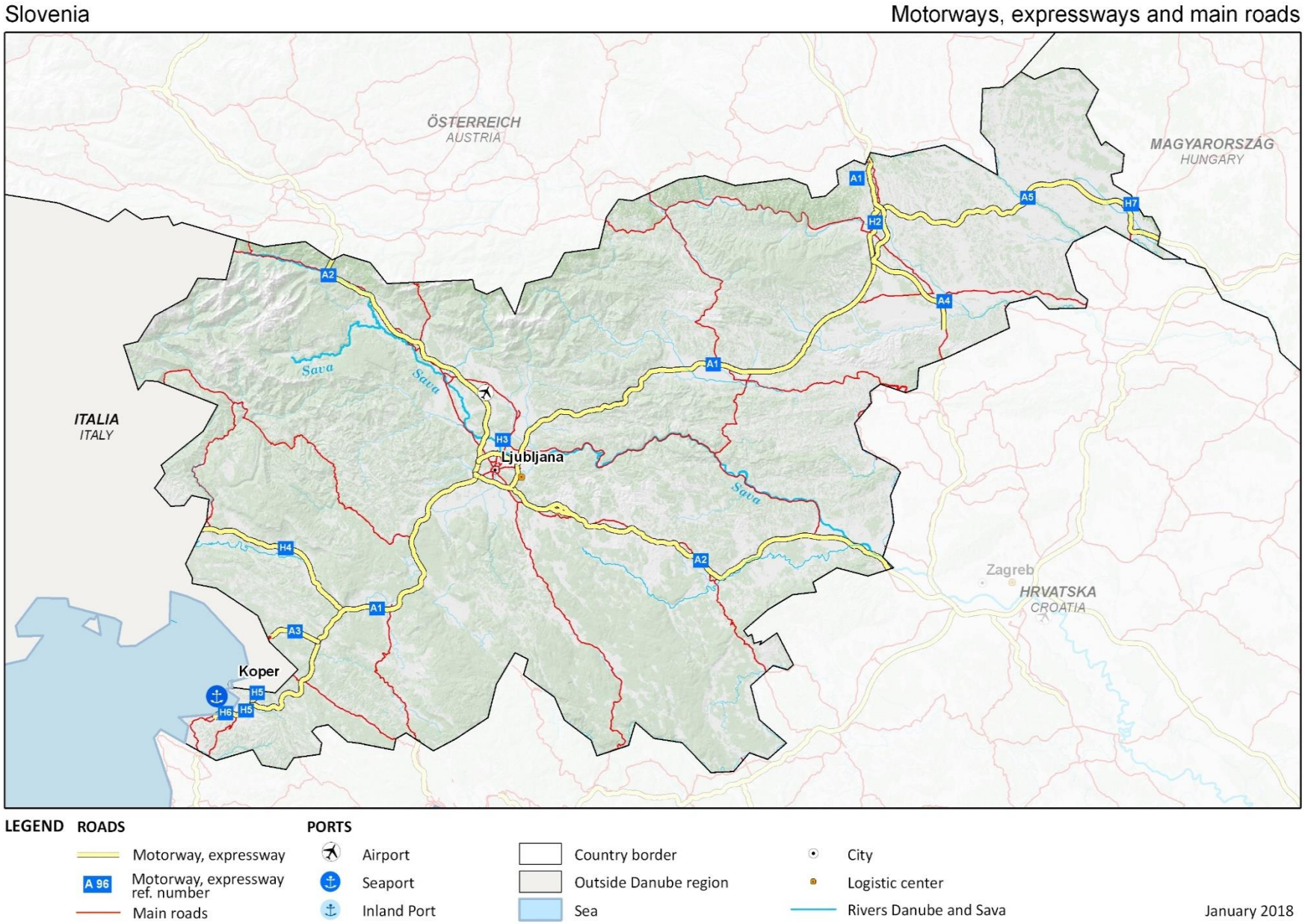

Figure 49: Motorway and main road map of Slovenia

4.2.7 Danube Region roads: CROATIA

1. General data[6364]

- Inhabitants / 2016: **4.285.000**
- membership in the EU: **1.7.2013**
- GDP / 2016 in EUR million: **45.818,7**
- GDP per capita / 2016 in EUR: **10.693**
- capital city: **Zagreb**
- land area - km²: **56.594**
- km of roads per million inhabitants: **6.269**
- km of roads per km² of the land area: **0,47**
- km of motorways per million inhabitants: **331**
- km of motorways per km² of the land area: **0,025**

2. Description of the road network[65]

- length of motorways – km: **1.417**
- length of main or national roads – km: **6.914**
- length of secondary or regional roads – km: **9.595**
- length of other roads – km: **8.939**
- total lengths of all roads – km: **26.845**

3. Main features of the road network

3.1. Traffic

3.1.1. General traffic estimates:

Traffic loads are large and concentrated in the area of large cities like Zagreb, Rijeka and Split and in the direction of the transit corridors west – east, southwest – northeast and north – southeast (along the coast). Traffic is both domestic and international. Personal traffic is greatly increased during the summer tourist season.

As for the summer traffic, the share of freight in total summer traffic amounts to 9,78%, while personal transport (light vehicles) amounts to 90,22%. The share of freight traffic in total traffic on the annual basis is 14,17%, and the personal vehicle is 85,83%.

[63] Official website of the European Union
[64] DZS RH
[65] MMPI RH

3.1.2. Average annual daily traffic AADT[66]

- Average annual daily traffic (AADT) on all state roads 2016: **8.095**
- Average annual daily traffic (AADT) on motorways 2016: **12.488**
- Average annual daily traffic (AADT) on main or national roads 2016: **3.702**

3.2. International road corridors:

- TEN-T corridors:
    - ***Mediterranean Corridor****: Barcelona – Torino - Ljubljana – Zagreb – Budapest - Kiev – Sarajevo – Beograd.*

- Other main international roads:
    - TEN-T Core Network - motorways A1, A3, A4 and A6
    - TEN-T Comprehensive Network - motorways A2, A5, A7, A8 and A10

3.3. Toll system

The toll collection system on motorways and expressways is with the use of toll gates.

3.4. Condition of road surfaces and structures

Condition of roads and road structures is as following:

- Condition of pavement structures on motorways and express roads in 2017 is:
    - good 62%
    - marginal 16%
    - poor 22%

- Condition of pavement structures on national roads in 2016 is:
    - Good 52,8 %
    - marginal 21,1 %
    - poor 26,1 %

- Condition of road structures on motorways and express roads in 2017 is:
    - good 81%
    - marginal 16%
    - poor 3%

- Condition of road structures on national roads in 2016 is:
    - good 37,3 %
    - marginal 33,3 %
    - poor 29,4 %.

[66] Traffic counting on the roadways of Croatia in 2016

3.5. Speed limit

- speed limits on motorways: **130 km/h**
- speed limits on other national roads: **50/90/110 km/h**

3.6. Traffic safety[67]

- Traffic safety - number of killed persons in road accidents in year 2014 were: **306**
- Traffic safety - number of killed persons per million inhabitants in road accidents in year 2014 were**: 71**

Traffic safety has improved over the past 10 years. In 2017 there were 46,7 % less fatal accidents (deaths) on the roads in comparison to 2006.

Main causes of traffic accidents were losing control over the steering wheel, unpredictable road hazards, delayed detection of danger, speeding, alcohol and poor infrastructure.

As part of the SENSoR project, inspections of 346km were carried out, 61% of which were single carriageways and Star Ratings were produced.

57% of vehicle occupant Star Ratings achieved 3-star or higher.

3.7. Protection of the environment and inhabitants from the impact of road traffic (noise, water)

The motorway system in particular is built with many measures to protect the natural and living environment. Thus, most settlements along motorways and expressways are protected by active anti-noise protection measures. Especially on old motorways anti-noise measures are being constructed on sections where they were not built at the time of construction. On national roads, these measures are less frequent. Particularly where roads are passing towns and smaller settlements inhabitants are not protected against excessive noise.

3.8. Main weaknesses on the road network

3.8.1. Missing sections

On motorway network main missing links are:

- motorway A5, Hungarian border - Osijek section, l=29,6 km - part of the international Pan-European road corridor Vc and the comprehensive TEN-T network. At the moment, under construction is Osijek - Drava Bridge subsection and preparation for

[67] Road Statistics Yearbook 2016

construction of Drava Bridge - Beli Manastir subsection. Only missing part after 2020 shall be Hungarian border - Beli Manastir section, l=5,0 km.

- motorway A7 Križišće - Žuta Lokva section, l=56,5 km - part of Adriatic-Ionian motorway and the comprehensive TEN-T network

3.8.2. Bottlenecks

There are quite a few sections of roads or areas where traffic is already close to the limit capacity. These are in particular:

- New Zagreb Bypass, l=101,0 km - existing Zagreb Bypass is constructed in motorway profile but it is out of toll system. Zagreb as the largest intersection of international traffic corridors represents the most loaded point in transit traffic. All traffic with 5 motorway routes (motorways A2, A3, A4, A6, A11) from which 4 compete with international road corridors passes through toll stations and city traffic road system. The construction of the New Bypass would ensure:
    - separation of transit from urban traffic,
    - unrestricted transit traffic in the tolling system without waiting at toll stations
    - traffic forecast is around 25.000 AADT on New Zagreb Bypass

3.8.3. Hazardous road sections

- More than 17 road crossings need improvements to increase road safety,
- 364 / 2152 km (16,9 %) of state roads are rated at a high level of risk (2016)[68]
- 14 are passively protected level crossings of roads and railways (with only traffic sign)

STATE ROAD	BLACK SPOT	GPS Location
DC 1	Rakov Potok	45.738602, 15.797670 & 45.733727, 15.789194
DC 102	Malinska	
DC 106	Zrče	44.53806, 14.90684
DC 27	Raskrižje DC 27-DC 59	43.86754, 15.73714
DC 3	Varaždin	46.31339, 16.34947
DC 3	Dubravci	45.45361, 15.44162
DC 36	Odra	45.49861, 16.35055
DC 38	Dervišaga Kuzmica	45.32886, 17.74482
DC 410	Split, B. Bušića	2 km + 100 m
DC 410	Split, Spinčićeva	43.50521, 16.45633
DC 45	Garešnica	45.57837, 16.94041
DC 46	Ivankovo,Ulica Bošnjaci 180-190	45.29476, 18.69965

[68] we have not done network safety management (NSM) during 2016 and therefore we do not have full required data for the whole state road network (7.100km), the data provided in the brackets are gathered on 2.152 km of main state roads (D1, D2, D3, D4, D5, D6, D7, D8, D9, D23, D200, D212, D410 and D420) where EuroRAP RRM has been done

DC 5	Filipovac	45.42693, 17.18334
DC 51	Baćin Dol	45.31299, 17.43635
DC 55	GP Županja	
DC 55	Vinkovci, Boškovićeva	45.28131, 18.80969
DC 6	Brajakovo Brdo	45.51124, 15.42905
DC 8	Rijeka, raskrižje DC8-DC 304	45.33869 , 14.40311
DC 8	Bakar	45.29973, 14.555646
DC 8	Rijeka 1	45.3365, 14.41558
DC 8	Rijeka, Krešimirova	45.3288, 14.43561
DC 8	Jasenova	45.13849, 14.75442
DC 8	Rijeka, raskrižje J. P. Kamova i DC 8	45.31414, 14.4736
DC 8	Jadranovo-Klanfari	
DC 8	Vodice, Šibenik	43.76125, 15.78469
DC 8	Zadar,raskrižje DC 8-DC 422	44.09606, 15.27245

Figure 50: Locations of primarily dangerous places

3.8.4. Inadequate protection of the environment and inhabitants

Most of roads are built with adequate protection against excessive noise pollution from road traffic for the living environment. At the crossings of state roads through settlements, protection is unregulated.

As a rule, measures are taken for the controlled drainage of water from roads into the arrester through containers along motorways.

Wildlife crossings (ecoducts, green bridges) are built to allow land-based creatures to pass safely from one side of the road to another. On several motorway sections underpass tunnels (mainly for large animals) and tunnels and culverts (for amphibian and small mammals such as otters and hedgehogs) are also included.

3.9. Links with neighbouring countries

Croatian motorway system is mainly well connected with neighbouring countries Slovenia, Hungary, Serbia, Bosnia and Herzegovina. For completion of motorway links to neighbouring it is necessary to build next sections:

- interstate Svilaj Bridge on motorway A5 (connection to motorway in Bosnia and Herzegovina) - bridge is under construction, completion is planned in 2019
- Hungarian border - Beli Manastir section on motorway A5 - adjustment of technical elements of motorways in Croatia and Hungary is in progress, construction start is planned in the beginning of 2021
- Umag - Slovenian border section on motorway A9 - missing link between constructed motorway A9 in Croatia near Umag with motorway in Slovenia via Koper

3.10. Systems for informing users of individual transport systems

3.10.1. Notification by category of roads

Based on the public authorization traffic information on the state roads, notification is entrusted to:

- Croatian Automobile Club (HAK) for motorways and expressways (and main roads on regional level).

Municipalities are responsible for informing about the situation on local/municipality roads.

3.10.2. Ways of informing

The Croatian motorways provide regular and extraordinary information on traffic conditions to the Croatian Automobile Club (HAK), which informs the public of all regular and exceptional events on the motorways via HR 2.

4. Investing spending and maintenance expenditures

4.1. Gross investment spending in road infrastructure

In 2017, **149,3 mio EUR** were invested in national roads.

4.2. Maintenance expenditures in road infrastructure

In 2017, **86,2** mio EUR were used for the maintenance of state roads

5. The objectives of the transport policy and the future development of the road network

5.1. The goals of the transport policy

The vision of transport policy is defined as ensuring the sustainable mobility of the population and supplying the economy with the following objectives:

- improve mobility and accessibility,
- improve supply of the economy,
- improve road safety and security,
- reduce energy consumption,
- reduce user and operator costs,
- reduce environmental burdens.

Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

5.2. The main priorities of road development

General measures in areas such as:

- ensuring an adequate standard of existing road infrastructure, including road rehabilitation,
- traffic safety,
- protection of the natural and living environment from the impact of road transport,
- improving accessibility to regional centers,
- preparedness for extreme weather events and
- road measures in individual parts of the country

The following major projects are planned on the road network:

- construction of missing link on motorway A5, Hungarian border - Drava Bridge section
- improvement of energy efficiency in road and tunnel lighting by implementing LED technology
- rehabilitation of road service facilities in order to provide a high level of service to users
- harmonization of tunnels on motorways A1 and A4 with Directive 2004/54/EC
- construction of noise protection barriers on old sections of motorway
- harmonization of security fences on motorways with regulation

6. Road management

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.
In Croatia a computer-aided system (e.g. DTIMS_CT or PMS (Pavement Management System)) was introduced on the motorways and also on other state roads. It enables continuous monitoring of the condition of the carriageway and the preparation of reconstruction plans. Plans are made on the basis of mathematical models which are based on collapse curves of the carriageway. Such systems provide efficient infrastructure management and long-term financial sustainability

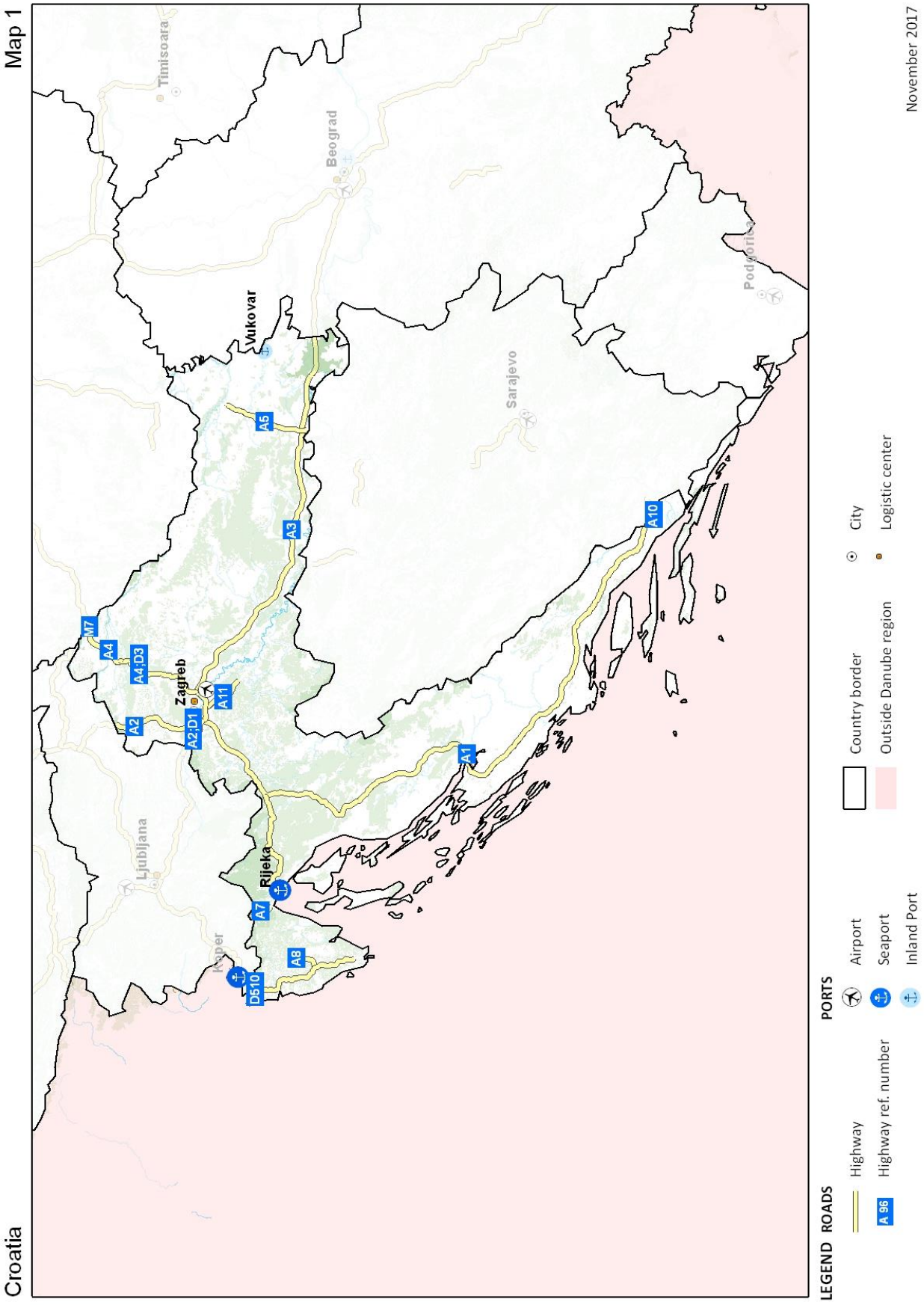

Figure 51: Motorway map of Croatia

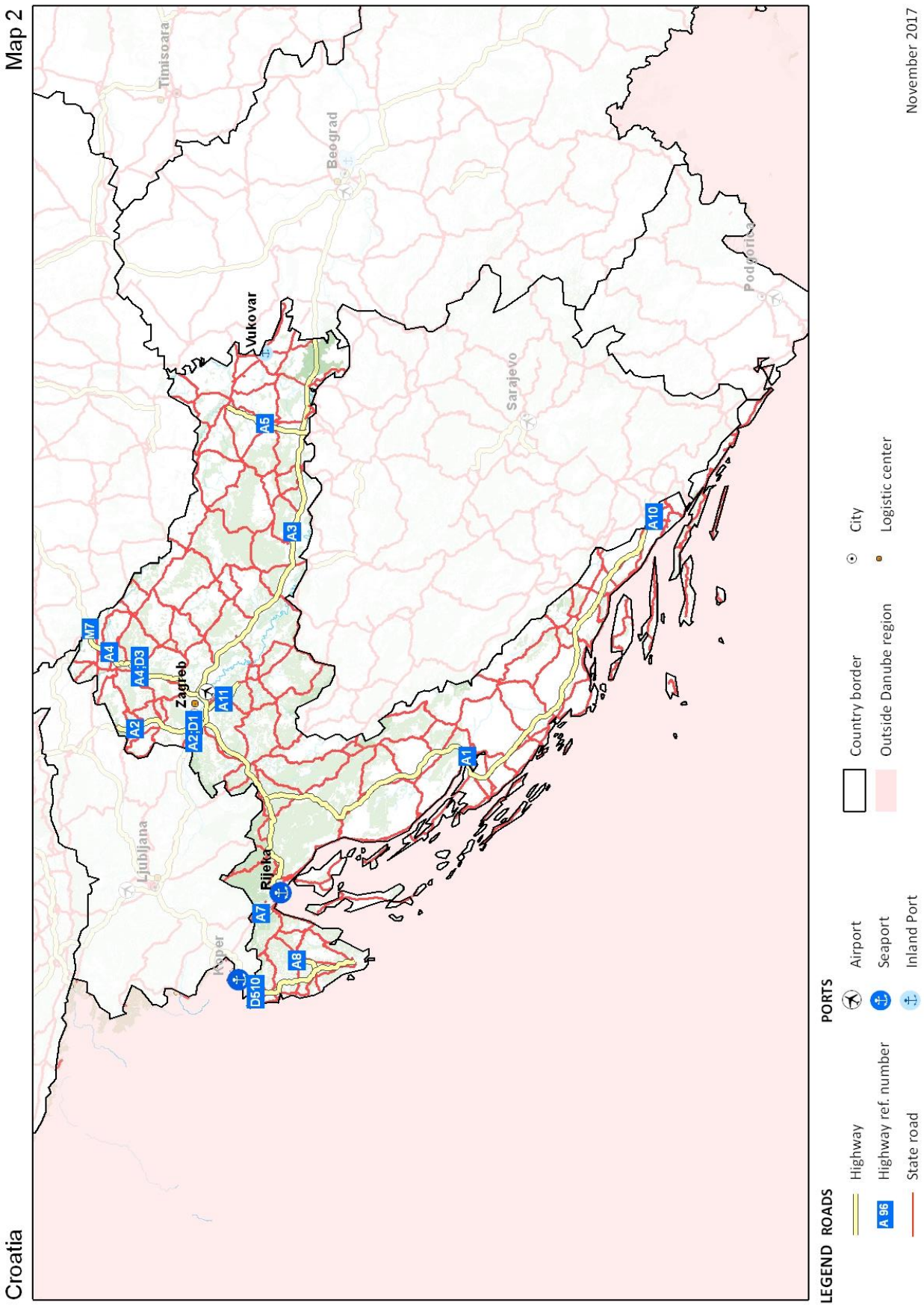

Figure 52: Motorway and main road map of Croatia

4.2.8 Danube Region roads: HUNGARY

1. General data[69]

- Inhabitants / 2016: **9.830.485**
- membership in the EU: **1.5.2004**
- GDP / 2016 in EUR million: **112.398,7**
- GDP per capita / 2016 in EUR: **11.434**
- capital city: **Budapest**
- land area - km²: **93.011**
- km of roads per million inhabitants: **20.681**
- km of roads per km² of the land area: **2,19**
- km of motorways per million inhabitants: **180**
- km of motorways per km² of the land area: **0,019**

2. Description of the road network[70]

- length of motorways (2013) – km: **1.767**
- length of main or national roads (2013) – km: **6.824**
- length of secondary or regional roads (2013) – km: **23.169**
- length of other roads (2013) – km: **171.549**
- total lengths of all roads (2013) – km: **203.309**

3. Main features of the road network

3.1.1 General traffic estimates:

Traffic loads are large and concentrated in the area of capital city Budapest and in the direction of the transit corridor northwest – southeast (Hegyeshalom/border with AT – Budapest – Nagylak/border with RO and Röszke/Border with SRB) and southwest - northeast (Tornyiszentmiklós/border with SLO and Letenye/border with CRO – Budapest – border with UA. Traffic is both domestic and transit. Personal traffic is greatly increased during summer tourist season (between Budapest and Lake Balaton). International freight transport equals to 21 % in volume (tones).

3.1.2. Average annual daily traffic (AADT)[71]

- Average annual daily traffic (AADT) on all state roads: **4.216**
- Average annual daily traffic (AADT) on motorways: **32.312**
- Average annual daily traffic (AADT) on main or national roads: **6.104-9.165**
- Average annual daily traffic (AADT) on secondary or regional roads: **1.595**

[69] Official website of the European Union
[70] Eurostat, IRF 2013
[71] Magyar Közút Nonprofit Zrt.

3.2. International road corridors:

- TEN-T corridors:
  - ***Orient - East Mediterranean Corridor****: Rostock – Praha – Bratislava – Budapest – Beograd – Sofija – Athenes,*
  - ***Rhine – Danube Corridor****: Strasbourg – Vienna – Bratislava – Bucharest – Constanta, and*
  - ***Mediterranean Corridor****: Barcelona – Torino - Ljubljana – Zagreb – Budapest - Kijev – Sarajevo - Beograd*

- Apart of TEN-T core network corridor sections, other Hungarian expressways are part of TEN-T comprehensive network:
  - M6 between Budapest and M60 (near Pécs) was constructed, missing section between M60 (near Pécs) and border with Croatia (direction Osijek) is planned to finish till 2021
  - M30 between M3 motorway and Miskolc was constructed, missing sections between Miskolc and border with Slovakia (direction Kosice) is planned to finish till 2022
  - M35 between M3 motorway and Debrecen was constructed, missing sections between Debrecen and border with Romania (direction Oradea) is planned to finish till 2019

3.3. Toll system

Trucks (vehicles with the maximum permissible weigh over 3.5 tones) pay a distance-based toll on motor-, expressways and main roads, altogether 21,5% of national road network (ca. 6500 km). The system is without stopping. Toll is based on emission category of engine, number of axles of truck, and use of expressway or main road.

Use of annual, monthly or 10 days' vignette is mandatory for all personal vehicles, buses/coaches and trucks under weight of 3.5 tones on motor- and expressways, altogether 4,3% of national road network. Vignettes are available for the whole country and also for each of the 19 counties.

3.4. Condition of road surfaces and structures

Condition of roads and road structures is as following according to regular monitoring of Magyar Közút NZrt.:

- Condition of pavement structures on national road network in 2015 is:
  - good 10%
  - suitable 6%
  - bearable 22%
  - non suitable 12%
  - poor 50%

- Condition of pavement structures on main roads in 2015 is:
    - good 15%
    - suitable 8%
    - bearable 27%
    - non suitable 13%
    - poor 37%

3.5. Speed Limits

- speed limits on motorways: **130 Km/h**
- speed limits on other national roads: **50/90/110 km/h**

3.6. Traffic safety [72]

- Traffic safety - number of killed persons in road accidents in year 2014 were: **626**
- Traffic safety - number of killed persons per million inhabitants in road accidents in year 2014 were: **64**

Traffic safety has improved over the past 10 years. In 2016 there were 53 % less fatal accidents (deaths 1303 vs. 607) on the roads in comparison to 2006. Significant improvements occurred when the introduction of related measures in various areas was applied, from the construction of motorway network to changes in legislation rules like" objective" responsibility (owners' liability), "zero-tolerance" against drinking and driving, rendering more stringent demerit point system, and automated speed cameras. Unfortunately, number of injuries is improving slowly, decrease was only 24% between 2006 and 2016 (27977 and 21329 injuries).

The reasons of road traffic accidents are too high speed (31%), not keeping rules for changeovers (27%), not giving way (26%). 16627 accidents were used mainly by drivers of passenger cars (64%), bicyclists (11%), truck-drivers (9%), moto-cyclists (8%), pedestrians (6%) and others (4%) in 2016.

Based on EURORAP data research as part of the SENSoR project, inspections of 2,923km were carried out, 66% of which were single carriageways and Star Ratings were produced.

3.7. Protection of the environment and inhabitants from the impact of road traffic (noise, water)

The motorway system in particular is built with many measures to protect the natural and living environment. Thus, most settlements along motorways and expressways are protected by active anti-noise protection measures. Especially on old motorways anti-noise measures are being constructed on sections where they were not built at the time of construction. On

[72] Road Statistics Yearbook 2016

national roads, these measures are less frequent. Particularly where roads are passing towns and smaller settlements inhabitants are not protected against excessive noise.

3.8. Main weaknesses on the road network

3.8.1. Missing sections

Main Hungarian missing road sections are as following:

- Missing part of Budapest ring expressway. Preparation of M0 Northern and Western sections are under way and are planned to be finished by 2020.
- Expressways to several cities with county-rights (e.g. Szolnok, Kaposvár, Sopron, Békéscsaba).
- Several bypasses to avoid built-up areas (e.g. Győr, Kecskemét, Várpalota). There are several projects to ease this problem.
- Low number of Danube bridges. New road bridges are planned to build at Komárom and Kalocsa.

3.8.2. Bottlenecks

There are quite a few sections of roads or areas where traffic is already close to the limit capacity. These are in particular:

- Main roads entering to Budapest
- M1 motorway between Budapest and Győr. The preparation of developing it 2x3 lanes is planned to be finished till 2020.

3.8.3. Hazardous road sections

Dangerous places are primarily on the roads:

- More than 100 road crossings need improvements to increase road safety,
- Based on estimates from SENSoR (South East Neighbourhood Safe Route) project around 10-15 % of national road network is rated at a high level of risk
- There are 5649 rail-road level crossings on the Hungarian rail network. More than half of them are passively protected level crossings of roads and railways (with only traffic sign) this level are only 12% in case of TEN-T lines.

Dangerous places are primarily on the roads according to SENSoR project are:

- Main road No. 2. between Vác and Nagyoroszi,
- Pest county section of main road No. 3.,
- Sections of main road No. 4. near to Szolnok, Debrecen and Záhony,
- Sections of main road No. 6. between Pécs and Barcs,
- Main road 44. between Kecskemét and Békéscsaba,
- Sections of main road 68. between M7 motorway and Barcs, and
- Section of main road No. 74. near to Nagykanizsa.

3.8.4. Inadequate protection of the environment and inhabitants

Most of roads are built with adequate protection against excessive noise pollution from road traffic for the living environment. At the crossings of state roads through settlements, protection is unregulated.

As a rule, measures are taken for the controlled drainage of water from roads into the arrester through containers along motorways.

Wildlife crossings (ecoducts, green bridges) are built to allow land-based creatures to pass safely from one side of the road to another. On several motorway sections underpass tunnels (mainly for large animals) and tunnels and culverts (for amphibian and small mammals such as otters and hedgehogs) are also included.

3.9. Links with neighbouring countries

Hungarian motor- and expressway system is well connected with neighbouring countries Austria, Romania, Serbia, Croatia and Slovenia. There are unfinished connections with:

- Slovakia, where:
  - reconstruction of M15 to 2x2 lanes from CEF grants is under way and it will be finished by end of 2020
  - M30 section between Miskolc and Tornyosnemeti (direction Kosice) is missing. It is planned to be built by 2022.
- Austria, where M85 between Csorna – Sopron and Hungarian-Austrian border is planned by 2022.
- Slovenia, where M70 is only partially 2x2 lanes. Reconstruction of M70 to 2x2 lanes from CEF grants is under way and it will be finished by end of 2019
- Croatia, where M6 between M6 (near Pecs) and Hungarian-Croatian border (direction Osijek) is missing. It is planned to be built by 2021.
- Romania, where M35-M4 between Debrecen and Hungarian-Romanian border (direction Oradea) It is under way and planned to be finished by 2019.

3.10. Systems for informing users of individual transport systems

3.10.1 Notification by category of roads

Municipalities are responsible for informing about the situation on local/municipality roads. Based on the public authorization, traffic information on the state roads is entrusted to:

- Magyar Közút Nzrt. for majority of national road network. – ca. 31500 km
- Concessional companies:
  - M5 motorway (AKA Alföld Koncessziós Autópálya Zrt.) – 173 km,
  - M6 motorway (M6 Duna Autópálya Koncessziós Zrt.; M6 Tolna Autópálya Koncessziós Zrt.; Mecsek Autópálya Koncessziós Zrt.) –193 km

Municipalities are responsible for informing about the situation on local/municipality roads – 167407 km.

3.10.2 Ways of informing

The traffic information center, managed by Magyar Közút Nzrt for motorway networks, collects information of conditions on the state roads (such as accidents or winter conditions) and daily traffic (such as road work sites or congestions). This information is transmitted to the public media and users of the national road network.

3.11 Responsibility and operators

- ministry responsible for road infrastructure: Nemzeti Fejlesztési Minisztérium
- motorway operators: Magyar Közút Nonprofit Zrt., M5 motorway (AKA Alföld Koncessziós Autópálya Zrt.), M6 motorway (M6 Duna Autópálya Koncessziós Zrt.; M6 Tolna Autópálya Koncessziós Zrt.; Mecsek Autópálya Koncessziós Zrt.)
- operators of other state roads: Magyar Közút Nonprofit Zrt.

4. Investing spending and maintenance expenditures[73]

Gross investment spending in road infrastructure

In 2013, **411 mio EUR** were invested in national roads.

4.1. Maintenance expenditures in road infrastructure

In 2013, **411,55 mio EUR** were used for the maintenance of state roads.

5. The objectives of the transport policy and the future development of the road network

5.1. The goals of the transport policy

The vision of National Transport Infrastructure Development Strategy (approved by Hungarian Government in August 2014) is defined in a way to ensure the mobility needed for the economy and the prosperity of the society with the following objectives:

- Ensure the mobility needed for the economy and the prosperity of the society.
- Reducing the negative impacts on the environment.

[73] Road Statistics Yearbook 2016

- Improving the prosperity and mobility conditions of the population.
- Mitigation of regional differences.
- Strengthening international relations.

Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

5.2. The main priorities of road development

General measures are in areas such as:

- extend the motorways to the national borders,
- establish the accessibility of county seats via the expressway network,
- significant reduction of the number of fatal accidents, and

The planned major projects of Hungarian road network are contained by Annex 2. of Government Decree 1505/2016[74], which contains also the financing resources and deadlines for realization. Biggest projects (in construction costs) are the followings:

- M44 motorway between Kecskemet and Bekescsaba
- M85 expressway between Csorna, Sopron and Hungarian-Austrian border
- M30 motorway between Miskolc and Tornyosnemeti (direction Kosice)
- M4 motorway between Budapest and Szolnok
- M35-M4 motorway between Debrecen and Hungraian-Romanian border (direction Oradea)

6. Road management

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

In Hungary, a computer-aided system (e.g. DTIMS_CT or PMS (Pavement Management System)) was introduced on the motorways and also on other state roads. It enables continuous monitoring of the conditions of the carriageways and the preparation of reconstruction plans. Plans are made on the basis of mathematical models which are based on collapse curves of the carriageway. Such systems provide efficient infrastructure management and long-term financial sustainability.

[74] http://njt.hu/cgi_bin/njt_doc.cgi?docid=197456.348244

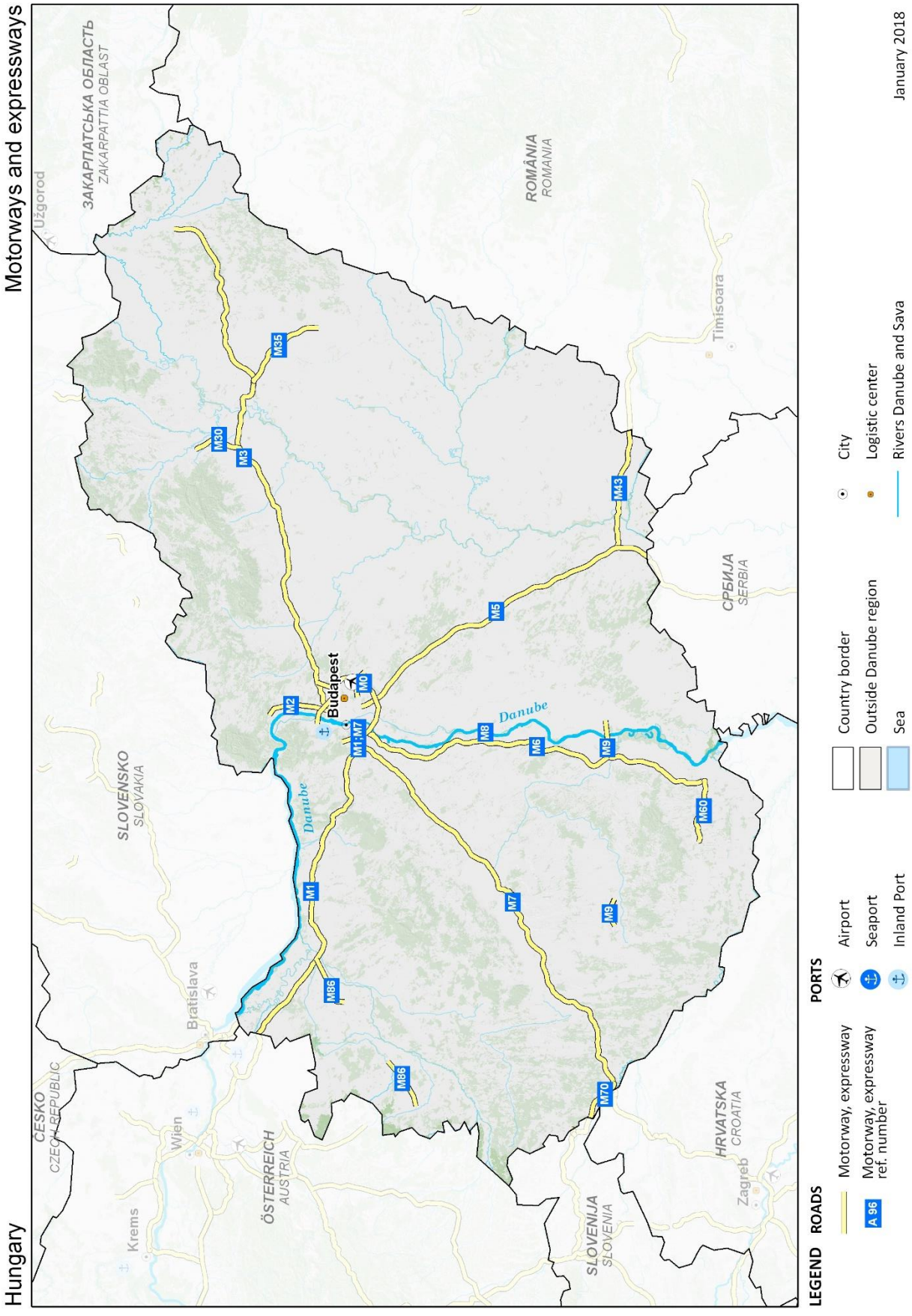

Figure 53: Motorway map of Hungary

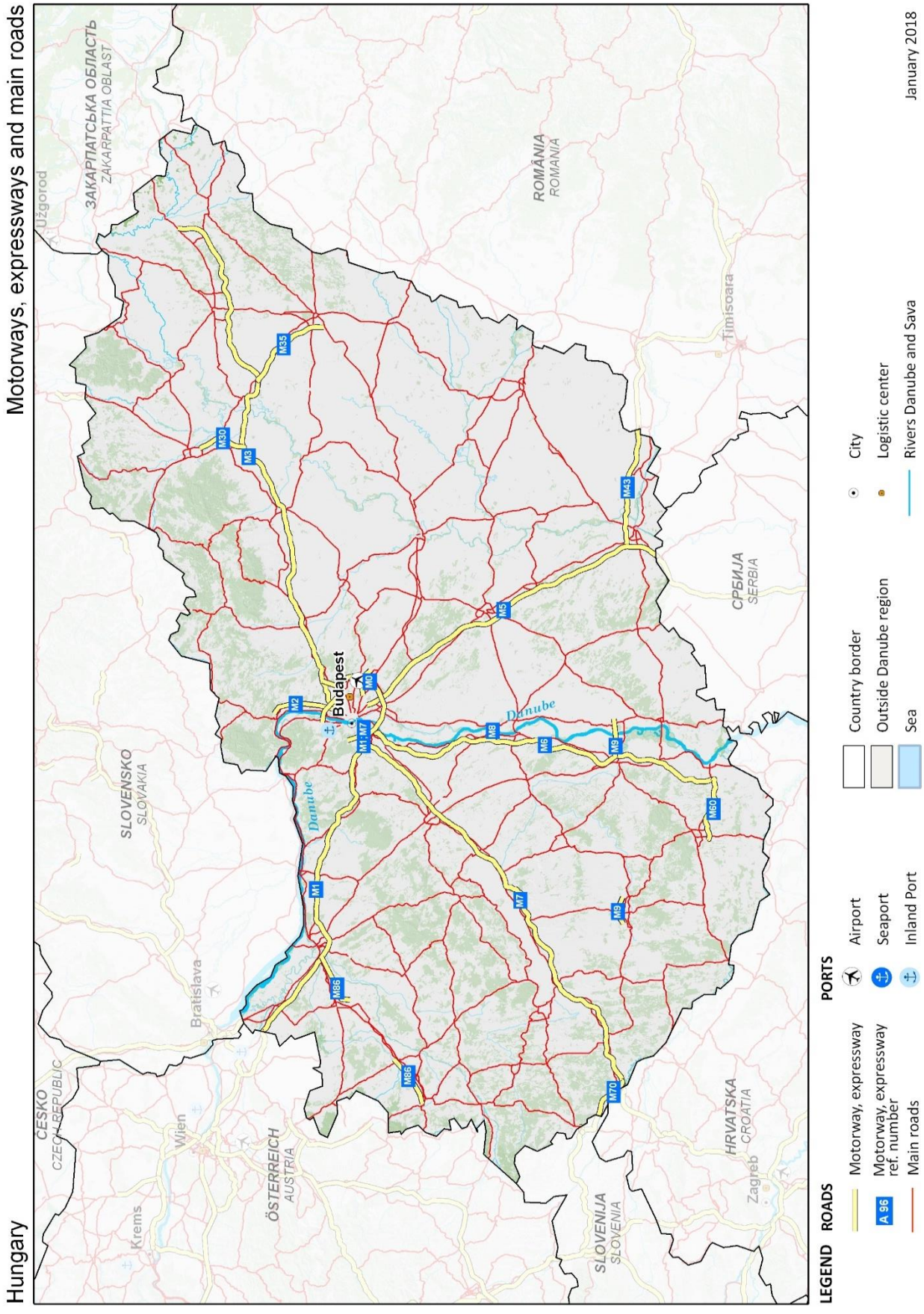

Figure 54: Motorway and main road map of Hungry

4.2.9 Danube Region roads: SERBIA

1. General data

- Inhabitants / 2016: **7.100.000**
- membership in the EU: **no**
- GDP / 2016 in EUR million: **34.115,2**
- GDP per capita / 2016 in EUR: **4.805**
- capital city: **Belgrade**
- land area - km²: **88.361**
- km of roads per million inhabitants: **6.337**
- km of roads per km² of the land area: **0,51**
- km of motorways per million inhabitants: **105**
- km of motorways per km² of the land area: **0,008**

2. Description of the road network[75]

- length of motorways (2013) – km: **747**
- length of main or national roads (2013) – km: **4.482**
- length of secondary or regional roads (2013) – km: **10.951**
- length of other roads (2013) – km: **0**
- total lengths of all roads (2013) – km: **44.995**

3. Main features of the road network

3.1 Traffic

3.1.1 General traffic estimates:

Traffic loads are large and concentrated in the area of large big cities like Belgrade, Novi Sad, Niš and in the direction of the transit corridor north – southeast and southwest. Traffic is both domestic and transit. The total number of vehicles on Serbian motorways in 2016 was 43 006 496, of which 78.62% are passenger vehicles, and 21.38 % of heavy vehicles.

3.1.2. Average annual daily traffic (AADT)[76]

- Average annual daily traffic (AADT) on all state roads: **2.955**
- Average annual daily traffic (AADT) on motorways: **14.865**
- Average annual daily traffic (AADT) on main or national roads: **4.107**
- Average annual daily traffic (AADT) on secondary or regional roads: **1.639**

[75] Eurostat, IRF 2017
[76] PE "Roads of Serbia" AADT on all state roads

3.2 International road corridors:

- Once Serbia becomes an EU member, the SEETO network will become part of following TEN-T Corridors:
    - ***Mediterranean Corridor**: Barcelona – Torino - Ljubljana – Zagreb –including indicative extension for neighboring cantry/Batrovici, Croatian border/- Beograd*
    - ***Orient - East Mediterranean Corridor**: Rostock – Praha – Bratislava – Budapest – including indicative extension for neighboring cantry Horgos, hungarian border-Beograd –a/ Nis- Sofija b/ Nis-Skoplje- Athenes c/Nis-Pristina and branch indicative extension for neighboring cantry Bucurest-Vrsac/Romanian border-Belgrade-Pozega-Podgorica-Bar*

- SEETO Network:

    - *SEETO Core Network – Corridor X (726km) CRO border /Batrovci –Belgrade (SER) – Skopje (MKD) – Bogorodica/GR border*
    - *SEETO Core Network – Corridor XB (185km) HU border/ Horgos—Novi Belgrade (SER)*
    - *SEETO Core Network – Corridor XC (110km) Nis (SER) —Gradina/BG border*
    - *SEETO Comprehensive Network – Route 3 (185km) Sarajevo (BIH) —Uzice (SER)*
    - *SEETO Comprehensive Network – Route 4 (601km) Romanian border/Vatin – Belgrade (SER) – Podgorica (MNE) – Bar (MNE)*
    - *SEETO Comprehensive Network – Route 5 (213km) Cacak (SER) – Krusevac (SER) – Paracin (SER) – Vrska Cuka/BG border*
    - *SEETO Comprehensive Network – Route 6a (259km) Ribarevina (MNE) – Ribarice (SER) – Pristina (KOS) – Skopje (MKD)*
    - *SEETO Comprehensive Network – Route 7 (314km) Lezhe (ALB) – Pristina (KOS) – Doljevac (SER)*
    - *SEETO Comprehensive Network – Route 9a (305km) Novi Sad (SER) – Ruma (SER) – Loznica (SER)/Zvornik (BIH) – Tuzla (BiH) – Doboj (BiH) – Banja Luka (BiH)*

3.3 Toll system

Toll is collected on motorways in the total length of 603 km, through the automatic technical toll collection system. The system consists of 45 toll stations.

Users are enabled to choose the method of toll payment on all toll stations:

- Cash,
- Payment Cards (Visa, Visa Electron, MasterCard, Maestro, Postcard, Dina card, American Express),
- Electronic Toll Collection – E-GO - Payment without Stopping.

3.4 Condition of road surfaces and structures

The existing database on condition of road surfaces and structure has not been updated since 2008, and thus no official data on condition of road surfaces and structure are available. It is expected that the state-of-the-road database will be updated in 2018.

3.5. Speed Limits[77]

- speed limits on motorways: **120 km/h**
- speed limits on other national roads: **80/50 km/h**

3.6. Traffic safety [78]

- Traffic safety - number of killed persons in road accidents in year 2016 were: **607**
- Traffic safety - number of killed persons per million inhabitants in road accidents in year 2016 were: **84**

Road traffic safety is gradually improving. Compared with 2001 the number of road fatalities has halved. Starting from 2010 significant improvements occurred through to changes in road safety legislation: introduction of road safety management and system of penalty points for misdemeanors, revocation of driver's license due to negligent driving, improvement of the drivers training system, obligatory use of safety belts at rear seat, ban on using mobile phones, rules that considerably more rigorously deal with infringements due to non-compliance with speed limits, driving under the influence of alcohol, drugs or psychoactive substances, etc. Important are also road safety measures introduced at the level of municipalities and the influence of the media and non-governmental organizations. Important are also road safety measures introduced at the level of municipalities and the influence of the media and non-governmental organizations.

The reasons of traffic accidents are various, for example, bed behavior of road users, poor road infrastructure, old vehicle fleet and poorly maintained and the like. The most frequent cause of traffic accidents still is exceeding of speed limits.

Based on EURORAP data research, a third of the network achieved 1- or 2-stars and a third achieved 4- or 5-stars. Separate Star Ratings were undertaken for pedestrians and cyclists.

As part of the SENSoR project, new inspections of 137km were updated, 97% of which were single carriageways and Star Ratings were produced.

30% of vehicle occupant Star Ratings achieved 3-star or higher.

[77] AMZS Slovenia
[78] Serbia, Road Traffic Safety Agency, Statistical report on the state traffic safety in the Republic of Serbia for the year 2016

3.7. Protection of the environment and inhabitants from the impact of road traffic (noise, water)

All new sections of state roads and motorways in Republic of Serbia are designed and build in accordance with an environmental impact assessment regulation. As a result, environmental protection measures are implemented. Noise protection measures, mostly in form of noise barriers, are now present on all new roads. On old sections of state roads noise reduction measures are applied to a smaller extent, because they were not built in a time of constructions. In these sections, noise protection measures are implemented where they are most needed.

On state roads and motorways, controlled drainage of water is standard, and closed drainage systems were designed especially in protected areas (protected nature and protected water supply areas).

When planning and designing roads, all conditions and restrictions were met, so that state road is integrated with environment and measures are taken to reduce negative impact of road exploitation on nature and population.

The Study Research snowdrifts on state roads of the Category I from 2016 opened a new approach that refers to the protection of the road from the impact of natural disasters, ie climate change. Integrated with timely and reliable meteorological data on the occurrence of snowfall, snow drifts research study may be a useful tool to optimize the activities necessary in order to ensure the mobility of road infrastructure and traffic safety.

Another aspect of road protection from environmental factors relating to the occurrence of floods and torrential flows and exposure to road networks to their destructive effect.

Territory of Republic of Serbia is susceptible to natural disasters, and especially floods, torrents and landslides, as well as other natural disasters (drought, fires, etc.). The most endangered areas are those around biggest rivers, like Sava, Drina, Kolubara, Western and Southern Morava rivers and their effluents.

Electric vehicle infrastructure should be driven by national policy too. Fast chargers, as well as semi-quick ones, should allow seamless trips of electric vehicle drivers (every forty-fifty kilometers or so) via Class I network. Certain policies should also be applied for promotion of Euro 5 and Euro 6 standard vehicles, electric, biogas and/ or hydrogen buses and coaches.)

3.8. Main weaknesses on the road network

3.8.1. Missing sections

In the following directions, there are missing sections of motorways or expressways:

- Corridor X – Ringroad around Belgrade
- Route 4 – Section Surčin –Obrenovac and Preljina- Požega
- Route 5 – Pojate –Preljina

3.8.2. Bottlenecks

- Corridor X – Ringroad around Belgrade
- Route 5 – Pojate -Preljina
- Route 9a – Novi Sad-Ruma-Šabac- Loznica

3.8.3. Hazardous road sections

Risk mapping projects on state roads in Serbia are currently being prepared. The European program EuroRAP-Serbia was implemented in one part of the national road network, and the recording of the road network was performed for the purpose of risk mapping and road marking by the star system (in accordance with the iRAP methodology of road evaluation) in 2008. This program provided guidelines for improving safety through the creation of 40 roundabouts, marking 30 dangerous curves and 60 rehabilitation zones around the school. The Serbian AMSS developed its vehicle for these purposes according to European standards. In 2018, the completion of the Risk Mapping Project for the state road network is expected, based on which the planned approach to the improvement of critical sections and intersections will be planned.

3.8.4. Inadequate protection of the environment and inhabitants

Most of roads are built with adequate protection against excessive noise pollution from road traffic for the living environment. At the crossings of state roads through settlements, protection is unregulated.

As a rule, measures are taken for the controlled drainage of water from roads into the retentions along state roads and motorways.

Wildlife crossings (Eco ducts, green bridges) have not been built yet.

3.9. Links with neighbouring countries

Serbian motorway system is well connected with neighboring countries Croatia and Hungary.

Connections with Romania, Bulgaria, Macedonia, Albania, Montenegro and Bosnia and Herzegovina have not been constructed in full motorway profile.

According to 2013 data, a turnover was recorded of 50,086,225 passengers at all border crossings for all modes of transport; the busiest passenger traffic is by road 22,144,193, i.e.,

44.20 %. On the route of Corridor X, the busiest border crossings are: Horgoš (6,500,811), Batrovci (7,348,755), Preševo (4,393,537) and Gradina (3,901,090).

3.10. Systems for informing users of individual transport systems

3.10.1. Notification by category of roads

Based on the public authorization traffic information on the state roads of the Category I and II (motorways/expressways and main roads on regional level) notification is entrusted to the Public Enterprise “Roads of Serbia” (PERS).

Municipalities are responsible for informing about the situation on local/municipality roads.

3.10.2. Ways of informing

Information Center PERS is a service providing center for road users in the Republic of Serbia focused on provision of fast and accurate information on road works and traffic regime modifications, closures and traffic normalizations, rock falls and landslides, bans for certain vehicle categories, situation on the bridges, in the tunnels and other road structures, as well as about all current activities during the Winter Service term.

Keeping the public informed about the above mentioned scope of activities of Information Center is performed daily by forwarding announcements and entering data into PERS’ web presentation and IVR of the automatic telephone exchange of the Information Center.

Users calling the Information Center can also obtain information on current situation on every toll station, in all four sections of the motorways in the Republic of Serbia, about eventual longer delays, which is regularly updated on PERS’ web presentation.

In order to provide efficient, timely information of good quality to the users, the Information Center is operational 24 h.

4. Investing spending and maintenance expenditures

4.1. Gross investment spending in road infrastructure

In 2016, **313 mio EUR** were invested in national roads.

4.2. Maintenance expenditures in road infrastructure

In 2016, **171 mio EUR** were used for the maintenance of state roads.

5. The objectives of the transport policy and the future development of the road network

5.1. The goals of the transport policy

The main priorities are the following:

- Full harmonization of Serbian transport legislation with the *acquis* and strengthened institutional framework and administrative capacity for implementation.
- Road transport infrastructures on the SEETO comprehensive network improved, especially Corridor X and Rout 4
- Intermodal transport and connectivity of transport modes improved.
- Decrease of negative impact of transport on the environment.
- Increase of road traffic safety and security of road transport system.
- Establishing stable financing of the road transport sector development.

5.2. The main priorities of road development

The priority at the moment is to complete the construction of Corridor X with branches (Xb and Xc) as well as works on part of Routes 4 (Belgrade to Požega) and to complete bypass of Belgrade. At present funding of SEETO Comprehensive network is of the main importance.

- ensuring an adequate standard of existing road infrastructure, including road rehabilitation,
- traffic safety,
- protection of the natural and living environment from the impact of road transport,
- improving accessibility to regional centers,
- preparedness for extreme weather events and
- road measures in individual parts of the country.

6. Road management

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

In 2008, after the last update of the road database, the road sections were prioritized for road rehabilitation by mean of HDM-4. The rehabilitation of those road sections (54 sections / 1100 km) have been implemented in the framework of the Road rehabilitation and safety project (IFI loans of 390 million euros). The preparation of technical documentation for rehabilitation apply the Safe Road Design principles, and independent Road Safety Audit. Such systems provide efficient infrastructure management and long-term financial sustainability.

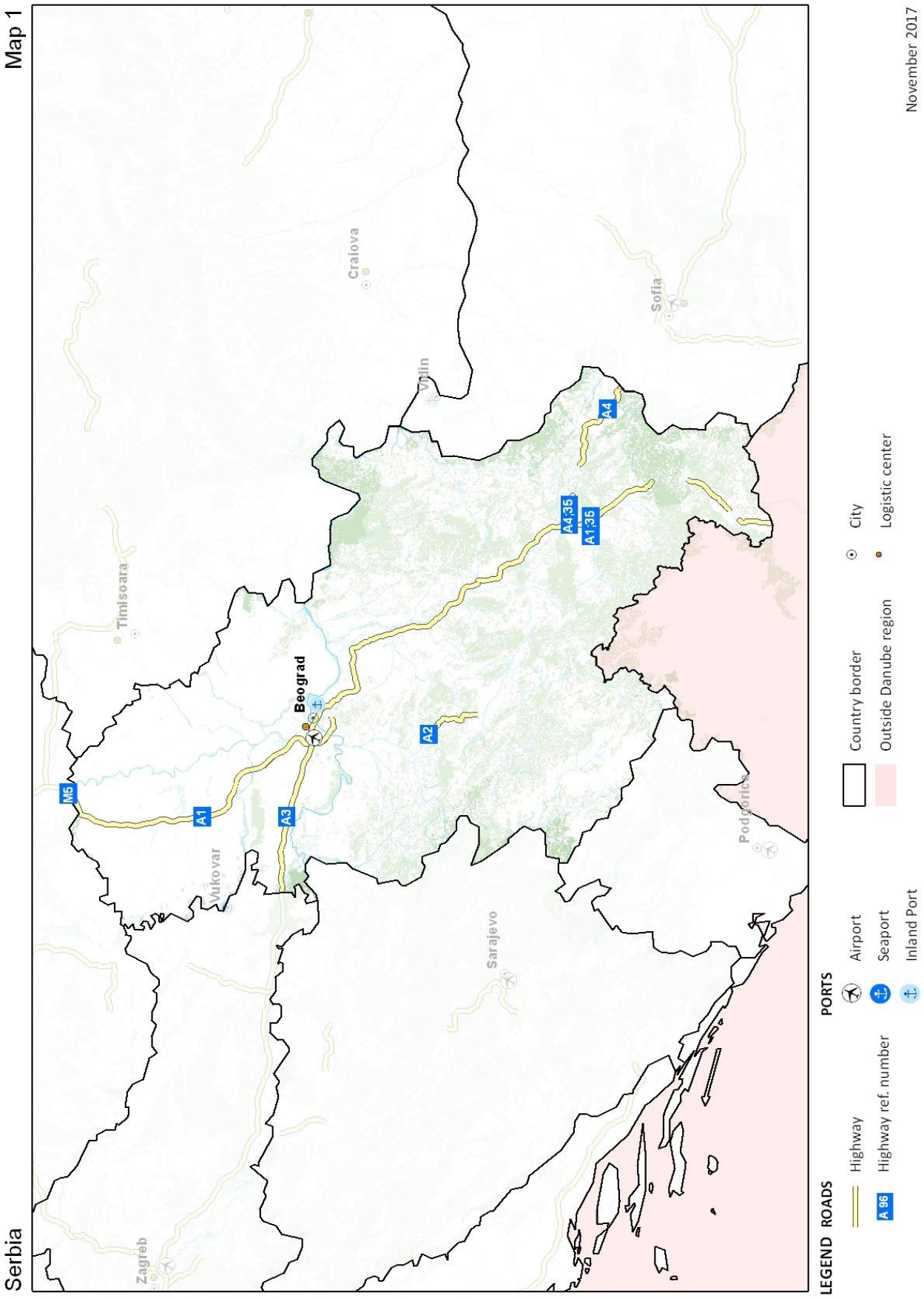

Figure 55: Motorway map of Serbia

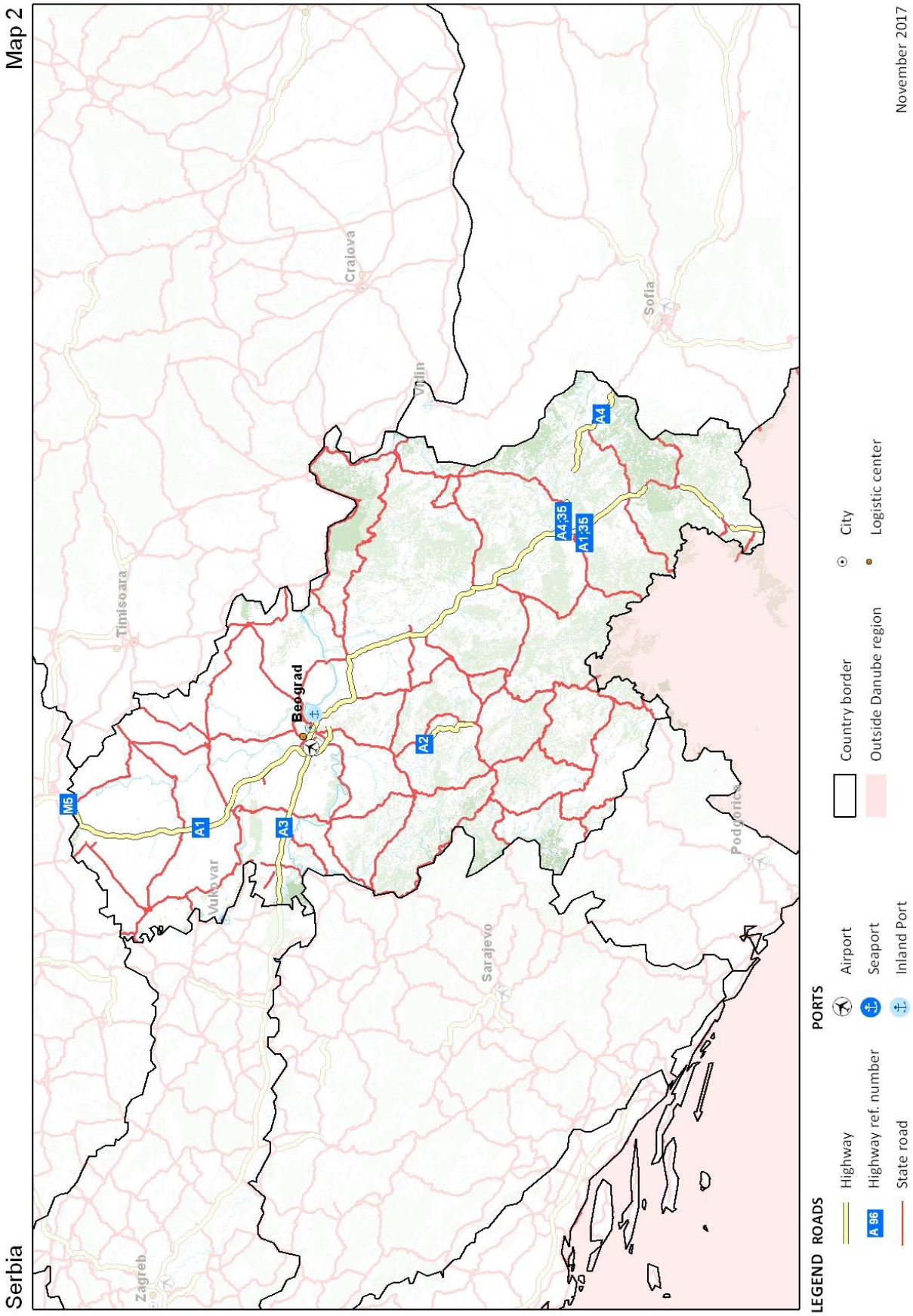

Figure 56: Motorway and main road map of Serbia

4.2.10 Danube Region roads: BOSNIA AND HERZEGOVINA

1. General data[79][80]

- Inhabitants / 2016: **3.531.159**
- membership in the EU: **no**
- GDP / 2016 in EUR million: **15.248**
- GDP per capita / 2016 in EUR: **4.354**
- capital city: **Sarajevo**
- land area - km²:**51.209**
- km of roads per million inhabitants: **4.715**
- km of roads per km² of the land area: 0,325
- km of motorways per million inhabitants: **52**
- km of motorways per km² of the land area: **0,004**

2. Description of the road network

- length of motorways – km: **183**
- length of main or national roads – km: **3.965**
- length of secondary or regional roads – km: **2.151**
- length of other roads – km: **10.349**
- total lengths of all roads – km: **16.648**
- length of national roads without anti-dust protection: **78**

3. Main features of the road network

3.1. Traffic

3.1.1 General traffic estimates:

Traffic loads are large and concentrated in the area of capital city Sarajevo and in the direction of the transit corridor north – south. Traffic is both domestic and transit. Personal transit traffic represents 4 %, while freight transport in transit represents 15 %.

3.1.2 Average annual daily traffic (AADT)

Average annual daily traffic (AADT) on main or national roads: 6.900

[79] www.bhas.ba/?option=com_content&view=article&id=52&itemid=80&lang=ba
[80] www.bhas.ba/saopstenja/2017/BDP%202016%20proizvodni.pdf

3.2. International road corridors:

- TEN-T corridors:
  - ***Mediterranean Corridor****: Barcelona-Torino-Ljubljana-Zagreb-Budapest-Kijev-Sarajevo - Beograd*
  - ***Corridor V, branch „c ":*** CRO border/Bosanski Samac (BIH)-Sarajevo (BIH) - Doljani/CRO border

- Other main international roads:
  - *Route 1: CRO border/Neum Northwest-Neum (BIH)-Bar (MNE)*
  - *Route 2a: CRO border/Gradiška-Banja Luka (BIH)-Lašva (BIH)*
  - *Route 2b: Sarajevo (BIH)-Podgorica (MNE)-Vore (ALB)*
  - *Route 3: Sarajevo (BIH)-Užice (SER)*
  - *Route 9a: Novi Sad (SER)-Ruma (SER)-Loznica (SER)/Zvornik (BIH)-Tuzla (BiH)-Doboj (BiH)-Banja Luka (BiH).*

3.3. Toll system

The toll collection system on motorways is with the use of toll gates. On expressways the toll is not charged.

3.4. Condition of road surfaces and structures

Condition of roads and road structures is the following:

- Condition of pavement structures on motorways and express roads in 2016 is:
  - Good 100 %
  - marginal 0 %
  - poor 0 %

- Condition of pavement structures on national roads in 2016 is:
  - Good 29 %
  - marginal 58,35 %
  - poor 12,65 %

- Condition of road structures on motorways and express roads in 2016 is:
  - good 100 %
  - marginal 0 %
  - poor 0 %

- Condition of road structures on national roads in 2016 is:
  - good 25 %
  - marginal 60 %

- poor 15 %.

3.5. Speed Limits

- speed limits on motorways: **130 km/h**
- speed limits on other national roads: **80/50 km/h**

3.6. Traffic safety

- Traffic safety - number of killed persons in road accidents in year 2015 were: **321**
- Traffic safety - number of killed persons per million inhabitants in road accidents in year 2015 were**: 91**

There were 44 % less fatal accidents (deaths) on the roads-between 2005 and 2014.

Based on EURORAP data research, as part of the SENSoR project, inspections of 312km were carried out, 83% of which were single carriageways and Star Ratings were produced.
Less than half of vehicle occupant Star Ratings achieved 3-star or higher.

Until 31 December 2016, there were 370.767 vehicles registered in the Republika Srpska. The average vehicle age was 16,9 years, while 68.117 vehicle were declared as non-roadworthy during the check. Total number of road accidents in the Republika Srpska has increased (+4,3%) as compared to the reference year 2011. Therefore, it can be noted that a downward trend in the number of road accidents projected in the Strategy has not been created. This is typical for countries not having stable and strong road safety protection systems.

The most common causes of road traffic accidents in 2016 were improper actions made with vehicles in traffic (25,3 %) and improper and inadequate speed (24,7 %). In terms of accident causes percentage share, this is followed by failure to maintain safe distance 13,7 % and failure to yield the right of way 13,2 %. There is a very small percentage of certain causes, which does not represent the real state of affairs, such as vehicles roadworthiness, road factor, etc. Causes of accidents resulting in deaths are as follows: improper and inadequate speed in 65 road traffic accidents (53,72%), wrong-way driving, improper actions made with vehicles in traffic, improper overtaking, etc. Causes of accidents resulting in severe injuries are as follows: improper and inadequate speed in 258 road traffic accidents (44,71%), wrong-way driving, failure to yield the right of way, improper actions made with vehicles in traffic, improper overtaking, etc.

3.7. Protection of the environment and inhabitants from the impact of road traffic (noise, water)

The motorway system in particular is built with measures to protect the natural and living environment, like active anti-noise protection measures. There are no such measures on other national roads.

3.8. Main weaknesses on the road network

3.8.1. Missing sections

In the following directions, there are missing sections of motorways or expressways:

- Budapest – Sarajevo – Dubrovnik, section border with Croatia – Zenica and Sarajevo - Ploče
- Banja Luka – Beograd, section Laktaši – Prnjavor

3.8.2. Bottlenecks

- Wide range of magistral and regional roads require significant interventions;
- Traffic bottlenecks in larger cities
- Criticalities on the road network: blackspots, poor geometry, country development level that does not allow proper reconstruction;
- The most critical bottleneck relates to M14.1 in urban area of Brčko, since it is a main West-East transit route to Bijeljina and onwards for all vehicles, including heavy trucks.
- Condition of the pavements on magistral and regional roads is unfavorable (presence of numerous cracks and rutting);
- Substantial part of local roads is unpaved.

3.8.3. Inadequate protection of the environment and inhabitants

There are no measures to protect against noise on national roads.

Controlled drainage of water from roads is not constructed on motorways.

There are no green bridges for wildlife to pass across motorways.

3.9. Links with neighbouring countries

Bosnian and Herzegovinian motorway system is connected with neighbouring country Croatia.

3.10. Systems for informing users of individual transport systems

3.10.1. Notification by category of roads

Based on the public authorization, traffic information on the state roads is entrusted to:

- PC „Republic of Srpska motorways“ for motorways and expressways (www.autoputevirs.com)

- PC „Roads of Republic of Srpska“ for main roads (www.putevirs.com).
- Public Enterprise Autoceste FBiH for motorways and expressways in FBiH (www.jpautoceste.ba)
- Public Enterprise Ceste FBiH for magistral roads (www.jpdcfbh.ba)

Municipalities are responsible for informing about the situation on local/municipality roads.

3.10.2. Ways of informing

The traffic information center, managed by PC „Republic of Srpska motorways “for motorway networks, collects information of conditions on the state roads (such as accidents or winter conditions) and daily traffic (such as road work sites or congestions). This information is transmitted to the public media and users of the national road network.

3.11. Responsibility and operators

- Ministry responsible for road infrastructure:
- Motorway operators: PC „Republic of Srpska motorways “and Public Enterprise Autoceste FBiH
- Operators of other state roads: PC „Roads of Republic of Srpska “and Public Enterprise Ceste FBiH

4. Investing spending and maintenance expenditures

4.1. Gross investment spending in road infrastructure

In 2013, **79,5 mio EUR** were invested in national roads.

4.2. Maintenance expenditures in road infrastructure

In 2013, **15,8 mio EUR** were used for the maintenance of state roads.

5. The objectives of the transport policy and the future development of the road network

5.1. The goals of the transport policy

The vision of transport policy is defined as ensuring the sustainable mobility of the population and supplying the economy with the following objectives:

- improve mobility and accessibility,
- improve supply of the economy,

- improve road safety and security,
- reduce energy consumption,
- reduce user and operator costs,
- reduce environmental burdens.

The Transport sector has to contribute to sustainable and steady economic development through four general objectives:

- ensuring institutional efficiency,
- ensuring financial sustainability,
- stimulating economic development, and
- addressing the environmental and social impacts.

These four objectives will have to be achieved through specific actions according to the needs and peculiarities of the entities and Brčko District. Furthermore, the Transport Policy sets six objectives to achieve the overall goal of sustainable development of the transport system, as presented here below:

- meet social and economic demands,
- provide the best level of services at the lowest possible cost,
- satisfy safety and information requirements,
- be financially sustainable and based on the principal financing sources ranging from user charges, municipal budgetary resources and private sector involvement, satisfy the needs in terms of maintenance, improvement and development of transport infrastructure,
- comply with EU standards and regulations,
- have a minimal permissible environmental impact.

Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

5.2. The main priorities of road development

The following major projects are planned on the road network:

Federation of Bosnia and Herzegovina
Motorways: 100 km of express road will be upgraded to motorways (with an estimated total cost of about EUR 472 M). Current financing models are the main issue for the development of motorways.
Magistral roads: main planned interventions consist of a “Modernization Program” which will be developed in the short and medium term, more specifically:

a) Short term investments (already on-going 2016-2020) with an estimated total cost of about EUR 165.72 M; partly financed through an EIB/WB loan (EUR 100.72 M) and the remaining financed through EBRD
b) Medium term investments with an estimated total cost of about EUR 126.45 M will be financed through an EBRD loan.

Republic of Srpska
Planned express ways:

- Lukavica-Pale-Sokolac-Rogatica-Ustiprača-Višegrad-border with Serbia (SEETO Route 3),
- Bijeljina-Zvornik-Sokolac,
- Trebinje-Gacko-Foča-Ustiprača-Višegrad,
- Prijedor-Kozarska Dubica-Donja Gradina,
- Banja Luka-Čelinac-Kotor Varoš-Obodnik.

According to the Amendments to the Spatial Plan of RS to 2025, and plans by public roads managers, the transformation of road transport will continue in order to increase reliability, availability and efficiency. In addition to ongoing programmed maintenance, rehabilitation and modernization according to defined priorities, it is necessary to construct and modernise the magistral and regional road network in RS. Priority routes for construction are:

- Magistral road M-18 Brod on river Drina (Foča)-Hum (Šćepan Polje) (Route 2b),
- Regional road R-435 Nevesinje-Berkovići,
- Regional road R-405 Bronzani Majdan-inter entity border RS/FBiH,
- Regional road R-477 Gornji Podgradci-Mrakovica,
- Regional road R-413 Kotor Varoš-Mitrovići (Kneževo).

Brčko District of Bosnia and Herzegovina

- Construction of the West-East bypass road which will have the role of deviating transit traffic flows from the urban area of Brčko (magistral road standard for 80 kph, 18 km long);
- Construction of the motorway Tuzla-Orašje (50 km passing through BD including links to the existing road network);
  - Motorway Tuzla-Orašje: Gorica-Brka-Dubrave (implementation of this project is planned but has not started yet)
  - Bypass road Gorice-Grbavica-Čađavac-Gredice (implementation of this project is underway)

6. Road management

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

In Bosnia and Herzegovina, a computer-aided system (e.g. DTIMS_CT or PMS (Pavement Management System)) was introduced on the motorways and also on other state roads. It enables continuous monitoring of the conditions of the carriageways and the preparation of reconstruction plans. Plans are made on the basis of mathematical models which are based on collapse curves of the carriageway. Such systems provide efficient infrastructure management and long-term financial sustainability.

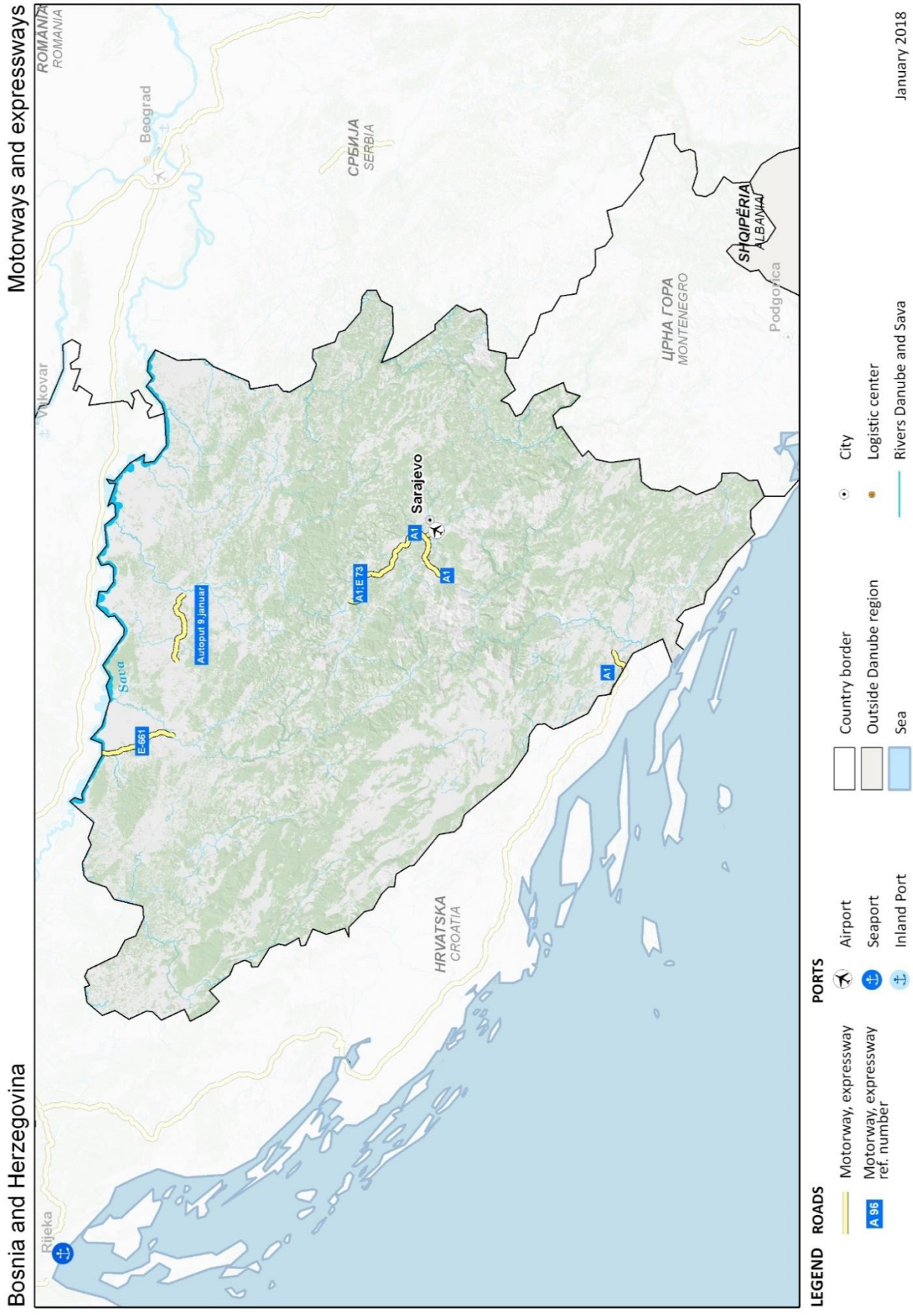

Figure 57: Motorway map of Bosna and Hercegovina

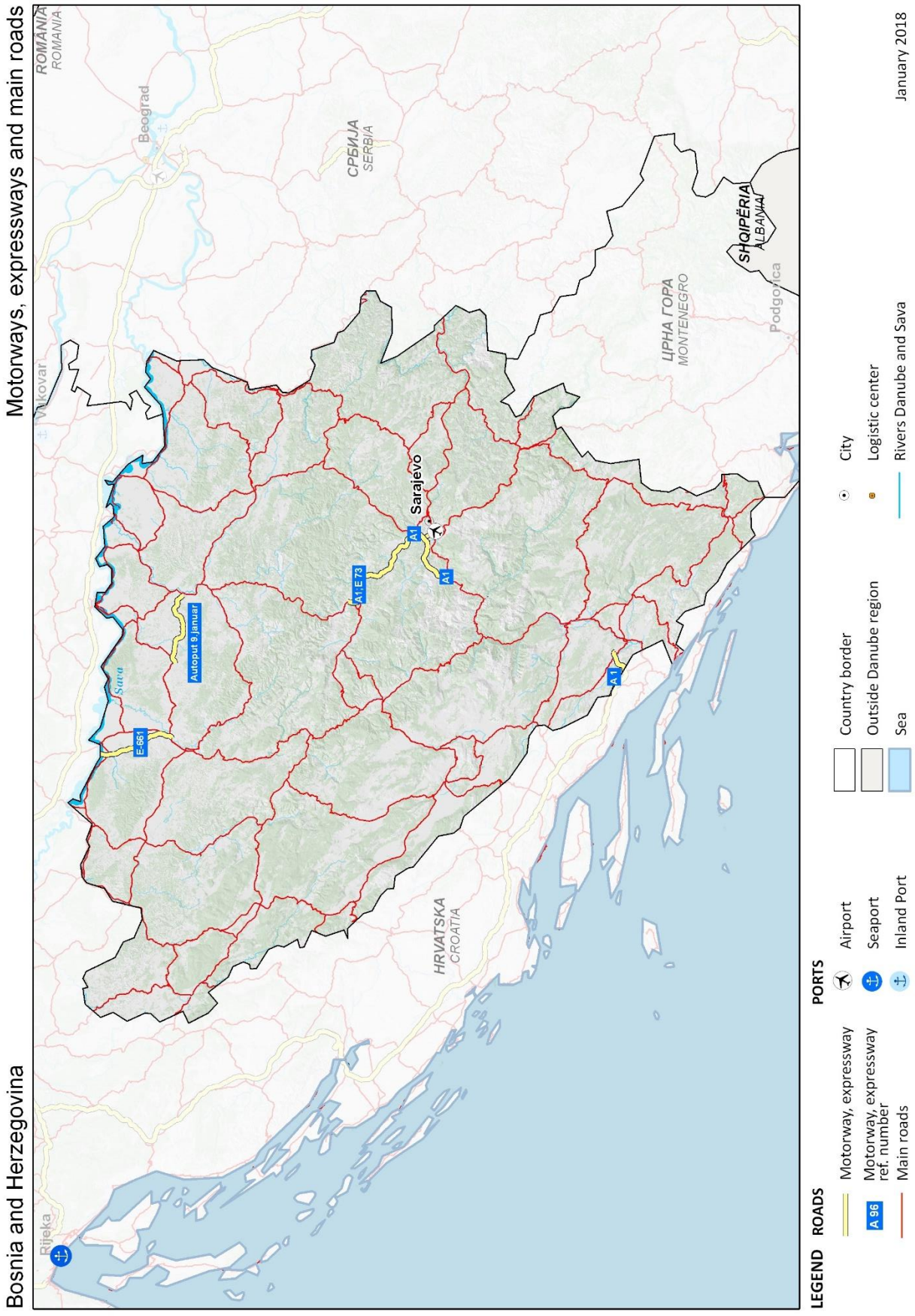

Figure 58: Motorway and main road map of Bosna in Hercegovina

4.2.11 Danube Region roads: MONTENEGRO

1. General data

- Inhabitants / 2016: **650.000**
- membership in the EU: **no**
- GDP / 2016 in EUR million: **3.624,7**
- GDP per capita / 2016 in EUR: **5.576**
- capital city: **Podgorica**
- land area - km²: **13.812**
- km of roads per million inhabitants: **12.254**
- km of roads per km² of the land area: **0,58**
- km of motorways per million inhabitants: **0**
- km of motorways per km² of the land area: **0,000**

2. Description of the road network[81]

- length of main or national roads – km: **7.965**
- total lengths of all roads – km: **7.965**

3. Main features of the road network

3.1 Traffic

3.1.1 General traffic estimates:

Traffic loads are large and concentrated in the area of capital city Podgorica and in the direction of the transit corridor north – south and along the coast. Traffic is both domestic and transit. Personal transit traffic is greatly increased during the summer tourist season.

3.2 International road corridors:

- TEN-T corridors:
  - ***Orient - East Mediterranean Corridor****: Rostock – Praha – Bratislava – Budapest – Belgrade – Podgorica.*

3.3 Toll system

There is only toll collection on direction Podgorica – Bar for tunnel Sozina.

[81] Eurostat, IRF 2013

3.4 Speed Limits

- speed limits on motorways: **100 km/h**
- speed limits on other national roads: **80/50 km/h**

3.5 Traffic safety

Based on EURORAP data research, Montenegro's rapid growth in the 2000s was accompanied by an increase in vehicular ownership and road accidents, underscoring the need for a comprehensive program to improve road safety**.**

Between 2004 and 2007, Montenegro experienced a 40% increase in road accidents and associated personal damages. The economic cost of traffic accidents in Montenegro is nearly 2% of GDP-a half point higher than in most middle-income countries.

Authorities have prioritized upgrading road safety equipment and practices in line with EU standards, and are taking steps to upgrade relevant signage and infrastructure. However, assistance is needed to build the technical and institutional capacity of relevant road agencies and implement investments and pilot projects.

The Automobile Association of Montenegro (AMSCG) was an Observer of the SENSoR project and Star Rating results for 539km were undertaken, 97% of which were single carriageways.

16% of vehicle occupant Star Ratings achieved 3-star or higher.

3.6 Links with neighbouring countries

There is no motorway connection with neighbouring countries. Road links are satisfactory with Serbia, Albania and Croatia.

4. Investing spending and maintenance expenditures[82]

4.1. Gross investment spending in road infrastructure

In 2013, **20 mio EUR** were invested in national roads

[82] Road Statistics Yearbook 2016

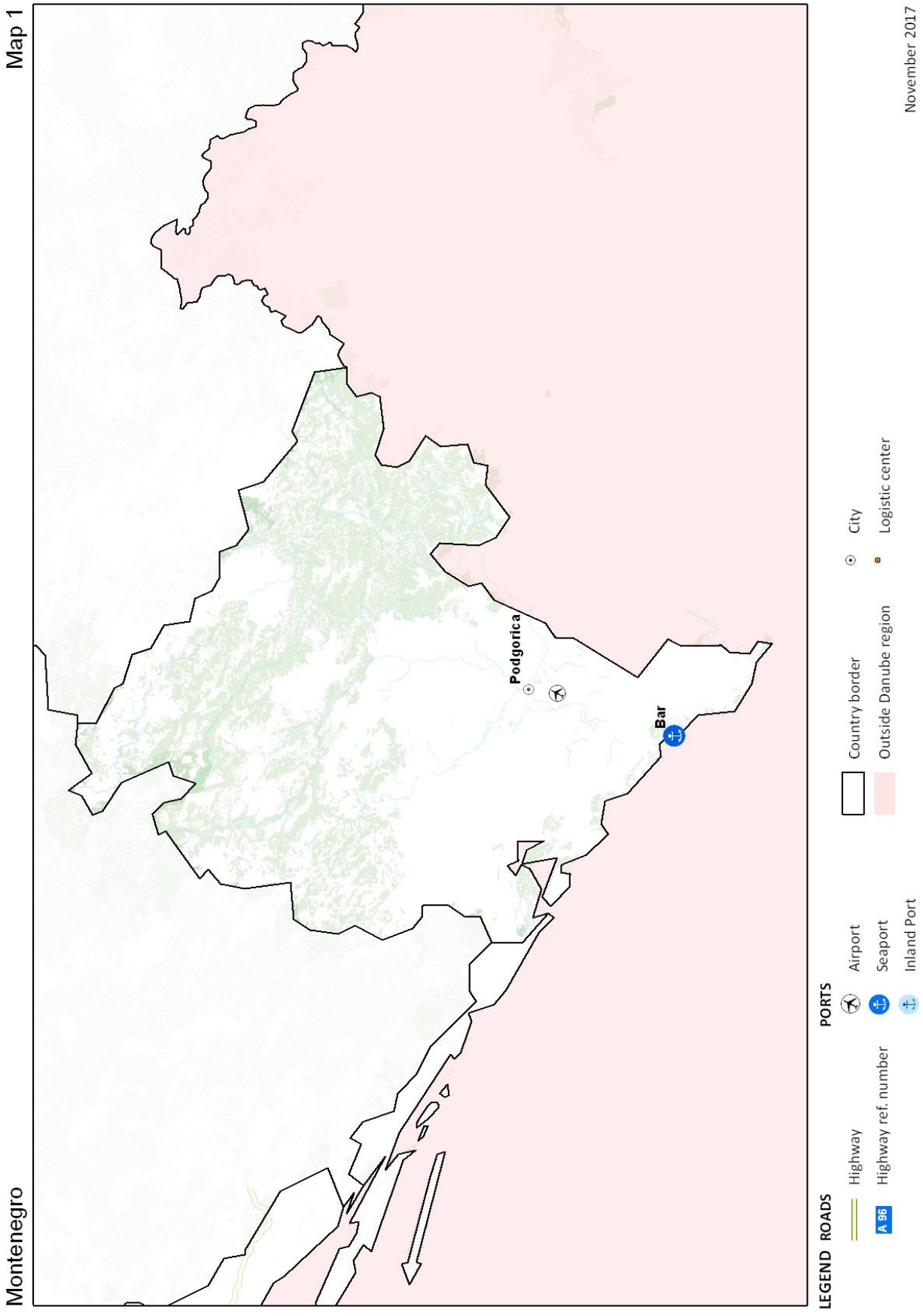

Figure 59: Motorway map of Montenegro

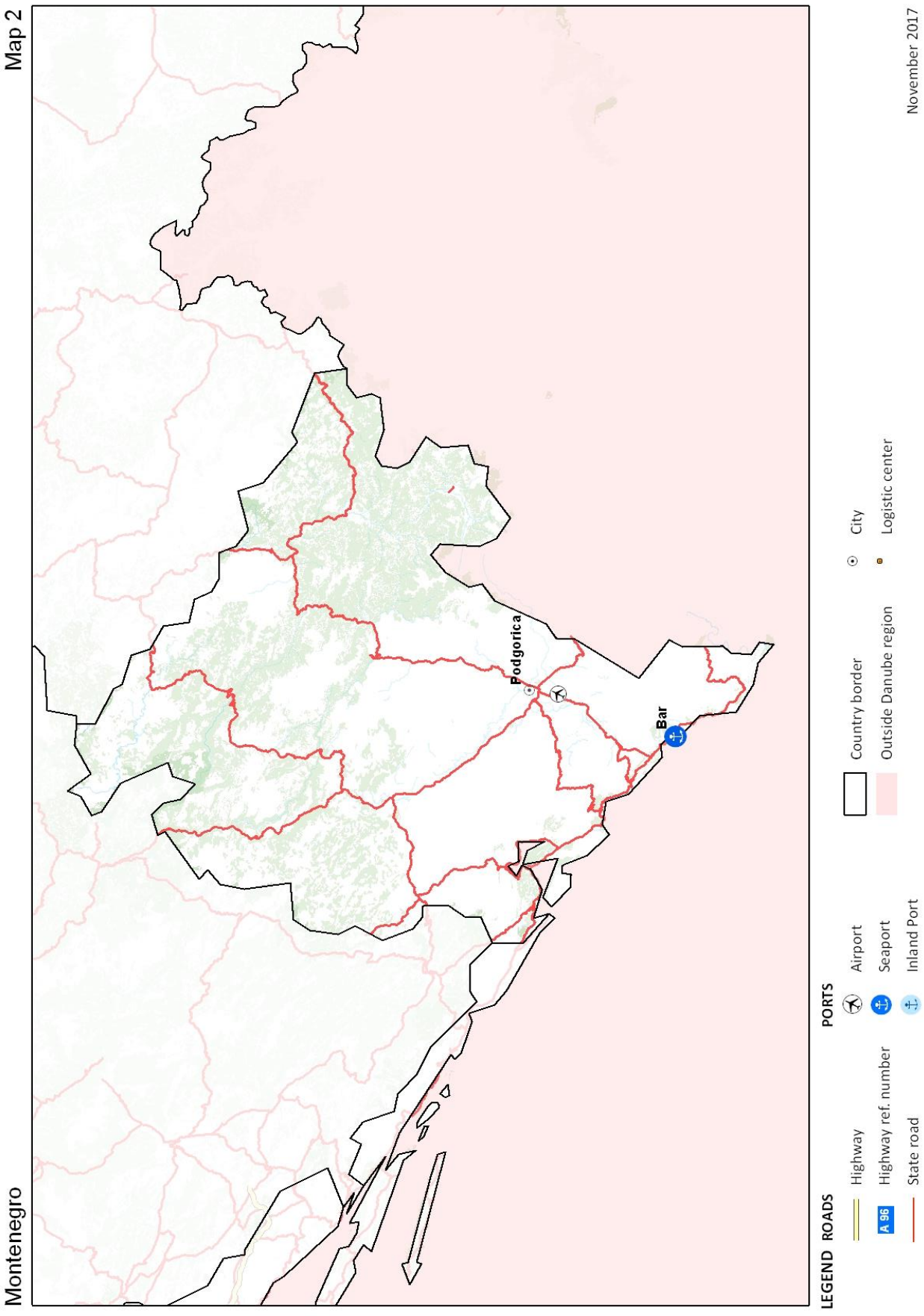

Figure 60: Motorway and main road map of Montenegro

4.2.12 Danube Region roads: MOLDOVA

1. General data[83][84]

- Inhabitants / 2015: **3.550.852**
- membership in the EU: **no**
- GDP / 2016 in EUR million: **6.118**
- GDP per capita / 2016 in EUR: **1.723**
- capital city: **Chisinau**
- land area - km²: **33.846**
- km of roads per million inhabitants: **2.619**
- km of roads per km² of the land area: **0,28**
- km of motorways per million inhabitants: **0**
- km of motorways per km² of the land area: **0**

2. Description of the road network[85]

- length of main or national roads (2017) – km: **2.627**
- length of secondary roads (2017)- km: **3.277**
- length of other road (2017) – km: **3.394**
- total lengths of all roads (2017) – km: **9.298**
- length of national roads without anti-dust protection – km: **1.987**

3. Main features of the road network

3.1 Traffic

3.1.1 General traffic estimates:

Traffic loads are large and concentrated in the area of capital city Chisinau and in the direction of the transit corridor north – south and west – east. Traffic is both domestic and transit.

3.2. International road corridors:

- TEN-T Core corridors sections:
  - *R1 Chisinau- Ungheni – Romanian border (missing link bridge near Ungheni)*
  - *M5 Chisinau –Tiraspol – Ukraine border*
  - *M1 Chisinau – Dubasari – Ukraine border*

[83] UNECE 2017
[84] FOCUSECONOMICS 2016
[85] Goverment of Republic Moldova Ministry of economy and infrstructure 2017

- Apart of TEN-T core corridors sections, other Moldavian motorways are part of the TEN-T comprehensive network:

    - *M5 Ukraine border – Criva – Balti - Chisinau*
    - *M3 Chisinau – Comrat – Giurgiulesti – Ukraine border*
    - *M1 Romanian border – Leuseni – Chisinau*

3.3. Toll system

Personal vehicles must have 7, 15, 30, 90, 180 days' vignette.

3.4. Condition of road surfaces and structures [86]

Condition of roads and road structures is as following:

- Condition of pavement structures on national roads in 2016 is:
    - good 28 %
    - marginal 32 %
    - poor 40 %

3.5. Speed Limits[87]

- speed limits on motorways: **110 km/h**
- speed limits on other national roads: **80/50 km/h**

3.6. Traffic safety [88]

- Traffic safety - number of killed persons in road accidents in year 2017 were: **308**
- Traffic safety - number of killed persons per million inhabitants in road accidents in year 2017 were: **87**

Traffic safety has improved over the past years. Significant improvements occurred with implementation of the combination of passive and active measures of road safety and improvement of road infrastructure, road user behavior by training, raising awareness, licensing, and compliance with traffic regulations.

In 2015 there was 34.2% less fatal accidents (deaths) on the roads in comparison with 2001. Main causes of traffic accidents were speeding, alcohol, crossing by pedestrians, poor road infrastructure and other causes.

Based on EURORAP data research the Government of Moldova is committed to building a modern road infrastructure, taking account internationally recognized standards and criteria on road safety.

[86] Goverment of Republic Moldova Ministry of economy and infrstructure 2017
[87] AMZS Slovenia
[88] Goverment of Republic Moldova Ministry of economy and infrstructure 2017

Supported by the World Bank, star Ratings for 2,513km of roads of national and regional importance were published in 2011. To mark the start of road inspections in July 2010 a media event was held in Chisinau, and included attendance by the Prime Minister.

The network covered, accounted for nearly a third of the paved road network in Moldova where approximately a third of deaths are concentrated. The results were used to assist the Road Safety Council with information for the development of a multi-sectoral Road Safety Action Plan.

Results showed that the majority of the network (56%) scored the lowest 1-star rating for car occupants, with a further 23% rated as 2-star. Only 6% of the network length surveyed fell into the lower risk range, with no sections achieving the safest category. On the measure of pedestrian safety, 95% of the network scored 3-stars, with 1% achieving the highest 5-stars.

3.7. Protection of the environment and inhabitants from the impact of road traffic (noise, water)

The motorway system in particular is built with many measures to protect the natural and living environment. On national roads, these measures are less frequent. Particularly where roads are passing towns and smaller settlements inhabitants are not protected against excessive noise.

3.8. Main weaknesses on the road network

3.8.1. Missing sections

On the main motorway system there are several missing sections M3 Porumbrei – Cimislia, bypass of town Comrat, bypass of town Vulcanesti, bypass of town Slobozia Mare, bypass of village Bahmut – R1.

3.8.2. Bottlenecks

The M1 Romanian border- Leuseni – Chisinau – Dubasari – Ukraine border, km 93- 102 is the area where traffic is already close to the limit capacity.

3.8.3. Hazardous road sections

Dangerous places are primarily on the roads:

- R3 Chisinau – Hincesti – Cimislia – Basarabeasca, km 83-84
- R1 Chisinau – Ungheni –Romanian Border, km 52+53
- R36 Ceadir Lunga – Taraclia – R32, km 51-52
- L 580 Mihailovca – Sagaidac- Valea Perjei

3.8.4. Inadequate protection of the environment and inhabitants

Most of roads are built with adequate protection against excessive noise pollution from road traffic for the living environment. At the crossings of state roads through settlements, protection is unregulated.

As a rule, measures are taken for the controlled drainage of water from roads into the arrester through containers along motorways.

3.9. Links with neighbouring countries

Road system is well connected with neighbouring countries Romania and Ukraine.

3.10. Systems for informing users of individual transport systems

3.10.1. Notification by category of roads

Based on the public authorization, traffic information on the state roads is entrusted to The State Road Administration for motorways and main and regional roads (www.asd.md)

3.10.2. Ways of informing

The traffic information center for state roads, on behalf of The State Road Administration, collects information of conditions on the state roads (such as winter conditions). This information is transmitted to the public media and users of the national road network.

3.11. Responsibility and operators

- ministry responsible for road infrastructure: Ministry of Economy and Infrastructure
- motorway operators: Ministry of Economy and Infrastructure
- operators of other state roads: Ministry of Economy and Infrastructure

4. Investing spending and maintenance expenditures[89]

4.1 Gross investment spending in road infrastructure

In 2015, **33 mio EUR** were invested in national roads.

4.2. Maintenance expenditures in road infrastructure

In 2015, **43 mio EUR** were used for the maintenance of state roads**.**

[89] [89] Goverment of Republic Moldova Ministry of economy and infrstructure 2017

5. The objectives of the transport policy and the future development of the road network

5.1. The goals of the transport policy

The vision of transport policy is defined as ensuring the sustainable mobility of the population and supplying the economy with the following objectives:

- improve mobility and accessibility,
- improve supply of the economy,
- improve road safety and security,
- reduce energy consumption,
- reduce user and operator costs,
- reduce environmental burdens.

Quality road infrastructure is one of the basic conditions for a harmonious regional development, creating the best opportunities for an efficient course of economic activity and indirectly for settling in these suitable areas of the country. Therefore, further development of national road network is necessary (building the best possible road network and maintaining and upgrading the already built network at an appropriate level).

5.2. The main priorities of road development

General measures are in areas such as:

- ensuring an adequate standard of existing road infrastructure, including road rehabilitation,
- traffic safety,
- protection of the natural and living environment from the impact of road transport,
- improving accessibility to regional centers,
- preparedness for extreme weather events and
- road measures in individual parts of the country

The following major projects are planned on the road network:

- construction of the bypass of village Bahmut
- construction of M3 Porumbrei - Cimislia
- construction of the bypass of village Vulcanesti
- rehabilitation of M3 Chisinau-Giurgiulesti (2021)
- rehabilitation of R1 Chisinau – Ungheni (2018)
- rehabilitation of R33 Hincesti- Lapusna- M1 (2019)
- rehabilitation of R14 Balti-Sarateni
- rehabilitation of R16 Balti- Falesti – Sculeni (2019)
- rehabilitation of R34 Hincesti – Leova- Cahul –M3 (2021)

- rehabilitation of R9 Soroca – Arionesti (2021)

6. Road management

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure. In Moldova a computer-aided system (e.g. DTIMS_CT or PMS (Pavement Management System)) is under implementation.

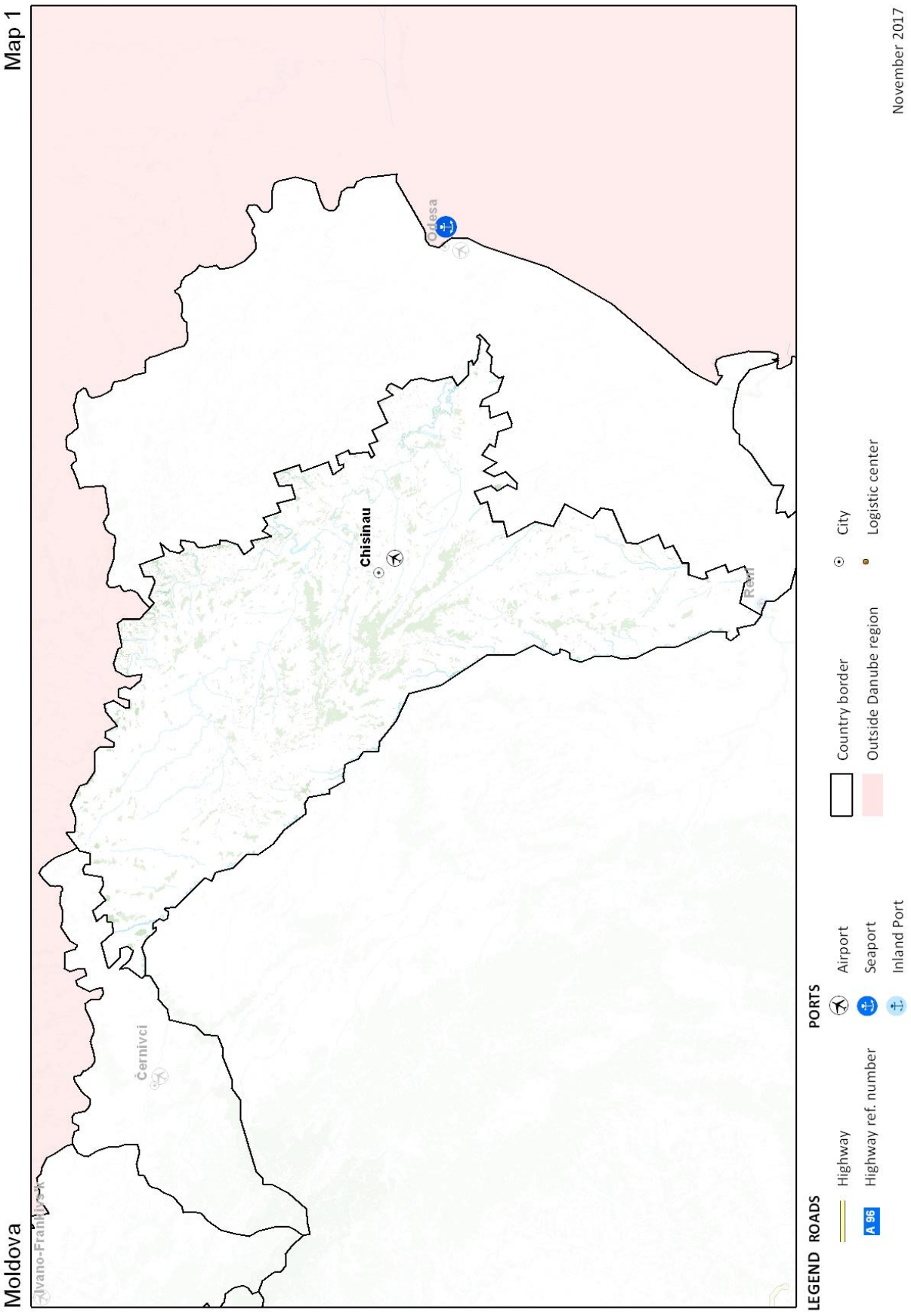

Figure 61: Motorway map of Moldova

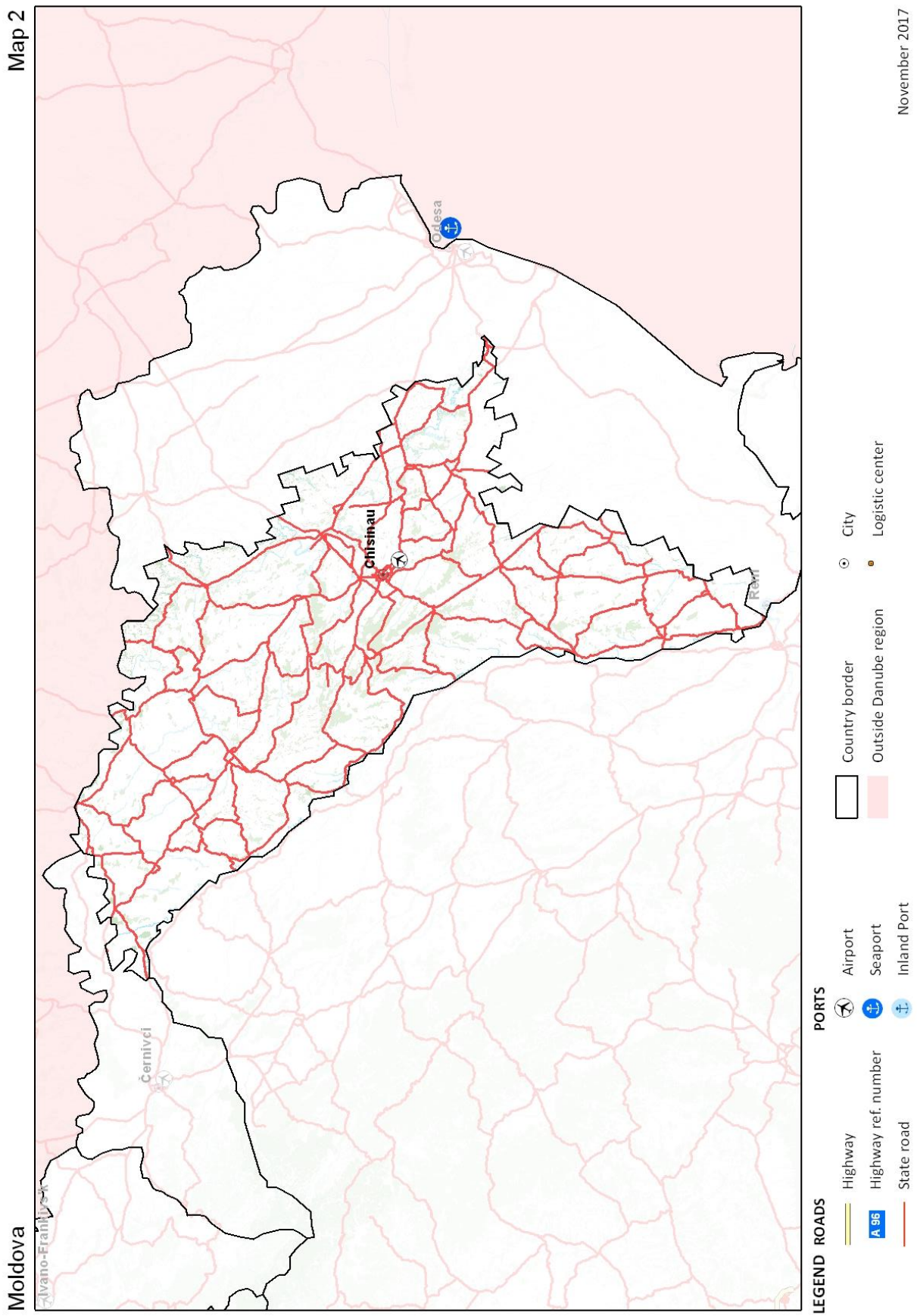

Figure 62: Motorway and main road map of Moldova

4.2.13 Danube Region roads: ODESSA[90]

1. General data

- Inhabitants / 2016: **2.382.671**
- membership in the EU: **no**
- GDP / 2016 in EUR million: **5.255**
- GDP per capita / 2016 in EUR: **2.206**
- capital city: **Odessa**
- land area - km²: **33.314**
- km of roads per million inhabitants: **6.980**
- km of roads per km² of the land area: **0,50**
- km of motorways per million inhabitants: **0**
- km of motorways per km² of the land area: **0,000**

2. Description of the road network

- length of main or national roads (2016) – km: **8.136**
- length of secondary or regional roads (2016) – km: **704**
- length of other roads (2016) – km: **7.612**
- total lengths of all roads (2016) – km: **16.632**

3. Main features of the road network

3.1. Traffic

3.1.1. General traffic estimates:

Traffic loads are large and concentrated in the area of capital city Odessa and in the direction of the transit corridor north – south and west – east. Traffic is both domestic and transit.

3.1.2. Average annual daily traffic (AADT)

- Average annual daily traffic (AADT) on all state roads (2016): **25.842**
- Average annual daily traffic (AADT) on main or national roads (2016): 2**3.959**
- Average annual daily traffic (AADT) on secondary or regional roads (2016): **1.883**

3.2. Toll system

There is no toll system.

[90] State Road Agency of Ukraine (Ukravtodor)

3.3. Speed Limits

- speed limits on motorways: **130 km/h**
- speed limits on other national roads: **90/60 km/h**

3.4. Traffic safety

- Traffic safety - number of killed persons in road accidents in 2016 were: **115**
- Traffic safety - number of killed persons per million inhabitants in road accidents in 2016 were: **48**

3.5. Links with neighbouring countries

Odessas roads system is well connected with neighbouring countries.

3.6. Responsibility and operators

- ministry responsible for road infrastructure: **Ministry of Infrastructure of Ukraine**
- motorway operators: **Road service in Odesa region**
- operators of other state roads: **Road service in Odesa region**

4. Road management

Basis for optimal road management are various measurements that enable the assessment of the actual quality of the infrastructure.

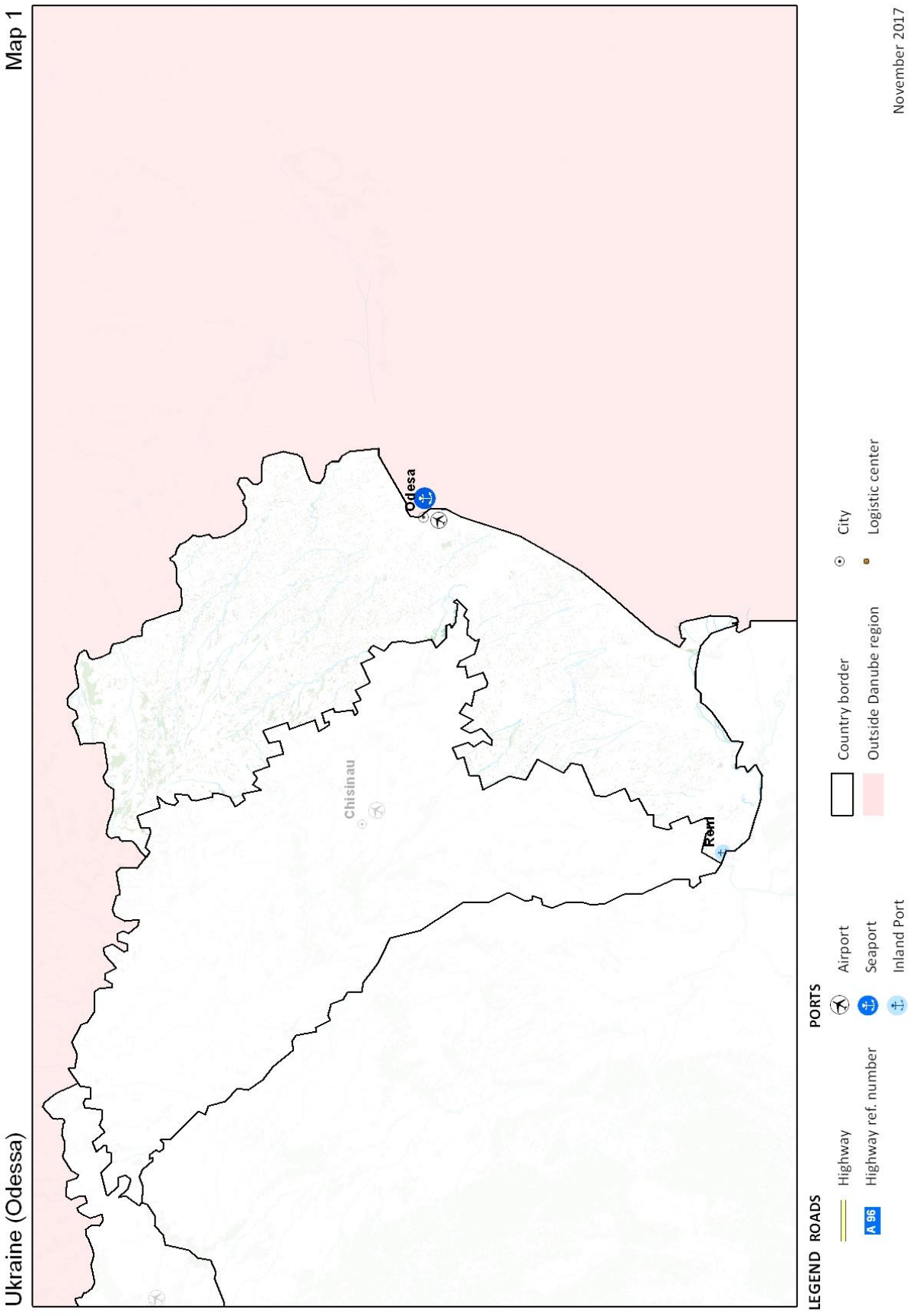

Figure 63: Motorway road map of Odessa oblast (Ukraine)

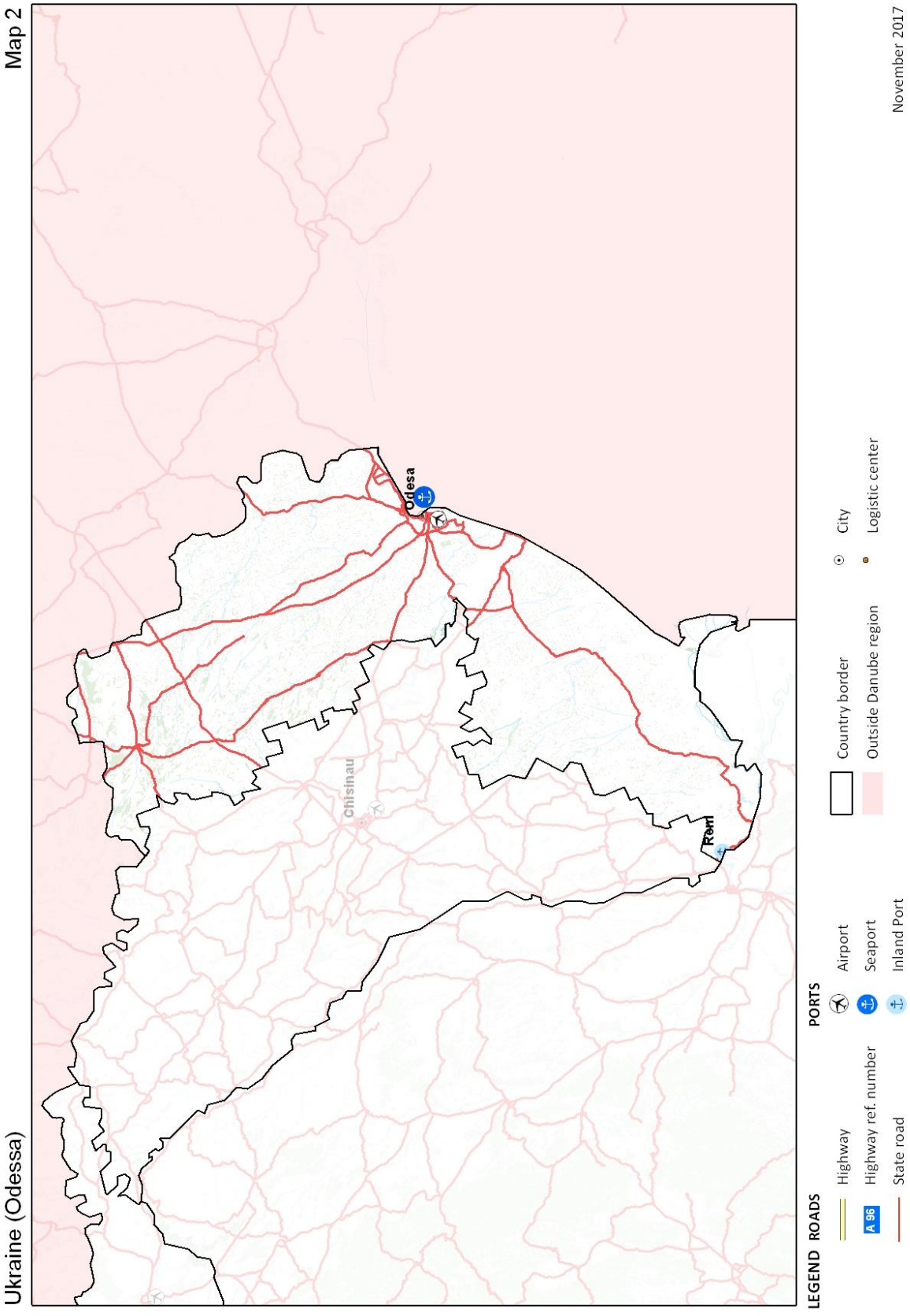

Figure 64: Motorway and main road map of Odessa oblast (Ukraine)

4.2.14 Danube Region roads: IVANO FRANKIVSKA[91]

1. General data

- Inhabitants / 2016: **1.406.129**
- membership in the EU: **no**
- GDP / 2016 in EUR million: **3.101**
- GDP per capita / 2016 in EUR: **2.206**
- capital city: **Ivano Frankivska**
- land area - km²: **13.900**
- km of roads per million inhabitants: **2.923**
- km of roads per km² of the land area: **0,30**
- km of motorways per million inhabitants: **0**
- km of motorways per km² of the land area: **0,000**

2. Description of the road network

- length of main or national roads – km:**438**
- length of secondary or regional roads – km: **557**
- length of other roads – km: **3.115**
- total lengths of all roads – km: **4.110**
- length of national roads without anti-dust protection – km: **405**

3. Main features of the road network

3.1 Traffic

3.1.1 General traffic estimates:

Traffic loads are large and concentrated in the area of capital city Ivano Frankivska and in the direction of the transit corridor northwest – southeast. Traffic is both domestic and transit. For personal transit traffic represents ...%, while freight transport in transit represent ...%.

3.1.2. Average annual daily traffic (AADT)

- Average annual daily traffic (AADT) on all state roads (2016): **6.332**
- Average annual daily traffic (AADT) on main or national roads (2016): **8.600**
- Average annual daily traffic (AADT) on secondary or regional roads (2016): **2.699**

[91] State Road Agency of Ukraine (Ukravtodor)

3.2. Toll system

There is no toll system.

3.3. Speed Limits

- speed limits on motorways: **130 km/h**
- speed limits on other national roads: **90/60 km/h**

3.4. Traffic safety

- Traffic safety - number of killed persons in road accidents in 2016 were: **97**
- Traffic safety - number of killed persons per million inhabitants in road accidents in 2016 were: **69**

3.5. Links with neighbouring countries

Ivano Frankivskas roads system is well connected with neighbouring countries.

3.6. Responsibility and operators

- ministry responsible for road infrastructure: **Ministry of Infrastructure of Ukraine**
- motorway operators: **Branch of the state enterprise "Ivano-Frankivsk Oblavtodor"**
- operators of other state roads: **Branch of the state enterprise "Ivano-Frankivsk Oblavtodor"**

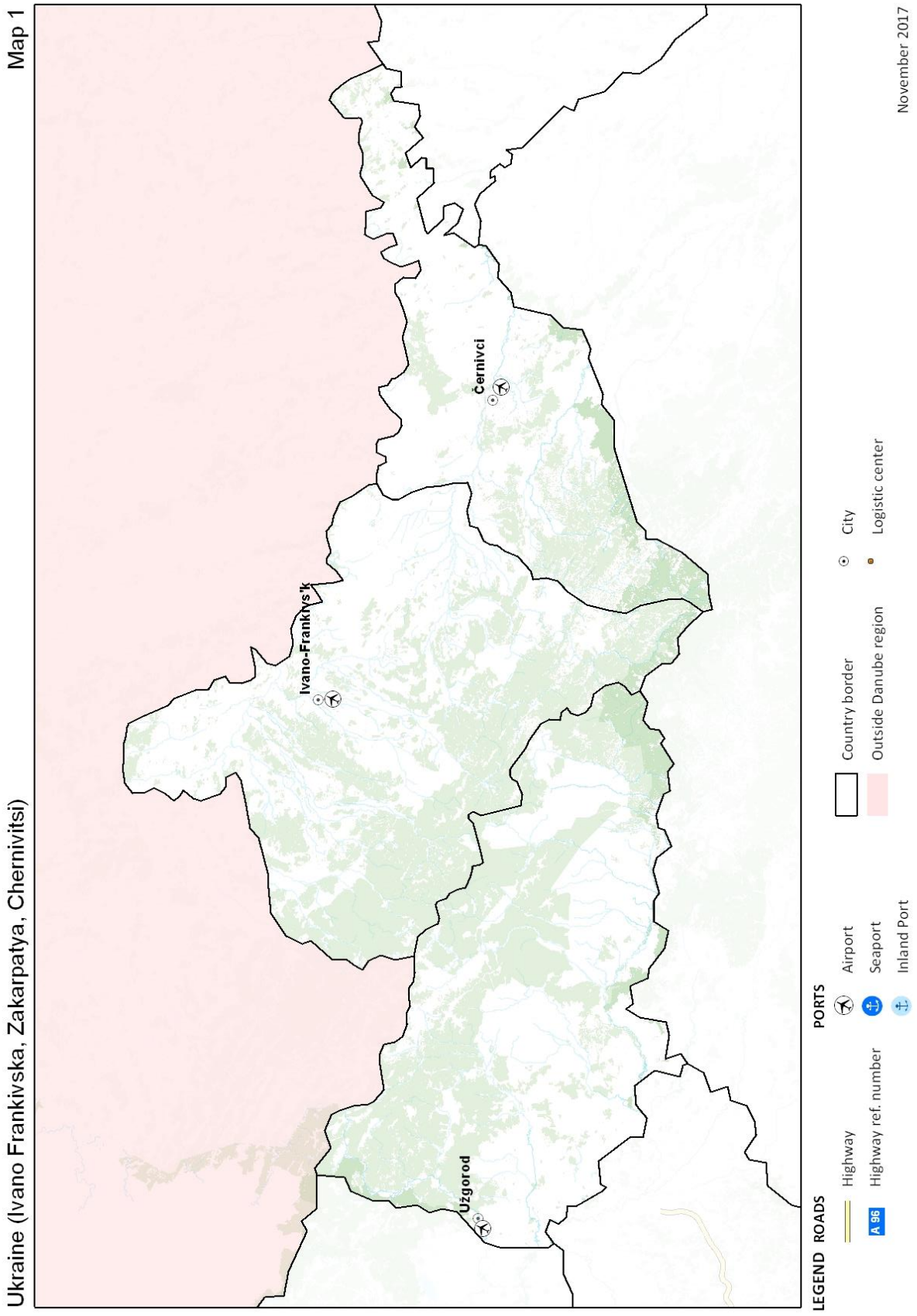

Figure 65:: Motorway road map of Ivano Frankivska (Ukraine)

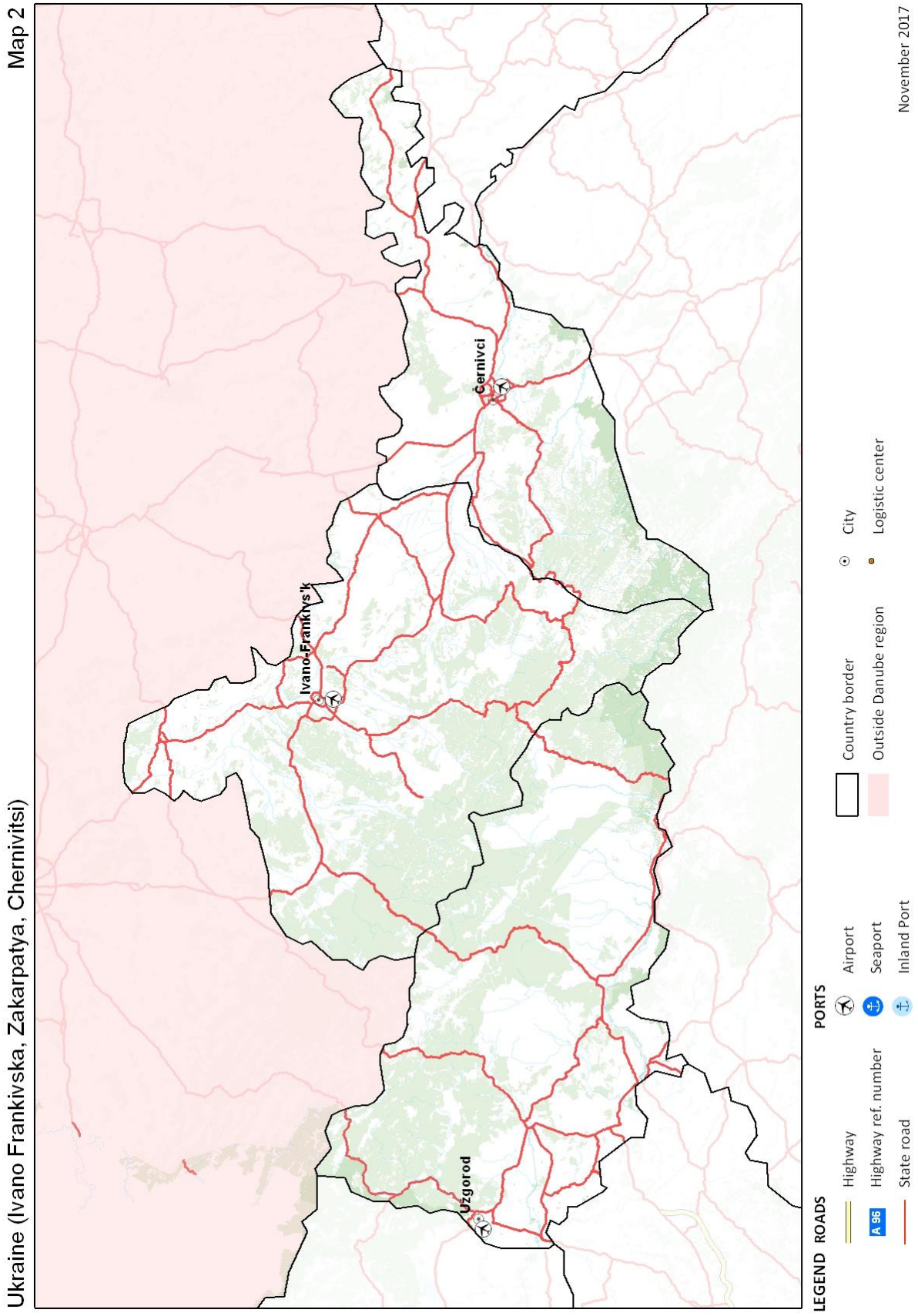

Figure 66: Motorway and main road map of Ivano Frankivska (Ukraine)

4.2.15 Danube Region roads: CHERNIVITSI[92]

1. General data

- Inhabitants / 2016: **922.800**
- membership in the EU: **no**
- GDP / 2016 in EUR million**: 2.035**
- GDP per capita / 2016 in EUR million: **2.206**
- capital city: **Chernivitsi**
- land area - km²: **8.100**
- km of roads per million inhabitants: **3.472**
- km of roads per km² of the land area: **0,40**
- km of motorways per million inhabitants: **0**
- km of motorways per km² of the land area: **0**

2. Description of the road network

- length of main or national roads (2016) – km: **2.886**
- length of secondary or regional roads (2016) – km: **117**
- length of other roads – km: **201**
- total lengths of all roads (2016) – km: **3.204**

3. Main features of the road network

3.1 Traffic

3.1.1. General traffic estimates:

Traffic loads are large and concentrated in the area of capital city Chernivitsi and in the direction of the transit corridor north – south. Traffic is both domestic and transit.

3.1.2. Average annual daily traffic (AADT)

- Average annual daily traffic (AADT) on all state roads (2016): **2.316**
- Average annual daily traffic (AADT) on main or national roads (2016): **11.468**
- Average annual daily traffic (AADT) on secondary or regional roads (2016): **2.706**

3.2. Toll system

There is no toll system.

[92] State Road Agency of Ukraine (Ukravtodor)

3.3. Speed Limits

- speed limits on motorways: **130 km/h**
- speed limits on other national roads: **90/60 km/h**

3.4. Traffic safety

- Traffic safety - number of killed persons in road accidents in 2016 were: **24**
- Traffic safety - number of killed persons per million inhabitants in road accidents in 2016 were: **26**

3.5. Links with neighbouring countries

Chernitsis roads system is well connected with neighbouring countries.

3.6. Responsibility and operators

- ministry responsible for road infrastructure: **Ministry of Infrastructure of Ukraine**
- motorway operators: **Road service in Chernivitsi region**
- operators of other state roads: **Road service in Chernivitsi region**

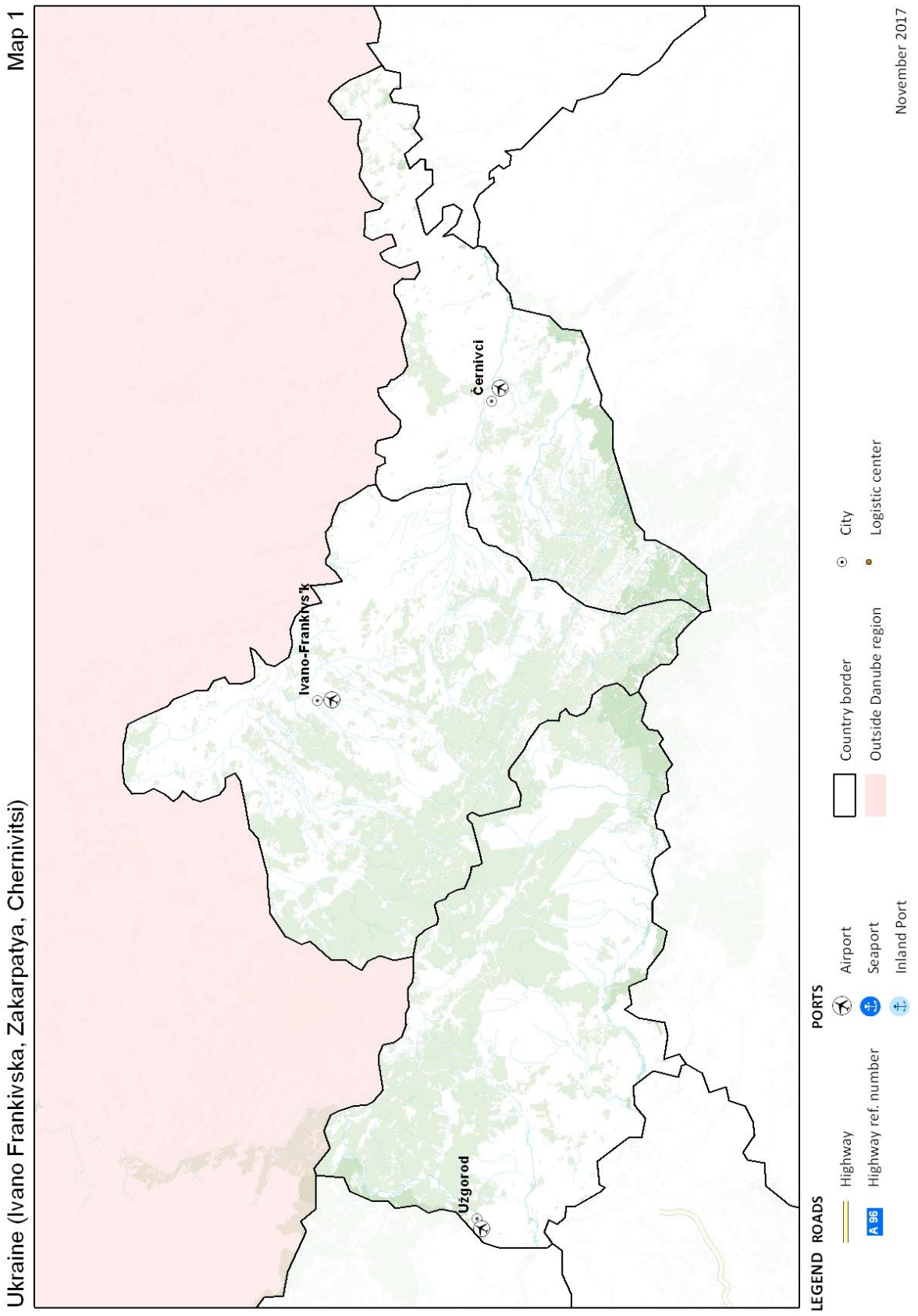

Figure 67: : Motorway map of Chernivitsi (Ukraine)

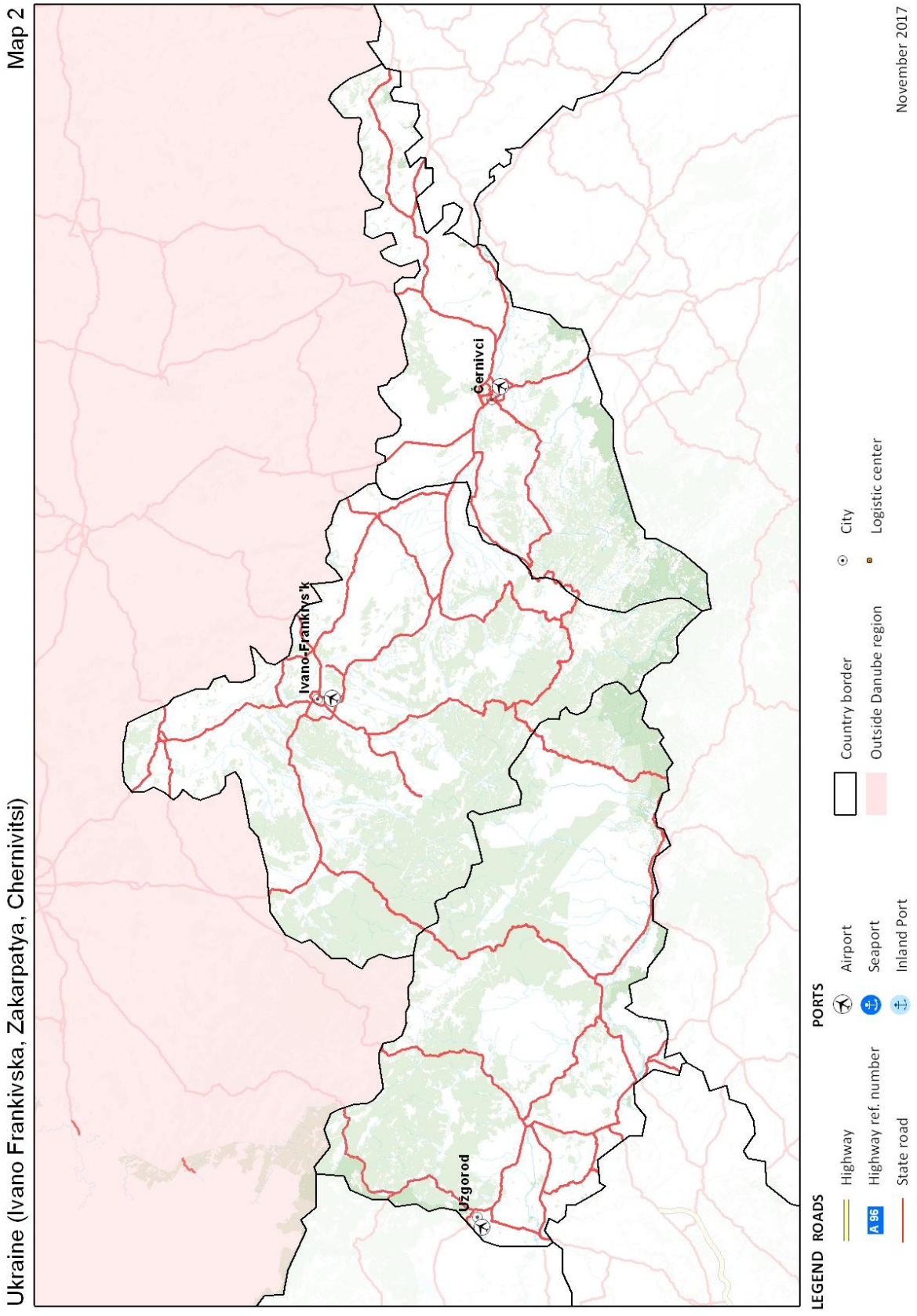

Figure 68:: Motorway and main road map of Chernivitsi (Ukraine)

4.2.16 Danube Region roads: ZAKARPATYA[93]

1. General data

- Inhabitants / 2016: **1.247.400**
- membership in the EU: **no**
- GDP / 2016 in EUR million: **2.840**
- GDP per capita / 2016 in EUR: **2.206**
- capital city: **Uzhorod**
- land area - km²: **12.735**
- km of roads per million inhabitants: **7.467**
- km of roads per km² of the land area: **0,76**

2. Description of the road network

- length of main or national roads (2016) – km: **3.348**
- length of secondary or regional roads (2016) – km: **382**
- length of other roads (2016) – km: **5.883**
- total lengths of all roads (2016) – km: **9.613**

3. Main features of the road network

3.1 Traffic

3.1.1 General traffic estimates:

Traffic loads are large and concentrated in the area of capital city Uzhhorod and in the direction of the transit corridor northwest – southeast. Traffic is both domestic and transit.

3.1.2. Average annual daily traffic (AADT)

- Average annual daily traffic (AADT) on all state roads (2016): **8.400**
- Average annual daily traffic (AADT) on main or national roads (2016): **20.000**
- Average annual daily traffic (AADT) on secondary or regional roads (2016): **5.500**

3.2 Toll system

There is no toll system.

3.3 Speed Limits

- speed limits on motorways: **130 km/h**
- speed limits on other national roads: **90/60 km/h**

[93] State Road Agency of Ukraine (Ukravtodor)

3.4 Traffic safety

- Traffic safety - number of killed persons in road accidents I 2016 were: **91**
- Traffic safety - number of killed persons per million inhabitants in road accidents in 2016 were: **71**

3.5 Links with neighbouring countries

Zakarpatyas roads system is well connected with neighbouring countries.

3.6 Responsibility and operators

- ministry responsible for road infrastructure: **Ministry of Infrastructure of Ukraine**
- motorway operators: **State Enterprise "Zakarpatya Oblavtodor"**
- operators of other state roads: **State Enterprise "Zakarpatya Oblavtodor"**

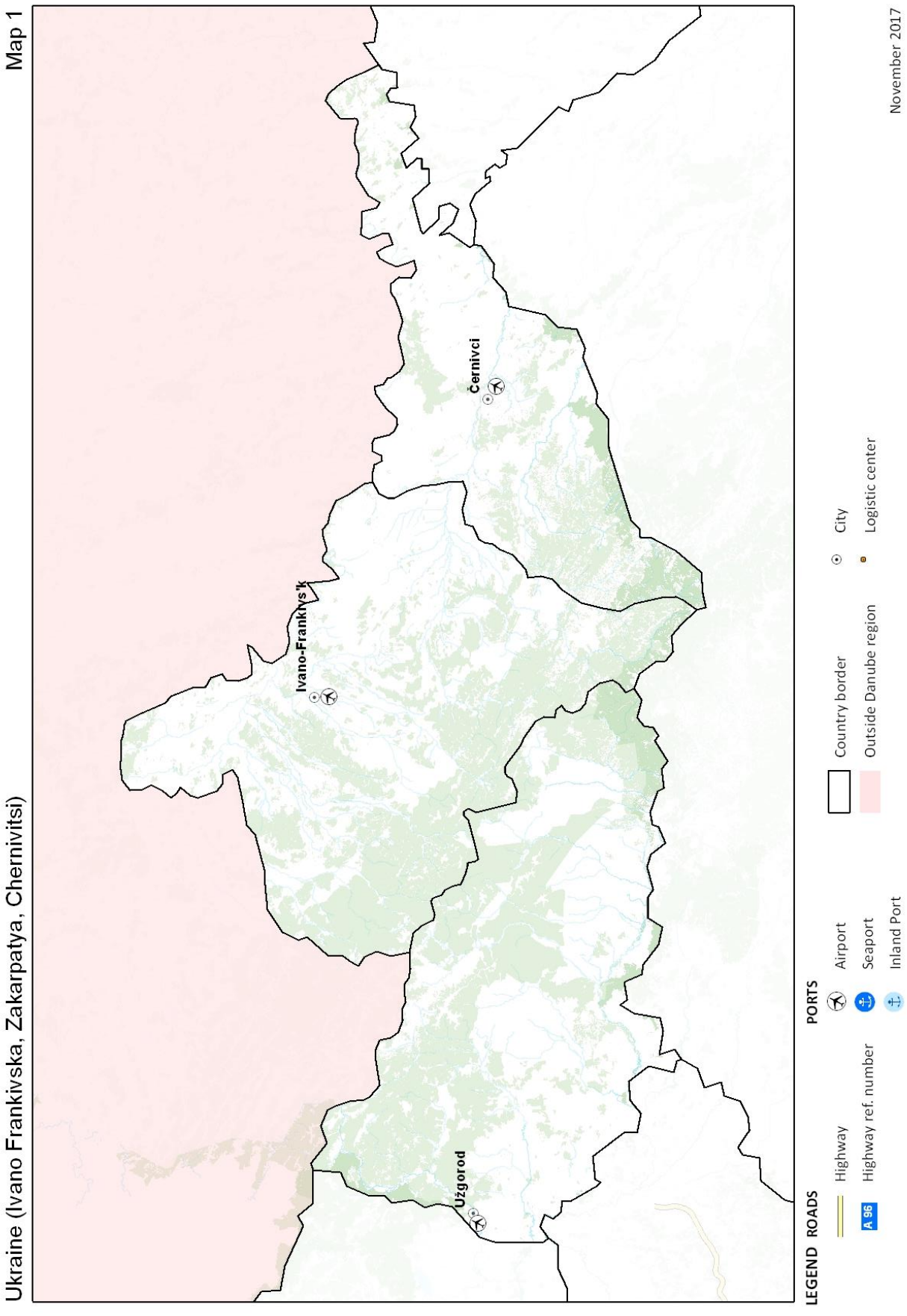

Figure 69: : Motorway map of Zakarpatya (Ukraine)

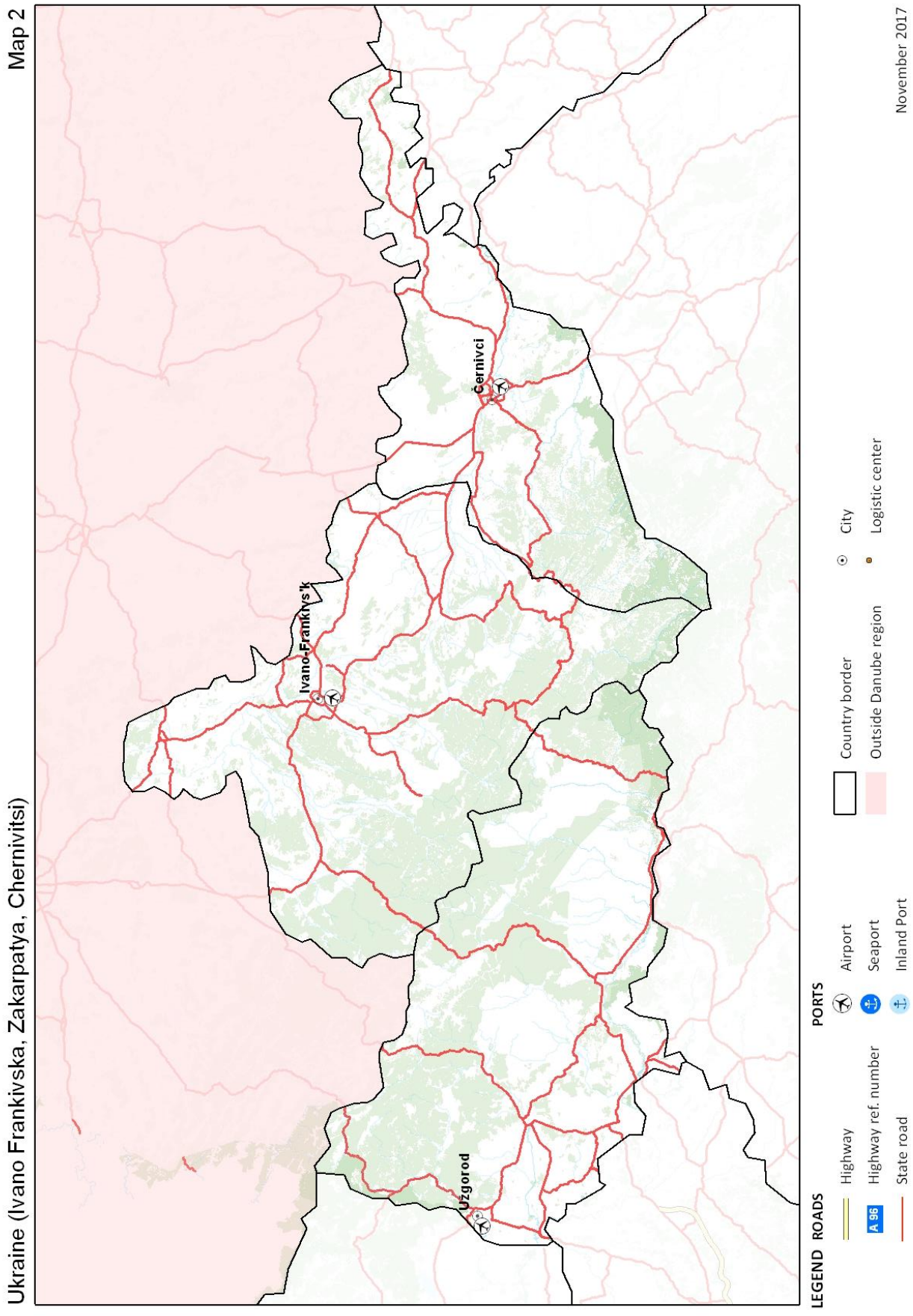

Figure 70: : Motorway and main road map of Zakarpatya (Ukraine)

4.2.17 Danube Region roads: BULGARIA

1. General data[94]

- Inhabitants / 2016: **7.153.784**
- membership in the EU: **1.1.2007**
- GDP / 2016 in EUR million: **47.364,1**
- GDP per capita / 2016 in EUR: **6.621**
- capital city: **Sofia**
- land area - km²: **110.370**
- km of roads per million inhabitants: **2.782**
- km of roads per km² of the land area: **0,18**
- km of motorways per million inhabitants: **103**
- km of motorways per km² of the land area: **0,007**

2. Description of the road network[95]

- length of motorways (2016) – km: **740**
- length of main or national roads (2016) – km: **2.983**
- length of secondary or regional roads (2016) – km: **4.028**
- length of other roads (2016) – km: **12.151**
- total lengths of all roads (2016) – km: **19.902**
- length of national roads without anti-dust protection (2016) – km: **408**

3. Main features of the road network

3.1. Traffic

3.1.1. General traffic estimates:

Traffic loads are large and concentrated in the area of large big cities like Sofia and Varna and in the direction of the transit corridors west - east. Traffic is both domestic and transit.

3.1.2. Average annual daily traffic (AADT)[96]

- Average annual daily traffic (AADT) on motorways: **21.696**
- Average annual daily traffic (AADT) on main or national roads: **8.630**
- Average annual daily traffic (AADT) on secondary or regional roads: **6.559**

[94] Official website of the European Union
[95] National Statistical Institute
[96] Bulgarian Construction Chamber

3.2. International road corridors:

- TEN-T corridor:

    - ***Orient - East Mediterranean Corridor****: Rostock – Praha – Bratislava – Budapest – Belgrade – Sofia - Athens*

3.3. Toll system

On motorways and expressways is toll collection system with vignettes for 1 day, weekly, monthly or year.

3.4. Speed Limits[97]

- speed limits on motorways: **130 km/h**
- speed limits on other national roads: **50/90 km/h**

3.5. Traffic safety [98]

- Traffic safety - number of killed persons in road accidents in year 2016 were: **708**
- Traffic safety - number of killed persons per million inhabitants in road accidents in year 2016 were: **99**

There were 31 % less fatal accidents (deaths) on the roads between 2005 and 2014.

3.6. Protection of the environment and inhabitants from the impact of road traffic (noise, water)

The motorway system in particular is built with many measures to protect the natural and living environment. Thus, most settlements along motorways and expressways are protected by active anti-noise protection measures. On national roads, these measures are less frequent. Particularly where roads are passing towns and smaller settlements inhabitants are not protected against excessive noise.

3.7. Main weaknesses on the road network

3.7.1. Missing sections

- Sofia – Varna - section Jablanica – Šumen
- Sofia – Thessaloniki (Greece), section Blagoevgrad – Sandanski
- Sofia – Belgrade, section Sofia – border with Serbia

[97] Road Statistics Yearbook 2016
[98] National Statistical Institute

3.7.2. Inadequate protection of the environment and inhabitants

Most of roads are built with adequate protection against excessive noise pollution from road traffic for the living environment. At the crossings of state roads through settlements, protection is unregulated.

Controlled drainage of water from roads is not constructed on motorways.

There are no green bridges for wildlife to pass across motorways.

3.8. Links with neighbouring countries

Bulgarian motorway system is well connected with neighbouring countries Greek and Turkey.

Unfinished connections are with Serbia and Romania.

3.9. Responsibility and operators

- ministry responsible for road infrastructure: **Ministry of Regional Development and Public Works**
- motorway operators: **Road Infrastructure Agency**
- operators of other state roads: **Road Infrastructure Agency.**

4. Investing spending and maintenance expenditures[99]

4.1. Gross investment spending in road infrastructure

In 2013 **359,00 mio EUR** it were invested in national roads.

4.2. Maintenance expenditures in road infrastructure

In 2013, **95,61 mio EUR** were used for the maintenance of state roads.

[99] Road Statistics Yearbook 2016

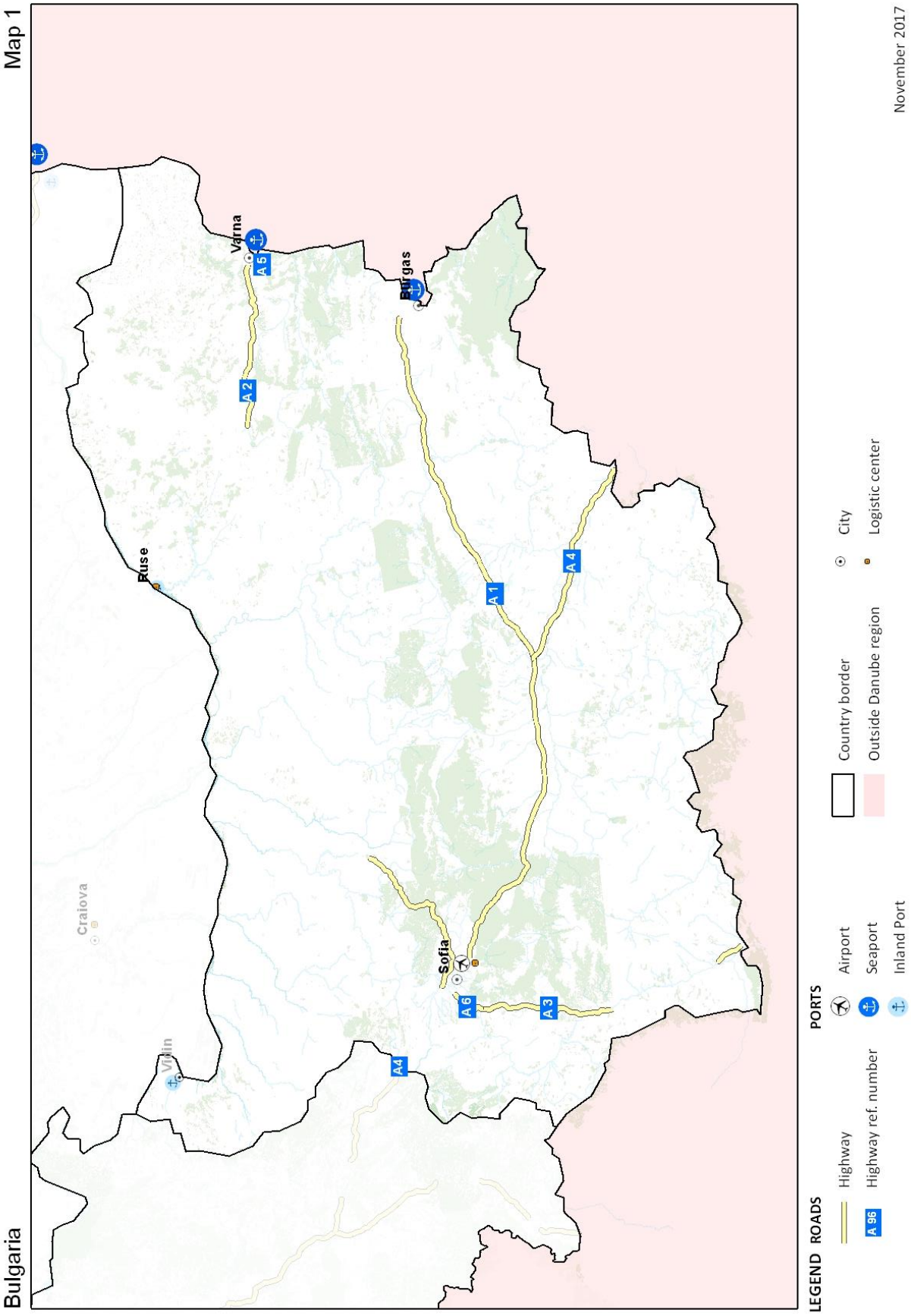

Figure 71: Motorway map of Bulgaria

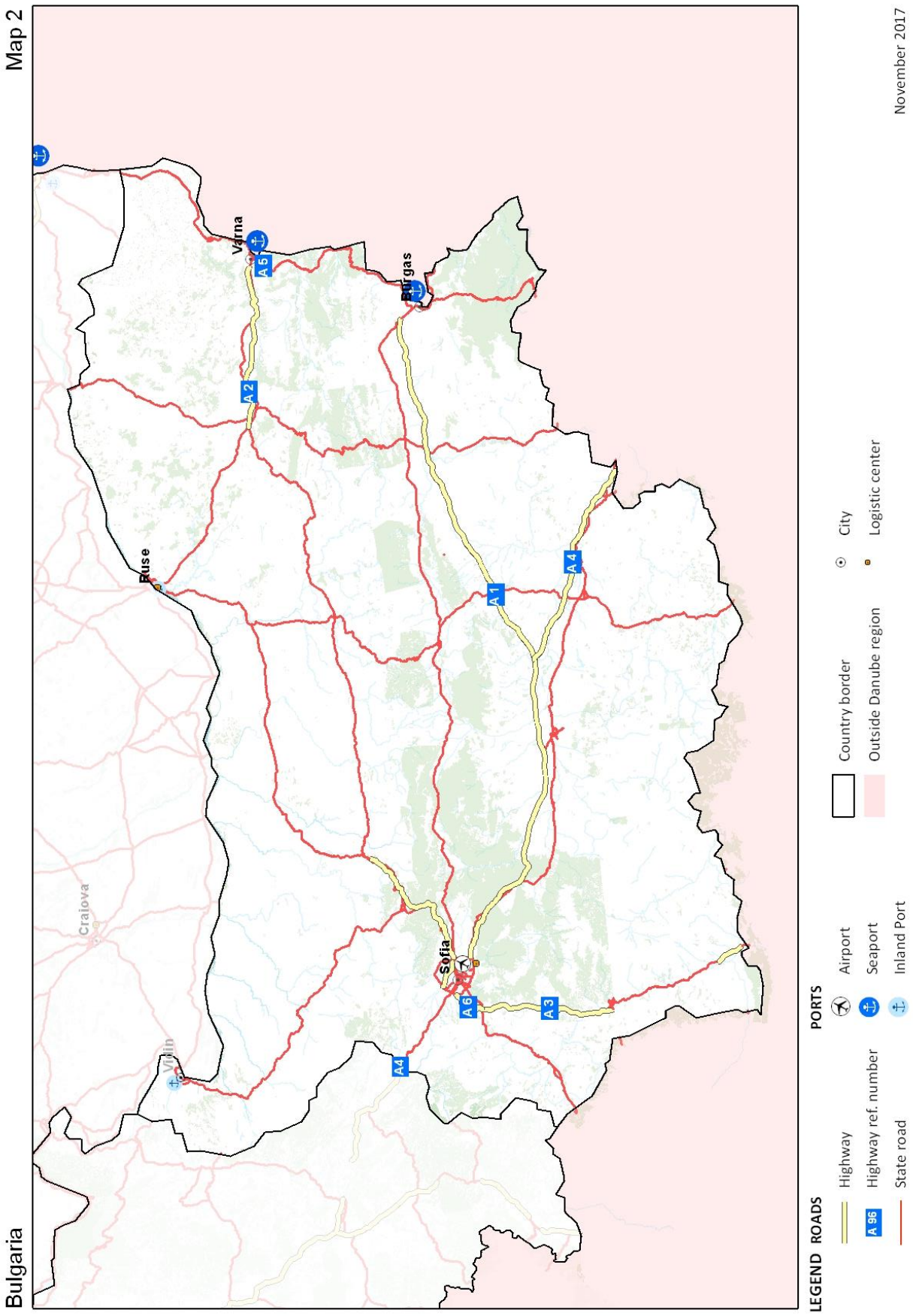

Figure 72: Motorway and main road map of Bulgaria

4.2.18 Danube Region roads: ROMANIA

1. General data[100]

- Inhabitants / 2016: **19.760.314**
- membership in the EU: **1.1.2007**
- GDP / 2016 in EUR million: **169.578,1**
- GDP per capita / 2016 in EUR: **8.582**
- capital city: **Bucharest**
- land area - km²: **238.391**
- km of roads per million inhabitants: **4.328**
- km of roads per km² of the land area: **0,36**
- km of motorways per million inhabitants: **33**
- km of motorways per km² of the land area: **0,003**

2. Description of the road network[101]

- length of motorways (2013) – km: **644**
- length of main or national roads (2013) – km: **17.110**
- length of secondary or regional roads (2013) – km: **35.587**
- length of other roads (2013) – km: **32.190**
- total lengths of all roads (2013) – km: **85.531**

3. Main features of the road network

3.1 Traffic

3.1.1. General traffic estimates:

Traffic loads are large and concentrated in the area of large big cities like Bucharest and Timisoara and in the direction of the transit corridors northwest - southeast. Traffic is both domestic and transit.

3.2 International road corridors:

- TEN-T corridors:
  - ***Rhine – Danube Corridor****: Frankfurt – Munich – Praha - Vienna – Bratislava – Budapest – Bucharest - Constanta*
  - ***Orient - East Mediterranean Corridor****: Rostock – Praha – Bratislava – Budapest – Belgrade – Sofia - Athens*

[100] Official website of the European Union
[101] Eurostat, IRF 2013

3.3 Toll system

On motorways and expressways is toll collection system with vignettes for 1 day, weekly, monthly or year.

3.4 Condition of road surfaces and structures

3.5 Speed Limits[102]

- speed limits on motorways: **130 km/h**
- speed limits on other national roads: **50/90/100 km/h**

3.6 Traffic safety [103]

- Traffic safety - number of killed persons in road accidents in year 2014 2016 were: **1818**
- Traffic safety - number of killed persons per million inhabitants in road accidents in year 2014 were: **92**

There were 31 % less fatal accidents (deaths) on the roads between 2005 and 2014.

3.7.1. Missing sections

In the following directions, there are missing sections of motorways or expressways:

- Bucharest – Budapest, section Sibiu – Pitesti.

3.8. Links with neighbouring countries

Romanian motorway system is well connected with neighbouring country Hungary.

There are no connections with Serbia, Ukraine, Moldova and Bulgaria.

4. Investing spending and maintenance expenditures[104]

4.1. Gross investment spending in road infrastructure

In 2013, **2.729,00 mio EUR** were invested in national roads.

[102] Road Statistics Yearbook 2016
[103] Road Statistics Yearbook 2016
[104] Road Statistics Yearbook 2016

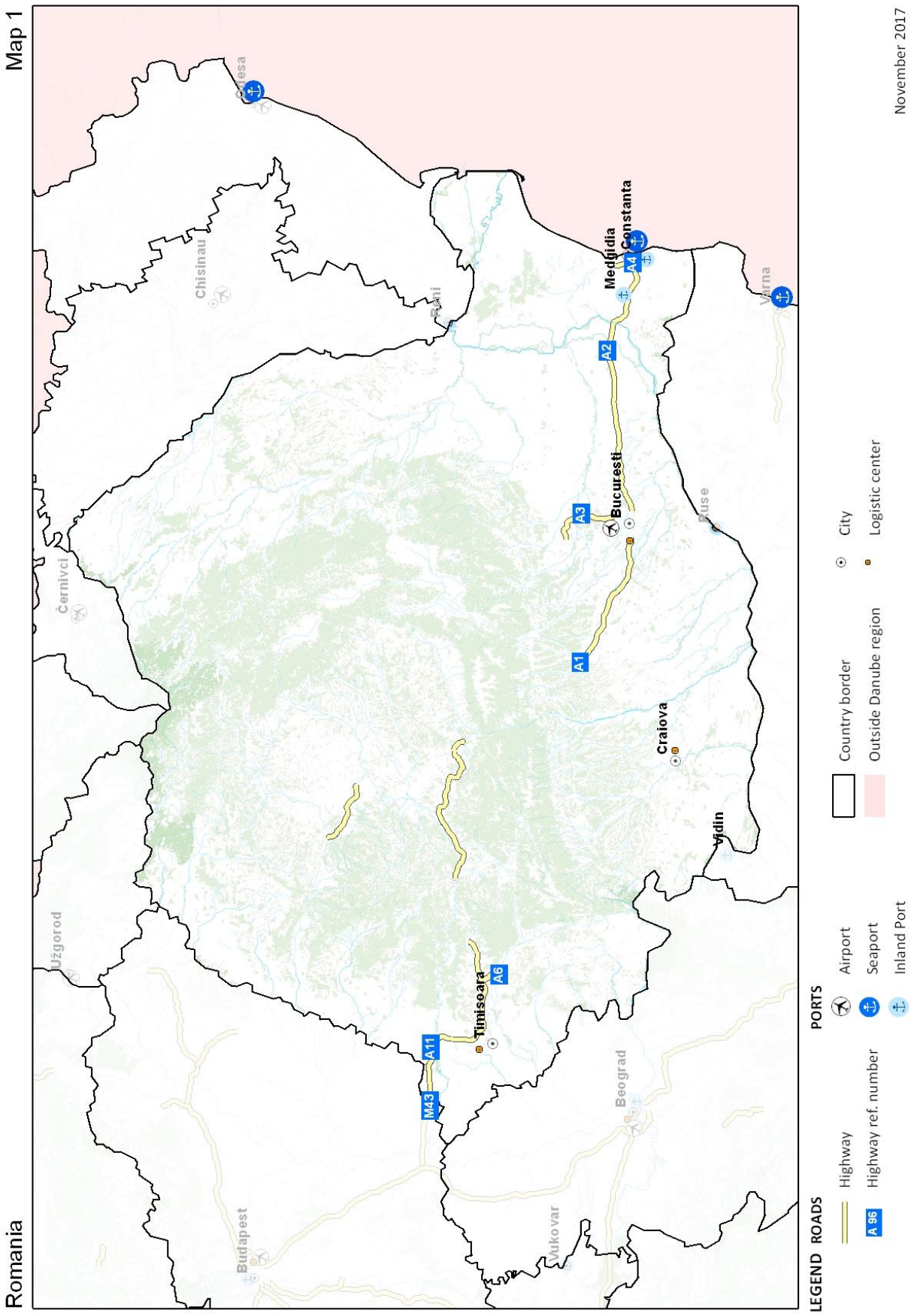

Figure 73: Motorway map of Romania

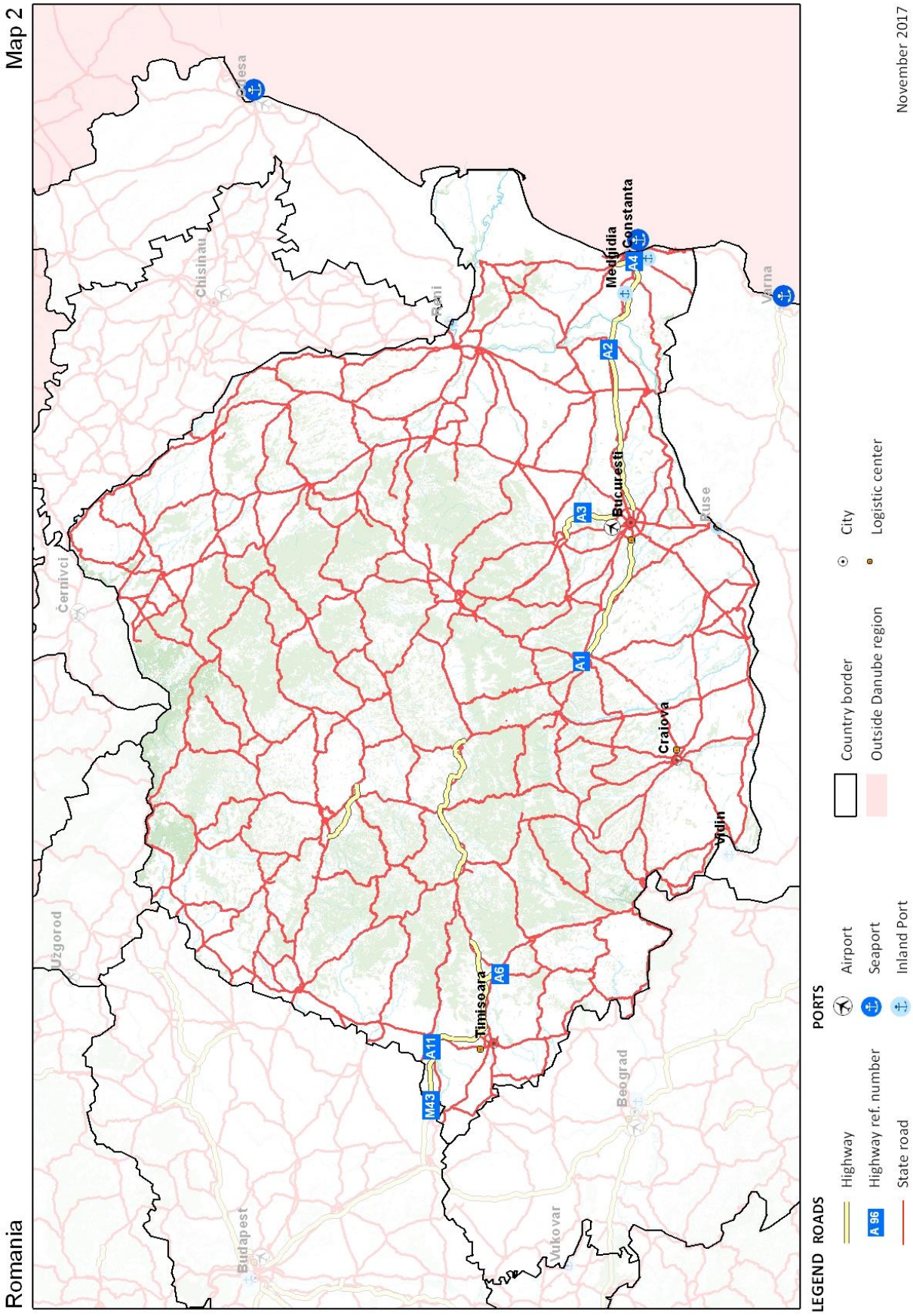

Figure 74: Motorway and main road map of Romania

5 CONCLUSION

The Transport Infrastructure Study in the Danube region - road links, shows the basic data on the network in the Danube region.

The study is based on a number of data from available EU databases. In addition, data from individual countries were obtained in three rounds. In doing so, experts from various countries were involved.

The diversity of development, landscape and climatic conditions are also conditioned by the diversity of the approach to road problems in each country. Nevertheless, the study shows the characteristics of roads in the Danube Region. From gathered data a big difference in scale and condition of road network between countries/states in the region, was noticed.

The classification of national roads in individual categories is not uniform in all countries. Nevertheless, we followed the sorting in the EU bases and tried to unify the categories as much as possible.

The study will be able to serve a number of purposes, for further joint treatment of roads in the Danube Region. It represents a good database for further collusion and decision making on roads in this region. On the basis of the data from the study, it will be possible to expand the knowledge of roads in the Danube Region with additional contents.

Road network is a national treasure to the country and to the whole region. Therefore, this infrastructure should be properly maintained. Proper maintenance is presented in a chapter about pavement management system. PMS system enables a user to choose the most optimal investment in the road network. A well maintained network is the basic condition for a smooth mobility in a country and also for the whole region. In this area there are a lot of possibilities for further cooperation between the countries of the region.

Alongside road conservation, there are other important elements, such as: traffic safety, influence of roads on the environment and constant traffic flow.

Roads are an infrastructure element which has to be, for the satisfaction of users and functionality of the state, open for traffic all hours in a year. This is the reason why full attention has to be given to road networks. Basic condition for effective management is a good database, which can give as a well-defined overview of the condition and scale of road network.

This elaborate gives us one of the steps to better overview of the roads of the Danube region and can be useful to anyone who is dealing with this subject.
