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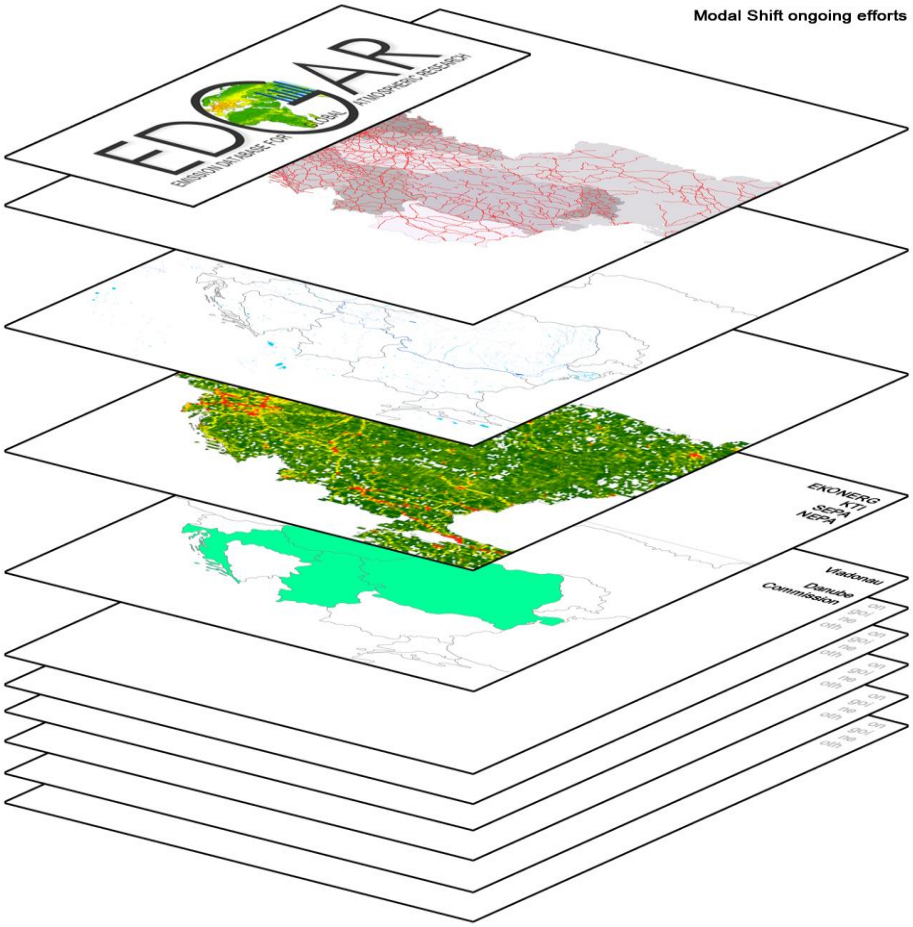
The impact of a modal shift in transport on emissions to the atmosphere:

Methodology development for the best use of the available information and expertise in the Danube Region



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Abstract

A modal shift in transport can represent a promising option where the economic added value is demonstrated. However, the impact of this action on the environment is important as well. In the framework of the JRC scientific support to the Danube Strategy, the EDGAR modal shift initiative focuses on the emissions evaluation for ex-post modal shift scenarios, as a contribution to the Danube Air Nexus. Given the complexity of this topic, a methodology for the best use of the available information and expertise in the Danube Region has been developed and is presented in this report.

This work is the outcome of the joint efforts of the JRC/EDGAR team, country emission experts and relevant institutions in the Danube Region. It shows that, in addition to the EDGAR data and gridding tool, the participation by and contributions of experts from the Danube Region is essential in compiling emissions from the transport sector and enriching knowledge of variations in national circumstances, on inland domestic and international shipping and by bringing details of ship and truck freight transport.

Considering the transboundary characteristics of the transport sector, the EDGAR team developed a Web-based emissions gridding tool (EDGAR.ms) to be used by experts, institutions and authorities in the region to distribute emissions from road transport sector in a consistent manner. Emission experts from four countries (Hungary, Romania, Serbia and Croatia) tested the EDGAR.ms tool with their national data and this user friendly application is now available to all country emission experts in the Danube Region (upon request). Regarding navigation, the contribution of Viadonau and Danube Commission is essential to evaluate ship emissions. It is appreciated that, this scientific network, which includes both EU and Non-EU countries, has the capability to explore and evaluate emissions changes from a modal shift in transport and to identify the advantages and drawbacks related to emission patterns changes but to be fully comprehensive, this undertaking requires participation/contribution from specialized institutions in the region and country emission experts from the entire Danube Region.

1. Introduction

The work presented in this report was performed in the framework of the Danube Air Nexus of the "JRC scientific support to the European Union Strategy for the Danube Region (EUSDR)". Since the Danube Region includes both EU Member States and Non-EU Countries, connecting the expertise/ideas of people in the region by building on significant research perspectives is of utmost importance both for a consistent implementation of this macro-region strategy and for the future development of the region (EUSDR, 2010). Moreover, integrated approaches e.g. environment-mobility-economic development and human resource development are encouraged by the EUSDR (EUSDR/Action Plan, 2010). One of the priorities of the EUSDR under Pillar 1 "Connect the region" is focused on improving mobility and multimodality considering inland waterways (PA1a), and road, rail and air links (PA1b). The transport sector in the Danube Region, which is increasingly transnational, needs comprehensive knowledge on which transport modes are more beneficial not just economically but also environmentally. So, an integrated view on the transportation in the region is needed considering e.g. impacts on air quality (PA6-to preserve biodiversity, landscape and the quality of air and soil) while improving mobility and multi-modality by avoiding congestion/bottlenecks in order to support a shift to more energy efficient and environmentally friendly transport modes like rail and water.

As road freight transport contributes more and more to both environmental pollution and congestion, modals shift actions are seen as an alternative, which could influence the supply chain and economic cost (Marco Polo, 2015a). However, the implementation of modal shift projects is driven by their economic benefit in the current market conditions. An example of a modal shift project - trucks to ships - for the Danube Region is the "Via Danube" project (partners: Intershipping Ltd. Burgas, Bulgaria and Intershipping Romania SRL). This project aims to upgrade the Danube as a freight corridor from northern France via Germany to the Black Sea; the fleet on the Danube has been increased with an addition of four river-going barges powered by push-boat units used for freight travelling from Passau in Bavaria to Vidin/Russe (Marco Polo, 2015b).

This work explores the changes in pollutant emissions pattern changes of trucks to ships modal shifts under different ex-post scenarios. These emission scenarios will be used as input for a second study to further investigate the benefits of sustainable freight transport; in this second study also the emission scenarios developed in LIMITS project (Stringent air quality policies without climate change mitigation and Climate policies without further air quality policies for 2030) and the new IPCC "Shared socioeconomic pathways" (SSPs) will be used as input to the Fast Scenario Screening Tool (FASST) (Van Dingenen et al., 2015), to evaluate the impact of short-lived pollutants on air quality, human health and ecosystems.

The first step in the study was to engage with countries of the Danube Region in order to develop a scientific network and together with this network, develop a methodology for the best use of the available information and expertise in the Danube Region to evaluate the emissions to the atmosphere from the transport sector. This task was accomplished by organizing two activities:

- EDGAR training workshop "From polluting human activities to emission gridmaps using the Emission Database for Global Atmospheric Research (EDGAR)", November 2014;
- EDGAR modal shift working group and brainstorming meeting on "The impact of modal shift (ship/truck) in transport on emissions to the atmosphere: methodology development for the best use of the available information and expertise in the Danube Region.", October 2015.

This scientific network includes not only country emission experts but also experts from other relevant institutions in the Danube Region (e.g. Viadonau, Danube Commission).

In this framework the EC/JRC/EDGAR team has worked together with these experts to design and build an on-line tool (EDGAR.ms) that distributes air pollutant emissions from road transport sector on regional gridmaps. The air pollutant emissions are estimated by the user and gridded with EDGAR.ms tool. Given the transnational nature of the transport sector in both infrastructure (road/navigable rivers) and air pollutant emissions, the Web-based tool has a set of consistent proxy-data for transport sector covering all countries in the Danube Region.

The outcome of the work on the development of the methodology for the best use of the available information and expertize in the Danube Region is presented in this report; it represents Deliverable 5 "Methodology development" of the Danube Air Nexus project (DAN), Scenarios of future emissions and air quality work package. Chapter 2 briefly describes the EDGAR methodology to estimate emissions for different ex-post modal shift scenarios, which will be used to produce part of the input for a FASST tool study that follows. Also, some remarks on the countries' potentiality to develop region-specific modal shift scenarios are given in this chapter. The expertise and data availability in the Danube Region for road transport and navigation is presented in Chapter 3 together with a comprehensive comparison of EDGAR emissions vs National emissions for road transport sector. Chapter 4 describes the EDGAR.ms Web-based gridding tool and provides the emission gridmaps of Hungary, Romania, Serbia and Croatia created with both EDGAR emissions and National emissions. Conclusions are presented in Chapter 5.

2. Methodology: emissions from modal shift in transport

Changes in emissions corresponding to various modal shift scenarios will be estimated next year based on the methodology described in chapter 2.1. The modal shift scenarios consist of the change in 2005 emissions data from exchanging truck transport with ship transport, which is expected not only to lead to a reduction in total transport emissions (because of the lower fuel consumption per tonne and kilometre of freight carried by ships) but also a displacement of the emissions, away from road corridors. These emission scenarios will subsequently be used as input for a study to evaluate the impacts of the emission changes on human health and vegetation.

Danube countries' potential to develop more region-specific modal shift emissions scenarios is robust, but requires concerted efforts by specialised institutions in the Danube Region to provide a reliable outcome as stipulated in chapter 2.2; these modal shift scenarios could open and foster further discussion on a possible sustainable undertaking of a transportation shift in the future.

2.1 EDGAR ex-post modal shift scenarios: description

Air pollutant emissions from 2005 are used as the baseline for the study. They will be evaluated for two modal shift scenarios; these are extreme scenarios. As input, the EDGARv4.3 activity data (diesel fuel consumption of IEA, 2014) will be used and in addition to that we will estimate also: a) fuel consumption of typical Danube freight ships per tonne kilometre of freight and b) fuel consumption of heavy duty vehicle per tonne kilometre of freight.

The two modal shift emissions scenarios are defined as following:

Scenario 1: all freight transport of 2005 on ship:

- no fuel consumption by heavy duty vehicles,
- calculate the needed increase in fuel consumption for ship transport,
- calculate emissions for the new ship transport, either assuming current fleet or enhanced fleet with lower EFs of new ships.

Scenario 2: all freight transport of 2005 on heavy duty vehicles:

- no fuel consumption of ships,
- calculate the needed increase in fuel consumption for road transport (much more heavy duty vehicles needed),
- calculate emissions for new heavy duty transport, either assuming current fleet or enhanced fleet with lower EFs of new trucks.

2.2 Countries' potential to develop region-specific modal shift scenarios

In Europe, Inland waterway transport is a viable alternative with potential benefits in terms of cost savings, reduced pollution and increased transport safety when considering shifting traffic from road to more environmentally friendly transport modes. Yet, the elimination of infrastructure bottlenecks is obligatory for the development of inland navigation in Europe.

The Rhine-Danube network represents about half of the inland waterways of international importance in Europe and the Danube basin has the potential to guarantee river navigation between the North Sea and Black Sea (ECA, 2015). The Danube Strategy has a target of increasing the cargo transport on the river by 20 % in 2020 compared to 2010. Region-specific modal shift scenarios related to the traffic intensification on the Danube River could open and foster further discussion on a possible sustained transportation shifts in the future.

As described in chapter 3 of this study, emissions evaluation for transport sector in the future, when resources become available, will be based on information provided by specialised databases, modern data acquisition systems and tools. These advances could lead to more refined emissions estimations by moving from a "fuel sold" approach to a "fuel used" methodology. Moreover, further improvements in emissions distribution could be based on an extensive use of the information available in traffic count databases, which are becoming increasingly abundant in some countries. In future, experts from countries in the Danube Region could work together to develop more region-specific modal shift scenarios in transport and evaluate emissions changes from them. These emissions could be consistently distributed in the Danube Region by using an improved version of EDGAR.ms tool in which the proxy data would have to be updated accordingly.

3. Expertise and data availability in the Danube Region

In the Danube Region we have investigated data availability for emissions from the transport sector, road transport and river transport in particular.

Regarding road transport, disaggregation of National emissions is needed for correct freight transport emission allocation and for an exact matching with the level of details in EDGAR. Comparison between National emissions and EDGAR emissions requires a coupling matrix of activity codes of both emission inventories; this was used in order to have the same emissions aggregation and to ensure the comparability of emissions data from different sources.

The emissions from road transport have been aggregated in six groups based on the type of vehicles as following:

- Buses (BS0)
- Heavy Duty vehicles (HD0)
- Light Duty vehicles (LD0)
- Motorcycles (MC0)
- Mopeds (MP0)
- Passenger Cars (PC0)

The coupling matrix has been completed by providing the definitions of fuels used in road transport. Nine fuel types are defined in EDGAR: Gas/Diesel Oil (DIE), Motor Gasoline (MOG), Residual Fuel Oil (HFO), Liquefied Petroleum (LPG), Kerosene (OKE), Natural Gas (NGS), Biodiesel (BDS), Biogasoline (BGL) and Naphta (NAP) and used to calculate emissions in EDGAR; this list covers also the fuels used in road transport in countries that participated in this exercise.

Emissions from ships on the Danube River and other navigable rivers shall be estimated for both inland domestic waterway traffic and inland international waterway traffic. The Parties' reporting obligations under the Long-range Transboundary Air Pollution (CLRTAP) Convention for this sector are only for inland domestic waterway traffic and emission estimations are based on fuel-sold (info/data from national statistics). Emission estimates for inland domestic waterway traffic are available in both national inventories and EDGARv4.3. The evaluation of emissions for inland international shipping traffic remains an issue, which requires a more complex fleet-composition/fleet-movement approach that needs to be developed and applied. As a first approximation, the same fleet composition and emission profiles as for domestic inland waterway traffic could be used.

As is the case with the activities of the other Nexi of the JRC scientific support to the Danube Strategy, this work is a pilot study developing and demonstrating a process that relevant experts and institutions in the Danube Region can contribute to and take forward towards more comprehensive estimations of emissions from different modal shift scenarios in the Danube Region. The interactive JRC tool EDGAR.ms can be used to support such future efforts.

The EDGAR.ms gridding tool has been tested by emission experts from the following countries in the Danube Region: Hungary, Romania, Serbia and Croatia. These experts were invited in order to cover both EU and non EU countries in the Danube Region as a sub-regional sample for data/info screening. In the first step, the experts compared the EDGARv4.3 emissions with the national emissions from their countries and after they used the tool to distribute the national emissions. The results of the comparison of EDGAR4.3 with the National emissions inventory of each country are discussed in chapters 3.1 and the Metadata of the National emissions inventories are provided in Annex I.

The contribution of country emission experts to a more region-specific approach to evaluate changes in air emissions from a modal shift in transport is of interest since they

use well documented and official activity data (AD) and emission factors (EFs) to compile the national emission inventories and can provide also details on national circumstances.

3.1 National data

3.1.1 Croatia

The national emissions inventory of Croatia provides air pollutant emissions for all sectors; official data sources for both activity data and emission factors are used to estimate these emissions. For transport, emissions are provided for navigation (shipping), railways, road transport and aviation sector.

Regarding road transport, the activity data used for emissions calculation are:

- fuel sold by type,
- number of vehicles by type and annual mileage,
- minimum and maximum temperature for big towns (e.g. cold emission factors are temperature dependent),
- sulphur content in fuel by type.

Official data and information are provided by the Ministry of Economy (energy balance) on fuel sold, by the Ministry of Internal Affairs (vehicle database) on number of vehicles, by the Central Bureau of Statistics (CBS) (statistical yearbook) on annual mileage and temperatures for big towns, and by major national fuel producer on sulphur content in fuel. Road transport is a key source category and emissions estimation is based on fuel sold and vehicle fleet composition data; the fleet split by vehicle type, type of engine, cylinder capacity, and a weighted fleet composition is used in COPERT 4v.10.0 (Tier 2/3 method) (COPERT4, 2015).

Rail and national navigation are not key sources; therefore, emissions estimations for both activities are based on fuel sold. For navigation on rivers, lakes and sea the data on fuel in the national energy balance is not disaggregated. As a consequence, emissions from inland waterways are agregated with emissions from sea and coastal emissions. Emissions from national navigation source category for NFR code 1.A.3.d.ii(i) were calculated using the Tier 1 EMEP/CORINAIR methodology. The share of inland waterways emissions in total national navigation (sea and river) emissions is currently minor (1.8% in 2012 and 2013). Nevertheless an intensification of river transport of biomass is expected in the future due to the completion of two new biomass power plants (BCHP Osijek and BCHP Sisak), in 2017, both of which are on tributaries of the Danube.

The emissions distribution methodology uses proxy data e.g. for road transport:

- grid cell area,
- length of roads by type (urban, rural, highway),
- population density,
- data on vehicle counting by type of vehicle (future development).

In this study, only emissions from road transport are analysed and distributed using EDGAR proxy data (see 4.2). In this chapter, we compare EDGAR emissions inventory with the official National emissions inventory of Croatia. CO_2 and NO_x emissions are compared to evaluate the differences in emissions from motor gasoline and gas/oil diesel consumption, which are the main fuels used in road transport.

Since CO_2 emissions are not affected by the control measures, the comparison gives an indication about the quantity of fuel used in road transport and considered for emissions calculation. Figures 1 and 2 show that both EDGAR and National emissions inventory of Croatia (NE_Croatia) used the same quantities of motor gasoline and gas/diesel oil each year to calculate CO_2 emissions. Yet, there are differences when analysing the CO_2 emissions per vehicle type. This is better seen in Figures 3 and 4 where the NO_x emissions are compared for both motor gasoline and gas/diesel oil. This comparison clearly shows that the accurate data on number of vehicles provided by the Ministry of

Internal Affairs (vehicle database) and on annual mileage provided by the Central Bureau of Statistics (CBS) (statistical yearbook) in Croatia results in better emissions evaluation in the National emissions inventory.

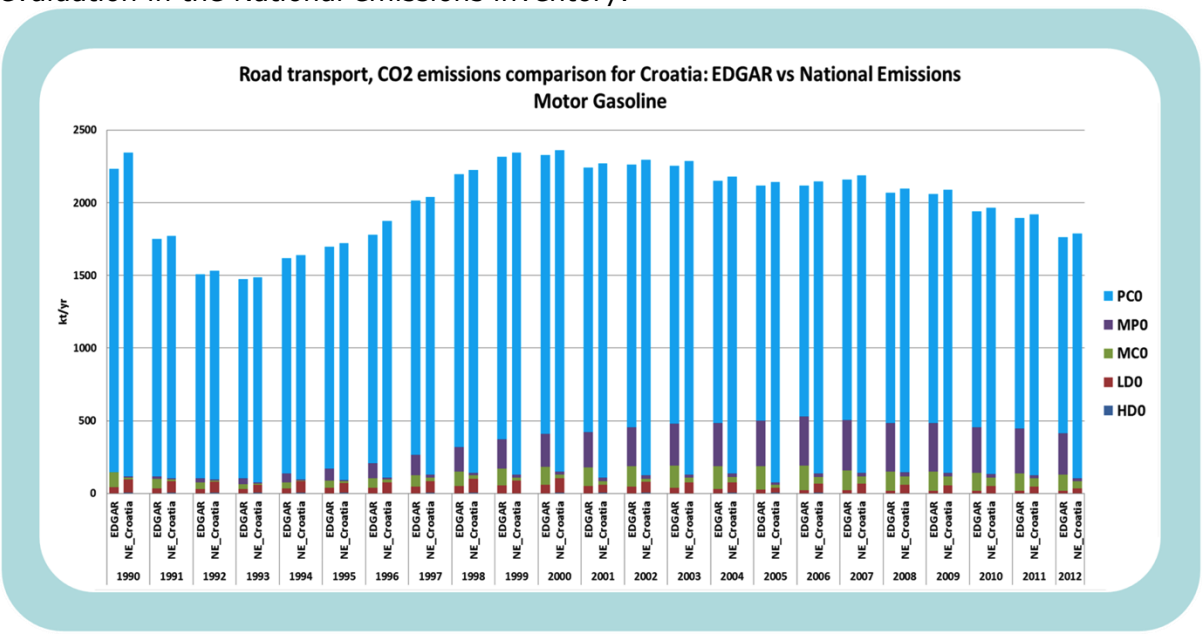


Figure 1 Croatia, CO2 emissions comparison – motor gasoline.

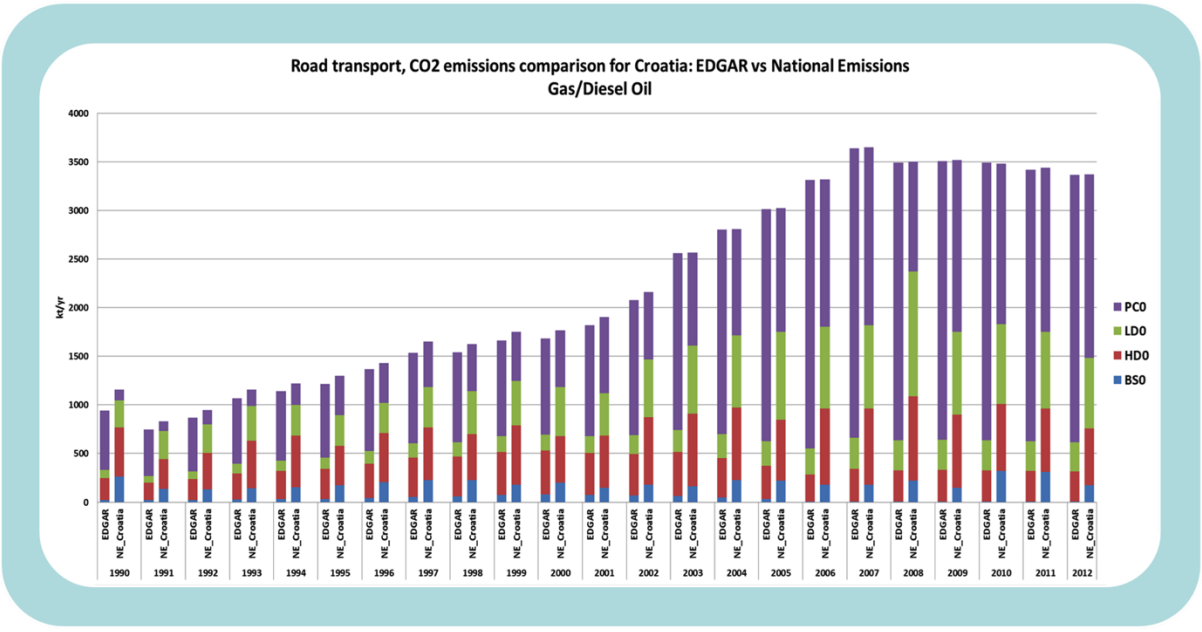


Figure 2 Croatia, CO2 emissions comparison – gas/diesel oil.

As a consequence, the differences between the EDGAR values and those in the National emissions inventory of Croatia are significant. Figure 3 illustrates the NO_x emissions for the two emissions inventories; we can see higher emissions from Mopeds (MP0) in the EDGAR emissions inventory compared to the National emissions inventory of Croatia. The values of emission factors (EF) used by the two emissions inventories are equally important in contributing to the differences in emissions comparison. However, only an in deep analysis at the level of activity data, technology, end-of-pipe and emission factors could provide more quantitative clarifications.

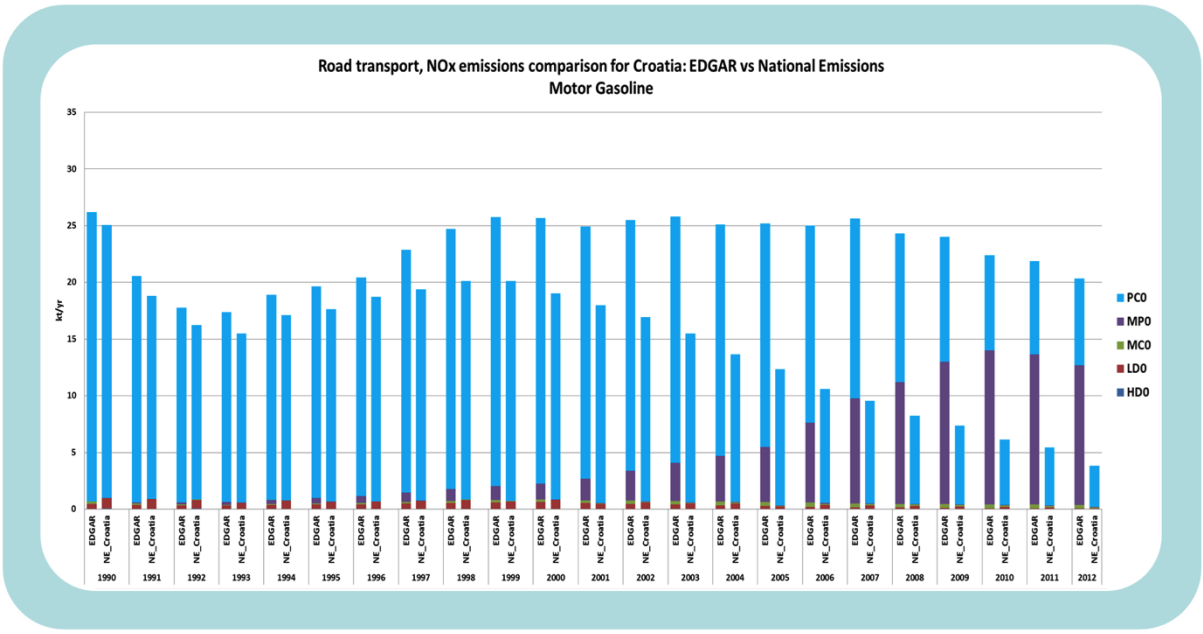


Figure 3 Croatia, NOx emissions comparison – motor gasoline.

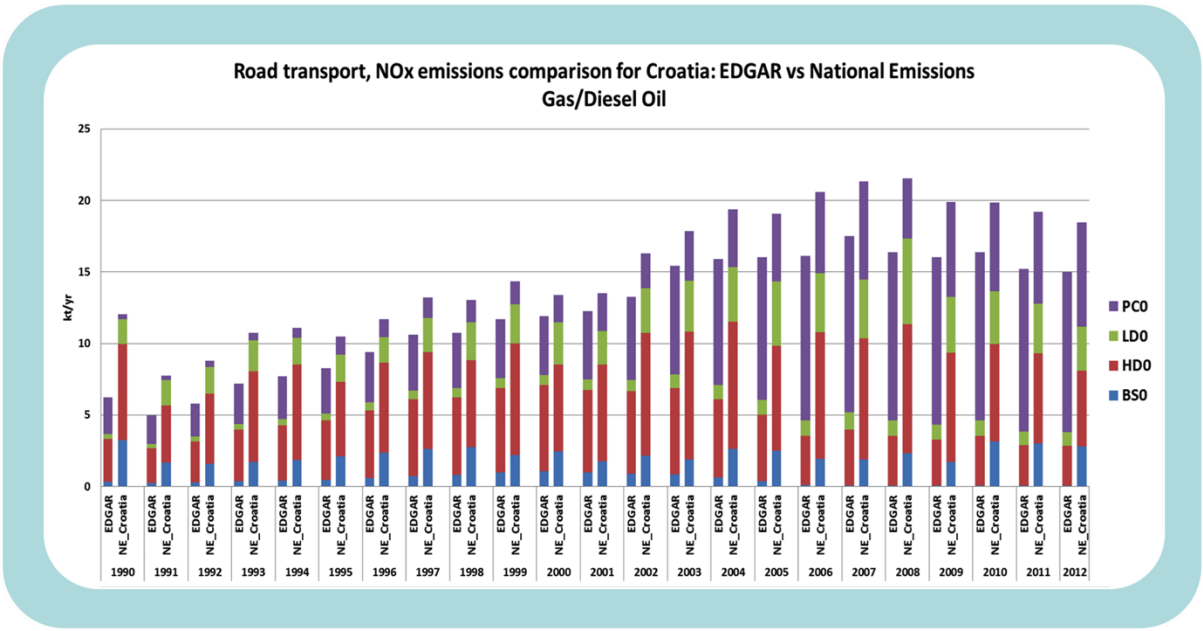


Figure 4 Croatia, NOx emissions comparison – gas/diesel oil.

3.1.2 Serbia

The methodologies used by the Environmental Protection Agency to compile the national emissions inventory are:

- EMEP/EEA air pollutant emission inventory guidebook (EMEP/EEA, 2013)
- IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006)

As activity data, the quantity of fuel consumed is used to calculate the amount of pollutants emitted into the air from rail and water transportation; these data are taken from the Statistical Yearbook (1990-2014). For the calculation of emissions from road transport, data on vehicles registered in the Republic of Serbia are provided by the Traffic Police of the Ministry of Interior Affairs for whole period.

Emission factors from EMEP/EEA Guidebook 2013 and 2006 IPCC Guidelines for National Greenhouse Gas Inventories have been used to estimate emissions from rail and inland waterways transport. Emissions from road transport were estimated using the emission factors included in COPERT 4v.11.3 (COPERT4, 2015).

Regarding emissions distribution, the inventory team in Serbia provides gridded emissions in the new EMEP grid. Emission gridding could be improved by using average annual daily traffic information, which is available from more than ten years of vehicle counting. An advanced emissions distribution methodology is used for ship emissions considering only navigable rivers, rather than the water surface of all rivers. In this study only emissions from road transport were analysed and distributed using EDGAR proxy data (see 4.2).

National circumstances affect the inter-annual variation in air pollutant emissions. Details of national circumstances such as inflation, bombing events, registration issues etc. for Republic of Serbia are provided in Figure 10. These events are also reflected in the fleet composition at country level as illustrated in Figure 9 and could also have affected the quality of the data reported to international bodies; in Figure 5 and 7, which show the CO_2 and NO_x comparison for motor gasoline used in road transport, we can see significant differences between EDGAR and National inventory (NE_Serbia) emissions in 1992, 1997, 2004, 2005 and 2006.

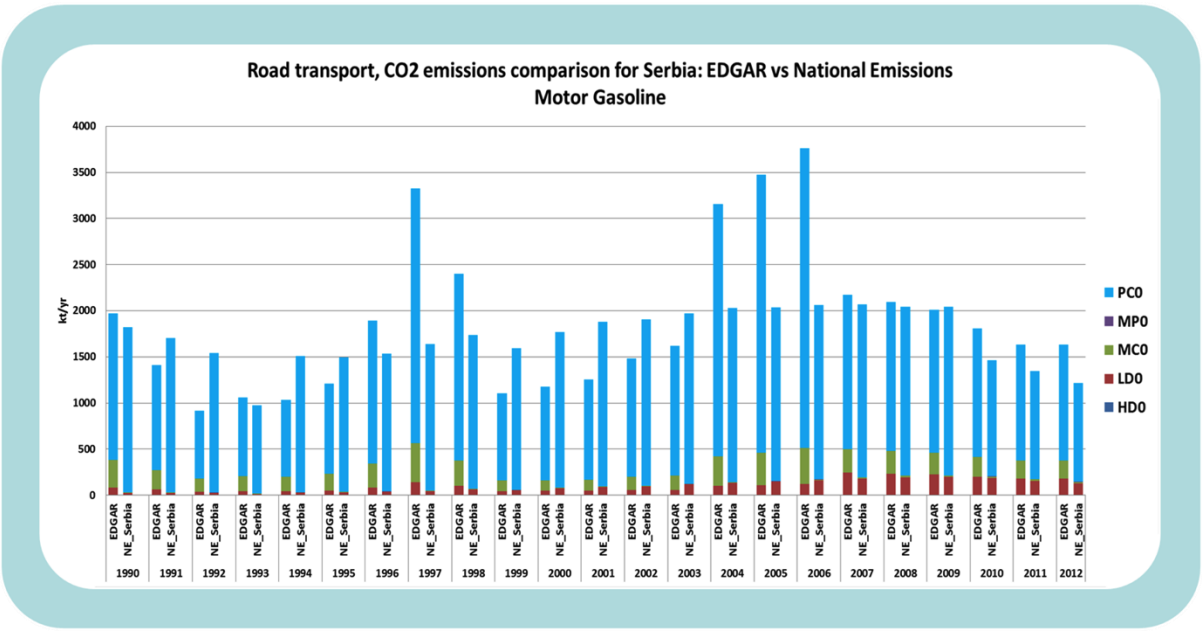


Figure 5 Serbia, CO2 emissions comparison – motor gasoline.

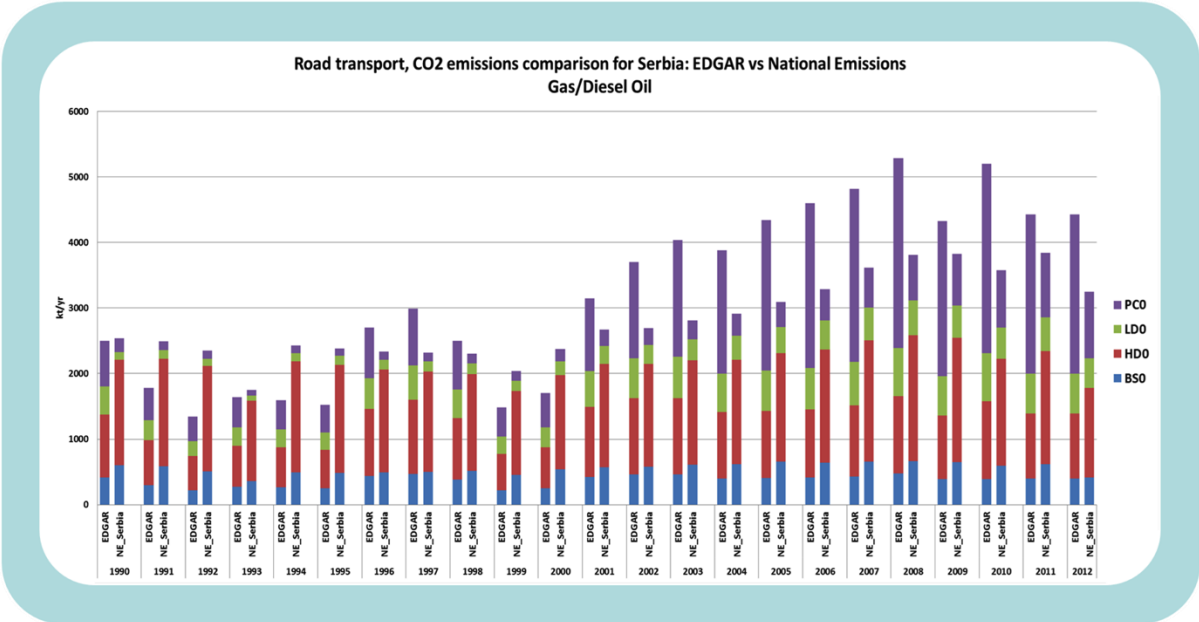


Figure 6 Serbia, CO2 emissions comparison – gas/diesel oil.

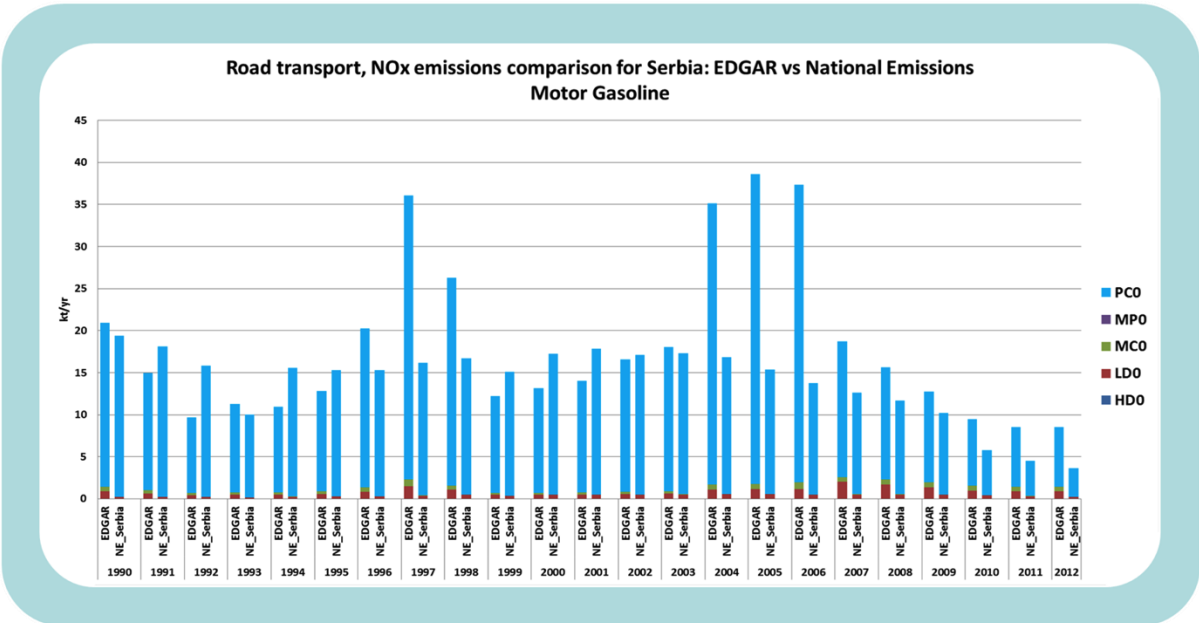


Figure 7 Serbia, NOx emissions comparison – motor gasoline.

In addition to these issues related to country circumstances, the two emissions inventories use different data sources to prepare the input for emissions estimation, which includes information on annual mileage, number of vehicles and emission factors. The resulting differences between EDGAR and the national inventory emissions can be seen in Figure 5 and 6 for CO_2 emissions comparison and in Figures 7 and 8 for NO_x emissions comparison.

For a complete discussion on the differences in emissions, as mentioned before, an in deep analysis at the level of activity data, technology, end-of-pipe and emission factors is needed, which is not the scope of this study. Yet the comparison gives an insight on

the difference of emissions by vehicle type e.g. heavy duty vehicles, which are relevant for freight transport.

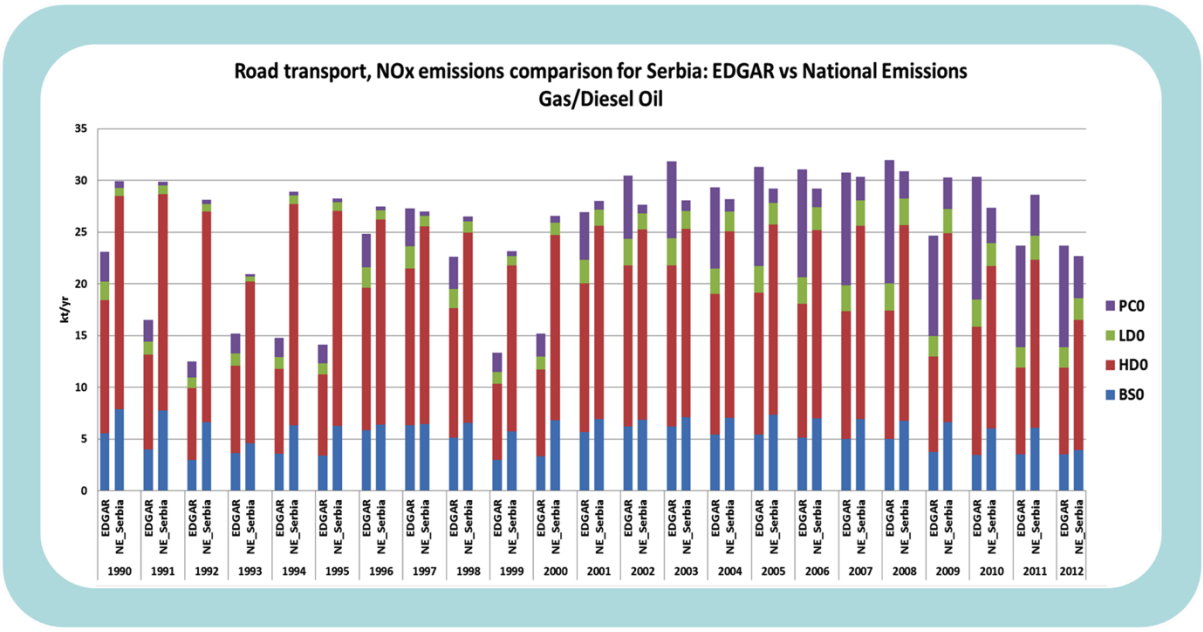


Figure 8 Serbia, NOx emissions comparison – gas/diesel oil.

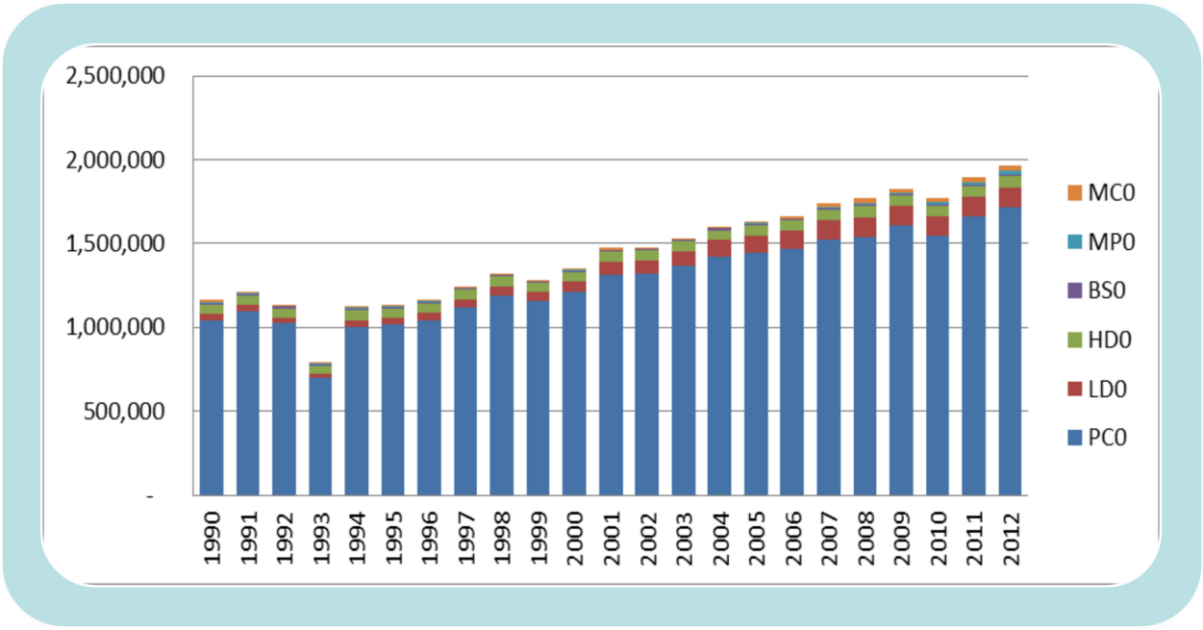


Figure 9 Fleet composition in Serbia: 1990-2012. Source: presentation of Nebojsa Redzic at the EDGAR modal shift working group, November 2015.

Figure 10 Events (e.g. Independent Serbia, SRB in 2006) **with significant effects on emissions estimation in Serbia.** Source: presentation of Nebojsa Redzic at the EDGAR modal shift working group, November 2015.

3.1.3 Romania

As in the other National emissions inventories, air emissions from road transport were calculated for different vehicle categories: passenger cars, light duty vehicles, heavy duty vehicles, mopeds and motorcycles considering fuel and technology/end-of-pipe related to various emission standards (e.g. Euro 1, 2, 3, 4, 5, 6).

COPERT 4v.11 (COPERT4, 2015) was used to estimate emissions from road transport considering the following specific input parameters for this model:

- number of vehicles
- mileage per vehicle
- fuel injection and evaporation control
- urban/rural/highway speed (km/h)
- urban/rural/highway driving (%)

The activity data as fuel consumption (unleaded gasoline, diesel, biodiesel and LPG) and the input parameters for COPERT model have been obtained from two institutions:

- International Energy Agency (IEA-EUROSTAT-UNECE-Energy Questionnaire Oil)
- Romanian Auto Registry (RAR)

Regarding railways and national navigation, Tier 1 (fuel sold from IEA) and default EMEP/EEA guidebook 2013 emission factors have been used for air pollutant emissions estimation for both activities. Higher Tier methodology is not considered for emissions estimation since these activities are not key sources.

In this study, only emissions from road transport were analysed and distributed using EDGAR proxy data (see 4.2). In this section, we compare the EDGAR emissions inventory with the official national emissions inventory of Romania. The comparison is provided for CO_2 and NO_x emissions. The fact that there are no differences between EDGAR CO_2 emissions and those of National inventory (see Figures 11 and 12) shows that the quantities of motor gasoline and gas/diesel oil allocated to road transport and used for emissions calculation in both emissions inventories are almost the same. Regarding NO_x emissions from motor gasoline consumption in road transport sector, the EDGAR emissions are higher than the National ones for all years; significant differences can be seen between the two emissions inventories for Motorcycles (MC0) and Light Duty vehicles (LD0) as illustrated in Figure 13.

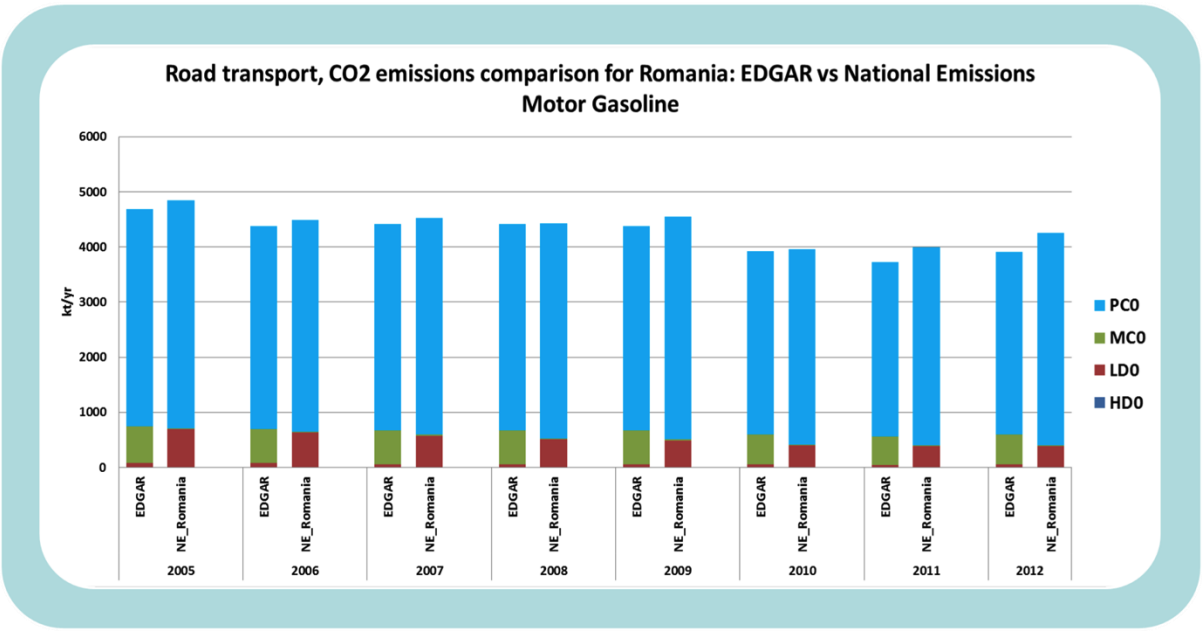


Figure 11 Romania, CO2 emissions comparison – motor gasoline.

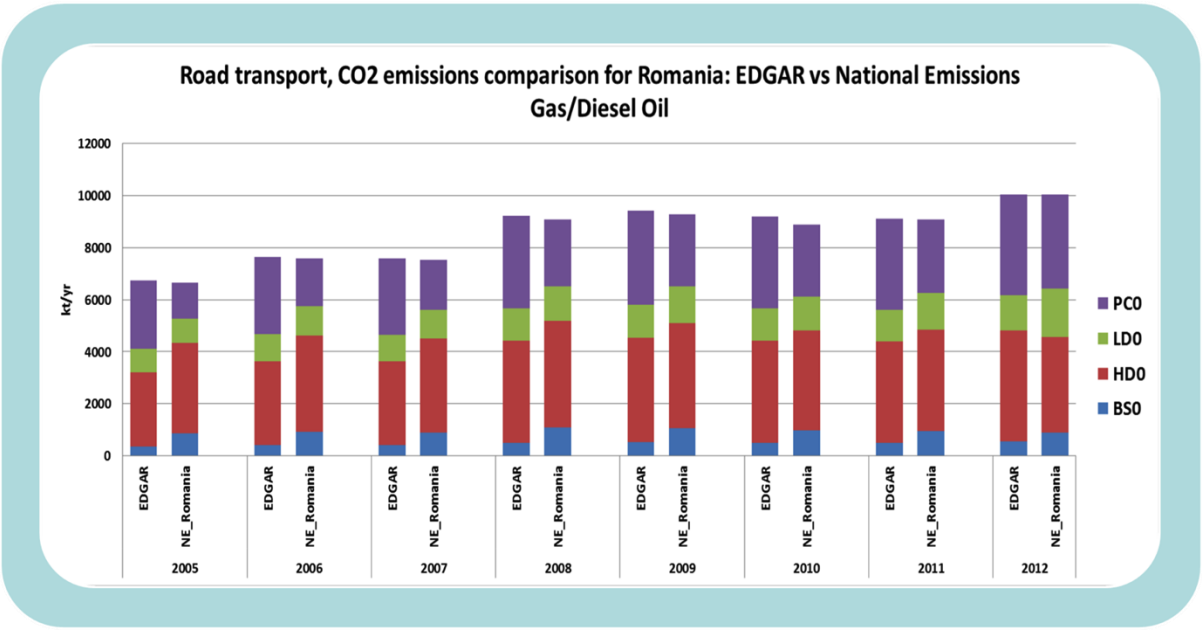


Figure 12 Romania, CO2 emissions comparison – gas/diesel oil.

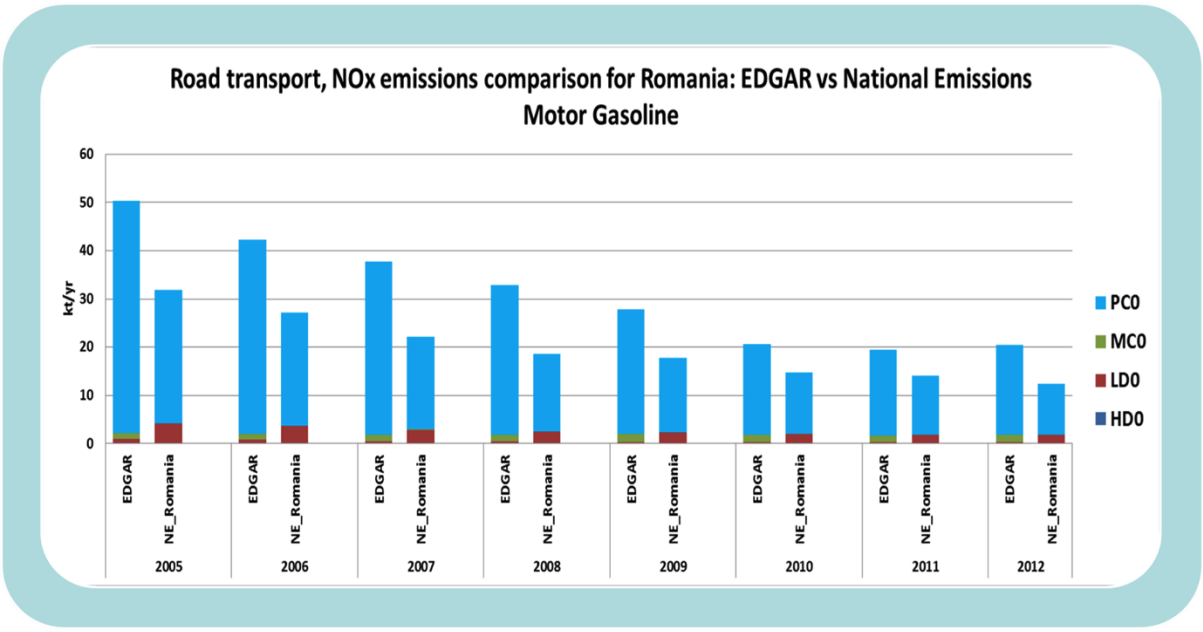


Figure 13 Romania, NOx emissions comparison – motor gasoline.

For gas/diesel oil consumption the EDGAR NO_x emissions are lower than the national emissions (NE_Romania) for most of the years, and significant differences in emissions from Buses (BS0) are observed in Figure 14. In spite of all these differences, the EDGAR CO_2 and NO_x emissions compare well with those of the national emissions inventory.

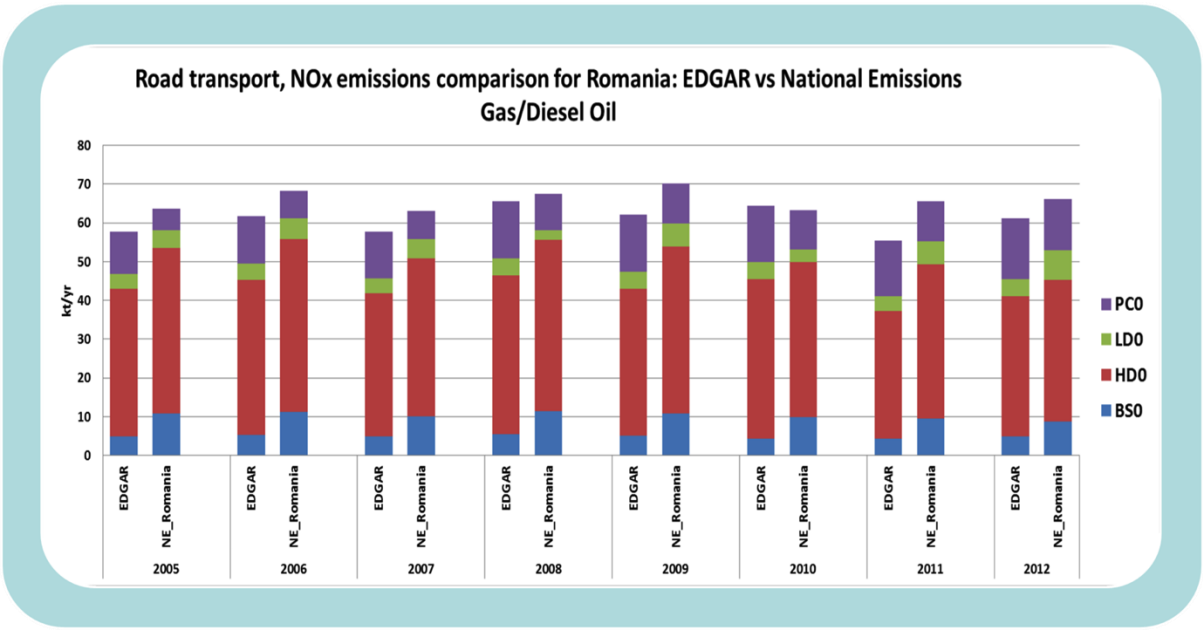


Figure 14 Romania, NOx emissions comparison – gas/diesel oil.

3.1.4 Hungary

The KTI Institute for Transport Sciences Nonprofit Ltd. evaluates emissions from transport sector in Hungary.

For road transport the methodology used is COPERT4 - EEA Guidebook Tier 3 (COPERT4, 2015) with fleet composition from Hungarian Central Statistical Office (vehicle fleet database based on the vehicle register) and COPERT4 built in emission factors. The fleet composition consists of:

- vehicle category
- manufacturer
- kind of the vehicle
- year of manufacturing
- year of first registration in Hungary
- fuel type
- unladen weight
- gross vehicle weight
- engine displacement

Moving from "fuel sold" approach to a "fuel used" methodology is envisaged, so future efforts are focused on activity data estimation based on information from:

- National Traffic Count Database (average daily traffic per road section and vehicle category),
- National Transport Authority/Periodic Technical Inspection Database (annual mileage for each vehicle registered in Hungary),
- National Road Toll Office/Electronic Road Toll System Database (for vehicles over 3.5 t: vehicle category, nationality, euro category, permitted road sections and permitted period of time or time of use).

In the next period a methodology will be developed to improve emissions distribution in Hungary by using also the data/info from the National Traffic Count Database.

Future planning to improve the emissions estimation is foreseen for both inland navigation and rail transport. For inland navigation, activity data will be estimated based on the data/information from "River Information Services" (www.rsoe.hu) and fleet data including engine parameters from "Ship register" (www.nkh.hu). Emission factors will be derived from type approval motor test bench data (NRMM Directive, 97/68/EC) and Portable Emission Measurements Systems (PEMS) measurements results. Regarding rail transport, activity data will be collected from "Rail Traffic Database" of MÁV Ltd and fleet data including engine parameters from "National Transportation Authotity" whereas the emission factors will be based on both type approval requirements (NRMM Directive, 97/68/EC) and PEMS measurements completed with data collected by the Locomotive On Board Equipments.

Regarding road transport sector, as for the other national emissions inventories, the CO_2 and NO_x emissions of the National emissions inventory (NE_Hungary) are compared with EDGAR emissions. The comparison for CO_2 is presented in Figures 15 and 16; for gas diesel oil consumption in road transport the EDGAR emissions are lower than those of National inventory with significant differences for Buses (BS0) and Light Duty vehicles (LD0). Also, NO_x emissions in EDGAR are significantly lower for both motor gasoline and gas/diesel oil consumption in road transport as illustrated in Figures 17 and 18.

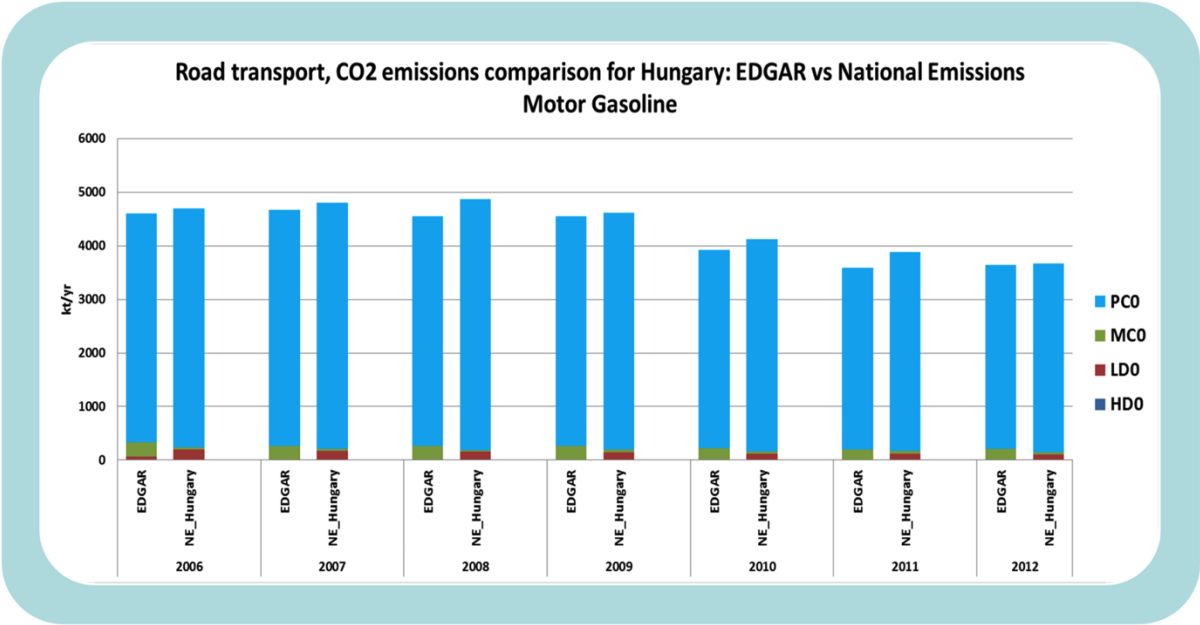


Figure 15 Hungary, CO2 emissions comparison – motor gasoline.

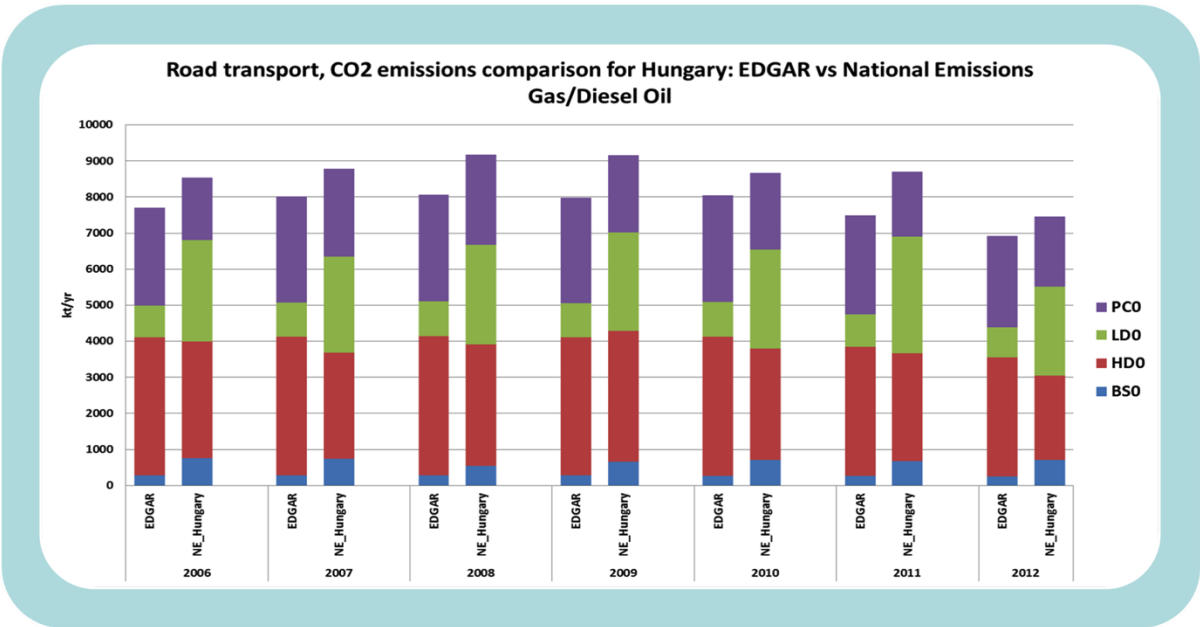


Figure 16 Hungary, CO2 emissions comparison – gas/diesel oil.

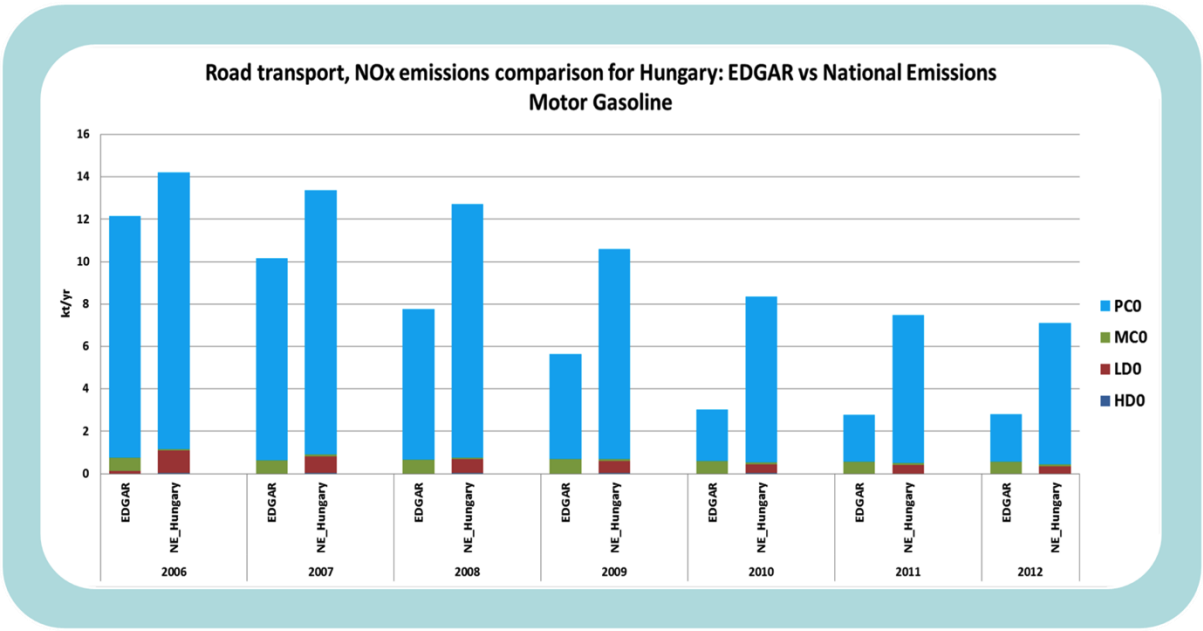


Figure 17 Hungary, NOx emissions comparison – motor gasoline.

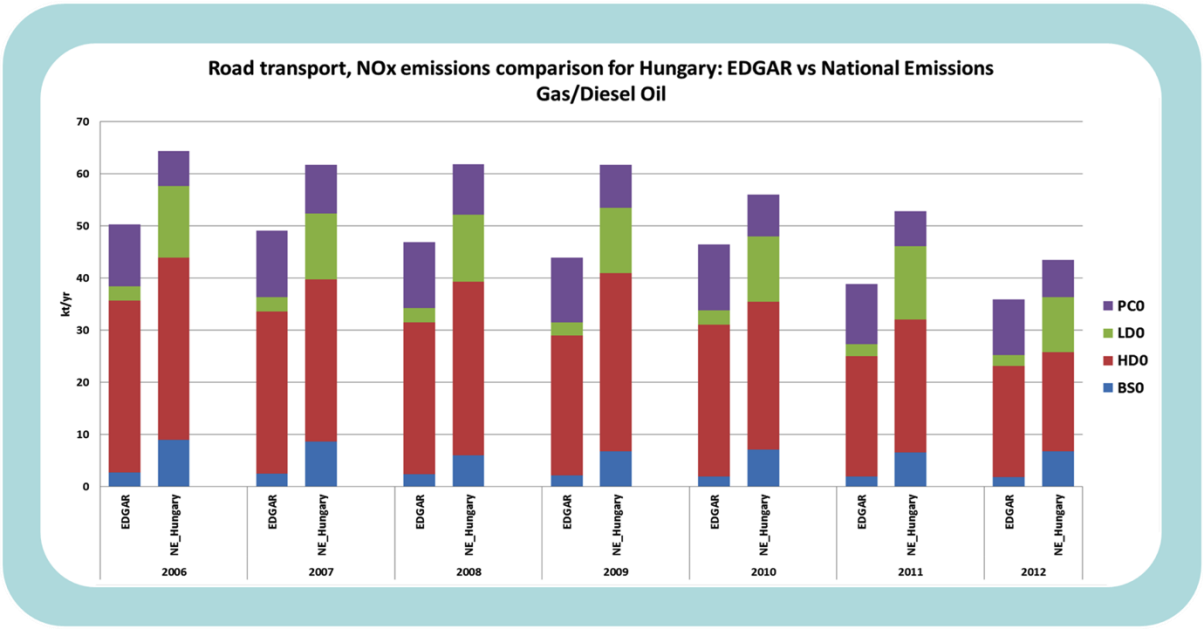


Figure 18 Hungary, NOx emissions comparison – gas/diesel oil.

3.2 Domestic and international shipping

Usually, the fuel sold methodology is applied to estimate emissions from ships. On navigable rivers, which are connected to seas/oceans, two types of navigations can be distinguished:

- inland international navigation, which includes journeys that depart in one country and arrive in a different country (EMEP/EEA, 2013);
- inland domestic navigation, which includes journeys of vessels of all flags that depart and arrive in the same country (EMEP/EEA, 2013).

Regarding inland domestic ship emissions, country emission experts calculate emissions based on fuel sold using data/info provided by national statistics (activity data from IEA (2014) for emissions calculation in EDGARv4.3 with sector split for transport sector from IPCC (2006)). An issue remains related to inland international ship emissions evaluation and distribution.

In this chapter we provide an overview on the legislation related to ship emissions, the expertise of Viadonau on ship emissions calculation, discuss on fleet characterisation based on the Danube Commission statistics and enumerate also other data sources that could be used to refine the ship emissions estimation in the Danube Region.

3.2.1 Legislation

The legislation on shipping has a crossing complexity as both an international and a European framework exist. The international legislation in the maritime arena is designed by the International Maritime Organization (IMO) where the MARPOL Convention Annex VI Prevention of Air Pollution from Ships displays the framework for air pollutants emitted from ships. The European legislative framework on air pollutants emitted by ships adds an additional complexity as it is spread out in various directives. Generally, legislation focusing on the mitigation of atmospheric emissions from shipping applies to fuel quality and engine technology. The latter encompasses combustion technologies and exhaust gas treatment both of which being used to lower e.g. NOx.

It should be highlighted that the MARPOL Convention Annex VI does only apply to Parties of Annex VI as this is part of the voluntary annexes of the MARPOL Convention; at present time 86 Parties have ratified the MARPOL Annex VI, which corresponds to 95.34% of the world tonnage (IMO 2015a). The European legislation, however, applies to all Member States within the European Union and to any ship regardless of flag sailing within the Union territory, unless otherwise specified.

The MARPOL Convention Annex VI Prevention of Air Pollution from Ships includes NO_x, SO_x and PM, GHGs, ozone-depleting substances (ODS) and volatile organic compounds (VOC) (IMO 2015b). In addition, an inclusion of Emission Control Areas (ECAs) has the purpose of further reducing these air pollutants in specified sea areas.

IMO revised its MARPOL Convention Annex VI Prevention of Air Pollution from Ships by including (among other initiatives) the NO_x Technical Code 2008, which regulates NO_x emissions and includes several elements; the main features are the focus on marine diesel engine capacity (≥130kW power output) concurrent with the ship construction date. Three categories exist, Tier I, II and III, corresponding to ships constructed on and after 1 January 2000, 1 January 2011 and 1 January 2016, respectively (IMO 2015c). Tier III applies to NO_x emission control areas (NECAs) only, which are currently only designated along the North American coast and the US Caribbean Sea, outside NECAs tier II is applied. Further distinction between engine outputs within the tiers is made with rated speed <130kW, between 130-1999kW and ≥2000kW, respectively and limit values are set by the IMO for each of these engine's rated speed categories.

The global SO_x emission limit set by the IMO is at present 3.50% by mass (m/m) of the fuel content; from 1 January 2020 it will be further lowered to 0.50% m/m if fuel is

available. Otherwise, the deadline is postponed until 2025. Within sulphur emission control areas (SECAs; Baltic Sea, North Sea, English Channel, North American and US Caribbean Sea), the emission limit has recently (1 January 2015) been lowered to 0.10% m/m. Requirements specifically concerning PM are only encompassed within NECAs.

In addition, IMO has made an Energy Efficiency Design Index (EEDI) and a Ship Energy Efficiency Management Plan (SEEMP), which are both mandatory; the former for all ships constructed on and after 1 January 2013, the latter for all ships regardless of age (IMO 2015d). These are technical and operational measures that have the purpose of increasing energy efficiency and lowering CO_2 emissions (IMO 2015b).

Regarding European Union legislation, the Directive 97/68/EC amended by Directive 2004/26/EC lays down the procedural steps of the approval of engines with the purpose of mitigating emissions of gaseous and particulate pollutants; inland waterway (IWW) vessels have to comply with stage IIIA of the amending Directive, which specifies 5 g/kWh CO, 7.2-11 g/kWh HC+NOx and 0.2-0.5 g/kWh Particulates as limit values for different engines for propulsion of IWW vessels.

The European Union has been actively developing a legislative framework for lowering SOx emissions from shipping for the past few decades. To improve air quality in Europe, Council Directive 93/12/EEC initiates this process with a prohibition of marketing certain liquid fuels, including gas oil used for maritime purposes, within Member States if a sulphur content of >0.2% (1 October 1994) and >0.05% (1 October 1996) by weight is exceeded. Subsequently, amendments to Council Directive 93/12/EEC have been made. It makes a distinction between heavy fuel oil (HFO) and gas oil (GO) and sets the first limits on marine gas oil (MGO); the content of sulphur must not exceed 0.20% m/m effective from July 2000 and 0.10% m/m effective from 1 January 2008. Succeeding these minor initial actions on shipping emissions, the Directive 2005/33/EC takes a significant step forward by predominantly focusing on shipping issues connected to SOx emissions. This Directive distinguishes between different fuels and draws up specifications for SECAs and passenger ships sailing to or from Member State ports, IWWs and ships at berth, and emission abatement technologies (EATs). Also, for both SECAs and passenger ships it sets the sulphur content limit on fuels to be 1.5% m/m and makes Member States accountable for ensuring that only marine diesel oils (MDOs) with a content of maximum 1.5% m/m sulphur is available within their territory, all applicable from 11 August 2006. Also, the Directive 2009/30/EC sets the limits of sulphur content in fuels for GO used by IWW vessels to be 0.1% m/m from 1 January 2008 and 0.001% m/m from 1 January 2011.

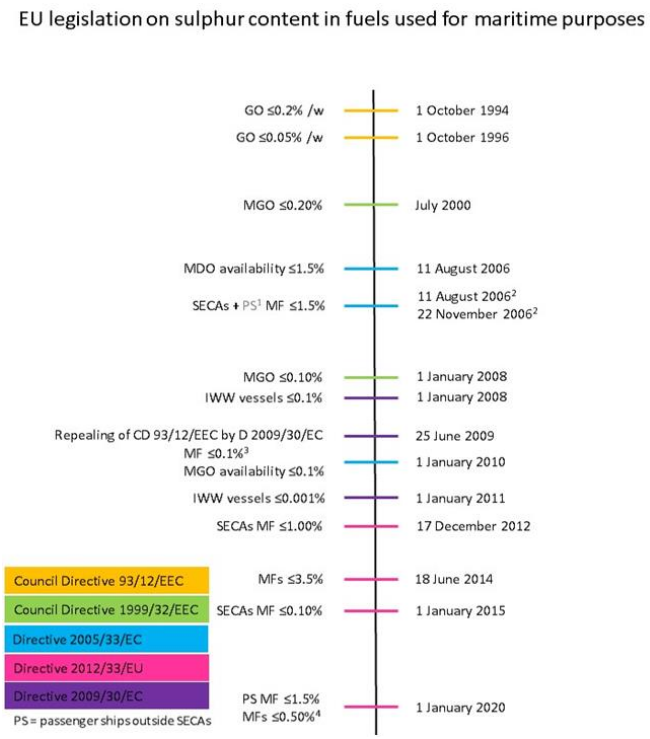


Figure 19 Timeline of the evolution of SOx legislation concerning shipping within the European Union.

[1]Passenger ships using marine fuels ≤1.5% postponed from 11 August 2006 until 1 January 2020.
[2]For the Baltic and North Sea, respectively. The latter following the IMO implementation schedule.
[3]Inland waterway vessels and vessels at berth.
[4] >3.5% m/m for ships with scrubbers allowed (except closed systems).
Where:
GO - gas oil,
MGO - marine gas oil,
MDO - marine diesel oil,
SECAs - sulphur emission control areas,
IWW - inland waterways,
MF – marine fuel.

Most recently, the Directive 2012/33/EU makes another step towards SOx emission mitigation from shipping, by inter alia aligning with the already existing IMO legislation as it adapts the emission limits set by the IMO on sulphur content of fuel within and outside SECAs. Further, reformulates the concept of EATs to emission abatement methods (EAMs) thereby widening the concept to also include e.g. alternative fuel, compliance method or procedural measures as alternatives to low sulphur marine fuels. It separately specifies that Member States are obliged to ensure that HFO used for maritime purposes with a SOx content of maximum 3.50% m/m is the only type of HFO used within their territory, unless otherwise specified. In addition, Member States are responsible for only having MDO with max of 1.5% m/m available on their market.

A comprehensive overview on the timeline of the EU legislation on sulphur content in fuels used for maritime purpose is provided in Figure 19.

3.2.2 Data availability

3.2.2.1 Viadonau statistics

Viadonau provides a reliable and safe waterway infrastructure, supports environment-friendly navigation, and modernizes and operates facilities aimed at protecting the population from floods. The company acts as neutral platform for business contacts, provides active support to the business players and builds knowledge and expertise regarding Danube Logistics. Moreover, it provides technical know-how and subject-specific contact network for the implementation of projects in the field of inland waterway transport.

According to viadonau 11.1, 9.9, 10.7, 10.6 and 10.1 Mio.t of goods have been transported on the Danube/Austrian stretch in 2010, 2011, 2012, 2013 and 2014 respectively. The resulted CO_2 emissions from this activity are illustrated in Figure 20.

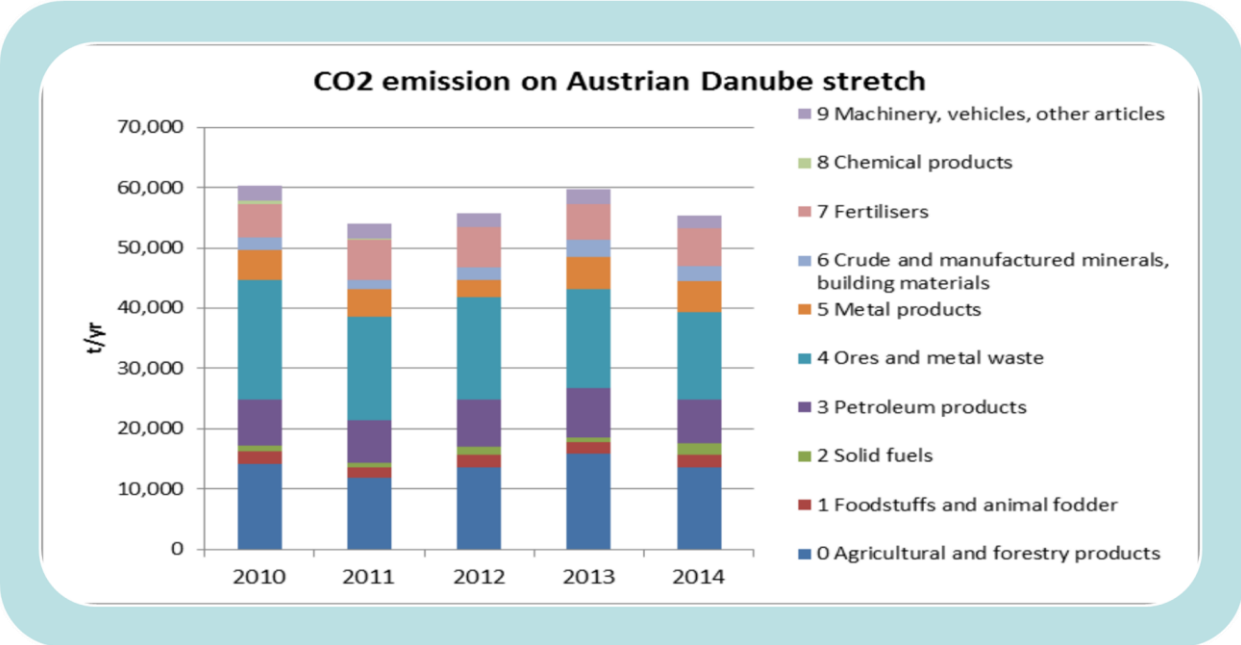


Figure 20 CO_2 emissions by commodity group on Austrian stretch, inland waterways shipping. Source: Viadonau.

The CO_2 emissions in Figure 20 are presented for each commodity group as defined in the Standard Goods Classification for Transport Statistics/Revised (NST/R) classification of commodities (CPA 2008 – NST 2007).

The CO_2 emissions calculation is based on the actual ton kilometres (tkm) per commodity group, realized on the Austrian Danube stretch. Tkm are annually evaluated

by Statistics Austria (http://www.statistik.at/web_en/statistics/index.html), the national statistics office, and provided to viadonau.

The average fuel consumption for motor-cargo vessels and convoys accounts *for 8 g diesel per tkm* (Source: Manual on Danube Navigation, 2007). The values stated in the viadonau Manual on Danube Navigation (2007) which amount between 8.5 – 10.5 g/tkm were recently corrected to the average of 8 g/tkm based on expert interviews with captains and their long term fuel consumption observations.

In order to calculate CO_2 emissions of inland vessels, fuel consumption has to be multiplied with the CO_2 emission factor of 3.175 kg/kg fuel. Full description of the emission factors of CO_2 and also of NO_x, PM, HC, CO and SO_2 for inland waterways vessels is provided in "MoveIT!" project publications (MoveIT!, 2013). In "MoveIT!" project, which aims at a modernization of inland waterways vessels focusing also on improvement of energy efficiency and environmental behaviour, these emission factors have been used to calculate emissions for a sample of vessels being operated on the Rhine, the Danube and the Seine.

Here, CO_2 emission calculation on Austrian Danube stretch is described in a few steps with an example for NST/R group 0 "Agricultural and forestry products" in 2014:

Step 1: Transport performance by commodity group (in 1,000 tkm)

TRANSPORT PERFORMANCE BY COMMODITY GROUPS ON AUSTRIAN DANUBE STRETCH (in 1,000 tkm)

Classification of commodities by NST/R*	Domestic		Import		Export		Transit		Total 2014	
	upstream	downstream	upstream	downstream	upstream	downstream	upstream	downstream	upstream	downstream
0 Agricultural and forestry products	126		84 506	17 038	33 232	2 615	388 924	5 259	506 788	24 912

Step2: Fuel consumption by commodity group (in grams/tkm)

Multiplication actual tkm * 8 (8 grams diesel consumption per tkm)

FUEL CONSUMPTION BY COMMODITY GROUP ON AUSTRIAN DANUBE STRETCH (in grams/tkm)

Classification of commodities by NST/R*	Domestic		Import		Export		Transit		Total 2014	
	upstream	downstream	upstream	downstream	upstream	downstream	upstream	downstream	upstream	downstream
0 Agricultural and forestry products	1 008 000	0	676 048 000	136 304 000	265 856 000	20 920 000	3111 392 000	42 072 000	4054 304 000	199 296 000

Step3: CO2 emissions (in grams)

Multiplication fuel consumption * 3,175 (CO_2 emission factor)

CO2 - EMISSION BY COMMODITY GROUP ON AUSTRIAN DANUBE STRETCH (in grams)

Classification of commodities by NST/R*	Domestic		Import		Export		Transit		Total 2014	
	upstream	downstream	upstream	downstream	upstream	downstream	upstream	downstream	upstream	downstream
0 Agricultural and forestry products	3 200 400	0	2146 452 400	432 765 200	844 092 800	66 421 000	9878 669 600	133 578 600	12872 415 200	632 764 800

These emissions could be 5% higher if the impact of auxiliary engines is taken into account.

Limitations in ship emissions calculation are from the fact that the emissions from empty trips cannot be evaluated because there are no data available as there is no obligation to register them.

A more precise methodology to evaluate emissions for this sector could be based on the known fuel consumption of every vessel operating on the Danube and information on the journeys of all vessels. This would assume a complete surveillance of the vessels, which is legally not possible.

3.2.2.2 Danube Commission statistics

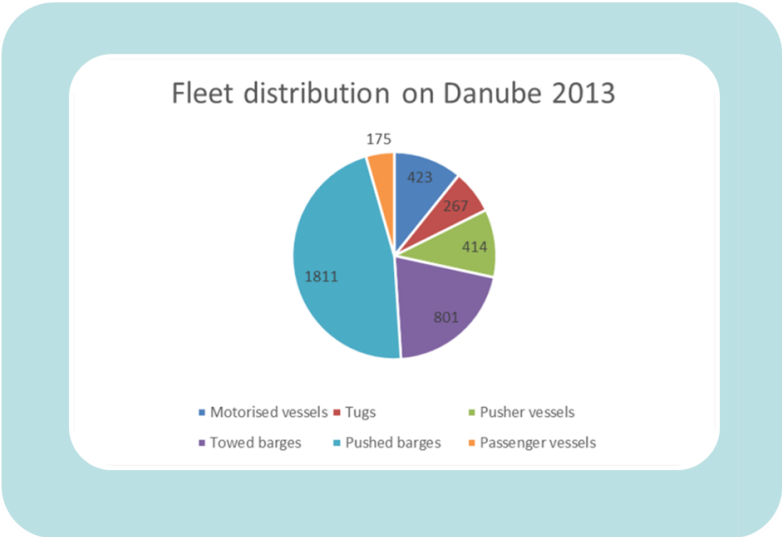
The following countries are members of the Danube Commission: Ukraine, Republic of Moldova, Romania, Republic of Bulgaria, Republic of Serbia, Hungary, Slovak Republic, Republic of Austria, Federal Republic of Germany and Russia Federation. The Danube Commission provides for all these countries detailed statistics (2011-2012, 2012-2013) about:

- Fleet composition
- Fleet by years of construction
- Quantity of goods (left, entered, carried within national territories and in transit) transported on the Danube River
- Cargo turnover of all Danube ports
- Major ports on the Danube River with cargo turnover over 1 mil. t
- Passenger fleet
- Transport of dangerous goods on the Danube River.

The distribution of vessel types on the Danube is summarised in Figure 21. The upper pane of the Figure 21 provides an overview of the fleet distribution in 2013 where towed and pushed barges accounted for ≈67% of all vessels and the share of pushed barges mounted up to more than 46%.

The fleet statistics for the period 2011-13 show a slight decrease in the number of vessels. The only increase is seen for passenger ships, which is also minor as illustrated in the lower pane of the Figure 21. The highest drop (in actual numbers) is seen for towed and pushed barges. Further, both motorised vessels and tugs drop in number in 2012 with a subsequent increase in 2013; however, this increase does not exceed the statistics of 2011 and can therefore, on a short term, still be interpreted as an overall decrease for these vessel types.

Important to be mentioned is the fact that, according to the Danube Commission statistics, the distribution of the age of the fleet operating on the Danube shows that the majority of the fleet is fairly old compared to the average age of a ship (25-30 years) ranging between 25-55 years. It should be noted that there has been only limited procurement of new ships since 2000 has occurred and none since 2010.



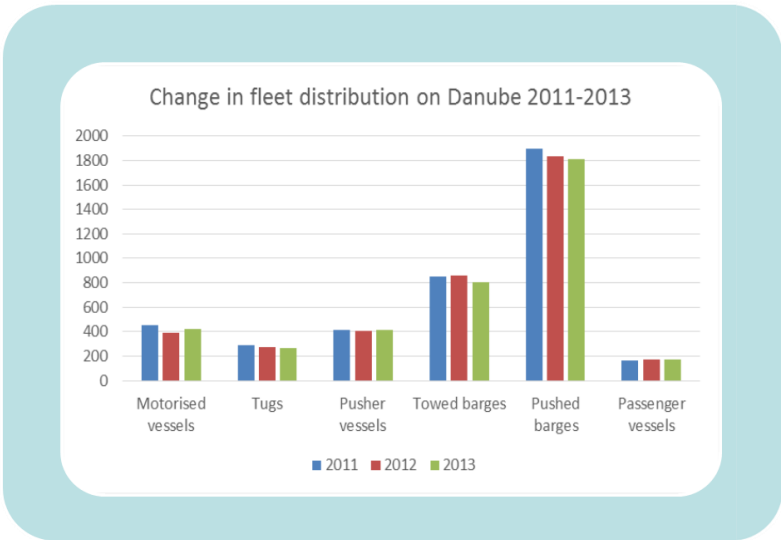


Figure 21 Danube fleet characterization: 2011-2013.
Source: Danube Commission, 2013/2014

3.2.2.3 Eurostat

As mentioned before, the distinction between domestic and international inland navigation can be approximated by fuel sale. Inland domestic ship emissions can be estimated based on fuel sold, which is provided by the national navigation statistics. On the other hand, fuel based emissions calculation for international shipping has some limitations; information on the bunker fuel sold (from IEA) is not sufficient to evaluate emissions from inland international shipping. For navigation in the Danube Region, besides Viadonau and Danube Commissions statistics, Eurostat provides also detailed information on inland waterways transport (Eurostat, 2015). National statistical port arrivals data for the EU are collected and provided to Eurostat by all Member States according to the Maritime Statistics Directive (Directive 95/64/EC). Information of interest for ship emissions evaluation is included in the Member States reporting to Eurostat e.g. mandatory reporting is foreseen for goods transport by type of goods, by nationality of vessel and by type of vessel as well as container transport by type of goods while the reporting on annual vessel traffic is voluntary.

4. EDGAR.ms interactive Web-based emissions gridding tool

The EDGAR.ms is a macro-regional approach implemented in the JRC/EDGAR tool (info on http://edgar.jrc.ec.europa.eu/). It is designed as an interactive instrument to distribute air pollutant emissions estimated for different ex-post scenarios in the Danube Region.

4.1 Description

The EDGAR.ms tool is a Web-based application to create high resolution 0.1deg by 0.1deg gridmaps. It contains a set of consistent proxy-data for the transport sector and covers all countries in the Danube Region.

The input consists of pollutant emissions as country totals provided in an excel Template with information and emissions data as described in Annex II.

This application is currently located in a restricted area and the access rights have to be requested. The diagram in Figure 22 describes the main steps in creating an emission gridmap using EDGAR,ms tool. Details on how to navigate in the application and on how to access each section of the menu are given in Annex II; the sections of the menu are: My profile, Emissions datasets, Gridding-tool, Gridmaps and Maps.

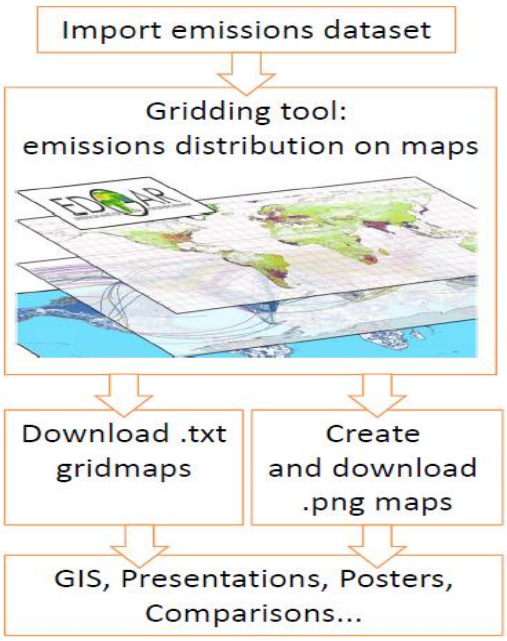


Figure 22 EDGAR.ms flow chart: steps in creating emission gridmaps

The final products of the EDGAR.ms are gridded emissions (e.g. modal-shift scenario air emission gridmaps) for transport sector in the Danube Region. These emission gridmaps can be created based on country/region or EDGAR data. The added value is that the institutions/authorities/PAs in the region can provide their emission scenarios resulting from the macro-regional transport mobility policy as input to EDGAR.ms and assess the air emission pattern changes for different options. The benefits of a sustainable transport policy, freight transport in particular e.g. the effects of exchanging trucks by ships for freight transport exploiting the Danube River could be further explored.

4.2 Emission gridmaps

As mentioned in section 4.1, the final products of the EDGAR.ms are emission gridmaps. The country emission experts from Croatia, Serbia, Romania and Hungary tested the preliminary version on the EDGAR.ms tool on their National emissions inventories for road transport. They distributed their NO_x emissions using EDGAR.ms tool, which contains a set of proxy data for transport sector. It has been proved that the emissions from National inventories of the countries in the Danube Region can be consistently distributed using harmonized proxy data. The panes on the right side of Figure 23 show the National Emissions (NO_x) for 2006 and 2010 distributed using EDGAR proxy data.

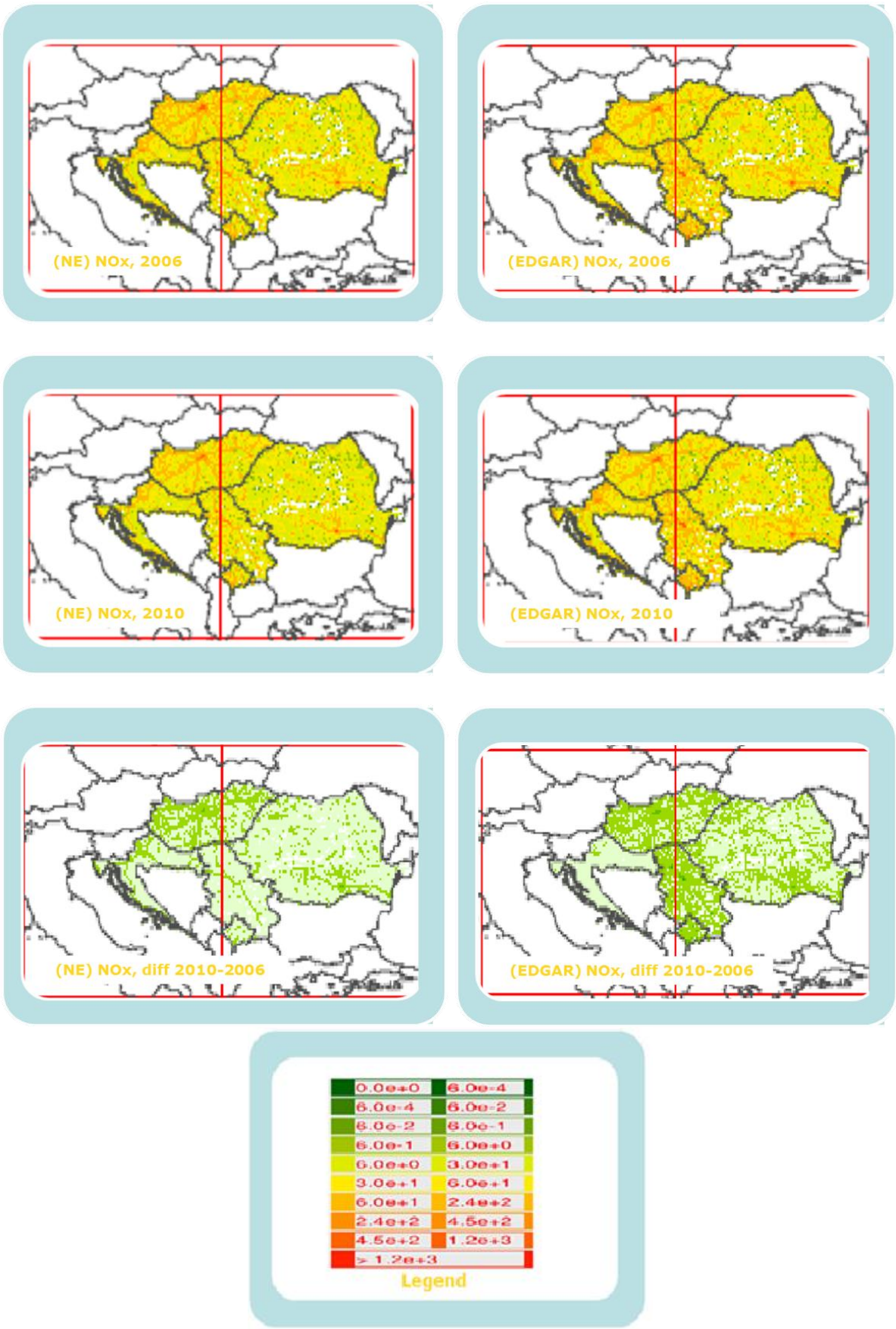


Figure 23 Emission gridmaps created using EDGAR.ms.
On the left side: National Emissions for 2006 and 2010 of Croatia, Serbia, Romania and Hungary distributed using EDGAR proxy, the difference is also provided.
On the right side: EDGAR emissions for 2006 and 2010 of Croatia, Serbia, Romania and Hungary distributed using EDGAR proxy, the difference is also provided.

The panes on the right side of Figure 23 show the EDGAR NO_x emissions from road transport for 2006 and 2010 distributed using EDGAR proxy. Only the countries participated in the EDGAR modal shift working group (19-21 October 2015) are represented, which are Croatia, Serbia, Romania and Hungary.

The differences of NO_x emissions in 2010 and 2006 are also represented for each case; these maps show a slight increase in emissions in both EDGAR and National inventories in 2010 when compare with emissions in 2006.

5. Conclusions

The EDGAR modal shift study will evaluate changes in air pollutant emissions for two extreme modal shift scenarios in transport: 1. all freight transport of 2005 on ships with no fuel consumption of heavy duty vehicles and 2. all freight transport of 2005 on heavy duty vehicles with no fuel consumption of ships. These emissions scenarios will be used as input for a second study to further investigate the benefits of sustainable freight transport; in this second study the emissions scenarios developed in the LIMITS project (Stringent air quality policies without climate change mitigation and Climate policies without further air quality policies for 2030) and the new IPCC "Shared socioeconomic pathways" (SSPs) will be also used as input for FASST tool to evaluate the impact of short-lived pollutants on air quality, human health and ecosystems in the Danube Region.

Evaluation of the changes in emissions resulting from modal shifts in transport is a complex undertaking requiring contributions from the JRC/EDGAR team, country emission experts and relevant institutions in the Danube Region in order to provide reliable findings. Therefore, EDGAR team has developed links with many specialised institutions in this area in prior activities such as the EDGAR modal shift Working Group organized in October 2015; the outcomes of this working group are presented in this report. This study, which focuses on a methodology development for the best use of the available information and expertise in the Danube Region, investigates the countries' potential to contribute to the emissions evaluation for modal shift scenarios in transport. It was demonstrated that, besides the EDGAR data and gridding tool, concerted efforts and contributions of the experts in the Danube Region are vital in understanding the effects of national circumstances, by providing additional information on inland domestic and international shipping and by providing details on ship and truck freight transport in the Danube Region.

Annex I: Metadata

Metadata Croatia:

Metadata element		
ID		
Resource title	Basic network of transport infrastructure of the Republic of Croatia	National data for the Transport sector
Organization name	EKONERG Ltd. Energy and Environmental Protection Institute	EKONERG Ltd. Energy and Environmental Protection Institute
Point of contact	Mirela Poljanac	Mirela Poljanac
Contact e-mail	mirela.poljanac@ekonerg.hr	mirela.poljanac@ekonerg.hr
Resource abstract	Web page provides maps (pdf format) on: Classification of public roads, Road network (administratively divided into highways, state roads, country roads and local roads), Trans-European Networks road in Croatia - TEN roads, Tunnels on the trans-European road network in the Republic of Croatia, Railway network, seaports, Inland waterways and Airports.	Statistical fuel consumption data for Shipping, Road, Rail and Air Transportation. Available years: 2008 - 2013 (submission in 2010).
Resource type	maps	report, datasets
Resource locator	http://www.mppi.hr/default.aspx?id=3113	http://www.azo.hr/Reports04
		http://cdr.eionet.europa.eu/hr/un/UNECE_CLRTAP_HR
		http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2015_submissions/
Main distribution format	pdf	pdf
INSPIRE theme(s)	Transport networks	Energy resources
Constraints applying to access and use	publicly available but only on Croatian language	publicly available
Data of publication	No specific date of publication	No specific date of publication
Keywords	transport	transport
Lineage / Policy Context	Data on basic network of transport infrastructure of the Republic of Croatia provided by the Rebulic of Croatia - Ministry of Maritime Affairs, Transport and Infrastructure.	National data for the Transport sector are part of data for CLRTAP and UNFCCC reporting obligations and officialyy published by the Croatian Environment Agency. The Croatian Environment Agency was united with State Institute for Nature Protection in june 2015 and the Croatian Agency for Environment and Nature was established.

Metadata Serbia:

Metadata element	Description of element
Resource title	Transport emissions
Organization name	Environmental Protection Agency Republic of Serbia
Point of contact	Nebojsa Redzic
Contact e-mail	nebojsa.redzic@sepa.gov.rs
Resource abstract	Presented maps were computed using emissions data from transport sector for few air pollutants. For road transport sector data emissions are calculated using COPERT model, and for other sectors - water and railway SEPA used EMEP/EEA 2013 methodology. The calculation covered period from 1990 -2014. Gridded data was prepared for 2014 for each transport sector and then summarized for road transport and total for all transport sectors.
Resource type	data set series
Resource locator	http://www.ceip.at/
Main distribution format	gif, shp, doc, pdf, xls
INSPIRE theme(s)	Transport networks Geographical grid system
Constraints applying to access and use	Reuse is authorized according to the European Commission legal notice at http://ec.europa.eu/geninfo/legal_notices_en.htm
Keywords	modelling, spatial distribution, air pollution, climatic change, mathematical analysis, transport
Lineage / Policy Context	These data are part of data for CLRTAP and GHG reporting obligations.

Metadata Romania:

Metadata element	Description of element
Resource title	National Air Pollutant Emissions Data (including data for Transport Sector - Rail/Shipping/Road)
Organization name	National Environmental Protection Agency - Romania
Point of contact	RO NEPA - Air Quality Assesment Centre
Contact e-mail	bogdan.gird@anpm.ro; monitoring_integrat@anpm.ro; www.anpm.ro
Resource abstract	Statistical fuel consumption data for Shipping, Road and Rail Transportation from data reported to IEA-UNECE by the National Statistics Institute. Vehicle mileages adjusted in order to match COPERT 4 V.11 calculated ones by less than 1% deviation. Copert 4 V.11 fleet data from the Romanian Auto Registry (confidential data). Note: aggregated fleet data might be available for public use. Default Tier 1 emission factors from EMEP/EEA Guidebook 2013 for Railoroads and Shipping. CLRTAP air pollutant emissions for Shipping, Road and Rail Transportation. Available years: 2005 - 2013.
Resource type	Dataset series
Resource locator	http://cdr.eionet.europa.eu/ro/un/UNECE_CLRTAP_RO/envvqlrlg/ http://cdr.eionet.europa.eu/ro/un/UNECE_CLRTAP_RO/envvqltiw/
Main distribution format	.xls template
INSPIRE theme(s)	
Constraints applying to access and use	Public data except for Road Transport Fleet Data (owned by the Romanian Auto Registry)
Data of publication	2015-13-03
Keywords	Europe, Romania, CLRTAP, National Inventory, Transport, Air Quality, Railways, Shipping, Activity data, Emissions, UNECE, NEC, reporting, EIONET
Lineage / Policy Context	All data (excluding fleet composition for road transport) were reported under the LRTAP convention and are available by using the link from "Resource locator". All data can be yearly recalculated re-reported, changes are recorded for each sector and NFR code in the National Inventory Report (the latest version can be found by following the second link from "Resource locator").

Metadata Hungary:

Metadata element	Description of element	Description of element	Description of element
Resource title	Traffic Count Database	HU-GO; Electronic Road Toll Database	Periodic Technical Inspection Database
Organization name	Magyar Közút Ltd.	NÚSZ	NKH - National Transportation Authority
Contact e-mail	ugyfelszolgalat@kozut.hu	ugyfel@hu-go.hu	NA
Resource abstract	Annual road traffic of Hungary by vehicle categories and road sections. Vehicle number on road sections (highway, main road, rural road, etc.). Municipal roads are excluded.	Electronic road toll database by vehicle categories over 3,5t and by Euro categories. Categories by vehicle axles: J2: two axles J3: three axles J4: four or more axles	Technical parameters of each vehicle with a valid registration certificate; includes tachometer data too.
Resource type	table	dataset	dataset
Resource locator	http://internet.kozut.hu/Lapok/forgalomszamlalas.aspx	NA	www.nkh.hu
	http://internet.kozut.hu	www.nusz.hu	http://www.nkh.gov.hu/en/web/english/contact-us
Constraints applying to access and use	Reuse is authorised according to the 1310/2015. (V. 21.) Gov. decree	Reuse is authorised according to the 1310/2015. (V. 21.) Gov. decree	NA
Data of publication	by request (contract)	by request (contract)	NA
Keywords	traffic, vehicles, vehicle categories, road type, road sections	traffic, heavy duty vehicles, road toll vehicle categories, road type, road sections; Euro categories	periodic technical inspection, annual mileage, technical parameters, euro category, fuel type, engine displacement, net weight, max. weight

Metadata element	Description of element	Description of element	Description of element
Resource title	Vehicle Registration Database	Energy Statistics	Meteorological Data
Organization name	KSH - Central Statistical Office	IEA - International Energy Agency EUROSTAT	OMSZ - Hungarian Meteorological Service
Contact e-mail	NA	stats@iea.org; oilaq@iea.org; estat-energy@ec.europa.eu	klimaker@met.hu
Resource abstract	Technical data of vehicles registered in Hungary (31/12/YYYY)	Annual fuel consumption (road): - Total motor gasoline[t] - Total gas/diesel oil [t]	Climate information and data processing: - Monthly average minimum temperature [°C] - Monthly average maximum temperature [°C] - Relative humidity per month [%]
Resource type	dataset	dataset	table
Resource locator	www.ksh.hu	http://www.iea.org/	http://www.met.hu/
	https://kapcsolat.ksh.hu/ContactCenter/opennewcase.xhtml	http://www.iea.org/statistics/resources/questionnaires/annual/	
Data of publication	by request (contract)	NA	by request (contract)
Keywords	technical parameters, euro category, fuel type, engine displacement, net weight, max. weight, years of manufacture, first year of registration	fuel type, fuel consumption, motor gasoline, gas/diesel oil	climate information, temperature, relative humidity

These metadata are on the Danube Reference Data and Services Infrastructure (DRDSI) WEB site, "EDGAR modal shift: air emissions evaluation and distribution for multi-modal transport shifts in the Danube region" user story http://drdsi.jrc.ec.europa.eu/user-story/edgar.

Annex II: EDGAR.ms user guide

The EDGAR.ms Web-based gridding tool was designed as a user friendly tool (self-explaining), yet we provide below a few steps to be followed:

- **Step 1:** Prepare the input file

The input file of the EDGAR.ms gridding tool should contain information as illustrated in Table 1. A Template is provided (.xls) by EDGAR team to be compiled with emissions as country totals.

Dataset	**dataset_name**						
Dataset owner	**edgar**						
Substance							
Country							
Process code	**TRO.ROA**						
IPCC code	**1A3b**						
Unit	**Ktonnes**						
Year from	**2008**						
Year to	**2012**						
Substance	**Process code**	**Country_ISO_A3**	**2008**	**2009**	**2010**	**2011**	**2012**

Table 1 Template (empty input file) of the EDGAR.ms gridding tool.

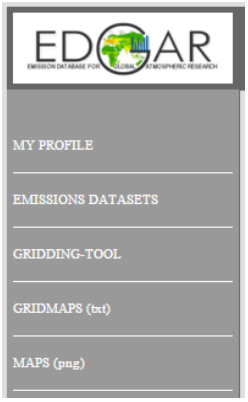
Where: "Substance" stands for e.g. CO2, NOx, SO2 and "Process code" means e.g. TRO.ROA.DIE.BS0 with the codes of three digits: TRO-transport, ROA-road transport sector, and DIE-Gas/Diesel Oil as fuel used in BS0-buses (see all definitions in Table 2).

The definitions of fuel/technology in EDGAR for road transport sector are given in the table below.

FUEL		TECHNOLOGY	
DIE	Gas/Diesel Oil	BS0	Buses
MOG	Motor Gasoline	HD0	Heavy duty vehicles
HFO	Residual Fuel Oil	LD0	light duty vehicles
LPG	Liquefied Petroleum Gases	MC0	Motorcycles
OKE	Kerosene	MP0	Mopeds
NGS	Natural Gas	PC0	Passenger cars
BDS	Biodiesel		
BGL	Biogasoline		
NAP	Naphta		

Table 2 Road transport: fuels and technologies in EDGAR.

- **Step 2:** Navigate into the EDGAR.ms application; create emission gridmaps

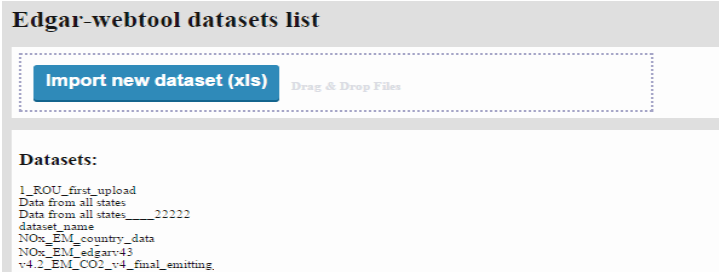


The MENU of the application is located on the left side of the screen. The user can access different sections as following: my profile, emissions datasets, gridding-tool, gridmaps (txt), maps (png).

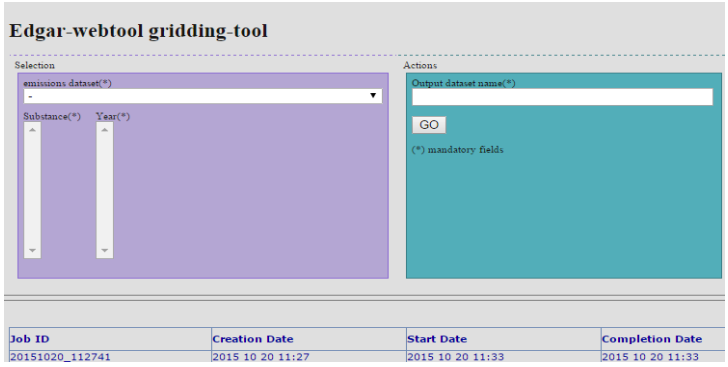
In the section:

a) MY PROFILE - the user can update the password by inserting the old one, the new one and the confirmations.

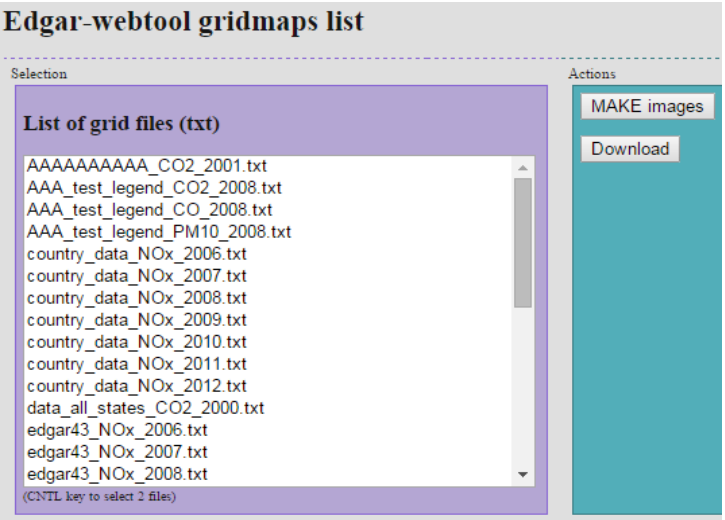
b) EMISSIONS DATASETS - the user can import new emissions datasets by uploading the template compiled with countries data/emissions. In addition, the user can edit and delete datasets in this section.



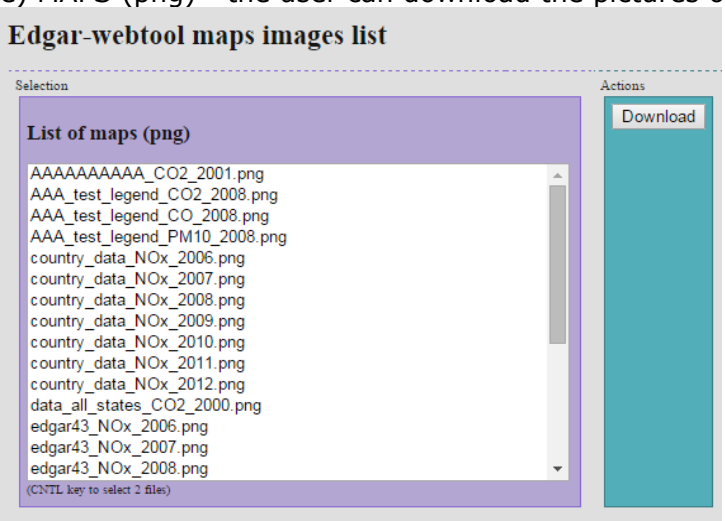
c) GRIDDING-TOOL - the user can run the gridding process. From the selection panel, first select the dataset (previously imported) and after select the substance and the year from the lists. In the actions panel insert a name for the output grid-map and click the GO button. In the list on the bottom of the page is possible to check the process state. Once the process is ended, files are available in the GRIDMAPS section.



d) GRIDMAPS (txt) - the user can select the grid-maps from the list in selection panel and download the files in zip format. In the same way is possible to create pictures of the grid-maps by clicking the MAKE images button.



e) MAPS (png) - the user can download the pictures of the grid-maps previously created.



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List of figures and tables

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