# Estimation of Road Transport Related Emissions in Serbia using COPERT 4 Versions 9 and 10 between 2009 and 2012

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## Introduction

Evidence of a decrease in road transport related emissions was observed in the period from 2009 to 2012. On the one hand, the reason lies in a decrease of average annual mileages of private vehicles due to the raise of conventional fuel prices. This fuel cost increase directly influences users' behaviour while choosing the transport mode for the next trip, with an equally interesting impact on the number of trips, trip lengths and total mileage, meanwhile increasing vehicle (or mode) energy efficiency (as a global industry and socio-economic trend). Another very important and influential trend is the decline of newly purchased vehicles in the Serbian vehicle fleet between 2009 and 2012 influenced by the world economic crisis.

At the same time, transport companies and company fleets in similar circumstances of raising fuel costs tend to optimise their transport operations either by increasing transport volumes per vehicle, through boosting vehicle capacity utilisation by freight consolidation or by adapting the vehicles to individual transport tasks based on load size and/or capacity.

One more effect that took place was the eradication of leaded petrol in the beginnings of 2011. In 2009 and 2010 there was an important use of this harmful fuel (dominant over unleaded petrol). Although Serbia was one of the last countries in the world to ban the leaded petrol production and sales in 2011, there were still some remaining quantities on the market in 2011 and even in 2012.

## Background

Serbian Environmental Protection Agency has adopted COPERT 4 as a tool for the estimation of road transport related emissions of pollutants, which was created based on EEA methodology (EEA, 2009). The authors of this paper participated in the first project (Papić, et al., 2010) aimed at producing pollutant emission estimation for the Republic of Serbia between 1990 and 2009. Public Enterprise "Roads of Serbia" initiated a study (Momčilović, et al., 2014), in December 2013, intended for updating the road transport related pollutant emission estimation for 2010-2012, as well as obtaining a methodology for pollutant's atmospheric emission estimation on different road categories (per sections) based on relevant vehicle fleet structure and related traffic flow features.

The circumstances in Serbia can be described as follows. The value of GDP per capita decreases after 2008 largely as a result of the world economic crisis, with a slight recovery in 2011, when GDP per capita reaches 4,351 EUR, and declines again in 2012 to the value of 4,112 EUR.

Regarding Serbian population, it decreases from 7,321 million in 2009 to 7,199 million inhabitants in 2012.

Serbian road network length is 44,613 km in 2012 (excluding Kosovo). The road network categories' shares are as follows:

- 1st category national roads: 10.54 % (with 4,702 km),
- 2nd category national roads: 23.95 % (with 10,684 km), and
- municipal (local) roads: 29,227 represent 65.51 % of the network.

The number of vehicles in Serbian fleet decreases from 1.827 in 2009 to 1,774 1.965 million vehicles in 2012. The passenger cars share, although dominant by far, is decreasing from initial 89.3 % in 1990 to roughly 87.1 % in 2012, but in absolute values has grown for around 70 %. The number of heavy freight vehicles has almost doubled in the period 1990-2012 from 95.2 thousand vehicles, steadily growing from 2000 until 2008 when it slightly decreases, but reprises from 2011 to reach the 190.0 thousand vehicles. The number of buses and coaches has varied significantly but ultimately decreased for about 16 % from 9,861 to 8,288. The number of mopeds and motorcycles in 1990 was close to 19.7 thousand and has significantly and steadily grown (2.75 times) since 2005 to reach 54.4 thousand units.

**Table 1:** Number of registered vehicles (2009-2012)

| Year | Passenger Cars | Motorcycles and Mopeds | Buses | Light Commercial Vehicles and Heavy Duty Trucks | Total |
|---|---|---|---|---|---|
| 2009 | 1,605,737 | 29,394 | 8,669 | 183,391 | **1,827,191** |
| 2010 | 1,547,310 | 38,089 | 7,891 | 180,840 | **1,774,130** |
| 2011 | 1,658,720 | 44,771 | 8,096 | 185,502 | **1,897,089** |
| 2012. | 1,713,008 | 54,360 | 8,288 | 190,045 | **1,965,701** |

The motorisation rate, expressed in passenger cars (PC) per 1,000 inhabitants is generally growing, except from 2009 to 2010 when the value falls from 219 to 212, but then reprising to reach 238 PC's per 1,000 inhabitants in 2012, which is far below the EU average that in 2011 was 477 PC's per 1,000 inhabitants.

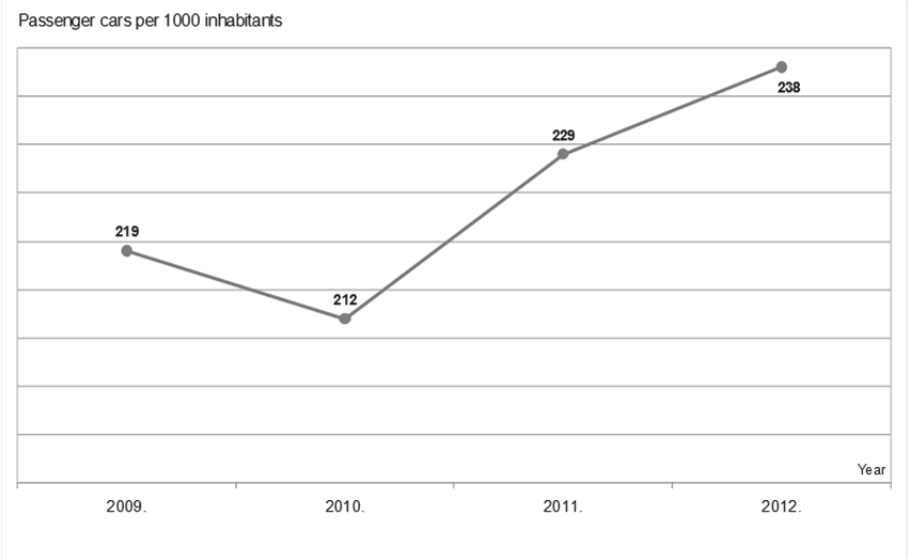


**Figure 1:** Motorisation rate in Serbia (2009-2012)

Fuel sales dedicated to road transport were taken from the energy balance from 2009 to 2012 and given on the following **Figure 2**.

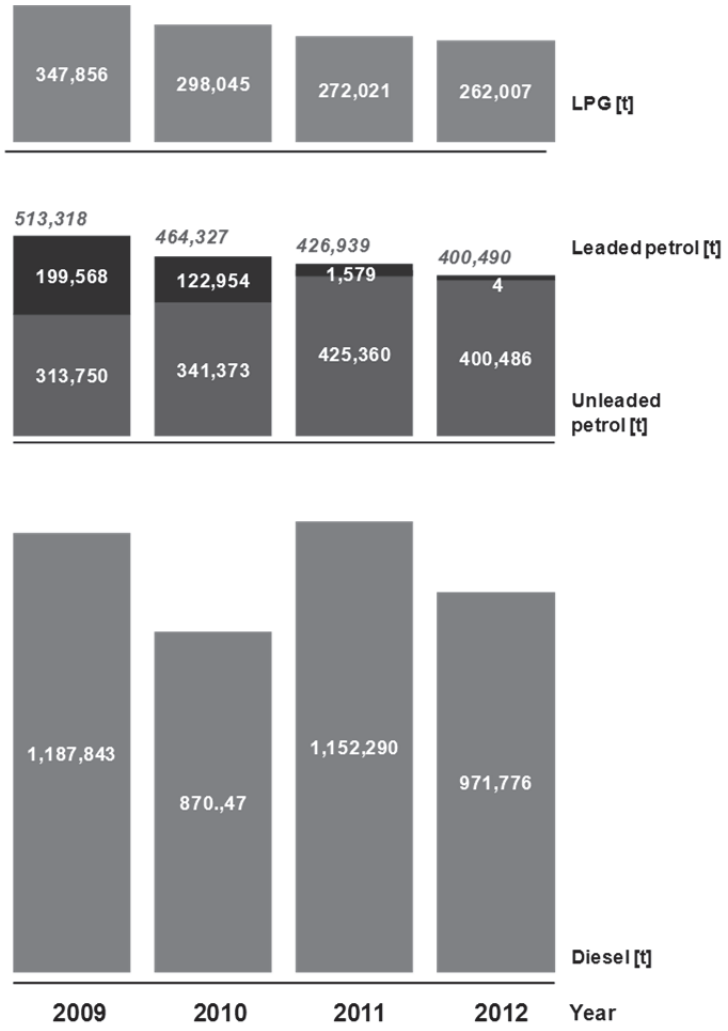


**Figure 2:** Conventional fuel sales in Serbia (2009-2012)

Nevertheless, there is an important share of petrol vehicles of pre-EURO emission control technologies. Some of those vehicles have opted to retrofit to LPG, since this fuel is still importantly cheaper than petrol in Serbia. Such retrofitting was very well received among national official structures in charge of energy, environment, transport and vehicles. Although there are no direct subventions for this fuel, initially it was exempted from the excise duty, which was later reintroduced in 2012.

## Survey

The actual environmental effects of mentioned conversions are very suspicious because of the engine cycle efficiency, engine quality, dominant maintenance practices (especially regarding very old vehicles) and importantly higher average consumptions of this fuel compared to petrol and especially diesel which was testified by the interview results (shown in the following tables 2 and 3). In the Serbian capital - Belgrade region - there is an increased fuel consumption caused by more dominant urban use of vehicles than in other regions (shown in **Table 2**).

**Table 2**: Survey of fuel consumptions [l/100 km] among regions and on the entire sample (2012)

| Region | Petrol | Diesel | LPG | Average |
|---|---|---|---|---|
| Belgrade | 8.04 | 7.37 | 10.34 | 8.18 |
| Vojvodina | 7.49 | 6.63 | 9.28 | 7.69 |
| South and East | 8.02 | 6.70 | 9.82 | 8.05 |
| Šumadija and West | 8.03 | 6.71 | 9.31 | 7.91 |
| Sample | 7.86 | 6.85 | 9.57 | 7.93 |

Besides the differences among different fuels, there is also an important influence of the vehicle ownership in view of average usage and fuel consumptions (shown in **Table 3**).

**Table 3:** Survey of fuel consumption [l/100 km] differences among private and company cars (2012)

| | Petrol | Diesel | LPG | Average |
|---|---|---|---|---|
| Private | 7.78 | 6.66 | 9.48 | 7.85 |
| Company | 8.66 | 7.95 | 11.00 | 8.65 |

Another interesting result is the observed mileage per private and company (business related) cars obtained in the course of the same survey (**Table 4**).

**Table 4:** Survey of average annual mileages [km] for private and company cars (2012)

| Region | Private | Company | Average |
|---|---|---|---|
| Belgrade | 10,528 | 31,219 | 14,809 |
| Vojvodina | 10,753 | 30,597 | 12,726 |
| South and East | 8,869 | 25,286 | 9,684 |
| Šumadija and West | 9,936 | 23,227 | 10,526 |
| **Sample** | **10,085** | **29,347** | **11,952** |

As shown in the previous table, although there are considerable differences among private and company (business related) cars mileages the sample of private (individual) cars was dominant by far over company vehicles, which is consistent with the data in the vehicle registration database (at least regarding passenger cars).

On the basis of relevant international experience, the research methodology of the mileage on national and regional levels has been formulated. The research was based on two surveys: one involving face-to-face interviews of drivers at vehicle inspection stations, on refuelling stations, parking lots and garages, and another consisting in questionnaires sent to and filled by transport companies. The surveys (interviews) involved drivers of both private and company vehicles. In order to obtain data for 2009 and 2011, two surveys have been realised during March and April 2010 and 2012 regarding annual and total mileages, as well as fuel consumptions segregated by road and user types. The data was appropriately prepared for the application of COPERT 4 and analysed and calibrated with amounts of different fuels (shown on figure 2) sold to road transport operations.

## Results of the estimation of transport related emissions

The results of the estimations using COPERT 4 are presented in the following figures where it has been shown the expected decrease in the pollutant emissions.

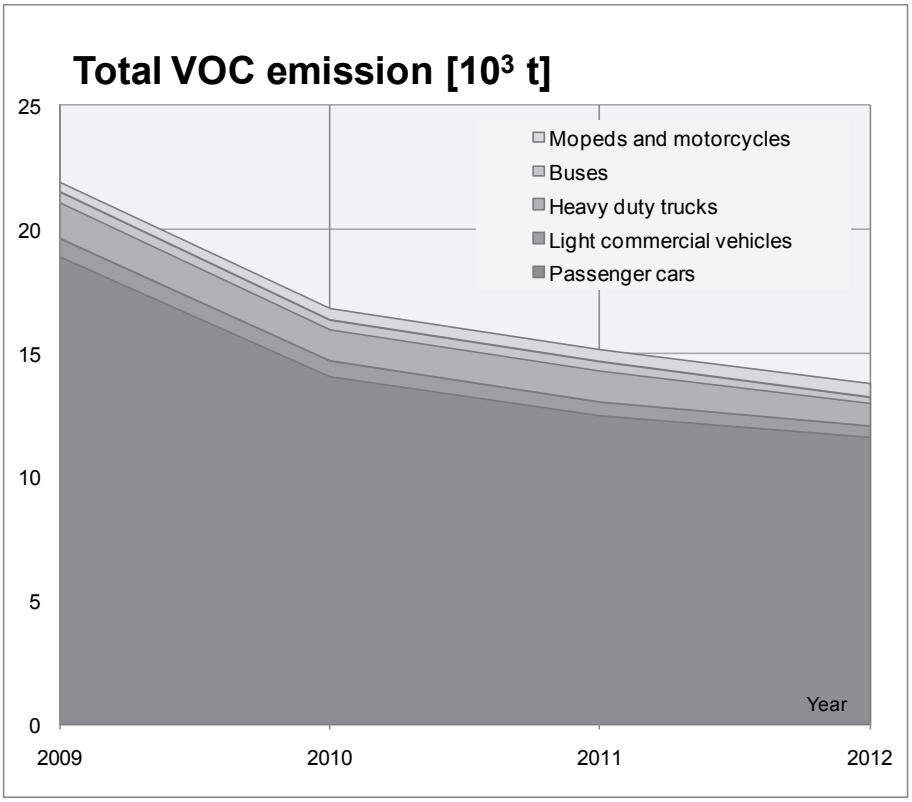


**Figure 3:** Total VOC emissions in Serbia (2009-2012)

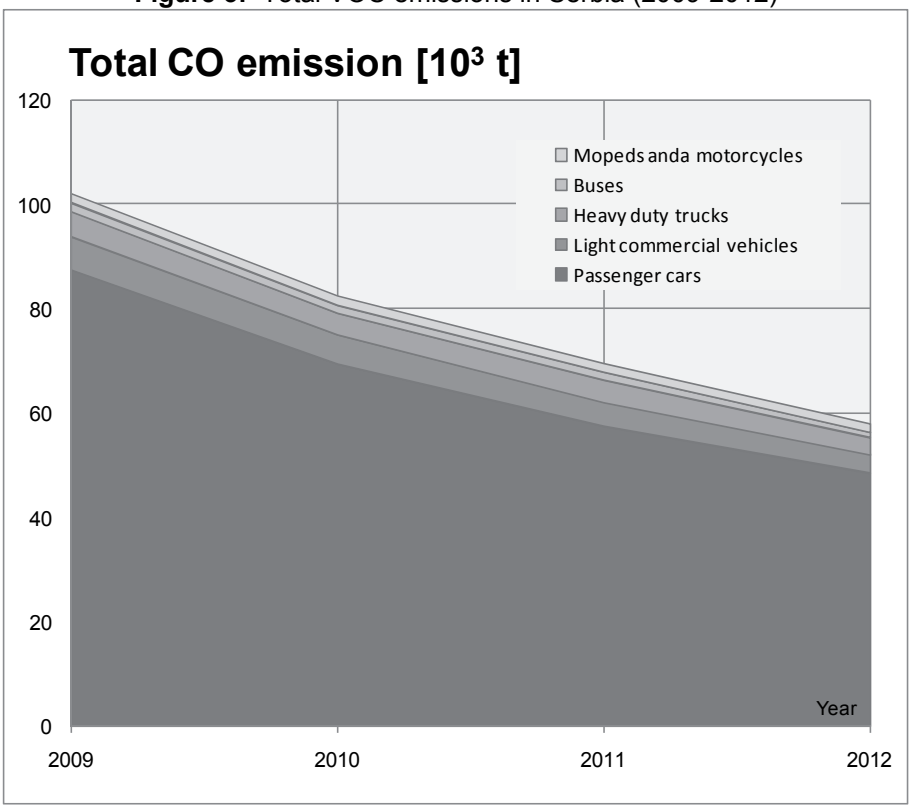


**Figure 4:** Total CO emissions in Serbia (2009-2012)

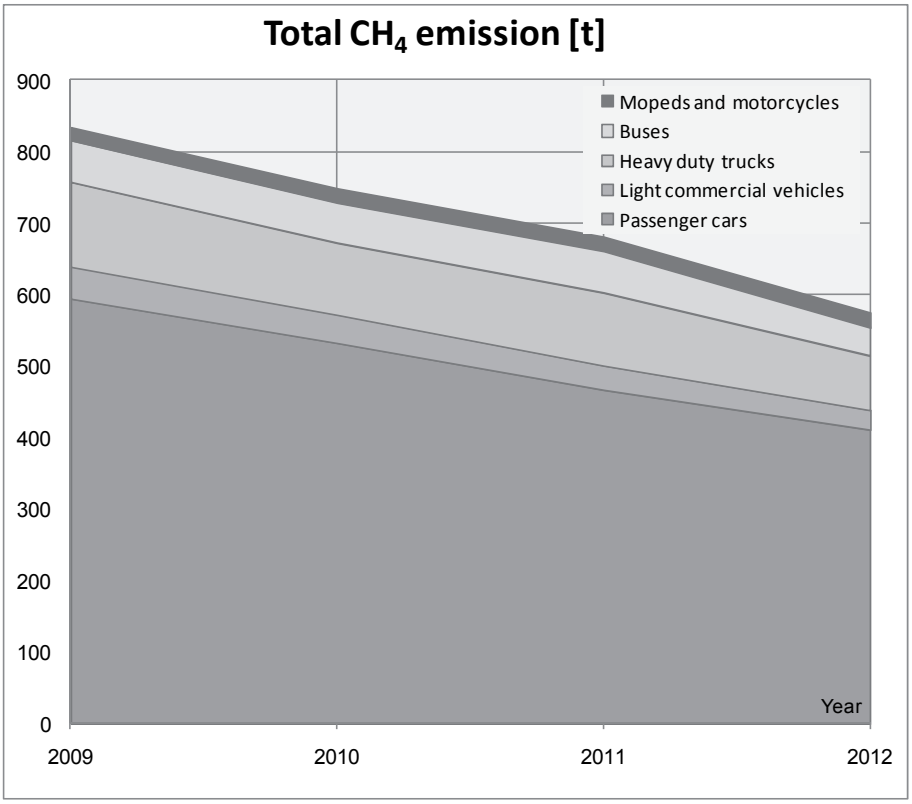


**Figure 5:** Total $CH_4$ emissions in Serbia (2009-2012)

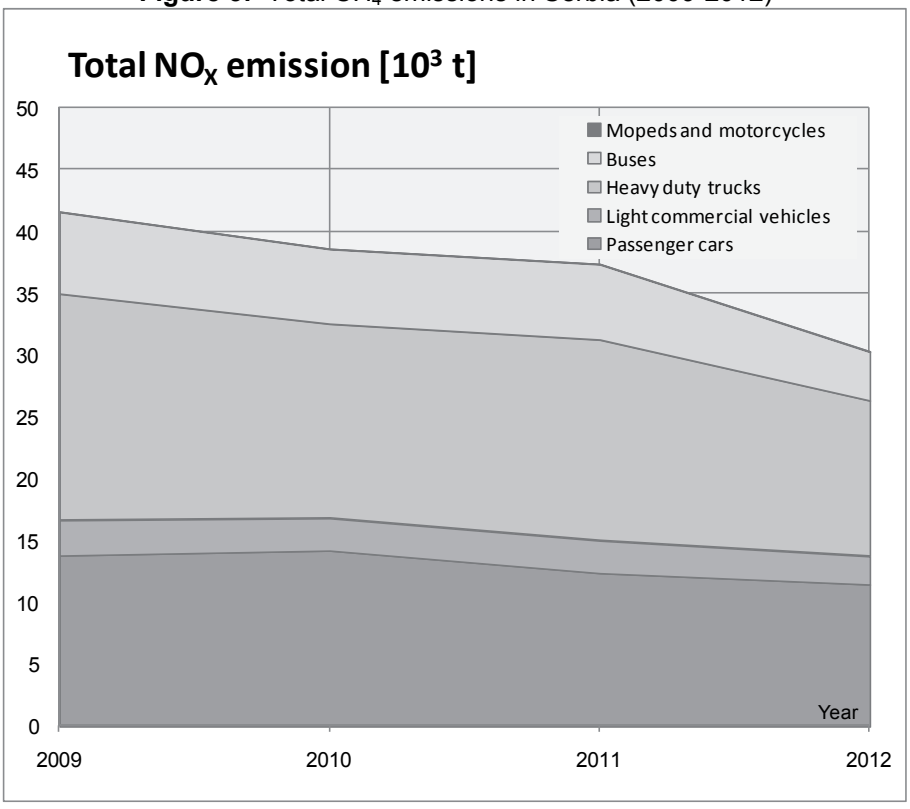


**Figure 6:** Total $NO_X$ emissions in Serbia (2009-2012)

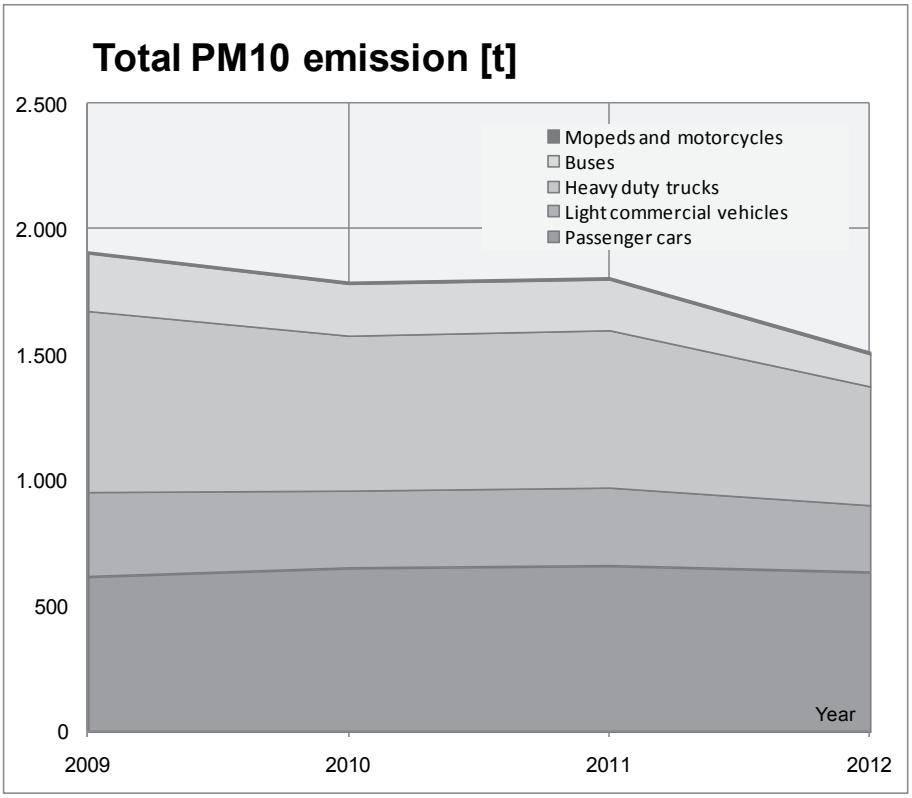


**Figure 7:** Total $PM_{10}$ emissions in Serbia (2009-2012)

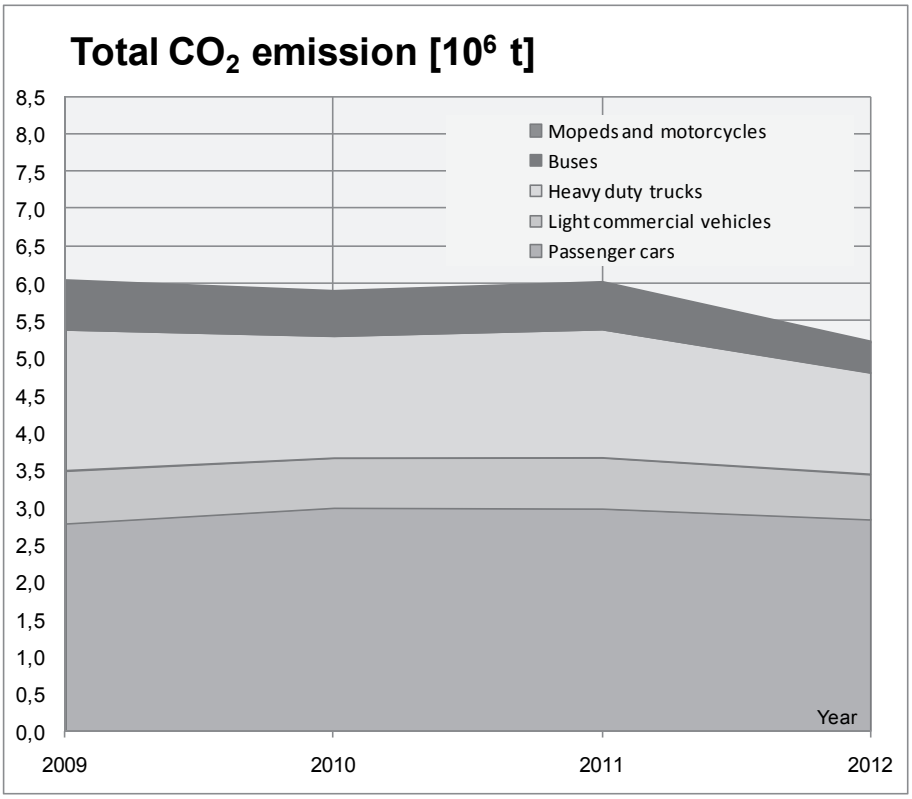


**Figure 8:** Total $CO_2$ emissions in Serbia (2009-2012)

## Conclusions

For the estimation of pollutant emissions from road transport it has been used the software package COPERT 4. Necessary data has been systematised and adequately corrected, as well as collected from a survey that was realised on the vehicle inspection stations in 2012.

There were also challenges in the analysis and comparison of data for different years: for 2009 (and earlier years) COPERT 4 version 9 was used, while for all other subsequent years its version 10 was used introducing new vehicle classes (e.g. petrol <800 cm3 and diesel <1400 cm3 for EURO 4 and 5 passenger vehicles), which had to be consistently reapplied to earlier databases; new national licence plates were introduced in 2011 that caused a “clean-up” of number of vehicles that haven’t renewed their registration, which until then “burdened” the national vehicle database (although not in everyday use) because they haven’t been officially written-off. The second problem was and still is important since the vehicle owner pays related taxes only while registering his/her vehicle and is not due to pay any taxes if he/she skips the registration. Such recommendations have been given to pertinent authorities.

## Acknowledgement

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