Survey of the annual vehicle kilometres travelled (VKT) in the Republic of Serbia within the UNFCCC scheme for emission inventory

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Introduction

The Republic of Serbia is a developing country in the Southeast Europe, more precisely in the Balkans region. Since 2000, after a decade of economic crisis and hyperinflation of the 1990's, the country has been struggling with outdated fleets in all transport modes but especially in road transport, railways and internal waterways as a result of a systemic lack of maintenance and renewal. It was estimated that at the end of 2005, the average age of road vehicles was 15.3 years and that as much as 20% of vehicles (i.e. over 400,000) were over 20 years old (Ministry of natural resources, mining and spatial planning, 2011), which importantly influenced the emission technology, and therefore average vehicle emission levels. Such situation has improved importantly in the years that followed 2005, but once again lost its pace in the recent crisis (since 2009).

There are six major stakeholders in the national policy sector regarding the field of environmental protection and energy efficiency, as follows: the Ministry of mining and energy, the Ministry of environment and spatial planning, the Energy efficiency agency, the Serbian environmental protection agency, the Energy agency and the Environmental protection fund. Consequently, based on the Energy Community Ministerial Council Decision 2009/05/MC-Enc of 18 December 2009, the Republic of Serbia has drafted its first Energy Efficiency (Action) Plan covering the period 2010 – 2012 setting the average indicative energy savings target over this period at 1.5% of the final domestic energy consumption from 2008 (0.1254 Mtoe) which represents ultimately a target of at least 9% of final energy consumption in the ninth year of implementation. The targeted final energy savings of 1.5% will be achieved with the implementation of the energy efficiency enhancement measures in the sectors of households and public and commercial activity (0.0235 Mtoe), industry (0.0566 Mtoe) and transport (0.0453 Mtoe). Republic of Serbia has equally ratified the UN Framework Convention on Climate Change (UNFCCC) in March 2001 as a non-Annex I country and its Kyoto protocol in October 2007 (entering into force in January 2008) as a non-Annex B party. Therefore, Serbia is not bound to quantified commitments regarding reduction of GHG emissions neither to trade emissions meanwhile is eligible for implementation of the CDM projects. Nevertheless, it has to make the periodical reports to the UNFCCC, therefore the Republic of Serbia is currently preparing its first national communication with the GHG Inventory. Nowadays, Serbia is in process of negotiating its commitment for the post-Kyoto protocol period, which along with subsequent accession to the EU will further emphasise the environmental issues.

It was estimated by the Climate change sector of the Serbian Ministry of environment, mining and spatial planning that in 2007 Serbian road transport accounted for 6.7% of the total GHG emissions contrary to the EU road transport whose share was estimated at 17.2% (as shown in table 1).

Table 1: Comparison of GHG emission inventory of EU and Serbia in 2007

Inventory category	European Union		Serbia	
1.A.1 Energy industries	30.0%	42.2%	46.3%	54.1%
1.A.2 Manufacturing industries and construction	12.0%		7.8%	
1.A.3.A Civil aviation	0.4%	24.3%	0.0%	7.2%
International aviation	2.6%		0.2%	
1.A.3.B Road transport	17.2%		6.7%	
1.A.3.C Railways	0.2%		0.1%	
1.A.3.D IWW Navigation	0.4%		0.2%	
International maritime transport	3.3%		0.0%	
1.A.3.E Other transport	0.2%		0.0%	
1.A.4 Other sectors (households & services)	12.4%	12.4%	12.3%	12.3%
1.A.5 Other (not elsewhere specified)	0.2%	-	0.0%	0.0%
1.B Fugitive emissions from fuels	1.6%	1.6%	3.7%	3.7%
6 Waste	2.6%	2.6%	4.1%	4.1%

Source: EEA and Serbian UNFCCC INC

The final energy consumption in the transport sector and the sector defined as households, public and commercial activities fluctuated slightly in the 2002-2008 period. However, in 2008, the energy consumption registered in 2008 was exceeded (by almost 50% in the transport sector), as shown in the following table 2.

Table 2: Final energy consumption by sectors 2002-2008

Year	2002	2004	2006	2008
FEC (Mtoe)	6.95	7.663	7.367	8.412
Industrial sector	2.43	2.088	2.586	2.832
Transport sector	1.58	2.252	1.774	2.361
Other sectors	2.94	3.323	3.000	3.219

Source: The First Energy Efficiency Plan of the Republic of Serbia for the period from 2010 to 2012

The preceding table 2 shows that the share of the households, public and commercial activities sector was 38.3%, that of the transport sector is 28.1% and that of the industry is 33.7% of the total final energy consumption in 2008. As transport has an important share in the GHG emissions there is a growing awareness about the policy measures to be implemented. Since Serbian road fleet has rapidly grown since 2000, from the number of registered vehicles, passenger cars have outgrown all the others with a dominant share of about 87%. Meanwhile, over the last two decades (1990-2009), the number of passenger cars has increased for about 60%, number of goods vehicles has almost doubled, while adversely number of buses has decreased for more than 10%. In the recent couple of years, due to the global economic crisis, the number of newly registered vehicles has declined compared to the period until 2009. The situation with the number of registered vehicles in the relevant categories for the research period is shown on the figure 1 below. Therefore, six major policy measures have been recognized as crucial in the transport sector, especially regarding road transport, as follows:

- implementation of gasoline and diesel hybrids,
- accelerated replacement of old (outdated technology) vehicles with more efficient ones,
- purchase of highly efficient vehicles instead of standard ones,
- improvement of ineffective roads/infrastructure encumbered by traffic congestions,
- reduction of road transport share in view of passenger and goods transport by increasing other transport modes' (railways and waterways) shares, and

– use of biofuels.

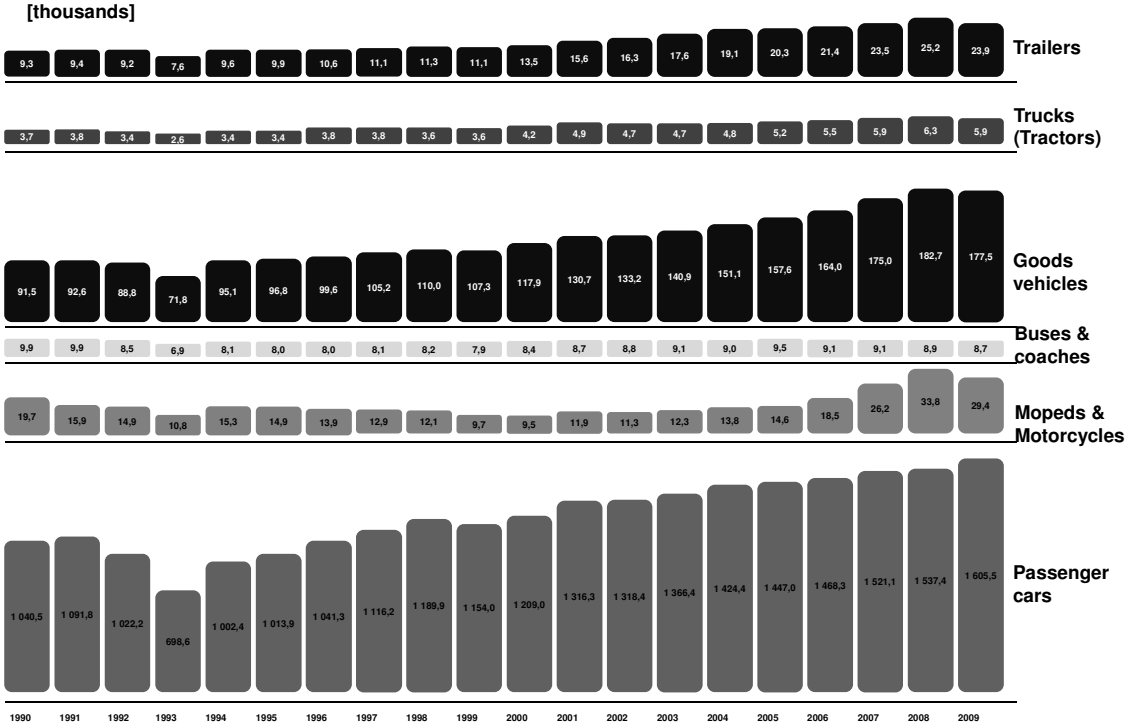

Figure 1: Number of registered vehicles in Serbia 1990-2009

The survey of road transport activity data

In 2010, the Faculty of Transport and Traffic Engineering within the project named "Determination of gaseous pollutants' emissions from road transport using COPERT 4 model of the European Environment Agency (EEA)" has estimated the GHG emissions between 1990 and 2009 for the Serbian Environmental Protection Agency (SEPA) (Papić et al. 2010).

After reviewing the database of registered cars in Serbia it was found that there were certain gaps (data missing) and also some inconsistencies in the records, in almost every element of vehicles database. Depending on the vehicle categories different errors in the vehicle data were observed (erroneous fuel / propulsion, models produced outside manufacturing period, categories). Therefore the database required first an important systemic inspection and adequate corrections in order to minimize system mistakes, but also in order to minimize the time spent on corrections. After a thorough analysis, the method for the missing data collection, specific data corrections and adaptations to the format required by Copert 4 has been established. Especially, in lack of relevant national statistics regarding the annual VKT for different vehicle categories and road classes, the team had organised an extensive survey to estimate them. Actually, two surveys were conducted: one on transport company fleets and another on individual passenger cars. The first consisted of a questionnaire sent to the major part of transport companies. Meanwhile, the second involved individual users in a survey on fuelling stations, parking lots and vehicle inspection lines. 8,650 vehicle users were interviewed in this process. Most recently, during April and May 2012, the project team has conducted an update of the Survey realised in major transport companies and on vehicle inspection lines (for individual users) in order to check the input data variations and assess the influence of the global economic crisis on previous emission estimations.

Within the mentioned project a particular survey has been realised for determining the average annual vehicle kilometres travelled (VKT) in 2009. The survey consisted in an interview of drivers of road transport vehicles at the refuelling stations, parking lots and transport companies all over the Republic of Serbia. The drivers were requested to state their average annual VKT of the present vehicle. The total number of vehicle kilometres travelled was obtained by odometer readings (denoting the present total VKT) of the vehicle, and the remaining data were taken from the vehicle registration booklet (so-called traffic license). The survey involved 8,650

vehicles, and as a result of data processing average annual VKT in 2009 for each category of vehicles was obtained. The questionnaires from both surveys are shown on the figure 2 below.

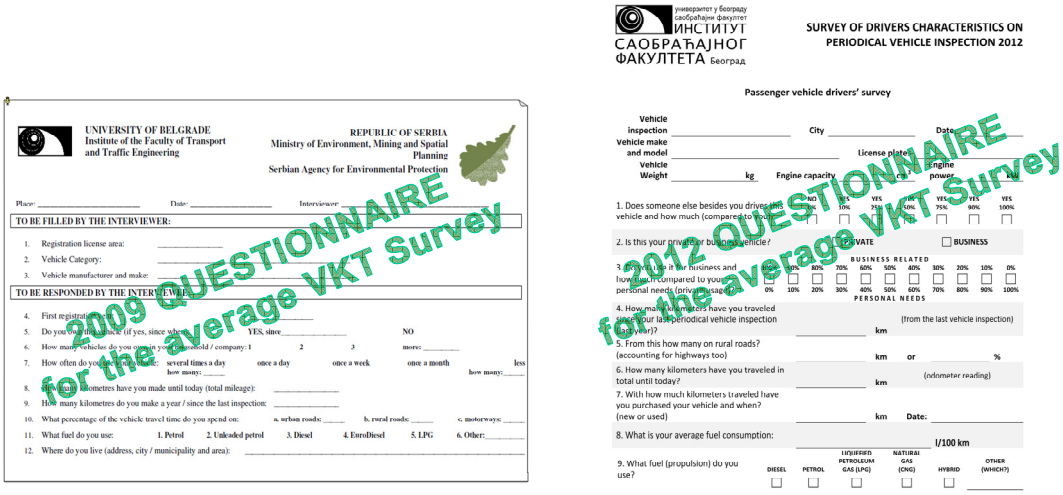

Figure 2: The VKT survey questionnaires in Serbia used in 2009 and in 2012

Based on the realised survey results, i.e. values of average annual mileage, the total emissions of pollutants for all vehicle categories have been calculated for 2009. The calculated values have been compared to the emissions obtained based on slightly increased EU average mileages for 2005.

Methodology for road transport emissions assessment

The project team used COPERT 4 as a model for the assessment of road transport related emissions, requiring a large set of categorised inputs, urging for a complex procedure for input data acquisition and collection, considering that it was done for a twenty years period (1990-2009). Total consumption of fuels per type, number of vehicles per categories and emission technologies, average annual vehicle kilometres travelled (VKT) per vehicle category and road classes (urban, rural, motorway), average speed per vehicle category and road classes, climate condition data, etc. Certain of mentioned input data have been obtained from the National Statistical Office, Ministry of Energy, Ministry of Interior and National Hydro Meteorological Institute.

Based on the input statistical and other relevant data, but also calculations and survey results we have obtained the following emission estimations. Total quantities of emitted pollutants of certain categories have been presented on the following figures. The analysis of pollutants emissions have been focused on regulated pollutants (as CO, NOX, PM10, and VOC), GHG emissions (as CH4, CO2) and fuel-related emissions (as SO2 and lead). The results of the emissions obtained based on the realized survey for 2009 have been also presented hereafter. The quantities of pollutant emissions in the observed period, between 1990 and 2009, is in minor growth except for VOC, CO (Figure 3) and CH4 emissions that all decrease during the analysed period. Important decrease of pollutants emissions has been observed as well in 1993 as in 1999. It is estimated of being a consequence of socio-economic situation arisen in 1993 and 1999 where the number of registered vehicles has also decreased.

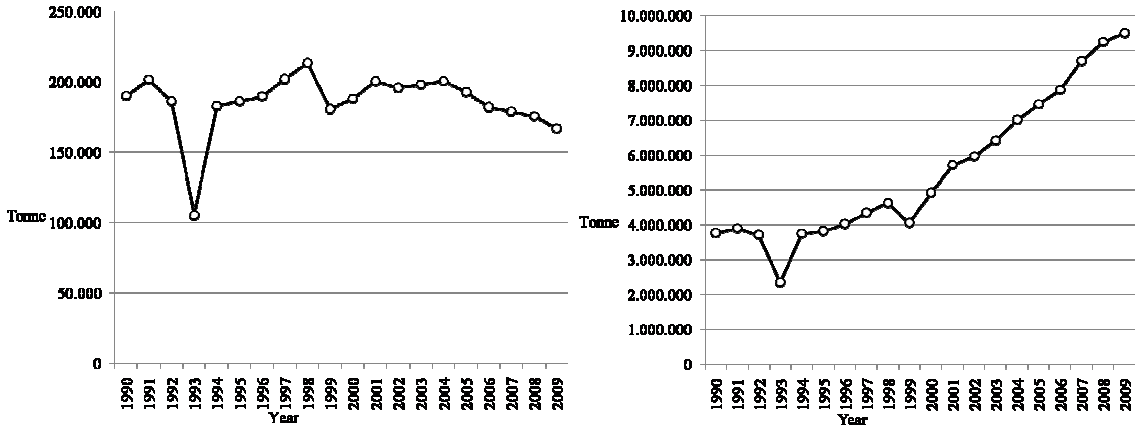

Figure 3: CO and CO_2 emissions between 1990 and 2009

The quantities of pollutant emissions in the observed period, between 1990 and 2009, is in minor growth except for VOC (Figure 4), CO (Figure 1) and CH4 emissions that all decrease during the analysed period. Important decrease of pollutants emissions has been observed as well in 1993 as in 1999. It is estimated of being a consequence of socio-economic situation arisen in 1993 and 1999 where the number of registered vehicles has also decreased. Upon calculation results, the road transport related carbon dioxide emissions show a growing trend (shown on Figure 3). CO2 emissions in 2009 were as much as 9,493,642.48 tonnes, which is higher than the previous 2008 for more than 2.71%, and related to 1990 it is 60.41% higher, when the carbon dioxide emissions accounted for 3,758,228.84 tonnes.

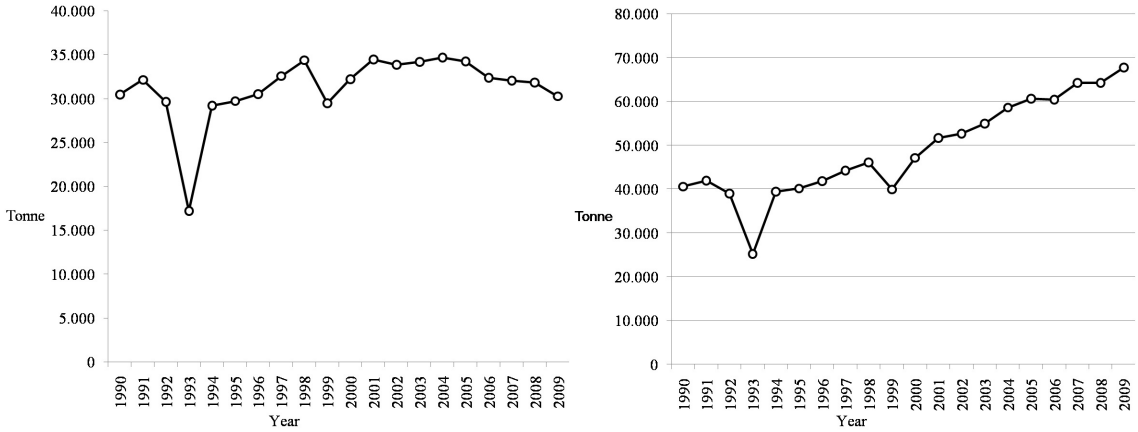

Figure 4: VOC and NO_x emissions between 1990 and 2009

As shown on previous figure 4 the emissions of Volatile Organic Compounds (VOC) since 2001 have a trend of slender decrease. The emission of VOC in 2009 was 30,245.69 tonnes, which is less than in the previous 2008 for 5.21%, and related to 2001 it decreased for 13.87%, when the VOC emission was 34,439.89 tonnes. The volatile organic compounds emission in 1990 was 30,447.66 tonnes, which is more than in 2009 for about 0.67%. The emission of Nitrogen Oxides has a growing trend (figure 4). NO_X emissions in 2009 were 67,755.92 tonnes, which is 5.15% more than in 2008, and for 40.08% higher than in 1990, when the NOX emissions were 40,599.14 tonnes.

Conclusions and future research

The authors of the paper, after becoming acquainted with all the features and capacities of the Copert 4 model for emission estimations, have initiated the collection and acquisition of indispensable but lacking data through a dedicated survey. All previously mentioned procedures required an exhaustive engagement on data acquisition and adaptation to model requirements, as well as on data processing and analysis. Evidently the quality of vehicle database has shown as not sufficient, with many omissions and inconsistencies. Afterwards, by implementing the particular developed software, vehicle were grouped in required categories by the model.

Quality and accurate data represent the basis for modelling of different scenarios of vehicle renewal and utilisation, as well as their respective environmental impacts and their effects on the taxation policy in view of ownership and utilisation on different policy and decision-making levels. Obtained emissions estimations for the research period (between 1990 and 2009) were used for the emission estimations and projections for the future period. The emission levels are influenced by anticipated transport policy measures to be implemented. Some of the most important measures are fleet structure modification by introduction of new EURO emission standards, fuel quality improvement, internalisation of external costs and others. The stated possibility to estimate the policy impacts offers an important tool for correction and improvement of transport policy measures. The implementation of the model and software Copert 4 for the calculation of road vehicles related pollutants emissions allows realisation of transparent, standardised and comparable databases and reporting on pollutants emissions, complying with international mandatory standards and regulations.

This method allows thorough analyses of certain vehicle categories (e.g. bus) fleet development and projections, future renewal. In subsequent research, the authors will outline the development scenarios and consider their relative and absolute influence compared to previous emission results. Thus, analysis of two different but complementary policy measures is foreseen, as mentioned in introduction first a rapid replacement of outdated vehicles with efficient ones (with subsidies for the purchase of highly efficient vehicles) as well as different alternative fuels' implementation (gasoline and diesel hybrids, biofuels) as different scenarios. The comparison of results of scenarios will eventually highlight the efficiency and important differences in view of costs (for new technology introduction, subsidies and emissions). Something rather agonising is that the carbon-dioxide emissions will keep an increasing trend which is in opposite of preferred projections. This trend indicates the need for additional measures to influence CO_2 emission reduction. Through several scenarios analyses to date, the Copert 4 model has shown its indisputable quality for quantification of effects of different emission related policies applied to analysed vehicle fleets. Further research should assess the feasibility of measures, i.e. whether those projected benefits are worth the investment, especially in view of a developing country as Serbia.

Acknowledgment

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