

Emission of pollutants from motor vehicles in Poland comparing to pollutant emission in the European Union

The inventory results of pollutant emission from motor vehicles in Poland comparing to the emission of pollutants in the European Union have been presented in the paper. The analysis is based on the official results of the pollution inventory reported to the European Union. Emission of the following substances was considered for the years 1990–2016 for Poland and the European Union from all civilization and road transport activities: carbon monoxide, non-methane volatile organic compounds, nitrogen oxides and particulate matter consisting of fractions: total suspended particles, PM10 and PM2.5. It was observed that the share of pollutant emission from road transport in Poland is smaller than for the entire European Union. This is especially evident in the case of particulate matter and nitrogen oxides. As a result of the analysis of the emission inventory in the European Union, it was confirmed that the share of motorisation in the emission of pollutants harmful to human health is significantly smaller in Poland than in the entire European Union. Therefore, conducting a detailed analysis of specific distance emission of pollutants from a statistical vehicle as well as extending research on greenhouse gas emission from motor vehicles is recommended.

Key words: inventory of pollutant emission, motor vehicles

1. Introduction

Since 1990 the emission of pollutants from sectors of civilization activity which is harmful to the health of living organisms have been regularly inventoried in the European Union and in most other European countries [3–8, 10, 12, 13]. Also other countries prepare an inventory of pollutant emission, including the United States of America, Canada and Asia [1, 2, 11]. While reports on the inventory of pollutant emission from anthropogenic sources are published, relatively few results of analyzes are issued. This is also due to the fact that until present day the methodology for the inventory of pollutant emission from particular sectors of civilization activity has not been strictly unified, even in such structures as the European Union. The structure of pollutant emission estimation is relatively precisely unified, *inter alia* due to the characteristics of emission sources [5, 8–10], but there is still a large freedom in adopting emission characteristics [9]. Also, the intensity of civilization activity is relatively unclear, e.g. the annual mileage of motor vehicles in elementary categories [4–7]. Despite these reservations, data presented in published reports on anthropogenic pollution emission are official and as such they may be used in analyzes.

In this paper the share of pollutant emission from the road transport sector in Poland and the European Union over the period 1990–2016 [8, 10] has been analyzed.

Substances estimated in official reports in the European Union are listed below [8, 10]:

- carbon monoxide – CO,
- non-methane volatile organic compounds – NMVOC,
- nitrogen oxides reduced to nitrogen dioxide – NO_x,
- ammonia – NH₃,
- total suspended particles – TSP,
- particulate matter PM10,
- particulate matter PM2.5,
- black carbon – BC,
- sulphur oxides reduced to sulphur dioxide – SO₂,

- priority heavy metals: lead – Pb, cadmium – Cd and mercury – Hg,
- additional heavy metals: arsenic – As, chromium – Cr, copper – Cu, nickel – Ni, selenium – Se and zinc – Zn,
- persistent organic pollutants – POPs.

This article presents the results of the analysis for the following substances: carbon monoxide, non-methane volatile organic compounds, nitrogen oxides and particulate matter dimensional fractions: total suspended particles, PM10 and PM2.5.

Not all substances, analyzed in this work, are in official reports issued in the European Union. The limitation applies to particulate matter PM10 and PM2.5. Not all Member States had performed inventories of these substances before 1999, *inter alia* Austria, Belgium and Germany [8, 10].

The COPERT 5 software was used for the inventory of pollutant emission in Poland for the years 1990–2016. The following categories of motor vehicles are included in the inventory of pollutant emission from road transport [4–10]:

1. Passenger cars:
 - gasoline passenger cars with spark ignition engine,
 - liquefied petroleum gas passenger cars with spark ignition engine,
 - passenger cars with compression ignition engine,
 - hybrid passenger cars.
2. Light commercial vehicles (light duty vehicles):
 - light commercial vehicles with spark ignition engine,
 - light commercial vehicles with compression ignition engine.
3. Heavy duty trucks:
 - heavy duty trucks – rigid (heavy duty container trucks),
 - heavy duty trucks – articulated (tractor units, ballast tractors).
4. Urban buses.

5. Coaches.
6. Motorcycles.
7. Mopeds.

The methodology for determining the emission of total pollution from motor vehicles is compatible with [9]. The methodology for the selection of parameters for the COPERT software is described in [4–7]. The methodology for determining emission of pollutants from sectors other than road transport is compatible with [7–10].

2. Results of the inventory of the analyzed pollutant emission in the European Union and Poland

Figures 1–6 present the annual emission of pollutants from all sectors of civilization activity and from the road transport sector in the European Union: total – EU-T and from motor vehicles – EU-RT, and annual emission of pollutants in Poland: total – PL-T and motor vehicles – PL-RT in 1990–2016.

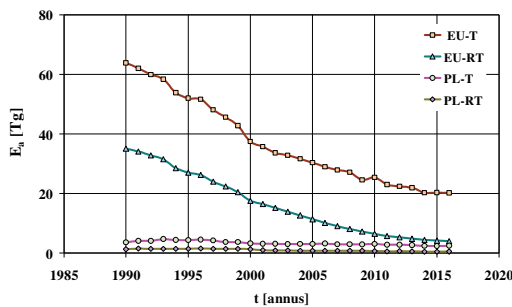


Fig. 1. Annual emission of carbon monoxide: total in the European Union – EU-T, from motor vehicles in the European Union – EU-RT, total in Poland – PL-T, from motor vehicles in Poland – PL-RT in years 1990–2016

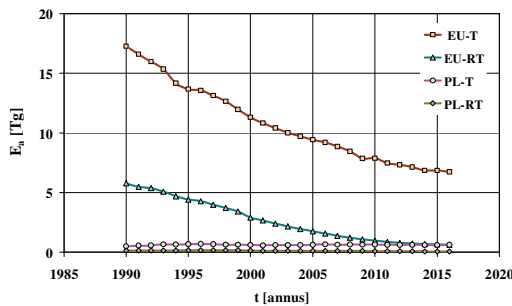


Fig. 2. Annual emission of non-methane volatile organic compounds: total in the European Union – EU-T, from motor vehicles in the European Union – EU-RT, total in Poland – PL-T, from motor vehicles in Poland – PL-RT in years 1990–2016

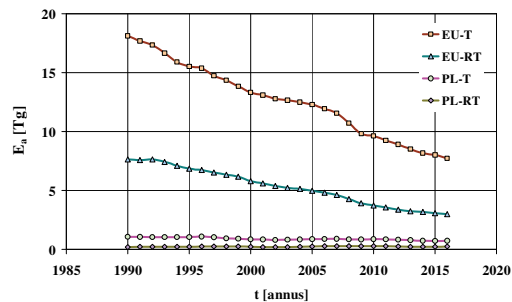


Fig. 3. Annual emission of nitrogen oxides: total in the European Union – EU-T, from motor vehicles in the European Union – EU-RT, total in Poland – PL-T, from motor vehicles in Poland – PL-RT in years 1990–2016

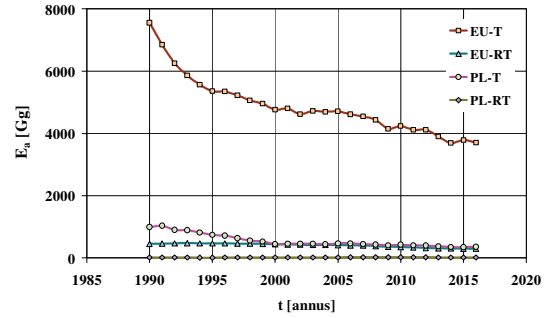


Fig. 4. Annual emission of total suspended particles: total in the European Union – EU-T, from motor vehicles in the European Union – EU-RT, total in Poland – PL-T, from motor vehicles in Poland – PL-RT in years 1990–2016

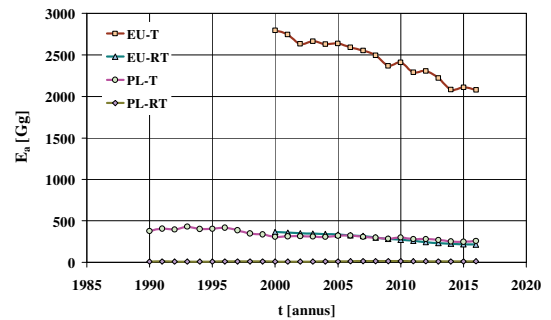


Fig. 5. Annual emission of particulate matter PM10: total in the European Union – EU-T, from motor vehicles in the European Union – EU-RT, total in Poland – PL-T, from motor vehicles in Poland – PL-RT in years 1990–2016

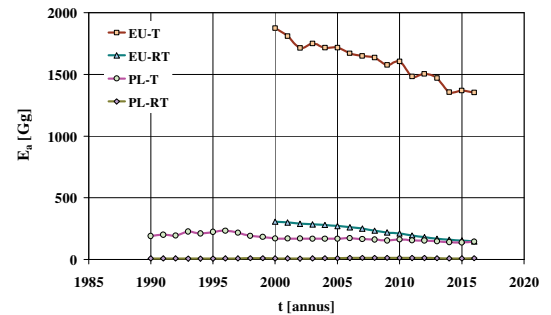


Fig. 6. Annual emission of particulate matter PM2.5: total in the European Union – EU-T, from motor vehicles in the European Union – EU-RT, total in Poland – PL-T, from motor vehicles in Poland – PL-RT in years 1990–2016

3. Results of the analysis of pollutant emission inventories in the European Union and in Poland

Figures 7–12 show the share of annual emission in Poland from all sectors of civilization activity and from the road transport sector comparing to the annual emission in the European Union for pollutants: for total emission – T and for emission from motor vehicles – RT in the years 1990–2016.

The average share of annual emission of pollutants in Poland comparing to the annual emission in the European Union is:

- for all sectors of civilization activity – 0.094: from 0.062 – for non-methane volatile organic compounds to 0.120 – for particular matter PM10,
- for road transport – 0.051: from 0.032 – for particular matter to 0.076 – for carbon monoxide.

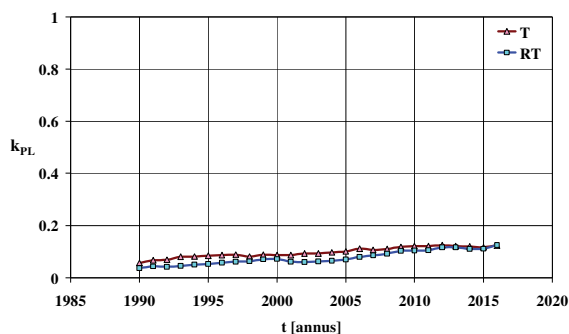


Fig. 7. Share of annual emission in Poland comparing to the annual emission in the European Union for carbon monoxide: for total emission – T and for emission from motor vehicles – RT in years 1990–2016

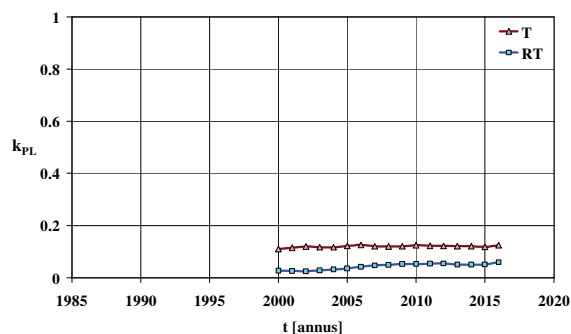


Fig. 11. Share of annual emission in Poland comparing to the annual emission in the European Union for particulate matter PM10: for total emission – T and for emission from motor vehicles – RT in years 1990–2016

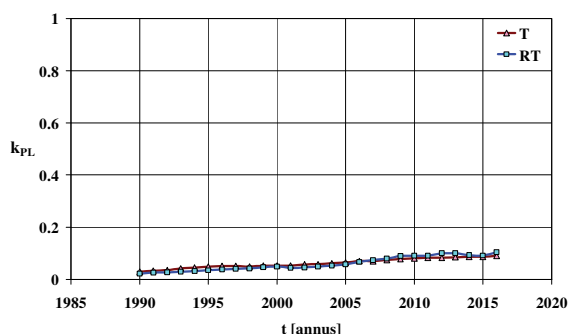


Fig. 8. Share of annual emission in Poland comparing to the annual emission in the European Union for non-methane volatile organic compounds: for total emission – T and for emission from motor vehicles – RT in years 1990–2016

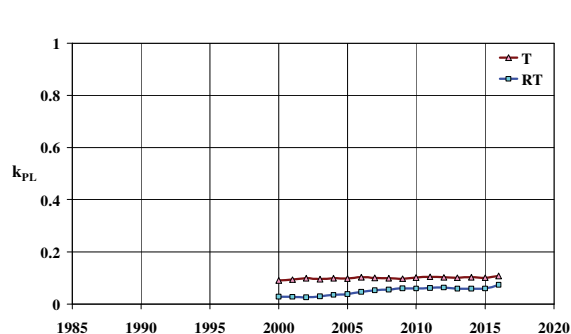


Fig. 12. Share of annual emission in Poland comparing to the annual emission in the European Union for particulate matter PM2.5: for total emission – T and for emission from motor vehicles – RT in years 1990–2016

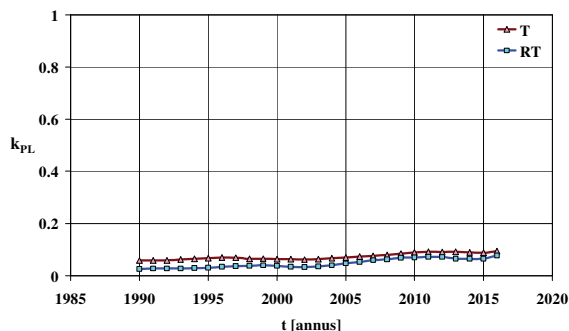


Fig. 9. Share of annual emission in Poland comparing to the annual emission in the European Union for nitrogen oxides: for total emission – T and for emission from motor vehicles – RT in years 1990–2016

Figures 13–18 show the share of annual emission from motor vehicles in relation to total annual emission: in Poland – PL and in the European Union – EU in 1990–2016.

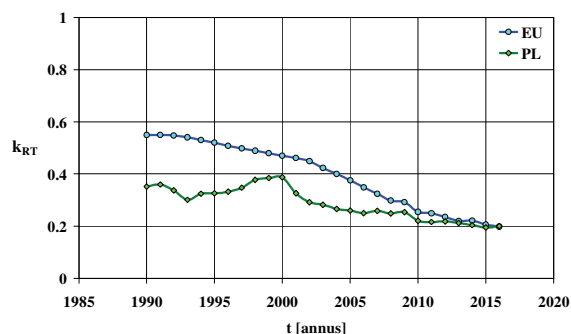


Fig. 13. Share of annual emission from motor vehicles comparing to the total annual emission for carbon monoxide: in Poland – PL and in the European Union – EU in years 1990–2016

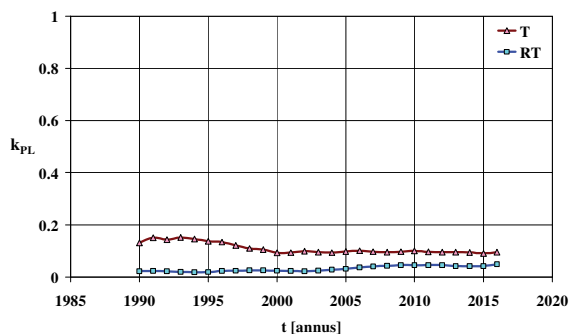


Fig. 10. Share of annual emission in Poland comparing to the annual emission in the European Union for total suspended particles: for total emission – T and for emission from motor vehicles – RT in years 1990–2016

The average share of annual emission of pollutants from motor vehicles in relation to the total annual emission is:

- for the European Union – 0.228: from 0.087 – for particular matter to 0.414 – for nitrogen oxides,
- for Poland – 0.141 – from 0.026: for particular matter to 0.286 – for carbon monoxide.

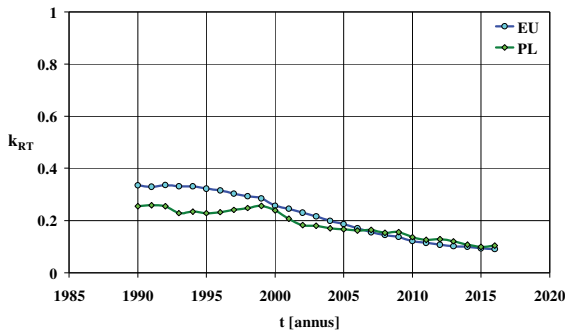


Fig. 14. Share of annual emission from motor vehicles in relation to the total annual emission for non-methane volatile organic compounds: in Poland – PL and in the European Union – EU in years 1990–2016

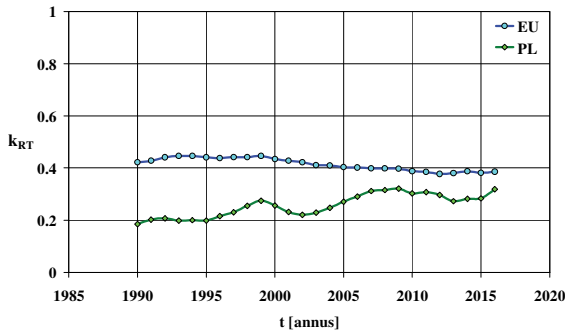


Fig. 15. Share of annual emission from motor vehicles comparing to the total annual emission for nitrogen oxides: in Poland – PL and in the European Union – EU in years 1990–2016

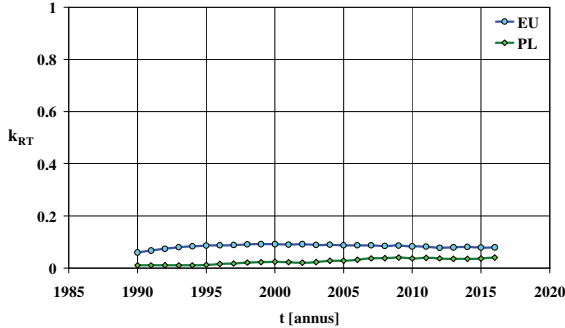


Fig. 16. Share of annual emission from motor vehicles comparing to the total annual emission for total suspended particles: in Poland – PL and in the European Union – EU in years 1990–2016

In the case of carbon monoxide and non-methane volatile organic compounds, there is a noticeable tendency of reducing the share of annual emission from motor vehicles in comparison to the annual emission from all sectors of civilization activity.

4. Recapitulation

Inventory of pollutants emission from anthropogenic sources is an effective method of assessing the environmental threat posed by particular sectors of civilization

activity. A requirement to maintain the objectivity of this assessment is development of a coherent method of estimating pollutant emission from particular sectors of civilization activity. Unfortunately, despite many attempts to standardize the methodology of estimating the total emission of pollutants by individual countries, the full coherence of methods applied by Member States of the European Union requires further development [8, 10].

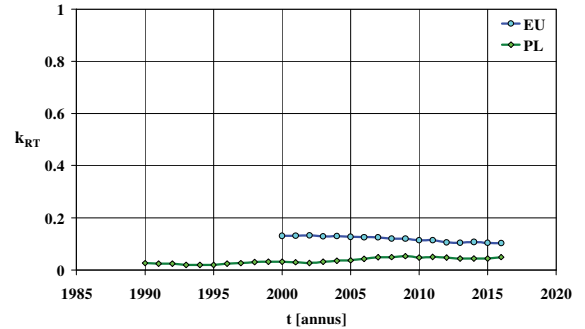


Fig. 17. Share of annual emission from motor vehicles comparing to the total annual emission for particulate matter PM10: in Poland – PL and in the European Union – EU in years 1990–2016

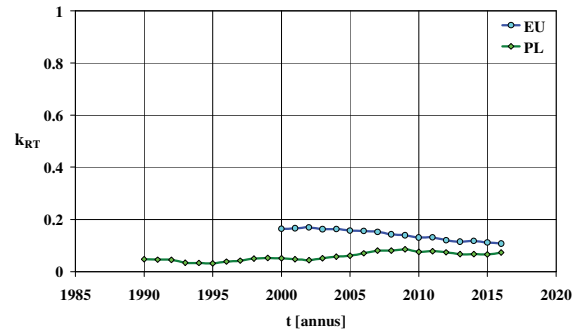


Fig. 18. Share of annual emission from motor vehicles comparing to the total annual emission for particulate matter PM2.5: in Poland – PL and in the European Union – EU in years 1990–2016

Based on the study results presented above, the following conclusions can be drawn:

1. The share of annual emission of pollutants in Poland in comparison to the annual emission in the European Union is lower for road transport than for all sectors of civilization activity. This positive trend concerns mainly particular matters – all particle size fractions.
2. The share of annual emission of pollutants from motor vehicles compared to the total annual emission is lower for Poland than for the European Union. Therefore the actions undertaken in Poland to reduce pollutant emission from motor vehicles are considered as effective, the more that the dynamic development of the Polish automotive industry is not accompanied by a noticeable increase in the analyzed share.

Nomenclature

As	arsenic	Cd	cadmium
BC	black carbon	CO	carbon monoxide

Cr	chrome	PM exhaust	particular matter from exhaust system
Cu	copper	PM10	particular matter PM10
E _a	annual emission	PM2.5	particular matter PM2.5
Hg	mercury	POPs	persistent organic pollutants
k _{PL}	share	RT	road transport
k _{RT}	share	Se	selenium
NFR	nomenclature for reporting	SO ₂	sulphur oxides
NH ₃	ammonia	t	time
Ni	nickel	T	total
NMVOC	non-methane volatile organic compounds	TSP	total suspended particles
NO _x	nitrogen oxides	Zn	zinc
Pb	lead		

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