UNDER THE UNECE CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

INFORMATIVE INVENTORY REPORT 2017

SLOVAK REPUBLIC

Slovak
Hydrometeorological
Institute

Ministry of Environment
of the Slovak Republic

Country

Slovak Republic

Editor

Ivana Ďuricová

Authors

Ivana Ďuricová
Kristína Tonhauzer
Ján Horváth
Marcel Zemko
Monika Jalšovská

Legal guarantor of the report

Ing. Zuzana Kocunová
Tel: 00421-905-668014
Mail: zuzana.kocunova@enviro.gvo.sk
Mail: lucia.rosolankova@enviro.gov.sk

Ministry of Environment of the Slovak Republic
Air Protection Department (National Focal Point)
Námestie Ľ. Štúra 1, 812 35 Bratislava 1
Slovak Republic

Expert guarantor of the report

Ing. Ivana Ďuricová
Tel: 00421-2-59415 335
Mail: ivana.duricova@shmu.sk

Slovak Hydrometeorological Institute
Department of Emissions and Air Quality Monitoring (CLRTAP inventory coordinator)
Jeséniova 17, 833 15 Bratislava
Slovak Republic

Submission date

March 15th, 2017 – DRAFT VERSION

PREFACE

The Slovak Republic Informative Inventory Report (SK IIR) is an official document accompanying the Slovak emission inventory submission under the Convention on Long-Range Transboundary Air Pollution (LRTAP Convention). SK IIR is annually prepared by Slovak Hydrometeorological Institute (Slovenský hydrometeorologický ústav – SHMÚ) at Department of Emissions and Biofuels as a responsible body and approved by the Ministry of Environment (Ministerstvo životného prostredia Slovenskej republiky – MŽP SR), and delivered to the United Nations Economic Commission for Europe (UNECE) Environment and Human Settlements Division the emission inventory and projections.

The submission of the Slovak Informative Inventory Report is based on year cycle of reporting obligations. After the legislation changes during 2016, the preliminary version of the SK IIR is submitted by the 15th of March as the first official document under LRTAP Convention and Directive 2016/2284/EU on the reduction of national emissions of certain atmospheric pollutants which entered into force on 31 December 2016.

This Directive sets national reduction commitments for each country for the five pollutants that caused acidification, eutrophication and ground-level ozone pollution. The new Directive repeals and replaces NEC Directive 2001/81/EC, the National Emission Ceilings Directive.

The final version of the document will be updated to the 15th of April. Reporting is carried out via the European Environment Information and Observation Network (EIONET) Central Data Repository (CDR) tool.

The general purpose of this document is to provide a technical and methodological support for the emission information presented in common template for LRTAP Convention submission and NECD submission template. The report is supposed to bring sufficiently detailed information that allows transparent view onto emission preparation process of Slovak emission inventory.

The structure of document is in line with general recommendations and presents institutional background information and arrangement, trends of pollutants, emission inventory preparation process, emission factors, sources and references that are being used during the compilations or expert judgements. Then major changes, recalculations and updates which has been done and reported in the regular template to the European Commission (EC) as well as planned improvements. And finally, the national projections and the process of their preparation.

Glossary

Acronyms and Definitions

CDR	Central Data Repository
EP and Council	European Parliament and the Council
EC	European Commission
EIONET	European Environment Information and Observation Network
EMEP	European Monitoring and Evaluation Programme
IED	Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control)
LCP	Large Combustion Plant
LRTAP Convention	Convention on Long-Range Transboundary Air Pollution
MPaRV	Ministerstvo pôdohospodárstva a rozvoja vidieka The Ministry of Agriculture and Rural Development
MŽP SR	Ministerstvo životného prostredia Slovenskej republiky The Ministry of Environment of the Slovak Republic
NEC Directive	National Emission Ceiling Directive
NPPC	Národné poľnohospodárske a potravinárske centrum National Agriculture and Food Centre
NEIS	Národný emisný informačný systém National Emission Information System
REZZO	Register emisií a zdrojov znečistenia ovzdušia Emission and Air Pollution Source Inventory
RDF	Refuse-Derived Fuel
RTI	Rated Thermal Input
SHMÚ	Slovenský hydrometeorologický ústav Slovak Hydrometeorological Institute
SK IIR	Slovak Republic Informative Inventory Report
ŠÚ SR	Štatistický úrad Slovenskej Republiky Statistical Office of the Slovak Republic
UNECE	United Nations Economic Commission for Europe
EI	Emission Inventory
VÚVZ	Výskumný ústav výživy zvierat Research Institute for Animal Production
US EPA	Environmental Protection Agency (United States)

CONTENT

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The Slovak Republic has submitted the national emission inventory 2017 (EI 2017) to the UNECE in comply with obligation related to the Convention on Long-range Transboundary Air Pollution (LRTAP Convention). The emission inventory submission was uploaded 16 February 2016.

Resubmission of the national emission inventory 2017 version 2 together with SK IIR 2017 was delivered on 15 March 2016. The entire Slovak submission included:

- *SK_IIR_2017. pdf*
  Report of the Slovak Republic in written form

- *SK_CLRTAP_2017_v1. xlsm*
  Reporting template for the emission inventory for years 1990 – 2015
  Reporting template contains information on emissions of
  NECD Pollutants: NO_X, SO_X, NMVOC, NH_3, $PM_{2.5}$,
  Other Pollutants: CO
  Particulate Matter: TSP, PM_{10}, $PM_{2.5}$, BC
  Heavy Metals: Pb, Hg, Cd, As, Cr, Cu, Ni, Se, Zn
  and Persistent Organic Pollutants: PCDD/ PCDF, PAHs, HCB, PCBs, benzo(a) pyrene, benzo(b)fluoranthene, benzo(k), fluoranthen, Indeno (1,2,3-cd) pyrene, total 1-4

- SK_CLRTAP_NECD_2017_v2.xlsm
  Reporting template for the emission inventory for years 1990 – 2015
  Resubmitted version of emission inventory

MAJOR GENERAL CHANGES

All changes were done with aim to achieve improvement in data quality, data completeness and transparency of working results in line with the legal requirements and also with the SK Review 2015 Recommendations.

Format name of reported files

To apply fully the principle of transparency, several formal changes in nomenclature and naming of reported files has been done. Now, the file name has general structure that contains 4 mandatory features: a/ specification of state, b/ specification of form type, c/ year 20XX, when the report was submitted (means that file is concerning data for year 20XX-2 in case of LRTAP Convention), d/ specification of submitted version (means v1 indication of very first report, in case of second v2, etc.). SK_FORM TYPE_20XX.(pdf/xlsm/docx)

Structure of IIR

General model of IIR from the sectoral point of view was introduced in 2016 and implemented in compare to the older SK IIRs, where the pollutant approach had being used. In the internal preparation system of LRTAP Convention emission inventory process, the responsibility also has been partly adapted correspondingly to the sectoral division. In the past, national or external experts were in charge of particular pollutant or pollutants emissions across all categories. According to new circumstances, sectoral liability diversification has been done. Current list of team members and their roles can be seen in chapter *1 Institutional Arrangements*.

The document structure of SR IIR reflects abovementioned changes and previous endeavours to follow recommended template to ensure the clarity of reported data. The individual chapters of categories provide in logical structure: a/ the general description of emission trends and key drivers of the changes throughout the years, b/ detailed description of emission trends and key drivers for each subcategory, c/ description and more detail explanation of methodology, level of method used, activity data and emission factors used in each sector subcategory compilation, d/ reasoning for notation keys using or explanation for allocated items if needed, e/ description of recalculations that have been done covering the time series, f/ improvement plan for the next and future submissions. Even though, some parts are not updated yet in sufficient range, the planned progress in future is included in individual improvement plans of the categories or sectors.

Structural changes in institutional cooperation

There has been long-term cooperation of the Slovak Hydrometeorological Institute (Slovenský hydrometeorologický ústav – SHMÚ) with the Statistical Office of the Slovak Republic (Štatistický úrad Slovenskej Republiky – ŠÚ SR) in the field of data exchange. Bearing in mind to provide improved emission inventory with good quality of data, the official Agreement on mutual cooperation in the field of statistics between the Ministry of Environment of the Slovak Republic (Ministerstvo životného prostredia – MŽP SR)[1] and ŠÚ SR has been revised during the past year. The improvement of formal cooperation with ŠÚ SR was achieved. Recent update of existing agreement has brought about the flexible and secure way of data exchange. Revision was focused on security enhancing, especially for data transfer of individual and confidential data and their protection. The content extension of received and provided data were re-assessed and it has allowed the enlargements of activity data receiving from ŠÚ SR for inventory usage. Moreover, the shift to regular providing of data via FTP server erase the annual administration and paper work related to official necessary permissions between institutions. In addition, determination of qualified and authorized persons with direct access improve the effectivity of this cooperation. During the year 2016, it is planned the second revision.

The essential change has been arranged in the field of agriculture. We have managed the cooperation with The Ministry of Agriculture and Rural Development (Ministerstvo pôdohospodárstva a rozvoja vidieka – MPaRV). The National Agriculture and Food Centre (Národné poľnohospodárske a potravinárske centrum – NPPC) that formally merged 9 Research Institutes in this area was delegated. So the submission 2017 is the second year when the emission inventory for livestock was done with cooperation of experts from Research Institute for Animal Production (Výskumný ústav výživy zvierat – VÚVZ). Methodology details, results and sector assessment are provided in chapter *Agriculture (NFR3).*

Other changes

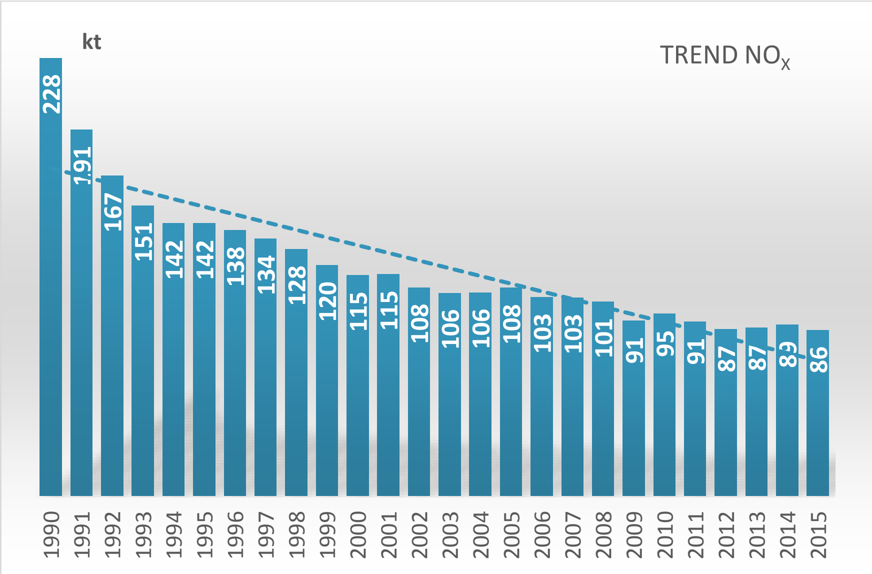
In light of continual improvements, the historical years in disaggregation into the NFR categories were performed based on the expert judgements and extrapolation of data, and the revision of notation keys was carried out.

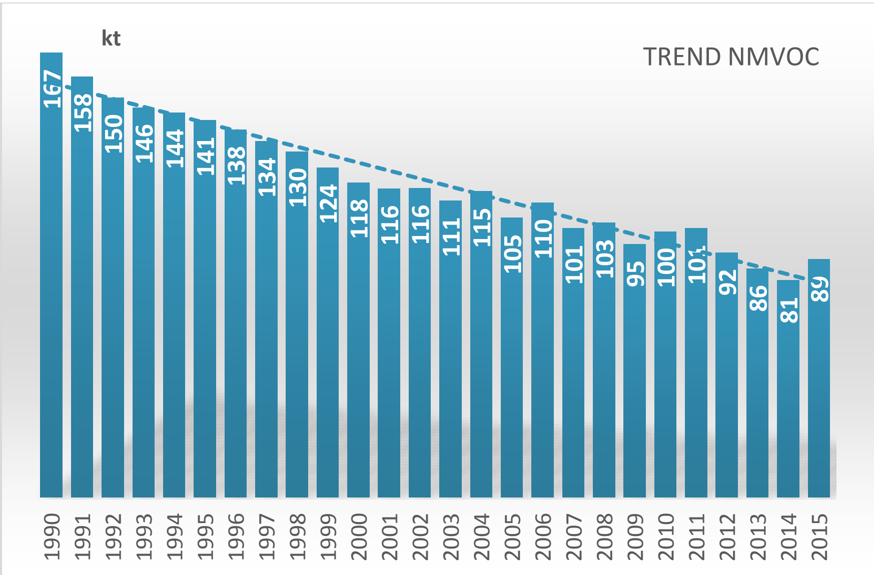
[1] Note: Slovak Hydrometeorological Institute is the allowance institution to the Ministry of Environment and thus the Contract is formally between Statistical Office of the Slovak Republic and the Ministry of Environment

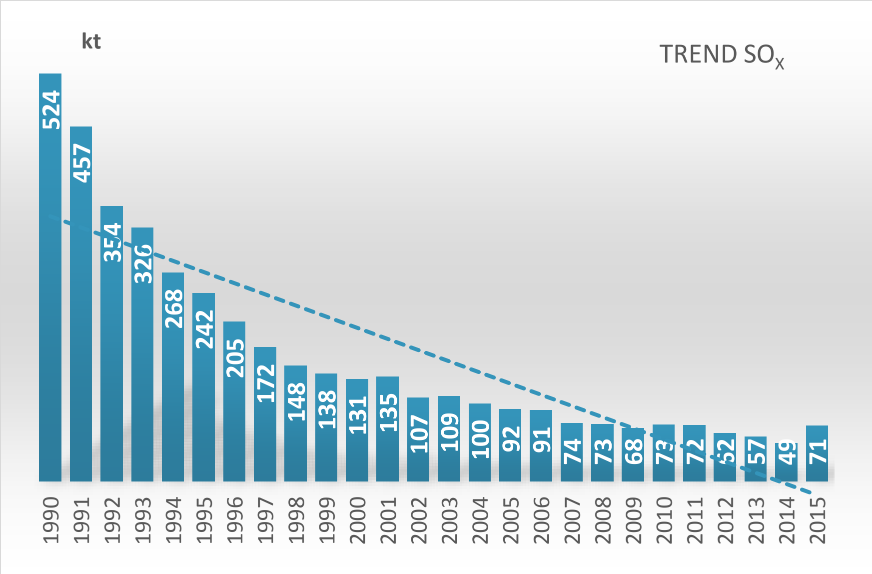
KEY TRENDS IN EMISSIONS

The chapter depictures overall trends in emission progress through recorded years. In general, the national totals of the most emissions are having decreasing trend due to air policy of The Slovak Republic but also by impact of industry and development. Reported values for each pollutant can be found on EIONET (CDR Repository).

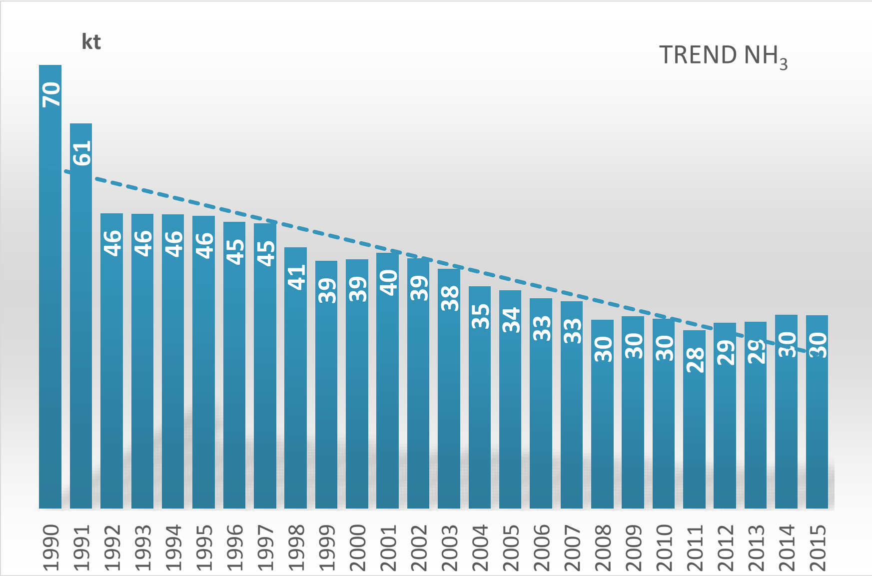
Figure 1: *Summary of pollutant trends since 1990*



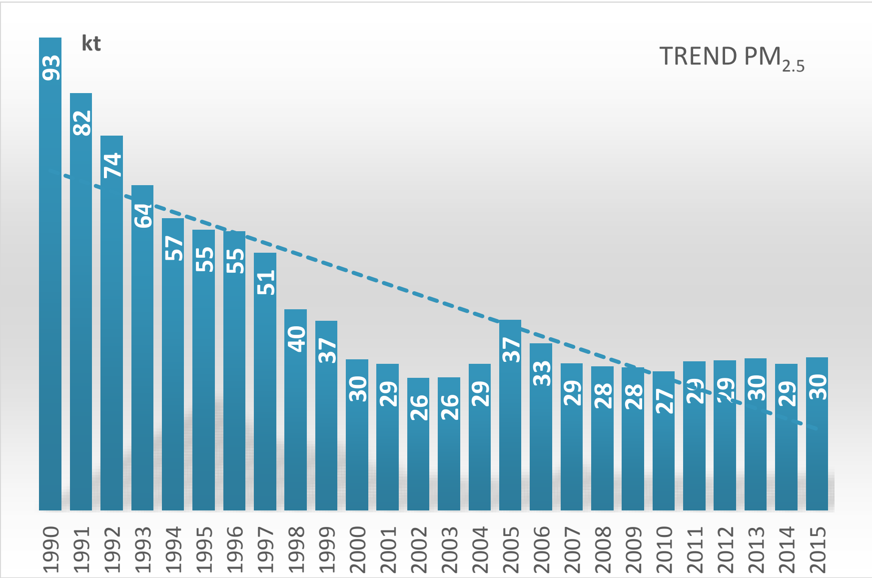




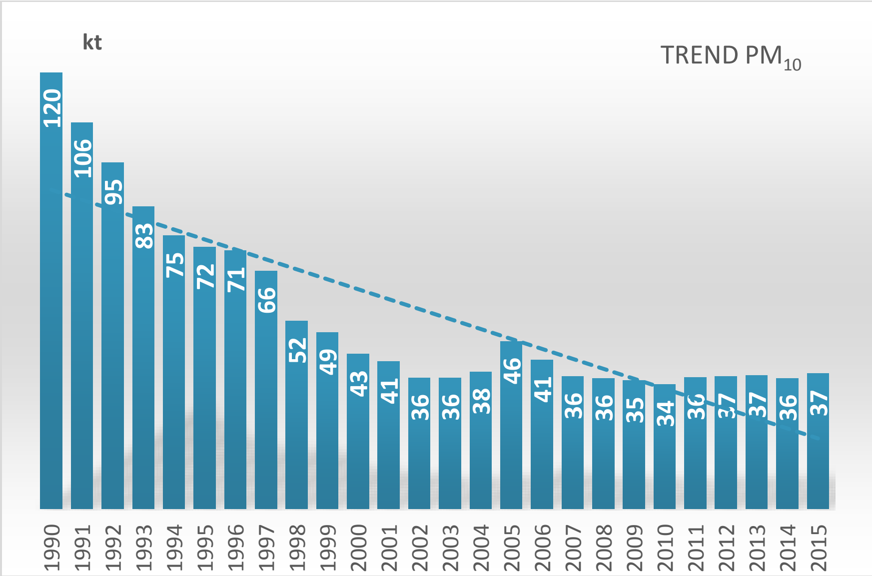
kt
TREND SO_X
524
457
326
268
242
205
172
148
138
131
135
107
109
100
92
91
74
73
68
72
57
49
71
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

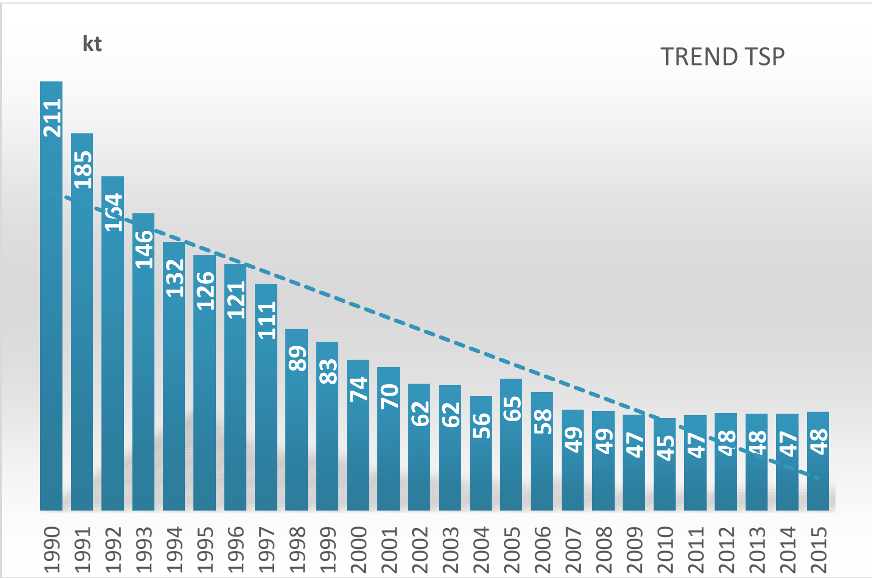


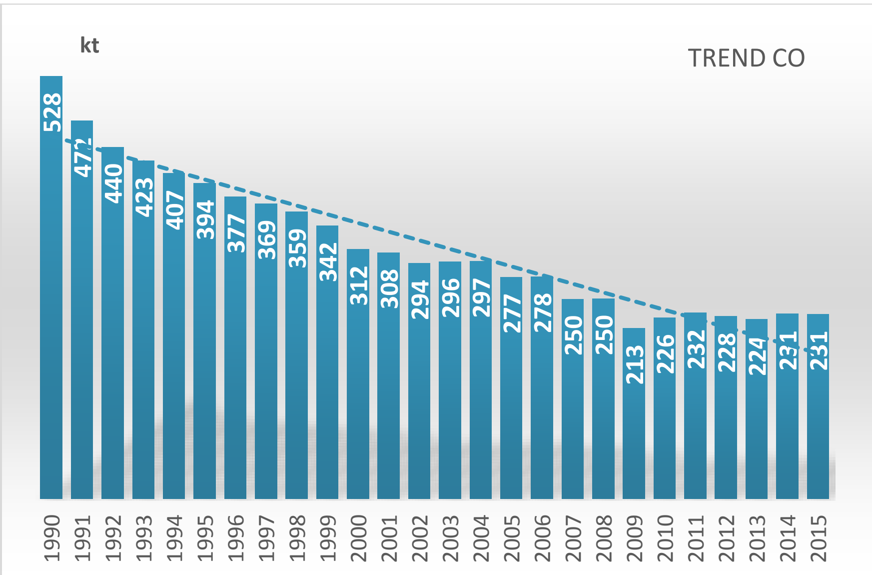
kt
TREND NH_3
70
61
46
46
46
46
45
45
41
39
39
40
39
38
35
34
33
33
30
30
30
28
29
29
30
30
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015



kt
TREND $PM_{2.5}$
93
82
74
64
57
55
55
51
40
37
30
29
26
26
29
37
33
29
28
28
27
30
29
30
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


kt
TREND PM_{10}
120 106 95 83 75 72 71 66 52 49 43 41 36 36 38 46 41 36 36 35 34 36 37 37 36 37
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


kt
TREND TSP
211 185 164 146 132 126 121 111 89 83 74 70 62 62 56 65 58 49 49 47 45 47 48 48 47 48
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


kt
TREND CO
528 440 423 407 394 377 369 359 342 312 308 294 296 297 277 278 250 250 213 226 232 228 224 231 231
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

TRENDS IN EMISSIONS OF NO_X

Generally, the emissions of nitrogen oxides NO_X have decreasing trend from 1990. Emissions do not extend the emission ceilings set up in NECD for 2010. The annual comparison 2015 and 2014 shows slight decrease due to the decrease in pollution from the road transport of heavy duty vehicles. The key sources categories for NOx emission are shown also in analysis in Chyba! Nenašiel sa žiaden zdroj odkazov.. The composition of main contributing categories is stable during the time series and identifies clearly the main sources of emissions that are for NO_X, for year 2015 was the representation of categories same as in year 2014:

- 1A1a Public electricity and heat production (2015: 6.48 kt)
- 1A2a Stationary comb. in manuf. industry and construction: Iron and steel (2015: 6.20 kt)
- 1A3bi Road transport: Passenger cars (2015: 8.95 kt)
- 1A3biii Road transport: Heavy duty vehicles and buses (2015: 25.35 kt)
- 1A4bi Residential: Stationary (2015: 8.24 kt)

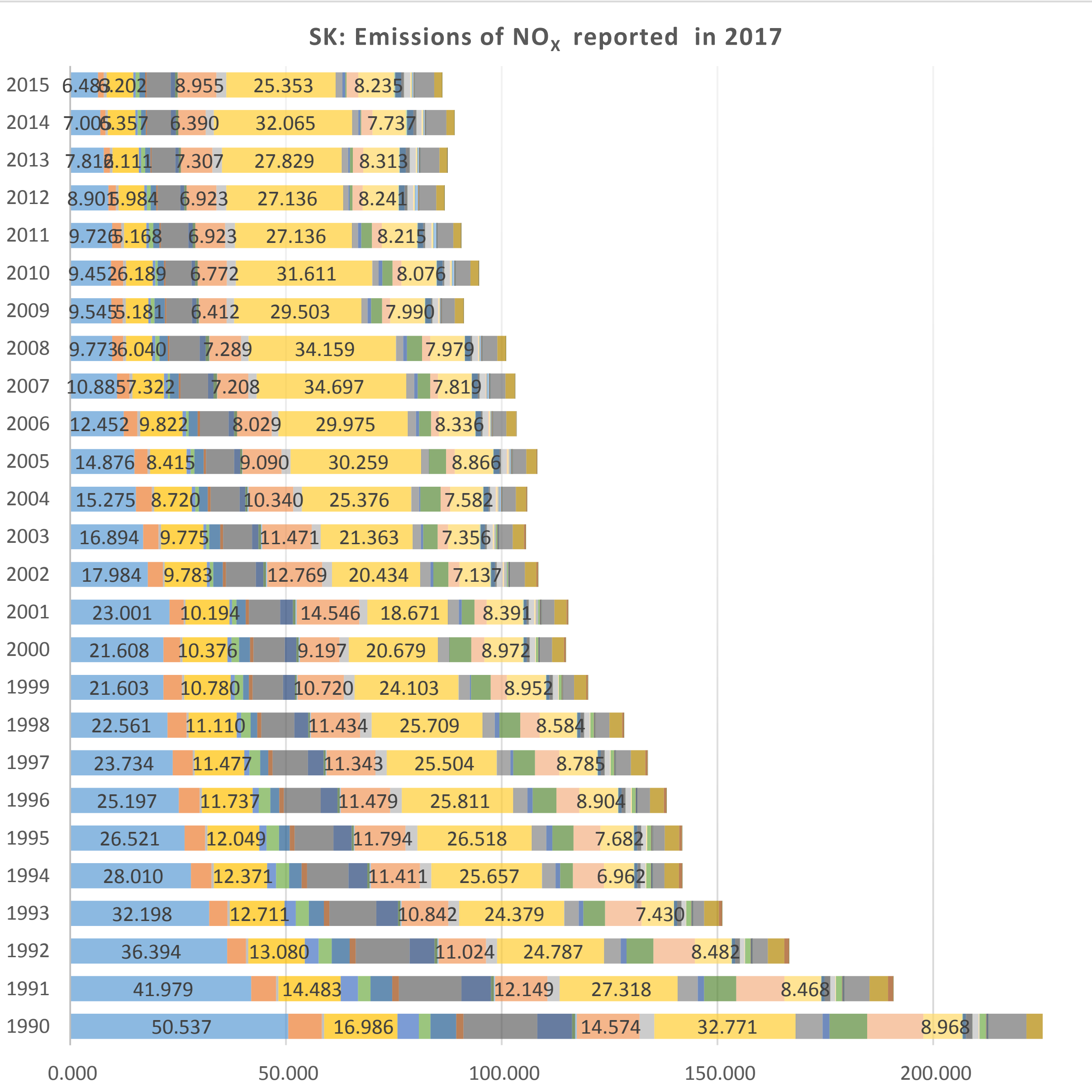


Figure 2: *Nitrogen Oxides (NOx) emissions data 1990 – 2015*

***Table 1:** The Overview of the sectoral emission of NO_X share*

Sector share in NT	ENERGY	COMB. IN INDU.	TRAN.	HOUS., COMM., AFF	FUGI.	INDU.	SOLV.	AGRI	WASTE	NAT. TOTAL [kt]
1990	25.83%	25.19%	30.00%	10.66%	0.66%	0.73%	*0%*	6.26%	0.68%	228.03
1991	25.29%	25.83%	29.80%	11.42%	0.64%	0.79%	*0%*	5.61%	0.62%	190.74
1992	24.79%	25.90%	30.43%	12.03%	0.63%	0.84%	*0%*	4.74%	0.63%	166.59
1993	24.48%	25.79%	31.76%	11.70%	0.68%	0.82%	*0%*	4.28%	0.48%	151.10
1994	23.46%	25.10%	33.55%	11.06%	0.81%	0.86%	*0%*	4.60%	0.55%	141.86
1995	22.43%	23.56%	36.30%	11.00%	0.88%	0.79%	*0%*	4.61%	0.44%	141.80
1996	22.11%	22.71%	36.71%	11.56%	0.91%	0.77%	*0%*	4.78%	0.44%	138.21
1997	21.60%	22.28%	36.60%	12.04%	0.96%	0.71%	*0%*	5.41%	0.41%	133.82
1998	21.42%	21.56%	38.30%	11.50%	1.02%	0.74%	*0%*	5.11%	0.34%	128.34
1999	22.03%	21.37%	37.82%	11.94%	1.09%	0.64%	*0%*	4.77%	0.33%	119.99
2000	22.68%	22.99%	35.27%	11.79%	1.14%	0.60%	*0%*	5.20%	0.35%	114.83
2001	23.15%	21.61%	36.49%	10.84%	1.15%	1.17%	0.0002%	5.34%	0.26%	115.36
2002	20.21%	21.04%	39.58%	10.30%	1.24%	1.27%	0.0005%	6.03%	0.33%	108.44
2003	19.96%	21.35%	39.35%	10.77%	1.29%	1.07%	0.0023%	5.80%	0.41%	105.58
2004	18.42%	19.97%	42.68%	10.80%	1.30%	1.19%	0.0014%	5.47%	0.16%	105.85
2005	17.15%	19.24%	44.12%	11.73%	1.24%	1.00%	0.0013%	5.37%	0.15%	108.22
2006	15.69%	21.06%	44.09%	11.50%	1.31%	0.79%	0.0014%	5.41%	0.14%	103.43
2007	14.00%	18.20%	48.72%	11.03%	1.39%	0.82%	0.0014%	5.73%	0.10%	103.12
2008	12.86%	18.25%	49.66%	11.42%	1.39%	0.74%	0.0014%	5.60%	0.08%	101.00
2009	14.17%	17.90%	47.22%	12.71%	1.50%	0.66%	0.0013%	5.77%	0.06%	91.18
2010	13.69%	16.87%	48.30%	12.66%	1.38%	1.15%	0.0016%	5.89%	0.04%	94.69
2011	13.77%	17.60%	45.85%	13.54%	1.59%	1.33%	0.0004%	6.27%	0.06%	90.61
2012	12.91%	17.60%	44.95%	14.64%	1.50%	1.37%	0.0003%	6.98%	0.05%	86.73
2013	11.19%	17.61%	46.15%	15.04%	1.61%	0.95%	0.0002%	7.42%	0.04%	87.40
2014	9.80%	17.76%	48.20%	14.31%	1.41%	0.92%	0.0002%	7.58%	0.03%	89.04
2015	9.79%	18.40%	46.06%	15.47%	1.66%	0.98%	0.0000%	7.61%	0.03%	86.21

TRENDS IN EMISSIONS OF NMVOCs

The general downward trend of NVVOCs is visible throughout the entire provided time line. Major contributors of NMVOC emissions are:

- 1A3bi Road transport: Passenger cars (2015: 3.95 kt)
- 1A4bi Residential: Stationary (2015: 12.28 kt)
- 2D3d Coating applications (2015: 25.61 kt)
- 2D3h Printing (2015: 7.11 kt)
- 5A Biological treatment of waste - Solid waste disposal on land (2015: 6.13 kt)

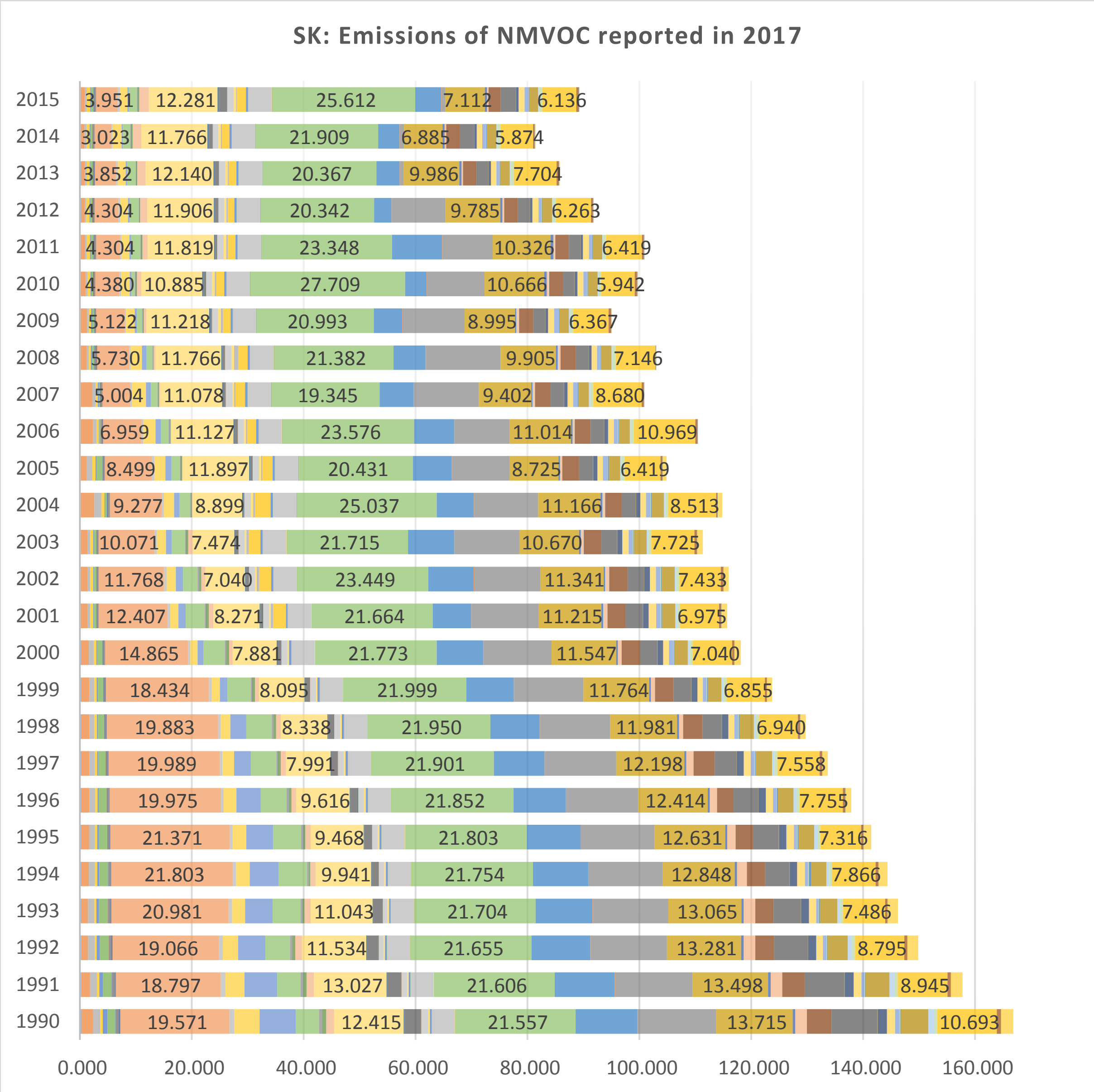


Figure 3: *Non-Methane Volatile Organic Compounds (NMVOC) emissions data 1990 – 2015*

The development of automotive industry in Slovakia was and still is the significant contributor of nmvoc. In early 90ties, it was Volkswagen company. Later in the years 2005 and 2006 was important milestone the expansion in automotive industry in Slovakia (PSA Peugeot Citroën in Trnava, KIA in Zilina - build of manufacture started in April 2004 and became operational at the end of 2006) due to the broad supplier network that was developed. Many of paint shops were opened and so the

consumption of paints has increased. The import of print's ink and solvent paints has increased, too. Since 2007, Directive 1999/13/EC entered into force with which operators had to adjust to emission limits. Decline in 2009 is being associated with financial crises and following increase associated to the slight revitalisation of production. The recent decline is due to the technological improvements in industry. However, the automotive industry is a key sector and strong driving force in economy development. All three established automakers are also among the biggest exporters in the country. It was already announced the arrival of new carmaker Jaguar Land Rover.
Recalculations of NMVOCs caused increased values compared to the previous reporting 2015. The inventory was fulfilled by categories that was not reported before. Due to the new activity data, cooperation with experts from agricultural sector as well as wider use of NEIS database. Detailed description of all changes is provided in chapter SOLVENTS (NFR 2.D).

Table 2: *The Overview of the sectoral emission of NMVOC share*

Sector share in NT	ENERGY	COMB. IN INDU.	TRAN.	HOUS., COMM., AFF	FUGI.	INDU.	SOLV.	AGRI	WASTE	NAT. TOTAL [kt]
1990	2.18%	2.12%	22.08%	10.15%	0.97%	1.42%	38.97%	13.94%	8.16%	166.83
1991	1.92%	2.13%	21.63%	10.72%	0.86%	1.51%	40.80%	13.06%	7.36%	157.76
1992	1.75%	2.11%	21.83%	9.92%	0.81%	1.61%	42.52%	11.91%	7.55%	149.86
1993	1.76%	2.05%	23.67%	9.51%	0.82%	1.61%	43.15%	10.77%	6.66%	146.20
1994	1.86%	1.99%	24.67%	8.46%	0.92%	1.45%	43.26%	10.49%	6.91%	144.36
1995	1.90%	1.92%	24.69%	8.36%	1.00%	1.29%	43.69%	10.69%	6.47%	141.48
1996	1.97%	1.85%	23.60%	8.61%	1.04%	1.14%	44.36%	10.71%	6.72%	137.90
1997	1.99%	1.79%	23.07%	7.62%	1.09%	1.23%	45.29%	11.21%	6.71%	133.66
1998	1.99%	1.69%	23.37%	7.94%	1.13%	0.82%	46.17%	10.48%	6.41%	129.74
1999	2.07%	1.64%	21.59%	7.90%	1.15%	0.84%	47.89%	10.35%	6.57%	123.71
2000	2.08%	1.69%	18.80%	7.88%	1.23%	0.87%	49.45%	10.72%	7.28%	118.13
2001	1.61%	1.25%	17.07%	8.33%	1.27%	3.25%	48.71%	11.21%	7.29%	115.71
2002	1.61%	1.25%	15.87%	7.29%	1.30%	3.16%	51.15%	10.78%	7.60%	115.95
2003	1.67%	1.30%	14.44%	8.00%	1.38%	3.07%	51.03%	10.83%	8.27%	111.33
2004	3.38%	1.26%	12.83%	8.08%	1.46%	3.52%	51.24%	9.88%	8.35%	114.80
2005	2.12%	2.09%	13.21%	11.98%	1.52%	2.74%	48.59%	10.58%	7.18%	104.87
2006	2.67%	1.01%	10.98%	10.85%	1.39%	2.40%	50.77%	9.57%	10.36%	110.48
2007	2.79%	1.17%	10.05%	11.79%	1.56%	2.77%	50.47%	10.33%	9.07%	100.91
2008	1.53%	1.43%	9.86%	12.33%	1.68%	3.21%	53.37%	9.54%	7.05%	103.02
2009	1.67%	1.33%	9.04%	12.74%	1.75%	2.78%	53.31%	10.14%	7.24%	95.03
2010	1.42%	1.26%	7.55%	12.33%	1.65%	2.48%	57.41%	9.38%	6.53%	99.74
2011	1.23%	1.61%	8.22%	13.21%	1.69%	2.37%	55.83%	9.01%	6.83%	100.95
2012	1.23%	1.59%	8.90%	15.17%	1.69%	2.35%	51.68%	10.05%	7.35%	91.87
2013	1.41%	1.64%	8.87%	16.98%	1.92%	2.61%	46.41%	10.54%	9.62%	85.80
2014	1.43%	1.77%	8.38%	17.55%	1.86%	2.77%	46.74%	11.86%	7.65%	81.39
2015	1.39%	1.78%	8.69%	17.55%	1.88%	2.77%	47.77%	10.69%	7.47%	89.30

TRENDS IN EMISSIONS OF SO_X

The trends of SO_X emission, likewise NO_X, until 2014 continually decrease. Since 1990 SO_X emissions have noticed the significant decrease due to strict air protective legislative. Downward trend relates also to the composition of fuel use in all sectors and related legislative limitations.

The major contributor is in long-term the energy sector and combustion in industry:

- 1A1a Public electricity and heat production (2015: 50.899 kt)
- 1A1b Petroleum refining (2015: 1.892 kt)
- 1A2a Stationary comb. in manuf. industry and construction: Iron and steel (2015: 7.247kt)
- 1A4bi Residential: Stationary (2015: 2.326kt)
- 1B2aiv Fugitive emissions oil: Refining / storage (2015: 3.692 kt)

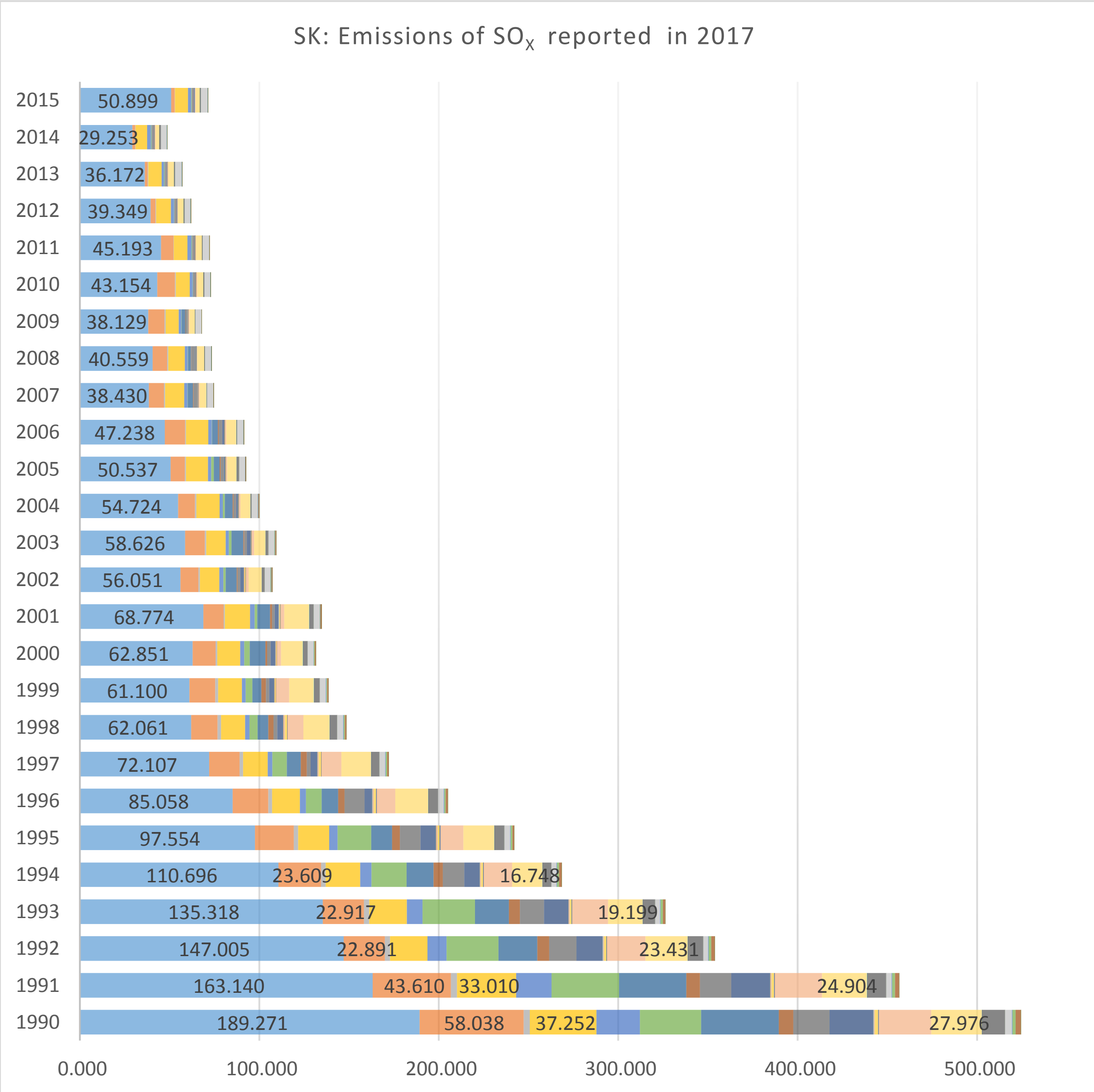


Figure 4: *Sulphur oxides (SOx) emissions data 1990 - 2015*

In the comparison to the 2015 the value of SO_X emission is substantially higher (annual increase from 48.63 kt to 71.42 kt.). All emissions are originated from the source Slovenské elektrárne. According to records of a database of NEIS, power plant - ENO 0023 B-block 3 and 4 burnt twice the amount of brown coal than the previous year 2014. Due to the extensive reconstruction of blocks B1 B2 ENO (from a report SE), the ENO and K1, K2 were used, which are not abated granules boilers. Apparently SE used the last year of special exception (max.20 000 hours of operation from 1.1.2008 to 31.12.2015), for not applying any emission limits and abatement technology. From 1.1.2016, it is possible to operate such facilities only when comply with the strict legislation limits. Therefore it expect a marked drop in emissions of SO_X in 2016.

The following table provides the overview of share SO_X emissions for individual sectors.

Table 3: *The Overview of the sectoral emission of SO_X share*

Sector share in NT	ENERGY	COMB. IN INDU.	TRAN.	HOUS., COMM., AFF	FUGI.	INDU.	SOLV.	AGRI	WASTE	NAT. TOTAL [kt]
1990	47.81%	36.52%	0.59%	13.38%	0.74%	0.41%	0%	0%	0.55%	524.33
1991	46.03%	38.23%	0.57%	13.58%	0.69%	0.43%	0%	0%	0.48%	456.51
1992	48.87%	33.46%	0.66%	15.18%	0.77%	0.51%	0%	0%	0.55%	353.79
1993	49.44%	33.99%	0.67%	14.18%	0.81%	0.49%	0%	0%	0.41%	326.13
1994	51.02%	31.92%	0.84%	14.04%	1.11%	0.54%	0%	0%	0.52%	268.50
1995	50.24%	31.73%	1.02%	14.70%	1.32%	0.52%	0%	0%	0.46%	242.05
1996	52.21%	27.27%	1.20%	16.65%	1.59%	0.56%	0%	0%	0.53%	204.96
1997	52.83%	24.00%	1.38%	18.74%	1.92%	0.58%	0%	0%	0.56%	172.11
1998	52.95%	23.31%	1.71%	18.59%	2.28%	0.65%	0%	0%	0.51%	148.39
1999	55.64%	22.58%	0.71%	17.59%	2.43%	0.58%	0%	0%	0.48%	138.42
2000	58.18%	24.65%	0.67%	12.93%	2.57%	0.50%	0%	0%	0.50%	131.43
2001	59.91%	22.26%	0.78%	13.73%	2.53%	0.35%	0.000%	0%	0.44%	134.71
2002	62.32%	22.82%	1.06%	9.74%	3.25%	0.35%	0.000%	0%	0.45%	107.18
2003	64.38%	22.66%	0.47%	8.47%	3.21%	0.38%	0.001%	0%	0.43%	109.31
2004	64.94%	23.19%	0.39%	7.16%	3.55%	0.39%	0.001%	0%	0.37%	99.90
2005	63.85%	23.70%	0.25%	8.03%	3.75%	0.09%	0.001%	0%	0.32%	92.48
2006	64.69%	23.24%	0.46%	7.40%	3.83%	0.11%	0.001%	0%	0.28%	91.44
2007	63.71%	24.36%	0.62%	6.22%	4.96%	0.11%	0.002%	0%	0.01%	74.47
2008	67.18%	20.90%	0.66%	6.18%	4.95%	0.12%	0.002%	0%	0.01%	73.26
2009	70.49%	17.92%	0.64%	5.66%	5.21%	0.07%	0.002%	0%	0.01%	67.82
2010	73.39%	15.24%	0.40%	6.10%	4.65%	0.21%	0.002%	0%	0.00%	72.80
2011	72.46%	16.20%	0.39%	5.55%	5.14%	0.26%	0%	0%	0.00%	72.24
2012	68.65%	18.82%	0.23%	6.55%	5.42%	0.34%	0%	0%	0.00%	61.79
2013	66.99%	18.42%	0.31%	7.26%	6.39%	0.63%	0.0005%	0%	0.00%	56.97
2014	63.89%	21.42%	0.40%	6.86%	6.66%	0.76%	0.0000%	0%	0.00%	48.63
2015	74.25%	15.04%	0.37%	4.55%	5.17%	0.62%	0.0000%	0%	0.00%	71.42

TRENDS IN EMISSIONS OF NH_3

The results of the methodology changes and new circumstances, where the provider and expert guarantor of emission inventory is the Research Institute for animal production (VÚVZ) under the auspices of the National Agriculture and Food Centre (NPPC) are most visible at elevated values of emissions in time series. Indeed, the share of ammonia reach that nearly 90% in recent years. The first vast recalculation was done in 2016. After the reviews of methodology under the ESD and UNFCCC, the corrections were implemented into Slovak methodology and values are recalculated for all timelines.

Major categories that contribute to ammonia emissions pollution are:

- 3B1a Manure management - Dairy cattle (2015: 2.12 kt)
- 3B1b Manure management - Non-dairy cattle (2015: 2.02 kt)
- 3B3 Manure management - Swine (2015: 2.16 kt)
- 3Da1 Inorganic N-fertilizers (2015: 5.74 kt)
- 3Da2a Animal manure applied to soils (2015: 10.23kt)

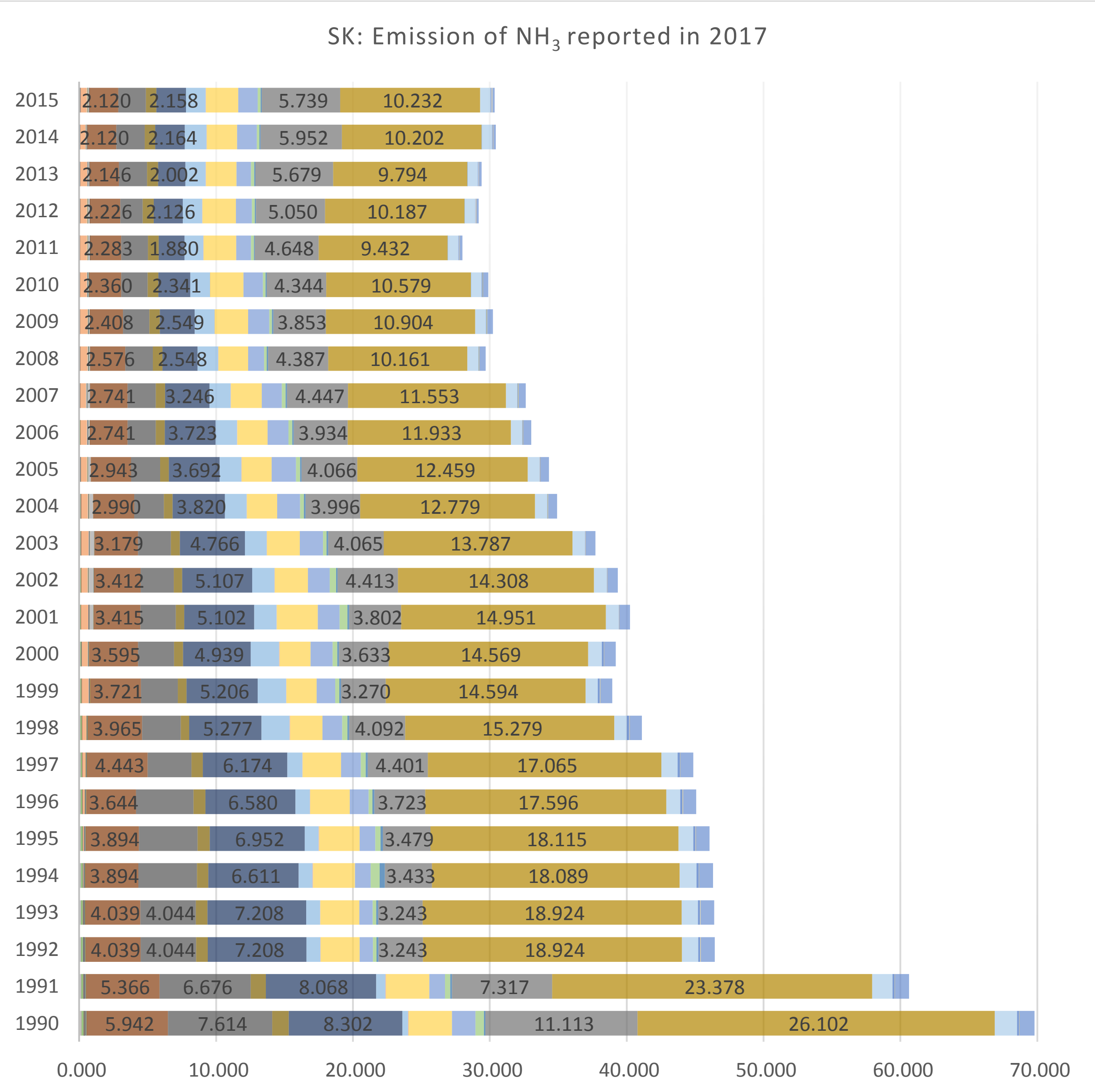


***Figure 5:** Ammonia (NH_3) emissions data 1990 - 2015*

The overall trend of emission inventory for ammonia (NH_3) from 1990 has a stable decreasing tendency until 2011. Emissions in 2015, 2014, 2013 and 2012 have increasing trend. The major driver is the slight increase of number of animals and application of the inorganic N-fertilized into soils. (***Figure 5***). More detail information on trends is available in chapter AGRICULTURE (NFR 3). The decrease of emission during the previous years until 2006 was mainly caused by reduction of numbers in the livestock. After 2006 the decrease has moderate tendency mainly due to technological improvements in the sector. Questionable is the progress of Agriculture in Slovak republic and the aim to support the self-sufficiency in the main agricultural commodities including the support of primary livestock production and thus consequently the increase waste in manure management.

Table 4: *The Overview of the sectoral emission of NH_3 share*

Sector share in NT	ENERGY	COMB. IN INDU.	TRAN.	HOUS., COMM., AFF	FUGI.	INDU.	SOLV.	AGRI	WASTE	NAT. TOTAL [kt]
1990	0.25%	0.25%	0.04%	0.21%	0.02%	0.00%	0%	97.38%	1.84%	69.79
1991	0.26%	0.29%	0.04%	0.21%	0.02%	0.00%	0%	97.15%	2.02%	60.63
1992	0.31%	0.37%	0.06%	0.23%	0.03%	0.00%	0%	96.38%	2.63%	46.44
1993	0.29%	0.35%	0.09%	0.20%	0.03%	0.00%	0%	96.45%	2.60%	46.40
1994	0.29%	0.34%	0.14%	0.14%	0.03%	0.00%	0%	96.46%	2.59%	46.31
1995	0.28%	0.31%	0.24%	0.17%	0.03%	0.01%	0%	96.38%	2.58%	46.05
1996	0.28%	0.29%	0.36%	0.18%	0.03%	0.01%	0%	96.27%	2.59%	45.08
1997	0.26%	0.26%	0.55%	0.17%	0.03%	0.01%	0%	96.20%	2.53%	44.86
1998	0.27%	0.24%	0.80%	0.18%	0.03%	0.01%	0%	95.79%	2.69%	41.12
1999	0.27%	0.22%	1.35%	0.16%	0.03%	0.00%	0%	95.21%	2.75%	38.95
2000	0.26%	0.20%	1.19%	0.13%	0.03%	0.01%	0%	95.58%	2.60%	39.20
2001	0.19%	0.13%	1.44%	0.12%	0.03%	0.73%	0.02%	95.33%	2.02%	40.23
2002	0.28%	0.09%	1.27%	0.12%	0.03%	0.93%	0.02%	95.21%	2.05%	39.36
2003	0.27%	0.10%	1.55%	0.09%	0.03%	0.89%	0.02%	95.00%	2.04%	37.72
2004	0.28%	0.13%	1.51%	0.12%	0.04%	0.84%	0.01%	95.00%	2.06%	34.92
2005	0.23%	0.12%	1.42%	0.09%	0.04%	0.60%	0.01%	95.53%	1.97%	34.31
2006	0.14%	0.14%	1.61%	0.09%	0.04%	0.36%	0.01%	95.60%	2.01%	33.03
2007	0.11%	0.14%	1.47%	0.10%	0.04%	0.57%	0.01%	95.71%	1.85%	32.61
2008	0.12%	0.15%	2.00%	0.11%	0.04%	0.27%	0.02%	95.48%	1.82%	29.70
2009	0.10%	0.13%	1.96%	0.10%	0.03%	0.26%	0.02%	95.69%	1.71%	30.24
2010	0.11%	0.13%	1.84%	0.06%	0.04%	0.20%	0.01%	96.04%	1.56%	29.88
2011	0.13%	0.12%	1.93%	0.06%	0.04%	0.57%	0.01%	96.05%	1.09%	28.00
2012	0.09%	0.17%	1.85%	0.06%	0.04%	0.48%	0.00%	96.38%	0.91%	29.19
2013	0.12%	0.13%	1.89%	0.06%	0.04%	0.34%	0.01%	96.46%	0.94%	29.40
2014	0.11%	0.12%	1.42%	0.06%	0.04%	0.20%	0.01%	97.15%	0.89%	30.44
2015	0.16%	0.22%	1.65%	0.07%	0.04%	0.31%	0.01%	96.59%	0.97%	30.36

TRENDS IN EMISSIONS OF TSP, $PM_{2.5}$ AND PM_{10}

The main sectors producing the TSP, $PM_{2,5}$, PM_{10}, CO are Stationary combustion and Transport. Especially for TSP and PM is residential sector important contributor. In general, the trend of these emissions has overall decreasing tendency.

All three pollutants are having decreasing trends of emissions. However, in recent years very slight. The major contributor in recent years is combustion of biomass in residential sector:

- 1A1a Public electricity and heat production (in the past strong decline)
- 1A2a Stationary combustion in manufacturing industries and construction: Iron and steel (in the past strong decline)
- 1A4bi Residential: Stationary

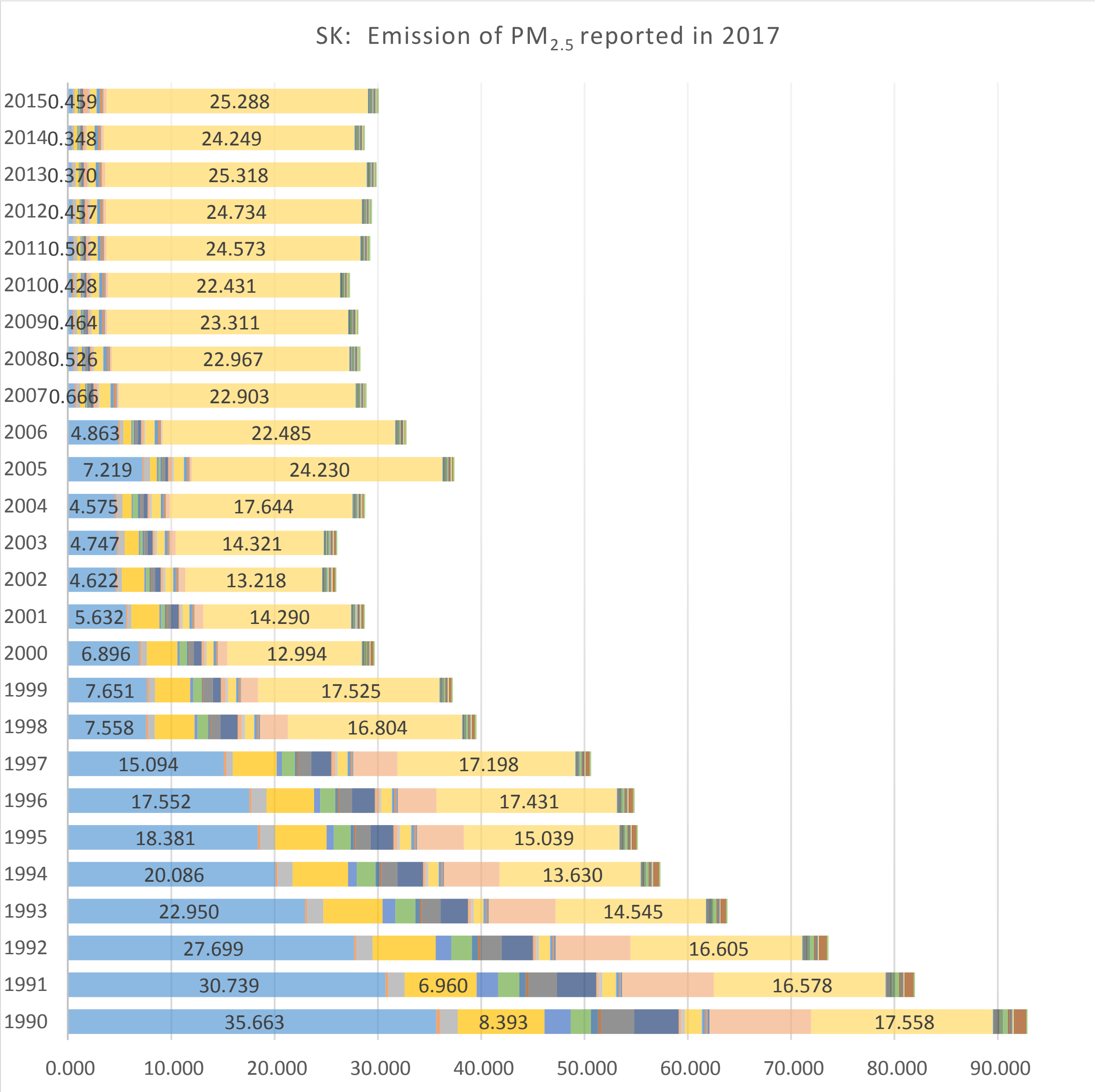


Figure 6: *Particulate matters ($PM_{2.5}$) emissions data 1990 – 2015*

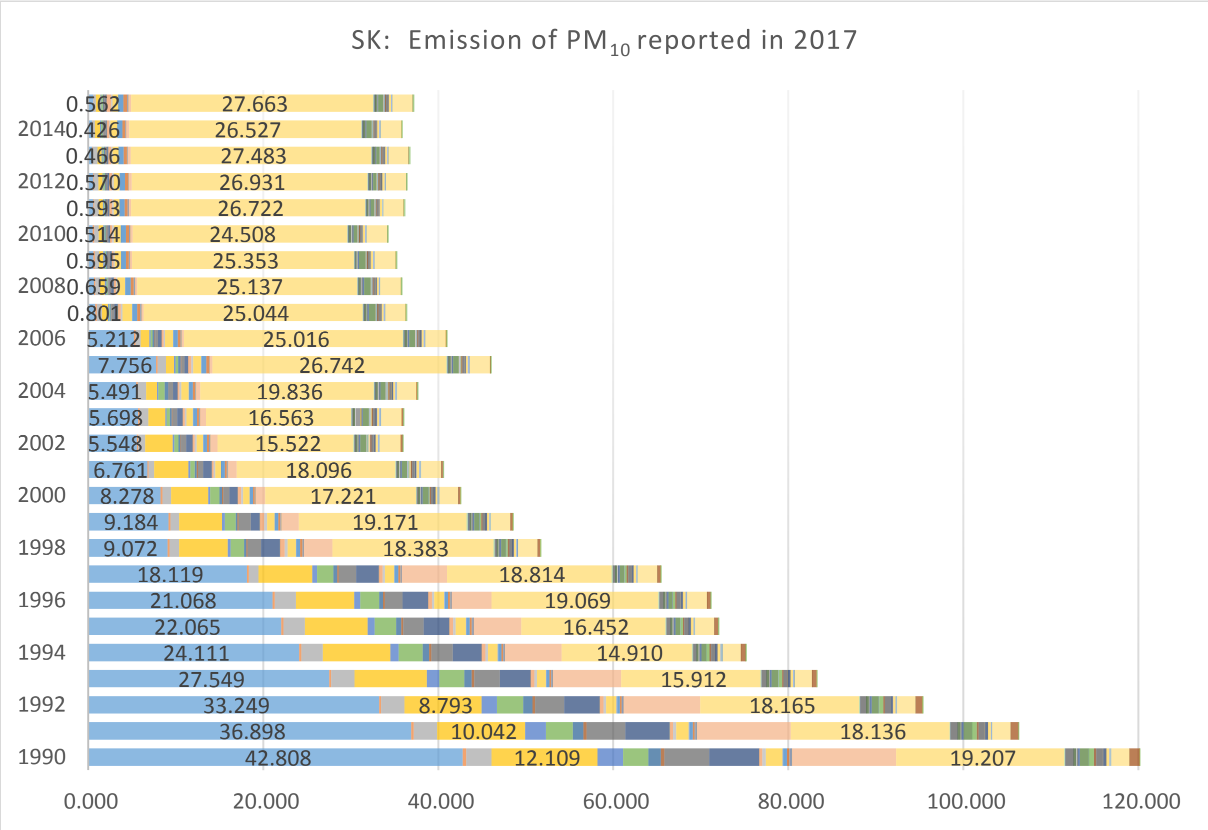


Figure 7: *Particulate matters (PM_{10}) emissions data 1990 - 2015*

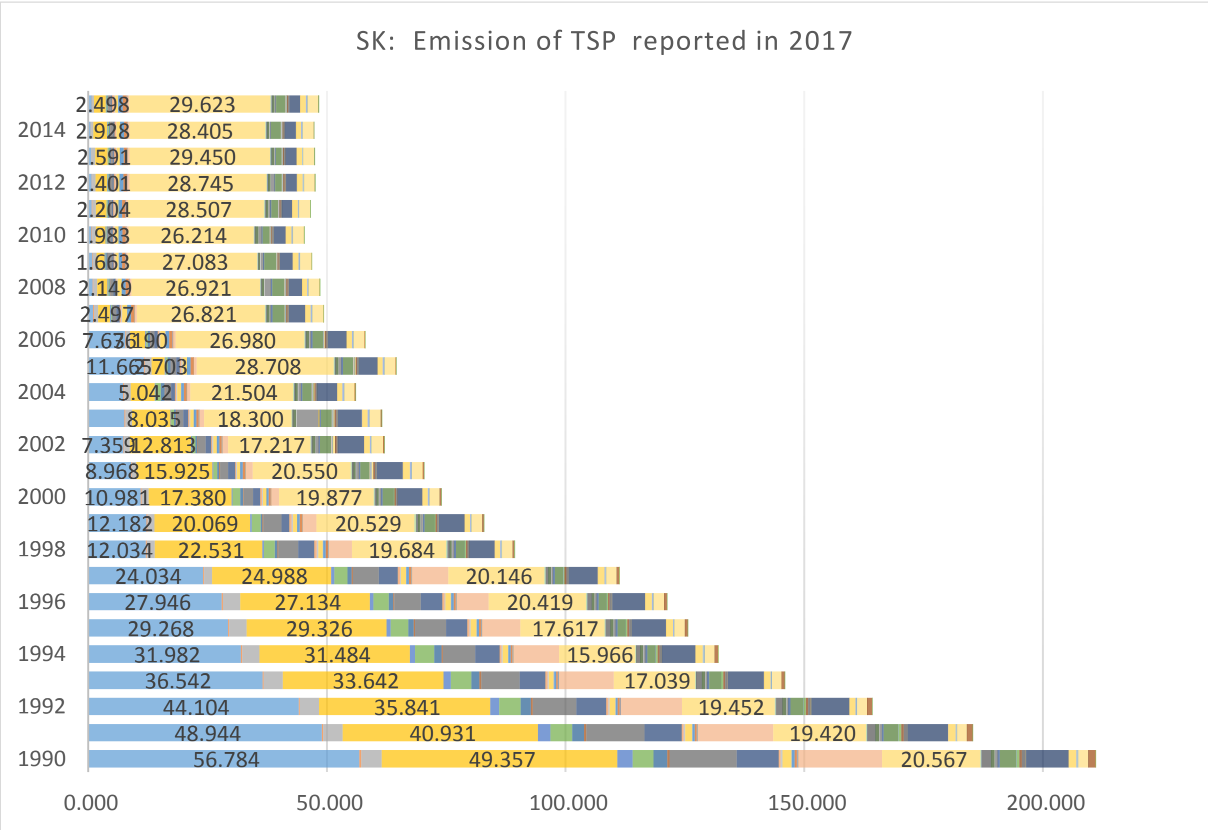


Figure 8: *Total solid particles (TSP) emissions data 1990 - 2015*

Table 5: *The Overview of the sectoral emission of* $PM_{2.5}$ *share*

Sector share in NT	ENERGY	COMB. IN INDUSTRY	TRAN.	HOUS., COMM., AFF	FUGI.	INDU.	SOLV.	AGRI	WASTE	NAT. TOTAL [kt]
1990	40.62%	23.01%	3.20%	30.16%	0.18%	0.79%	0%	0.64%	1.40%	92.87
1991	39.75%	22.60%	3.05%	31.70%	0.20%	0.81%	0%	0.65%	1.24%	82.00
1992	40.07%	21.08%	2.96%	33.00%	0.22%	0.79%	0%	0.64%	1.24%	73.60
1993	38.74%	21.89%	3.12%	33.55%	0.21%	0.80%	0%	0.65%	1.05%	63.85
1994	37.93%	21.94%	3.56%	33.64%	0.24%	0.70%	0%	0.77%	1.22%	57.36
1995	36.35%	20.73%	4.17%	36.06%	0.25%	0.64%	0%	0.76%	1.06%	55.16
1996	35.04%	19.12%	4.02%	39.23%	0.23%	0.59%	0%	0.73%	1.05%	54.85
1997	31.53%	18.80%	4.15%	42.86%	0.25%	0.59%	0%	0.79%	1.04%	50.64
1998	21.29%	20.20%	5.48%	49.94%	0.28%	0.76%	0%	0.93%	1.12%	39.54
1999	22.61%	17.10%	5.19%	52.04%	0.31%	0.78%	0%	0.93%	1.04%	37.26
2000	25.78%	17.73%	5.27%	47.41%	0.41%	0.93%	0%	1.15%	1.31%	29.70
2001	21.39%	15.86%	5.35%	53.19%	0.42%	1.30%	0.07%	1.26%	1.15%	28.73
2002	20.12%	14.42%	6.54%	54.11%	0.49%	1.52%	0.08%	1.35%	1.37%	25.98
2003	21.06%	10.36%	6.34%	57.66%	0.51%	1.59%	0.05%	1.27%	1.15%	26.07
2004	18.45%	8.36%	6.06%	63.33%	0.46%	1.28%	0.05%	1.07%	0.93%	28.76
2005	21.25%	4.64%	5.50%	65.84%	0.35%	0.92%	0.02%	0.83%	0.65%	37.42
2006	16.41%	5.14%	5.79%	69.64%	0.40%	0.97%	0.02%	0.92%	0.72%	32.79
2007	4.08%	4.47%	7.79%	80.40%	0.46%	1.12%	0.03%	1.03%	0.62%	28.91
2008	3.48%	4.01%	6.87%	82.30%	0.43%	1.23%	0.03%	1.01%	0.64%	28.31
2009	3.22%	3.62%	5.92%	84.09%	0.30%	1.17%	0.03%	1.02%	0.63%	28.12
2010	3.26%	3.26%	6.80%	83.49%	0.53%	0.93%	0.03%	1.03%	0.66%	27.32
2011	3.08%	2.77%	5.98%	85.27%	0.40%	0.85%	0.02%	0.94%	0.68%	29.28
2012	2.85%	2.63%	6.10%	85.52%	0.38%	0.89%	0.02%	0.94%	0.66%	29.43
2013	2.50%	2.56%	5.92%	86.22%	0.38%	0.87%	0.02%	0.92%	0.62%	29.90
2014	1.96%	2.95%	6.14%	85.90%	0.39%	1.11%	0.02%	0.96%	0.57%	28.75
2015	2.21%	2.58%	6.59%	85.60%	0.38%	1.07%	0.02%	0.91%	0.63%	30.08

TRENDS IN EMISSIONS OF CO

In general, the pollutant is having decreasing trends of emissions. However, in recent years the slight upsurge is noticed. The major contributor in recent years is combustion in residential sector:

- 1A2a Stationary combustion in manufacturing industries and construction: Iron and steel
- 1A3bi Road transport: Passenger cars
- 1A4bi Residential: Stationary

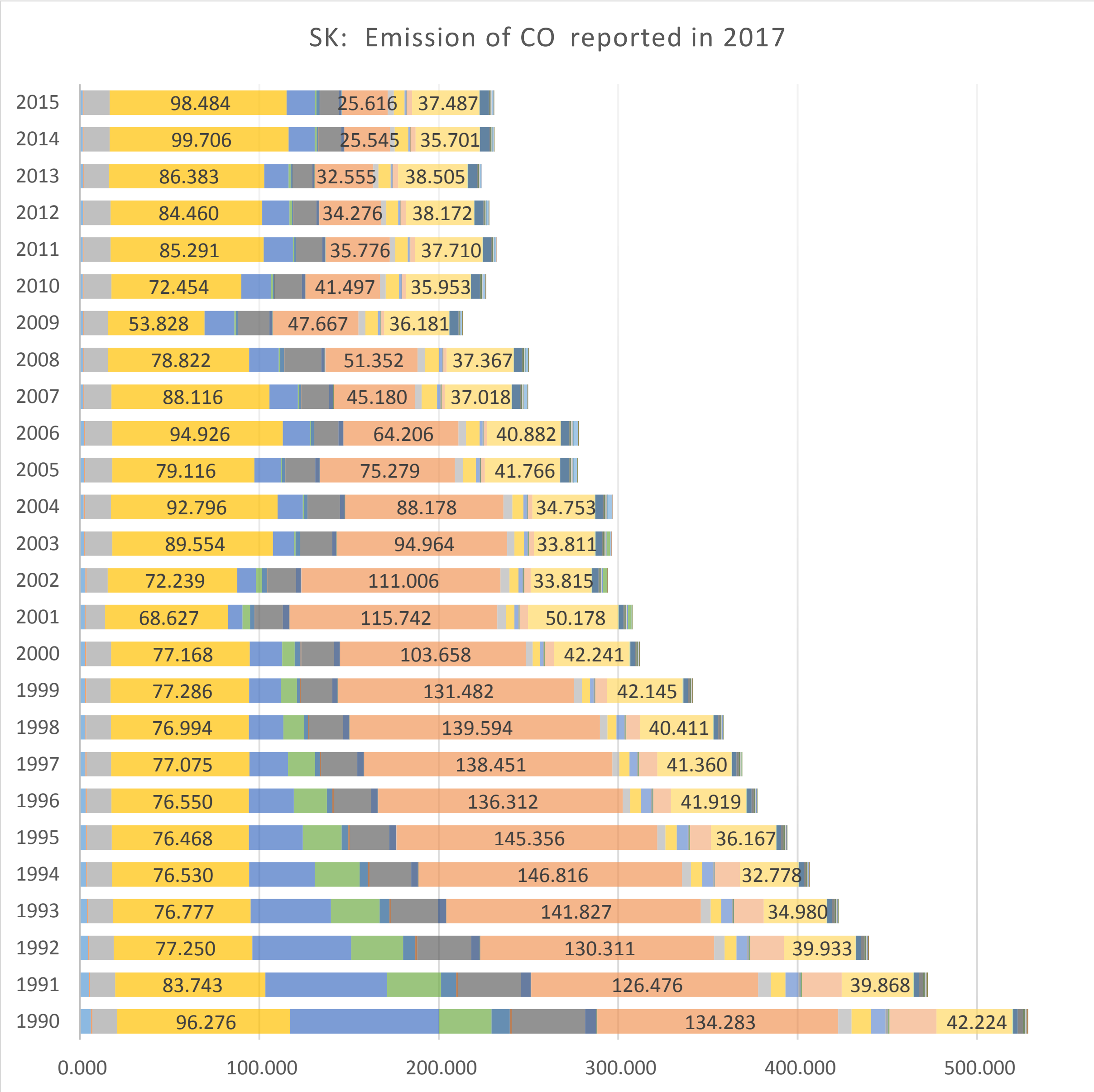


Figure 9 *Carbon monoxide (CO) emissions data 1990 - 2015*

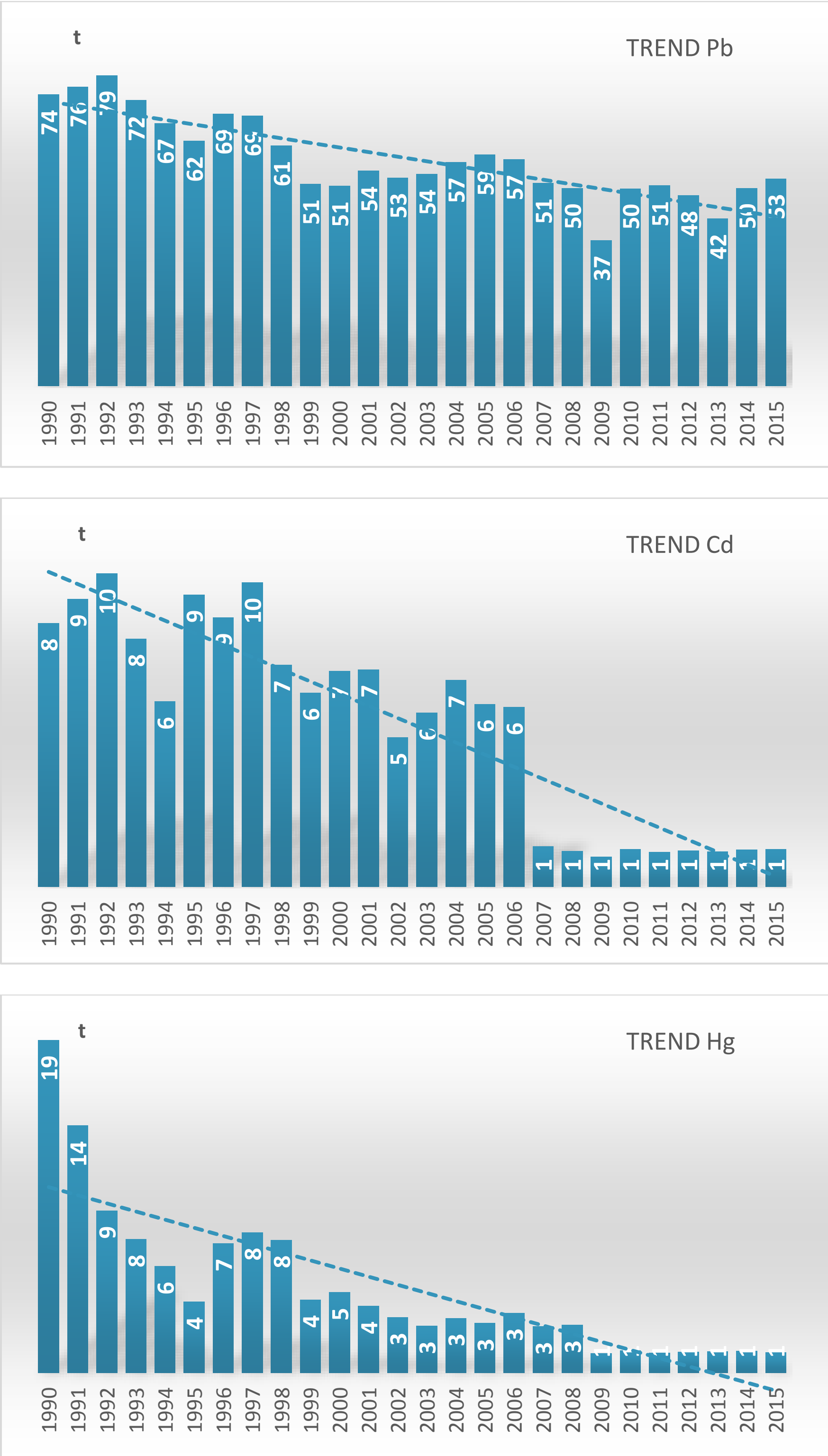
Table 6: *The Overview of the sectoral emission of CO share*

Sector share in NT	ENERGY	COMB. IN INDUSTRY	TRAN.	HOUS., COMM., AFF	FUGI.	INDU.	SOLV.	AGRI	WASTE	NAT. TOTAL [kt]
1990	3.94%	50.57%	30.91%	14.06%	0.31%	0.09%	0%	0%	0.12%	528.23
1991	4.15%	49.02%	32.02%	14.29%	0.32%	0.10%	0%	0%	0.10%	472.31
1992	4.28%	46.41%	34.28%	14.51%	0.33%	0.10%	0%	0%	0.10%	439.57
1993	4.33%	43.92%	38.03%	13.24%	0.30%	0.10%	0%	0%	0.07%	422.60
1994	4.39%	41.94%	40.72%	12.45%	0.32%	0.10%	0%	0%	0.08%	406.62
1995	4.49%	40.20%	41.59%	13.23%	0.33%	0.10%	0%	0%	0.06%	394.10
1996	4.65%	39.31%	40.70%	14.85%	0.33%	0.10%	0%	0%	0.06%	377.45
1997	4.70%	38.15%	41.59%	15.06%	0.35%	0.10%	0%	0%	0.06%	368.99
1998	4.80%	37.04%	43.09%	14.61%	0.32%	0.10%	0%	0%	0.05%	358.51
1999	5.00%	37.06%	42.06%	15.38%	0.35%	0.10%	0%	0%	0.04%	341.50
2000	5.59%	40.79%	36.70%	16.36%	0.39%	0.11%	0%	0%	0.05%	311.90
2001	4.53%	33.34%	41.78%	18.96%	0.40%	0.94%	0.0002%	0%	0.03%	307.69
2002	5.27%	36.59%	42.35%	14.22%	0.44%	1.09%	0.0007%	0%	0.05%	294.09
2003	6.09%	42.10%	36.23%	13.95%	0.45%	1.15%	0.0006%	0%	0.05%	296.37
2004	5.84%	43.85%	34.42%	14.27%	0.45%	1.16%	0.0002%	0%	0.01%	296.92
2005	6.53%	41.66%	32.46%	17.79%	0.47%	1.07%	0.0003%	0%	0.01%	277.14
2006	6.51%	46.22%	28.29%	17.23%	0.47%	1.27%	0.0%	0%	0.01%	277.73
2007	7.02%	49.57%	24.16%	17.68%	0.54%	1.03%	0.0003%	0%	0.00%	249.61
2008	6.23%	48.32%	26.45%	17.66%	0.50%	0.84%	0.0003%	0%	0.00%	250.05
2009	7.34%	42.99%	28.35%	20.40%	0.46%	0.46%	0.0002%	0%	0.00%	213.07
2010	7.75%	47.69%	23.91%	19.32%	0.62%	0.71%	0.0005%	0%	0.00%	226.17
2011	7.34%	51.47%	20.46%	19.57%	0.53%	0.63%	0.0007%	0%	0.00%	232.32
2012	7.49%	50.89%	19.96%	20.50%	0.51%	0.64%	0.0006%	0%	0.00%	227.97
2013	7.28%	51.05%	19.45%	21.17%	0.53%	0.52%	0.0010%	0%	0.00%	224.08
2014	7.18%	56.50%	16.07%	19.25%	0.50%	0.49%	0.0002%	0%	0.00%	230.92
2015	7.20%	55.98%	15.84%	19.99%	0.52%	0.47%	0.0012%	0%	0.00%	230.60

TRENDS IN EMISSIONS OF HEAVY METALS

The overall trends in emission progress through recorded years. In general, the national totals of the most emissions are having decreasing trend due to air policy of The Slovak Republic but also by impact of industry and development. Reported values for each pollutant can be found on EIONET (CDR Repository).

Figure 10: *Summary of pollutant trends since 1990*



EMISSION INVENTORY OF POPS

Emission inventory of POPs (PCB, DIOX, PAH - benzo(a)pyrene, benzo(k)fluoranthene, benzo(b)fluoranthene and ideno(1,2,3-cd)pyrene) for the Slovak Republic is elaborated according to EMEP/EEA Air Pollution Emission Inventory Guidebook and in coincidence with requirements of the respective of working group for emission inventory (UN ECE Task Force on Emission Inventory).

The individual sectors are defined in the sense of the SNAP nomenclature. In the sense of the requirements for the NFR reporting the NFR codes were assigned to the individual sectors upon the base of SNAP nomenclature. Emission factors for the emission estimation have been taken over from literature, Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, UNEP Chemicals) and smaller amount comes from the measurements on sources in the SR, Poland and Czech Republic and from EMEP/EEA Air Pollution Emission Inventory Guidebook.

Trends

Emissions trend in POPs mostly influenced by changes in Slovak industry. Emissions of PCDD/F have declined because of reconstruction of some technologies (waste incineration, iron ore agglomeration), increase in 2014 reflects the increase of iron ore agglomeration. Downward trend of PAHs emissions to the air proved to be most remarkable in in the 90-ties, when it was caused mostly by the change of aluminium production technology (use of pre-baked anodes). After year 2000 there is slight increase of PAHs emissions, from the year 2005 PAHs emissions are stabilize. Emissions of HCB in 90-ties and after 2000 decreased because of reconstruction of waste incineration plants. The greatest change in this sector occurred in 2006, when those plants, which did not proved compliance with emissions limit for PCDD/F were closed. Recent variations of HCB emissions are given mainly by changes in production of secondary copper. Slightly increased emissions of polychlorinated biphenyls (PCB) were influenced by the increase of consumption in crude oil in the road transport and using wood in the residential sector. Increased consumption of wood in this sector influenced also total emission of PAHs.

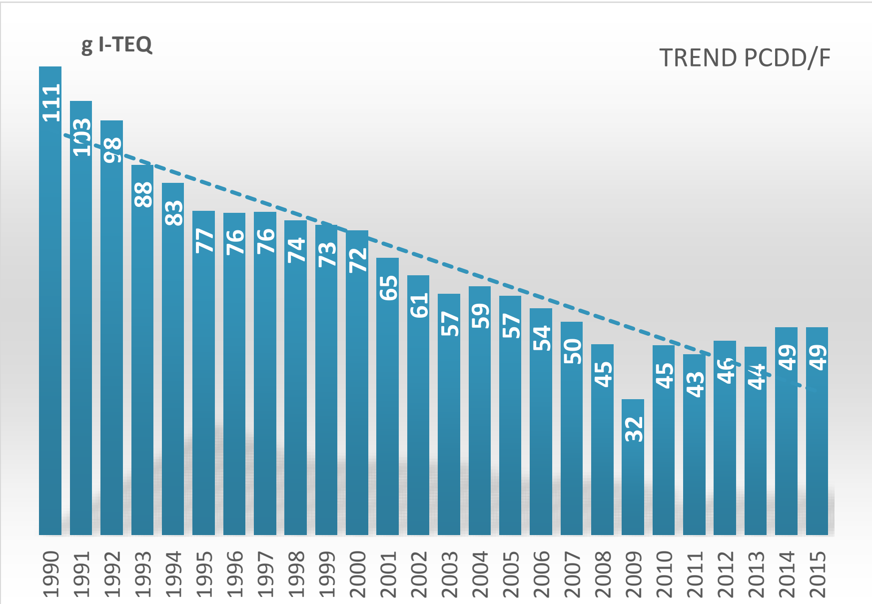


Figure 11: *Polychlorinated dibenzodioxins, polychlorinated dibenzofurans (PCDD, PCDF) emissions data 1990 - 2015*

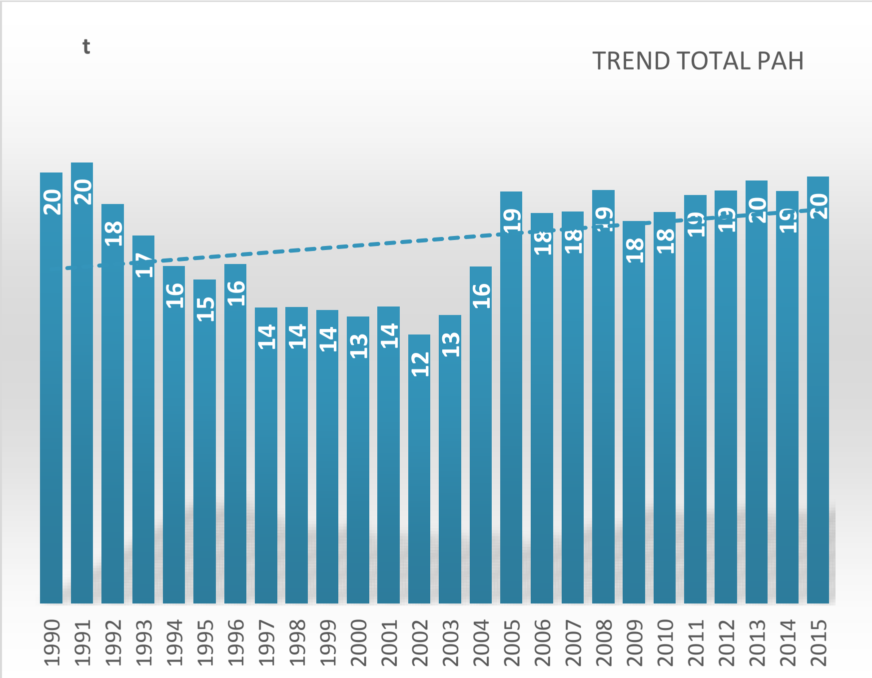


Figure 12: *Polycyclic aromatic hydrocarbons (PAH) emissions data 1990 – 2015*

Individually reported PAHs:

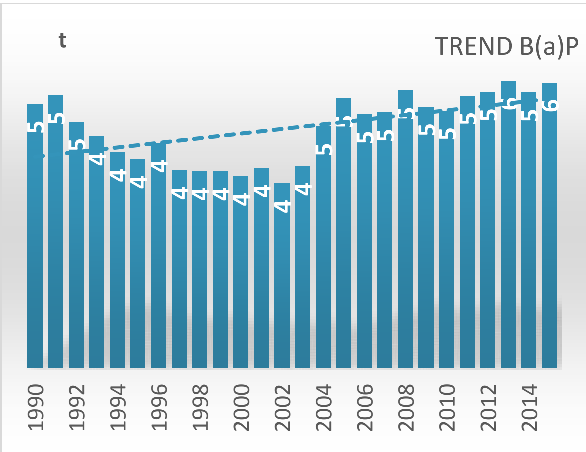


Figure 13*: Benzo[a]pyrene emissions data 1990 – 2015*

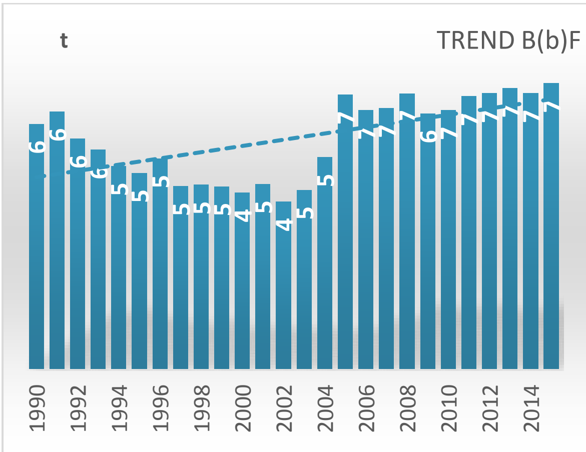


Figure 15: *Benzo[b]fluoranthene emissions data 1990 - 2015*

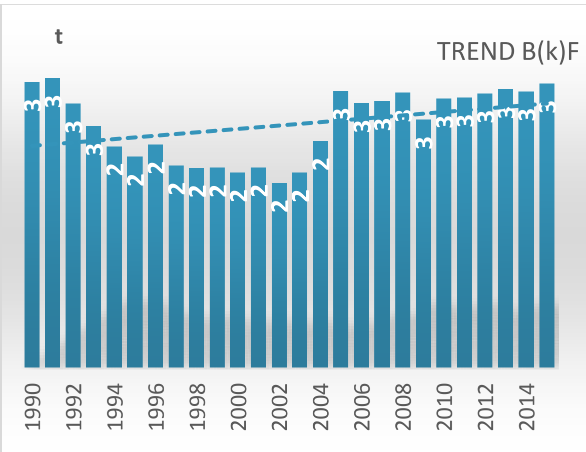


Figure 14*:Benzo[k]fluoranthene emissions data 1990–2015*

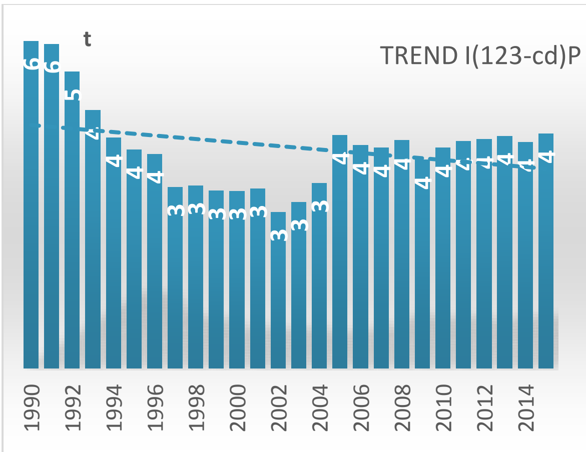


Figure 16: *Indeno[1,2,3-c,d]pyrene emissions 1990-2015*

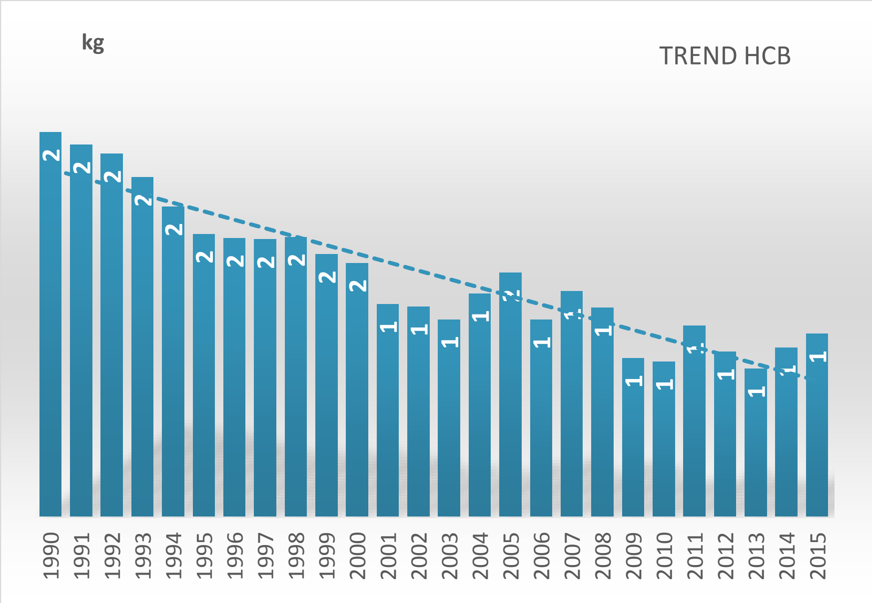


Figure 17: *Hexachlorobenzene emissions data 1990 – 2015*

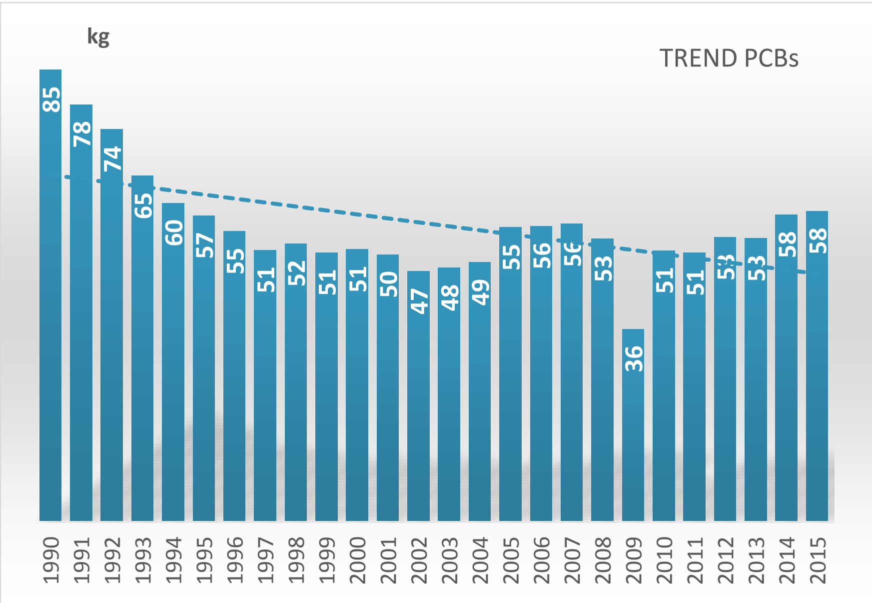


Figure 18*: Polychlorobifenyls emissions data 1990 - 2015*

1. INTRODUCTION

1.1 LEGISLATIVE FRAMEWORK

1.1.1 Historical background and circumstances

Political changes in 90`s as well as endeavour of Slovak Republic to access into the European Union enable considerable changes in the field of environment. The first intentions of Slovak Republic to be a member of European Union were already in 1991. However, accomplishment of this vision was interrupted by split of former Czechoslovakia into Czech and Slovak independent states in 1993. The Slovak republic consequently on 4 October 1993 signed Association Agreement in Luxemburg, which was ratified by in 1995. Integration process, when necessary political, economic and legislative changes had to be done, culminated in access on 1 May 2004.

In the field of environment, these efforts lead into implementation of strict air protection that has been established in fact very early in 1991 (in legislation - Act 17/1992[2] on Environment). This strict base that was introduced into Slovak law was according to German pattern. Therefore, there was no space for uncontrolled rise of industry. The issue of air quality (Council Directive 96/62/EC on air protection) was mainly governed by the following legal regulations in the Slovak Republic's legal system:

- Act No. 309/1991*Coll. on the Protection of Air from Pollutants (Air Act) as amended
- Act No. 134/1992*Coll. on State Administration of Air Protection as amended
- Governmental Ordinance No. 92/1996*Coll. through which Act No. 309/1991*Coll. on the Protection of Air from Pollutants (Air Act) as amended is implemented,
- Ministry of the Environment Decree No. 112/1993*Coll. as amended by Decree No. 103/1995*Coll.

Note: * all above mentioned legislative has been through the years repealed or amended

In 2004 Slovak Republic has become a member of European Union during the largest enlargement. Integration process brought about the transposition of earlier EU *acquis,* which was fully implemented*:

- Air Quality Framework Directive 96/62/EC and its daughter directives (1999/30/EC, 92/72/EEC, 2000/69/EC, 2002/3/EC, 2004/107/EC)
- Directive 84/360/EEC of the European Parliament and of the Council on combating of air pollution from industrial plants
- Directive 2001/81/EC of the European Parliament and of the Council on national emission ceilings for certain atmospheric pollutants
- Directive2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants
- Directive2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste
- Council Directive 94/63/EC of the European Parliament and of the Council on the control of volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution from terminals to service stations
- Council Directive 1999/13/EC of the European Parliament and of the Council on the limitation of emission of volatile organic compounds due to the use of organic solvents in certain activities and installations

---

2 *not valid nowadays

- Council Directive 1999/32/EC of the European Parliament and of the Council relating to a reduction in the sulphur content of certain liquid fuels
- Council Directive 96/61/EC of the European Parliament and of the Council concerning integrated pollution prevention and control

In response of all legislative circumstances and obligations, the Slovak Republic has implemented legal regulation in time of accession process. The twinning project SR 98/IB/EN/03: "Strengthening of Institutions in the Sector of Air Pollution" was launched in May 2000. This project has been resulted in proposals for amendments to legal regulations concerning air protection and the transposition into Slovak legislation. The new Clean Air Act and related ministerial decrees has been adopted by the end of 2002 and full harmonisation has been achieved.

- Act No. 478/2002* on air protection
- Decree of the Ministry of Environment of the Slovak Republic No. 408/2003* on monitoring of emissions and air quality monitoring
- Decree No. 409/2003* on emission limits, technical requirements and general operational conditions of certain activities and installations, which use organic solvents
- Decree No. 706/2002* on air pollution sources, on emission limits, on technical requirements and general operational conditions, on list of pollutants, on categorization of air pollution sources and on requirements of emission's dispersion as amended
- Decree No. 705/2002* on air quality
- Decree No. 704/2002* on the control of volatile organic compounds emissions resulting from the storage of petrol and its distribution from terminals to service stations
- Decree No.60/2003* on the Specification of maximum volume of discharged pollutants (emission quotas)
- Decree No. 53/2004* on the Requirements for the quality of fuels

* Nowadays, act/decree has been repealed or it is covered by Act on air protection No. **137/2010 as amended** and related regulations

1.1.2 Legislation on Air protection

The Slovak Republic, as a party of several international conventions, is obliged to report annually the air emission data to fulfil mandatory requirements resulted from adopted and implemented acts and agreements:

- **Geneva Protocol**[3] on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)
    - acceded as Czechoslovakia on 26 November 1986
    - succession: Slovak Republic on 28 May 1993

- **LRTAP Convention**[3] - The Convention on Long-range Transboundary Air Pollution and related protocols
    - *Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent (1985)*
        - Signed and approved as Czechoslovakia on 9 July 1985 and 26 November 1986, respectively
        - Slovak Republic succession on 28 May 1993

[3] http://www.unece.org/env/lrtap/status/lrtap_s.html

- *Sofia Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes (1988)*
    - Signed and approved as Czechoslovakia on 1 November 1988 and 17 August 1990, respectively[3]
    - Slovak Republic succession on 28 May 1993

- *Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes (1991)*
    - Slovak Republic accession on 15 December 1999

- *Oslo Protocol on Further Reduction of Sulphur Emissions (1994)*
    - Slovak Republic ratification on 1 April 1998

- *Aarhus Protocol on Heavy Metals (1998)*
    - Slovak Republic acceptance on 30 December 2002

- *Aarhus Protocol on Persistent Organic Pollutants (POPs*) (1998)
    - Slovak Republic acceptance on 30 December 2002

- *Gothenburg Protocol[4] to Abate Acidification, Eutrophication and Ground-level Ozone (1999)*
    - Slovak Republic ratification on 28 April 2005

➢ **NEC Directive[5]** - Directive 2001/81/EC of the European Parliament and the Council on National Emission Ceilings for certain pollutants

The purpose of Directive was defined as decline of the adverse effect in:
- water and soil driven by acidification and eutrophication
- and air driven by ground-level ozone

The aim is being achieved by determination of national emission ceilings for 4 main (basic) pollutants:
- Sulphur dioxides (SO_X)
- Non-methane volatile organic compounds (NMVOC)
- Nitrogen oxides (NO_X)
- Ammonia (NH_3)

The reduction of pollution was with the aim of human health protections and environment. Moreover, reduction was intended to be a long-term objective of not exceeding critical levels and loads with defined years 2010 and 2020 as benchmarks, and by means of successive reviews. In vision of quoted directive text, the emission ceilings for 2010 have been determined as exact value of pollutants (in kt) for each member state to ensure the achievement of goals.
Directive has been amended after the process of European Union enlargement when the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia and the Slovak Republic joined the Union. The conditions were defined in the Act OJ L236 23.9.2003 and Council Directive 2006*105/EC of 20 November 2006, with regard to the accession of Bulgaria and Romania.

---

[4] known also as a Multi-pollutant Protocol
[5] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0081&from=EN

These national emission ceilings are intended broadly to meet the following interim environmental objectives, for the Community as a whole, by 2010:

- The areas where the critical loads of acidification are exceeded shall be reduced by at least 50 per cent compared to 1990 levels.
- The ground-level ozone concentration above the critical level for human health shall be reduced by two-thirds compared to 1990 levels. Moreover, the ground-level ozone load shall not exceed an absolute limit of 2.9 ppm.h in any grid cell (150 km ×150 km2) (150 km × 150 km square).
- The ground-level ozone load above the critical level for crops and semi-natural vegetation shall be reduced by one-third compared with the situation in 1990. Moreover, the ground-level ozone load shall not exceed an absolute limit of 10 ppm.h (expressed as an exceedance of the critical level of 3 ppm.h).

The emission ceiling to be attained by the Slovak republic were quantified accordingly

Table 7: *Emission ceiling of Slovak republic for the year 2010*

	NO_X	SO_X	VOC	NH_3
SLOVAK REPUBLIC	130	110	140	39
EU - 27	8297	9003	8848	4294

Accomplishment of the targets was fully in competence of every member state in order to provide the solutions flexibility. According to the *Article 6* of Directive, National Reduction Programme of each member state was required to prepare with the closing date 1 October 2002 and revision up to 1 December 2006. In addition, the obligation of the regular emission report of basic pollutants (NO_X, NMVOC, SO_X, and NH_3) was a must.

Further developments[6]
In 2007 the Commission started the preparatory work for a legislative proposal to revise the Directive. This revision will set emission ceilings to be respected by 2020 for the four already regulated pollutants but it does not intend to affect the national emission ceilings already set for 2010. The revision will also build upon the evaluation and review of the National Programmes 2002 and 2006, the work performed under the Clean Air for Europe (CAFE) Programme, the Thematic Strategy on Air Pollution, legislative proposals on specific source categories (like Euro 5/6, € VI) and the revision of the IPPC Directive 2008/1/EC.

Related legislation[7]
Directive 2001/81/EC sets national emission ceilings for four major air pollutants. These pollutants arise from a very wide range of sources. Therefore, much of the legislation relating to industrial pollution and vehicle emissions is relevant to this Directive. Reducing overall emissions also contributes to meet air quality objectives locally and, therefore, such legislation is also relevant to Directive 2001/81/EC. Some of the more important related legislation is set out below:

- The Integrated Pollution Prevention and Control Directive 2008/1/EC.
- Large Combustion Plant Directive 2001/80/EC.
- Waste Incineration Directive 2000/76/EC.
- Solvent Emissions Directive 1999/13/EC.

[6] Farmer, A.M. (2012) (Editor). Manual of European Environmental Policy. 1043pp. Routledge, London
[7] Farmer, A.M. (2012) (Editor). Manual of European Environmental Policy. 1043pp. Routledge, London

- Directive 94/63/EC on volatile organic compounds from petrol.
- Air Quality Framework Directive 2008/50/EC.
- Directive 2010/75/EU on industrial emissions (briefly IED)[8]

Currently is Directive under revision process as part of The Clean Air Policy Package in order to achieve the objectives for human health and environment in 2020 and 2030.

- **UNFCCC** - The United Nations Framework Convention on Climate change
The basic international legal instrument to protect global climate was adopted at the UN Conference on the Environment and Development (Rio de Janeiro, 1992). The final goal of the Convention is to achieve the stabilization of greenhouse gas concentrations in the atmosphere at a level that would not cause any dangerous interference in the climate system.

In the Slovak Republic, the Convention came into force on 23 November 1994. The Slovak Republic accepted all the commitments of the Convention, including the reduction of GHG emissions by 2000 to the 1990 level. In response to the significant increase in GHG emissions since 1992 an urgent need to adopt an additional and efficient instrument that would stimulate mitigation effort has occurred. In 1997, the Parties to the Convention agreed to adopt the Kyoto Protocol (KP) that defines reduction objectives and means to achieve mitigation goals by the countries included in Annex I to the Convention. The Slovak Republic and the former EU Member States ratified the Kyoto Protocol on 31 May 2002. After joining the European Union (1 May 2004) by the Slovak Republic, set of new environmental legislative requirements have been adopted, including climate change and air protection.

The European Union (EU) considers climate change as one of the four environmental priorities. The Slovak Republic submits the preliminary data on GHG emission inventory for the year X-2 in required scope by January 15th each year (Annual Report), according to Regulation No 525/2013/EU (the MMR) repealing Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community GHG emissions and for implementing the Kyoto Protocol.

The Kyoto Protocol specifies a quantified emission limitation and reduction commitment for each developed country Party as well as related rules for accounting. Agreed rules are applicable to the assigned amounts of Parties; land-use related activities; and the use of flexibility mechanisms (emissions trading (ET), the clean development mechanism (CDM) and joint implementation (JI).
- More information on UNFCCC GHG inventory of The Slovak Republic is available: http://ghginventory.shmu.sk/documents.php
- National Inventory Report 2016: http://ghg-inventory.shmu.sk/documents.php?lang=2

Slovak legislation

Chapter in development

[8] IED has been implemented into the Slovak legislation by the amendment of Act on air protection No. 137/2010 (Act No. 318/2012 from 19 September 2012).

1.2 INSTITUTIONAL ARRANGEMENTS AND COMPETENCES

Ministry of Environment of The Slovak Republic[9] (MŽP SR) is responsible for development and implementation of national environmental policy including climate change and air protection objectives. It has the responsibility to develop strategies and further instruments of implementation, such as acts, regulatory measures, economic and market based instruments for cost efficient fulfilment of adopted goals. Both, the conceptual documents as well as legislative proposals are always annotated by all ministries and other relevant bodies. Following the commenting process, the proposed acts are negotiated in the Legislative Council of the Government, approved by the Government, and finally by the Slovak Parliament.

The Ministry of Environment of the Slovak Republic is the main body to ensure conditions and to monitor the progress of Slovak Republic to meet all commitments and obligations of air protection, climate change and adaptation policy.

The Slovak Hydrometeorological Institute (SHMÚ) is delegated by the Ministry of Environment for the technical preparation of the national emission inventories and projections. The SHMÚ, as the allowance resort organisation, arranges necessary cooperation with external experts who are contributors within preparation process and participate in compilations. The list of internal experts of Slovak Hydrometeorological Institute involved in emission inventory and list of external designated experts involved in emission inventory are in following table (***Table** 8*).

***Table 8:** List of internal and external contributors into the emission inventory under CLRTAP*

SECTOR / Subsector	CONTRIBUTOR	Institution	e-mail
CLRTAP coordinator	Ivana Ďuricová	SHMÚ	ivana.duricova@shmu.sk
ENERGY	Monika Jalšovská	SHMÚ	monika.jalsovska@shmu.sk
	Ivana Ďuricová	SHMÚ	ivana.duricova@shmu.sk
TRANSPORT	Ján Horváth	SHMÚ	jan.horvath@shmu.sk
	Jiří Dufek	external	Motran Research - contributor
INDUSTRIAL PROCESSES	Ivana Ďuricová	SHMÚ	ivana.duricova@shmu.sk
	Ľubomír Polakovič	external	VUIS - CESTY - Research Institute of Engineering Constructions
	Lýdia Pokorná	external	VURUP - Research Institute of Petroleum and Hydrocarbon Gases
AGRICULTURE	Kristína Tonhauzer	SHMÚ	kristina.tonhauzer@shmu.sk
	Zuzana Palkovičová	external	NPPC - Research Institute for Animal Production
	Vojtech Brestenský	external	NPPC - Research Institute for Animal Production
WASTE	Ivana Ďuricová	SHMÚ	ivana.duricova@shmu.sk
PROJECTIONS	Marcel Zemko	SHMÚ	marcel.zemko@shmu.sk
	Jiří Balajka	external	senior consultant
POPs emissions	Marcel Zemko	SHMÚ	marcel.zemko@shmu.sk
QA/QC	Marcel Zemko	SHMÚ	marcel.zemko@shmu.sk

[9] http://www.minzp.sk/o-nas/mzp-sr/

There has been long-term cooperation of the Slovak Hydrometeorological Institute (SHMÚ) with the Statistical Office of the Slovak Republic[10] (ŠÚ SR) in the field of data exchange. On base of the official Agreement on mutual cooperation in the field of statistics between the Ministry of Environment (MŽP SR)[11] and ŠÚ SR the flexible and secure way of data exchange will be annually performed via FTP server. Data transfer of individual and confidential data and their protection is ensured by determination of qualified and authorized persons with direct access to server. During the year 2017, it is planned the second revision for enlargement of activity data and improve the cooperation.

Transport sector emission inventory is partly performed by external expert using the model COPERT IV. Activity data for model are obtained from Transport Research Institute, JSC. (Výskumný ústav dopravný, a. s. - VÚD) in cooperation with The Ministry of Transport, Construction and Regional Development of the Slovak Republic (Ministerstvo dopravy, výstavby a regionálneho rozvoja SR – MDVRR), and from the Statistical Office of the Slovak Republic.

Agricultural sector emission inventory is performed in cooperation with The Ministry of Agriculture and Rural Development[12] (Ministerstvo pôdohospodárstva a rozvoja vidieka – MPaRV). The responsibility for data and compilations of 3.B Manure management was consequently shifted to the allowance organization - the National Agriculture and Food Centre[13] (Národné poľnohospodárske a potravinárske centrum – NPPC) that formally merged 9 Research Institutes in this area. So the submission 2017 is the second year when the emission inventory for livestock is done by experts from Research Institute for Animal Production (Výskumný ústav výživy zvierat – VÚVZ). A check assessment for the results, as a QA/QC step, is being done at SHMÚ and information on methodological procedure is provided in chapter planned improvements.

[10] https://slovak.statistics.sk/

[11] Note: Slovak Hydrometeorological Institute is the allowance institution to the Ministry of Environment and thus the Contract is formally between Statistical Office of the Slovak Republic and the Ministry of Environment

[12] http://www.mpsr.sk/

[13] http://www.nppc.sk/index.php/sk/

1.3 INVENTORY PREPARATION PROCESS

Slovak Hydrometeorological Institute is in charge of entire cooperation and preparation process of emission inventory under the LRTAP Convention, namely:

- Ensure the cooperation with institutions, experts and necessary background studies or papers
- Ensure the processing and verification of data in NEIS database
- ensure the technical preparation and compilation of data
- ensure the processing of data from the Statistical Office
- preparation of LRTAP Convention reporting template
- annual actualization of IIR SK
- submission of LRTAP Convention reporting template and IIR SR
- cooperation during the review procedure for national emission inventories
- providing data to Slovak Environmental Agency (SEA , Slovenská agentúra životného prostredia – SAŽP)
- providing processed emission data to Statistical Office of the Slovak Republic (ŠÚ SR)

Note: SHMÚ ensures similarly the technical preparation and compilation of data for Air Environmental Accounts - AEA[14] that are processed by inventory first approach and used the emission inventory of LRTAP Convention.

NEIS database and emission outputs are used for several international reports:
a/ LRTAP Convention and Directive 2001/81/EC of the European Parliament and the Council on National Emission Ceilings for certain pollutants (more in chapter 38)
b/ Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants
c/ for verification of E-PRTR

The emission inventory under LRTAP Convention is prepared with the consistency of the greenhouse gases (GHG) emission inventory under UNFCCC and the projection requirements of the decision 280/2004/EC. UNFCCC and the projection requirements of the Regulation (EU) No. 525/2013 an implementing regulation (EU) No 749/2014.

Preliminary emissions data is submitted under the Article 8 paragraph 1 of the National Emission Ceiling Directive (NEC) 2001/81/EC of the European Parliament and the Council and relates to the emissions of $NO_{x,}$ NMVOC, $SO_{x,}$ NH_3 and CO.

This emission submission is prepared according to the methodology included in the EMEP/EEA Guidebook 2013[15]. In some cases, the methodology is adjusted to the country specific circumstances.

The national emission inventory is prepared mostly in comply with the updated version of EMEP/EEA Air Pollutant Emission Inventory Guidebook – 2013 (GB 2013) and has implemented changes in NFR (Nomenclature for reporting) and categories. Data is provided in range of years 2001 – 2014.

[14] under the Regulation (EU) No 691/2011 of the EP and of the Council on European environmental economic accounts, http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32011R0691
[15] http://www.eea.europa.eu/publications/emep-eea-guidebook-2013

1.4 METHODS AND DATA SOURCES

1.4.1 Main Data Suppliers

There are several sources of input data among which the most important are the National Emission Information System (NEIS) and data from the Statistical Office of the Slovak Republic (ŠÚ SR).
According to the changes described in *Structural changes in institutional cooperation* the data exchange between Slovak Hydrometeorological Institute (SHMÚ) and Statistical Office of the Slovak Republic (ŠÚ SR) is performed through the FTP server where the access has only the authorized persons. It is based on the legal Agreement on mutual cooperation in the field of statistics.

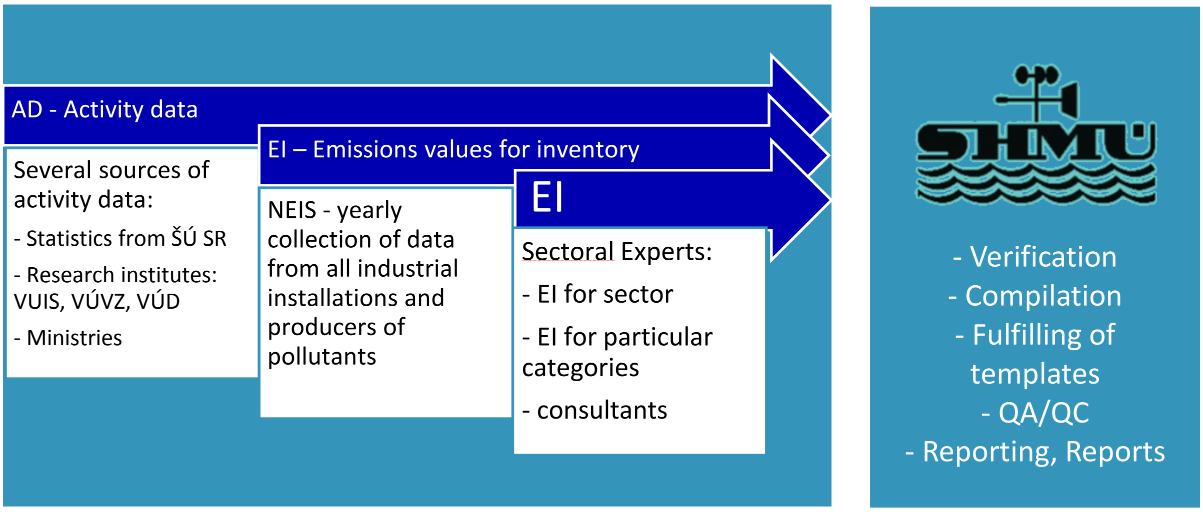


Figure 19: Scheme of different sources for emission inventory of basic and other pollutants and processes performing in SHMU

The National Emission Information System (Národný emisný informačný systém – NEIS) still remains as a major source for inventory in key categories and sectors (Energy, Industry, and Waste).

Then sector experts from research institutes or cooperative external experts providing emission inventory studies or material balances studies that are consequently involved in compilation process.
The SHMÚ is also authorized by the Ministry of Environment of the Slovak Republic to arrange the communication with the producers with the aim of collection necessary data that are not mandatory to provide into the National Emission Information System (NEIS).
The Ministry of Environment of the Slovak Republic, the Ministry of Agriculture and Rural Development and some other governmental institutions provided input data into projections.

1.4.2 NEIS database

1.4.2.1 Overview

NEIS database (Národný emisný informačný systém - NEIS) is National Emission Information System for other pollutants (NO_X, SO_X, NMVOC, NH_3, HM and TSP). Information System NEIS was established in 1998. The database was developed in order to fulfil the national legislation in air quality and the requirements in pollutants fees decisions (Act No. 401/1998 on air pollution charges as amended). Since 2000, when NEIS was set into the operation, the emissions are directly collected in consistent way and verified on more levels. This database replaced an old system REZZO (Register emisií a zdrojov znečistenia ovzdušia - Emission and Air Pollution Source Inventory). These systems are comparable merely at the national level. The first collection and processing of data by NEIS was realized in 2001. Department of Emissions and Air Quality Monitoring of the Slovak Hydrometeorological Institute is in charge of processing of final data in central database. The following scheme represents the formation of database as a project in line with the time line of important dates.

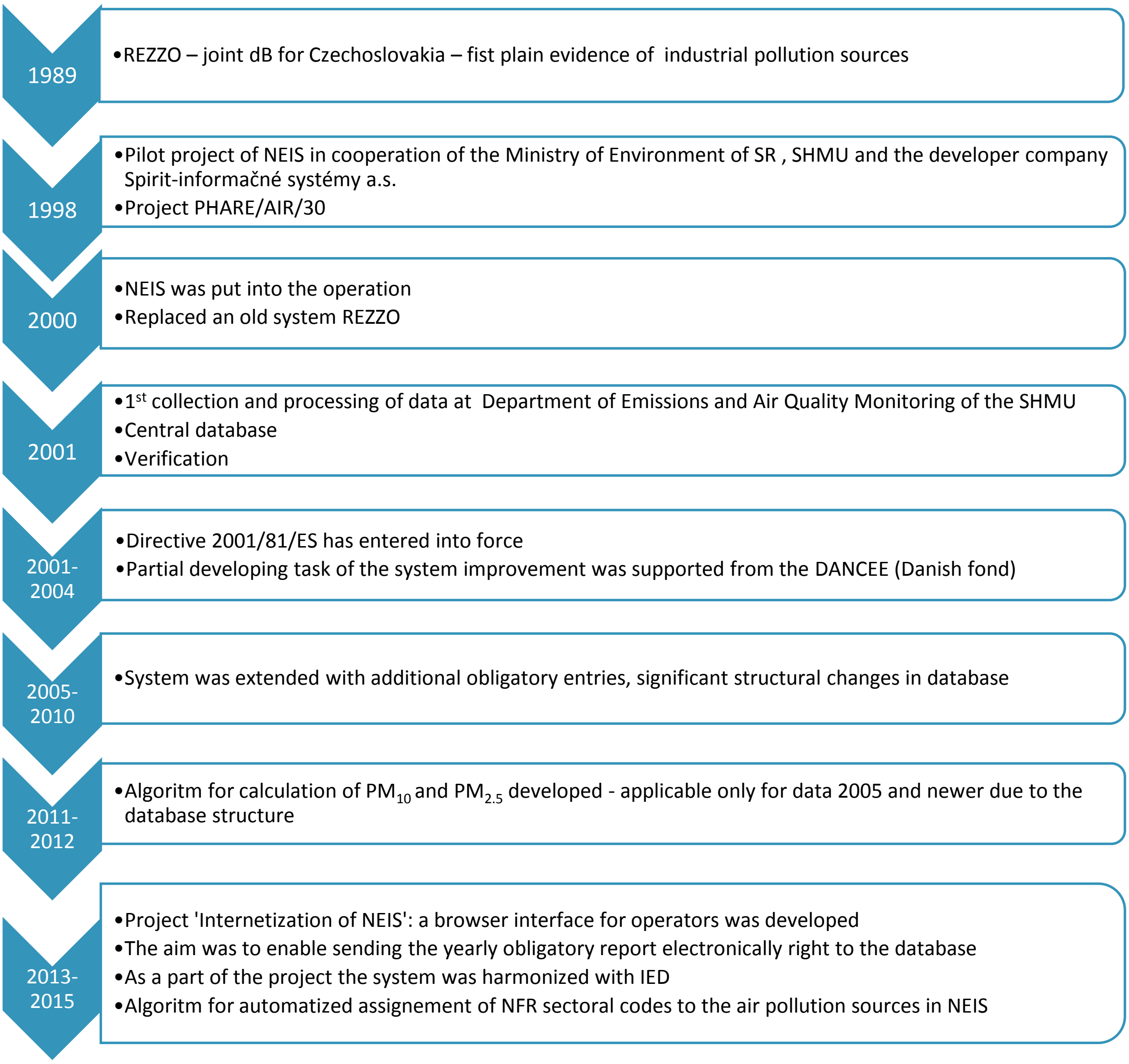


Figure 20: Milestones in development NEIS database

The last changes within the improvement of the NEIS was carried out since December 2013 till August 2015. Within the scope of the recent Project 'Internetization of NEIS' a browser interface was developed. The aim was to enable sending the yearly obligatory report electronically right to the database NEIS PZ WEB. The module NEIS BU on district offices is connected to this database and data is synchronized.

1.4.2.2 System characteristics

Database NEIS includes cca 13000 sources of air pollution per year. The sources are categorized by activity and projected capacity as large or medium (Decree No 410/2012 Coll.) as follow:

- **Large sources**
  - Technological units containing combustion plants having total rated thermal input more than 50 MW and other technological units with a capacity above the defined limit
  - In year 2014 the system contained 902 (735 of it in operation) large sources

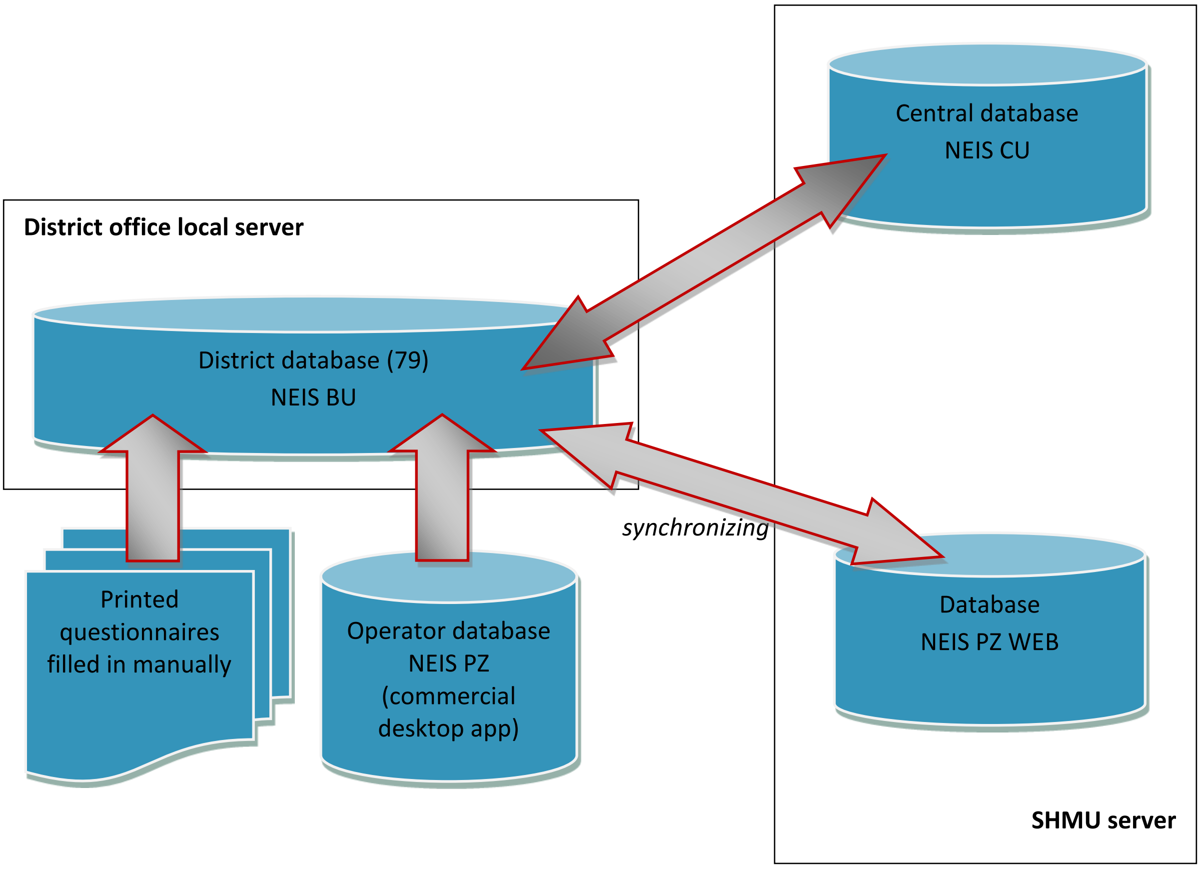


Figure 21: *The scheme of the connection of individual databased in NEIS*

- **Medium sources**
  - Technological units containing combustion plants having total rated thermal input between 0.3 – 50 MW and other technological units with a capacity under the defined limit for the large sources but over the defined limit for the medium sources
  - In year 2014 the system contained 12 851 (10 553 of it in operation) medium sources

Operators of large and medium sources are obliged to annually report specific dataset about operation (e.g. quantity of emissions and calculation of the air pollution fee). The reported data is gathered in NEIS. Sources below the relevant projected capacity are defined as small and these are not included individually in this system. However, the emission balance of small sources is being processed on district level.

Emissions are summarized on the level of the sources releasing pollutants into the air. The term 'source' is defined in the national Act No 137/2010 as a stationary technological unit (including storage of fuels, raw materials or products, quarries and other areas or objects), plant or activity, which is polluting or can pollute air; delimited is as a functional and spatial complex of all plants and activities. In some cases this definition overlap the definition of the 'installation' in IED, but mainly 'source' is a part of the 'installation'. Another IED term 'plant' is also mainly a part of the 'source' or identical with it.

Each source can contain one or more combustion plant and/or one or more technology. The quantifying of the yearly emissions is executed on the plant/technology level. The applicable methods for the quantifying are enacted in Decree No 411/2012 on emission monitoring in stationary sources of air pollution:

a) Prescribed technical balance approach,
b) Explicit emission-dependence approach,
c) Continuous measurement,
d) Calculation using representative individual emission factor or representative individual mass flow,
e) Calculation using emission factor evaluated by periodic measurement,
f) Calculation using mass flow or mass concentration evaluated by periodic measurement,
g) General emission-dependence approach,
h) Default emission factor approach[16],
i) Calculation using emission-dependence approach or EF published in technical standards, directive, guidelines or other official document of competent authority, EU and related organizations,
j) Other suitable approach filling given requirements,
k) Combination of previous approaches.

Possibly activity data is the operation hours, fuel consumption, volume of the waste gases, amount of produced energy or other relevant product.

Due to the NFR sectoral code changes it was necessary to recalculate the accessible timeline. Revision of all sources (cca 13 000 x 15 years = 195 000) expected the development of the methodology for automatized re-assignment of sectoral codes to the individual sources. The accessible timeline in NEIS (2000-2014) was revised: emissions from individual air pollution sources were re-allocated according to revised sectoral codes.

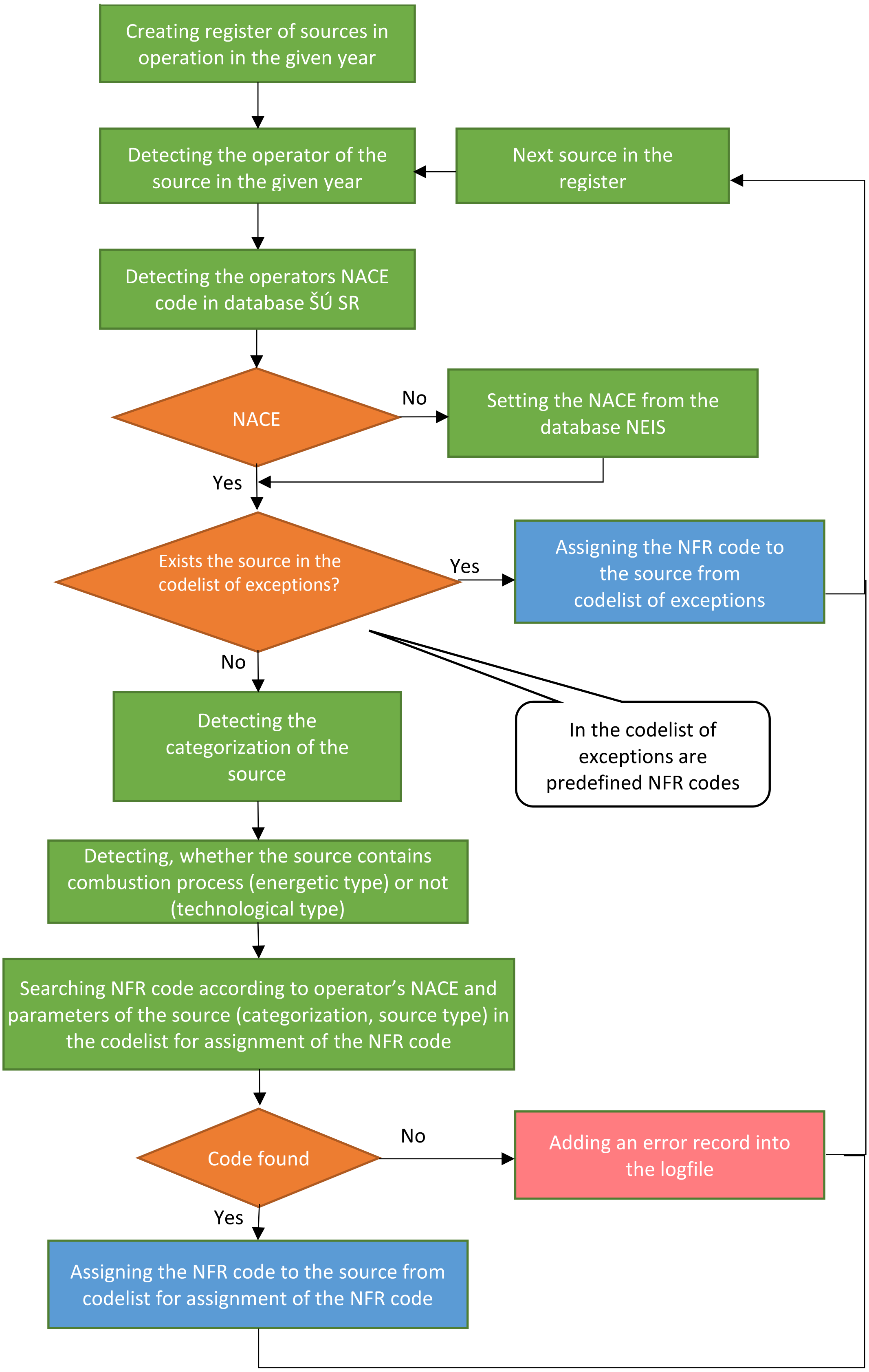
Methodology for automatized re-assignment is based on following key data:

- Air pollution source category (Decree No. 410/2012 Coll.)
- SK NACE rev.2 code of the operator
- Existence of combustion activity in the source

Developed algorithm checks the key data, compare thus with the assignment rules and due to result executes the assignment of the relevant NFR sectoral code. Procedure is iterated for every source-record in chosen year. It is also possible add exception.

[16] General relations as well as default EF are published in Bulletin of the Ministry of the environment

__Figure 22:__ Flowchart of code matching process



➢ **Small sources**

– Stationary equipment – domestic heating equipment for combustion of solid fuels and natural gas with total rated thermal input less than 0.3 MW

The sources below 0.3 MW (category 1A4bi – Residential: Stationary plants) are qualified as small sources. These are not registered as individual point sources. The emission balance is being processed centrally (NEIS CU - central unit) and it is based on:

- Solid fossil fuels sold (data on district level) for operator of fuel combustion plants with RTI up to 0,3 MW (households)
  - in 2001 – 2003 according to Decree No. 144/2000
  - in 2004 – 2009 according to Decree No. 53/2004
  - since 2010 according to Decree No. 362/2010
- Consumption of natural gas for the inhabitants and the annual market share on the gas sale in SR
- Consumption of the electric energy in the households
- Annually specified emission factors

1.4.2.3 Dataflow and processing

According to the Act No. 137/2010 Coll. as amended by the Act No. 318/2012 Coll. operators of large and medium sources are obliged to annually report specific dataset about operation. The main data is the amount of released emissions, the pollutant fee and the fuel consumption. The dataset contains also amount of various metadata. This reporting obligation since 1/2016 can be fulfilled by using the browser-interfaced tool NEIS PZ WEB, which was developed for the operators as result of project 'Internetisation of the National emission information system'. Data from operators are collected and verified by the district offices using SW module NEIS BU. District environmental offices are obliged to prepare the annually dataset containing operational characteristics of air pollution sources in their districts and provide this to the SHMÚ central database in specified format (79 district databases) for the next processing.

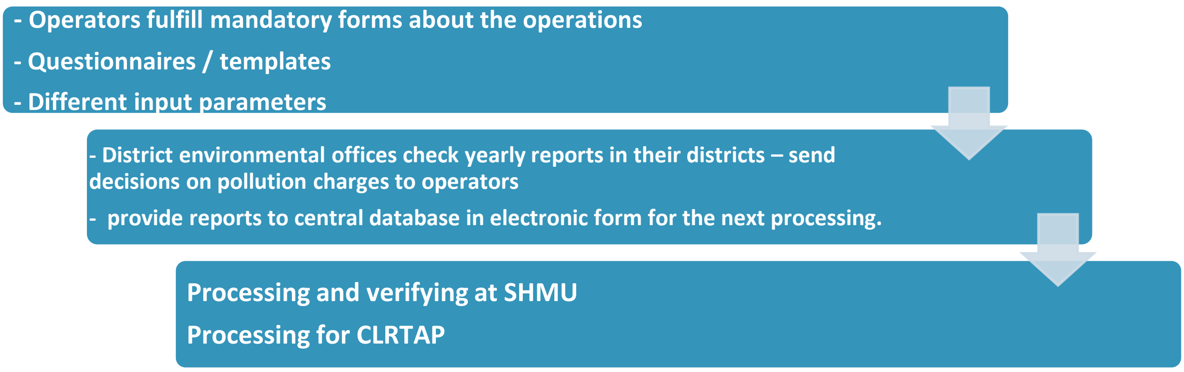


Figure 23: How does it work within the NEIS

1.4.2.4 Verification process of NEIS data

Chapter is in development, progress will be update as soon as possible.

1.4.3 Emissions inventory of TSP, PM_{10} and $PM_{2.5}$

Total Suspended Particles (TSP) emissions are provided directly by operators of individual large and medium sources on the base of measurements or more precisely by calculation (in coincidence with the air protection legislation of the Slovak Republic). Emission inventory of PM_{10} and $PM_{2.5}$ for the Slovak Republic are elaborated according to the EMEP/EEA Air Pollution Emission Inventory Guidebook and in coincidence with requirements of the respective of working group for emission inventory (UN ECE Task Force on Emission inventory) and methodology is based on IIASA's report [17].

The NEIS database contains a special program that automatically calculates emissions of PM_{10} and $PM_{2.5}$. The outputs from the NEIS database are verified and performed in excel sheets. Efficiency of the installed separation of fractions is defined and then emissions of PM_{10} and $PM_{2.5}$ behind separator were calculated. After calculations behind separator, the calculation of total emissions PM_{10} and $PM_{2.5}$ is taken to NFR tables.

Calculation of emissions PM_{10} and $PM_{2.5}$ were processed with certain sectoral default indicators. In respect of that on the EU level were defined emission ceiling for 2020 based on GAINS model (from IIASA) so we resolved to methodology of calculation inventory of PM_{10} and $PM_{2.5}$. National inventory is base to modelling of national projections.

1.5 KEY CATEGORIES

1.6 QA/QC AND VERIFICATION METHODS

QA/QC procedure for CLRTAP is compare to GHG inventory not fully developed. This issue will be continuously improved within horizons of following 2 years since 2016. It a point in improvement plan for general part of reporting and necessary QA/QC procedure. The plan is to accept and take over the pattern already implemented in the Slovak GHG emission inventory.

1.7 Data archiving

Official submissions of the emission inventory and projections are archived electronically at SHMÚ as well as at the Ministry of Environment. Emission projections are also printed as an inside document for the Ministry of Environment.

Data related to the NEIS are all archived and backup is done on daily base on the backup serves of SHMU. This activity is performed for all data processed in SHMU (that covers many different sources – meteorological, hydrological, air quality data and the others). In addition the backup, especially for the NEIS database, is also performed automatically once a week on the remote server of the developer company Spirit-informačné systémy a. s.

The data from the Statistical Office of the Slovak Republic are except of the arranged FTP server, are archived electronically at SHMÚ as well as the Statistical yearbook published annually by Statistical Office are stored in paper form.

Documents and background all materials of the internal expert of SHMÚ and external are archived too. Printed documents are archived in central archive of the SHMU and at the OMEaKO. The electronical archive have been created for all electronical documents relates to the emission inventories. However, it is still in development. The progress will be reported in the next submission.

[17] http://www.iiasa.ac.at/rains/reports/ir-02-076.pdf

1.8 UNCERTAINTY

Uncertainty analysis were not provided in the past due to the insufficient capacities. Nevertheless this important issue was involved in the improvement plan as the item with the high importance and thus to be solved.

1.9 ASSESMENT OF COMPLETENESS

Assessment of completeness is one of the elements of quality control procedure in the inventory preparation on general and sectoral level. The completeness of the emission inventory is improving from year to year, especially submission 2016 implemented several methodological issues and new distinguish and breakdown into specific subcategories. Even thoug the results are not satified yet, we believe that ongoing work will bring the shift and another step forward to better quality.The updates will be regularly reported in the Informative Inventory Reports.

Several categories are reported as not occurring (NO) due to the not existence of the emission source or the source is out of threshold and measurement range (***Table 9***).

Table 9*: Summary of categories using notation key NO*

NFR14	Longname	notation key
1A4ciii	Agriculture/Forestry/Fishing: National fishing	NO
1B1c	Other fugitive emissions from solid fuels	NO
2B3	Adipic acid production	NO
2B6	Titanium dioxide production	NO
2B7	Soda ash production	
2C6	Zinc production	NO
2C7b	Nickel production	NO
2J	Production of POPs	NO
3B4a	Manure management - Buffalo	NO
3B4f	Manure management - Mules and asses	NO
3Da2b	Sewage sludge applied to soils	NO
3F	Field burning of agricultural residues	NO
5C1bvi	Other waste incineration	NO
5C2	Open burning of waste	NO
6A	Other (included in national total for entire territory)	NO

If the methodology does not exist in the Guidelines, there is no data from NEIS database and no certain pollutants is creating from given activity, the notation key not applicable (NA) is used.

Several not estimated (NE) for categories have been reported in 2017 submission. Two reasons for not estimated categories are no methodology is available or insufficient activity data.

The notation key included elsewhere (IE) is also used in case of allocation. Allocation of more types is being occurred:

- First, when entire category is allocated into another category or more categories.
- Second, some pollutants of category is allocated into another category or more categories.
- Third, cases where partial allocation is used. Usually, it is related to NEIS sources and partial allocation into the energy sector. When the sources release emissions from technological process and combustion as one output that we cannot separate. It is due to number of reasons: a/ technological constitution of facility units and methodology based on the measures from one release; b/ character of compilation processes using the fuel directly into technological processes; c/ diferrent processes that are clasified inline with Slovak legislative regulations in NEIS and cover more NFR categories as one category; d/ other reasons.

The explanations and also describtion is given in this report in appropriate sectoral and categories chapters. The geographic coverage is complete; the entire territory of the Slovak Republic is covered by the inventory.

2 ENERGY SECTOR (NFR 1)

Chapters in development, results will be available as soon as possible

2.1 TRANSPORT (1.A.3)

2.1.1 Category description and trends

Transport has a very special position in the energy sector, as it is not covered by any legislative regulations. Thus emissions in this category are very difficult to regulate. The emissions from category 1.A.3 Transport include subcategories Domestic aviation (1.A.3.a), Road transportation (1.A.3.b), Railways (1.A.3.c), Domestic navigation (1.A.3.d) and Pipeline transport (1.A.3.e.i). During recent years, the shift from a public transportation to individual passenger cars has been observed. The level of transit transport (HDV) has been increased at the same time. The consumption of fuels in railways is decreasing continuously, while the consumption of fuels in road transportation is sharply increasing. Total aggregated pollutants in transport decreased against the base year in range of 21.53 % (TSP) and 91.55 % (SO_x), although emission of ammonia have increased by 1563.73 %, in comparison with the base. More information can be found below in Table 15. Ammonia as a pollutant mostly comes from road transportation, exactly 99.5 % of it and the rest is railways and navigation (0.05 %). The emissions from road and non-road transport were calculated by using models, default methodologies and the consistent data series from 1990 – 2015.

Table 10: *Overview of the main pollutants in sector Transport in years 1990 – 2015*

YEAR	EMISSIONS							
	kt							
	NO_x		NMVOC		SO_x		NH_3	
1990	59.63	0.00%	36.84	0.00%	3.11	0.00%	0.03	0.00%
1991	49.38	-17.19%	34.12	-7.40%	2.59	-16.79%	0.03	-10.45%
1992	44.49	-25.39%	32.71	-11.22%	2.33	-24.98%	0.03	-7.92%
1993	43.01	-27.88%	34.60	-6.08%	2.18	-30.04%	0.04	31.68%
1994	44.67	-25.09%	35.61	-3.33%	2.26	-27.26%	0.07	122.73%
1995	46.56	-21.92%	34.93	-5.19%	2.47	-20.60%	0.11	265.86%
1996	45.26	-24.11%	32.55	-11.66%	2.46	-20.80%	0.16	445.66%
1997	44.00	-26.21%	30.84	-16.29%	2.37	-23.87%	0.24	711.81%
1998	44.28	-25.75%	30.32	-17.71%	2.53	-18.50%	0.33	995.08%
1999	40.79	-31.60%	26.70	-27.51%	0.98	-68.61%	0.53	1643.62%
2000	35.39	-40.65%	22.21	-39.71%	0.88	-71.76%	0.47	1451.42%
2001	39.10	-34.44%	23.14	-37.18%	1.06	-66.04%	0.58	1820.61%
2002	39.46	-33.83%	20.99	-43.02%	1.14	-63.32%	0.50	1562.33%
2003	38.22	-35.91%	18.46	-49.88%	0.51	-83.45%	0.59	1847.33%
2004	40.48	-32.12%	16.64	-54.84%	0.39	-87.49%	0.53	1652.72%
2005	43.77	-26.60%	15.33	-58.38%	0.23	-92.46%	0.49	1520.42%
2006	42.86	-28.14%	13.55	-63.22%	0.42	-86.60%	0.53	1661.02%
2007	47.20	-20.85%	11.31	-69.31%	0.46	-85.25%	0.48	1487.07%
2008	46.64	-21.79%	11.21	-69.59%	0.47	-84.92%	0.59	1871.09%
2009	40.49	-32.11%	9.47	-74.28%	0.44	-85.98%	0.59	1864.92%
2010	43.41	-27.20%	9.12	-75.25%	0.29	-90.54%	0.55	1727.66%
2011	39.05	-34.52%	8.29	-77.49%	0.28	-90.92%	0.54	1695.99%
2012	39.28	-34.14%	7.89	-78.57%	0.63	-79.90%	0.53	1647.89%
2013	39.68	-33.47%	7.61	-79.34%	0.17	-94.38%	0.56	1744.37%
2014	42.73	-28.35%	6.82	-81.50%	0.19	-93.76%	0.43	1332.65%
2015	39.48	-33.79%	7.76	-78.93%	0.26	-91.55%	0.50	1563.73%

YEAR	EMISSIONS							
	kt				t			
	TSP		CO		heavy metals		POPs	
1990	4.10	0.00%	162.83	0.00%	27.62	0.00%	1.30	0.00%
1991	3.39	-17.46%	150.88	-7.34%	23.93	-13.37%	0.99	-24.14%
1992	2.99	-27.11%	150.39	-7.64%	22.77	-17.57%	0.82	-36.76%
1993	2.79	-32.00%	160.50	-1.43%	23.19	-16.05%	0.71	-44.99%

YEAR	EMISSIONS							
	kt				t			
	TSP		CO		heavy metals		POPs	
1994	2.92	-28.91%	165.46	1.61%	24.69	-10.61%	0.69	-47.26%
1995	3.09	-24.68%	163.70	0.53%	25.96	-5.99%	0.74	-43.21%
1996	3.02	-26.43%	153.42	-5.78%	25.87	-6.33%	0.73	-44.00%
1997	2.95	-28.05%	153.28	-5.86%	26.51	-4.03%	0.69	-46.70%
1998	3.05	-25.68%	154.32	-5.23%	27.57	-0.19%	0.65	-50.14%
1999	2.78	-32.13%	143.52	-11.86%	26.22	-5.07%	0.60	-54.06%
2000	2.28	-44.37%	114.34	-29.78%	18.55	-32.84%	0.57	-55.90%
2001	2.17	-47.12%	128.56	-21.05%	14.21	-48.55%	0.58	-55.73%
2002	2.35	-42.83%	124.53	-23.52%	14.19	-48.64%	0.55	-57.85%
2003	2.33	-43.18%	107.37	-34.06%	14.39	-47.91%	0.46	-64.64%
2004	2.45	-40.22%	102.21	-37.23%	14.77	-46.51%	0.45	-65.30%
2005	2.93	-28.59%	90.12	-44.66%	17.57	-36.39%	0.47	-64.12%
2006	3.22	-21.58%	78.56	-51.75%	16.73	-39.42%	0.48	-63.05%
2007	3.22	-21.58%	60.29	-62.98%	18.45	-33.21%	0.49	-62.49%
2008	2.94	-28.24%	66.14	-59.38%	19.56	-29.17%	0.46	-64.53%
2009	2.60	-36.68%	60.42	-62.90%	17.55	-36.46%	0.41	-68.74%
2010	2.87	-30.07%	54.07	-66.79%	19.40	-29.75%	0.43	-66.68%
2011	2.70	-34.24%	47.53	-70.81%	18.40	-33.37%	0.42	-67.60%
2012	2.80	-31.66%	45.50	-72.06%	19.08	-30.94%	0.39	-69.66%
2013	2.76	-32.83%	43.59	-73.23%	18.45	-33.21%	0.44	-66.10%
2014	2.77	-32.57%	37.11	-77.21%	18.46	-33.17%	0.43	-67.12%
2015	3.22	-21.53%	36.52	-77.57%	15.34	-44.47%	0.45	-65.00%

Domestic aviation (1.A.3.a.i) and international aviation (1.A.3.a.ii) - These categories are not key categories. In the absence of national data on the exact numbers of domestic and international LTO cycles (only total numbers of LTO cycles is available), summary information from the EUROCONTROL database was used. All important Slovak airports (Bratislava, Kosice, Poprad, Sliac, Piestany and Zilina) are managed by the Slovak Management of Airports, except of the airport in Zilina, where exercises with light aircrafts of the Zilina University predominate. Other smaller civil airports (Nitra, Prievidza, Ruzomberok, Lucenec) are operated by aero-clubs with predominating character of sport flights. Emissions estimation was calculated based on data directly provided by the individual airports based on detailed statistics on LTO cycles, aircrafts type, their weights and type of engines. Described approach is maintained for a time series from 1990 to 2004. For time series 2005-2015 were used EUROCONTROL data on the number of flights, fuel consumption and division of domestic and international flights. The emissions of NO_x, SO_x, PMs and CO were taken from EUROCONTROL file for LTO and Cruise and reported in Domestic and International Aviation (Table 1). The emissions of NMVOC were calculated using the EUROCONTROl data on partial pollutants falling under this category (1,3-butadien; acetaldehyde; acrolein; etc.). For the years 1990-2004, we did not receive better and more accurate data and that is why we did not recalculate these years. The fuel consumption decreased compared to the base year 1990 by 2% and the decrease of emissions can be seen in Table X2. The total consumption of jet kerosene was 48.20 TJ and the consumption of aviation gasoline was 2.11 TJ allocated in domestic aviation in 2015. Since 2005, domestic aviation emissions are decreasing. This decrease and the whole category is influenced by the fact, that the Slovak Republic has no official national airlines since the Slovak Airlines are out of business since 2007, SkyEurope since 2009 and close distance of other big international airports in Vienna and Budapest.

Table 11: *Overview of emissions from domestic and international aviation (1990 – 2015)*

YEAR	EMISSIONS – DOMESTIC AVIATION							
	kt						t	
	NO_x	NMVOC	SO_x	NH_3	TSP	CO	heavy metals	POPs
1990	0.332	0.001	0.077	NE	0.002	0.104	NE	NE
1991	0.308	0.001	0.071	NE	0.002	0.096	NE	NE
1992	0.284	0.001	0.066	NE	0.002	0.089	NE	NE
1993	0.262	0.001	0.061	NE	0.002	0.082	NE	NE
1994	0.238	0.001	0.055	NE	0.002	0.074	NE	NE
1995	0.221	0.001	0.051	NE	0.002	0.069	NE	NE
1996	0.242	0.001	0.056	NE	0.002	0.076	NE	NE
1997	0.215	0.001	0.049	NE	0.002	0.068	NE	NE
1998	0.191	0.001	0.044	NE	0.001	0.060	NE	NE
1999	0.203	0.001	0.047	NE	0.001	0.064	NE	NE
2000	0.251	0.001	0.059	NE	0.002	0.078	NE	NE
2001	0.260	0.001	0.061	NE	0.002	0.081	NE	NE
2002	0.280	0.001	0.066	NE	0.002	0.087	NE	NE
2003	0.278	0.001	0.064	NE	0.002	0.087	NE	NE
2004	0.220	0.001	0.048	NE	0.002	0.071	NE	NE
2005	0.029	0.000	0.002	NE	0.014	0.048	NE	NE
2006	0.043	0.000	0.003	NE	0.015	0.062	NE	NE
2007	0.058	0.000	0.003	NE	0.014	0.071	NE	NE
2008	0.074	0.000	0.004	NE	0.019	0.069	NE	NE
2009	0.058	0.000	0.003	NE	0.012	0.060	NE	NE
2010	0.019	0.000	0.001	NE	0.010	0.068	NE	NE
2011	0.015	0.000	0.001	NE	0.010	0.066	NE	NE
2012	0.014	0.000	0.001	NE	0.008	0.075	NE	NE
2013	0.012	0.000	0.001	NE	0.008	0.059	NE	NE
2014	0.012	0.000	0.001	NE	0.008	0.049	NE	NE
2015	0.013	0.000	0.001	NE	0.001	0.069	NE	NE
2005 - 2015	-54.90%	34.33%	-53.03%	NE	-92.27%	44.16%	NE	NE
1990 - 2015	-96.10%	-78.72%	-98.73%	NE	-54.46%	-33.68%	NE	NE

YEAR	EMISSIONS - INTERNATIONAL AVIATION							
	kt						t	
	NO_x	NMVOC	SO_x	NH_3	TSP	CO	heavy metals	POPs
1990	0.729	0.003	0.193	NE	0.008	0.274	NE	NE
1991	0.677	0.003	0.179	NE	0.008	0.254	NE	NE
1992	0.625	0.003	0.165	NE	0.007	0.235	NE	NE
1993	0.574	0.003	0.152	NE	0.007	0.219	NE	NE
1994	0.523	0.002	0.138	NE	0.006	0.196	NE	NE
1995	0.484	0.002	0.128	NE	0.006	0.185	NE	NE
1996	0.528	0.002	0.141	NE	0.006	0.205	NE	NE
1997	0.469	0.002	0.125	NE	0.006	0.182	NE	NE
1998	0.416	0.002	0.111	NE	0.005	0.163	NE	NE
1999	0.443	0.002	0.118	NE	0.005	0.171	NE	NE
2000	0.554	0.003	0.146	NE	0.006	0.205	NE	NE
2001	0.576	0.003	0.151	NE	0.006	0.209	NE	NE
2002	0.622	0.003	0.162	NE	0.007	0.225	NE	NE
2003	0.609	0.003	0.162	NE	0.007	0.233	NE	NE
2004	0.458	0.002	0.127	NE	0.007	0.205	NE	NE
2005	0.499	0.003	0.037	NE	0.014	0.267	NE	NE
2006	0.631	0.003	0.044	NE	0.015	0.311	NE	NE
2007	0.705	0.003	0.046	NE	0.014	0.276	NE	NE
2008	0.812	0.003	0.052	NE	0.019	0.293	NE	NE
2009	0.585	0.003	0.038	NE	0.012	0.247	NE	NE

YEAR	EMISSIONS - INTERNATIONAL AVIATION							
	kt						t	
	NO_x	NMVOC	SO_x	NH_3	TSP	CO	heavy metals	POPs
2010	0.566	0.003	0.035	NE	0.010	0.221	NE	NE
2011	0.572	0.003	0.036	NE	0.010	0.215	NE	NE
2012	0.517	0.003	0.032	NE	0.008	0.208	NE	NE
2013	0.483	0.003	0.030	NE	0.008	0.202	NE	NE
2014	0.516	0.003	0.032	NE	0.008	0.191	NE	NE
2015	0.628	0.003	0.038	NE	0.011	0.239	NE	NE
2005 - 2015	25.71%	23.94%	3.77%	NE	-22.34%	-10.52%	NE	NE
1990 - 2015	-13.90%	-6.15%	-80.05%	NE	31.19%	-12.71%	NE	NE

Road Transportation (CRF 1.A.3.b) - Short distance passenger transport is an important part of road transport. It is the most exploited type of transport in the Slovak Republic due to a high density of roads, the quality of road network and interconnection of all municipalities. In recent 12 years, road transport has expanded significantly in the transport of goods and persons. In 2015, the transport network included 463 km of highways, 264 km of motorways and 3 302 km of the category 1st class roads. Total roads network represented 18 019 km of roads in the Slovak Republic in 2015. Road transportation is the most important and key category within transport with the highest share of emissions and continually increasing trend in fuel consumption. There is a huge increase in emission of ammonia compared to base year - 1618.2 % (Table 17). This is caused by the expand of road transport and rising EF for ammonia.

Table 12: *Overview of emissions in road transport in years 1990 – 2015*

YEAR	EMISSIONS - ROAD TRANSPORT							
	kt						t	
	NO_x	NMVOC	SO_x	NH_3	TSP	CO	heavy metals	POPs
1990	36.181	35.536	2.424	0.029	3.785	160.586	26.554	0.107
1991	30.161	33.041	1.972	0.026	3.129	149.049	23.034	0.088
1992	27.366	31.797	1.757	0.027	2.764	148.811	21.953	0.081
1993	26.916	33.834	1.679	0.039	2.598	159.145	22.509	0.079
1994	28.327	35.037	1.798	0.067	2.735	164.286	24.044	0.085
1995	29.277	34.127	1.925	0.110	2.873	162.336	25.139	0.091
1996	28.497	31.688	1.955	0.164	2.819	152.014	25.146	0.093
1997	28.158	30.050	2.006	0.244	2.798	152.016	26.013	0.097
1998	28.384	29.531	2.119	0.329	2.880	153.097	26.958	0.101
1999	26.611	25.980	0.754	0.525	2.685	142.415	25.981	0.097
2000	22.831	21.424	0.670	0.467	2.200	113.171	18.409	0.081
2001	20.526	22.387	0.675	0.578	2.036	127.348	13.776	0.089
2002	22.726	20.327	0.730	0.500	2.212	123.273	13.738	0.096
2003	23.444	17.894	0.150	0.586	2.225	106.268	14.041	0.098
2004	27.454	16.280	0.159	0.528	2.375	101.161	14.580	0.105
2005	32.383	14.935	0.189	0.488	2.849	89.077	17.466	0.129
2006	31.532	13.207	0.177	0.530	3.074	77.516	16.289	0.121
2007	36.629	11.042	0.204	0.478	3.074	59.244	17.985	0.143
2008	35.960	10.929	0.194	0.593	2.791	65.068	19.085	0.145
2009	31.226	9.094	0.194	0.591	2.470	59.568	17.116	0.134
2010	33.753	8.759	0.042	0.550	2.741	53.217	18.950	0.155
2011	29.406	7.931	0.041	0.541	2.579	46.722	17.993	0.152
2012	29.624	7.646	0.526	0.526	2.733	44.871	18.895	0.167
2013	30.017	7.317	0.040	0.555	2.665	42.930	18.185	0.161
2014	33.954	6.415	0.042	0.431	2.673	36.483	18.170	0.162
2015	27.658	7.366	0.043	0.501	3.107	35.783	14.936	0.162

YEAR	EMISSIONS - ROAD TRANSPORT							
	kt						t	
	NO_x	NMVOC	SO_x	NH_3	TSP	CO	heavy metals	POPs
2005 - 2015	-14.59%	-50.68%	-77.46%	2.67%	9.07%	-59.83%	-14.49%	25.57%
1990 - 2015	-23.56%	-79.27%	-98.24%	1618.2%	-17.90%	-77.72%	-43.75%	52.04%

The major share of emissions belongs to heavy duty vehicles and passenger cars (Table 18). Most of the heavy metals comes from tyre and brake wear abrasion.

Table 13: *Overview of total emissions according to the type of vehicles in 2015*

VEHICLE CATEGORY	NO_x	NMVOC	SO_x	NH_3	TSP	CO	heavy metals	POPs
	kt						t	
Passenger cars	8.95	3.95	0.02	0.45	0.53	25.62	2.22	0.07
Light duty vehicles	2.29	0.35	0.00	0.03	0.16	3.27	0.40	0.02
Heavy duty vehicles and buses	25.35	1.34	0.02	0.02	0.64	6.07	1.61	0.08
Mopeds & motorcycles	0.01	0.26	0.00	0.00	0.01	0.83	0.01	0.00
Gasoline evaporation	NA	1.47	NA	NA	NA	NA	NA	NA
Automobile tyre and brake wear abrasion	NA	NA	NA	NA	0.94	NA	10.70	NA
Automobile road abrasion	NA	NA	NA	NA	0.84	NA	NE	NE

Railways (1.A.3.c) - Railways is the second most important source of emissions in transport, despite the decreasing character of this transport mode. Railways and rail transport are modernized with the support of the EU funds. Improved quality and ecology of rail transport and the increase in passengers' number are the results of this modernization. Modernization of rail infrastructure results in an increase of operational speed to 160 km/h and increase of safety. According to the Annual Report of Slovak Railways in 2015[18], the length of managed railways was 3 626 km of which the length of electric railways was 1 587 km. Total emissions from railways transport decreased by 13.40 % in last 10 years and by 75.00% compared to base year (Table 19). The decrease of fuels consumption was caused by the improvements of technical parameters (new locomotives and wagons and electrification of railways).

Table 14: *Overview of emissions in railways in years 1990 – 2015*

YEAR	EMISSIONS							
	kt						t	
	NO_x	NMVOC	SO_x	NH_3	TSP	CO	heavy metals	POPs
1990	6.193	0.550	0.002	0.001	0.180	1.265	0.336	1.191
1991	4.658	0.413	0.002	0.001	0.135	0.951	0.252	0.896
1992	3.843	0.341	0.001	0.001	0.111	0.785	0.208	0.739
1993	3.300	0.293	0.001	0.000	0.096	0.674	0.179	0.635
1994	3.115	0.276	0.001	0.000	0.090	0.636	0.169	0.599
1995	3.354	0.298	0.001	0.000	0.097	0.685	0.182	0.645
1996	3.292	0.292	0.001	0.000	0.095	0.672	0.178	0.633
1997	3.093	0.274	0.001	0.000	0.090	0.632	0.168	0.595
1998	2.837	0.252	0.001	0.000	0.082	0.579	0.154	0.546
1999	2.597	0.230	0.001	0.000	0.075	0.530	0.141	0.500
2000	2.560	0.227	0.001	0.000	0.074	0.523	0.139	0.492
2001	2.525	0.224	0.001	0.000	0.073	0.516	0.137	0.486
2002	2.345	0.208	0.001	0.000	0.068	0.479	0.127	0.451
2003	1.876	0.166	0.001	0.000	0.054	0.383	0.102	0.361

[18] Annual Report of Slovak Railway 2015, p.11, http://www.zsr.sk/buxus/docs/vyrSpravy/VyrocnaSprava2015.pdf

YEAR	EMISSIONS							
	kt						t	
	NO_x	NMVOC	SO_x	NH_3	TSP	CO	heavy metals	POPs
2004	1.799	0.160	0.001	0.000	0.052	0.367	0.098	0.346
2005	1.752	0.155	0.001	0.000	0.051	0.358	0.095	0.337
2006	1.861	0.165	0.001	0.000	0.054	0.380	0.101	0.358
2007	1.786	0.159	0.001	0.000	0.052	0.365	0.097	0.344
2008	1.640	0.145	0.001	0.000	0.048	0.335	0.089	0.315
2009	1.412	0.125	0.001	0.000	0.041	0.288	0.077	0.272
2010	1.443	0.128	0.001	0.000	0.042	0.295	0.078	0.278
2011	1.393	0.124	0.001	0.000	0.040	0.284	0.075	0.268
2012	1.179	0.105	0.000	0.000	0.034	0.241	0.064	0.227
2013	1.451	0.129	0.001	0.000	0.042	0.296	0.079	0.279
2014	1.379	0.122	0.001	0.000	0.040	0.282	0.075	0.265
2015	1.517	0.135	0.001	0.000	0.044	0.310	0.082	0.292
2005 - 2015	-13.40%	-13.40%	-13.40%	-13.40%	-13.40%	-13.40%	-13.40%	-13.40%
1990 - 2015	-75.50%	-75.50%	-75.50%	-75.50%	-75.50%	-75.50%	-75.50%	-75.50%

National navigation (1.A.3.d.ii) and International inland waterways (1.A.3.d.ii (ii)) - The major share of emissions from inland shipping in Slovakia are realized as transit on Danube River. Due to lack of data are these two categories reported together as national emissions. Based on the information from the State Navigation Administration (the SNA), there are movements realized between the Gabcikovo and Komarno ports on the Slovak territory (national transport). Due to the international character of shipping transportation on the Danube River, the ships do not stop their operation on the Slovak territory, but the transit continues to Austria or Hungary. The experts from the Slovak Shipping and Ports Company confirmed that before 2005, negligible number of movements was between the Slovak ports registered. Inland shipping transportation on small lakes for tourist purposes was also estimated and added to the total emissions in this category.

Decreasing trends of emission of air pollutants were recognized compared to the previous years and compared to the base year (Table 20), despite of increase of touristic activities in Slovakia. The emissions for the years 2000 and 2005 were estimated to be negligible, because of increasing prices of diesel oil in the Slovak Republic and decreasing prices of fuels in the neighbouring countries (market discrepancies).

Table 15: *Overview of emissions in navigation (national and international) in years 1990 – 2015*

YEAR	EMISSIONS							
	kt						t	
	NO_x	NMVOC	SO_x	NH_3	TSP	CO	heavy metals	POPs
1990	1.626	0.055	0.410	0.000	0.127	0.152	0.730	0.002
1991	1.428	0.049	0.360	0.000	0.112	0.133	0.641	0.001
1992	1.349	0.046	0.340	0.000	0.105	0.126	0.605	0.001
1993	1.111	0.038	0.280	0.000	0.087	0.104	0.498	0.001
1994	1.062	0.036	0.268	0.000	0.083	0.099	0.477	0.001
1995	1.433	0.049	0.361	0.000	0.112	0.134	0.643	0.001
1996	1.221	0.042	0.308	0.000	0.095	0.114	0.548	0.001
1997	0.728	0.025	0.183	0.000	0.057	0.068	0.326	0.001
1998	1.017	0.035	0.256	0.000	0.079	0.095	0.456	0.001
1999	0.215	0.007	0.054	0.000	0.017	0.020	0.096	0.000
2000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.664	0.023	0.167	0.000	0.052	0.062	0.298	0.001
2002	0.717	0.024	0.181	0.000	0.056	0.067	0.321	0.001

YEAR	EMISSIONS							
	kt						t	
	NO_x	NMVOC	SO_x	NH_3	TSP	CO	heavy metals	POPs
2003	0.543	0.018	0.137	0.000	0.042	0.051	0.244	0.001
2004	0.212	0.007	0.053	0.000	0.017	0.020	0.095	0.000
2005	0.018	0.001	0.004	0.000	0.001	0.002	0.008	0.000
2006	0.760	0.026	0.192	0.000	0.059	0.071	0.341	0.001
2007	0.812	0.028	0.205	0.000	0.064	0.076	0.364	0.001
2008	0.867	0.030	0.219	0.000	0.068	0.081	0.389	0.001
2009	0.795	0.027	0.200	0.000	0.062	0.074	0.357	0.001
2010	0.837	0.028	0.211	0.000	0.065	0.078	0.376	0.001
2011	0.743	0.025	0.187	0.000	0.058	0.069	0.333	0.001
2012	0.259	0.009	0.065	0.000	0.020	0.024	0.116	0.000
2013	0.408	0.014	0.103	0.000	0.032	0.038	0.183	0.000
2014	0.474	0.016	0.120	0.000	0.037	0.044	0.213	0.000
2015	0.714	0.024	0.180	0.000	0.056	0.067	0.320	0.001
2006 - 2015	-6%	-6%	-6%	-6%	-6%	-6%	-6%	-6%
1990 - 2015	-56%	-56%	-56%	-56%	-56%	-56%	-56%	-56%

Pipeline Transport (1.A.3.e.i) - There is a significant decrease of fuel consumption in recent years and this trend is related to decrease of natural gas transit through the Slovak Republic. The fuel emissions are shown in the Table 21.

Table 16: *Overview of emissions from pipeline transport in years 1990 – 2015*

YEAR	EMISSIONS				
	NO_x	NMVOC	SO_x	TSP	CO
	kt				
1990	4.444	0.696	0.003	0.000	0.454
1991	3.893	0.610	0.003	0.000	0.397
1992	3.329	0.521	0.002	0.000	0.340
1993	2.757	0.432	0.002	0.000	0.281
1994	1.664	0.261	0.001	0.000	0.170
1995	2.881	0.451	0.002	0.000	0.294
1996	3.323	0.520	0.002	0.000	0.339
1997	3.119	0.488	0.002	0.000	0.318
1998	3.170	0.496	0.002	0.000	0.324
1999	3.092	0.484	0.002	0.000	0.316
2000	3.562	0.558	0.003	0.000	0.364
2001	3.000	0.505	0.001	0.000	0.343
2002	3.459	0.428	0.001	0.000	0.404
2003	3.327	0.382	0.001	0.000	0.347
2004	4.696	0.187	0.001	0.000	0.385
2005	3.974	0.238	0.001	0.000	0.365
2006	2.746	0.150	0.001	0.000	0.223
2007	2.918	0.075	0.000	0.000	0.257
2008	3.513	0.098	0.000	0.000	0.290
2009	2.585	0.225	0.000	0.000	0.180
2010	2.350	0.200	0.004	0.000	0.194
2011	2.494	0.211	0.017	0.000	0.171
2012	0.689	0.132	0.000	0.000	0.082
2013	0.658	0.149	0.000	0.000	0.066
2014	0.186	0.260	0.000	0.000	0.063
2015	0.227	0.233	0.000	0.000	0.049
2005 - 2015	-94%	-2%	-98%	86%	-87%
1990 - 2015	-95%	-66%	-99%	-55%	-89%

2.4.2 Methodological issues

Domestic aviation (1.A.3.a.i) and international aviation (1.A.3.a.ii) - Aviation is not a key category. The airport traffic in Slovakia is determined only by the origin of airlines. It means, that there is no direct information about the number of domestic and international flights in statistics. Tier 1 methodology for emission estimation in aviation, both for aviation gasoline and jet kerosene was used for time series 1990 – 2004. Tier 1 methodology is based on fuel sold on the airports. For this period, only total number of LTO cycles is known, therefore average disaggregation of activities between national and international aviation was revised. The share for national and international aviation activities for the period 1990 – 2004 was improved based on the real number used for time series 2005 – 2015. The share is constant value. Real share of national and international activities for the period 2005 – 2015 was taken from the EUROCONTROL database directly. More data and revision is provided in the Table 22.

Table 17: *The share of fuel consumption in domestic and international aviation for the period 1990 – 2015*

FUELS	DOMESTIC AVIATION	INTERNATIONAL AVIATION
	1990 – 2004	
Aviation gasoline	30 %	70 %
Jet kerosene	5 %	95 %

The implied emission factors for jet kerosene applied in this submissions for the years 1990 – 2004 were calculated as average EFs from available EUROCONTROL data for 2005 – 2015. These average emission factors (Table 23) for all pollutants were used for the years 1990 – 2004 in current submissions in national and international aviation. Emission factors applied for aviation gasoline, for the period 1990 – 2004, were from EMEP/EEA air pollutant emission inventory guidebook 2016.

Activity data for the years 1990 – 1993 are not available and were estimated as expert judgment according to real LTO cycles in this period. For the period 1994 – 2004, activity data were directly provided by the airports on annual basis.

From the year 2005 onwards, Slovakia decided to use the EUROCONTROL data. The decision was made based on analysis of the national data and data obtained from the EUROCONTROL. Results showed that EUROCONTROL data are more consistent and accurate in line with the QA/QC rules. These results were thereafter approved by the Ministry of Transport of the Slovak Republic. EUROCONTROL data used tier 3 methodology applying the Advanced Emissions Model (AEM). Following data were taken from the EUROCONTROL data published in 2016 into national inventory:

- fuel consumption of aviation gasoline for domestic flights;
- fuel consumption of aviation gasoline for international flights;
- fuel consumption of jet kerosene for domestic flights;
- fuel consumption of jet kerosene for international flights;
- pollutant emissions for all subcategories.

Table 18: *Average emission factors for the pollutants in civil aviation according to EUROCNTROL*

FUEL TYPE		EMISSION FACTORS					
		NO_x	NMVOC	SO_x	TSP	CO	BC
		kg/t					
Aviation gasoline	national	4.00	19.00	1.00	0.03	1200.00	0.48
	international	4.00	19.00	1.00	0.03	1200.00	0.48
Jet kerosene	national	14.38	0.08	0.84	0.08	6.26	0.48
	international	13.66	0.04	0.84	0.16	3.08	0.48

Road Transportation (1.A.3.b) - COPERT IV model (version 9.0) was used for estimation of emissions in road transportation for the years 1990 – 2014 and for the year 2015 COPERT V model was used. The version V of the model distinguishes vehicle categories and emission factors reflecting the recent development and research. Due to capacity reasons and lack of input data, the years 1990 – 2014 were not recalculated yet. This is planned for the next year submission. Calculation in model COPERT IV/V is based on EMEP/EEA Guidebook methodology. The methodology is often referred to the name of program (methodology "COPERT"). This methodology is balancing fifteen different emissions including greenhouse gases from road transport. Preparation of basic pollutants inventory is based on sequence calculation for each vehicle category and summing. Emission factors are set by model and they are different for all types of fuel, different vehicle categories and different technological level. Statistically recorded fuel consumption and fuel consumption calculated through COPERT methodology shall be equal or the difference shall not be more than 2%. The COPERT V defined new vehicle categories for the calculation of pollutants, with the disaggregation into 6 base categories and 275 subcategories. Further disaggregation was applied according to the operation of road vehicles in the agglomeration, road and highway traffic mode. In COPERT V, buses were divided into 8 sub-districts and 2 subgroups (urban and coaches). Heavy duty vehicles are divided into 2 basic groups (rigid and articulated). Rigid vehicles are further divided by weight into 8 subgroups and articulated into 6 subgroups. COPERT IV and COPERT V model versions have almost the same methodology, which is described below. This methodology used technical parameters of different vehicle types and country characteristics, such as the composition of car fleet, the age of the cars, the parameters of operation and fuels or climate conditions.

Methodology recognizes several country specific parameters:

- Structure of vehicle fleet
- Vehicle age
- Predominant type of character traffic
- Parameters of fuels
- Climate conditions

Emission calculation is based on following types of input data:

- Total fuel consumption
- Vehicle fleet
- Driving conditions
- Emission factors
- Additional parameters

Exhaust emissions from road transport are divided on two types:

- so-called "cold emissions", which are additional emissions with start of cold motor
- so-called "hot emissions", which produce motor of vehicle warmed on operating temperature

Based on these input parameters the emissions can be estimated. Information about the vehicle fleet is based on database operated by the Police Presidium of the Slovak Republic. The SHMU has access to the database and can download the necessary information directly from the IS EVO (Information System for Vehicle Evidence) website http://www.minv.sk/?statisticke-prehlady-agendy-vozidiel.

The EFs values for air pollutants in COPERT are defined separately for the different types of fuels, types of vehicles and the different technological level of vehicles. The emission factors for pollutants such as SO_x, NO_x, NH_3, PM and partially also CH_4 can be obtained by the simple formula of driving mode and consumed fuel. Emission factors are then calculated automatically by the model based on the input parameters such as the average speed, the quality of fuels, the age of vehicles, the weight of vehicles and the volume of cylinders.

Accurate and actual data on distance-based values and parameter values are necessary to run the COPERT model (Table 24). Particularly kilometres (km) travelled are not available in Slovakia and therefore these AD are estimated according to the recommendations provided within the framework of the COPERT model, including consistency with fuel consumption. Main source of activity data such as intensity on urban, rural and highways is the Traffic Census of Slovakia, conducted every five years (2000, 2005, 2010 and 2015[19]).

Table 19: *Overview of input data used in COPERT V model in 2015*

Category of road vehicles	Activity data		
	Number of vehicles	Average of fuel consumption (l/100 km)	Average mileage (km/veh)
Passenger cars	**2 034 381**	**7.28**	**8 328.94**
gasoline < 1.4 l	742 699	7.21	6 049.49
gasoline 1.4-2.0 l	337 003	8.36	5 695.16
gasoline > 2.0 l	73 416	10.13	10 469.52
diesel < 2.0 l	686 049	6.19	10 497.52
diesel > 2.0 l	151 135	7.98	12 908.28
LPG	43 989	10.00	13 882.42
CNG, E85, Hybrid	0	10.90	3 650.00
two stroke engine	90	10.79	0.00
Light duty vehicles	**185 781**	**21.13**	**13 615.18**
gasoline < 3.5 t	46 228	9.36	12 526.84
diesel < 3.5 t	139 553	25.03	13 975.70
Heavy duty vehicles	**150 313**	**23.39**	**30 870.32**
diesel <= 7.5 t	66 211	19.05	26 884.14
diesel 7.5-12 t	9 516	20.54	26 100.06
diesel 12-14 t	5 008	23.72	26 949.48
diesel 14-20 t	17 061	26.28	30 347.16
diesel 20-26 t	11 293	27.90	39 560.45
diesel 26-28 t	3 764	32.02	37 708.53
diesel 28-32 t	5 646	30.65	46 951.88
diesel > 32 t	1 882	21.80	46 290.59
diesel 14-20 t	15 564	26.71	26 296.08
diesel 20-28 t	7 483	27.65	39 037.38
diesel 28-34 t	3 592	30.82	39 260.75
diesel 34-40 t	3 293	32.93	53 381.68
Buses	**8 865**	**21.73**	**46 657.00**
City buses CNG	243	21.95	79 698.45
City buses Midi <=15 t	862	29.40	36 892.20
City buses Stand. 15-18 t	3 017	37.83	44 831.73
City buses >18 t	1 294	26.46	44 571.22
Long Line buses	3 449	3.93	49 148.75
Motorcycles	**87 201**	**4.57**	**1 461.99**

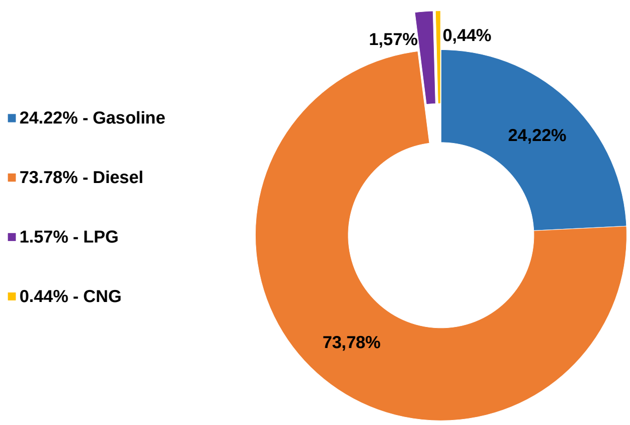
[19] Data were published in 2016 but not used in the 2017 submission, http://www.ssc.sk/sk/cinnosti/rozvoj-cestnej-siete/dopravne-inzinierstvo.ssc

Category of road vehicles	Activity data		
	Number of vehicles	Average of fuel consumption (l/100 km)	Average mileage (km/veh)
< 50 cm3 (mopeds)	27 756	3.74	974.61
Two stroke engine > 50 cm3	43 194	3.63	1 294.34
Four stroke engine < 250 cm3	6 219	4.21	2 301.34
Four stroke engine 250-750 cm3	4 798	5.49	2 924.35
Four stroke engine > 750 cm3	5 234	16.27	3 092.19
Total road transportation	**2 466 540**		**9 995.78**

Input parameters for CNG buses are known only since 2000. Before the year 2000, CNG consumption in transport was negligible. The consumption of CNG as fuel can neither be used for a diesel engine nor for a gasoline engine without modifications. The CNG buses have completely different combustion and after-treatment technology despite using the same fuel as passenger cars for CNG. Hence, their emissions performance may vary significantly. Therefore, CNG buses also need to fulfil a specific emissions standard (Euro II, Euro III, etc.). Due to the low NO_x and PM performance compared to diesel oil, an additional emissions standard has been set for CNG vehicles, known as the standard for Enhanced Environmental Vehicles (EEV). The emission limits imposed for EEV are even below Euro V and usually EEVs are benefited from taxation waivers and free entrance to low emission zones. New stoichiometry buses are able to fulfil the EEV requirements, while older buses were usually registered as Euro II, Euro III, Euro IV or Euro V.

Important information about the import, production, distribution and sale of gasoline and diesel oil were received from domestic producer Slovnaft Ltd. Bratislava refinery, from the Customs Directory of the Slovak Republic and the Statistical Office of the Slovak Republic. The bottom-up data from the distribution stations in the Slovak Republic are known also from the NEIS database. Data about LPG and CNG distribution and sale were obtained from exclusive dealers and the Slovak Gas Industry, Ltd. All documents are in Slovak language and they are official and available for the national inventory experts. According to the statistical information, the diesel oil represents 73.8% share on fuel balance, followed by gasoline with 24.2% share, then LPG (1.6%) and CNG (0.4%) (Figure 35).

Figure 24: *Fuels balance in road transportation in 2015*



Railways (1.A.3.c) – Railways transport represents the operation of diesel traction using the simple methodology tier 1 according to the EMEP/EEA emission inventory guidebook 2016. The emissions of the pollutants are calculated from the consumed fuels by diesel rail traction multiplied by the appropriate emission factor. The consumption of diesel oil for the motor traction in the Slovak Republic was obtained from the Railways Company, Ltd. (ZSSK) for the all years in time series. It is assumed that the consumption of diesel oil in motor traction of railways transportation is equal to the diesel oil sold for the railways. The mobile sources of pollution in the railways transport include vehicles of motor traction of ZSSK. This motor traction is divided into 2 basic groups of vehicles: motor locomotives (Traction 70) and motor wagons (Traction 80). The motor traction has been operated by 4 depots in the organizational structure of ZSSK since 2002 (Bratislava, Zvolen, Zilina and Kosice). Table 36 shows activity data and statistical information used for inventory preparation. Fuel consumption of the new company operated on the Slovak rails (REGIOJET) is also included in the inventory.

Figure 25: *Overview of activity data used in the inventory for railways transport in 2015*

DEPOTS	Košice	Žilina	Zvolen	Bratislava	Total public	Total CARGO	REGIO JET
Number of loco	168	92	144	105	280	242	13
km per year (x1 000)	5 202.1	2 846.8	7 310.8	3 224.9	15 202.5	4 775.4	1 393.3
Operations (hrkm)x1 000	611 191	278 838	1 377 711	368 596	1 566 596	1 193 352	123 612
Consumption (m3) (blended)	10 886.7	4 067.5	12 850.3	5 480.2	22 155.7	12 496.8	1 367.7
Consumption (t) (blended)	9 097	3 399	10 738	4 579	18 513	10 442	1 143

National navigation (1.A.3.d.ii) - This subcategory includes all emissions from national and international shipping between ports on Danube River on Slovak territory and domestic shipping on lakes and dams for touristic purposes.

Shipping between Slovak ports on Danube River: The Slovak Shipping and Ports Company is providing detailed information on diesel oil consumption on the Danube River. This activity represents movements of ships between Slovak ports (Bratislava, Devin and Komarno).

Shipping on lakes: The State Navigation Administration was officially requested to check availability of information about the shipping activity in the Slovak Republic except the Danube River movements. The expert was informed that they register total number of ships and boats operated except the Danube River, but without information about their activity or fuel consumption. Based on expert research, three other relevant shipping routes, except the shipping routes on Danube river, occur in Slovakia, however in limited extent. The three shipping routes are:

- River – basin of the Vah (Pieštany, Trenčín, Liptovská Mara dam);
- The tributary River of the Váh (Oravská priehrada dam);
- River – basin of the Bodrog (Zemplínska Šírava dam).

While the public and tourist shipping activities in the Slovak Republic are not very frequent and have expanded only in the recent years (due increase of tourisms), it was necessary to propose an appropriate methodological approach for emissions estimation. Chosen activity data were:

- The number of trips per year:

The number of trips per year is limited by the daily schedule of trips mostly in summer months (May-October).

- The duration of trips (in hours):

The duration can differ according to the type of trips (mostly short or long tours).

- The technical parameters of the most populated ships:

The technical parameters of vessels can be found on the webpage. The engines are mostly with 100 kilowatts power, which is a common type of engine used in non-road mechanisms, or in agricultural machinery (type Zetor). The engines run on diesel oil.

- The average consumption of diesel oil in litres per hour:

The average consumption based on technical description of the engines is 12 litres of diesel oil per hour of work. The consumption of diesel oil in tons was calculated using average density of diesel oil (0.84 kg/dm3).

The emissions are calculated from the consumed fuel by diesel motor boats multiplied by emission factor. The emission factors are taken from the EMEP/EEA emission inventory guidebook 2016 and the emissions were recalculated for all-time series. Activity data for domestic navigation are shown in Tables 25 and 26.

Table 20: *Overview of fuel consumption of navigation in 1990 – 2015*

Year	Consumption (t)	
	Danube	lakes
1990	20500	7.136349
1991	18000	6.096276
1992	17000	5.686538
1993	14000	5.794692
1994	13387	6.154253
1995	18066	6.513813
1996	15390	6.966058
1997	9167	7.270891
1998	12813	7.590284
1999	20 500.00	7.14
2000	18 000.00	6.10
2001	17 000.00	5.69
2002	14 000.00	5.79
2003	13 387.00	6.15
2004	18 066.00	6.51
2005	15 390.00	6.97
2006	9 167.00	7.27
2007	12 813.00	7.59
2008	2 701.00	7.59
2009	0.00	7.70
2010	8 366.00	7.96
2011	9 027.20	8.34
2012	6 836.00	8.73
2013	2 660.97	9.18
2014	214.00	9.78
2015	9 569.00	10.61

Table 21*: The emission estimation in national shipping for touristic purposes (CRF 1.A.3.d) in 2015*

	Location							Total SR
Activity Data	Piešťany long trip	Piešťany short trip	Trenčín	Liptovská Mara	Oravská priehrada short trip	Oravská priehrada long trip	Zemplín-ska Šírava	
Number of Trips (per year)	237	0	36	120	353	90	150	985
Duration of Trip (hours)	1	0	0.35	1	0.5	1.5	0.75	

Activity Data	Location							Total SR
	Piešťany long trip	Piešťany short trip	Trenčín	Liptovská Mara	Oravská priehrada short trip	Oravská priehrada long trip	Zemplínska Šírava	
Total Duration (hours/year)	237	0	13	120	176	135	113	793
Fuel Consumption (l/hour)	12	0	12	12	12	12	12	
Total Consumption (l/year)	2 840	0	151	1 440	2 115	1 620	1 350	9 516
Total Consumption (kg/year)	2 373	0	126	1 203	1 767	1 354	1 128	7 952
Total Consumption (TJ/year)	0.100	0.000	0.005	0.051	0.074	0.057	0.048	0.335

Pipeline Transport (1.A.3.e.i) - The activity data on consumption of natural gas used for energy to drive turbines were obtained from the NEIS database. Tier 2 methodology and the country specific emission factor was used for emissions estimation in pipeline transport category.

2.4.3 Category-specific QA/QC and verification process

The emissions inventory in transport categories were prepared by the sectoral experts with the cooperation of the Transport Research Institute in Zilina. Formal bilateral agreement was set up in 2013 and will continue in the future.

2.4.4 Category-specific recalculations

Recalculations were made in sectors:

1. navigation (1.A.3.d),
2. pipeline transport (1.A.3.e).

Recalculations in the Navigation sector (1.A.3.d) were made due to double counting of international emissions of air pollutants (emissions reported also by Austria and Hungry) and new EFs for some pollutants (e.g. SO_x and heavy metals).

Table 22: *Recalculation of air pollutants in sector Navigation for years 2001 – 2014*

YEAR	kt											
	NO_x			NMVOC			SO_x			NH_3		
	2016	2017	%	2016	2017	%	2016	2017	%	2016	2017	%
2001	2.098	0.664	-68%	0.191	0.023	-88%	0.150	0.167	12%	0.000	0.000	-80%
2002	2.197	0.717	-67%	0.197	0.024	-88%	0.027	0.181	569%	0.000	0.000	-79%
2003	2.194	0.543	-75%	0.197	0.018	-91%	0.027	0.137	407%	0.000	0.000	-84%
2004	2.456	0.212	-91%	0.221	0.007	-97%	0.030	0.053	77%	0.000	0.000	-95%
2005	2.703	0.018	-99%	0.243	0.001	-100%	0.033	0.004	-87%	0.000	0.000	-100%
2006	2.266	0.760	-66%	0.204	0.026	-87%	0.028	0.192	584%	0.000	0.000	-78%
2007	2.570	0.812	-68%	0.231	0.028	-88%	0.031	0.205	561%	0.000	0.000	-80%
2008	2.351	0.867	-63%	0.211	0.030	-86%	0.028	0.219	681%	0.000	0.000	-76%
2009	2.231	0.795	-64%	0.200	0.027	-87%	0.027	0.200	631%	0.000	0.000	-77%
2010	3.383	0.837	-75%	0.304	0.028	-91%	0.042	0.211	408%	0.000	0.000	-84%
2011	2.711	0.743	-73%	0.244	0.025	-90%	0.005	0.187	3839%	0.000	0.000	-82%
2012	2.834	0.259	-91%	0.255	0.009	-97%	0.005	0.065	1213%	0.000	0.000	-94%
2013	2.578	0.408	-84%	0.229	0.014	-94%	0.005	0.103	1991%	0.000	0.000	-90%
2014	2.689	0.474	-82%	0.239	0.016	-93%	0.005	0.120	2231%	0.000	0.000	-88%

YEAR	kt						t					
	TSP			CO			heavy metals			POPs		
	2016	2017	%	2016	2017	%	2016	2017	%	2016	2017	%
2001	0.191	0.052	-73%	0.450	0.062	-86%	0.114	0.298	161%	0.388	0.001	-100%

2002	0.167	0.056	-66%	0.463	0.067	-86%	0.110	0.321	191%	0.399	0.001	-100%
2003	0.167	0.042	-75%	0.462	0.051	-89%	0.109	0.244	123%	0.398	0.001	-100%
2004	0.187	0.017	-91%	0.517	0.020	-96%	0.122	0.095	-22%	0.446	0.000	-100%
2005	0.205	0.001	-99%	0.569	0.002	-100%	0.139	0.008	-94%	0.491	0.000	-100%
2006	0.172	0.059	-65%	0.477	0.071	-85%	0.117	0.341	191%	0.411	0.001	-100%
2007	1.952	0.064	-97%	0.541	0.076	-86%	0.128	0.364	186%	0.467	0.001	-100%
2008	0.178	0.068	-62%	0.495	0.081	-84%	0.117	0.389	233%	0.427	0.001	-100%
2009	0.170	0.062	-63%	0.470	0.074	-84%	0.111	0.357	221%	0.405	0.001	-100%
2010	0.257	0.065	-75%	0.712	0.078	-89%	0.169	0.376	123%	0.614	0.001	-100%
2011	0.206	0.058	-72%	0.509	0.069	-86%	0.135	0.333	147%	0.492	0.001	-100%
2012	0.215	0.020	-91%	0.597	0.024	-96%	0.141	0.116	-18%	0.515	0.000	-100%
2013	0.006	0.032	405%	0.526	0.038	-93%	0.140	0.183	31%	0.509	0.000	-100%
2014	0.078	0.037	-52%	0.549	0.044	-92%	0.146	0.213	46%	0.531	0.000	-100%

Recalculation in the pipeline transport was necessary due change in activity data.

Table 23: *Recalculation of air pollutants in sector pipeline for years 2001 – 2014*

YEAR	kt								
	NO_X			NMVOC			SO_x		
	2016	2017	%	2016	2017	%	2016	2017	%
2001	3.00	3.00	0.00%	0.20	0.50	156.92%	0.00	0.00	0.00%
2002	3.46	3.46	0.00%	0.19	0.43	126.04%	0.00	0.00	0.00%
2003	3.33	3.33	0.00%	0.20	0.38	92.99%	0.00	0.00	0.00%
2004	4.70	4.70	0.00%	0.19	0.19	0.00%	0.00	0.00	0.00%
2005	3.97	3.97	0.00%	0.24	0.24	0.00%	0.00	0.00	0.00%
2006	2.75	2.75	0.00%	0.15	0.15	0.00%	0.00	0.00	0.00%
2007	2.92	2.92	0.00%	0.07	0.07	0.00%	0.00	0.00	0.00%
2008	3.51	3.51	0.00%	0.10	0.10	0.00%	0.00	0.00	0.00%
2009	2.59	2.59	0.00%	0.23	0.23	0.00%	0.00	0.00	0.00%
2010	2.35	2.35	0.00%	0.20	0.20	0.00%	0.00	0.00	0.00%
2011	2.49	2.49	0.00%	0.21	0.21	0.00%	0.02	0.02	0.00%
2012	0.69	0.69	0.00%	0.13	0.13	0.00%	0.00	0.00	0.00%
2013	0.66	0.66	0.00%	0.15	0.15	0.00%	0.00	0.00	0.00%
2014	0.19	0.19	0.00%	0.26	0.26	0.00%	0.00	0.00	0.00%
2015	0.23	0.23	0.00%	0.23	0.23	0.00%	0.00	0.00	0.00%

YEAR	kt					
	TSP			CO		
	2016	2017	%	2016	2017	%
2001	0.00	0.00	172.86%	0.34	0.34	0.00%
2002	0.00	0.00	140.06%	0.40	0.40	0.00%
2003	0.00	0.00	104.96%	0.35	0.35	0.00%
2004	0.00	0.00	173.88%	0.38	0.38	0.00%
2005	0.00	0.00	0.00%	0.37	0.37	0.00%
2006	0.00	0.00	0.00%	0.22	0.22	0.00%
2007	0.00	0.00	0.00%	0.26	0.26	0.00%
2008	0.00	0.00	0.00%	0.29	0.29	0.00%
2009	0.00	0.00	0.00%	0.18	0.18	0.00%
2010	0.00	0.00	0.00%	0.19	0.19	0.00%
2011	0.00	0.00	0.00%	0.17	0.17	0.00%
2012	0.00	0.00	0.00%	0.08	0.08	0.00%
2013	0.00	0.00	0.00%	0.07	0.07	0.00%
2014	0.00	0.00	0.00%	0.06	0.06	0.00%
2015	0.00	0.00	0.00%	0.05	0.05	0.00%

2.1.2 Category-specific improvements and implementation

Transport general (1.A.3) – Revision of notation keys.

Domestic aviation (1.A.3.a) – No specific improvements are planned for the next submission.

Road transportation (1.A.3.b) – consecutive recalculation of the time-series for all emissions with COPERT V model is planned for the IIR 2018.

Railways (1.A.3.c) – the information on fuel consumption in the international public transport corridors will be verified in the future submissions.

Domestic navigation (1.A.3.d) – Information about inland tourists shipping in the Slovak Republic can be collected in more details and update of activity data about transport on small lakes and Rivers is planned. New methodology emission estimation for international inland waterways will be introduced in the future submissions.

Pipeline transport (1.A.3.e.i) – No specific improvements are planned for the next submission.

2.2 POPs in Energy sector

Emission inventory of POPs in energy sector is estimated based on producers' activity and emissions factors. In cases where abatement was applied, EF had lower value. Activity data, which are represented by the amount of product produced, are acquired from facility operators. Amount of fuel used for residential sector 1A4bi is obtained from fuel sellers, fuel for other sectors (1A1a, 1A1c, 1A1gviii, 1A4ai and 1A4ci) are obtained from database NEIS.

In Energy sector arise the biggest share of POPs emissions. The key category of the PCDD/F emissions is 1A2a stationary combustion in Iron and steel production. Especially combustion in process of iron ore agglomeration has higher effect. Residential heating (1A4bi) has the biggest impact on all PAHs emissions. Copper production in category 1A2b is most important for HCB emissions. Iron ore agglomeration and residential heating have also high impact on PCB emissions.

The overview of all emission factors used with the process of compilation of emission inventory in energy sector are shown on the following Tables:

Table 24*: Emission factors for calculation of PAH emissions in Energy sector*

NFR	Sector	Activity data (amount of...)	Emission factor	Unit	Ref.
1A1a	**Public electricity and heat production**				
	Brown coal	burned fuel	0.025	mg/t	[1]
	Hard coal	burned fuel	0.025	mg/t	[1]
	Fuel Oil	burned fuel	36.53	mg/t	[1]
	Wood	burned fuel	38.265	mg/t	[1]
	Municipal waste	incinerated waste	38.87	mg/t	[1]
1A1c	**Coke production**	produced product	1 100	mg/t	[1]
1A2a	**Ore agglomeration**	produced agglomerate	11.67	mg/t	[1]
	Iron production	produced product	17	mg/t	[1]
	Cast iron production	produced product	0.316	mg/t	[1]
1A2b	**Secondary aluminium production**	produced product	3.264	mg/t	[1]
1A2gviii	**Thermal processes in industry**				
	Brown coal	burned fuel	0.025	mg/t	[1]
	Hard coal	burned fuel	0.025	mg/t	[1]
	Fuel Oil	burned fuel	36.53	mg/t	[1]
	Wood	burned fuel	38.265	mg/t	[1]
1A4ai	**Commercial / Institutional**				
	Brown coal	burned fuel	0.025	mg/t	[1]
	Hard coal	burned fuel	0.025	mg/t	[1]
	Fuel Oil	burned fuel	36.53	mg/t	[1]
	Wood	burned fuel	38.265	mg/t	[1]
1A4bi	**Residential plants**				
	Brown coal	burned fuel	3 630	mg/t	[1]
	Hard coal	burned fuel	6 150	mg/t	[1]
	Wood	burned fuel	8 580	mg/t	[1]
1A4ci	**Agriculture**				
	Brown coal	burned fuel	0.025	mg/t	[1]
	Hard coal	burned fuel	0.025	mg/t	[1]
	Fuel Oil	burned fuel	36.53	mg/t	[1]
	Wood	burned fuel	38.265	mg/t	[1]

[1] K. Magulova: Methodical inventory of persistent organic pollutants, November 2003.

Table 25: *Emission factors for calculation of PCDD-F emissions in energy sector*

NFR	Sector	Activity data (amount of...)	Emission factor	Unit	Ref.
1A1a	**Public electricity and heat production**				
	Brown coal	burned fuel	0.001	mg I-TEQ/t	[1]
	Hard coal	burned fuel	0.0002	mg I-TEQ/t	[1]
	Fuel Oil	burned fuel	0.0001	mg I-TEQ/t	[1]
	Wood	burned fuel	0.001	mg I-TEQ/t	[1]
	Natural gas	burned fuel	0.00002	mg I-TEQ/t	[1]
	Municipal waste good APC	incinerated waste	0.06	mg I-TEQ/t	[4]
	Municipal waste very good APC	incinerated waste	0.0004	mg I-TEQ/t	[4]
1A1c	**Coke production**	produced product	0.003	mg I-TEQ/t	[1]
1A2a	**Ore agglomeration (1990-2001)**	produced agglomerate	0.013	mg I-TEQ/t	[5]
	Ore agglomeration (2002)	produced agglomerate	0.01	mg I-TEQ/t	[1]
	Iron ore agglomeration (2003 - now)	produced agglomerate	0.007	mg I-TEQ/t	[5]
	Production of pellets (1990-2008)	produced product	0.000057	mg I-TEQ/t	[2]
	Iron production	produced product	0.0001	mg I-TEQ/t	[1]
	Cast iron production	produced product	0.002	mg I-TEQ/t	[1]
1A2b	**Secondary aluminium production**	produced product	0.1	mg I-TEQ/t	[3]
	Secondary copper production	produced product	0.05	mg I-TEQ/t	[1]
1A2f	**Glass production**	produced product	0.00002	mg I-TEQ/t	[1]
	Cement production	produced product	0.00015	mg I-TEQ/t	[1]
	Lime production	produced product	0.00007	mg I-TEQ/t	[1]
1A2gviii	**Thermal processes in industry**				
	Brown coal	burned fuel	0.001	mg I-TEQ/t	[1]
	Hard coal	burned fuel	0.0002	mg I-TEQ/t	[1]
	Fuel Oil	burned fuel	0.0001	mg I-TEQ/t	[1]
	Wood	burned fuel	0.001	mg I-TEQ/t	[1]
	Natural gas	burned fuel	0.00002	mg I-TEQ/t	[1]
	Black liquor	burned fuel	0.00007	mg I-TEQ/t	[3]
1A4ai	**Commercial / Institutional**				
	Brown coal	burned fuel	0.001	mg I-TEQ/t	[1]
	Hard coal	burned fuel	0.0002	mg I-TEQ/t	[1]
	Fuel Oil	burned fuel	0.0001	mg I-TEQ/t	[1]
	Wood	burned fuel	0.001	mg I-TEQ/t	[1]
	Natural gas	burned fuel	0.00002	mg I-TEQ/ ths.m^3	[1]
1A4bi	**Residential plants**				
	Brown coal	burned fuel	0.005	mg I-TEQ/t	[1]
	Hard coal	burned fuel	0.004	mg I-TEQ/t	[1]
	Wood	burned fuel	0.001	mg I-TEQ/t	[3]
	Natural gas	burned fuel	0.00005	mg I-TEQ/t	[3]
1A4ci	**Agriculture**				
	Brown coal	burned fuel	0.001	mg I-TEQ/t	[1]
	Hard coal	burned fuel	0.0002	mg I-TEQ/t	[1]
	Fuel Oil	burned fuel	0.0001	mg I-TEQ/t	[1]
	Wood	burned fuel	0.001	mg I-TEQ/t	[1]
	Natural gas	burned fuel	0.00002	mg I-TEQ/t	[1]

[1] K. Magulova: Methodical inventory of persistent organic pollutants, November 2003.
[2] Best Available Techniques Reference Document on the Production of Iron and Steel, December, 2001.
[3] Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, UNEP Chemicals, February 2005.
[4] Emission inventory of POPs into the air (Notes to recalculation), Bratislava, 2005.

Table 26: *Emission factors for calculation of HCB emissions in energy sector*

NFR	Sector	Activity data (amount of...)	Emission factor	Unit	Ref.
1A1a	**Public electricity and heat production**				
	Brown coal	burned fuel	0.048	mg/t	[1]
	Hard coal	burned fuel	0.074	mg/t	[1]
	Fuel Oil	burned fuel	0.128	mg/t	[1]
	Wood	burned fuel	0.043	mg/t	[1]
	Municipal waste	incinerated waste	3	mg/t	[1]
1A2a	**Ore agglomeration**	produced agglomerate	0.032	mg/t	[2]
1A2b	**Secondary copper production**	produced product	39	mg/t	[3]
1A2f	**Cement production**	produced product	0.011	mg/t	[1]
	Lime production	produced product	0.01	mg/t	[1]
1A2gviii	**Thermal processes in industry**				
	Brown coal	burned fuel	0.048	mg/t	[1]
	Hard coal	burned fuel	0.074	mg/t	[1]
	Fuel Oil	burned fuel	0.128	mg/t	[1]
	Wood	burned fuel	0.043	mg/t	[1]
1A4ai	**Commercial / Institutional**				
	Brown coal	burned fuel	0.048	mg/t	[1]
	Hard coal	burned fuel	0.074	mg/t	[1]
	Fuel Oil	burned fuel	0.128	mg/t	[1]
	Wood	burned fuel	0.043	mg/t	[1]
1A4bi	**Residential plants**				
	Brown coal	burned fuel	0.088	mg/t	[1]
	Hard coal	burned fuel	0.088	mg/t	[1]
	Wood	burned fuel	0.088	mg/t	[1]
1A4ci	**Agriculture**				
	Brown coal	burned fuel	0.048	mg/t	[1]
	Hard coal	burned fuel	0.074	mg/t	[1]
	Fuel Oil	burned fuel	0.128	mg/t	[1]
	Wood	burned fuel	0.043	mg/t	[1]

[1] K. Magulova: Methodical inventory of persistent organic pollutants, November 2003.

[2] EMEP/CORINAIR Atmospheric Emission Inventory Guidebook.

[3] J. Zurek, M. Sadowski: Persistent Organic Pollutants, Volume I. National Profile - Poland, 2001.

__Table 27:__ Emission factors for calculation of PCB emissions in energy sector

NFR	Sector	Activity data (amount of...)	Emission factor	Unit	Ref.
1A1a	**Public electricity and heat production**				
	Brown coal	burned fuel	0.052	mg/t	[1]
	Hard coal	burned fuel	0.791	mg/t	[1]
	Fuel Oil	burned fuel	0.612	mg/t	[1]
	Wood	burned fuel	0.049	mg/t	[1]
	Municipal waste	incinerated waste	5.3	mg/t	[1]
1A2a	**Ore agglomeration (1990-2001)**	produced agglomerate	1.3	mg/t	[1]
	Ore agglomeration	produced agglomerate	1.1	mg/t	[1]
	Iron production	produced product	0.006	mg/t	[3]
	Cast iron production	produced product	0.383	mg/t	[1]
1A2b	**Secondary aluminium production**	produced product	16.652	mg/t	[1]
	Secondary copper production	produced product	2.6	mg/t	[2]
1A2f	**Cement production**	produced product	0.001	mg/t	[1]
	Lime production	produced product	0.025	mg/t	[1]
1A2gviii	**Thermal processes in industry**				
	Brown coal	burned fuel	0.052	mg/t	[1]
	Hard coal	burned fuel	0.791	mg/t	[1]
	Fuel Oil	burned fuel	0.612	mg/t	[1]
	Wood	burned fuel	0.049	mg/t	[1]
1A4ai	**Commercial / Institutional**				
	Brown coal	burned fuel	0.052	mg/t	[1]
	Hard coal	burned fuel	0.791	mg/t	[1]
	Fuel Oil	burned fuel	0.612	mg/t	[1]
	Wood	burned fuel	0.049	mg/t	[1]
1A4bi	**Residential plants**				
	Brown coal	burned fuel	10	mg/t	[1]
	Hard coal	burned fuel	30	mg/t	[1]
	Wood	burned fuel	3.6	mg/t	[1]
1A4ci	**Agriculture**				
	Brown coal	burned fuel	0.052	mg/t	[1]
	Hard coal	burned fuel	0.791	mg/t	[1]
	Fuel Oil	burned fuel	0.612	mg/t	[1]
	Wood	burned fuel	0.049	mg/t	[1]

[1] K. Magulova: Methodical inventory of persistent organic pollutants November 2003.

[2] J. Zurek, M. Sadowski: Persistent Organic Pollutants, Volume I. National Profile - Poland, 2001.

[3] Opportunities for Reduction of Dioxin Emissions from the Metallurgical sector in Poland Warsaw, 2005.

3 INDUSTRIAL PROCESSES AND PRODUCT USE (NFR 2)

Chapters in development, results will be available as soon as possible

3 Methodological issues

3.1.1.1 Activity data

3.1.1.2 Uncertainties

3.1.1.3 Completeness

3.1.1.4 Source specific QA/QC

3.1.2 Construction and demolition

3.1.2.1 Description

3.1.2.2 Methodological issues

3.1.2.3 Activity data

3.1.2.4 Uncertainties

3.1.2.5 Completeness

3.1.2.6 Source specific QA/QC

3.1.3 Storage, handling and transport of mineral products

3.1.3.1 Description

3.1.3.2 Methodological issues

3.1.3.3 Activity data

3.1.3.4 Uncertainties

3.1.3.5 Completeness

3.1.3.6 Source specific QA/QC

3.1.4 Other mineral products

3.1.4.1 Description

3.1.4.2 Methodological issues

3.1.4.3 Activity data

3.1.4.4 Uncertainties

3.1.4.5 Completeness

3.1.4.6 Source specific QA/QC

3.2 CHEMICAL INDUSTRY (NFR 2B)

3.2.1.1 Description

3.2.1.2 Methodological issues

3.2.1.3 Activity data

3.2.1.4 Uncertainties

3.2.1.5 Completeness

3.2.1.6 Source specific QA/QC

3.2.2 Ammonia production (2B1)

3.2.2.1 Description

3.2.2.2 Methodological issues

3.2.2.3 Activity data

3.2.2.4 Uncertainties

3.2.2.5 Completeness

3.2.2.6 Source specific QA/QC

3.2.3 Nitric acid production (2B2)

3.2.3.1 Description

3.2.3.2 Methodological issues

3.2.3.3 Activity data

3.2.3.4 Uncertainties

3.2.3.5 Completeness

3.2.3.6 Source specific QA/QC

3.2.4 Carbide production (2B5)

3.2.4.1 Description

3.2.4.2 Methodological issues

3.2.4.3 Activity data

3.2.4.4 Uncertainties

3.2.4.5 Completeness

3.2.4.6 Source specific QA/QC

3.2.5 Soda ash production (2B7)

3.2.5.1 Description

3.2.5.2 Methodological issues

3.2.5.3 Activity data

3.2.5.4 Uncertainties

3.2.5.5 Completeness

3.2.6 Chemical industry: Other (2B10a)

3.2.6.1 Description

3.2.6.2 Methodological issues

3.2.6.3 Activity data

3.2.6.4 Uncertainties

3.2.6.5 Completeness

3.2.6.6 Source specific QA/QC

3.2.7 Storage, handling and transport of chemical products (2B10b)

3.2.7.1 Description

3.2.7.2 Methodological issues

3.2.7.3 Activity data

3.2.7.4 Uncertainties

3.2.7.5 Completeness

3.2.7.6 Source specific QA/QC

3.3 METAL PRODUCTION (NFR 2C)

3.3.1 Iron and steel production (2C1)

3.3.1.1 Description

3.3.1.2 Methodological issues

3.3.1.3 Activity data

3.3.1.4 Uncertainties

3.3.1.5 Completeness

3.3.1.6 Source specific QA/QC

3.3.2 Ferroalloys production (2C2)

3.3.2.1 Description

3.3.2.2 Methodological issues

3.3.2.3 Activity data

3.3.2.4 Uncertainties

3.3.2.5 Completeness

3.3.2.6 Source specific QA/QC

3.3.3 Aluminium production (2C3)

3.3.3.1 Description

3.3.3.2 Methodological issues

3.3.3.3 Activity data

3.3.3.4 Uncertainties

3.3.3.5 Completeness

3.3.3.6 Source specific QA/QC

3.3.4 Magnesium production (2C4)

3.3.4.1 Description

3.3.4.2 Methodological issues

3.3.4.3 Activity data

3.3.4.4 Uncertainties

3.3.4.5 Completeness

3.3.4.6 Source specific QA/QC

3.3.5 Copper production (2C7a)

3.3.5.1 Description

3.3.5.2 Methodological issues

3.3.5.3 Activity data

3.3.5.4 Uncertainties

3.3.5.5 Completeness

3.3.5.6 Source specific QA/QC

3.3.6 Other metal production (2C7c)

3.3.6.1 Description

3.3.6.2 Methodological issues

3.3.6.3 Activity data

3.3.6.4 Uncertainties

3.3.6.5 Completeness

3.3.6.6 Source specific QA/QC

3.4 POPS IN INDUSTRY SECTOR

Emissions inventory of POPs in Industry sector are estimated based on producers activity and emissions factors. Activity data, which are represented by the amount of product produced, are acquired from facility operators.

Within process of improvement were emissions from some categories moved from Industry sector to Energy sector in correspondence with EMEP/EEA Air Pollution Emission Inventory Guidebook. It refers to Non-metallic minerals industry (2A1, 2A2, and 2A3), Soda ash production (2B7) and Copper production (2C7a). The key category of the PCDD/F emissions in industry is Iron and steel production (2C1), in PAHs it is primary aluminium production. There are no HCB emission in industry sector. The most significant impact on POPs emission in industry sector overall has PCB emissions from secondary lead production (2C5), which arise within the improvement of inventory. This is a new source in inventory of Slovak republic that caused important increase of PCB emissions overall.

The overview of emission factors used with the process of compilation of emission inventory in industry sector are shown on the following Tables.

***Table 28**: Emission factors for calculation of PCDD-F emissions in Industry sector*

NFR	Sector	Activity data (amount of...)	Emission factor	Unit	Ref.
2B10a	**PVC production**	produced product	0.0003	mg I-TEQ/t	[1]
2C1	**Iron and steel production**				
	Steel production from virgin iron	produced product	0.0002	mg I-TEQ/t	[1]
	Steel production from scrap	produced product	0.01	mg I-TEQ/t	[1]
2C2	**Production of ferroalloys**	produced product	0.003	mg I-TEQ/t	[1]
2C5	**Lead production**	produced product	8	mg I-TEQ/t	[2]

[1] K. Magulova: Methodical inventory of persistent organic pollutants, November 2003.

[2] EMEP/EEA Air Pollution Emission Inventory Guidebook 2013.

***Table 29:** Emission factors for calculation of PAH emissions in Industry sector*

NFR	Sector	Activity data (amount of...)	Emission factor	Unit	Ref.
2B10a	Carbonaceous materials production (1990)	produced product	285 000	mg/t	[1]
	Carbonaceous materials production	produced product	7 300	mg/t	[1]
2C1	Iron and steel production	produced product	17	mg/t	[1]
2C3	Aluminium production (1990)	produced product	141 360	mg/t	[1]
	Aluminium production	produced product	3 671	mg/t	[1]
	Production of anodes for aluminium production	produced product	7 300	mg/t	[1]

[1] K. Magulova: Methodical inventory of persistent organic pollutants, November 2003.

Table 30: Emission factors for calculation of PCB emissions in Industry sector

NFR	Sector	Activity data (amount of...)	Emission factor	Unit	Ref.
2C1	Steel production	produced product	0.383	mg/t	[1]

2C2	Production of ferroalloys	produced product	0.383	mg/t	[1]
2C5	Lead production	produced product	3.2	g/t	[2]

[1] K. Magulova: Methodical inventory of persistent organic pollutants, November 2003.

[2] EMEP/EEA Air Pollution Emission Inventory Guidebook 2013.

3.5 SOLVENTS (NFR 2.D)

3.5.1 GENERAL DESCRIPTION OF SOLVENTS 2.D

Concerning the air protection, the most important emissions rising up from the categories so-called SOLVENTS (2D3a, 2D3b, 2D3c, 2D3d, 2D3a, 2D3h, 2D3e, 2D3f, 2D3g, 2D3i, 2G) are non-methane volatile organic compounds (NMVOCs). They are part of many different substances, generally called solvents that are used in industry and human activities. The non-methane volatile organic compounds (NMVOCs) are known for their environmental and human health risk and damages that they can caused. NMVOCs indirect effects relate to photochemical ozone formation. Thus they are defined as precursors of ground-level ozone which have adverse effect on mankind and nature too.

The chemical definition of non-methane volatile compounds in the world vary. In European Union, the term VOC refers to a compounds having a vapour pressure greater than 0.074 mm Hg at 20 ° C. Environmental Protection Agency (US EPA) refers: "Vola*tile organic compounds, or VOCs are organic chemical compounds whose composition makes it possible for them to evaporate under normal indoor atmospheric conditions of temperature and pressure. This is the general definition of VOCs that is used in the scientific literature, and is consistent with the definition used for indoor air quality. Since the volatility of a compound is generally higher the lower its boiling point temperature, the volatility of organic compounds are sometimes defined and classified by their boiling points*"[20]. Substances CO, CO_2 and CH_4 are not involved.

The wide scale of substances includes NMVOCs: pure solvents (individual organic compounds) or many different mixtures used in industry, dry-cleaning agents, cleaning detergents, paints, paint thinners, glues, cosmetics and toiletries, variety of household products or car care products, fuels, hydraulic fluids and others. However, the fuels are not the objective of this chapter. Their versatility leads to more difficult tracking the fluxes and some categories are estimated, especially for domestic use.

The categories included under general label SOLVETNS are namely listed in *Table 31*:

Table 31: *Categories included in Solvents*

NFR code	Longname
2D3a	Domestic solvent use including fungicides
2D3b	Road paving with asphalt
2D3c	Asphalt roofing
2D3d	Coating applications
2D3e	Degreasing
2D3f	Dry cleaning
2D3g	Chemical products
2D3h	Printing
2D3i	Other solvent use
2G	Other product use

[20] https://www.epa.gov/indoor-air-quality-iaq/technical-overview-volatile-organic-compounds

3.5.2 TRENDS IN SOLVENTS 2.D

In the emission inventory of the Slovak Republic the share of solvents is generally in range from 38.67% to 53.27 % (*Table 32*) so the sector is considered as a key sector.

Table 32: *The overview of the SOLVENTS share in national total in the individual years*

Sector share in national total	SOLVENTS share in %	SOLVENTS ∑ in kt	NATIONAL TOTAL
1990	38,97%	65,02	166,830
1991	40,80%	64,37	157,756
1992	42,52%	63,73	149,861
1993	43,15%	63,08	146,200
1994	42,82%	61,82	144,365
1995	43,24%	61,17	141,481
1996	44,36%	61,17	137,902
1997	45,29%	60,53	133,660
1998	46,17%	59,89	129,736
1999	47,89%	59,24	123,715
2000	49,45%	58,41	118,127
2001	48,71%	56,37	115,713
2002	51,15%	59,30	115,949
2003	51,03%	56,82	111,332
2004	51,24%	58,82	114,800
2005	48,59%	50,95	104,869
2006	50,77%	56,09	110,483
2007	50,47%	50,92	100,906
2008	53,37%	54,98	103,023
2009	53,31%	50,66	95,034
2010	57,41%	57,26	99,744
2011	55,83%	56,36	100,951
2012	51,68%	47,47	91,866
2013	46,41%	39,82	85,797
2014	46,73%	38,03	81,393
2015	47,77%	42,66	89,298
Trend 1990/2015		-34,39%	
Trend 2013/2014		-4,49%	
Trend 2014/2015		12,16%	

The table shows the share as well as the values in kt for the solvents categories. Generally, solvents has decreased. Even though the inter-annual trend has increase by 12.15%, the overall decline from 1990 to 2015 is by 34.39%. The overall trend is not stable and vary throughout the reported year. The cause is the wide spectre of using the solvents in industry but no less in households. The industry is closely linked to the automotive industry and using of paints and the development reflects the productivity of the concerned industry. The statistical data is used without the smoothing correction, thus there can be more significant dumps or differences among the yearly values.

In the years 2004, 2005 and 2006 the prevalence of the automotive industry concerning with the construction of the new automotive plant brought about the upsurge the consumption of the paints and solvents. The sector noticed the increased of the emission. The values "jump" from the 54 kt in 2005 on 60 kt in 2006 within year and kept the next.

In 2007 entered into force the Council Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations. Bear in mind recent legislative changes, the operators had to adapt the installations to the legal requirements. The significant drop in emissions in 2009 was generally linked to the financial crises with the peak in 2009 when economic activity were considerably influenced. In years 2010 and 2011 is visible increased values, however, the sector has never returned to such high emission values also due to the environmental protection measures.

Figure 26 depict the contribution of categories to the sector. The major share of emissions origins from 2D3d – Coating application (60% in 2015), 2D3h Printing (16.67 % in 2015), 2D3e – Degreasing (10.86% in 2015),2D3a – Domestic solvents use (9.92% in 2015). The remarkable fall was noticed in category 2D3g – Chemical products in 2013 (from 9.569 kt in 2012 dropped to 0.666 kt in 2013) as well as in 2015 (0.682 kt; 13% in 2015). The significant change has been caused by reconstruction of the major contributing company in this field during 2014 when the installation was out of the service, while in the 2015 the small emission values was due to the realization of technological improvements. Another decrease has been noticed in the category 2D3c – Asphalt roofing when the value of 0.003 kt in 2014 dropped to the 0.00097 kt in 2015. 2D3a – Domestic solvents use including the fungicides is having the steady trend because the emission factor relates to the annual number of inhabitants and demographic development in SR is stable in long-term point of view.

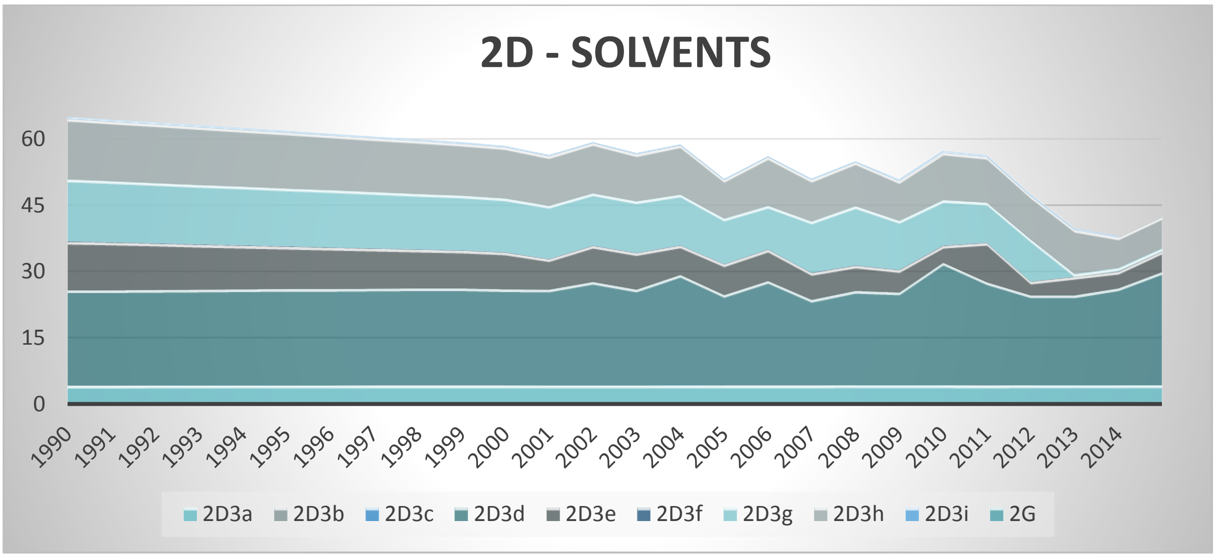


Figure 26: *Share of SOLVENTS categories in years 1990-2015*

Table 33*: The overview of activity data, method and Tier used for SOLVENTS categories*

NMVOC NFR	Tier	Activity Data	NEIS categories (Decree No 410/2012)	Method for 2016 reporting
2D3a	T1	ŠÚSR	-	Em $_{TOTAL}$ = inhabitants * Ef$_{(GB2016)}$
2D3b	T3	NEIS	NEIS: 3.5	Em $_{TOTAL}$ = 100% NEIS
2D3c	T3	NEIS	NEIS: 4.37	Em $_{TOTAL}$ = 100% NEIS
2D3d	T3+T2	ŠÚSR + NEIS	NEIS: 6.1 6.2 6.3 6.9	Em $_{TOTAL}$ = Small sources * Ef + Em$_{NEIS}$
2D3e	T3+T2	ŠÚSR + NEIS	NEIS: 6.4	Em $_{TOTAL}$ = Small sources * Ef + Em$_{NEIS}$
2D3f	T3	NEIS	NEIS: 6.5	Em $_{TOTAL}$ = 100% NEIS
2D3g	T3	NEIS	NEIS: 4.19 4.20 4.33 4.38	Em $_{TOTAL}$ = 100% NEIS
2D3h	T2	NEIS	NEIS: 6.7	Em $_{TOTAL}$ = Small sources * Ef + Em$_{NEIS}$
2D3i	T3+T2	ŠÚSR + NEIS	NEIS: 4.35 6.6 6.10 6.11	Em $_{TOTAL}$ = Small sources * Ef + Em$_{NEIS}$
2G	-	-	-	NA

3.5.3 Methodological issue - methods

The categories of SOLVENTS has undergone the general quality assurance and quality control. As a consequential results were findings and conclusions of underestimation, reassessment of activity data and possibilities to detach into individual categories. Thus entire group of solvents was revised and remade. Methodological changes in current annual reporting cycle 2016 has brought about the wider usage of NEIS database for NMVOCs. Sectoral approach applied in general for emission inventory of pollutants has induced detailed elaboration of individual NFR categories and quantification of explicit activities.

As a key aspect was an assessment of matching individual sources categorized according to the Decree No 410/2012 Coll. as amended, which are involved in the NEIS database. In line with general pattern, categorization was done into NFR 14. The overlap of sources defined pursuant to Decree No 410/2012 Coll. as amended with definition of NFR14 is in most cases suitable. If not sufficiently, each category is solved properly by involving missing activity data and compilations or explanation of problem and providing the solution. Accurate explanation of included activities are rendered under each chapter of individual categories.

The reason of insufficiency of emission data in NEIS it is caused by two main factors:

- Firstly, the registration definition of large, medium and small sources in the NEIS. Usually, small sources could not be covered precisely. The Annex No 6 of Decree No 410/2012 Coll. as amended by Regulation No 270/2014 determinate the specific limits for volume of production or volume of solvents consumption as an evidence limit for regular procedure of fulfil the input data and obligation of pollutions fees in accordance with Act No. 401/1998 on air pollution charges as amended.
- Secondly, the NEIS is covering the industrial sources. Thus several categories and sources concerned to domestic use are logically not occurring in the NEIS.

Therefore, the long-term activity data from Statistical Office for export, import and production for particular items was obtained. However, the first step required to arrange and revision of existing the Agreement on mutual cooperation in the field of statistics between the Ministry of Environment (Ministerstvo životného prostredia – MŽP SR)[21] and ŠÚ SR and create closer cooperation. The Agreement was amended and enlarged for historical timeline and new data. (More information available in chapter Structural changes in institutional cooperation and chapter 1.2). The availability of data in ŠÚ SR databases is not earlier than 2001. Activity data for each category are listed in ***Table 33*** together with description of methodology and the level of method used:

a/ Tier 1: Em_{TOTAL} = inhabitants * $Ef_{(GB2016)}$

b/ Tier 3: Em_{TOTAL} = 100% NEIS

- used in case when Decree No 410/2012 Coll. as amended defined limit 0 for obligation of solvents evidence and registering into the NEIS as a source of air pollution

c/ Tier 3 + Tier 2: Em_{TOTAL} = Em NEIS + Small sources * Ef

- used in case when Decree No 410/2012 Coll. as amended defined limit < 0 for obligation of solvents evidence and registering into the NEIS as a source of air pollution and small sources has to be balanced

3.5.4 Domestic solvent use including fungicides (NFR 2D3a)

Four main product use incorporate this category: cosmetics, household products, construction and car care products.

[21] Note: Slovak Hydrometeorological Institute is the allowance institution to the Ministry of Environment and thus the Contract is formally between Statistical Office of the Slovak Republic and the Ministry of Environment

The category is performed by the Tier 1 method due to the lack of detailed activity data from households. Thus the quotation a/ is used

Em $_{TOTAL}$ = inhabitants * Ef$_{(GB2016)}$

EF_{GB2013}	780	[g/person]

Emission factor (EF) used for calculation is based on the EMEP/EEA GB 2016. However, the EF in Guidebook *Table 3*-1 is 2 700 g/person. The lower values of *3.2.4 Emission factor for EU12 and 12 EECCA countries* was used with intention to avoid double counting because the data of paints and glues use are already balanced from statistical data in 2D3d and 2D3g.

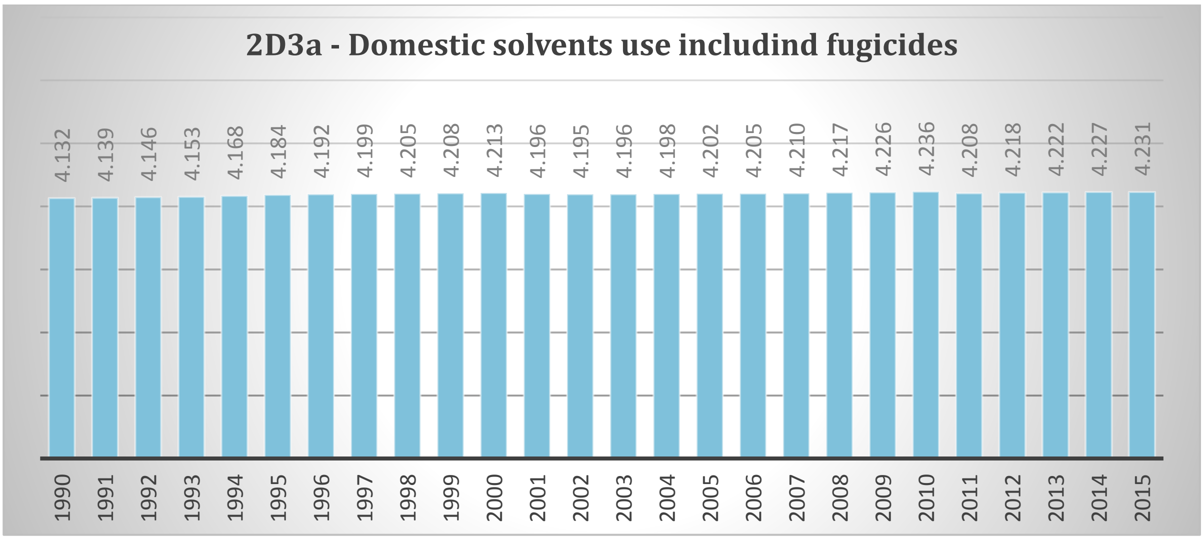


Figure 27: 2D3a: NMVOC emissions 1990 - 2015

3.5.5 Road paving with asphalt (NFR 2D3b)

The category source is NEIS database, sources assigned to the category 3.5 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as the Manufactures of bituminous mixtures with the design production capacity of the mixture in tonnes / hours. No small sources are on the territory of SR thus facility data from NEIS (b/ Tier 3: Em $_{TOTAL}$ = 100% NEIS) is used. Yearly numbers of operators vary around 50 installations. Average Emission factor is 201.03 g/Mg asphalt used. However, the emissions are taken from the NEIS. The category has decreasing overall trend with the upsurge in years 2005, 2006 due to the increase in asphalt production and road constructions.

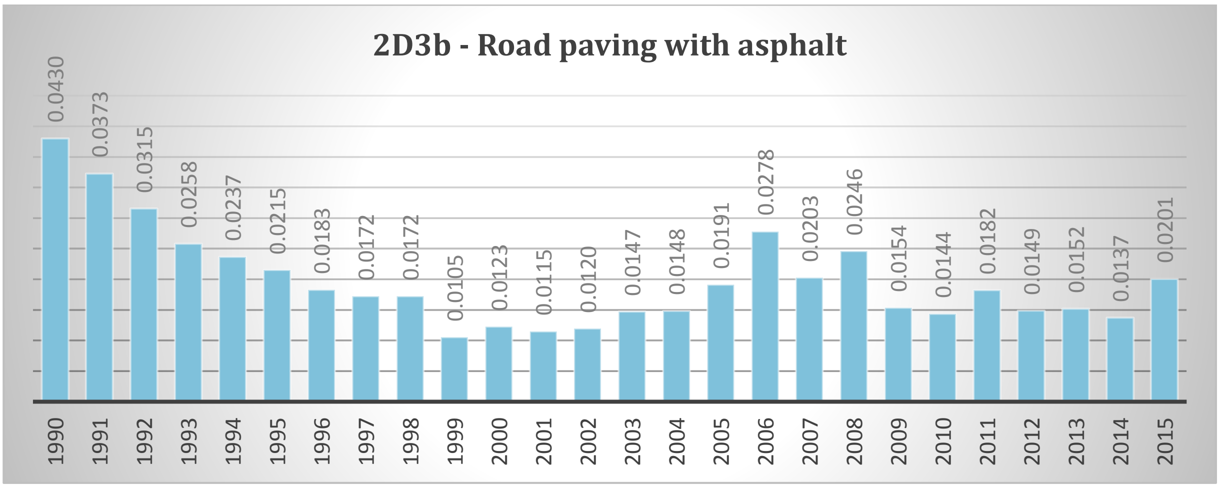


Figure 28: 2D3b: NMVOC emissions 1990 - 2015

3.5.6 Asphalt roofing (NFR 2D3c)

The category source is NEIS database, sources assigned to the category 4.37 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as production of waterproofing materials and floor coverings with a projected amount of raw materials processed in kg/h. No small sources are on the territory of SR thus only facility data from NEIS (b/ Tier 3: Em $_{TOTAL}$ = 100% NEIS) is used.

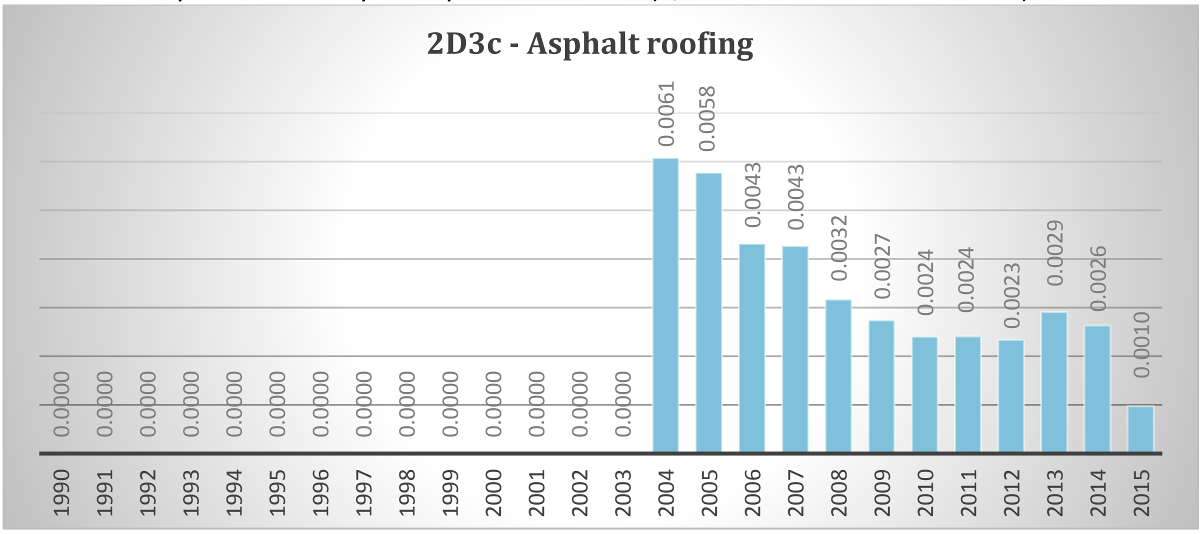


Figure 29: 2D3c: NMVOC emissions 1990 - 2015

3.5.7 Coating applications (NFR 2D3d)

The category source is NEIS database, sources assigned to the categories 6.1, 6.2, 6.3, 6.9 according to the Annex No 6 of Decree No 410/2012 Coll. as amended defined as

Table 34: *The NEIS categories included in 2D3d*

6.1	Paint shops in automotive industry with designed consumption of solvents
6.2	Surface coating of road vehicles with a total projected consumption of organic solvents in tonnes / year:
	a) in automotive manufacturing of small series
	b) surface coating of road vehicles in case not automatized on technological unit
	c) car repair – car paint shop (spray)
6.3	Coating application on surfaces, varnishing with a projected consumption of organic solvents in tonnes / year:
	a) surfaces of metals and plastic including the boats, airplanes surfaces, rail vehicles, textile, follies and paper
	b) the winding wire
	c) the winding wound strip of metallic materials
6.9	Industrial wood processing:
	a) mechanical processing of chopped wood with designed processing capacity in v m3/day
	b) mechanical processing of disintegrated wooden mass (e.g. sawdust, shavings, chips) with designed processing capacity in v m3/day
	c) production of agglomerated materials with designed consumption of poly condensation adhesives with designed consumption of poly condensation adhesives in tonnes of dry matter / year:
6.9	Processing and surface treatment using organic solvents including related activities, such as deburring, according to projected consumption of organic solvents in tonnes / year:
	d) adhesive coating
	e) wood and plastic lamination
	f) coating application
	g) impregnation

The category definition in SK legislation covers more activities concerning to the wood processing as defined in the NFR. Therefore, it is not possible to separate mechanical processing of wood from the category. Decree No 410/2012 Coll. as amended defined limit > 0 for obligation of solvents evidence and registering into the NEIS as a source of air pollution. Yearly numbers of operators vary around 450 that covers large and medium sources. Moreover, small sources has to be balanced. The balance of small sources is performed by top down approach. The statistical data is processed and total solvents consumption is calculated according to the studies on specific solvents content. Emissions taken from NEIS database are process by the system and abatement of environmental technology, recovery fluxes or separators are already taken into account in final emissions. For the small sources the assumption of no separator technology is used, thus the conversion of solvents used to the air is 100%.

Emission calculations: c/ Tier 3 + Tier 2:

$$Em_{TOTAL} = Em_{NEIS} + Small\ sources * Ef$$

Small sources calculation:

$$Production + Import - Export = Total\ Product\ Consumption$$
$$Total\ Product\ Consumption \rightarrow Total\ Solvents\ Consumption$$
$$Solvents\ Consumption - Industrial\ Solvents\ Consumption = Small\ Sources$$

The

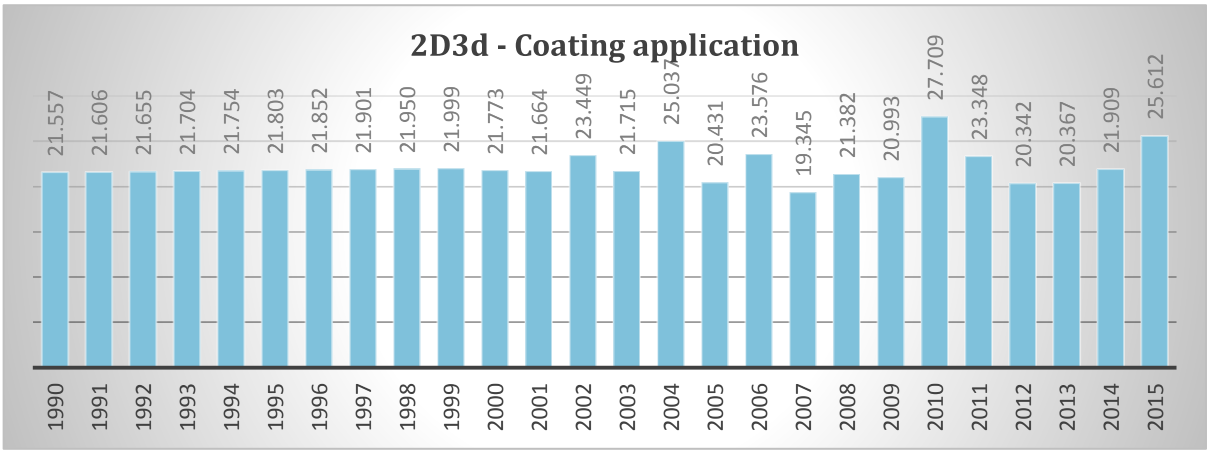


***Figure** 30* shows the emissions in time series from 1990. The activity data from the Statistical Office of the Slovak republic are not available for the historical years 1990 – 2000, missing years was estimated of combination extrapolation modelling and expert judgement, therefore the trend of emissions are stable. After 2002 the emission annually vary considerable, but general increasing trend can be seen from the figure 42. The reasons are wide use of solvents and paints in many different activities, but mainly the relations to the automotive industry.

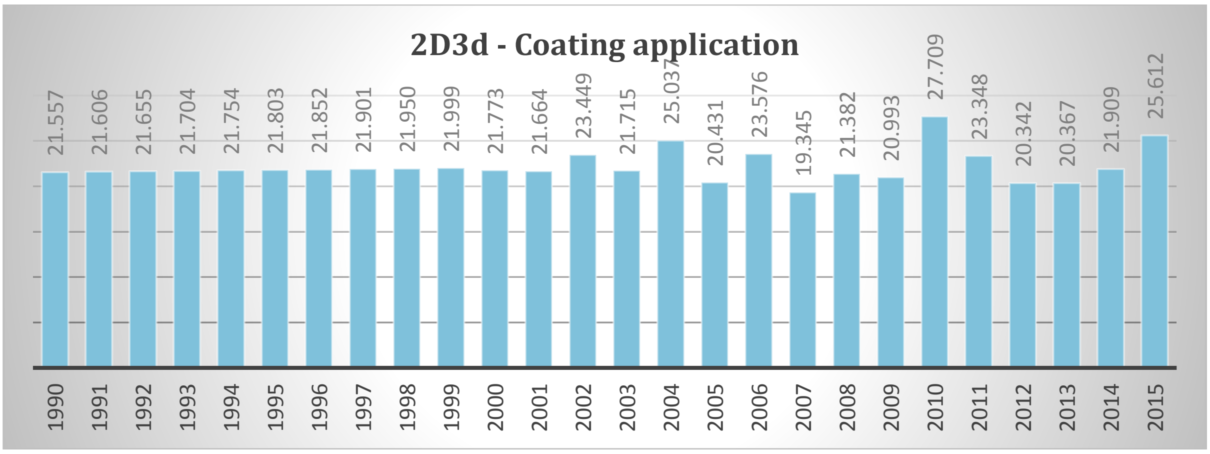


Figure 30: *2D3d: NMVOC emissions 1990 – 2015*

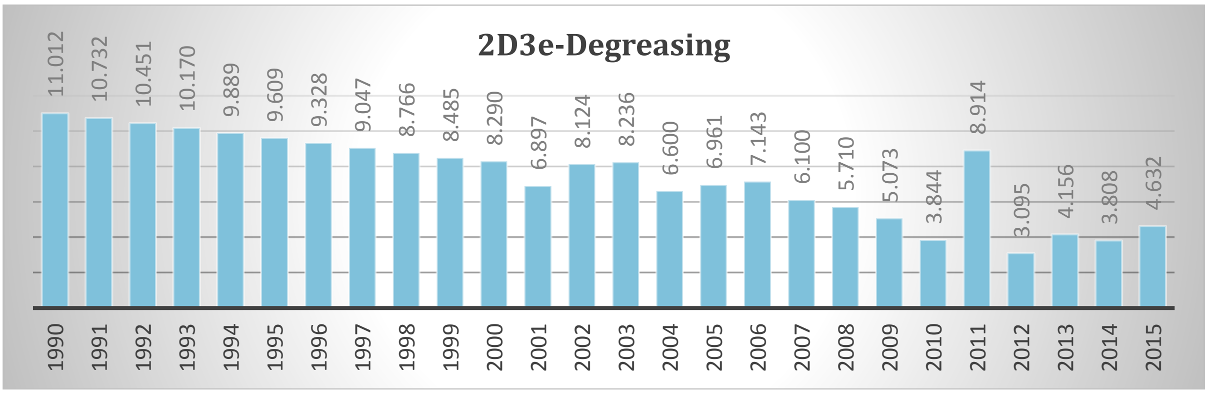


Figure 31: *2D3e: NMVOC emissions 1990 – 2015*

3.5.8 2D3e Degreasing

The category source is NEIS database, sources assigned to the category 6.4 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as Degreasing and cleaning of metal surfaces, electrical component, plastic and other materials, including paint stripping organic solvents with projected consumption in tonnes / year. Yearly numbers of operators has declined from 65 to 51 in recent years. Decree No 410/2012 Coll. as amended defined similarly the limit > 0 for obligation of solvents evidence and registering into the NEIS as a source of air pollution. So the calculation of small sources is balanced likewise in 2D3d. The balance of small sources is performed by top down approach. The statistical data is processed and total solvents consumption is calculated but without the step of calculating the VOC specific content because of the specific pure solvents are used for this purposes in SR. Emissions taken from NEIS database are process by the system and abatement of environmental technology, recovery fluxes or separators are already taken into account in final emissions. For the small sources the assumption of no separator technology is used, thus the conversion of solvents used to the air is 100%.

Emission calculations: c/ Tier 3 + Tier 2:

$$Em_{TOTAL} = Em_{NEIS} + Small\ sources * Ef$$

Small sources calculation:

$$Production + Import - Export = Total\ Product\ Consumption$$
$$Solvents\ Consumption - Industrial\ Solvents\ Consumption = Small\ Sources$$

On the ***Figure 43*** long-term decreasing in trend is seen, the value in 2011 relates to the statistical data (production/import/export balance), that are used without the smoothing correction, therefore is more significant jump in the yearly values. The increased value represents solvents (trichloroethylene, tetrachloroethylene, 1- propanol, 2- propanol, and acetone), but the change has been caused by high import of acetone according to data from Statistical Office.

3.5.9 2D3f Dry cleaning

The category source is NEIS database, sources assigned to the category 6.5 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as Dry cleaning of textiles, bleaching and dyeing of fabrics and other fibrous materials such as linen, cotton, jute by: a) projected consumption of organic solvents in tonnes / year, b) the projected amount of bleaching or dyeing fabrics or fibres in the tonnes / day. No small sources are on the territory of SR, because Decree defined limit = 0 for obligation of solvents evidence and registering into the NEIS as a source of air pollution. Thus facility data from NEIS (b/ Tier 3: Em $_{TOTAL}$ = 100% NEIS) is used. Yearly numbers of operators has declined from 127 to 109 in recent 10 years that is the first driver of decline. But no less the second driver which is rising difference between balances of solvents used in the operation and emission left to the air due to the environmental technological units according to the NEIS.

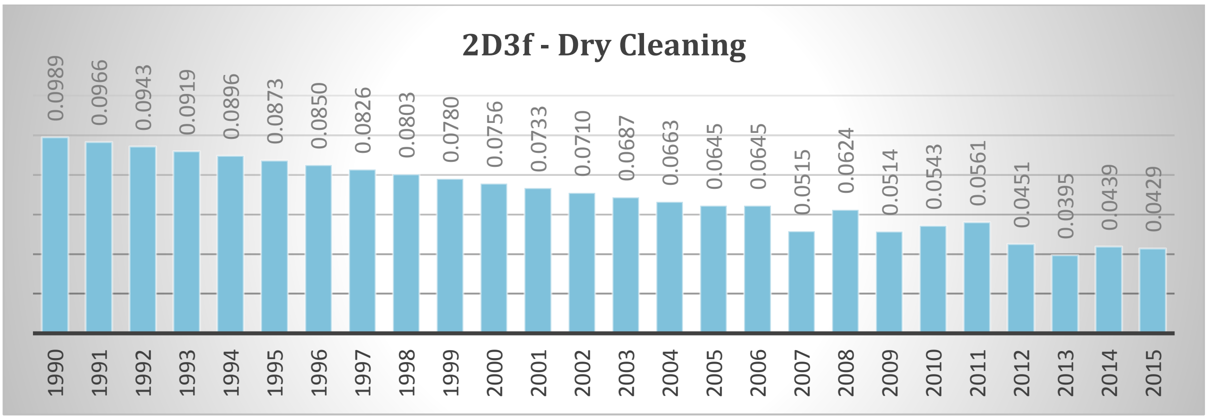


Figure 32: *2D3f: NMVOC emissions 1990-2015*

3.5.10 2D3g Chemical products (NFR 2D3g)

The category source is NEIS database, sources assigned to the categories 4.19, 4.20, 4.33, 4.38 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as in ***Table 35***.

The category covers also wide spectre of different activities.

Table 35*: The NEIS categories included in 2D3g*

4.19	Manufacture of paints, varnishes, inks, glues and adhesives with projected consumption of organic solvents in tonnes / year
4.20	Manufacture of pharmaceutical products with a projected consumption of organic solvents in tonnes / year
4.33	Manufacturing and processing of rubber - projected consumption of organic solvents in tonnes / year
	- Production of raw rubber compounds
	- Processing of the rubber composition designed in kg / h
4.38	Industrial Plastics Processing
	a) fibre production to design capacity in tonnes / year
	b) production of films and other products with a projected amount of processed polymer in kg / h
	c) the processing of polyester resins with the addition of styrene or epoxy resins with amines, such as production boats, trucks, car parts, with projected consumption of raw materials in kg / d
	d) the processing of amino and phenolic resins with projected consumption of raw materials in kg / d

	e) production of polyurethane products with projected consumption of organic solvents in tonnes / year
	f) manufacturing expanded plastic, such as polystyrene foam, with a projected consumption of organic blowing agents in t / year

The calculation under b/ Tier 3 – bottom-up approach is used due to the assumption of no small production in terms of activity type (manufacture of paints or of pharmaceutical products and others) even though the Decree set up no zero limits for registration as the pollution source.

$$EM_{TOTAL} = 100\%\ NEIS$$

The overall trend of decline is noticeable. The most remarkable decline was in 2013 (from 9.569 kt in 2012 dropped to 0.666 kt in 2013) as well as in 2015 (0.6817 kt; 13% in 2015). The significant change has been caused by reconstruction of the major contributing company, that is classified under 4.19 – Manufacture of paints, varnishes, inks, glues and adhesives during 2013 when the installation was out of the service, while in the 2015 the small emission values was due to the realization of technological improvements.

Due to the variety of activities in the categories, the other emission are also reported under 2D3g (NO_X, SO_X, NH_3, $PM_{2.5}$, PM_{10}, TSP, CO)

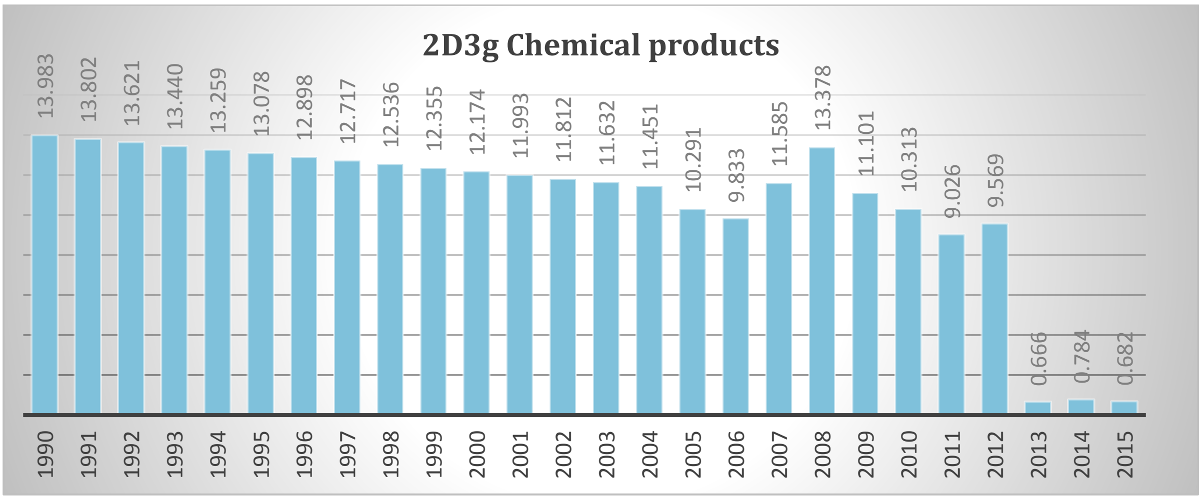


***Figure 33**: 2D3g: NMVOC emissions 1990-2015*

3.5.11 Printing (NFR 2D3h)

The category source is NEIS database, sources assigned to the category 6.7 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as Polygraphs on projected consumption of organic solvents in tonnes / year:

a) Publication rotogravure
b) Other rotogravure
c) Thermal rotary offset
d) Flexography
e) Varnishing and laminating technology
f) Rotary screen printing on textiles, paperboard
g) Other printing techniques, such as cold offset, sheet-fed equipment and other

The combination of bottom-up approach (Tier 3) and top-down approach (Tier 2) is used in accordance with quotation c/ Em_{TOTAL} = Em NEIS + Small sources * Ef where small sources are balanced together in category 2D3d. From the total balance of 2D3d the printing inks has been separated and allocated into 2D3h as a small sources. The drivers for the emissions decline is the implantation of effective techniques in the industrial sources.

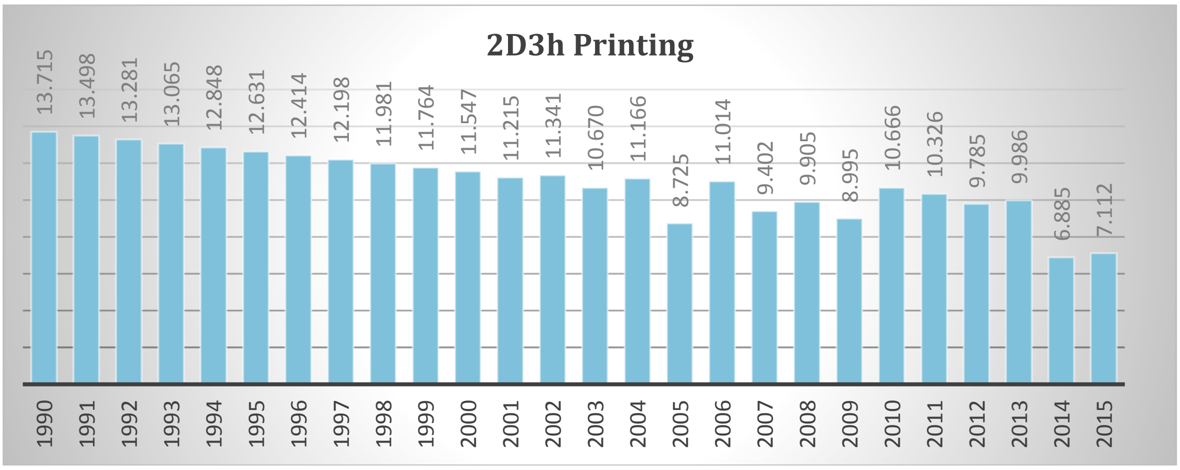


***Figure 34**: 2D3h: NMVOC emissions 1990-2015*

3.5.12 Other solvent use (NFR 2D3i)

The category was in pervious reporting filled with notation key, but the allocation was performed form the 2G. Moreover, the new sources has been accounted (leather processing, shoes manufacturing). The categories source is NEIS database, sources assigned to the category 4.35, 6.6, 6.10, 6.11 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as *Table 36*

***Table 36**: The NEIS categories included in 2D3h*

4.35	Industrial extraction of vegetable oil and animal fat and vegetable oil refining with a projected consumption of organic solvents in tonnes / year
6.6	Adhesive coating - bonding materials other than wood, wood products and agglomerated materials, leather and footwear production with a projected consumption of organic solvents in tonnes / year
6.10	Manufacturing and processing of leather
	a) Manufacture of leather with a projected quantities for t / d
	b) treatment of the leather, except of footwear and shoes production, coating and other applications on the leather, with a projected consumption of organic solvents in tonnes / year
6.11	Footwear and shoes production with projected consumption of organic solvents in tonnes / year

Similarly, the combination of bottom-up approach (Tier 3) and top-down approach (Tier 2) is used in accordance with quotation c/ Em_{TOTAL} = Em NEIS + Small sources * Ef where small sources are balanced together in category 2D3d. From the total balance of 2D3d the adhesive coatings has been separated and allocated into 2D3i as a small sources.

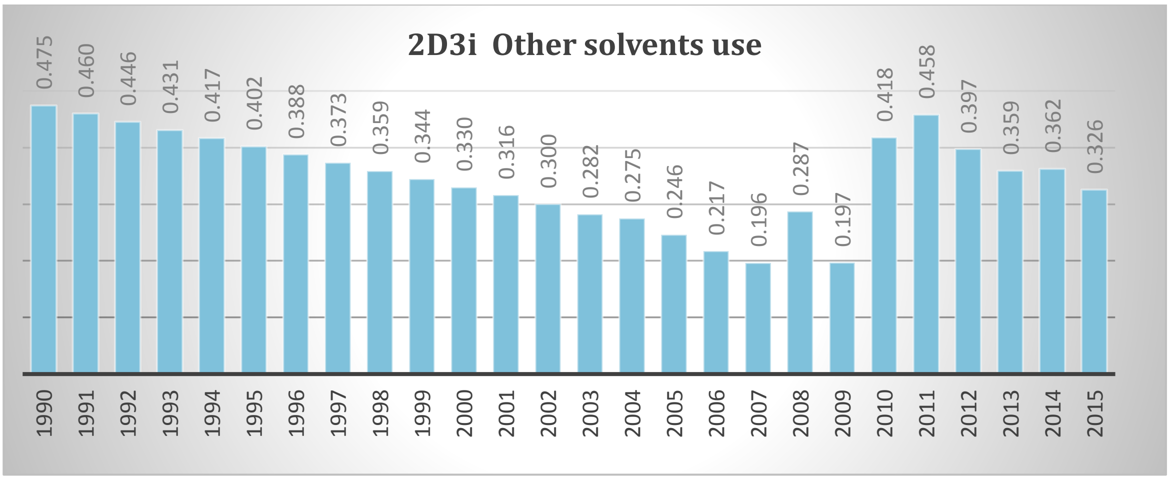


***Figure 35**: 2D3g: NMVOC emissions 1990-2015*

3.5.13 Other product use (NFR 2G)

The category is reported as NA.
In this category NMVOC are here reported, but the activity – defined under Regulation No 410/2012 as category 4.35 Industrial extraction of vegetable and edible oils and animal fats and refinery of vegetable oils with projected capacity of solvents consumed in t/year, that caused this emissions was allocated into the category *Other solvent use*.

Table 37: Emissions of NMVOC reported in the year 2017 under category 2G

2G Years	NMVOC [kt]	PM2.5 [kt]	PM10 [kt]	TSP [kt]
2001	NE	0,00000126	0,00000488	0,00001210
2002	NE	0,00000126	0,00000488	0,00001210
2003	NE	0,00000126	0,00000488	0,00001210
2004	0,00754659	0,00017563	0,00068001	0,00168553
2005	0,00807987	0,00014158	0,00056631	0,00141577
2006	0,00920014	0,00014302	0,00057209	0,00143022
2007	0,00709585	0,00008597	0,00034388	0,00085972
2008	0,01148585	0,00014829	0,00059314	0,00148285
2009	0,00654441	0,00004601	0,00018402	0,00046005
2010	0,00442405	0,00004484	0,00017935	0,00044838
2011	0,00590668	0,00005054	0,00020216	0,00050539
2012	0,00430476	0,00008866	0,00035464	0,00088660
2013	0,00833794	0,00022237	0,00072708	0,00171306
2014	0,00483522	0,00012285	0,00043639	0,00105554
2015	0,00089563	0,00009684	0,00038735	0,00096839

3.5.14 Planned improvements

4 AGRICULTURE (NFR 3)

4.1 OVERVIEW OF THE SECTOR (NFR 3)

In comparison with other sectors the generation of emissions and degree of environmental pollution by agriculture production have not been investigated thoroughly. Some agricultural emission sources are also difficult to quantify. Significant climate differences and different types of soil affect sowing procedures, manure applications and the management in Slovak agriculture.

The anthropogenic activities in agriculture sector significantly contribute to the concentration changes of some gases in atmosphere. Ammonia emitted from agriculture is considered as the most important gas from the point of view of planning adaptive measures to reduce their influence on environment. Sources of ammonia (NH_3), particulate matter (PM), Total suspend particulate (TSP), non-methane volatile organic compound (NMVOC) and nitrogen oxides (NO_X) emissions are analysed according to the EEA/EMEP Guidebook 2016 when principles of good practice in agriculture were taken into account. Some national data from research projects were also used. The emissions of NH_3, NO_X, PM and NMVOC can be reduced, if effective adaptation measures are implemented in agricultural practice. Effective measures have been already proposed for the conditions of the Slovak Republic. The absence of sufficient data in relation to storage and application of manure has resulted in the fact that the emissions are evaluated in the same way as usual. The methodology also use some results of research institutions in determination of nitrogen fluxes in the conditions of the Slovak Republic. Emissions from burning of field residuals have not been evaluated because these forms of soil cultivation are prohibited in the Slovak Republic. Methane (CH_4), ammonia (NH_3) and nitrogen oxides are the most important gases emitted from agriculture. Emission inventory of CH_4, N_2O and detailed description of applied methods for the emissions calculation can be found in the report "Slovakia´s National Inventory Report 2017" – Submission under the United Nations Framework Convention on Climate Change and the Kyoto Protocol". Calculation concerning of ammonia is in detailed description in this paper.

The share of agriculture and the food industry in the macro-economic indicators of the national economy has increased in most indicators in 2015 (income, cost, sales from own products).Despised this development was a consequence of the stagnation of the agriculture and food sector in the Slovak economy and a continuing dampening of agriculture and food industry production with negative impact on the total economic income and social benefits generated by these sectors. Subsidies from EU funds to improve economic results and without they would most businesses in losses. Gross value added in agriculture upsurges a result of the increase in gross agricultural output, more so in crops than in animals, with a concurrent in intermediate consumption and a significant upsurge in product subsidies. The biggest fall in prices of all agricultural products was in raw cow's milk (-10.7%) and slaughter pigs (-10.5%).The decline in yields of most commodity crop production (excluding wheat, legumes, fruit), with an impact on the reduction of their mass production and cereals (19.2%) and one in particular (48.8%) root crops, especially maize, fodder root crops (40%), sugar beet (22.2%) and potatoes (19.1%), oil (23.8%), fruit (3.6%), vegetables (14.1%) without leguminous, carrots, peaches and wine grapes. Lower-mass production of almost all groups of crucial slaughter animals, in particular pigs (9.7%), sheep (30.7%) and goat (1.3%), in addition to the slaughter of cattle and poultry (9.5% and 15.1%) (based on references published in the Green Report 2016).

The emission balance is compiled annually on the basis of sectoral statistics and in recent years on the basis of a new regionalisation of agricultural areas of the Slovak. The Ministry of Agriculture and Rural Development of the Slovak Republic issues annual statistics in the Green Report part Agriculture and Food Industry on a yearly basis. Activity data is also available in the Statistical Yearbooks. According the general changes in responsibilities, sectoral approach in preparation of inventory and with the aim to provide better quality data, the cooperation with Ministry of agriculture and rural development was arranged. Therefore, National Agricultural and Food Centre is responsible for some sectoral emission from 3.B Manure Management. SHMU coordinate these activity and manage QA/QC processes.

Table 38: *Overview of the agricultural emissions and methodological levels reported in Agriculture according to the NFR categories in 2014*

NFR codes/Title	Category (NFR codes and names)	Pollutants/Tier
3.B Manure Management	3B1a Dairy cattle	NH_3-T2, NO_x-T1, PM-T1, NMVOC-T2,
3.B Manure Management	3B1b Non-dairy cattle	NH_3-T2, NO_x-T1, PM-T1, NMVOC-T2,
3.B Manure Management	3B2 Sheep	NH_3-T2, NO_x-T1,PM-T1, NMVOC-T1,
3.B Manure Management	3B3 Swine	NH_3-T2,NO_x-T1,PM-T1, NMVOC-T1,
3.B Manure Management	3B4d Goats	NH_3-T2, NO_x-T1, PM-T1, NMVOC-T1,
3.B Manure Management	3B4e Horses	NH_3-T2, NO_x-T1, PM-T1. NMVOC-T1,
3.B Manure Management	3B4gi Laying hens	NH_3-T2, NO_x-T1, PM-T1. NMVOC-T1,
3.B Manure Management	3B4gii Broilers	NH_3-T2, NO_x-T1, PM-T1. NMVOC-T1,
3.B Manure Management	3B4giv Other poultry	NH_3-T2, NO_x-T1, PM-T1. NMVOC-T1,
3.D Crop Production	3Da1 Inorganic N-fertilizers	NH_3-T1,NO_x-T1
3.D Crop Production	3.Da 2 Animal manure applied to soil	NH_3-T2, NMVOC-T2,NO_X-T1
3.D Crop Production	3Da3 Urine and dung deposited by grazing	NH_3-T2, NMVOC-T2
3.D Crop Production	3. D c Farm-level agricultural operations including storage, handling and transport	PM-T1, TSP-T1
3.D Crop Production	3.D e Cultivated crops	NMVOC-T1,

Regarding NH_3 emissions, emissions from synthetic fertilization and organic fertilizers of agricultural soils were the most important sources, and they produced 16.73 Gg of NH_3 (57%) in sector in 2015. The major NMVOC emissions source is category 3.B with the share 75%, followed by the category 3.D represents 25% from the total sector emissions.

Following ***Figures 46,47*** and ***Table 44*** show overall emissions trends since base year 1990 according to gases and major categories.

Table 39: *Trend of emissions in the agriculture sector in years 2000 – 2015 in Gg*

Years	Sector 3 Agriculture					
	NH_3 emissions	NO_x	$PM_{2.5}$ emissions	PM_{10}	NMVOC	TSP
1990	67.964	14.273	0.598	4.061	23.249	14.383
1991	58.905	10.701	0.533	3.883	20.603	13.745
1992	50.816	7.896	0.469	3.691	17.842	12.799
1993	45.759	6.462	0.414	3.420	15.741	12.173
1994	44.578	6.529	0.441	3.583	15.147	11.899
1995	44.382	6.542	0.417	3.594	14.838	12.045
1996	43.401	6.606	0.400	3.612	14.763	11.742
1997	43.151	7.239	0.399	3.522	14.983	10.957
1998	39.386	6.559	0.368	3.386	13.602	9.785
1999	37.086	5.722	0.348	3.332	12.806	9.783
2000	37.464	5.968	0.343	3.237	12.663	9.473
2001	38.353	6.165	0.362	3.473	12.970	10.291
2002	37.474	6.538	0.351	3.484	12.500	10.037
2003	35.838	6.121	0.330	3.421	12.053	9.625
2004	33.175	5.790	0.308	3.165	11.339	8.391
2005	32.777	5.816	0.310	3.246	11.097	8.327
2006	31.578	5.600	0.301	3.259	10.574	8.280
2007	31.137	5.912	0.298	3.237	10.428	7.729
2008	28.357	5.659	0.287	3.207	9.833	6.979
2009	28.934	5.259	0.287	3.281	9.634	7.079
2010	28.694	5.580	0.281	3.204	9.360	6.890
2011	26.894	5.684	0.276	3.143	9.093	6.371
2012	28.137	6.056	0.278	3.136	9.237	6.569
2013	28.360	6.485	0.275	3.122	9.040	6.471

2014	29.573	6.752	0.275	3.179	9.344	6.538
2015	29.321	6.560	0.275	3.173	9.155	6.605

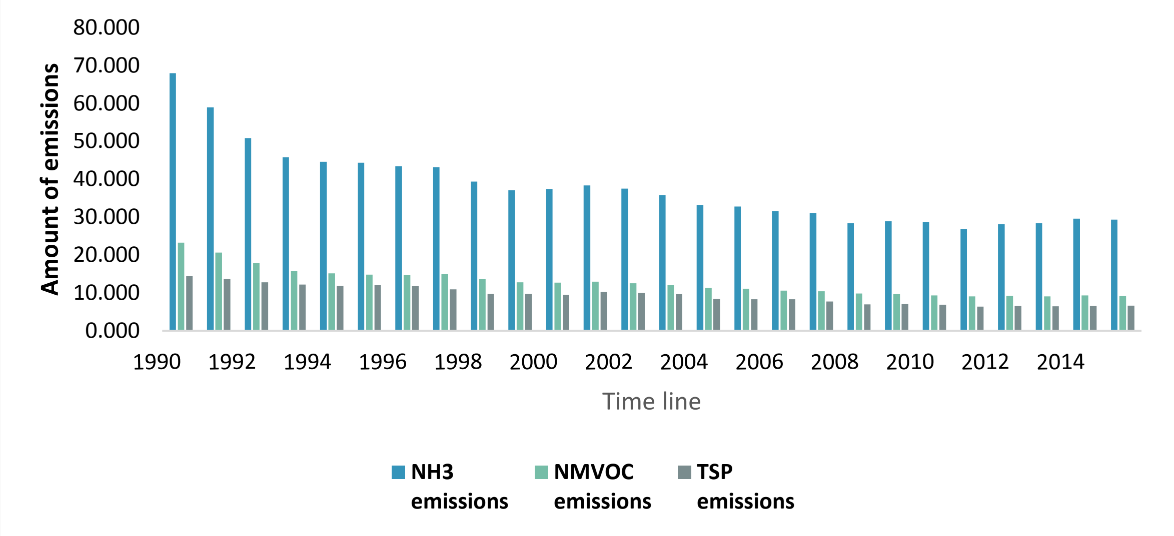


Figure 36: *Trend in aggregated significant pollution within agriculture sector in 2000 – 2015*

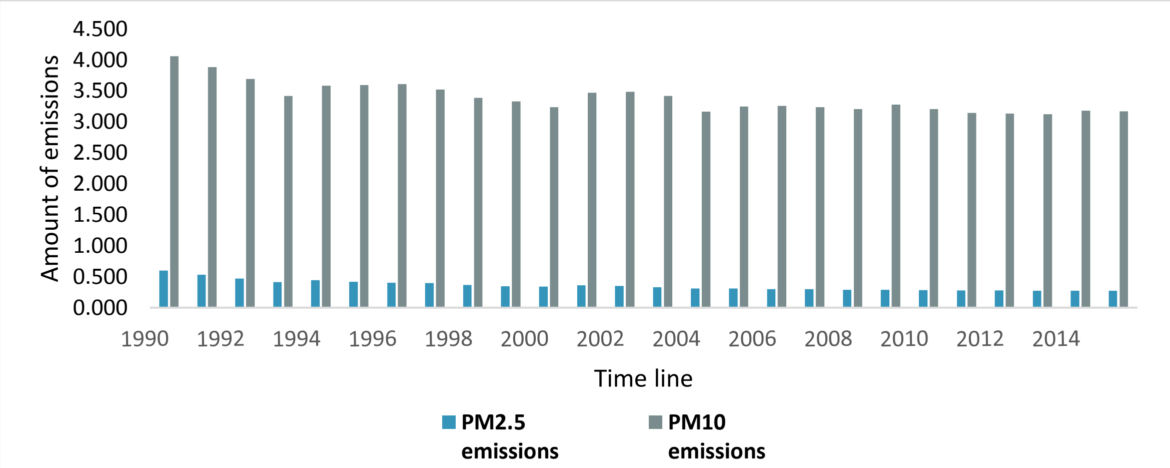


Figure 37: *Trend in aggregated non-significant pollution within agriculture sector in 2000 – 2015*

4.1.1 Category-specific improvements and implementation of recommendations

During the reviews in Agriculture sector by ESD and UNFCCC teams resulted in several recommendations. These recommendations were implemented in GHG inventory and had influence also at LRTAP inventory.

Recommendations, which were implemented:

Emissions from Agriculture for 3.B category were recalculated due to change of activity data. Statistical office of Slovak Republic provided very detailed data about number of livestock up to 1990 year. According to this improve we prepare accurate estimate of all kind of emissions from all animal species. New NEX are implemented, which was calculated in GHG inventory.

We found the discrepancy of the NH_3 emissions in 3B Manure management. In this submission we prepared the revise of NH_3estimate. Emissions were overestimated.

Revise of EMEP/EEA Guidebook had also influence to recalculation of emissions.

We prepare new estimate of NMVOC emissions for cattle category. New detailed information about number of livestock, ratio data and new estimate of NH_3 emissions was available. These implementations had influence at amount of NMVOC emission.

In 2017 submission we prepared new emission estimate for sources Sewage sludge, at the instigation the ERT team. We prepare estimate of emission NO_x and NH_3. Input data was available in chapter

This year have been implemented explanation about the regional differences. Results are described in chapter 4. Localization

All changes are available in following chapters.

4.1.2 Source Specific QA/QC and Verification

The QC checks (e.g. consistency check between NFR, CRF data and national statistics) were done during the IIR and NIR compilation, General QC formulary was filled and is archived by QA/QC manager.
Part of QA/QC activities is comparison of FAO database and NIR, descripted in chapter 4. below.

4.1.3 Comparison of the FAO data with the national activity data

Comparison of activity data is described in this section when trying to find out if the differences in inputs found in both databases can explain the differences in emissions, analysing trend of livestock population, cultivated area and fertilizer use for the time series 1993 – 2014.

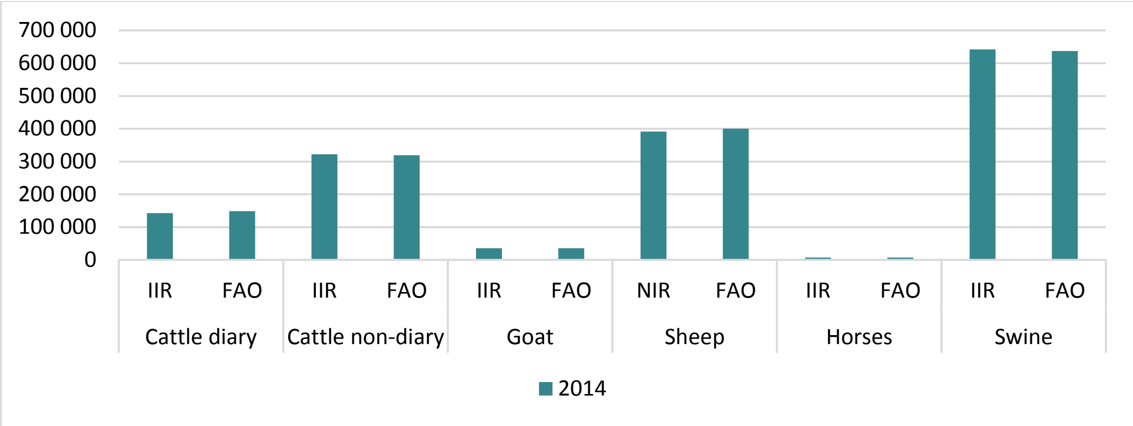
Livestock population

Number of animals is the most important input parameter into emission inventory. Inconsistencies in population are significant source of differences in calculated emissions. We recognised differences in methodological approach of data collection used in FAOSTAT and in national statistical authority. FAOSTAT grouped livestock numbers in 12-months period ending by September, 30 of each year. On the other hand, Statistical Office of the Slovak Republic provide national data on annual livestock numbers by December, 31 of a given year. Statistical survey is based on data from selected farms and by selected animal's categories and up to the regional level, and finally up to national level. Therefore, animal population of the FAO 2016 and the data used in the IIR 2016 are different.

In addition, with the detail analyses of the data provided in the ***table 48*** below, it is visible shift of the time series and wrong allocation of animal population in FAO 2016 for goats (since 1994), for sheep (since 1994), for horses (since 2000) and for swine (since 1994).

The highest inconsistences occurred in cattle and this is caused by the different rules for allocation between dairy and non-dairy. In total cattle population differences are not so significant, for example in 2014, national number of cattle population is 465 543 heads and FAO is 467 820 heads. ***Figure 50*** shown comparison between FAO and IIR databases.

Figure 38: *Comparison of population according to animal's species in 2015*



Sowing area

Comparison of sowing area provided in the FAO 2016 and using in the national inventory was provided in addition to the livestock analyses. Sowing areas is important input parameter for calculation PM, TSP and NMVOC emissions and emissions from crop residues.

The Statistical Office of the Slovak Republic provides sowing area statistics by July, 31 of each year. Our sowing areas show ***Figure 51.*** FAOSTAT has own calculation methodology for sowing area estimation. This approach is based on simple equation:

$$\text{Share of Agricultural land over total land } (\%) = \frac{\text{Agricultural area}}{\text{Land area}} * 100$$

This approach estimates constant value (2 347.90 kha) of sowing area in Slovakia, which is not in agreement of national data variables from year to year according to the actual statistics.

Figure 39: *Sowing area in national inventory of Slovakia (kha)*

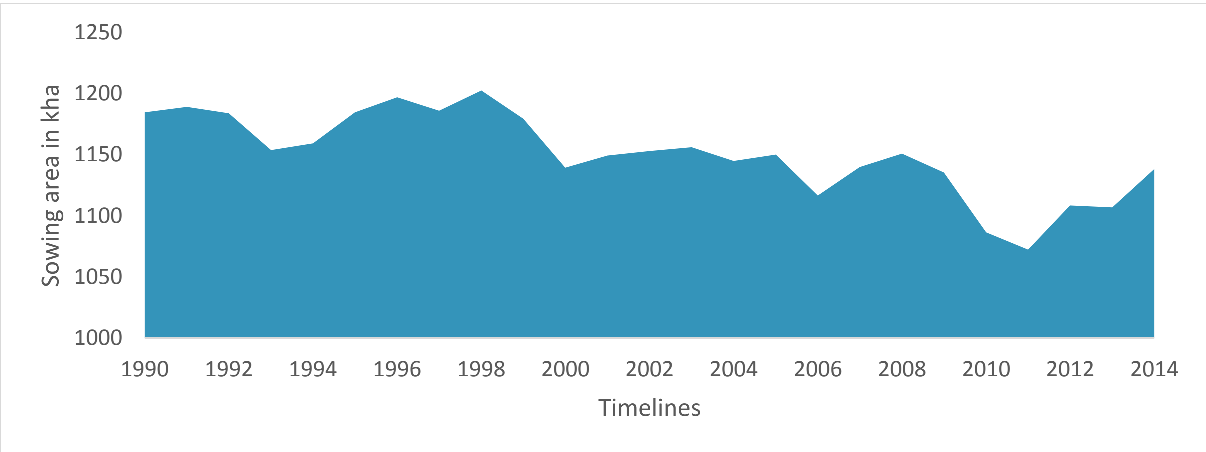


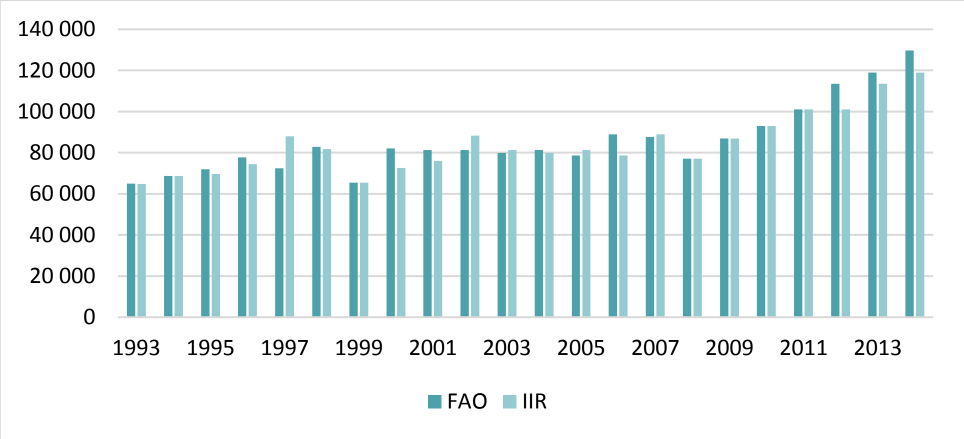
***Table 40**: Comparison livestock population for the time series 1993 – 2014 (in blue highlighted wrong time series discovered in the FAO 2016)*

Year	Cattle diary		Cattle non-diary		Goats		Sheep		Horses		Swine	
	IIR 2016	FAO 2016	IIR 2016	FAO 2016	IIR 2016	FAO 2016	IIR 2016	FAO 2016	IIR 2016	FAO 2016	IIR 2016	FAO 2016
1993	282 274	386 000	710 689	817 497	24 974	20 278	411 442	571 837	11 000	11 000	2 179 029	2 269 200
1994	272 450	364 000	643 703	628 963	25 010	24 974	397 043	411 442	11 000	11 000	2 037 371	2 179 029
1995	262 664	350 000	666 042	566 153	25 046	25 135	427 844	397 043	10 109	10 000	2 076 439	2 037 370
1996	245 833	339 000	646 158	589 706	26 147	25 046	418 823	427 844	9 722	10 000	1 985 223	2 076 439
1997	299 614	309 700	503 784	582 291	26 778	26 147	417 337	418 823	9 533	10 000	1 809 868	1 985 223
1998	267 282	287 600	437 510	515 798	50 905	26 778	326 200	417 337	9 550	10 000	1 592 599	1 809 868
1999	250 974	262 000	414 081	442 792	51 075	38 900	340 346	326 199	9 342	10 000	1 562 106	1 592 599
2000	242 496	250 974	403 652	414 081	51 419	51 075	347 983	340 346	9 516	9 342	1 488 441	1 562 106
2001	230 379	242 496	394 811	403 652	40 386	51 419	316 302	347 983	7 883	9 516	1 517 291	1 488 441
2002	230 182	230 379	377 653	394 811	40 194	40 386	316 028	316 302	8 122	7 883	1 553 880	1 517 291
2003	214 467	230 182	378 715	377 653	39 225	29 769	325 521	316 028	8 114	8 122	1 443 013	1 553 880
2004	201 725	210 317	338 421	382 865	39 012	39 225	321 227	325 521	8 209	8 114	1 149 282	1 443 013
2005	198 580	201 725	329 309	338 421	39 566	39 012	320 487	321 227	8 328	8 209	1 108 265	1 149 282
2006	184 950	198 580	322 870	329 309	38 352	39 566	332 571	320 487	8 222	8 328	1 104 829	1 108 266
2007	180 207	184 950	321 610	322 870	37 873	38 352	347 179	332 571	8 017	8 222	951 934	1 104 829
2008	173 854	180 207	314 527	321 610	37 088	37 873	361 634	347 179	8 421	8 017	748 515	951 934
2009	162 504	165 918	309 461	322 463	35 686	37 088	376 978	361 634	7 199	8 421	740 862	748 516
2010	159 260	162 504	307 865	309 461	35 292	35 686	394 175	376 978	7 111	7 199	687 260	740 862
2011	154 105	159 300	309 253	307 825	34 053	35 292	393 927	394 175	6 937	7 111	580 393	687 260
2012	150 272	156 126	320 819	307 232	34 823	34 053	409 569	393 927	7 249	6 937	631 464	580 393
2013	144 875	149 790	322 945	321 301	35 457	34 823	399 908	409 569	7 161	7 249	637 167	631 464
2014	143 083	148 750	322 460	319 070	35 178	35 457	391 151	399 908	6 828	7 161	641 827	637 167

Fertilizers

The last QA comparison exercise was provided for the data of fertilizers' consumption. Differences between FAO 2016 and SVK IIR 2016 were caused by using different methodological approach in FAOSTAT. This approach is based on annual balance of nitrogen production and net trade. On the other hand, activity data on fertilizers in national inventory are based on nitrogen consumption. *Figure 52* shows comparison between both databases.

Figure 40: *Fertilizers consumption and comparison of FAO 2016 and SVK IIR 2016 data (kg/year)*



Ammonia emissions

Emissions of ammonia causes acidification and eutrophication in environment. Agriculture is the main source of ammonia emissions. Deposition of ammonia can also raise nitrogen in soil and water, which may contribute to eutrophication in the aquatic ecosystems. FAO taken of total NH_3 emissions from European Monitoring and Evaluation Programme (EMEP).

$$Share\ Ammonia\ from\ agriculture\ (\%) = \frac{Total\ ammonia\ emissions\ from\ Agriculture\ (Gg)}{Total\ Ammonia\ emissions\ from\ all\ sectors\ (Gg)} * 100$$

On the table 59 is the inconsistency of the time series. The data are not complete, because some years are missing. In 2015 submissions we prepare new approach at estimating of emissions from this source. We prepare also recalculation of all time series until year 1990.Differents between two models are, because we used on the estimate of NH_3 emissions higher Tier 2 methodology in comparison with FAO, where Tier 1 has been used.

Table 41: *Comparison of ammonia emissions from sector agriculture*

Years	Percentage of ammonia in sector Agriculture		Comparison
	IIR	FAO	NIR-IIR
2001	95.03%	97.78%	2.90%
2002	95.03%	97.43%	2.53%
2003	95.56%	97.22%	1.74%
2004	95.64%	97.22%	1.66%
2005	95.95%	97.27%	1.38%
2006	95.54%	97.51%	2.06%
2007	95.76%	97.32%	1.63%
2008	96.11%	96.71%	0.63%
2009	93.13%	97.28%	4.46%

4.1.4 Localization

After 1990 Slovak farmers must adapted, because situation in Agriculture changed. They invested in to the development of own farms to avoid the bankrupt and they will be self-competitiveness in this sector. The used tools as base of transformation was supported by EU policy. The EU policy was transformed in to the Slovak legal system. Farmers must observe strictly critters (higher milk yield, changing of housing systems, decrease of pasture time, new storage capacity for organic waste), which is supported by Degree no 389/2005Coll and Nitrates Directive[22]. These measures are advanced and copy the practices of Western European countries. Therefore, default parameter for Western Europe are used. Slovak Republic have not same condition.

Example:

Cattle breeding in Slovakia is comparable with the Western Europe countries, what documents high milk yield of dairy cattle and high daily weight gains in non-daily cattle. To maintain a high milk yield and high daily gain food rich on proteins´ and cereals´ components is important. Dairy cows in 3 Slovak regions (Bratislava, Trnava, Nitra) produce 20-23 liters' milk/day. In other regions milk productivity is 14-15 liters/day. High producing dairy cows (milked 23 liters/day) need to be fed by 8 kg of cereal feed with very good digestibility and high nutrition. This practice is typical for Western European countries and comparable with it. Balanced and sustainable farming in Slovakia has an impact on the high value of AGEI (274.96 MJ/head/day) see ***Table 61***. Considering the mentioned parameters, it is evidently, that our production can be considered as "Western Europe".

Table 42: *The comparison of the Slovak milk yield with other milk production in 2015*

Dairy cattle	Slovakia	Western Europe	Eastern Europe	North America
Milk yield kg/year/cow	6537	6 000	2 550	8 400

[22]http://www.mpsr.sk/index.php?navID=78&id=1325 (in Slovak)

4.1.5 Activity data:

Activity data for dairy, non-dairy cattle and sheep used for tier 2 methodology are based on bottom-up statistical information at district level. The aggregation of input parameters is performed as weighted average. In 2016 The Statistical Office of the Slovak Republic provides national data of annual livestock numbers on a detailed region level see ***Table 62*** below. These data are based on livestock counts held on 31stDecember of each year.

In 2016 has been provided complete time series of the number of livestock at region level. Between years 1990-1996, the Slovak Republic was divided into three regions, due to the historical context. During these years were available data only for the three regions: Západoslovenský, Stredoslovenský and Východoslovenský). Due to this circumstance regions were reallocated in to the 5 regions (Bratislavský, Nitrianský, Trnavský, Bansko Bystrický, Prešovský, Košický, using the extrapolation tools.

In a cooperation with the Research Institute for Animal Production in Nitra the results of a questionnaire survey were used in better classification and disaggregation of cattle categories. Based on survey data, cattle were divided into dairy cattle and beef cattle. Dairy cows were are estimated separately from beef cattle. Dairy cows are defining in this method as cows that producing milk only for human consumption (high producing cows). Suckling cows are defining as cow, which are farmed for nutrition of calves (low producing cows). Suckling cows and other category of cattle as for example breeding bull, oxen, calves, heifer are in category non-dairy cattle.

Decline in the number of all species of livestock except of poultry and goats were recorded in the Slovak Republic. Number of poultry and goats has increased compared to base year. The highest decrease was observed in pigs (-75%) and non-dairy cattle category (-73%). Number of dairy cows (-3 %), non-dairy cattle-1% and sheep (-2 %) slightly decreased in the 2014-2015 Table 48.

This decrease was mainly affected by the poor economic situation in agriculture. Food manufacturers and retailers pushed down prices of raw material (even below of production costs) because of competitiveness of final products between Slovak and European food market. Continuous reduction in number of dairy cows was caused by political decision about milk quotas ending. These quotas ensured stable milk prices for primary producer. Decrease of the number of livestock had significant influence to cancel the milk quota.

Table 43: *Number of livestock for the year 2015*

CATEGORY		NUMBER OF LIVESTOCK							
DISTRICT		Bratislava	Trnava	Trenčín	Nitra	Žilina	Banská Bystrica	Prešov	Košice
DAIRY CATTLE	Dairy cows	5 139	23 749	14 127	22 978	22 617	20 069	20 716	9 834
	Calves in 6 month	1 956	11 093	6 098	12 369	6 585	7 192	7 223	3 090
	Heifer	1 809	9 741	5 203	9 958	10 978	9 103	9 340	4 494
	Heifer (pregnant)	1 630	6 731	4 472	7 868	5 695	4 985	5 408	2 584
	Fattening	243	9 244	3 765	6 754	3 384	3 252	2 983	1 939
	Oxen	14	13	169	67	563	27	0	21
BEEF CATTLE	Suckling cows	1 864	1 966	3 894	1 703	7 796	13 104	19 185	10 768
	Calves in 6 month	584	662	1 238	256	2 995	5 663	7 197	3 869
	Heifer	396	407	1 031	106	2 627	6 116	6 739	4 620
	Heifer (pregnant)	270	209	739	59	1 514	3 246	3 430	2 188
	Fattening	262	570	660	356	981	3 138	1 538	1 181
	Oxen	0	0	0	0	0	10	17	12
	Breeding bull	63	397	317	529	650	994	973	1225
DAIRY SHEEP	Mature ewes	221	429	16 085	3 799	45 908	43 060	36 471	13 962
	Growing lambs	6	298	5 289	1 067	12 971	12 383	9 566	5 308

	Growing lambs (pregnant)	1	245	3 658	725	8 510	11 158	6 339	3 145
	Other mature sheep	6	17	494	113	1 360	1 355	1 070	428
BEEF SHEEP	**Mature ewes**	470	1 039	7 002	4 488	15 268	43 249	13 146	15 870
	Growing lambs	91	217	1 372	872	3 246	6 752	3 318	3 057
	Growing lambs (pregnant)	14	178	949	593	2 130	6 084	2 199	1 811
	Other mature sheep	12	30	199	127	435	1 233	384	442
SWINE	**Market swine**	4 652	26 894	8 893	18 081	583	15 576	5 609	3 415
	Breeding swine	19 524	187 549	45 108	146 846	13 373	53 603	42 401	41 009
HORSES	**Horses (0-3year)**	99	95	160	405	158	341	233	187
	Stallions	61	78	97	281	166	250	292	112
	Mares	173	132	228	404	209	555	403	208
	Castrated stallions	81	82	121	146	270	305	377	157
GOATS	**Mature goats**	491	1498	2324	3035	5130	7194	3613	3660
	Growing goats (pregnant)	82	319	689	830	1071	1939	966	994
	Other mature goats	93	163	222	364	316	605	407	319
POULTRY	**Laying hens and cocks**	674426	524399	634420	1 747665	612010	983472	438980	596346
	Broilers	166757	273173	1 201507	1 813670	639272	269593	108433	1 828758
	Turkeys	1892	13650	3484	85433	8074	7014	3505	2827
	Ducks	6429	33191	10265	67832	7341	27185	14638	4123
	Geese	1341	4053	1909	8522	2909	4494	1659	1573

Table 44: *The development of livestock numbers in the period 2000-2015*

Domestic livestock population and its trend 2000-2015 in thousand heads							
Year	Population dairy cattle	Population non-dairy cattle	Population Sheep	Population pigs	Population Goats	Population Horses	Population Poultry
1990	401.123	1 161.947	600.426	2 520.524	10.322	13.595	16 477.763
1991	361.902	1 034.668	531.263	2 427.997	16.676	12.858	13 866.297
1992	298.072	883.588	571.837	2 269.232	20.278	11.652	13 266.789
1993	282.274	710.689	411.442	2 179.029	24.974	11.188	12 234.120
1994	272.450	643.703	397.043	2 037.371	25.010	10.652	14 245.954
1995	262.664	666.042	427.844	2 076.439	25.046	10.109	13 382.391
1996	245.833	646.158	418.823	1 985.223	26.147	9.722	14 147.177
1997	299.614	503.784	417.337	1 809.868	26.778	9.533	14 221.713
1998	267.282	437.510	326.200	1 592.599	50.905	9.550	13 353.654
1999	250.974	414.081	340.346	1 562.106	51.075	9.342	12 247.440
2000	242.496	403.652	347.983	1 488.441	51.419	9.516	13 580.042
2001	230.379	394.811	316.302	1 517.291	40.386	7.883	15 590.404
2002	230.182	377.653	316.028	1 553.880	40.194	8.122	13 959.404
2003	214.467	378.715	325.521	1 443.013	39.225	8.114	14 216.798
2004	201.725	338.421	321.227	1 149.282	39.012	8.209	13 713.239
2005	198.580	329.309	320.487	1 108.265	39.566	8.328	14 084.079
2006	184.950	322.870	332.571	1 104.829	38.352	8.222	13 038.303
2007	180.207	321.610	347.179	951.934	37.873	8.017	12 880.124
2008	173.854	314.527	361.634	748.515	37.088	8.421	11 228.140
2009	162.504	309.461	376.978	740.862	35.686	7.199	13 583.284
2010	159.260	307.865	394.175	687.260	35.292	7.111	12 991.916
2011	154.105	309.253	393.927	580.393	34.053	6.937	11 375.603
2012	150.272	320.819	409.569	631.464	34.823	7.249	11 849.818
2013	144.875	322.945	399.908	637.167	35.457	7.161	10 968.918
2014	143.083	322.460	391.151	641.827	35.178	6.828	12 494.074
2015	139.229	318.357	381.724	633.116	36.324	6.866	12 836.224
Trend 1990-2015	**-65%**	**-73%**	**-36%**	**-75%**	**252%**	**-49%**	**-22%**
Trend 2014-2015	**-3%**	**-1%**	**-2%**	**-1%**	**3%**	**1%**	**3%**

4.1.6 Manure Management (NRF 3.B)

4.1.7 Overview

Ammonia emissions from Sector 3 Agriculture are estimated according to the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 as Tier 2 approach for dairy cattle, non-dairy cattle, sheep swine, goats, horses and poultry, which are estimated by using a country specific detailed parameters about animal waste management systems. NO_x emissions from manure management have been estimated using the default emission factors (Tier 1) of the EMEP/EEA Emission Inventory Guidebook 2016. Even trought to NO_X sector is consideration as a key sectore. Still, T1 methodology was use and improvment to T2 is planned in future submission according to continous intentious of improvind quality

Detailed Tier 2 method was used to calculate NMVOC emissions for dairy cows and non-dairy cattle. For the other animals the Tier 1 methodology was used. In accordance with EMEP/EEA Emission Inventory Guidebook 2016. In manure management the emissions of PM_{10} and $PM_{2.5}$ were calculated. In accordance with EMEP/EEA Emission Inventory Guidebook 2016 has been used Tier 1 methodology for all animal species.

4.1.8 Ammonia emissions

Ammonia have significant impact on environment. Ammonia emissions cause eutrophication and acidification in all parts of environment. The volatilization of ammonia into the air is the result of farming, nutrition of animals and handling of liquid and solid manure. Ammonia emissions origins from excess of nitrogen in animal nutrition than cannot be sufficiently utilized by animal. Emissions is dependent on the surface of the stall floor, temperature, humidity of manure, used bedding type and method of disposal. Ammonia emissions are higher in summer than in winter. When the outside temperature increase by 1° C, emissions from housing rise by 2.6%. The frequent disposal of manure and cleaning stall floor has also impact on the size of emissions[23].

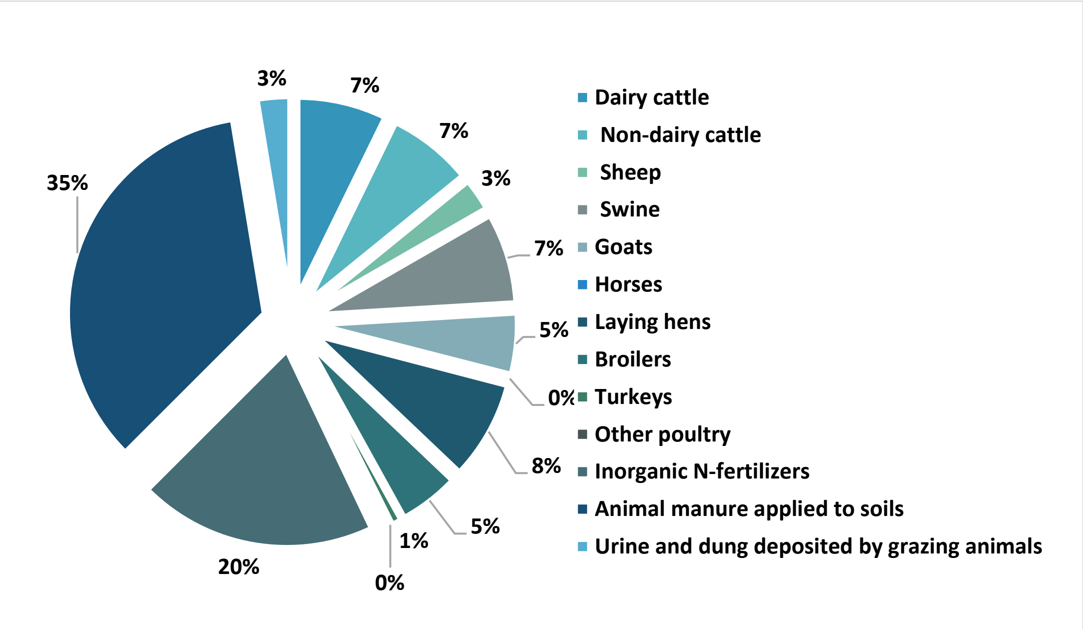


Figure 41: *The annual ammonia emissions within agriculture sector in 2015*

[23] http://www.vuzv.sk/pdf/metodiky_pre_prax/urcenie_emisii.pdf

4.1.9 Methodological issue-method

For the calculation of nitrogen emissions must be taking into account the nitrogen cycle, which is the basis for the correct calculation of the nitrogen emissions. This nitrogen cycle and available national parameters are taken account for more accurate emissions estimations.

Nitrogen is an essential element for livestock and for the growth of crops. Livestock transforms plant-proteins to animal proteins. Livestock integrated the nitrogen into the musculoskeletal (5-45%), it is necessary to produce milk. The unused nitrogen is excreted as manure and slurry back into the soil. In this cycle were lost of nitrogen as NOx, NH_3, N_2O emissions.

Nitrogen evaporates during the storage of manure approximately 2-40%, it is depending on kind of storage. After than manure and slurry are spreading in to the soil. During these procedures remaining nitrogen emitted approximately 2-50% in to atmosphere, depending on the used technique.

The production of organic manure is continuously decreasing, therefore it is necessary to compensate this lack by inorganic nitrogen fertilizers. The application of mineral fertilizers and next the denitrification processes emitted in approximately 8% nitrogen, and the leaching of fertilizer another approximately 30%[24]

AWMS were based on the analysis of housing practices in the farm of the Slovak Republic. Questionnaire survey was performed with the cooperation of the Research Institute for Animal Production in Nitra and other research institutions. Results of this survey were implemented in the inventory submission 2017. This survey also defined more accurate days for cattle, sheep, goats and horses which stay on pasture. For grazing categories of cattle, sheep, horses and goats it is approximately 180-200 days and for dairy cattle it is 150 days. The pasture is used in mountainous regions. Share of nitrogen allocated in AWMS according to animals is provided in the ***Table 64*** below. Allocation according to the climate conditions is 100% for cool climate for all animals based on the IPCC 2006 methodology and climate data. Default nitrogen excretion is take for Western Europe, the reasons of this choice is described in ***Section 4.5*** above.

Solid storage of manure was found as the most frequent AMWS in the conditions of the Slovak Republic mostly for cattle. Liquid storage of slurry is also frequently used especially in category pigs. Housing on grasslands from April to October is frequent for sheep, goats and horses (partly for non-dairy cattle). The methodology used for the estimation of manure management is based on IPCC methodology using country specific parameters and activity data for cattle, sheep, horses, goats, poultry and swine. Detailed parameters are in ***Table 64*** below***.***

As base of calculation is used different animal weights of different animal subcategories. Each animal's categories respectively subcategories have own body weight. This parameter was measured and it is country specific. Also AWMS share were derived from measured amount of nitrogen. If we have these parameters, nitrogen excretion rate can be calculated. Annual nitrogen excretion rates were determined for each livestock species respectively category of farm animals. These data has been provided of Research Institute for Animal Production in Nitra.

Nitrogen excretion rates for animals' categories were calculated based on the IPCC 2006 GL, equation 10.30:

$$NEX_T = N_{rate(T)} * \frac{TAM}{1000} * 365$$

[24] Brestenský; Straty hmotnosti dusíka pri manipulácií s maštalným hnojom (in Slovak) www.cvzv.sk/doc/Strary_N.doc

Where: NEX_T = annual N excretion for each livestock spices respectively category, kg N animal^{-1}.yr^{-1}; $N_{RATE(T)}$ = default N excretion rate, kg N (100 kg per animal mass)$^{-1}$day^{-1}(**from IPCC 2006 GL**) and TAM = country specific animal mass for each livestock spices/category (kg per animal^{-1}).

Direct emissions from manure management systems were estimated according to following equation:

$$N_2O_{EM} = \left[\sum\left[\sum(N.N_{EX}.AWMS)\right].EF\right].\frac{44}{28}$$

Where: N_2O_{EM} = direct N_2O emissions from manure management (kgN_2O per yr^{-1}); N = number of livestock species respectively category; N_{EX} = annual average N excretion per head of species respectively category (kg N per animal^{-1} per yr^{-1}); AMWS = percentage of total annual nitrogen excretion for each livestock respectively category, that is managed in manure management systems in the country, EF = default emission factor for direct N_2O emissions from manure management system (kg N_2O-Nkg N in manure management system)and 44/28 = conversion of N_2O-N emissions to N_2O emissions.

Table 45: *Percentage of nitrogen excreted by different animal waste management systems*

Category	Subcategory	Weighted average for body weight	N_{ex}	Liquid system	Solid syste m	Pasture	Litter
		kg	N kg/head/year	%			
Dairy cattle	Dairy cows	597.86	104.744	11.50	81.20	7.30	-
	Weighted	**597.86**	**104.75**	**11.50**	**81.20**	**7.30**	**-**
Beef cattle	Suckling cows	592.00	71.31	-	45.21	54.79	-
	Calves (6 month)	103.71	14.41	-	-	100.00	-
	Heifer	297.77	35.87	-	97.56	2.44	-
	Heifer pregnant	522.04	62.88	-	97.56	2.44	-
	Fattening	353.85	42.62	10	90	-	-
	Oxen	700.00	84.32	-	100	-	-
	Calves (6 month)	119.73	7.7	-	40	60	-
	Heifer	317.79	38.28	-	45.21	54.79	-
	Heifer pregnant	506.87	61.05	-	45.21	54.79	-
	Fattening	365.87	44.07	20	80	-	-
	Oxen	700.00	84.32	-	100	-	-
	Breeding bull	800.00	96.36	-	75.34	24.66	-
	Weighted	**360.65**	**45.36**	**1.54**	**76.89**	**21.57**	**-**
Sheep	Mature ewes	60.00	18.62	-	49.59	50.41	-
	Mature ewes	70.00	21.72	-	45.20	54.80	-
	Weighted	**63.50**	**19.81**	**-**	**47.90**	**52.10**	**-**
	Growing lambs	32.50	10.8	-	49.59	50.41	-
	Growing lambs	55.00	17.6	-	49.59	50.41	-
	Growing lambs	47.50	14.74	-	45.21	54.79	-
	Growing lambs	65.00	20.17	-	45.21	54.79	-
	Weighted average	46.80	**14.17**	**-**	**47.90**	**52.10**	**-**
	Rams	55.00	26.1	-	100.00	-	-
	Rams	90.00	27.92	-	100.00	-	-
	Weighted	**83.71**	**25.97**	**-**	**100.00**	**-**	**-**
Breeding swine	Piglets 1,2-20 kg	10.60	1.63	80.00	20.00	-	-
	Piglets 21-51 kg	35.50	5.44	80.00	20.00	-	-
	Yong sows 50-140	95.00	14.56	80.00	20.00	-	-
	Sows 180 kg	180.00	27.59	80.00	20.00	-	-
	Hogs	145.00	22.23	80.00	20.00	-	-
	Weighted	**108.94**	**16.7**	**80.00**	**20.00**	**-**	**-**
Market swine	Fattening 1,2-20	10.60	1.97	70.00	20.00	-	10.00
	Fattening 21-51 kg	35.50	6.61	70.00	20.00	-	10.00
	Fattening 50-80 kg	65.00	12.1	70.00	20.00	-	10.00
	Fattening 80-110	95.00	17.68	70.00	20.00	-	10.00

	Fattening 110 < kg	110.00	20.48	70.00	20.00	-	10.00
	Weighted	**52.32**	**9.74**	**70.00**	**20.00**	**-**	**10.00**
Swine	**Weighted**	**59.81**	**10.66**	**71.32**	**28.68-**	**-**	
Goats	Mature female	55	25.70	**-**	49.60	50.40	**-**
	Pregnant goats	47.5	22.19	**-**	49.60	50.40	**-**
	Other mature	21.5	10.05	**-**	49.60	50.40	**-**
	Weighted	**51.28**	**23.96**	**-**	**49.60**	**50.40**	**-**
Horses	Young horses	287.50	27.28	70.00	-	30.00	-
	Castrated horses	700.00	66.43	70.00	-	30.00	-
	Stallions	550.00	52.20	70.00	-	30.00	-
	Mares	500.00	47.45	70.00	-	30.00	-
	Weighted	**502.63**	**54.85**	**70.00**	**-**	**30.00**	**-**
Poultry	Laying hens +	3.14	1.10	85.00	-	15.00	-
	Broilers	1.10	0.80	-	-	100.00	-
	Turkeys	17.00	4.59	-	-	100.00	-
	Ducks	4.00	1.21	-	-	100.00	-
	Geese	6.00	1.82	-	-	100.00	-
	Weighted	**2.23**	**0.99**	**-**	**-**	**100.00**	**-**

*all parameters are weighted average represent aggregation in level SR.

Cattle is the largest producing of nitrogen emissions between in all livestock (see table 64 above). Cattle producing 81.20% of organic solid manure and 11.5 % of urine. Swine are the biggest producer of slurry (71.32%). Sheep, goats and poultry are less important in the production of organic solid manure (BRESTENSKÝ). Information about storage of manure is available in Ministry of Agriculture and Rural development issue Act. No 202/2008 Coll. and Decree No 462/2011 Coll. “Nitrate directive”.

Different between submissions 2016 a 2017 je very big, because methodological approach was change. In the first time we included NEX parameter from GHG inventory (calculation see above), also we found a discrepancy of our emissions estimates, which was repaired (***table 65***). For example emission from pasture and spreading was included in 3D Agricultural soils and 3.B Manure management. Emissions were overestimated, because we calculated bigger amount of volatile nitrogen. This discrepancy was caused as incorrect interpretation of the methodology.

Table 46: *Comparison of calculated weighted emission factors for livestock manure during its housing, storage, spreading and grazing*

		2014 Submission				2015 Submission			
Category	Subcategory	Housing	Storage	Spreading	Grazing	Housing	Storage	Spreading	Grazing
		(kg/head/year-1)							
Dairy cows	Dairy cows	11.56	11.86	25.46	0.0389	7.10	7.72	16.62	2.58
	Calves (6 month)	4.67	5.38	11.49	-	1.42	1.63	3.49	0.00
	Heifer	4.59	5.29	11.29	0.03	2.43	2.80	5.81	0.54
	Heifer pregnant	4.59	5.29	11.29	0.03	4.27	4.91	10.49	0.94
	Fattening	4.70	5.24	11.21	-	4.56	5.08	10.90	0.00
	Oxen	4.67	5.38	11.49	-	9.61	11.06	23.63	0.00
Beef cows	Suckling cows	2.11	2.43	5.19	0.81	3.67	4.23	9.03	1.41
	Calves (7 month)	0.52	1.11	2.36	0.85	0.18	0.21	0.45	0.09
	Heifer	2.11	2.43	5.19	0.81	2.05	2.36	5.04	0.79
	Heifer pregnant	2.11	2.43	5.19	0.81	3.24	3.73	7.97	1.24
	Fattening	4.72	5.09	10.92	-	4.68	5.04	10.86	0.00
	Oxen	4.67	5.38	11.49	-	9.61	11.06	23.63	0.00
	Breeding bull	3.52	4.05	8.66	0.36	8.77	10.10	21.57	0.91
Dairy sheep	Ewes	0.85	0.84	1.94	0.35	1.02	1.01	2.33	0.42
	Ewe lambs	0.845	0.84	1.94	0.35	0.93	0.92	2.14	0.39
	Mated yearlings	0.85	0.84	1.94	0.35	0.55	0.55	1.26	0.23
	Rams	1.71	1.69	3.92	-	2.73	2.71	6.27	0.00
Beef sheep	Ewes	0.77	0.77	1.77	0.38	1.08	1.07	2.48	0.54
	Ewe lambs	0.77	0.77	1.77	0.38	1.00	1.00	2.30	0.50
	Mated yearlings	0.77	0.77	1.77	0.38	0.73	0.73	1.68	0.36
	Rams	1.71	1.69	3.92	-	3.07	3.05	7.06	0.00
Breeding swine	Piglets 1.2-20kg	-	-	-	-	0.32	0.17	0.32	0.32
	Piglets 21 kg-51 kg	-	-	-	-	1.06	0.56	1.06	1.06
	Young sows 50-140 kg	-	-	-	-	2.83	1.49	2.83	2.83
	Sows and pregnant gilts	5.46	3.74	5.37	-	4.37	3.02	4.70	4.37
	Hogs	-	-	-	-	4.33	2.27	4.32	4.33
Market Swine	Fattening 1.2-20 kg	-	-	-	-	0.38	0.23	0.40	0.38
	Fattening 21-51 kg	-	-	-	-	1.28	0.78	1.34	1.28
	Fattening 50-80kg	2.35	1.43	2.29	-	2.35	1.43	2.46	2.35
	Fattening 80-110 kg	-	-	-	-	3.97	2.41	4.16	3.97
	Fattening 110 kg <	-	-	-	-	3.97	2.41	4.16	3.97
Goats	Mature female goats	0.85	0.84	1.94	0.35	1.40	1.39	3.22	0.58
	Pregnant goats	-	-	-	-	1.21	1.20	2.78	0.50
	Other goats	-	-	-	-	0.55	0.54	1.26	0.23
Horses	Young horses	-	-	-	-	0.69	0.86	1.43	1.72
	Castrated horses	4.39	5.45	9.10	2.99	1.68	2.09	3.49	4.19

	Stallions	-	-	-	-	1.32	1.64	2.74	3.29
	Mares	-	-	-	-	1.20	1.49	2.49	2.99
Poultry	**Laying hens and cocks**	0.22	0.04	0.19	-	0.32	0.06	0.27	-
	Broilers	0.07	0.03	0.10	-	0.16	0.07	0.22	-
	Turkeys	0.40	0.18	0.31	-	1.12	0.50	0.86	-
	Ducks	0.21	0.16	0.28	-	0.20	0.15	0.26	-
	Geese	0.22	0.03		-	0.73	0.09	0.21	-

*all parameters are weighted average represent aggregation in level SR.

For calculation of ammonia nitrogen (NH_3-N) from housing, storage, spreading and grazing we used TIER 2 methodology from EMEP/EEA emission inventory guidebook 2016. This process has been describe in followed formulas:

1. Assignment of **total nitrogen excretion (NEX_T)** according to the guideline EMEP/EEA, Table 3.7 for species**/**category (T)[25] of farm animals in the county in kg.head-year^{-1}

2. Calculation of **total ammonia nitrogen (TAN_T)** for species/category T of farm animals in kg.head-year^{-1}

$$TAN_T = NEX_T . pTAN_T$$

Where:

$pTAN_T$: proportion of TAN for species/category T of farm animals

2. Calculation of emission factors (EFs)

a/- Determination of basic EFs for housing, storage and spreading (kg.head.year^{-1}) from proportions of their EFs, if whole manure production is in the form solid or slurry (EMEP/EEA emission inventory guidebook, Table 3.7).

aa/- EF_T basic housing (kg.head.year^{-1})

$$EF_{T\ basic\ housing\ slurry} = TAN_T . pEF_{T\ housing\ slurry}$$

$$EF_{T\ basic\ housing\ solid} = TAN_T . pEF_{T\ housing\ solid}$$

ab/- EF_T basic storage (kg.head.year^{-1})

$$EF_{T\ basic\ storage\ slurry} = (TAN_T - EF_{T\ basic\ housing\ slurry} . pEF_{T\ storage\ slurry})$$

$$EF_{T\ basic\ storage\ slurry} = (TAN_T - EF_{T\ basic\ housing\ slurry} . pEF_{T\ storage\ slurry})$$

T...species/category of farm animals in the country

25

ac/- EF basic spreading slurry/solid: (kg.head.year^{-1})

$$EF_{T\ basic\ spreading\ slurry} = (TAN_T - EF_{T\ basic\ housing\ slurry} - EF_{T\ basic\ storage\ slurry}).pEF_{T\ spreading\ slurry}$$

$$EF_{T\ basic\ spreading\ solid} = (TAN_T - EF_{T\ basic\ housing\ solid} - EF_{T\ basic\ storage\ solid}).pEF_{T\ spreading\ solid}$$

Where:

pEF_T: proportion of EF for species/category T of farm animals in the country, specific for housing, storage, spreading, slurry and solid, it expresses proportion (share) of emitted NH_3-N in the given location from total ammonia nitrogen (TAN)

The manure emissions of NH_3-N from housing, storage and spreading will be calculated (**according to the basic EFs) for species/category** T of these farm animals, of which annual manure production will be **either** in the form **solid or slurry** and the animals will be **also not grazed.**

b/- If species/category T of farm animals produces only **one manure form** (solid or slurry) and it **is grazed** during the year we use for calculation of emissions **proportional emission factor (pEF)** for housing, storage, spreading and grazing.

ba/- EF_T proportional housing (kg.head.year$^{-1)}$

$$EF_{T\ proportion\ housing\ slurry} = \left(\frac{EF_{T\ basic\ housing\ slurry}}{100}\right).slurry\ proportional\ (\%)_*$$

$$EF_{T\ proportion\ housing\ solid} = \left(\frac{EF_{T\ basic\ housing\ solid}}{100}\right).solid\ proportinonal\ (\%)_*$$

*On the total manure production

bb/- EF_T proportional storage (kg.head.year$^{-1)}$

$$EF_{T\ proportion\ storage\ slurry} = \left(\frac{EF_{T\ basic\ storage\ slurry}}{100}\right).slurry\ proportional\ (\%)_*$$

$$EF_{T\ proportion\ storage\ solid} = \left(\frac{EF_{T\ basic\ storage\ solid}}{100}\right).solid\ proportional\ (\%)_*$$

*On the total manure production

bc/- EF_T proportional spreading (kg.head.year$^{-1)}$

$$EF_{T\ proportion\ spreading\ slurry} = \left(\frac{EF_{T\ basic\ spreading\ slurry}}{100}\right).slurry\ proportional\ (\%)_*$$

$$EF_{T\ proportion\ spreading\ solid} = \left(\frac{EF_{T\ basic\ spreading\ solid}}{100}\right).solid\ proportional\ (\%)_*$$

*On the total manure production

bd/- EF_T proportional grazing (kg.head.year^{-1})

$$EF_{T\ grazing\ year} = TAN_T\ .pEF_{T\ grazing}$$

Animals are grazed all year

$$EF_{T\ proportional\ grazing} = \left(\frac{EF_{T\ grazing\ year}}{100}\right).\ proportion\ of\ grazing\ (\%)_*$$

*On the total manure production

Where:

$pEF_{T\ grazing}$: proportion of EF for species/category T of farm animals in the country, specific for grazing, it expresses proportion (share) of emitted NH_3-N on the pasture from total ammonia nitrogen (TAN)

c/- If the **species/category** of farm animals produces manure in the **both forms** (**solid and slurry**) and the animals **are not grazed** during the year we use for calculation of emissions **combined emission factors** for housing, storage and spreading.

ca/- EF_T combined housing (kg.head.year^{-1})

$$EF_T = \frac{(EF_{T\ basic\ housing\ slurry}.\ slurry\ proportion\ (\%)_* + EF_{T\ basic\ housing\ solid}.solid\ proportion\ (\%)_*}{100}$$

*On the total manure production

cb/- EF_T combined storage (kg.head.year^{-1})

$$EF_T = \frac{(EF_{T\ basic\ storage\ slurry}.\ slurry\ proportion\ (\%)_* + EF_{T\ basic\ storage\ solid}.solid\ proportion\ (\%)_*}{100}$$

*On the total manure production

cc/- EF_T combined spreading (kg.head.year^{-1})

$$EF_T = \frac{(EF_{T\ basic\ spreading\ slurry} .\ slurry\ proportion\ (\%)_* + EF_{T\ basic\ spreading\ solid} . solid\ proportion\ (\%)_*}{100}$$

*On the total manure production

d/- If the species/category of farm animals produces manure **in the both form (solid and slurry)** and the animals **are grazed** during the year we use for calculation of emissions **combined emission factors** for housing, storage and spreading and **proportional emission factor for grazing.**

da/- EF_T combined housing (kg.head.year^{-1})

$$EF_T = \frac{(EF_{T\ basic\ housing\ slurry} .\ slurry\ proportion\ (\%)_* + EF_{T\ basic\ storage\ solid} . solid\ proportion\ (\%)_*}{(slurry\ proportion\ (\%)_* + solid\ proportion\ (\%)_*)}$$

*On the total manure production

db/- EF_T combined storage (kg.head.year^{-1})

$$EF_T = \frac{(EF_{T\ basic\ storage\ slurry} .\ slurry\ proportion\ (\%)_* + EF_{T\ basic\ storage\ solid} . solid\ proportion\ (\%)_*)}{(slurry\ proportion\ (\%)_* + solid\ proportion\ (\%)_*)}$$

*On the total manure production

bc/- EF_T combined spreading (kg.head.year^{-1})

$$EF_T = \frac{(EF_{T\ basic\ spreading\ slurry} . slurry\ proportion\ (\%)_* + EF_{T\ basic\ spreading\ solid} . solid\ proportion\ (\%)_*)}{(slurry\ proportion\ (\%)_* + solid\ proportion\ (\%)_*)}$$

*On the total manure production

EF_T proportional grazing (kg.head.year^{-1})

$$EF_{T grazing\ year} = TAN_T . pEF_{T\ grazing}$$

Animal are grazed all year

$$EF_{T\ proportional\ grazing} \left(\frac{EF_{T\ grazing\ year}}{100}\right) . proportion\ (\%) of\ grazing_*$$

*on the total manure production

4. From calculated emission factors for housing, storage, spreading (grazing - in the case of grazing animals) we will determine **total emission factor (tEF_T)** for given species/category T of farm animals (kg.head.year^{-1}) by the following equations:

a/- Species/category T of farm animals under point 3a

aa/

$$tEF_T = EF_{T\ basic\ housing\ slurry} + EF_{T\ basic\ storage\ slurry} + EF_{T\ basic\ spreading\ slurry}$$

** manure is in the form liquid (slurry) and the animals are not grazed*

or

ab/

$$tEF_T = EF_{T\ basic\ housing\ solid} + EF_{T\ basic\ storage\ solid} + EF_{T\ basic\ spreading\ solid}$$

**manure is in the form solid and the animals are not grazed*

b/- Species/category T of farm animals under point 3b

ba/

$$tEF_T = EF_{T\ proportional\ housing\ slurry} + EF_{T\ proportionl\ storage\ slurry} + EF_{T\ proportional\ spreading\ slurry} + EF_{T\ proportional\ grazing}$$

**manure is in the form liquid (slurry) and the animals are grazed*

or

bb/

$$tEF_T = EF_{T\ proportional\ housing\ solid} + EF_{T\ proportionl\ storage\ solid} + EF_{T\ proportional\ spreading\ solid} + EF_{T\ proportional\ grazing}$$

**manure is in the form solid and the animals are grazed*

c/- Species/category of farm animals under point 3c

$$tEF_T = EF_{T\ combined\ housing} + EF_{T\ combined\ storage} + EF_{T\ combined\ spreading}$$

**manure is produced in both forms - slurry and solid and the animals are not grazed*

d/- Species/category of farm animals under point 3d

$$tEF_T = EF_{T\ combined\ housing} + EF_{T\ combined\ storage} + EF_{T\ combined\ spreading} + EF_{T\ proportion\ grazing}$$

**manure is produced in both forms - slurry and solid and the animals are grazed*

5. In the next step the total emission factor (tEF_T) for species/category T of farm animals is multiplied by the number of animals for given species/category. Thus were acquired annual emission of ammonia nitrogen (NH_3-N) for given species/category T of farm animals (kg.year^{-1}).

$$E_{AT} = tEF_T \, . N_T$$

Where:

T : species/category of farm animals

N_T: the number of head for species/category T of farm animals in the country

E_{AT} : annual emission of NH_3-N for species/category T of farm animals (kg.year^{-1})

6. Finally, the annual NH_3-N emissions of all species/categories of farm animals will be added together and we receive final emission (**$_f$E**) of ammonia nitrogen from livestock farming for the given year (kg.year^{-1}).

$$fE = \sum E_{AT}$$

Where:

E_{AT}: annual emission for species/category T of farm animals (kg.year^{-1})

fE: final emission of NH_3-N from livestock farming (kg.year^{-1})

The calculation of ammonia nitrogen (NH_3-N) is the same for all species/category of farm animals except for points 3 and 4. In these points the differences will be in determination of EFs and tEFs among the various species/category of farm animals. The classification of farm animals for calculation of EFs and tEFs will be as follow table:

4.1.10 NO_X EMISSIONS FROM MANURE MANAGEMENT (NFR 3.B)

Total NO_x emissions from manure management decreased from 0.75 in 1990 to 0.23 Gg in 2015, which is the decrease by 69% and decrease by nearly 0.5 compared to the previous year. Decreasing trend of number of animals had influence of emissions decrease.

4.1.11 Methodology issue - Method

NO_X emissions from manure management have been calculated using the default Tier 1 emissions factors (***Table 66***) for each categories of farm animals. Methodology is fully accordance to EMEP/EEA emission inventory guidebook

Table 47: *Emissions NOx emissions factors and typical handled systems 2015*

Categories	AWMS	Emissions	Emissions	Emissions No_x
Dairy cows	solid, liquid	0.236	0.011	0.0344
Other cattle	solid, liquid	0.144	0.003	0.0468
Sheep	solid	0.008	-	0.0031
Sows	solid, liquid	0.006	0.204	0.0080
Fattening pigs	solid, liquid	0.002	0.069	0.0422
Goats	Solid	-	0.008	0.0503
Horses	Solid	0.008	-	0.0003
Laying hens	solid, liquid	0.201	-	0.0014
Broilers	Solid	0.005	0.0002	0.0323
Turkeys	Solid	0.002	-	0.0126
Geese	Solid	0.008	-	0.0010
Ducks	Solid	0.002	-	0.0001

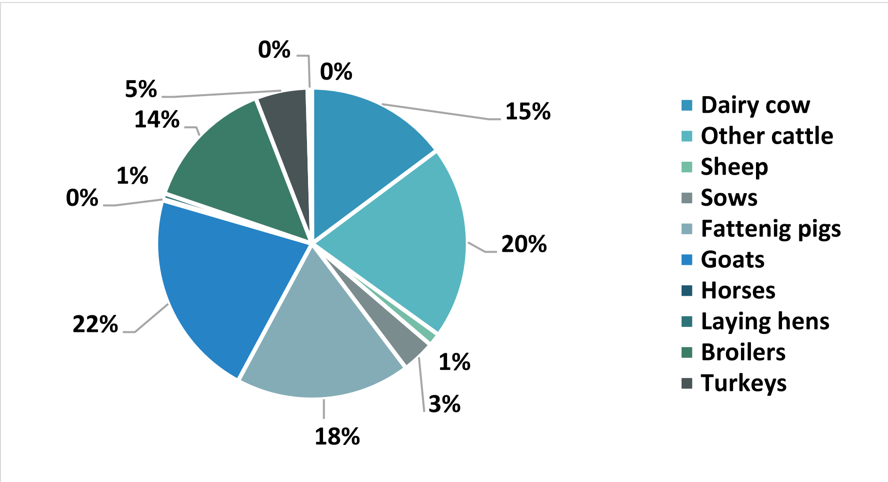


Figure 42: Emissions of nitrogen oxides from manure management in 2015

4.1.12 PM and TSP Emissions from manure management

The significant sources of particular matters are dust from straw, silage and residue of feed. Activity of animals can also this emission cause: feathers from poultry residues skin and other.

4.1.12.1 Methodology issue – Method

PM_{10}, $PM_{2.5}$, TSP emissions from manure management have been calculated using the default Tier 1 emissions factors (Table 67) for each categories of farm animals. Methodology is fully in accordance. Changes were main driver to changes of emissions factors and emissions. In this submissions TSP emissions are reported for the first time. Figures 50 and 51 shows trends of TSP, PM emissions. Total $PM_{2.5}$ and PM_{10} emissions from manure management decreased from 0.52 and 1.59 Gg in 1990 to 0.19

and 0,75 Gg in 2015, which is the decrease by 53% and 64% and decrease by nearly 0.04 and 2% compared to the previous year. Decreasing trend of number of animals had influence of emissions decrease.

Table 48: *Default emission factors*

Category	EF pre PM_{10} [kg/head/year^{-1}]	EF pre $PM_{2.5}$ [kg/head/year^{-1}]	EF pre TSP [kg/head/year^{-1}]
Dairy cattle	0.630	0.410	1.380
Non-dairy cattle	0.270	0.180	0.590
Calves	0.160	0.100	0.340
Sheep	0.060	0.020	0.140
Sows	0.170	0.010	0.620
Fattening pigs	0.140	0.006	4.050
Weaners	0.050	0.002	0.270
Goats	0.060	0.020	0.140
Horses	0.220	0.140	0.480
Laying hens	50.040	0.003	0.190
Broilers	0.020	0.002	0.040
Turkeys	0.110	0.020	0.110
Geese	0.240	0.030	0.240
Ducks	0.140	0.020	0.140

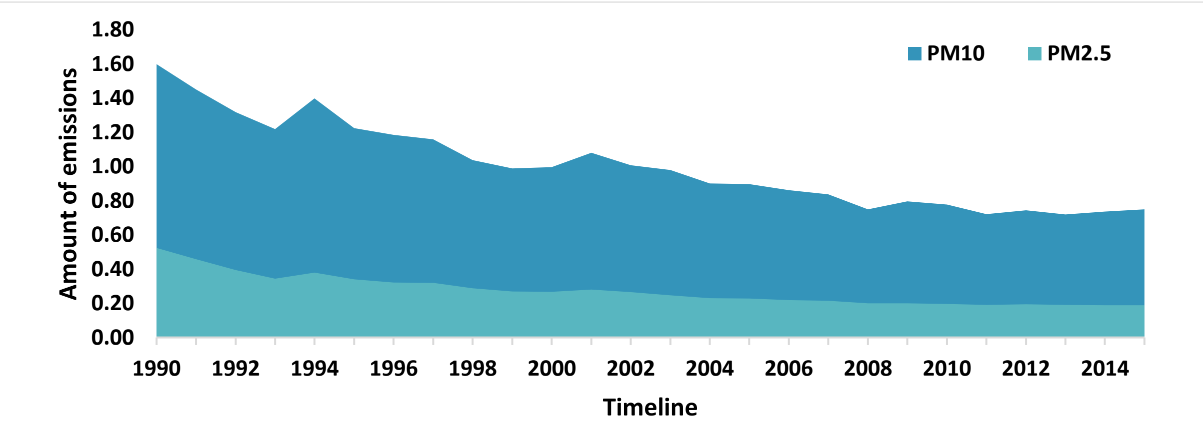


Figure 43: Trend of $PM_{2.5}$ and PM_{10}

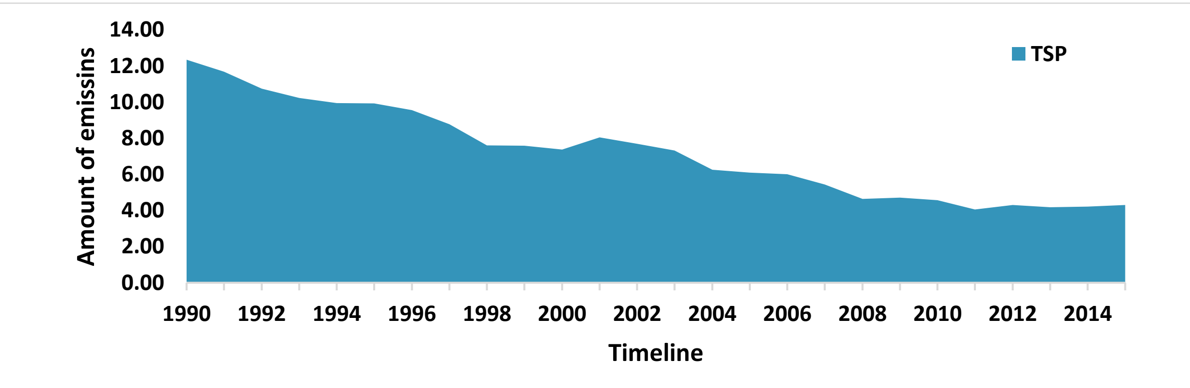


Figure 44: Trend of TSP emissions

4.1.13 NMVOC Emissions

Emissions of NMVOC originated from many sources. One part have risen from at enteric fermentation. This emission are producing in stomach by fermentation of partially digestible and non-digestible fats, carbohydrates and proteins. This pollutions are emitted by breathing and in form flatus. Next part is emitted by storage of silage and dang. Cattle emitted the most emissions of NMVOC in all farm animals (67%), followed poultry (26%), Swine (5%) and other animal. Value of emissions depend from temperature, speed of wind and direction. These parameters take not into the consideration in NMVOC emission balance. NMVOC emissions were estimate also in line with IPCC 2006 GL.

4.1.13.1 Methodological Issues-Methods

In terms of increased transparency in methodology and activity data of cattle, estimation of NMVOC was completed by the available parameters time of housing, feeding situation – amount of silage in ration and gross feed intake. Dairy cattle and non-dairy cattle have been calculated using Tier 2 methodology in accordance EMEP/EEA emission inventory guidebook 2016.

NMVOC for cattle are based on the following equation (EEA, Agriculture, 3B Manure managment, 2016):

$$E_{NMVOC\ i} = N_A.\left(E_{NMVOC,storr\ silage\ i} + E_{NMVOC,silage\ feeding\ i+} + E_{NMVOC,house\ i} + E_{MVOC,applic.i} + E_{NMVOC,pasture\ i}\right)$$

Where:

$$E_{NMVOC,silage\ store\ i} = MJ_i.x_{house\ i}\left(EF_{NMVOC,silage\ feeding\ i}.Frac_{silage}\right)$$

$$E_{NMVOC,\ silage\ feeding\ i} = MJ_i.x_{housing\ i}.\left(EF_{NMVOC\ feed\ silage\ i}.Frac_{silage}\right)$$

$$E_{NMVOC\ house\ i} = MJ_i.x_{house\ i}.\left(EF_{NMVOC\ silage}\right)$$

$$E_{NMVOC\ manure\ store\ i} = E_{NMVOC\ house\ i}.x_{house\ i}.\left(\frac{E_{NH_3\ storage\ i}}{E_{NH_3\ house\ i}}\right)$$

$$E_{NMVOC\ application\ i} = E_{NMVOC\ house\ i}.x_{house\ i}.\left(\frac{E_{NH_3\ appli\ i}}{E_{NH_3\ house\ i}}\right)$$

$$E_{NMVOC\ graz\ i} = MJ_i.(1 - x_{house\ i}).EF_{NMVOC,graz\ i}$$

Where

MJ_i: Gross feed intake in MJ year.

x_i : Share of time the animals spend in the animal house (%).

$Frac_{silage}$: If silage feeding is dominant $Frac_{silage}$ should be equal 1.0.

$Frac_{silage\ store}$: The share of the emission from the silage store compared to the emission from the feeding table in the barn.

$E_{NH_3\ applic\ i}$ $E_{NH_3\ house\ i}$ $E_{NH_3\ storage\ i}$. Emissions for 3.B Manure Management.

Total NMVOC emissions from manure management and enteric fermentation from cattle were estimated based on detailed classification of animals into the following categories: dairy cattle (high producing dairy cows and non-dairy cattle (suckling cows, calves 6 months, heifer, pregnancy heifer, breeding bull, oxen, fattening) and followed parameters table 68.

Table 49: Overview of parameters and emissions factors for cattle categories

Category	Subcategory	$Frac_{silag}$	MJ	EF $Frac_{silag}$	EF Housing	EF Storage	EF Spreading	EF Grazing
			MJ per year		[kg/head/year^{-1}]			
Dairy cows	Dairy cows	0.52	100 461	8.54	2.86	2.52	5.44	0.06
	Calves (6 month)	-	21 309	-	0.75	0.87	1.85	-
	Heifer	0.40	43 712	3.40	1.52	1.71	3.56	0.02
	Heifer pregnant	0.33	61 852	3.97	2.14	2.42	5.18	-
	Fattening	0.52	43 052	4.09	1.52	1.69	3.63	3.30
	Oxen	0.58	80 832	16.18	2.85	3.28	7.02	4.24
Beef cows	Suckling cows	0.07	81 652	0.55	1.30	0.68	1.45	0.31
	Calves (7 month)	0.00	29 608	0.00	0.47	-	0.53	0.12
	Heifer	0.14	49 430	0.61	0.79	0.41	0.88	0.19
	Heifer pregnant	0.15	70 923	0.96	1.13	0.59	1.26	0.27
	Fattening	0.60	49 809	6.02	1.76	1.89	4.32	-
	Oxen	0.58	80 832	9.34	2.85	3.28	7.02	-
	Breeding bull	0.56	61 167	5.16	1.63	1.41	3.01	0.10

*all parameters are weighted average represent aggregation in level SR.

Other farmed animals have been calculated using the default Tier 1 emission factor (EEA, Agriculture, 3B Manure managment, 2016):

Table 50: *Emission factor for other animal without silage feeding (1)*

Category	EF [kg/head/year^{-1}]
Sheep	0.169
Sows	1.704
Fattening pigs	0.551
Goats	0.542
Horses	4.275
Laying hens	0.165
Broilers	0.489
Turkeys	0.489
Ducks	0.489
Geese	0.489

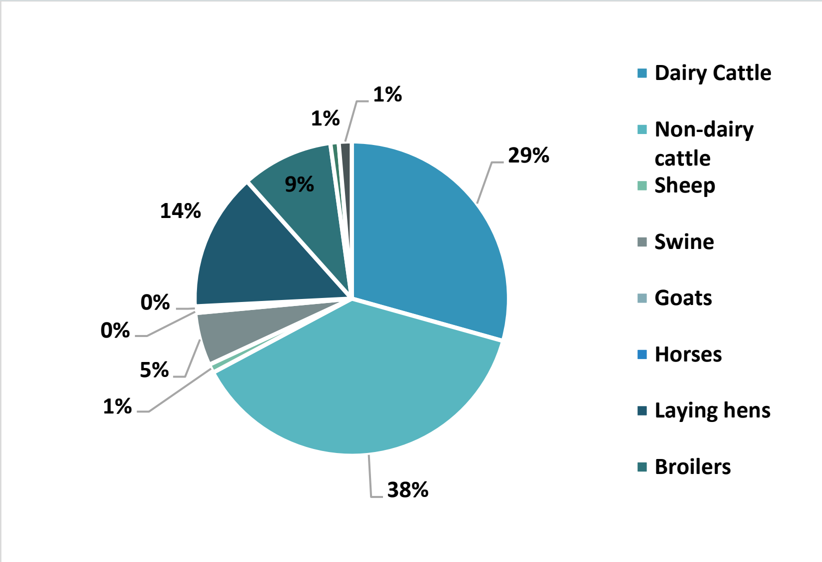


Figure 45: *Share of NMVOC emission from total emissions for Manure management*

4.1.14 AGRICULTURAL SOILS (NFR 3.D)

The amounts of synthetic fertilizers into cultivated soils have been low for the last 15 years.

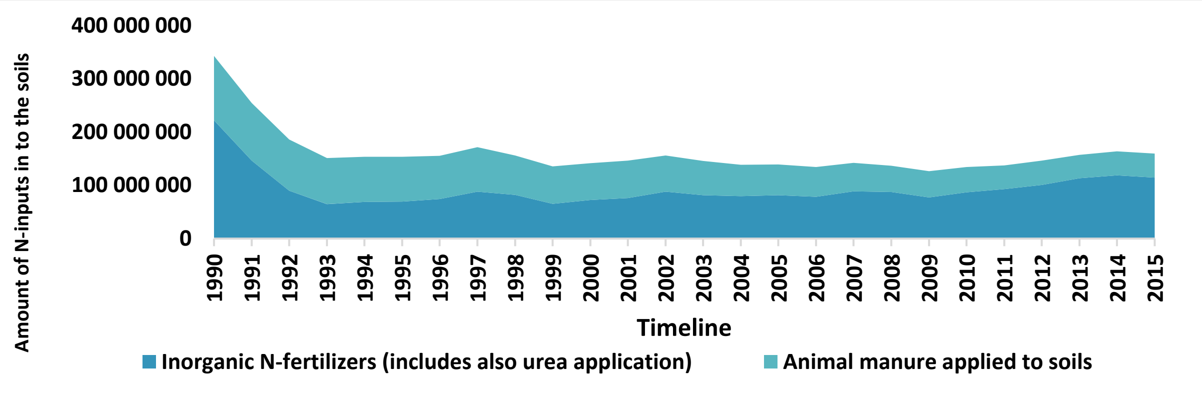


Figure 46: Trend of N inputs in to the soils.

The applied amounts of synthetic fertilizers into cultivated soils have been very low for the last 15 years. The potential for the volatilization of ammonia emissions can vary in a very large range. Emissions depend on the type of fertilizers, soil parameters pH. Urea can easily hydrolyzed by the enzyme urease to ammonium carbonate and ammonium cation, that is a major source of ammonia emissions. The volatility of ammonia depend on the pH in the soil. If the soil acidic is below 7 - volatility is low. If the pH is above 7 - the volatility have of the higher potential.

The data on the production of nitrogen from the excreta of domestic livestock are influenced by N production of domestic livestock and the number of domestic livestock according to the categories.

Total NH_3 emissions from agricultural soils were 16.73 Gg in 2015. The emissions decreased by almost 1% in comparison with 2014. In comparison with 1990 emissions decreased by almost 57%. Amount of synthetic fertilizers decrease almost 48%, N from application animal manure to soil also decrease to 63%. The major reason for the decreasing trend is a sharp decrease in the use of synthetic fertilizers and continual decrease in the use of animal manure (see Figure 59).

In the Slovakia inventory comprises source category 3.D Agricultural Soil NH_3 and NO_x emission from Application of inorganic N fertilizers (3.D.a.1).Animal manure applied to soil (3.D.a.2.a) and Urine and Dung deposited by grazing animals (3.B.a.3). This emission source is reported under NFR category 3.D Agricultural Soils in compliance with the revised EMEP/EEA Reporting Guidelines 2016.

4.1.15 Category-specific improvements and implementation of recommendations

For the first time, emission calculation of NH_3 and NO_x from Sewage sludge applied to soil have been performed. The estimation using the Tier 1 methodology follow the current version of the EMEP/EEA Guidebook 2016

No emissions are reported in the categories:

- 3. D.a.2.c Other organic fertilizers applied to soils.

  Notation key: NE

  These activities are carried out in the Slovak Republic, but there is no available activity data about compost used to the soils in the Slovak Republic.

- 3.D.f Use of pesticides

Notation key: NA

These activities are carried out in the Slovak republic. There is no available emissions factors and methodology for types of used pesticides in Slovak Republic. In previous submissions, the reported values was hexachlorbenzene. This value was based only on the estimation. Chemical substances mentioned in EMEP/EEA Guidebook 2016 were forbidden in consonance with Stockholm Convention on Persistent Organic Pollutants and these substances are not used in pesticides in territory of the Slovak Republic.

4.1.16 Activity data

Data of sown areas were taken from Statistical Office in Slovak Republic. Data is available each 20 May every year

Table 51: *Sown area in thousand hectares for years 1990-1999 (3)*

Years	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Sown area in thousand ha	**1332.98**	**1343.40**	**1348.15**	**1277.42**	**1331.01**	**1396.92**	**1434.74**	**1424.98**	**1431.34**	**1435.98**
Wheat (ha)	412 423	418 158	408 196	354 431	398 058	442 874	437 846	417 562	415 033	431 700
Rye (ha)	40 474	46 335	38 332	23 637	23 196	31 162	31 201	29 019	29 745	34 400
Rape (ha)	67 087	70 906	91 622	67 351	74 760	87 883	125 691	136 400	140 562	140 250
Grass (ha)	813 000	808 000	810 000	832 000	835 000	835 000	840 000	842 000	846 000	829 631

Table 52: *Sown areas in thousand hectares for years 2000-2007 (3)*

Years	2000	2001	2002	2003	2004	2005	2006	2007
Sown area in thousand ha	**1371.40**	**1470.68**	**1527.88**	**1505.48**	**1401.08**	**1457.08**	**1488.30**	**1490.90**
Wheat (ha)	295 800	405 200	448 900	405 800	306 900	367 800	349 105	360 786
Rye (ha)	29 800	31 500	38 200	38 000	25 200	32 500	28 717	36 408
Rape (ha)	225 800	173 900	180 700	201 600	208 900	196 700	250 397	233 620
Grass (ha)	820 000	860 084	860 084	860 084	860 084	860 084	860 084	860 084

Table 53: *Sown areas in thousand hectares for years 2008-2015 (3)*

Years	2008	2009	2010	2011	2012	2013	2014	2015
Sown area in thousand ha	**1524.46**	**1540.55**	**1504.41**	**1499.13**	**1477.98**	**1487.30**	**1510.39**	**1498.86**
Wheat (ha)	373 662	379 195	349 679	364 047	388 147	367 682	379 283	380 163
Rye (ha)	41 388	33 555	29 370	13 358	28 568	35 408	29 369	15 175
Rape (ha)	249 327	267 713	265 281	261 639	201 178	224 124	241 659	243 435
Grass (ha)	860 084	860 084	860 084	860 084	860 084	860 084	860 084	860 084

4.1.17 Inorganic N-fertilizers (NFR 3.D.a.1)

Activity data on synthetic fertilizers consumption in agriculture is based on the data provided by the Statistical Office of the Slovak Republic and the Ministry of Agriculture and Rural Development of the Slovak Republic and its research organization.

Trends

Amount inorganic nitrogen applied to the soil continual decrease. To the compared application inorganic nitrogen from 1990 considerably decrease (-48%). To the compared year 2014 decreased almost 4%. Fertilization is regulated by Act No. 202/2008 Coll., which ensures to avoid over fertilization of soils and subsequent contamination of the environment. For small and medium farmers, are available a code of good agricultural practice - *Proper use of fertilizers and water protection against pollution caused by nitrates from agricultural production in Slovak Republic*

4.1.18 Methodological ISSUES

Calculation of ammonia emissions from synthetic fertilizers are an accordance EMEP/EEA Guidebook 2016. Emissions factor see in the table (Table 73) (EEA, Agriculture, 3B Manure managment, 2016).

Table 54: *Inorganic nitrogen fertilizer of net nutrients, used emissions factors and calculate emissions.*

Years	N-input in	EFs	EFs	NH_3 emissions	NO_x emissions
	[kg/year]	[kg NH_3/kg N]	[kg NO_x/kg N]	[Gg]	[Gg]
1990	222 255 000	0.05	0.04	11.113	8.890
1991	146 341 000	0.05	0.04	7.317	5.854
1992	90 186 000	0.05	0.04	4.509	3.607
1993	64 852 000	0.05	0.04	3.243	2.594
1994	68 669 000	0.05	0.04	3.433	2.747
1995	69 587 000	0.05	0.04	3.479	2.783
1996	74 464 000	0.05	0.04	3.723	2.979
1997	88 017 000	0.05	0.04	4.401	3.521
1998	81 842 000	0.05	0.04	4.092	3.274
1999	65 392 000	0.05	0.04	3.270	2.616
2000	72 653 000	0.05	0.04	3.633	2.906
2001	76 032 000	0.05	0.04	3.802	3.041
2002	88 260 000	0.05	0.04	4.413	3.530
2003	81 300 000	0.05	0.04	4.065	3.252
2004	79 911 000	0.05	0.04	3.996	3.196
2005	81 317 000	0.05	0.04	4.066	3.253
2006	78 681 120	0.05	0.04	3.934	3.147
2007	88 935 400	0.05	0.04	4.447	3.557
2008	87 736 950	0.05	0.04	4.387	3.509
2009	77 058 450	0.05	0.04	3.853	3.082
2010	86 873 000	0.05	0.04	4.344	3.475
2011	92 969 000	0.05	0.04	4.648	3.719
2012	101 004 000	0.05	0.04	5.050	4.040
2013	113 581 390	0.05	0.04	5.679	4.543
2014	119 036 050	0.05	0.04	5.952	4.761
2015	114 773 000	0.05	0.04	5.739	4.591
Trend 1990-2015	-48.4%				
Trend 2014-2015	-3.6%				

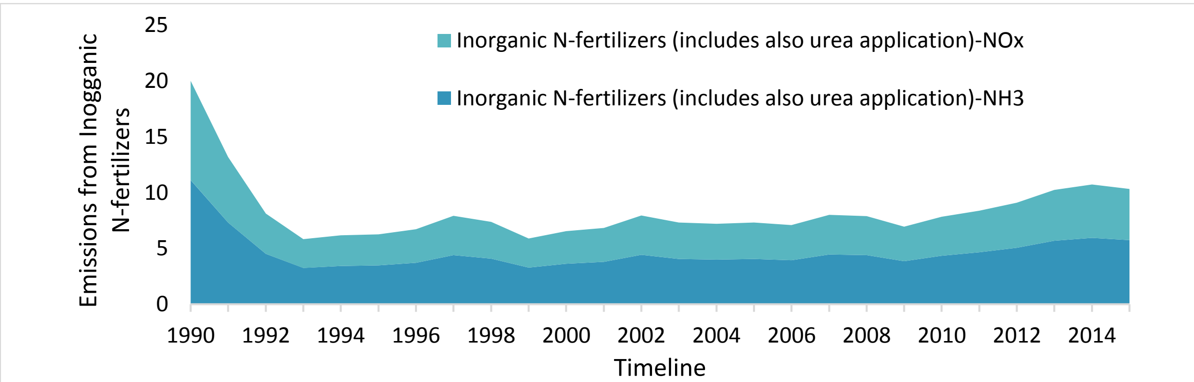


Figure 47: *Trends of emissions from Inorganic N-fertilizers*

4.1.19 Organic N-fertilizers applied to soils (NFR 3.D.a.2.a)

4.1.19.1 Animal manure applied to the soils (NFR 3.D.a.2.a)

Livestock number and information on animal waste management systems are described in chapter 4.6.Dung from livestock farming and storage are applied to the agricultural soils. This application is connected with utilization NH_3, PM, NMVOC, N_2O and NO_x losses. A detailed description of the methods applied for the calculation of N_2O emissions is given in the report "Slovakia´s National Inventory Report 2016" – Submission under the United Nations Framework Convention on Climate Change and the Kyoto Protocol". For this calculation has been applied a country specific methodology.

At application evaporate around 50% of ammonia. During this operation are the highest emissions of ammonia. During application (spreading) is formed on the fields a huge evaporating surface. Emissions are highest in windy and hot weather, by high humidity and permeability of the soil (BRESTENSKÝ).
Each farmer should be manure as quickly as possible to soil direct apply. After the ammonia losses are low. The crops have sufficient of nitrogen for grown. Ministry of Agriculture and Rural development issue Regulation Decree No 338/2005 Coll. ordering the solid into the soil organic fertilizers in 48 hours, and the liquid from arable land to 24 hours after application. This regulation is rather to prevent rafting fertilizers into surface waters as to prevent the escape of ammonia, because ammonia emissions are substantially immediately after application. First 6 hours after application evaporate of 50 % ammonia, then emissions decreased (BRESTENSKÝ).

4.1.20 Methodological ISSUES

The direct inputs of nitrogen slightly vary according to the applied methodology. Based on the IPCC 2006 GL total nitrogen excretion per liquid (11 949.1 t/N/year) and solid system (32 711.1t/N/year) in manure management in 2015 were used for the estimation of total nitrogen input of manure applied to soils.

Calculated amount of nitrogen input from animal waste applied to soils was 44 660.2t/N/year. Default EF is 0.04. Total amount of NO emissions from animal excreta applied to soils were 1.786 Gg in 2015. NH_3 emissions were 10.23 Gg and NMVOC emissions were 1.62 Gg in 2015. Trends of these emissions shown figures 60,61 and 62.

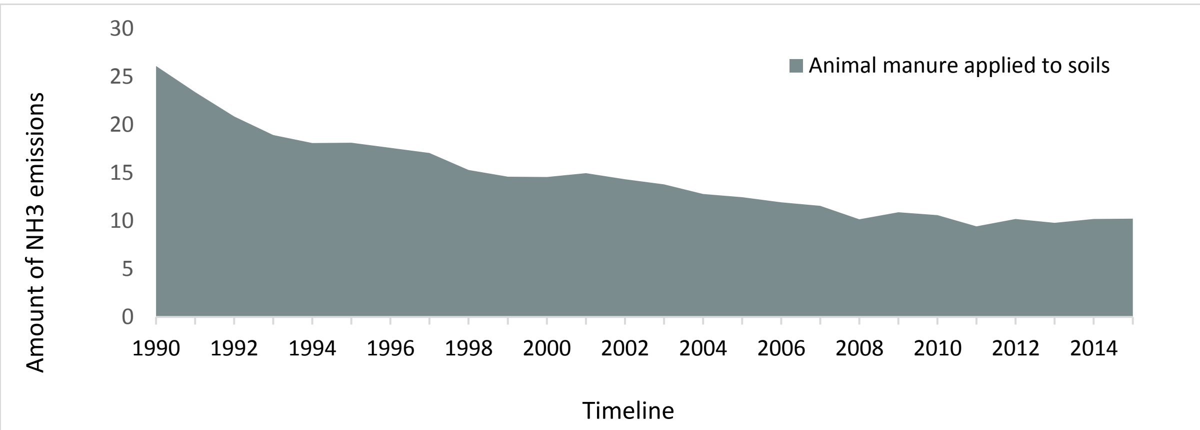


Figure 48: Trend of NH_3 emissions from Animal manure applied to soils

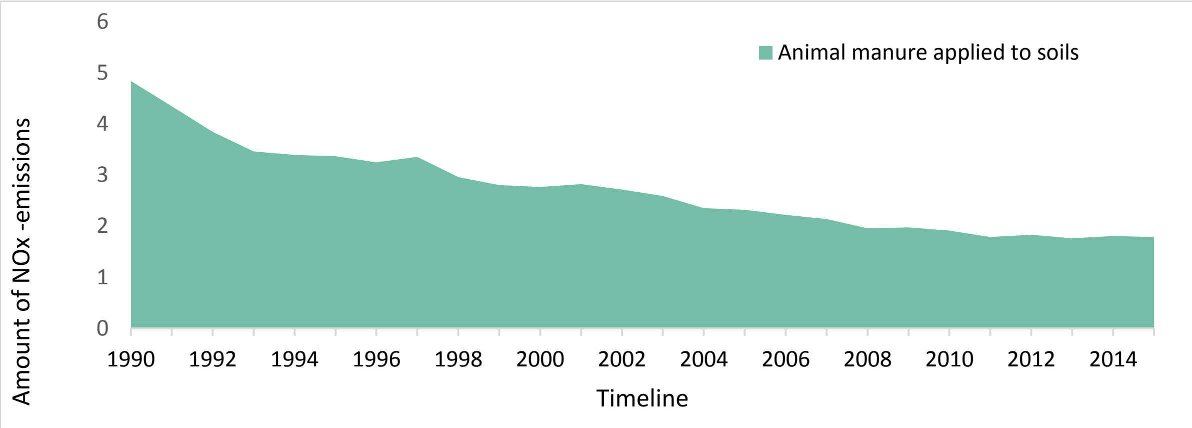


Figure 49: Trend of NO_x emissions from Animal manure applied to soils

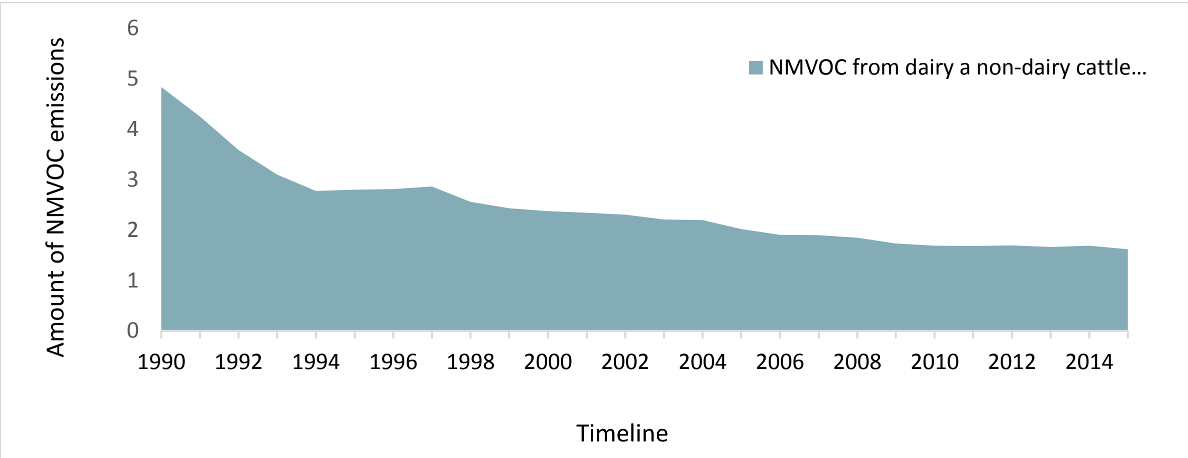


Figure 50: Trend of NMVOC emissions from Animal manure applied to soils

4.1.21 Sewage sludge applied to soils (NFR 3Da2b)

Reduction of organic matter in soil is dependent on the continuous decline in livestock production. Decrease of the amount of organic fertilizers causes pressure to find alternative sources of organic fertilizers. Sewage sludge is one of source to resolve this issue. The sludge is a potential source of nutrients and organic matter. Sewage sludge must be stabilized, then will applied in to the soils. Sludge must be biological, chemical or heat treatment, long-term storage or any other appropriate process. These processes cause significant reduction health risks and save the environment. Application of sludge to agricultural soils regulates law No 188/2003 Coll. It is possible pursuant to law No 188/2003 Coll. apply to only cropland from sewage sludge treatment plants cleaning wastewater from domestic or urban waste water.

4.1.21.1 Methodological issues – methods

Default methodology tier 1 and default emission factors were used for the estimation of NO and NH_3 emissions from sewage sludge applied to soils. Methodology was accordance with EMEP/EEA Guidebook 2016. Percentage of pure nitrogen in sewage sludge was provided from the Soil Science and Conservation Research Institute.[26]

In year 2015 sewage sludges have not been applied in to the agricultural soils. If emission will be estimated, calculation will be made by using these equation:

$$A_{sewage\ sludge} = N_{sewage\ sludge} * P_N$$

$$NO_{sewage\ sludge} = A_{sewage\ sludge} * EF_{NO}$$

$$NH_{3\ sewage\ sludge} = A_{sewage\ sludge} * EF_{NH3}$$

Where: $NH_{3\ sewage\ sludge}$, $NO_{sewage\ sludge}$: Emissions from sewage sludge applied in to the soil in kg, $N_{Sewage\ sludge}$: amount of sludge from waste water treatment in kg, P_N: Weight percentage of nitrogen from sewage sludge (3.31%), $EF_{NO,\ NH3}$: Emissions factors for NH_3 and NO kg NO respectively NH_3.

4.1.21.2 Activity data

Activity data on sewage sludge consumption in agriculture is based on the data provided by the Water Research Institute. Sewage sludge was applied into the soil even before year 2010, but there are no data available- notation key NE. In year 2015 Water Research Institute recognize, that sewage sludges not applied in to the agricultural soils. This is the reason, why we submitted notation key NO. Table 74 shown available data

Table 55: Input parameters and EFs in category 3.D.1.2 Sewage sludge in particular years

YEARS	Input in to the soil (kg/year)	N-input from sewage sludge (kg/year)	NH_3 emissions (Gg)	NO_x emissions (Gg)
2010	923 000	30 551	0,002016	0,000061
2011	358 000	11 850	0,000782	0,000024
2012	1 254 000	41 507	0,002739	0,000083
2013	518 000	17 146	0,001132	0,000034
2014	8 000	265	0,000017	0,000001
2015	NO	NO	NO	NO

[26]Guideline for sewage sludge application (In Slovak):http://www.vupop.sk/dokumenty/prv/prirucka_pre_aplikaciu_kalu.pdf

4.1.22 Other Organic Fertilizers applied to soils (NFR 3Da2c)

Compost deposing on cropland has very limited use (mostly in small private gardens, not industrial) in the Slovak Republic. Available data on the real amount of compost applied on soil is missing in the database of the special institute (The Central Controlling and Testing Institute in Agriculture) dealing with organic and inorganic fertilizers has no data about it. Notation key for this category is NE in time series.

4.1.23 Urine and dung deposited by grazing animals (NFR 3.D.a.3)

Pasture is typical for some livestock categories. Animals graze mainly during spring, summer and autumn in the small farm. During the winter are in own winter grounds. In the Slovak condition were grazed sheep, goats, horses and some subcategories of cattle. NH_3 emissions from pasture were based on the proportion of the pasture for housing that was made by the Research Institute for Animal Production in Nitra. Proportion of the pasture for category of animal's shows table 47.

4.1.23.1 Methodological issues – methods

It is supposed that sheep, goats and horses can stay at pasture for 200 days, 41% of dairy cattle stay only for 150 days. Results of the analysis on animal waste management system were used for the calculation of nitrogen input from animal husbandry into N-cycle. This analysis was based on the questionnaires from 222 agricultural subjects (21.3% of total amount of subjects in the Slovak Republic). These subjects cultivated 14.7% of total agricultural land and 15.2% of arable land. The storage of dry manures is probably more frequent than the questionnaires showed and the emissions from AWMS will be higher. Housing at grasslands from April to October is frequent for sheep, goats and horses. The duration of grazing period can vary significantly depending on weather conditions in different parts of the Slovak Republic. Reliable data for statistical evaluation is not available, but significant differences can be found in this regard.

The estimation of NH_3 from pasture of animals is based on Tier 2 method, which according to EMEP/EEA Guidebook 2016.

NMVOC estimation is included only pasture from cattle category. This Methodology is based on Tier 2 method, which according to EMEP/EEA Guidebook 2016 and is in line to GHG inventory. Calculation is based on this formula:

$E_{NMVOC\ graz\ i} = MJ_i . (1 - x_{house\ i}). EF_{NMVOC,graz\ i}$

Where:

MJ_i: Gross feed intake in MJ year.

x_i : Share of time the animals spend in the animal house (%).

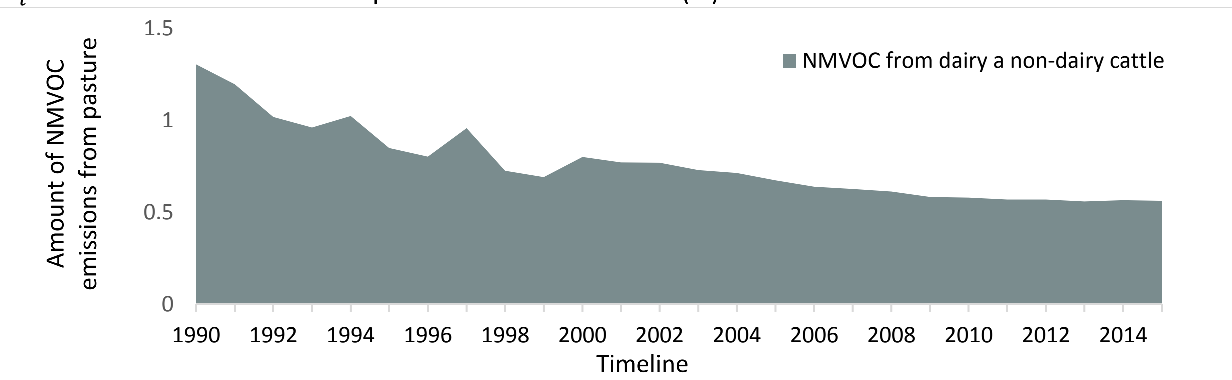


Figure 51: Trend of NMVOC emissions from Urine and dung deposited by grazing animals

Nitrogen excretions per AWMS estimated by manure management category. Total nitrogen from pasture was 9278.61 in 2015. Total emissions of NH_3 from pasture of animals were 0.76 Gg of NH3 and 0.144 of NMVOC in 2015. This category is estimated in the connection with the category manure management.

4.1.23.2 Activity data

Activity data are summarized in Table 47. Activity data on manure deposited on pasture is based on the data provided by the Ministry of Agriculture and Rural Development of the Slovak Republic and its research organisation Research Institute for Animal Production Nitra. Activity data in this category are in consistency with the activity data in category 3.B.2.2manure management.

4.1.24 PM and TSP emissions from Farm-level agricultural operations including storage, handling and transport of agricultural products (NFR 3Dc)

Particular matter have been emitted mostly when, farmers plowed of agricultural soils. This pollutions have small diameter in the other of microns. They are dangerous for health, because in breading penetrate into the lungs. Emissions of particular matter depend from clime condition.

4.1.24.1 Methodological ISSUES

Pollution $PM_{2.5}$, PM_{10} and TSP have been calculated by using Tier 1 methodology from EMEP/EEA Guideline 2016. Information was available about annual sown areas. This information have been provided by Statistical Office in Slovakia Republic.

Emissions should be calculated by multiplying the sowed area of crop by the emissions factors.

$$E_{PM} = EF_{PM} * \sum S_{area}$$

Where:

E_{PM} Emissions PM_{10} and $PM_{2.5}$ (kg.a^{-1}),EF_{PM} Annual default emission factor in (kg ha^{-1}),
S_{area} Annual sown area of the crop in ha.

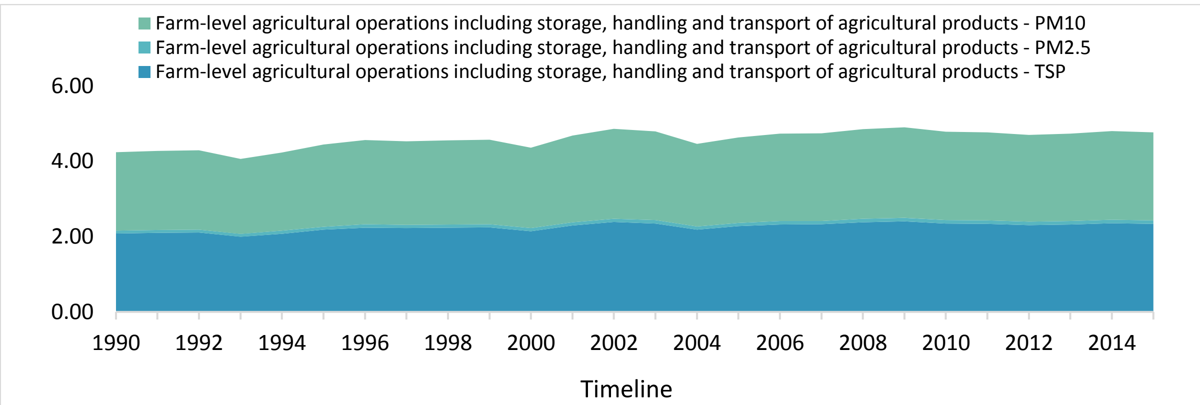


Figure 52: *Trends of emissions particulate matters from farm-level agricultural operations including storage handling and transport of agricultural products*

4.1.25 NMVOC Emissions from Cultivated crops

By crop production were NMVOC emitted mostly during changes in temperature and light intensity, during the growth phase of plants in air pollution and the aging plants. Specifically observed substances, alcohols, aldehydes monoterpenes, isoprene. (EEA, 3.D Crop production and agricultural soils, 2016).

4.1.25.1 Methodological ISSUES

EMEP/EEA Tier 1 simpler methodology was applied. We used for calculation default emission factor in EMEP/EEA emission inventory guidebook 2016 (Table 3-1) (EEA, 3.D Crop production and agricultural soils, 2016)

$$E_{NMVOC} = S_{Area} * EF_{NMVOC}$$

Where:

E_{NMVOC}: amount of pollutant emitted (kg), S_{Area}: annual sown area (ha), EF_{NMVOC}: annual default emission factor (kg.ha^{-1})

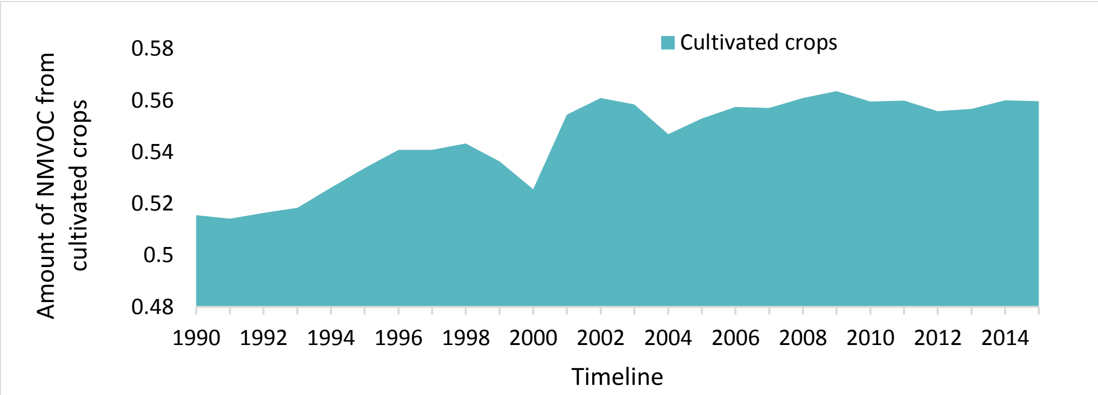


Figure 53: *Trend of NMVOC emissions from cultivated crops*

4.2 Bibliography

BRESTENSKÝ, V. (dátum neznámy). *Straty hmotnosti dusíka pri manipulácií s maštalným hnojom.* Cit. 27. January 2016. Online: Národná poľnohospodárske a potravinárske centrum: http://www.cvzv.sk/index.php/sk/poradcovia-cvzv-nitra/148-ing-vojtech-brestensky-csc

EEA. (7. March 2016). *3.D Crop production and agricultural soils.* Cit. 5. November 2015. Dostupné na Internete: European Environment Agency: http://www.eea.europa.eu/publications/emep-eea-guidebook-2016

EEA. (March. 7 2016). *Agriculture, 3B Manure managment.* Cit. 29. Október 2015. Online: European Environment Agency: http://www.eea.europa.eu/publications/emep-eea-guidebook-2016

SO, S. (2016). *Statistical yearbook of the Slovak Republic.* Bratislava: VEDA Publishing House of the Slovak Academy of Sciences.

5 WASTE (NFR 5)

5.1 OVERVIEW OF THE SECTOR

The chapter represents the emissions from the activities involved in the NFR categories listed in ***Table 56***. Waste sector emits all reported pollutants (ammonia, sulphur oxides, heavy metals, particular matters, black carbon, carbon oxides, persistent organic pollutants, non-methane organic pollutants, nitrogen oxides) due to the variety of activities, which they are rising from and diverse waste treatment manners. This year time series were completed. Emissions from Waste sector, which were calculated in NEIS, was reconstructing with help extrapolation and also expert judgement.

***Table 56**: Categories included in NFR 5: Waste*

NFR Code	Longname
5A	Biological treatment of waste - Solid waste disposal on land
5B1	Biological treatment of waste - Composting
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities
5C1a	Municipal waste incineration
5C1bi	Industrial waste incineration
5C1bii	Hazardous waste incineration
5C1biii	Clinical waste incineration
5C1biv	Sewage sludge incineration
5C1bv	Cremation
5C1bvi	Other waste incineration
5C2	Open burning of waste
5D1	Domestic wastewater handling
5D2	Industrial wastewater handling
5D3	Other wastewater handling
5E	Other waste
6A	Other (included in national total for entire territory)

The two sources of activity data and emissions are used (NEIS and data from the statistics - in detail specified in each category chapter). In line with statistics, total waste is classified and treated by three ways: a/ recovery (material recycling – not involved in inventory, incineration with energy recovery – relevant emissions allocated in energy chapter, composted – included here); b/ disposal (landfilling and incineration without energy recovery – included here) or c/ waste temporary stored in place of origin – not included in inventory.

According to the annual statistics of Statistical Office of the Slovak Republic 8675 kt of total industrial and other waste was produced in year 2015. The amount significantly increased compared to year 2014 (by 16.7%)[32] and slightly increased by 6.9%[27] compared to 2013. The largest share represents the waste from industrial production (47.95%)[32]. Stimulating of the economy had an influence on the amount of produced industrial waste. The second major share represents construction waste (33.6%)[32]. Mortgages availability for wider range of population caused a construction activity increase. Construction production raised (by 11.5 %)[32] in the Slovak Republic compared in previous year (new construction of houses, apartments and civil engineering works, modernization of old building and engineering works.

Total municipal waste produced in the Slovak republic in 2015 was 1 838 kt. Amount of municipal waste slightly increase compared in previously year (2.7%)[32]. Generation of the municipal waste per capita in Slovak republic is still below the European average. However, the prevailing treatment way is

[27] Statistical Office of the Slovak Republic http://www.statistics.sk/pls/elisw/vbd

disposal by disposal on land (69%)[32]or combustion and there is insufficiency in recycling and recovery. Slovak Republic recovered in year 2015 10.1%[32] of municipal waste.

5.2 TRENDS IN WASTE SECTOR

In the overall emission inventory of the Slovak Republic the share of waste sector is up to 5% in all reported time range except on NMVOC that vary in range up to 8%. (

Table 1*;*Table 2*;*Table 3*;*Table 4*;*Table 5). Therefore it is not considered as a key sector. Summary values for waste categories are given in the ***Table 57.*** The overall trend dramatically decline since 1990 due to the continual development of the legislative[28].

---

[28] *Act No 223/2001 Coll*. on wastes and on amendment and implement of some acts in wording of the Act No 553/2001 Coll. the *Act No 96/2002 Coll*., the Act No 261/2002, the *Act No 393/2002*, the *Act No 529/2002* Coll., *the Act No 188/2003* Coll., the *Act No 245/2003 Coll*., the *Act No 525/2003 Coll.,* the *Act No 24/2004 Coll*. and the *Act No 443/2004 Coll*., the Act *No 587/2004 Coll*., *Act No 733/2004* Coll., *Act No 479/2005* Coll., *Act No 532/2005* Coll., *Act No 571/2005* Coll. and *Act No 127/2006* Coll.
Act No 17/2004 Coll. on charges for placing of wastes of some acts in wording of the *Act No 587/2004* Coll.
Act No 127/2006 Coll. about persistent organic pollutants of some acts in wording of *Act No 223/2001* Coll. on wastes and on amendment and implement of some acts in wording.
Government Order No 153/2004 Coll. establishing obligatory limits on reuse of parts of end-of life vehicles and on recovery and recycling of wastes from end of life vehicles treatment (i.e. recovery and recycling limits).
Government Order No 388/2005 Coll. on obligatory limits for electro waste and electronic equipment recovery, re-use and recycling of components, materials and substances
Decree No 283/2001 Coll. on implementation of some provisions of the act on wastes in wording of the *Decree No 509/2002 Coll*. and of the *Decree No 128/2004 Coll*., and *Government Order No 599/2005 Coll*.
Decree of Ministry of Environment of the Slovak Republic *No 284/2001 Coll*. setting up a Waste catalogue in the wording of the *Decree No 409/2002 Coll*. and in wording of the *Decree No 129/2004 Coll*.
Decree of Ministry of Environment of the Slovak Republic *No 125/2004 Coll*. on details of down details concerning the processing of old vehicles treatment and on some demand on vehicle processing
Decree of Ministry of Environment of the Slovak Republic *No 126/2004 Coll*. on authorization, on issuing expert opinions, on authorized persons in waste management and on verification of professional skills those persons as amended by *Decree* of Ministry of Environment of the Slovak Republic *No 209/2005 Coll*.
Decree of the Ministry of Environment of the Slovak Republic *No 127/2004 Coll*. on calculation of recycle fund fees, on recycle fund list of liable products, materials and equipment and on contents of application on recycle fund grants and on details of application form concerning financial contribution granted by Recycling Fund as amended by *Decree* of the Ministry of Environment of the Slovak Republic *No 359/2005 Coll*.
Decree of the Ministry of Environment of the Slovak Republic *No 135/2004 Coll*. on decontamination of facilities containing polychlorinated biphenyls.
Decree of the Ministry of Environment of the Slovak Republic *No 208/2005 Coll*. on electrical waste and electrical equipment management
Declaration of the Ministry of Foreign Affairs of the Slovak Republic *No 60/1995 Coll*. on accession of the Slovak Republic to Basel convention on management of cross - border movement and dispersal of hazardous waste
Declaration of the Ministry of Foreign Affairs of the Slovak Republic *No 593/2004 Coll*. on accession of the Slovak Republic to Stockholm Convention on Persistent Organic Pollutants
Act No 529/2002 Coll. on packaging and about change and amendment implemented of some acts in wording Act No *245/2003 Coll., Act No 525/2003 Coll., Act No 24/2004 Coll., Act No 443/2004 Coll., Act No 587/2004 Coll. and Act No 733/2004 Coll.*
Government Order No 220/2005 Coll. establishing obligatory limits on the extent of recovery of packaging waste and to the extent of their recycling in relation to the total weight of packaging waste.
Decree of the Ministry of Environment of the Slovak Republic *No 732/2002* Coll. on list of backup packaging that are not reusable and on a financial deposit for them and for backup reusable packaging.
Decree of the Ministry of Environment of the Slovak Republic *No 210/2005 Coll*. on implementing certain provisions of the Act on Packaging

Table 57: The overview of the WASTE pollutants emissions and their trends

WASTE SECTOR	NO_X [kt]	NMVOC [kt]	SO_X [kt]	NH_3 [kt]	TSP [kt]	CO [kt]	Hg [t]
1990	0.545	1.805	0.840	1.283	0.548	0.183	0.357
1991	0.439	1.618	0.672	1.226	0.468	0.149	0.213
1992	0.416	1.543	0.634	1.219	0.451	0.142	0.202
1993	0.310	1.356	0.466	1.205	0.371	0.108	0.150
1994	0.348	1.366	0.527	1.199	0.402	0.120	0.170
1995	0.300	1.259	0.451	1.191	0.367	0.104	0.146
1996	0.316	1.241	0.478	1.167	0.381	0.110	0.154
1997	0.308	1.186	0.463	1.137	0.376	0.107	0.150
1998	0.270	1.087	0.402	1.104	0.348	0.094	0.132
1999	0.264	1.031	0.391	1.072	0.325	0.092	0.130
2000	0.294	1.032	0.439	1.021	0.354	0.101	0.145
2001	0.304	0.991	0.588	0.804	0.399	0.107	0.144
2002	0.352	0.978	0.478	0.799	0.431	0.142	0.155
2003	0.429	0.965	0.475	0.760	0.354	0.140	0.167
2004	0.173	1.078	0.369	0.709	0.310	0.044	0.173
2005	0.159	1.110	0.298	0.666	0.277	0.039	0.126
2006	0.146	0.477	0.258	0.653	0.261	0.023	0.250
2007	0.101	0.475	0.011	0.584	0.183	0.009	0.192
2008	0.078	0.121	0.010	0.521	0.183	0.004	0.086
2009	0.057	0.511	0.006	0.497	0.179	0.004	0.063
2010	0.040	0.570	0.003	0.446	0.182	0.004	0.202
2011	0.051	0.475	0.002	0.282	0.201	0.004	0.097
2012	0.042	0.486	0.002	0.236	0.197	0.007	0.183
2013	0.033	0.546	0.002	0.245	0.189	0.006	0.173
2014	0.029	0.353	0.001	0.237	0.165	0.007	0.154
Trend 1990/2015	-95.55%	-70.68%	-99.71%	-80.90%	-64.98%	-97.86%	-62.08%
Trend 2013/2014	-12.20%	-35.47%	-17.61%	-3.44%	-12.34%	25.35%	-11.30%
Trend 2014/2015	-16.95%	50.07%	88.72%	3.61%	15.99%	-45.22%	-11.92%

5.2.1 Methodological issue - methods

The inventory in waste sector was also revised. Reporting was completed by several categories. The methodology used for each category is summarised in the following table.

Table 58: The overview of activity data, method and Tier used for WASTE categories

NFR	**Tier**	**AD source**	**NEIS categories (Decree No 410/2012)**	**Method for 2016 reporting**	**Alloc./ NK**
5A	T1	ŠÚSR	-	$Em_{TOTAL} = AD * Ef_{(GB2016)}$	
5B1	T3	NEIS	NEIS: 5.4	Em_{TOTAL} = 100% NEIS	
5B2	T3	NEIS	NEIS: 5.7	Em_{TOTAL} = 100% NEIS	1A5a
5C1a	T3	NEIS	NEIS: 5.1	Em_{TOTAL} = 100% NEIS	1A1a
	T1*	ŠÚSR*	-	$Em_{TOTAL} = AD * Ef_{(GB2016)}$	1A1a
5C1bi	T3	NEIS	NEIS: 5.1	Em_{TOTAL} = 100% NEIS	
	T1*	ŠÚSR*	-	$Em_{TOTAL} = AD * Ef_{(GB2016)}$	
5C1bii	-	-	-	-	5C1bi
5C1biii	T3	NEIS	NEIS: 5.1	Em_{TOTAL} = 100% NEIS	
	T1*	ŠÚSR*	-	$Em_{TOTAL} = AD * Ef_{(GB2016)}$	
5C1biv	-	-	-	-	5C1bi
5C1bv	T3	NEIS	NEIS: 5.2 5.5	Em_{TOTAL} = 100% NEIS	
	T1*	ŠÚSR*		$Em_{TOTAL} = AD * Ef_{(GB2016)}$	

5C1bvi	-	-	-	-	NA
5C2	-	-	-	-	NO
5D1	T3	NEIS	NEIS: 5.3	Em_{TOTAL} = 100% NEIS	
5D2	T3	NEIS	NEIS: 5.3	Em_{TOTAL} = 100% NEIS	
5D3	T2	ŠÚSR*	-	Em_{TOTAL} = %inhabit.* $Ef_{(GB2016)}$	
5E	T2	FAI MI**	-	Em_{TOTAL} = AD * $Ef_{(GB2016)}$	
6A	-	-	-	-	NO

* for NMVOC, HM, POPs

** Fire Appraisal Institute of the Ministry of Interior

5.2.2 Biological treatment of waste - Solid waste disposal on land (NFR 5A)

5.2.2.1 Description

In comparison with base year emissions from solid waste disposal on land have very stable declining character because legislative conditions were tightened. However trend between years 2014 and 2015 have increasing character. Regulation No 372/2015[29] describes technical parameters of landfill. New landfills must be isolated bio-membrane or geotextile, drainage system and degassing system. These measurements decline the release of the emissions in atmosphere.

5.2.2.2 Methodological issues and activity data

Activity data from Statistical Yearbook[30] and emissions factors of Tier 1 from EMEP/EEA Guidebook 2016 have been used for the calculations according the basic formula:

$$Em_{TOTAL} = (Deposited\ municipal\ waste + Deposited\ industrial\ waste) * EF_{(GB2016)}$$

***Table 59**: Emissions factors - landfill*

Pollutants	Value	Unit
NMVOC	1.5600	kg/t
TSP	0.4630	g/t
PM_{10}	0.2190	g/t
$PM_{2.5}$	0.0330	g/t

***Table 60:** Overview of the activity, emissions and trends of 5A - Solid waste disposal on land*

Disposal on land	AD [kt]	NMVOC [kt]	$PM_{2.5}$ [kt]	PM_{10} [kt]	TSP [kt]
1990	6855	10.693	0.00023	0.002	0.003
1991	5734	8.945	0.00019	0.001	0.003
1992	5638	8.795	0.00019	0.001	0.003
1993	4798	7.486	0.00016	0.001	0.002
1994	5042	7.866	0.00017	0.001	0.002
1995	4690	7.316	0.00015	0.001	0.002
1996	4971	7.755	0.00016	0.001	0.002
1997	4845	7.558	0.00016	0.001	0.002
1998	4449	6.940	0.00015	0.001	0.002
1999	4394	6.855	0.00015	0.001	0.002
2000	4513	7.040	0.00015	0.001	0.002
2001	4471	6.975	0.00015	0.001	0.002
2002	4764	7.433	0.00016	0.001	0.002
2003	4952	7.725	0.00016	0.001	0.002
2004	5457	8.513	0.00018	0.001	0.003

[29] http://www.naturpack.sk/images/content/Vyhlaska_c_372_2015.pdf

[30] Statistical Yearbook
http://www.statistics.sk/pls/elisw/vbd

2005	4115	6.419	0.00014	0.001	0.002
2006	7031	10.969	0.00023	0.002	0.003
2007	5564	8.680	0.00018	0.001	0.003
2008	4581	7.146	0.00015	0.001	0.002
2009	4081	6.367	0.00013	0.001	0.002
2010	3809	5.942	0.00013	0.001	0.002
2011	4115	6.419	0.00014	0.001	0.002
2012	4015	6.263	0.00013	0.001	0.002
2013	4938	7.704	0.00016	0.001	0.002
2014	3766	5.874	0.00012	0.001	0.002
2015	3934	6.136	0.00013	0.001	0.002
Trend 1990/2015	-42.61%	-42.61%	-42.61%	-42.61%	-42.61%
Trend 2014/2015	4.46%	4.46%	4.46%	4.46%	4.46%

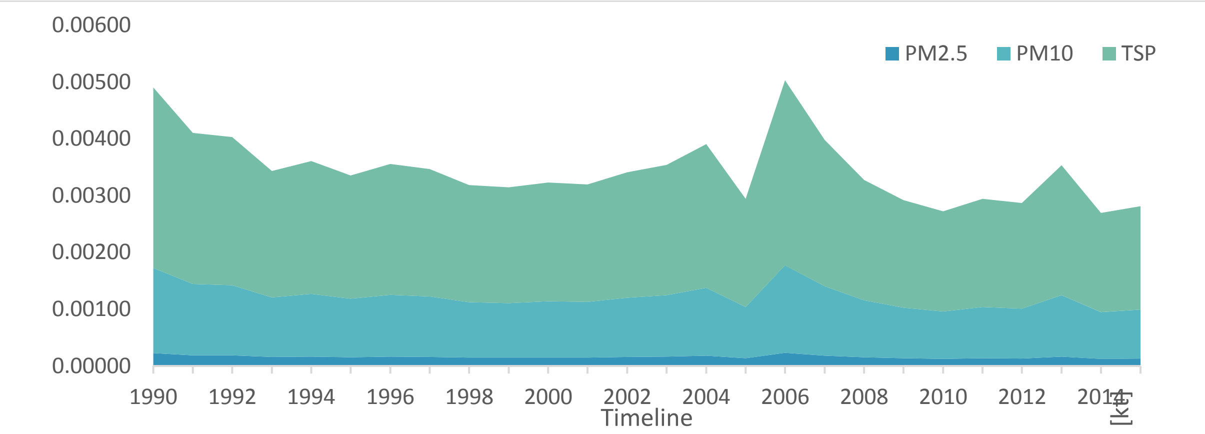


***Figure 54**: TSP, $PM_{2.5}$ and PM_{10} emissions from disposal on land*

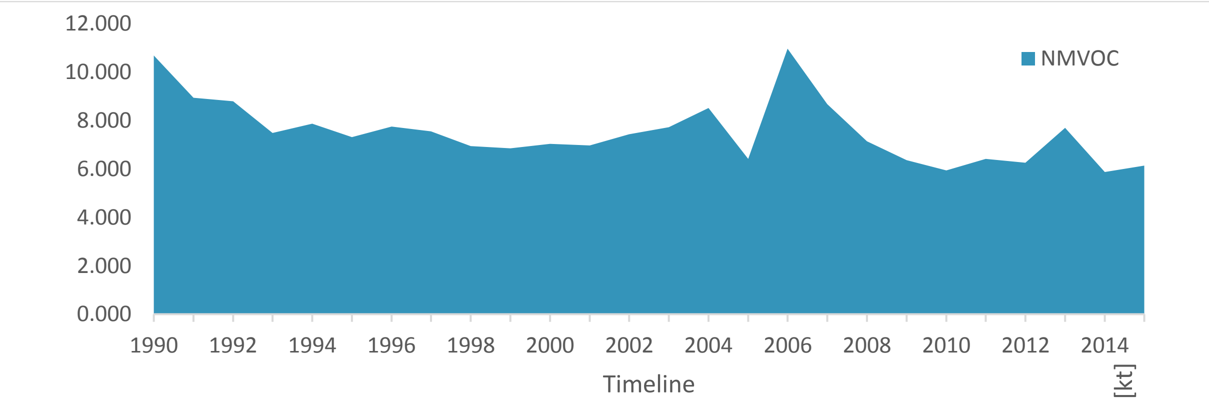


***Figure 55**: Emissions of NMVOC from disposal on land*

5.2.2.3 Completeness

The ammonia and carbon monoxide emissions have been reported as not estimated due to the no emission factor. Notation keys for these pollutants is NE.

5.2.3 Biological treatment of waste – Composting (NFR 5B1)

5.2.3.1 Description

In 2006 the prohibition of the biodegradable waste disposal came into a force pursuant to § 18 paragraph. 4 point. m) of the Act no. 223/2001 Coll.: Prohibition to dispose of biodegradable waste from gardens and parks, including the cemeteries and the other green. The change in legislation also brought about the obligation of municipality to introduce and ensure implementation of separate collection of biodegradable municipal waste except of that originating from the operator of the cantinas (according to the § 39 paragraph. 16 of the Waste Act valid from 1. 1. 2013).
Since 2004, National Emission Information System (NEIS) recorded four composting plants in Slovak Republic. Nowadays, the number of the installation is around 17.

5.2.3.2 Methodological issues and activity data

The category source is NEIS database, sources assigned to the category 5.4 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as Installations for composting with a designed output of processed waste in t/h. Methodology of Tier 3 is applied since NEIS database use the facility data from producers to emission calculations. For the first time TSP and PM emission are reported.

The ammonia was are reported. Since 1990 also the NMVOC has been recorded in the database.

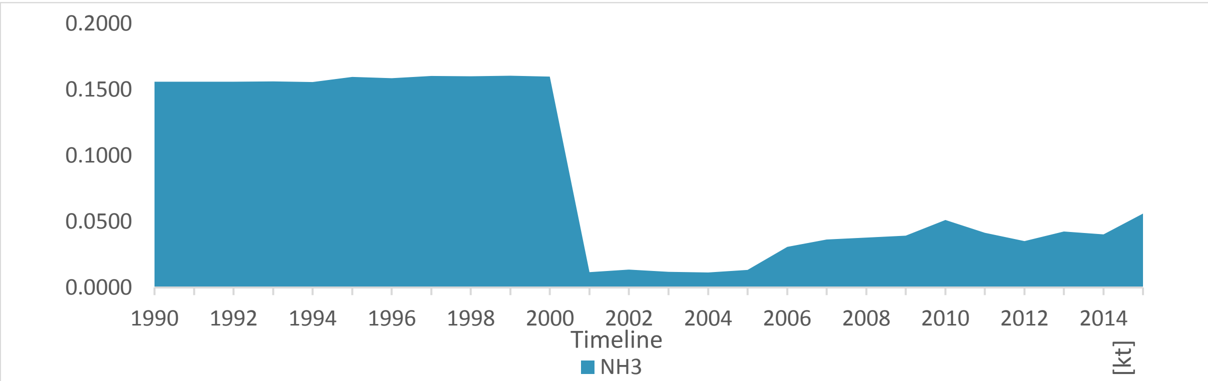


***Figure 56**: Emissions of NH_3 from composting activities*

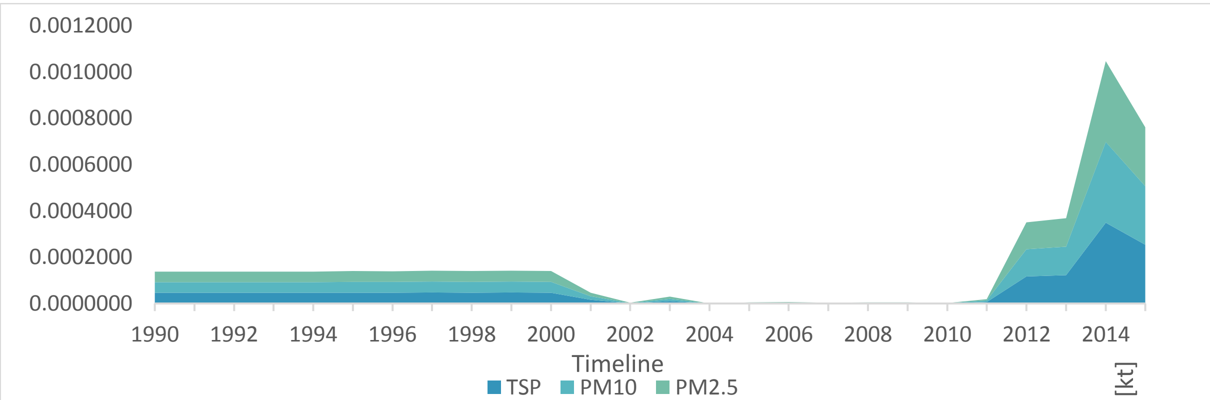


***Figure 57:** Emissions of TSP and PM from composting activities*

5.2.3.3 Completeness

CO was reported as NE. NEIS database does not record this pollutants from activity. Even though the GB 2016 provides default emission factor, there is no division for necessary activity data. BC was reported as NE due to the absent of methodology.

5.2.4 Biological treatment of waste – Anaerobic digestion at biogas facilities (NFR 5B2)

5.2.4.1 Description

In 2009 only five biogas facilities were in Slovak Republic. After the Act No 309/2009 on Support of Renewable Energy Sources and High Efficiency Combined Heat and Power (CHP) Generation enter into force and swift development of biogas facilities had been recorded. In 2014, 99 facilities were recorded.

5.2.4.2 Methodological issues and activity data

The category source is NEIS database, sources assigned to the category 5.7 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as: Installation for waste recovery by thermal processes such as pyrolysis, gasification or plasma processing, e.g. production of fuels from waste in this way. All defined sources are allocated into 1A5a and notation key IE is used due to the energy character of activity and produced emissions.

5.2.4.3 Completeness

All related pollution is covered.

5.2.5 Municipal Waste Incineration (NFR 5C1a)

5.2.5.1 Description

Only two incinerators of municipal waste are established in the Slovak Republic. Both are defined as large sources with the combustion capacity greater than 2 t/h. In line with waste-to-energy policy the energy recovery is ensured and these sources are considered as energy sources. The allocation was reassessed and changes into 1A1a category compare to previous years when 1A5a was used.

5.2.5.2 Methodological issues and activity data

The category source is NEIS database, sources assigned to the category 5.1 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as Waste incineration plants: a/ burning hazardous waste with a projected capacity in t/d; b/ burning non-hazardous waste with a capacity in t/h. Further selection based on the NACE categorisation and SNAP coding in database are also applied to separate the installation combusted municipal waste. All defined sources are allocated into 1A1a considering the fact of the energy recovery. Thus notation key IE for pollutants NO_X, NMVOC, SO_X, NH_3, CO, TSP, $PM_{2.5}$ and PM_{10} taken from NEIS is reported.

Heavy metals, POP and NMVOC are similarly allocated into 1A1a. However, for the emissions calculation the statistical activity data are used with the national emission factors. The values are given in tables below. For PCDD/F and HCB the EF are different until 2005 due to the older technology.

5.2.5.3 Completeness

The category is well documented and all sources are covered. The emission factors for HM will be revised in future.

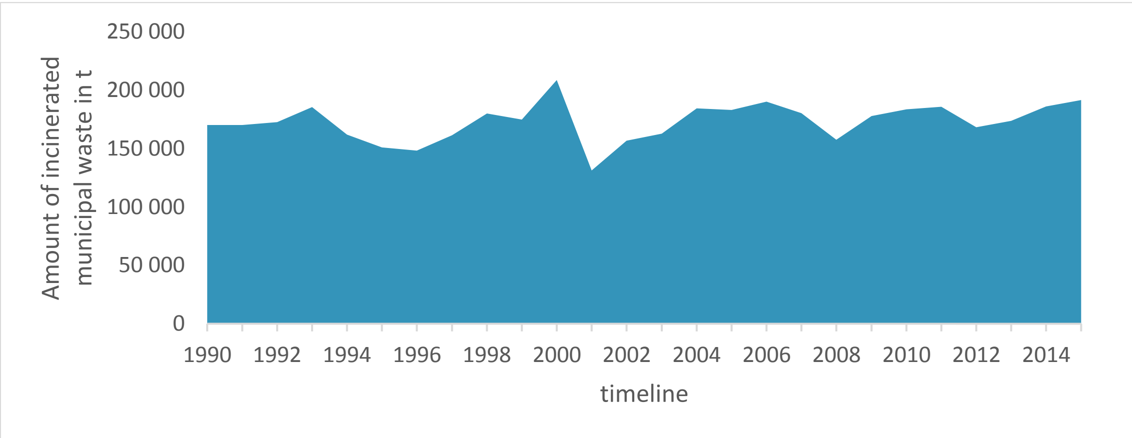
***Table 61:** Emission factor for MWI year 2015*

Pollutant	EF	unit
NO_x	647.59	[g/Mg]
NMVOC	10.47	[g/Mg]
SO_x	35.12	[g/Mg]
NH_3	3	[g/t]
TSP	8.49	[g/Mg]
CO	43.52	[g/Mg]
Pb	45	[g/t]
Cd	2.5	[g/t]
Hg	1.8	[g/t]
As	0.05	[g/t]
Cr	4.5	[g/t]
Cu	6.2	[g/t]
Ni	2.7	[g/t]
Se	0.013	[g/t]
Zn	17	[g/t]
PCDD/F	0.0004	[mg/t]
B(a)P	0.7	[mg/t]
B(b)F	19	[mg/t]
B(k)F	19	[mg/t]
I()P	0.17	[mg/t]
PAHs	38.87	[mg/t]
HCB	0.1	[mg/t]
PCB	5.3	[mg/t]

***Table 62:** Activity data for the municipal waste incineration*

MWI	incinerated MW [t]
1990	170000
1995	150821
2000	208435
2005	182850
2010	183279
2011	185500
2012	167933
2013	173660
2014	185939
2015	191432

***Figure 58:** Trend of incinerated municipal waste with recovery*



5.2.6 Industrial waste incineration (NFR 5C1bi)

5.2.6.1 Description

There are several industrial incinerators but only two have the capacity greater than 2 t/h, others are smaller. Special installations designed for the waste co-firing (for example waste co-incineration in cement production) are not included in the sector and allocation is applied.

5.2.6.2 Methodological issues and activity data

The category source for pollutants NO_X, SO_X, NH_3, CO, TSP, $PM_{2.5}$ and PM_{10} is NEIS database and emissions taken from NEIS are reported in waste sector. Likewise the municipal waste incineration (MWI), sources assigned to the category 5.1 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as Waste incineration plants: a/ burning hazardous waste with a projected capacity in t/d; b/ burning non-hazardous waste with a capacity in t/h. Further selection based on the NACE categorisation and SNAP coding in database are also applied to separate the installation combusted industrial waste.

Table 63: *Overview and trends of reported emissions 5Cbi - Industrial waste incineration*

Industrial	NOx [kt]	NMVOC [kt]	SOx [kt]	TSP [kt]	CO [kt]
1990	1.5363	0.7089	2.9018	1.5472	0.6238
1991	1.1617	0.5659	2.1841	1.1618	0.4687
1992	1.0343	0.5335	1.9344	1.0263	0.4144
1993	0.7116	0.3900	1.3231	0.6998	0.2829
1994	0.7572	0.4427	1.3985	0.7371	0.2983
1995	0.6029	0.3777	1.1048	0.5800	0.2351
1996	0.5945	0.4011	1.0798	0.5641	0.2290
1997	0.5312	0.3883	0.9545	0.4959	0.2017
1998	0.4219	0.3365	0.7486	0.3862	0.1574
1999	0.3720	0.3264	0.6500	0.3324	0.1359
2000	0.3772	0.3678	0.6465	0.3270	0.1342
2001	0.2872	0.3682	0.5803	0.2591	0.0897
2002	0.3364	0.3959	0.4707	0.2884	0.1273
2003	0.4149	0.4267	0.4710	0.2013	0.1284
2004	0.1585	0.2323	0.3651	0.1583	0.0348
2005	0.1482	0.3491	0.2968	0.1206	0.0316
2006	0.1103	0.3496	0.2529	0.0894	0.0213
2007	0.0694	0.3485	0.0064	0.0006	0.0075
2008	0.0495	0.0037	0.0059	0.0003	0.0020
2009	0.0436	0.3907	0.0039	0.0004	0.0023
2010	0.0314	0.4097	0.0024	0.0001	0.0020
2011	0.0427	0.3044	0.0015	0.0003	0.0028
2012	0.0339	0.3385	0.0014	0.0003	0.0055
2013	0.0248	0.3369	0.0009	0.0002	0.0040
2014	0.0208	0.2176	0.0006	0.0004	0.0055
2015	0.0155	0.3780	0.0015	0.0001	0.0021
Trend 1990/2015	-99%	-47%	-100%	-100%	-100%
Trend 2014/2015	-26%	74%	142%	-60%	-61%

Heavy metals, POP and NMVOC are reported, however, for the emissions calculation the statistical activity data are used with the national emission factors. The values are given in tables below. For PAH and HCB the EF is different until 2000 and until 2005 due to the shift old then new technology.

Table 64: *Emission factor for IWI*

Pollutant	EF	unit
NMVOC	3.91	[kg/Mg]
NO_x	0.40	[kg/Mg]
SO_x	0.04	[kg/Mg]
Pb	1.3	[g/t]
TSP	4.72	[kg/Mg]
CO	1.97	[kg/Mg]
$PM_{2.5}$	0.0023	[kg/Mg]
PM_{10}	0.0023	[kg/Mg]
Cd	3	[g/t]
Hg	3	[g/t]
As	0.05	[g/t]
Cr	0.48	[g/t]
Cu	3	[g/t]
Ni	0.1	[g/t]
Se	0.06	[g/t]
Zn	21	[g/t]
PCDD/F	0.0750	[mg/t]
B(a)P	0.7	[mg/t]
B(b)F	19	[mg/t]
B(k)F	19	[mg/t]
I()P	0.17	[mg/t]
PAHs	38.87	[mg/t]
HCB	0.139	[mg/t]
PCB	10	[mg/t]

Table 65: *Activity data for the industrial waste incineration*

IWI	incinerated IW [t]
1990	84 963
1995	45 263
2000	44 084
2005	36 974
2010	60 857
2011	25 723
2012	54 525
2013	51 060
2014	44 375
2015	38 155

Table 66: *Overview and trends of reported heavy metals emissions 5Cbi - Industrial waste incineration*

Industrial	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]
1990	2.9737	0.2549	0.2549	0.0042	0.0408	0.2549
1991	2.3736	0.2035	0.2035	0.0034	0.0326	0.2035
1992	2.2378	0.1918	0.1918	0.0032	0.0307	0.1918
1993	1.6359	0.1402	0.1402	0.0023	0.0224	0.1402
1994	1.8570	0.1592	0.1592	0.0027	0.0255	0.1592
1995	1.5842	0.1358	0.1358	0.0023	0.0217	0.1358
1996	1.6826	0.1442	0.1442	0.0024	0.0231	0.1442
1997	1.6288	0.1396	0.1396	0.0023	0.0223	0.1396
1998	1.4115	0.1210	0.1210	0.0020	0.0194	0.1210
1999	1.3693	0.1174	0.1174	0.0020	0.0188	0.1174
2000	0.0573	0.1323	0.1323	0.0022	0.0212	0.1323
2001	0.0574	0.1324	0.1324	0.0022	0.0212	0.1324
2002	0.0617	0.1423	0.1423	0.0024	0.0228	0.1423
2003	0.0665	0.1534	0.1534	0.0026	0.0245	0.1534
2004	0.0689	0.1590	0.1590	0.0026	0.0254	0.1590
2005	0.0481	0.1109	0.1109	0.0018	0.0177	0.1109
2006	0.1016	0.2346	0.2346	0.0039	0.0375	0.2346
2007	0.0764	0.1762	0.1762	0.0029	0.0282	0.1762
2008	0.0295	0.0681	0.0681	0.0011	0.0109	0.0681
2009	0.0198	0.0457	0.0457	0.0008	0.0073	0.0457
2010	0.0791	0.1826	0.1826	0.0030	0.0292	0.1826
2011	0.0334	0.0772	0.0772	0.0013	0.0123	0.0772
2012	0.0709	0.1636	0.1636	0.0027	0.0262	0.1636
2013	0.0664	0.1532	0.1532	0.0026	0.0245	0.1532
2014	0.0577	0.1331	0.1331	0.0022	0.0213	0.1331
2015	0.0496	0.1145	0.1145	0.0019	0.0183	0.1145
Trend	-98%	-55%	-55%	-55%	-55%	-55%
Trend	-14%	-14%	-14%	-14%	-14%	-14%

5.2.6.3 Completeness

All rising pollutants are recorded and reported.

5.2.7 Clinical waste incineration (NFR 5C1biii)

5.2.7.1 Description

Clinical waste represents risk for the population health. It contains harmful infectious materials, sharp objects and biological materials. Insufficiency in treatment leads to the infection spreading, pollution of the environment and injuries. According to Decree of the Ministry of Environment No. 284/2001 Coll. as amended establishing the Waste Catalogue this waste is classified into group O (Other) and N (Hazard) for example: needles, sharp objects, fragments of human bodies, blood bank and other. Most of the existing incinerators are located closely to the hospitals.

5.2.7.2 Methodological issues and activity data

The category source for pollutants NO_X, SO_X, NH_3, CO, TSP, $PM_{2.5}$ and PM_{10} is NEIS database and emissions taken from NEIS are reported in waste sector. Sources assigned to the category 5.1 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as Waste incineration plants: a/ burning hazardous waste with a projected capacity in t/d; b/ burning non-hazardous waste with a capacity in t/h. Further selection based on the NACE categorisation and SNAP coding in database are also applied to separate the installation combusted clinical waste.

***Table 67**: Overview and trends of reported emissions 5Cbiii - Clinical waste incineration*

Clinical waste incineration CWI	NOx [kt]	NMVOC [kt]	SOx [kt]	TSP [kt]	CO [kt]
1990	0.0118	0.0017	0.0065	0.0041	0.0144
1991	0.0121	0.0017	0.0067	0.0042	0.0148
1992	0.0121	0.0017	0.0066	0.0042	0.0148
1993	0.0123	0.0018	0.0068	0.0043	0.0151
1994	0.0116	0.0017	0.0063	0.0041	0.0142
1995	0.0115	0.0016	0.0063	0.0040	0.0141
1996	0.0116	0.0017	0.0064	0.0041	0.0143
1997	0.0116	0.0016	0.0063	0.0040	0.0142
1998	0.0115	0.0016	0.0063	0.0040	0.0141
1999	0.0113	0.0016	0.0062	0.0040	0.0139
2000	0.0110	0.0016	0.0061	0.0039	0.0135
2001	0.0114	0.0015	0.0070	0.0050	0.0158
2002	0.0105	0.0015	0.0068	0.0038	0.0138
2003	0.0085	0.0015	0.0042	0.0030	0.0106
2004	0.0088	0.0011	0.0038	0.0022	0.0085
2005	0.0047	0.0009	0.0013	0.0015	0.0061
2006	0.0041	0.0001	0.0002	0.0000	0.0002
2007	0.0036	0.0000	0.0002	0.0000	0.0002
2008	0.0036	0.0000	0.0002	0.0000	0.0002
2009	0.0024	0.0000	0.0002	0.0000	0.0002
2010	0.0020	0.0000	0.0001	0.0000	0.0002
2011	0.0016	0.0000	0.0001	0.0000	0.0001
2012	0.0014	0.0000	0.0001	0.0000	0.0001
2013	0.0017	0.0000	0.0001	0.0000	0.0001
2014	0.0017	0.0000	0.0001	0.0000	0.0001
2015	0.0015	0.0000	0.0001	0.0000	0.0002
Trend 1990/2015	-87%	-99%	-98%	-100%	-99%
Trend 2014/2015	-10%	-43%	12%	-84%	20%

Heavy metals, POP and NMVOC are reported, however, for the emissions calculation the statistical activity data are used with the national emission factors. The values are given in tables below. For HCB the EF is different until 2005 due to the older technology.

Table 68: *Emission factor for CWI*

Pollutant	EF	unit
NMVOC	1.19	[kg/Mg]
NO_x	165.95	[kg/Mg]
Pb	35	[kg/t]
SO_x	0,21	[kg/Mg]
TSP	0.10	[kg/Mg]
CO	16.45	[kg/Mg]
SO_x	12.96	[kg/Mg]
PM_{10}	0.08	[kg/Mg]
$PM_{2.5}$	0.08	[kg/Mg]
Cd	3	[g/t]
Hg	3	[g/t]
As	0.05	[g/t]
Cr	0.48	[g/t]
Cu	3	[g/t]
Ni	0.1	[g/t]
Se	0.06	[g/t]
Zn	21	[g/t]
PCDD/F	0.500	[mg/t]
B(a)P	0.700	[mg/t]
B(b)F	19	[mg/t]
B(k)F	19	[mg/t]
I()P	0.17	[mg/t]
PAHs	38.87	[mg/t]
HCB	0.046	[mg/t]
PCB	10	[mg/t]

Table 69: *Activity data for the clinical waste incineration*

CWI	incinerated CW [t]
1990	30 799
1995	30 145
2000	28 857
2005	20 384
2010	35 592
2011	11 996
2012	12 945
2013	7 988
2014	11 574
2015	9 166

Table 70: *Overview and trends of reported heavy metals emissions 5Cbiii - Clinical waste incineration*

Clinical waste incineration CWI	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]
1990	0.0011	0.000092	0.000092	0.000002	0.000015	0.000092
1991	0.0011	0.000095	0.000000	0.000002	0.000015	0.000095
1992	0.0011	0.000095	0.000000	0.000002	0.000015	0.000095
1993	0.0011	0.000097	0.000000	0.000002	0.000015	0.000097
1994	0.0011	0.000091	0.000000	0.000002	0.000015	0.000091
1995	0.0011	0.000090	0.000000	0.000002	0.000014	0.000090
1996	0.0011	0.000091	0.000000	0.000002	0.000015	0.000091
1997	0.0011	0.000091	0.000000	0.000002	0.000015	0.000091
1998	0.0011	0.000090	0.000000	0.000002	0.000014	0.000090
1999	0.0010	0.000089	0.000000	0.000001	0.000014	0.000089
2000	0.0010	0.000087	0.000000	0.000001	0.000014	0.000087
2001	0.0010	0.000084	0.000000	0.000001	0.000013	0.000084
2002	0.0010	0.000084	0.000000	0.000001	0.000013	0.000084
2003	0.0009	0.000081	0.000000	0.000001	0.000013	0.000081
2004	0.0007	0.000061	0.000000	0.000001	0.000010	0.000061
2005	0.0023	0.000198	0.000000	0.000003	0.000032	0.000198
2006	0.0007	0.000062	0.000000	0.000001	0.000010	0.000062
2007	0.0009	0.000078	0.000000	0.000001	0.000012	0.000078
2008	0.0015	0.000130	0.000000	0.000002	0.000021	0.000130
2009	0.0005	0.000041	0.000000	0.000001	0.000007	0.000041
2010	0.0012	0.000107	0.000000	0.000002	0.000017	0.000107
2011	0.0004	0.000036	0.000000	0.000001	0.000006	0.000036
2012	0.0005	0.000039	0.000000	0.000001	0.000006	0.000039
2013	0.0003	0.000024	0.000000	0.000000	0.000004	0.000024
2014	0.0004	0.000035	0.000000	0.000001	0.000006	0.000035
2015	0.0003	0.000027	0.000000	0.000000	0.000004	0.000027

Trend 1990/2015	-70%	-70%	-100%	-67%	-70%	-70%
Trend 2014/2015	-26%	-21%	-23%	-17%	-21%	-21%

5.2.7.3 Completeness

All rising pollutants are recorded and reported.

5.2.8 Hazardous waste incineration (NFR 5C1bii)

5.2.8.1 Description

According to definition of activity kind in category 5.1 the Annex No 6 of Decree No 410/2012 Coll. the separation on MWI and IWI is only possible. All sources are therefore allocated into sources of IWI and notation key IE is used.

5.2.8.2 Methodological issues and activity data

5.2.8.3 Completeness

5.2.9 Sewage sludge incineration (NFR 5C1biv)

5.2.9.1 Description

According to definition of activity kind in category 5.1 the Annex No 6 of Decree No 410/2012 Coll. the separation on MWI and IWI is only possible. All sources are therefore allocated into sources of IWI and notation key IE is used.

5.2.9.2 Methodological issues and activity data

5.2.9.3 Completeness

5.2.10 Cremation (NFR 5C1bv)

5.2.10.1 Description

Annual increase of cremated bodies gives rise to emissions of heavy metals and persistent pollutants by 9%. In comparison to the base year there was an increase in trends of NO_X, SO_X, TSP, CO, $PM_{2.5}$, PM_{10} emissions driven by the activity data.

***Table 71**: Overview and trends of reported emissions 5Cbv- Cremation*

Cremation	NOx [kt]	NMVOC [kt]	SOx [kt]	TSP [kt]	CO [kt]
1990	0.0083	0.000171	0.0011	0.004123	0.014411
1991	0.0085	0.000175	0.0011	0.004247	0.014844
1992	0.0087	0.000179	0.0011	0.004228	0.014777
1993	0.0089	0.000183	0.0011	0.004318	0.015095
1994	0.0091	0.000186	0.0012	0.004054	0.014169
1995	0.0092	0.000190	0.0012	0.004035	0.014105
1996	0.0080	0.000164	0.0010	0.004079	0.014257
1997	0.0086	0.000177	0.0011	0.004050	0.014155
1998	0.0092	0.000189	0.0012	0.004024	0.014065
1999	0.0108	0.000222	0.0014	0.003971	0.013882
2000	0.0108	0.000222	0.0014	0.003863	0.013502
2001	0.0051	0.000219	0.0002	0.005036	0.015798
2002	0.0055	0.000229	0.0002	0.003792	0.013774
2003	0.0053	0.000240	0.0002	0.003038	0.010647
2004	0.0054	0.000127	0.0002	0.002186	0.008549
2005	0.0061	0.000131	0.0003	0.001470	0.006108
2006	0.0315	0.000508	0.0049	0.000033	0.000155
2007	0.0283	0.000451	0.0044	0.000027	0.000237

2008	0.0252	0.000367	0.0038	0.000025	0.000208
2009	0.0111	0.000156	0.0023	0.000023	0.000197
2010	0.0066	0.000106	0.0006	0.000005	0.000186
2011	0.0063	0.000034	0.0005	0.000002	0.000103
2012	0.0066	0.000035	0.0005	0.000002	0.000089
2013	0.0068	0.000035	0.0005	0.000001	0.000139
2014	0.0067	0.000034	0.0006	0.000006	0.000126
2015	0.0072	0.000051	0.0008	0.000001	0.000151
Trend 1990/2015	-13%	-70%	-25%	-100%	-99%
Trend 2014/2015	8%	47%	45%	-84%	20%

5.2.10.2 Methodological issues and activity data

The category source for pollutants NO_X, SO_X, NH_3, CO, TSP, $PM_{2.5}$ and PM_{10} is NEIS database and emissions taken from NEIS are reported in waste sector. Emission factor for these category of pollution are available in ***Table 91***. Sources assigned to the category 5.2 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as Installations for recovery or disposing of carcasses or animal waste with a projected capacity of processing in t/d: a) plant for processing of animal by-products, b) combustion of carcasses. Sources assigned to the category 5.5 are defined as Crematories. Overview of the NEIS reported data is given in ***Table 71***.

Heavy metals, POP and NMVOC are reported, however, for the emissions calculation the statistical activity data are used with the default GB 2016 emission factors. The values are given in tables below.

Table 72: *Emission factor for Cremation*

Pollutant	EF	unit
NMVOC	0.004	[kg/Mg/body]
NO_x	0.55	[kg/Mg/body]
SO_x	0.061	[kg/Mg/body]
CO	0.13	[kg/Mg/body]
SO_x	0.061	[kg/Mg/body]
PM_{10}	0.152	[kg/Mg/body]
$PM_{2.5}$	0.152	[kg/Mg/body]
Pb	30.3	[mg/body]
TSP	0.152	[kg/Mg/body]
Cd	5.03	[mg/body]
Hg	1.49	[g/body]
As	13.61	[mg/body]
Cr	13.56	[mg/body]
Cu	12.43	[mg/body]
Ni	17.33	[mg/body]
Se	19.78	[mg/body]
Zn	160.12	[mg/body]
PCDD/F	0.0100	[mg/t]
B(a)P	0.0132	[mg/t]
B(b)F	0.0072	[mg/t]
B(k)F	0.0064	[mg/t]
I()P	0.0070	[mg/t]
PAHs	0.0338	[mg/t]
HCB	0.1500	[mg/t]
PCB	0.4100	[mg/t]

Table 73: *Activity data for the Cremation*

Cremation	burned bodies
1990	5 881
1995	6 524
2000	7 626
2005	20 384
2010	11 976
2011	12 332
2012	12 332
2013	12 686
2014	13 102
2015	13 233

Table 74*: Overview and trends of reported heavy metals emissions 5Cbv Cremation*

Cremation	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]
1990	0.00018	0.000030	0.0088	0.000080	0.000080	0.0000731
1991	0.00018	0.000030	0.0090	0.000082	0.000081	0.0000746
1992	0.00018	0.000031	0.0091	0.000084	0.000083	0.0000762
1993	0.00019	0.000032	0.0093	0.000085	0.000085	0.0000778
1994	0.00019	0.000032	0.0095	0.000087	0.000087	0.0000794
1995	0.00020	0.000033	0.0097	0.000089	0.000088	0.0000810
1996	0.00017	0.000028	0.0084	0.000077	0.000076	0.0000699
1997	0.00018	0.000031	0.0090	0.000083	0.000082	0.0000753
1998	0.00020	0.000033	0.0097	0.000088	0.000088	0.0000807

1999	0.00023	0.000038	0.0114	0.000104	0.000103	0.0000947
2000	0.00023	0.000038	0.0114	0.000104	0.000103	0.0000947
2001	0.00023	0.000038	0.0112	0.000102	0.000102	0.0000935
2002	0.00024	0.000040	0.0117	0.000107	0.000107	0.0000976
2003	0.00025	0.000042	0.0123	0.000112	0.000112	0.0001025
2004	0.00026	0.000043	0.0129	0.000117	0.000117	0.0001072
2005	0.00028	0.000048	0.0141	0.000129	0.000128	0.0001175
2006	0.00029	0.000048	0.0142	0.000130	0.000129	0.0001186
2007	0.00030	0.000050	0.0147	0.000134	0.000133	0.0001223
2008	0.00033	0.000055	0.0164	0.000150	0.000149	0.0001367
2009	0.00034	0.000056	0.0167	0.000152	0.000152	0.0001392
2010	0.00036	0.000060	0.0178	0.000163	0.000162	0.0001488
2011	0.00037	0.000062	0.0184	0.000168	0.000167	0.0001532
2012	0.00037	0.000062	0.0184	0.000168	0.000167	0.0001532
2013	0.00038	0.000064	0.0189	0.000173	0.000172	0.0001576
2014	0.00039	0.000066	0.0195	0.000178	0.000178	0.0001628
2015	0.00040	0.000067	0.0197	0.000180	0.000179	0.0001644
Trend 1990/2015	125%	125%	125%	125%	125%	125%
Trend 2014/2015	1%	1%	1%	1%	1%	1%

5.2.10.3 Completeness

All rising pollutants are recorded and reported.

5.2.11 Open burning waste (5C2)

5.2.11.1 Description

This activity is against the law of the Slovak Republic. (Decree No 410/2012 Coll. as amended) It is forbidden to perform open burning of waste. Notation key NO is used.

5.2.11.2 Methodological issues and activity data

5.2.11.3 Completeness

5.2.12 Domestic wastewater handling (NFR 5D1)

Industrial wastewater handling (NFR 5D2)

Other wastewater handling (NFR 5D3)

5.2.12.1 Overview

Households and industry released 595 234 thousand m^3 of wastewater in 2015. Nearly 93% of this wastewater has been treated. Households produced of this amount to 366 099 thousand m^3 of wastewater rest were industrial wastewater. Untreated wastewater has been discharged in year 2015 in amount 44 514 thousand m^3 into watercourses[31].

Council Directive 91/271/EEC concerning urban waste-water treatment as well as obligations rising from in the Treaty of Accession of the Slovak Republic to the European Union of 16. 4. 2003, has resulted in the construction of new sewage systems. The construction of new wastewater treatment plants and restore the hardware already functioning sewage treatment plants. In 2015, 686 wastewater treatment plants were operated in Slovak republic. Compare to the year 1996 the number increased by 60%. This activity has considerable influence of the emissions.

[31] Statistical yearbook 2017

5.2.12.2 Methodological issues and activity data 5D1 5D2

The category source for pollutants NH_3 and NMVOC is NEIS database and emissions taken from NEIS are reported in waste sector. Sources assigned to the category 5.3 according to the Annex No 6 of Decree No 410/2012 Coll. as amended are defined as Waste water treatment plant with a capacity of population equivalents: a/ Urban waste-water treatment plants; b/ industrial waste-water treatment plants.

***Table 75**: Overview of the trends and emission 5D1, 5D2*

	Domestic WW		Industrial WW				
Years	NH3 [kt]	NMVOC [kt]	NH3 [kt]	NMVOC [kt]	TSP [kt]	PM2.5 [kt]	PM10 [kt]
1990	0.02881288	0.00421199	0.00512911	2.21095964	0.00001472	0.00001472	0.00001472
1991	0.02915372	0.00946481	0.00501207	2.08688592	0.00000429	0.00000429	0.00000429
1992	0.02947733	0.01463002	0.00489503	1.96281221	0.00000851	0.00000851	0.00000851
1993	0.02964156	0.02006499	0.00478499	1.84616951	0.00001159	0.00001159	0.00001159
1994	0.02989923	0.02594539	0.00458555	1.63475083	0.00001370	0.00001370	0.00001370
1995	0.03105680	0.03240961	0.00438606	1.42327123	0.00001504	0.00001504	0.00001504
1996	0.03251895	0.03945266	0.00405843	1.07596229	0.00001575	0.00001575	0.00001575
1997	0.03332320	0.04591010	0.00396523	0.97716623	0.00001594	0.00001594	0.00001594
1998	0.03432103	0.04726250	0.00398023	0.99306375	0.00001573	0.00001573	0.00001573
1999	0.03508321	0.04973384	0.00389226	0.89981050	0.00001524	0.00001524	0.00001524
2000	0.01889190	0.05768507	0.00411146	1.13218224	0.00001453	0.00001453	0.00001453
2001	0.01456468	0.06441967	0.00247706	1.02370149	0.00000139	0.00000139	0.00000139
2002	0.02465477	0.07222290	0.00393897	0.91522074	0.00000261	0.00000261	0.00000261
2003	0.02951015	0.07766351	0.00502962	0.98112538	0.00000243	0.00000243	0.00000243
2004	0.03142333	0.08504968	0.00408610	0.75972957	0.00000243	0.00000243	0.00000243
2005	0.03045076	0.09028426	0.00357279	0.66956020	0.00000221	0.00000221	0.00000221
2006	0.03426639	0.09339785	0.00466489	0.03377006	0.00009901	0.00009901	0.00009901
2007	0.03433165	0.09359963	0.00469587	0.03224429	0.00000010	0.00000010	0.00000010
2008	0.03210511	0.09080793	0.00249803	0.02660849	0.00000009	0.00000009	0.00000009
2009	0.03376431	0.09365158	0.00274201	0.02598863	0.00000010	0.00000010	0.00000010
2010	0.04842063	0.13422855	0.00279217	0.02609319	0.00000009	0.00000009	0.00000009
2011	0.05445164	0.14561630	0.00243169	0.02520272	0.00000002	0.00000002	0.00000002
2012	0.04538720	0.12081573	0.00268667	0.02636971	0.00000013	0.00000013	0.00000013
2013	0.04928881	0.13002702	0.00278729	0.07935559	0.00000013	0.00000013	0.00000013
2014	0.04651618	0.12377355	0.00264234	0.01118134	0.00000009	0.00000009	0.00000009
2015	0.05208392	0.13964356	0.00299026	0.01138906	0.00000004	0.00000004	0.00000004
Trend 1990/2015	81%	3215%	-42%	-99%	-100%	-100%	-100%
Trend 2014/2015	12%	13%	13%	2%	-52%	-52%	-52%

5.2.12.3 Methodological issues and activity data 5D3

Principle of calculation consisted of determining the percentage of use of dry toilets in Slovakian household. This percentage is multiplied by middle year population for the reporting period. This parameter have been multiplied with emissions factors form EMEP/EEA Guidebook 2016. Thus Ammonia emissions were calculated from usage of dry toilets. Calculation is methodology Tier 2.

***Table 76**: Overview of trend, emission and activity data of 5D3 Other wastewater handling*

	NH_3 [kt]	Mid-year population [inhabitants]*	usage of dry toilets [%]
1990	1.0934606	5 297 774	13%
1991	1.0358730	5 306 727	12%
1992	1.0291155	5 315 679	12%
1993	1.0138099	5 324 632	12%
1994	1.0089763	5 344 154	12%
1995	0.9954983	5 363 676	12%
1996	0.9715818	5 373 793	11%
1997	0.9388358	5 383 233	11%
1998	0.9056655	5 390 866	11%
1999	0.8718844	5 395 324	10%
2000	0.8381854	5 400 679	10%
2001	0.7832960	5 379 780	9%
2002	0.7659424	5 378 809	9%
2003	0.7229309	5 378 950	8%
2004	0.6717452	5 382 574	8%
2005	0.6292349	5 387 285	7%
2006	0.5951867	5 391 184	7%
2007	0.5268220	5 397 766	6%
2008	0.4671624	5 406 972	5%
2009	0.4421393	5 418 374	5%
2010	0.3649648	5 431 024	4%
2011	0.2071392	5 394 251	2%
2012	0.1816947	5 407 579	2%
2013	0.1818900	5 413 393	2%
2014	0.1820666	5 418 649	2%
2015	0.1822397	5 423 800	2%
Trend 1990/2015	-83.33%	2.38%	-83.72%
Trend 2014/2015	0.10%	0.10%	0.00%

5.2.12.4 Completeness

Sources of NH_3 an NMVOC are well covered.

5.2.13 Other waste (NFR 5E)

5.2.13.1 Description

This chapter covers emissions from:

- Car fires
- Detached house fires
- Industrial building fires
- Apartment building fires

5.2.13.2 Methodological issues and activity data

Activity data were obtained from the fire statistics provided by Fire Appraisal Institute of the Ministry of Interior. Emission factor were according to EMEP/EEA Guidebook 2016.Emissions from fires were calculate as multiplying of activity data – number of fires with emission factor from EMEP/EEA GB see Table 97.

***Table 77**: Activity data on fire statistic*

Years	Car fire [No. of fires]	Detached houses [No. of fires]	Apartment [No. of fires]	Industrial [No of fires]
1990	561	659	545	246
1991	567	666	550	248
1992	576	676	559	252
1993	590	693	573	258
1994	602	707	584	264
1995	615	722	597	269
1996	631	742	613	277
1997	652	766	634	286
1998	663	779	644	291
1999	573	596	826	342
2000	587	592	960	361
2001	524	593	809	354
2002	643	621	804	342
2003	703	694	816	308
2004	659	705	762	329
2005	660	764	706	314
2006	729	876	678	331
2007	778	914	784	358
2008	819	933	770	307
2009	874	929	701	306
2010	837	989	615	260
2011	784	1119	603	293
2012	785	1098	561	295
2013	822	1061	519	240
2014	772	915	494	207
2015	822	1094	514	203

***Table 78:** Emission factors for calculation of emissions in Waste sector*

Emissions factor	TSP,PMs [kg/fire]	Pb [g/fire]	Cd [g/fire]	Hg [g/fire]	As [g/fire]	Cr [g/fire]	Cu [g/fire]	PCDD/F [mg/fire]
CAR Fires	2.30	-	-	-	-	-	-	-
Detached house fires	143.82	0.42	0.85	0.85	1.35	1.29	2.99	1.44
Apartment building fires	43.78	0.13	0.26	0.26	0.41	0.39	0.91	0.44
Industrial building fires	27.23	0.08	0.16	0.16	0.25	0.24	0.57	0.27

***Table 79:** Overview and trends of reported heavy metals emissions 5E Other waste*

Other waste	PM2.5	PM10	TSP	Pb	Cd	As	Cr	Cu
	[kt]	[kt]	[kt]	[t]	[t]	[t]	[t]	[t]
1990	0.13836	0.13836	0.13836	0.00040	0.00081	0.00128	0.00122	0.00284
1991	0.13981	0.13981	0.13981	0.00040	0.00082	0.00129	0.00124	0.00287
1992	0.14127	0.14127	0.14127	0.00041	0.00083	0.00131	0.00125	0.00290
1993	0.14272	0.14272	0.14272	0.00041	0.00083	0.00132	0.00126	0.00293
1994	0.14418	0.14418	0.14418	0.00042	0.00084	0.00134	0.00128	0.00296
1995	0.14564	0.14564	0.14564	0.00042	0.00085	0.00135	0.00129	0.00299
1996	0.14709	0.14709	0.14709	0.00043	0.00086	0.00136	0.00130	0.00302
1997	0.14855	0.14855	0.14855	0.00043	0.00087	0.00138	0.00131	0.00305
1998	0.15000	0.15000	0.15000	0.00043	0.00088	0.00139	0.00133	0.00308
1999	0.13278	0.13278	0.13278	0.00039	0.00078	0.00123	0.00117	0.00273
2000	0.13857	0.13857	0.13857	0.00040	0.00081	0.00128	0.00122	0.00285
2001	0.13169	0.13169	0.13169	0.00038	0.00077	0.00122	0.00117	0.00271
2002	0.13547	0.13547	0.13547	0.00039	0.00079	0.00125	0.00120	0.00278
2003	0.14580	0.14580	0.14580	0.00042	0.00085	0.00135	0.00129	0.00299
2004	0.14546	0.14546	0.14546	0.00042	0.00085	0.00135	0.00129	0.00299
2005	0.15108	0.15108	0.15108	0.00044	0.00088	0.00140	0.00134	0.00311
2006	0.16664	0.16664	0.16664	0.00048	0.00097	0.00154	0.00147	0.00342
2007	0.17761	0.17761	0.17761	0.00051	0.00104	0.00164	0.00157	0.00365
2008	0.17847	0.17847	0.17847	0.00052	0.00104	0.00165	0.00158	0.00367
2009	0.17500	0.17500	0.17500	0.00051	0.00102	0.00162	0.00155	0.00359
2010	0.17849	0.17849	0.17849	0.00052	0.00104	0.00165	0.00158	0.00366
2011	0.19740	0.19740	0.19740	0.00057	0.00115	0.00183	0.00175	0.00406
2012	0.19268	0.19268	0.19268	0.00056	0.00113	0.00179	0.00171	0.00396
2013	0.18404	0.18404	0.18404	0.00053	0.00108	0.00171	0.00163	0.00378
2014	0.16098	0.16098	0.16098	0.00047	0.00094	0.00149	0.00142	0.00330
2015	0.18757	0.18757	0.18757	0.00054	0.00110	0.00174	0.00166	0.00385
Trend 1990-2015	35.6%	35.6%	35.6%	35.4%	35.6%	35.7%	35.7%	35.6%
Trend 2014/2015	16.5%	16.5%	16.5%	16.7%	16.7%	16.7%	16.7%	16.7%

5.3 Other sources (NFR 6A)

5.3.1 Description

No other activities are occurred in the Slovak Republic. Notation key NO is used.

5.3.2 Methodological issues and activity data

5.3.3 Completeness

5.4 POPs in Waste sector

Emissions inventory of POPs in Waste sector are estimated based on producers activity and emissions factors. Activity data, which are represented by the amount of incinerated waste, are acquired from facility operators.

Emissions of POPs are estimated only for waste incineration categories (Industrial waste incineration, Clinical waste incineration and Cremation). Emissions from municipal waste incineration are included in category 1A1a according EMEP/EEA Air Pollution Emission Inventory Guidebook. All incinerated municipal waste is energy recovery. Emissions from industrial and clinical waste incineration are based on non-energy recovery waste.

The overview of emission factors used with the process of compilation of emission inventory in waste sector are shown on the following Tables.

Table 80: *Emission factors for calculation of PCDD-F emissions in Waste sector*

NFR	Sector	Activity data (amount of...)	Emission factor	Unit	Ref.
5C1bi	Industrial waste good APC	incinerated waste	0.075	mg I-TEQ/t	[2]
	Industrial waste 1990-1999	incinerated waste	0.275	mg I-TEQ/t	[1]
5C1biii	Clinical waste	incinerated waste	0.5	mg I-TEQ/t	[1]
	Clinical waste 1990 -1999	incinerated waste	0.815	mg I-TEQ/t	[1]
5C1bv	Cremation	cremation cycle	0.01	mg I-TEQ/cycle	[1]

[1] K. Magulova: Methodical inventory of persistent organic pollutants, November 2003.
[2] Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, UNEP Chemicals, February 2005.

Table 81: *Emission factors for calculation of PAH emissions in Waste sector*

NFR	Sector	Activity data (amount of...)	Emission factor	Unit	Ref.
5C1bi	Industrial waste	incinerated waste	38.87	mg/t	[1]
5C1biii	Clinical waste	incinerated waste	38.87	mg/t	[1]
5C1bv	Cremation	cremation cycle	0.03384	mg I-TEQ/cycle	[2]

[1] K. Magulova: Methodical inventory of persistent organic pollutants, November 2003.
[2] EMEP/EEA Air Pollution Emission Inventory Guidebook 2016.

Table 82*: Emission factors for calculation of HCB emissions in Waste sector*

NFR	Sector	Activity data (amount of...)	Emission factor	Unit	Ref.
5C1bi	Industrial waste (no or minimal APCs)	incinerated waste	3	mg/t	[1]
	Industrial waste (improved APCs)	incinerated waste	2	mg/t	[2]
	Industrial waste (good APCs)	incinerated waste	0.139	mg/t	[3]
5C1biii	Clinical waste	incinerated waste	0.046	mg/t	[1]
5C1bv	Cremation	cremation cycle	0.03384	mg I-TEQ/cycle	[2]

[1] K. Magulova: Methodical inventory of persistent organic pollutants, November 2003.
[2] EMEP/EEA Air Pollution Emission Inventory Guidebook 2016.
[3] Enabling activities to facilitate early action on the implementation of the Stockholm Convention on Persistent Organic Pollutants (POPs Convention) in Poland, 2002

Table 83: *Emission factors for calculation of PCB emissions in Waste sector*

NFR	Sector	Activity data (amount of...)	Emission factor	Unit	Ref.
5C1bi	Industrial waste	incinerated waste	10	mg/t	[1]
5C1biii	Clinical waste	incinerated waste	10	mg/t	[1]
5C1bv	Cremation	cremation cycle	0.6	mg I-TEQ/cycle	[2]

[1] K. Magulova: Methodical inventory of persistent organic pollutants, November 2003.
[2] EMEP/EEA Air Pollution Emission Inventory Guidebook 2016.

6 OTHER AND NATURAL EMISSIONS (NFR 6, NFR 11)

5.5 6A Other sources

5.5.1 Description

No other activities are occurred in the Slovak Republic. Notation key NO is used.

5.5.2 Methodological issues and activity data

5.5.3 Completeness

5.6 Forest fires

5.6.1 Description

The time series in range 1990-2014 was updated during the last reported cycle due to the change in activity data of the category 11B in order to maintain the consistency with greenhouse gas emissions inventory. Forest fires are important sources of persistent organic pollutants thus the recalculation of entire time series have been carried out too.

5.6.2 Methodological issues and activity data

5.6.3 Completeness

7 RECALCULATIONS AND IMPROVEMENTS

Chapters in development, results will be available as soon as possible

8 PROJECTIONS

Chapters in development, results will be available as soon as possible

9 ANNEXES

Chapters in development, results will be available as soon as possible