REPUBLIC OF SERBIA
Ministry of Environmental Protection
Environmental Protection Agency

ENVIRONMENT IN SERBIA

2004 – 2019

EXTENDED SUMMARY

Belgrade 2019

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Publisher: Ministry of the Environmental Protection/Environmental Protection Agency
For the Publisher: Filip Radović, Environmental Protection Agency, Director
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Front Page (Caricature): Pal Lephaft (Novi Sad), "Noe2019", First Cartoon Award - "This is the Earth for us - Get moving for the environment" (Delegation of the European Union, Ministry of European Integration of the Republic of Serbia and Ministry of Environmental Protection of the Republic of Serbia)
Translator: Nada Tarabić
Design: Environmental Protection Agency
Original title: Животна средина у Србији: 2004 – 2019
Print: All in one Business Center, Belgrade
ISBN 978-86-87159-25-9

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FOREWORD

First fifteen years

Since its founding 15 years ago, the Environmental Protection Agency, always in the capacity of legal entity within one of the ministries competent for environmental protection, has been one of the most ambitious *projects* on data collection and development of indicators aimed at supporting environmental policy in the Republic of Serbia. The complexity and interaction of ecological systems in the dynamics of modern world today, in our country not less complex either, requires the establishment of appropriate environmental monitoring to identify key sectors for evaluating the progress against the set goals. Systematic monitoring of water and air quality, collection of data on waste generation and sources of water, air and soil pollution, along with data on endangered natural values with different socio-economic indicators, all represent a wide array of activities falling under the competence of the Serbian Environmental Protection Agency, belonging to different areas defined by laws and by-laws of the Republic of Serbia.

Adoption and implementation of the national legislation pertaining to environment and climate change since 2000 is becoming probably the most dynamic areas of regulation in the process of European integration of our country. High-quality environmental data is a prerequisite for progress monitoring and for identification of deficiencies and emerging challenges, so cooperation between the European Environment Agency and the Environmental Protection Agency of Serbia is an indispensable benchmark for comparison with the EU Member States in this domain. What started with the First National State of the Environment Report (2006), which has been published annually ever since, as well as with thematic reports and publications in various fields, has evolved into an online platform of the Environmental Protection Agency, which for the past 15 years has been receiving, storing, processing and disseminating ever more reliable data and indicators.

In the time of environmental interactions we are exposed to, most important of which have been presented in a synthetic publication[1], adoption of effective measures cannot be planned without monitoring and reporting. Investing into human resources and equipment as a know-how system for these activities implemented by the Environmental Protection Agency is fundamental support to future-related decision making.

1 October 2019 **Filip Radović**

Director of the Environmental Protection Agency

[1] *"Extended Summary" is an extract of most important environmental data published by the Environmental Protection Agency in its annual reports and thematic publications over the past fifteen years, also published as integrated version in publication ENVIRONMENT IN SERBIA: 2014-2019.*

1. INTRODUCTION

The Environmental Protection Agency was established by virtue of the Law on Ministries on 1 November 2004, as a separate body within the Ministry responsible for environmental protection, with the aim of creating an operational institution that could meet national and international obligations related to monitoring, data collection and reporting in the area of environment. The organisational structure of the Agency comprises the Sector for Quality Control and Environmental Status, consisting of four departments: Air Quality Monitoring, Water and Sediment Quality Monitoring, Indicators, Reporting and Information System and National Register of Pollution Sources, while the National Laboratory is a separate department within the Agency. Preparation of the State of the Environment Report in the Republic of Serbia is the annual legal obligation accomplished by the Agency. The report is adopted by the Government of the Republic of Serbia. In the period from 2003 to the present date, 14 reports have been prepared and can be found in electronic form on the Agency's website. The reports contain all relevant data, information and indicators that explain the interconnections between the economy, society and the environment, in a single term called the eco-social system indicators (Figure 1).

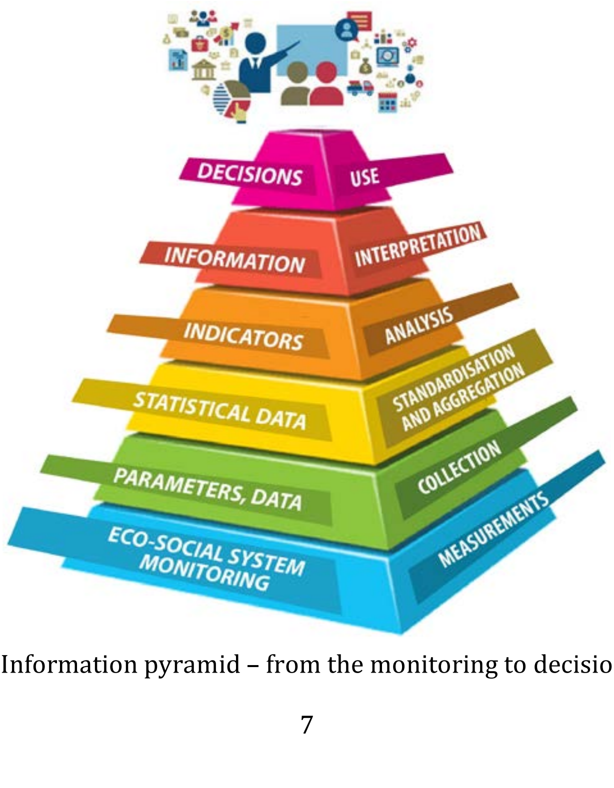


Figure 1. Information pyramid – from the monitoring to decision makers

The reports are primarily intended for decision-makers in the field of environmental protection, but also for professionals and general public. In addition to this main report, the Agency publishes a number of thematic reports, including: Report on air quality in the Republic of Serbia, Report on the status of surface waters, Report on waste management, Report on biodiversity, Report on the status of soil, Report on economic instruments in the area of environmental protection, and many others.

The Agency is the National focal point of the Republic of Serbia for cooperation with the European Environment Agency, and rating of this reporting based on evaluation conducted by EEA had recorded a growing trend in the period of 2004 – 2014, reaching 90% in 2014 compared to the initial value of 17%. The rating was not conducted in 2015 due to changes in the evaluation methodology aimed at raising the criteria and expanding the reporting data set, and in the next two years (2016 and 2017) the reporting was rated at 72% and 75% respectively, while in the last evaluation cycle (2018), it achieved a score of 93%, placing the Republic of Serbia on 13th position out of 39 European countries participating in this activity.

Fifteen years of work experience and an extensive bibliography of published reports and publications now create a comprehensive knowledge base that deserves to be synthesised and published, along with the challenge of presenting guidance for the coming fifteen years. Readers of different levels of education and roles in a decision-making system, hereby have a paper (extended summary in English) of which only they will be able to make a specific final judgment and evaluate the overall contribution of the Serbian Environmental Protection Agency.

2. DRIVING FORCES – PRESSURES – STATE – IMPACTS – RESPONSES

Applying the theoretical and methodological bases, developed by the European Environment Agency (EEA) under the name of DPSIR framework (D – Driving Forces, P – Pressures, S – State, I – Impact, R – Response), the Serbian Environmental Protection Agency has systematised a set of proper indicators. The interaction between people and the environment, according to this concept, describing a link between the cause and effect of a problem, is further presented in more details in the form of a summary (http://indicator.sepa.gov.rs/).

Belgrade (Photo: Vlada Marinkovic Wiki Commons)

2.1. DRIVING FORCES IN THE ENVIRONMENT

Driving forces of negative environmental impacts include production and consumption in economic sectors (e.g. agriculture, energy, industry, transport), where renewable and non-renewable resources are exploited, energy is consumed, technology applied, waste landfilled, and land used. Population, education level and economic stability are also primary forces since the human community is, depending on the size of population and development level, a significant "force" in terms of demand for food, water and tangible resources.

Key results and recommendations

In the period from 1990, energy production had remained at the same level, while total primary energy consumption had increased by 6.7% and in 2018 amounted to 16.65 Mtoe. Consumption is dominated by fossil fuels with 87.9%, while the share of renewable energy is 12.1%. Final energy consumption by end-users amounted to 8.90 Mtoe in 2018, and had decreased by 3.3% compared to 1990. The largest consumers are households with 32.5%, followed by industry 28.6% and transport 25.6%.

When it comes to forestry, 52.2% of forests in Serbia are privately owned, 39.8% belong to state property and 8% belong to another form of ownership. Forest quality parameters are different, depending on the ownership. Although state-owned forests account for less than 40% of total forests in Serbia, total amount of timber therein is 48.5% or 196 m^3/ha, while volume of timber in privately-owned forests (making up for more than 52% of total forest area) is lower than 45%, or 138 m^3/ha. Forests in the Republic of Serbia are managed by public companies. In the period 1953-2012, there was an increase in the area under forest by over one million hectares, an increase of 75% compared to 1953. The proportion of annual volume increase (about 9 million m^3) and annual logging (about 3.2 million m^3) is about 3:1. Together with the structure of forest roads and the certification process, it can be said that forest resources are being sustainably used.

Population trend of the most important hunting species was stable in the period 2014-2016. Quail, pheasant and wild boar showed a slight increase in population, while deer and rabbit recorded a slight decrease. The catch of fish decreased, after several years of increase. Freshwater habitats are more endangered than forest habitats, especially due to fragmentation of river habitats. Production in carp ponds increased by about 17%, but catch from carp ponds increased by about 31% compared to 2017. Production in trout ponds increased by about 70%, and catch from trout ponds doubled compared to 2016.

ENERGY CONSUMPTION BY FUEL AND SECTOR

Primary energy consumption means the energy needed to meet relevant demand in one country and includes domestic production and net energy imports, while final energy consumption means consumption of final energy in all sectors. Primary energy consumption in the Republic of Serbia has a slightly growing trend, and it had increased by 6.7%, in the period between 1990 and 2018, while obvious fluctuations in energy consumption are a consequence of economic activities. Sharp decline in economic activity in the early 1990s, and the fall in energy consumption and production in 1999 was followed by lower energy consumption and production in 2014 due to a disastrous flood, which led to a significant decrease in coal and electricity production (Figure 2).

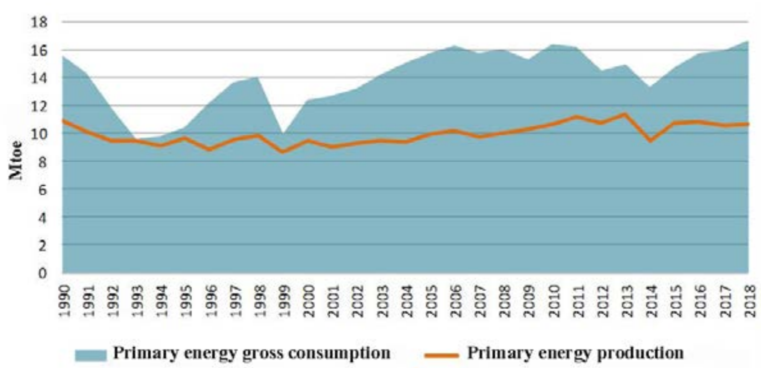


Figure 2. Primary energy consumption and production in the Republic of Serbia

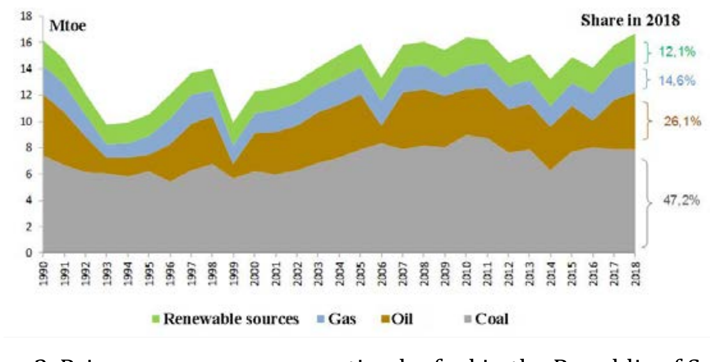


Figure 3. Primary energy consumption by fuel in the Republic of Serbia

Primary energy consumption amounted to 16.65 Mtoe in 2018. The structure of primary energy consumption is constantly dominated by fossil fuels. Since 1990, consumption of coal and gas has increased by 6.2% and 11.0% respectively, while oil consumption decreased by 6.5%. Consumption of energy from renewable sources has slightly grown by 7.5% (Figure 3).

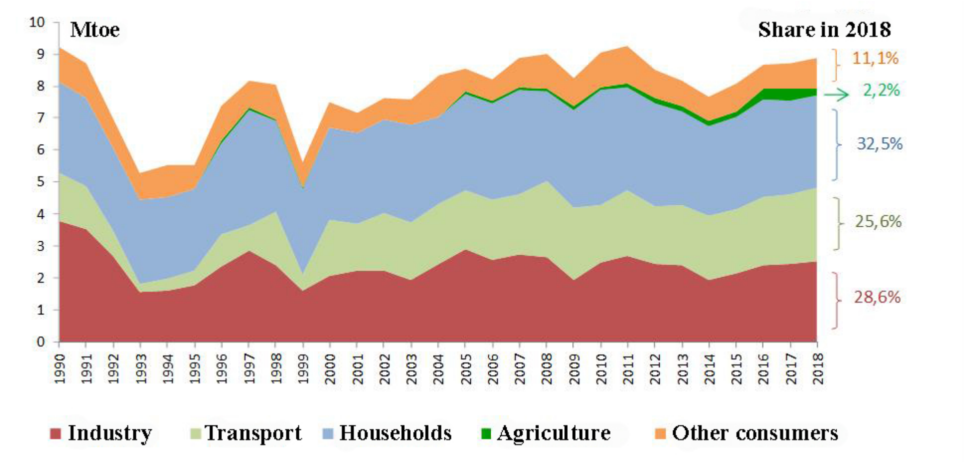


Figure 4. Final energy consumption by sectors in the Republic of Serbia

Final energy consumption for energy purposes amounted to 8.90 Mtoe in 2018. Observed by sectors, the most energy intensive ones were Households, Industry and Transport. Compared to 1990, final energy consumption has been reduced by 3.3%. Energy consumption has increased the most in the Transport sector, by 52.8%, and consumption in Households has grown by 1.1%. A decline in consumption has been recorded in Industry, a significant one of 32.9%, and by Other consumers by 6.8%. Data for Agriculture has been recorded since 1996, and the consumption has been growing ever since (Figure 4).

FORESTRY

Sustainable forest management pertains to total forest area covered by the plan. A management plan can be operational (Management Plan) or a less specific one. It can be registered or approved by public authorities, but it does not necessarily be a prerequisite. In Serbia, 52.2% of forests are private property, 39.8% are state-owned, while 8% belong to another ownership form. Forest quality parameters are different, and they depend on the ownership type. Although state-owned forests account for less than 40% of total forests in Serbia, the total amount of timber therein is 48.5% or 196 m^3/ha, while the volume of timber in privately owned forests (which make up more than 52% of total forest area) is lower than 45%, or 138 m^3/ha. Public companies are responsible for forest management in the Republic of Serbia. When it comes to certification schemes in Serbia, only public forests are certified through the Forest Stewardship Council (FSC®) certification system. Public Company Srbijasume has certified 834,439 ha, and Public Company Vojvodinasume 128,789 ha of forests, corresponding to 100% of forest areas managed by both companies.

The best indicator for a measure of sustainability of timber production as a potential for future availability and logging of timber is the proportion of annual volume increment (around 9 million m^3) and annual logging (3,217,000 m^3), which is around 3:1.

Figure 5. Wood increment and logging in the Republic of Serbia[2]

[2] *Source: Statistical Office of Republic of Serbia*

Mountain Tara (Photo: Slavisa Popovic)

FISHING AND HUNTING

Freshwater habitats are more endangered than forest ones. River habitat fragmentation in Serbia is 0.01895, with a significant increase recorded since 1930. Based on data available for 43 dams with information about the year of construction, an increase in the fragmentation index can be observed in the period from 1930 to 2010. Most dams are up to 20 m high, while 5 dams are about 100 m high. However, the construction of dams on the Danube resulted in significant negative effects, primarily on sturgeon species, which could no longer move upstream. No catches of eel have been recorded after the construction of Djerdap 1 (1970). Sturgeon catches had declined significantly after the construction of Djerdap 1, and it has almost disappeared after the construction of Djerdap 2 (1984). Sturgeon and beluga catches had increased after the construction of Djerdap 1, but has significantly declined after the construction of Djerdap 2.

According to abundance of populations of selected primary hunting species in the Republic of Serbia, the abundance trend was stable in the period from 2014 and 2016, hunting of large game increased, while hunting of small game decreased.

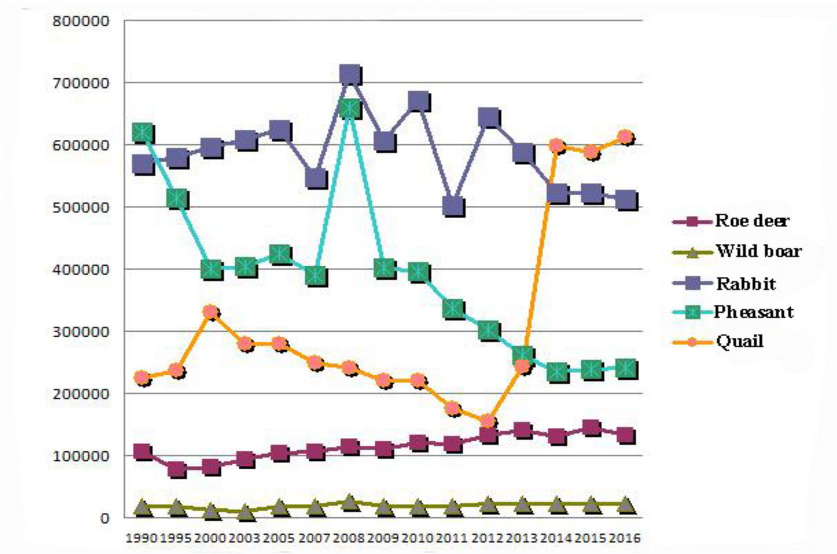


Figure 6. Trend of population abundance for selected hunting game species[3]

The trend of population abundance was stable for most significant hunting species in the period from 2014 to 2016. Quails, pheasant and wild boar indicated certain growth in abundance, while roe deer and rabbit indicated a certain decrease in abundance.

[3] *Source: Forest Directorate*

2.2. PRESSURES ON THE ENVIRONMENT

Environmental **pressures** stem out from driving forces, economic activities and factors that result in meeting the demand of society. These pressures, altogether, are a consequence of the overall production and consumption processes in the society and can be divided into three main groups: overexploitation of natural resources, change in land use, and emission of dangerous and harmful substances and chemicals into the air, water and soil.

Key results and recommendations:

The required level of waste management, especially of municipal waste, has not yet been achieved in the Republic of Serbia. Relevant data shows that the amount of municipal waste is increasing and estimates indicate it can reach 2 to 2.5 kg per capita over the next 5-7 years. Certain number of municipalities do not implement, or only partially implemented, the activities envisaged in Local and Regional Management Plans. The total amount of generated industrial and similar waste types is growing and in 2017 and 2018 it amounted to approximately 11.6 million tonnes. It should be emphasised that there had been a constant increase in the amount of recovered waste since 2015, which exceeded the amount of 2 million tonnes in 2018. Analysing air emissions-related data, the largest sources of sulphur and nitrogen oxides and particulate matter emissions are found to be combustion of solid fuels in electricity and heat production, and combustion for heating and cooking purposes in households. Road transport should also be mentioned as a considerable source of nitrogen oxides emissions. The most significant emitters of ammonia are farms, i.e. rearing of domestic animals, with a specific issue of manure management on farms.

Out of 32 investigated industrial contaminated sites, chemical industry “Zupa” Krusevac stands out with high concentrations of mercury, as well as parts of mining and smelter establishment Bor with high concentrations of copper and arsenic in the soil.

Comparing data referred to in water balance for the national territory (2001) and for the period between 2000 and 2017, revealed a negative trend in total internal surface water balance, which must be considered through modifications of management policy.

Besides the expressed problem of high percentage (about 90%) of untreated waste waters, solid waste management deserves attention due to the export of large amounts of waste for which there are processing capacities in Serbia. This practice directly and negatively affects the recycling industry, as regards, for example, metal scraps and waste paper. There have been records of imports from the countries to which the same waste type was exported.

The effect of climate change has been registered through an increased number of dried trees and severe defoliation in forests, as well as through more intense forest fires and damage in forests caused by natural disasters.

Although the practice of irrigating agricultural land has recorded a positive trend in the previous period, these are still small areas of land, causing proportionally low environmental pressure.

POLLUTANT EMISSIONS TO AIR

Based on data submitted to the Environmental Protection Agency for 2018, it has been found that the total emission of this pollutant amounted to 370.85 Gg in 2018. The largest sources are presented (Figure 7). The most significant emitted amounts originate from thermal power plants from the energy sector in general, mineral industry, animal and plant products from the food industry and from metal production and processing.

The most significant point sources of nitrous oxide in the Republic of Serbia are thermal power plants, chemical installations and mineral industry, as well as the production of animal and plant products from food industry. The overview of the most significant sources is given (Figure 8). The overall amount of nitrogen oxides emitted from the plants was 51.56 Gg in 2018.

The most significant quantities of particulate matters emitted in 2018 originated from thermal power plants from the energy sector, mineral industry, intensive livestock production and the food industry. The most significant sources are presented (Figure 9). Total emission of particulate matter amounted to 13.35 Gg.

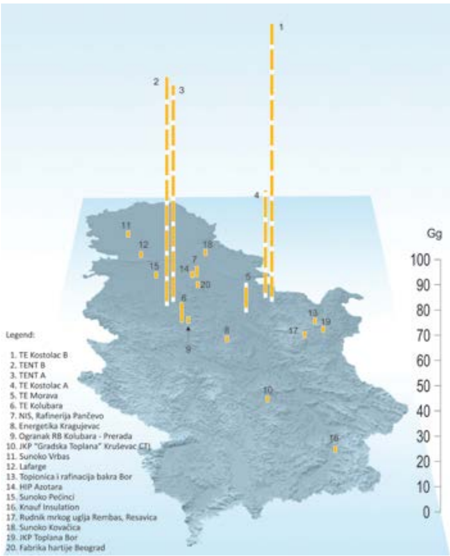


Figure 7. Sulphur oxide emissions

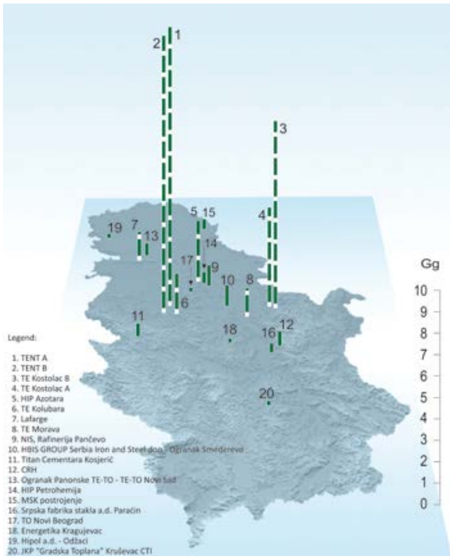


Figure 8. Nitrogen oxide emissions

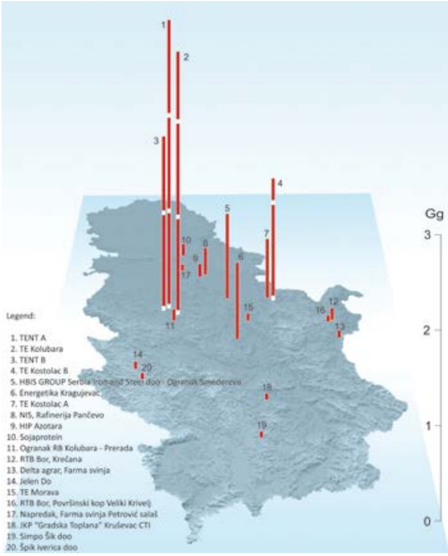


Figure 9. Particulate matter emissions

Pursuant to the EMEP/EEA methodology from 2016 of the Convention on Long-range Transboundary Air Pollution (1979), the Agency generates annual inventory of main air pollutants and, on the grounds thereof, generates the indicator of acidifying gas emissions which follows the trends of anthropogenic emissions of acidifying gases – nitrogen oxides (NOx), ammonia (NH_3), and sulphur oxides (SOx as SO_2) in the period from 1990 to 2017. The indicator also provides information on sectoral emissions in accordance with the above mentioned methodology.

Based on data presented (Figure 10), it can be concluded that sulphur oxides emissions were slightly decreased, while ammonia and nitrogen oxides emissions showed no significant changes in the period 1990 – 2017. Based on the inventory, the most significant contribution to total amount of acidifying gases emitted in 2017 was "Energy generation and distribution" for NOx – 49.2%, and "Road transport" – 23.7%, for SO_2 "Energy generation and distribution" – 91.4%, and "Agriculture" about 82.5% for NH_3.

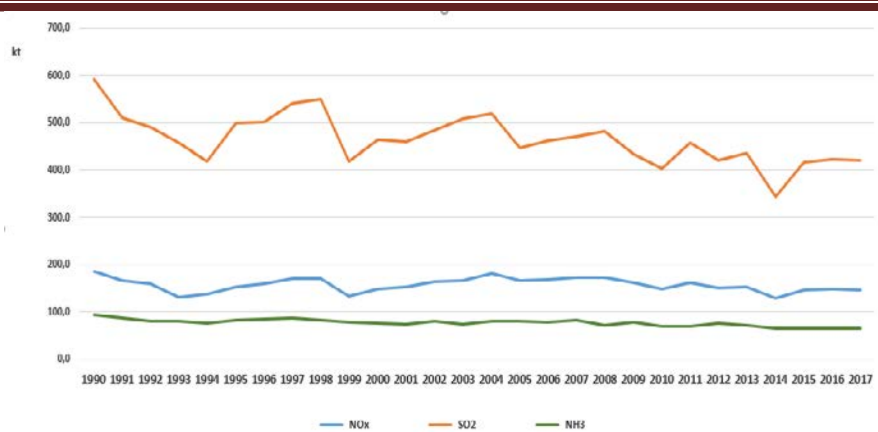


Figure 10. Emitted quantities of acidifying gases in the period 1990-2017

Total emissions and trend of ground-level ozone precursors (NOx, CO and NMVOC), excluding CH_4 emissions, indicated that emissions of carbon monoxide had decreased in the period 1990 – 2017, while emissions of volatile methane-free organic compounds had very slightly decreased in the mentioned period.

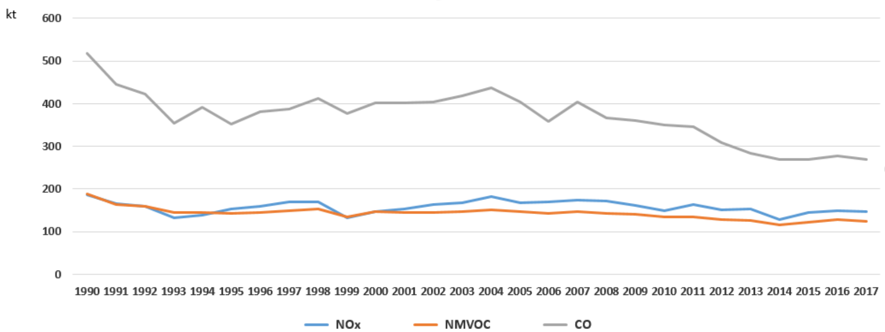


Figure 11. Emitted quantities of GL ozone precursors in the period 1990 – 2017

Total emissions and trend of primary particulate matter smaller than 10μm (PM_{10}) and secondary particulate matter precursors of NOx, NH_3 and SO_2, as well as information about pollutant emissions per sector has been developed in accordance with the EMEP/EEA 2016 methodology.

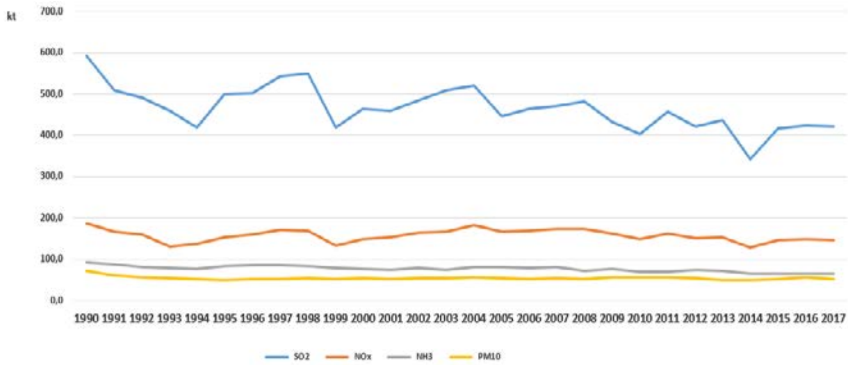


Figure 12. Emitted quantities of primary particulate matters and secondary particulate matter precursors in the period 1990 – 2017 (kt/y)

Uzice (Photo: Zoran Saponjic, 28.11.2016.)

The Figure 12 clearly demonstrates that sulphur oxides emissions slightly decreased in the period 1990 – 2017, while emissions of nitrogen oxides, ammonia and PM_{10} showed no significant changes in the mentioned period. Contribution of NOx, NH_3 and SO_2 emissions per sector was presented in the previous indicators, and the PM_{10} emission share was highest for "Thermal power plants of less than 50 MW output and individual heating", amounting to around 56.3% and "Energy use in industry and industrial processes" amounting to 13.4%.

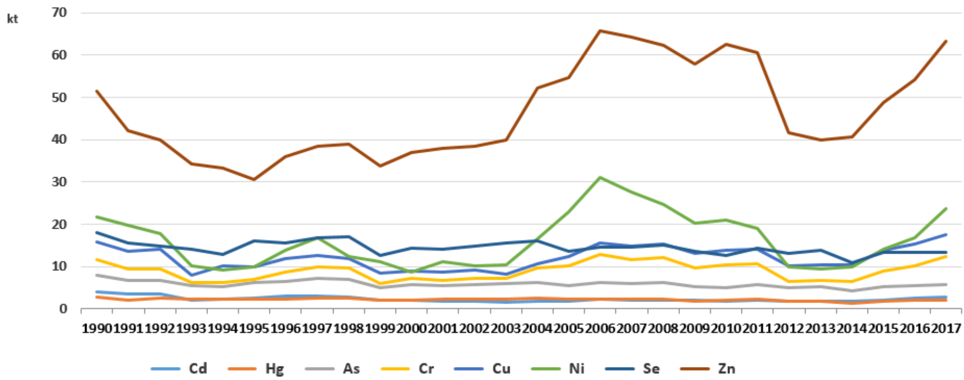


Figure 13. Emitted amounts of Hg, Cd, As, Cu, Cr, Ni, Se, Zn

The trend of total anthropogenic heavy metals emissions (Cd, Hg, As, Cr, Cu, Ni, Se and Zn) indicated a decrease in the period from 1990 to 1996, followed by the increase in emissions amounts.

The CLRTAP inventory monitors a total of 6 POP chemicals, and these are benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3, -cd)pyrene, HCB and PCB.

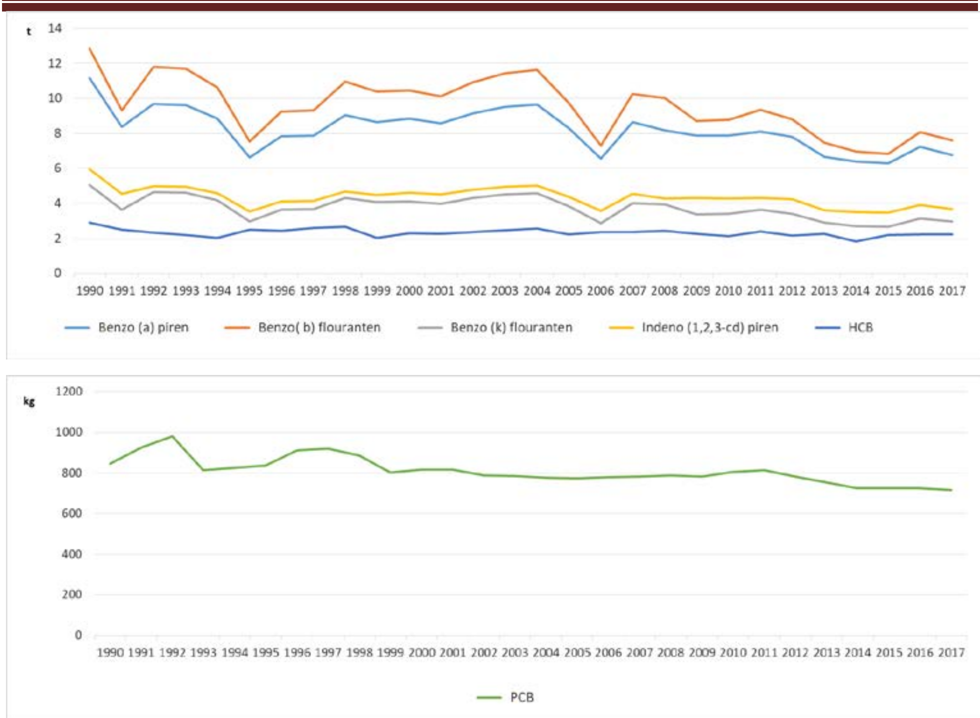


Figure 14. Emissions of unintentional POPs in the period 1990 – 2017

As can be seen from the above figures, the amounts of certain emitted POP chemicals were either in a very slight decrease or showed no significant deviation in the observed period.

According to the national emission balance report, submitted every year by the Environmental Protection Agency to the Convention on Long-range Transboundary Air Pollution, the dominant sources of emissions of suspended particles PM_{10} and $PM_{2.5}$ were heating power plants of less than 50 MW output and individual heating, which accounted for 57% for PM_{10} and 75% for $PM_{2.5}$ in 2017.

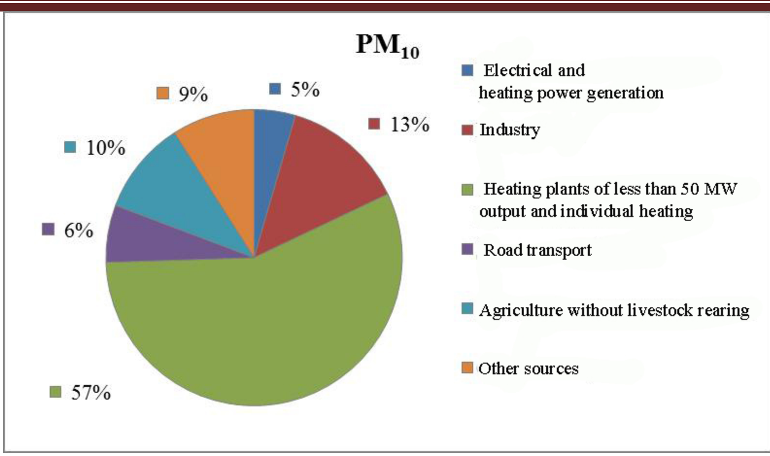


Figure 15. National emission balance for PM_{10} per sector

In addition to this sector, industry and agriculture without livestock rearing appear as identifiable sources contributing with 13% and 10% respectively to total PM_{10} emissions. The industry sector also appears as a source of $PM_{2.5}$ with 9%, with road traffic accounting for only 6% nationally.

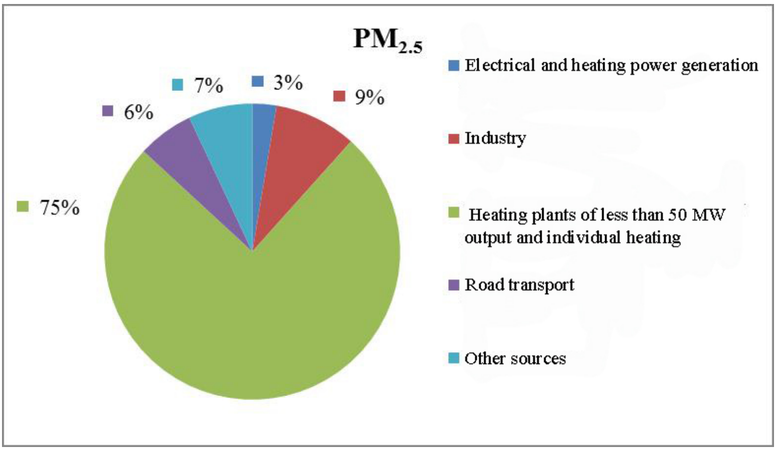


Figure 16. National emission balance for $PM_{2.5}$ per sector

POLLUTANT EMISSIONS TO WATER

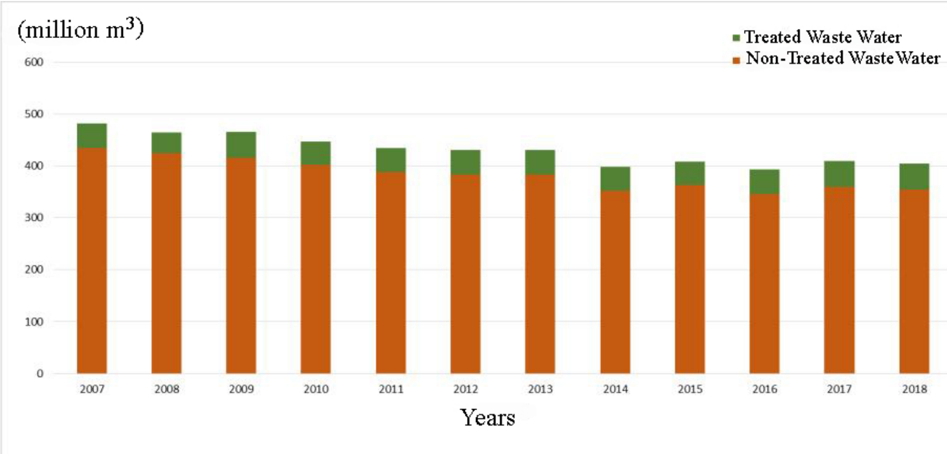


Figure 17. Waste water quantities in the Republic of Serbia

Total amount of waste water discharged from settlements in 2018 decreased by 1.3% compared to 2017, out of which the amount of waste water discharged into the public sewerage system decreased by 0.5% compared to the same period in 2017. The percentage of polluted (untreated) waste water had a favourable (declining) trend in the period 2008 – 2017. In 2017, it amounted to 87.9%, meaning that in 2017 the highest percentage of waste water (12.1%) was treated in the mentioned period. According to multiannual data, the amounts of total waste water in the period 2008 – 2017 had a declining trend.

Waste waters which discharged into the recipient without any kind of treatment (whether mechanical, biological or chemical one) are the key sources of water pollution in the Republic of Serbia and have a negative impact on the environment.

The most common treatment method was primary and secondary treatment. According to data provided to the Environmental Protection Agency by Public Utility Companies for 2018, 42 municipal waste water treatment plants (WWTPs) were operational, of which only a smaller number operated according to designed criteria, while the majority of plants operated at the efficiency far lower than the designed one. Reconstruction or construction of WWTPs are in progress in 18 municipalities /towns.

AVAILABILITY OF WATER RESOURCES

Comparing the data collected and compiled to define water management balance in the Water Management Strategy of the Republic of Serbia (2001) and for the period 2000 – 2017, there is an obvious negative trend of total internal surface water balance.

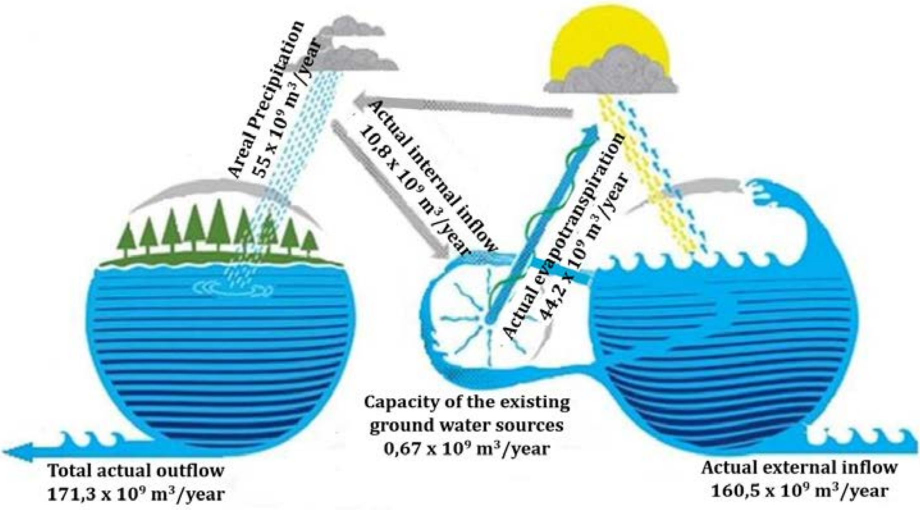
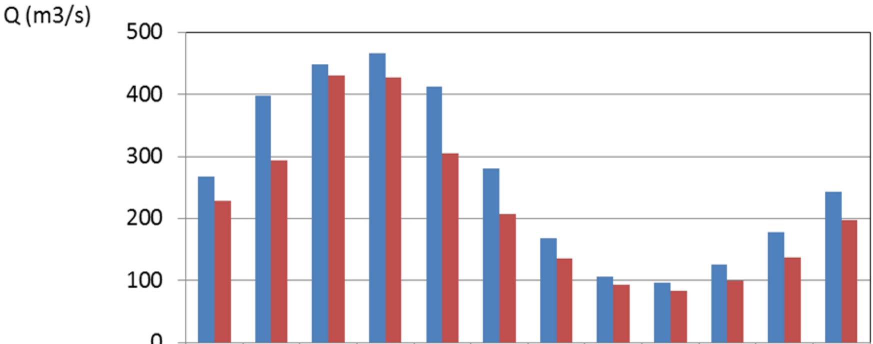


Figure 18. Water Balance in the Republic of Serbia: 2000 – 2017

Internal recharge (watershed run-off), inland waters that have formed on the national territory were of an average of 16 x 10^9 m^3/year in the period 1946-1991, reduced to 10.8 x10^9 m^3/year towards the end of the second decade of the 21st century (Figure 18). Rainfall has also decreased, in the period 1946 – 1991 it was 65x10^9 m^3/year, and evapotranspiration was 49x10^9 m^3/year, directly influencing the size of the total internal surface water balance. On the other hand, the external recharge was 162.5x10^9 m^3/year in the period 1946 – 1991, and a total run-off was 178.5x10^9 m^3/year. On the basis of these elements, there is a clear necessity for more adequate observation of a large number of factors defining the water regime on the territory of the Republic of Serbia and for application of measures to maintain both quantitative and qualitative status thereof. Projections of climate change will have negative effects on the volume of annual water balance, since earlier studies have demonstrated an average of 75% rainfall loss through evapotranspiration on the territory of the Republic of Serbia, i.e. only 25% of rainfall run-off.

For the Pomoravlje region water basins, the least run-off due to gross rainfall is in the Velika Morava River basin, and amounts to only 17%, followed by the Juzna Morava River basin with 29%, and the highest run-off is 33% recorded for the Zapadna

Morava River basin. Water abundance, as a specific watershed characteristic, is best represented by the average flow indicator. Based on the observations and measurements at the hydrological station Ljubicevski most, average monthly flows for the period 1951 – 2017 were calculated and a histogram made for the selected periods (Figure 19).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Q av (1951-1980)	267	398	449	467	412	281	168	106	97	125	178	243
Q av (1981-2017)	229	294	430	427	305	208	135	93	83	99	137	198

Figure 19. Multiannual mean monthly flows of the Velika Morava River on the Ljubicevski most profile

Average flow analyses were conducted for two perennial series, the period 1951 – 1980 and the period 1981 – 2017 to observe the relationship between water regime and climate characteristics in the course of the same period. The histogram of multiannual monthly flows of the Velika Morava River on the profile of the Ljubicevski most clearly indicated that lower mean monthly flows were recorded in the period 1981 – 2017 compared to the 1951 – 1980 period. The analysis indicated that long-term average flow of the Velika Morava River on the Ljubicevski most profile was reduced by 18% in the period 1981 – 2017 compared to the period of 1951 – 1980, with a maximum decrease in water abundance of 26% in February. The results of this analysis indicate a significant decrease in water abundance in rivers of the Pomoravlje Basin, but also a characteristic of the regime with expressed seasons of greater and lower water abundance. Spatial and time unevenness of the water regime in the territory of the Republic of Serbia and the presented elements of unfavourable short-term water balance indicate the entire complexity of the water management balance status.

WASTE MANAGEMENT

The total amount of generated waste, according to the data submitted to the Environmental Protection Agency, is presented on the Figure 20. Total amount of waste generated in 2018 reached about 11.6 million tons and the quantities were slightly increased compared to 2017, when they had increased compared to the previous ones due to the increase in number of reporting plants and the increased amount of waste generated by thermal power plants and a company activity of which is production of pig iron, steel and ferroalloys.

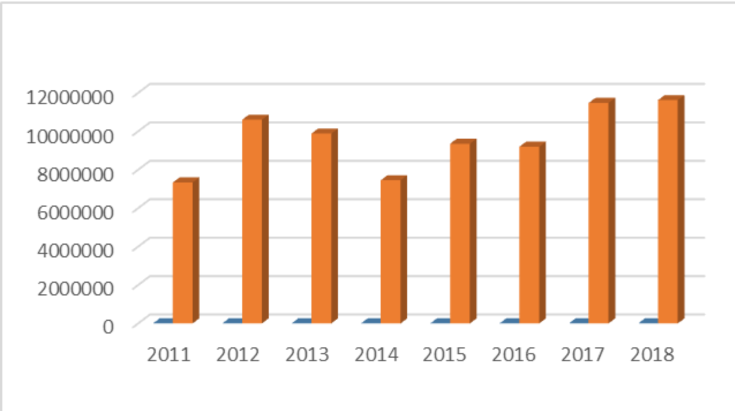


Figure 20. Total quantities of generated waste (t)

Total amount of waste obtained from the records of the Waste Catalogue by waste category shows that the highest amount of waste generated during the activities defined under category “Waste from thermal processes”, and amounts to about 70% of total generated waste. The largest waste generators are thermal power plants, which in the course of their operation generated 7.45 million tons of coal fly ash during 2018. They are followed by solidified waste from the waste treatment plants, scrap iron-containing metals and metalwork waste, and mixed construction and demolition waste. The total amount of municipal waste in 2018 amounted to 2.3 million tons, or 20% of the total amount of all waste categories.

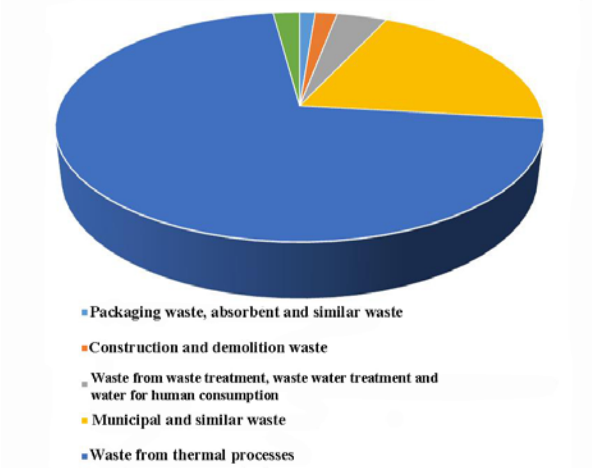


Figure 21. Total amount of waste per category from the Waste Catalogue in 2018 (t/y)

Based on quantities of generated hazardous waste as per waste groups from the Waste Catalogue, it can be concluded that the largest amount of hazardous waste belongs to the category "Waste from thermal processes", having a share of 34% of the total amount.

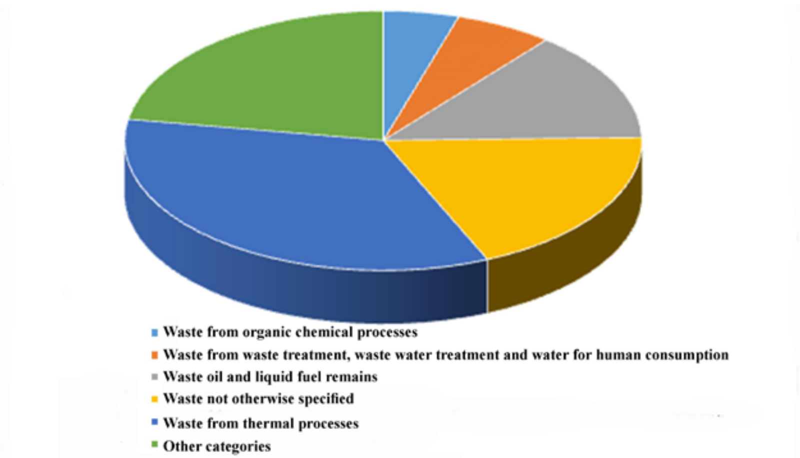


Figure 22. Total quantity of hazardous waste per waste category from the Waste Catalogue in 2018 (t/y)

Pursuant to the Law on Waste Management, competent authorities (Ministry, Secretariat of AP Vojvodina and local self-governments) issue permits, maintain a register of issued permits and submit data from the permit register to the Environmental Protection Agency. The Agency maintains a register of waste management permits issued in the territory of the Republic of Serbia. This database is available on the Environmental Protection Agency website. The register of waste management permits contains 2064 valid permits issued by the end of July 2019. The number of permits decreased compared to the same period of 2016 and 2017. The reason for such decrease is that a certain number of collection and transport permits valid for 5 years had expired and have not been renewed by companies, and several permits have been revoked. The overview of waste permits by industry is given at (Figure 23)

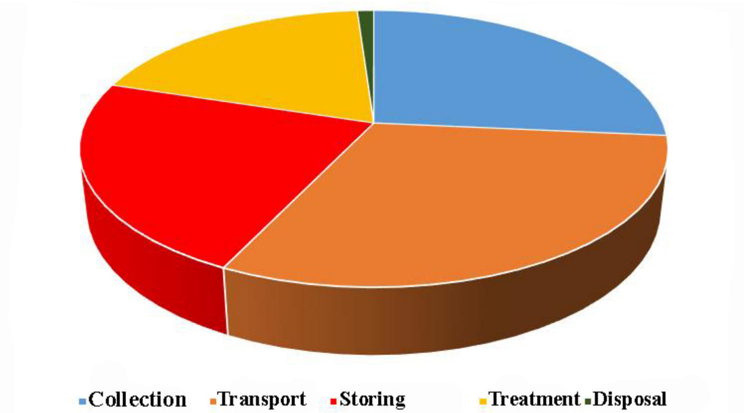


Figure 23. Preview of permits by industry

Sediment sampling in Vrutci reservoir - Uzice Municipality (sampler Petar Kostic), August 2018.

PRESSURES ON NATURE AND BIODIVERSITY

The effect of climate change has been recorded by the correlation between dried trees and severe defoliation for 4 dominant species (beech, Italian oak, Turkey oak and spruce). Dependence on temperature and precipitation disturbances in the summer season (June, July, and August) was observed – when excessively hot and dry summers were recorded. Since 2008, there has been a significant increase in dried trees and strong defoliation of trees for 4 dominant species (beech, Italian oak, Turkey oak and spruce). The growth of dried trees in 2014 was 5 times higher than in 2007. When it comes to healthy trees, about 90% of coniferous and deciduous trees did not have or had poor defoliation. Defoliation was not registered on 92.4% of fir trees, 91.6% of spruce, 91% of Scots pine and about 40% of Austrian pine. Moderate and strong defoliation comprises about 43% of Austrian pine. As for deciduous species, 85% of hornbeam trees, 81% of oak trees, 73.2% of beech trees, 71% of European oak and 65.2% of sessile oak had no defoliation registered. Moderate and weak defoliation of deciduous species increased compared to 2017. In 2018, status assessment was carried out for forest species on 130 plot samples, on a total of 2,968 trees. In the course of 2018, no dried coniferous trees were recorded, while 0.1% deciduous trees dried out, but there was an increase in strong defoliation of coniferous species by about 30% and by about 50% of deciduous ones compared to 2017. Most severe damages to forests in 2011 and 2012 were caused by human activities, while over the past years the greatest damages have been caused by natural disasters and insects. In 2017, 11,415 cubic meters of timber burned down, which is about 70% less than in 2016. Compared to the previous year, when forest fires affected the area of about 296 ha, the area caught by fire in 2017 was 1,050 ha, which is almost 4 times greater area caught by fire.

As for the number of endangered and protected species, 2,633 wild species are protected in the territory of the Republic of Serbia, 1,783 of which strictly protected.

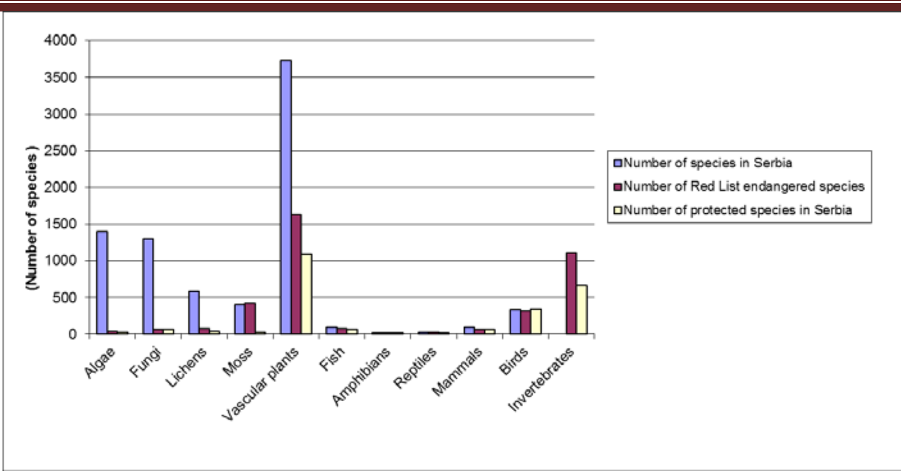


Figure 24. Endangered and protected species in the Republic of Serbia[4]

Amendments to the Rulebook on the proclamation and protection of strictly protected and protected wild species of plants, animals and fungi, protected and strictly protected species of wild flora and fauna (Official Gazette of RS, no. 5/2010, 47/2011, 32/2016 and 98/2016), there are 1,783 wild species of algae, plants, animals and fungi under strict protection regime, and 860 species are under regular protection regime. A total of 2,633 species are protected (10 species are present on both lists because they are strictly protected in the territory of AP Vojvodina and in the territory of Central Serbia). Almost all mammals, birds, amphibians and reptiles are under some regime of protection. Likewise, a large number of insects (especially daily butterflies) and plants are also protected. More than 50% of strictly protected species are listed in international conventions and EU Directives, especially from the Berne and Bonn Conventions lists and from the Birds Directive.

[4] *Source: Institute for Nature Conservation of Serbia, Provincial Institute for Nature Conservation*

CONTAMINATED SITES MANAGEMENT

Indicator *Progress in Contaminated Site Management* follows the progress in managing localised sources of soil pollution at national and international levels. The Environmental Protection Agency is responsible for introduction and management of the National Cadastre of Contaminated Sites, which is an integrated part of the Environmental Information System in the Republic of Serbia. Based on the first data published by the Environmental Protection Agency in 2007, 375 sites were identified in the territory of the Republic of Serbia, where soil pollution was confirmed by laboratory analyses of soil and groundwater in close proximity to localised pollution sources, and where pollution had been present for a longer period of time. Local soil pollution is found in the areas of intensive industrial activity, inadequate landfills, mines, at the sites of various accidents.

The highest share in the identified sites belongs to municipal waste disposal sites with 43.7%, followed by oil industry with 26.4%, and industrial and commercial sites with 16.3% (Figure 25). In the territory of the Republic of Serbia 709 potential contaminated and contaminated sites were identified in 2017.

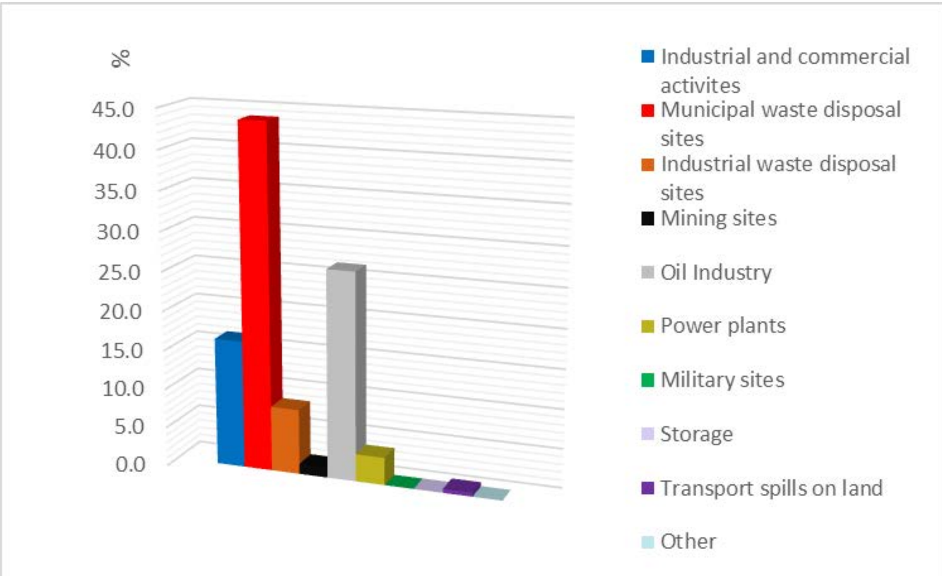


Figure 25. Share of main types of localised sources of soil pollution in the total number of identified sites (%)

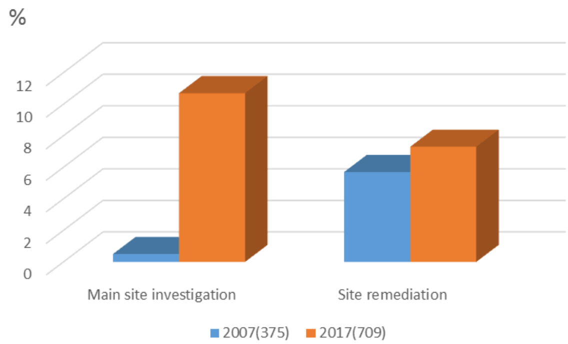


Figure 26. Progress in contaminated sites management

Following the progress in 2007-2017, it can be concluded that the share of sites where main site investigations were carried out, as well as site and remediation activities, was higher in 2017 (Figure 26).[5]

Contaminated land in Bor

[5] *Kukobrat, L., Vidic, D., SiljicTomic, A. 2018. Towards decontamination of land in Republika Srpska, Ministers' close the environment, the Environmental Protection Agency, ISBN: 978-86-87159-20-4* *http://www.sepa.gov.rs/download/zemljiste/KaDekontaminacijiZemljista.pdf*

IRRIGATION OF AGRICULTURAL LAND

The trend of irrigated agricultural land in the period 2005-2018 showed growth, but these were still small areas. Compared to the total used agricultural land in 2018, 1.4% thereof or 46,823 ha was irrigated, which is 7% less than in 2017. Irrigation water quality data is missing for environmental monitoring.

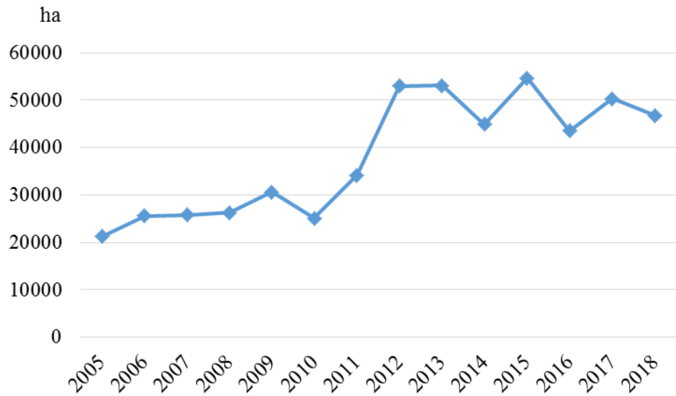


Figure 27. Trend of irrigated agricultural land in the period 2005-2018 (ha)

The amount of irrigation water abstracted on the territory of the Republic of Serbia in the period 2005 – 2018 ranged between 45.316 thousand m^3 and 110,445 thousand m^3. On average, 69,453 thousand cubic meters of irrigation water were abstracted. As for irrigation in 2018, a total of 54,540 thousand cubic meters of water were abstracted (Figure 28).

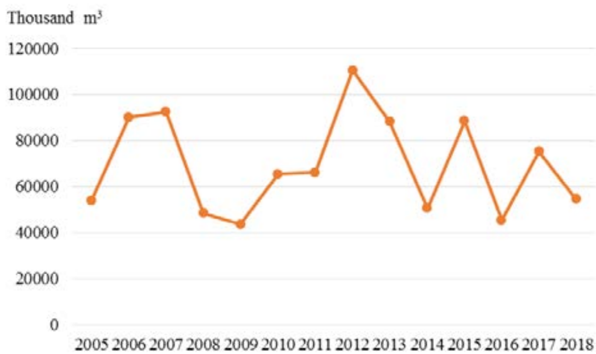


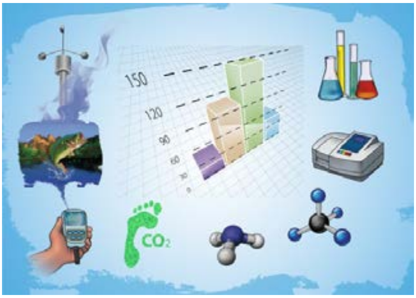
Figure 28. Total quantities of abstracted irrigation water

Most water is abstracted from watercourses, on average about 90%, while the remaining quantities are abstracted from groundwater aquifers, lakes, reservoirs and from the water supply network. In 2018, the most common type of irrigation was the sprinkling irrigation. Of the total irrigated area, 93.9% of the area was irrigated by sprinkling technique, 6.0% of the surface was under dripping system, and only 0.1% of the surface was under surface irrigation systems.

Irrigation System

Maize yield losses of nearly 60%

2.3. ENVIRONMENTAL STATUS



The environmental **status** results from pressures and is expressed through physical, chemical, biological, aesthetical and other indicators. These indicators serve to value the quality of natural resources: air, water, soil, forests, geological resources, plants and animals.

Key results and recommendations:

The environmental status is most affected by the aspect of surface water, ambient air and soil quality. Analysis of a vast number of samples, conducted monthly on average in the period 1998-2017, revealed the worst situation in this respect in watercourses and canals in Vojvodina watershed. As much as 40% of samples taken from this territory were indicated as "bad" and "very bad" compared to total number of samples analysed in the state monitoring network, and even 79% of the samples were classified as "very bad". The best quality, categorised as "excellent", was recorded in small watercourses running through hilly and mountainous areas in East, South-East and West Serbia.

Ambient air quality indicated sulphur-dioxide, nitrogen-dioxide, ground-level ozone, carbon-monoxide, and PM_{10} and $PM_{2.5}$ as the most common causes of excessive pollution. PM_{10} was registered as contributing to excessive air pollution even with 77% of all common causes. Ground-level ozone record breaches of cut-off values in both urban and rural areas every year and accounts for 19% of total breaches. Nitrogen-dioxide causes moderate air pollution in Belgrade and Uzice and occurs as a consequence of heavy traffic. Indicative measurements of heavy metals lead, arsenic, cadmium and nickel in PM_{10} demonstrated that arsenic exceeded limit values only in Bor, while benzo(a)pyrene was most present in particulate matters in Valjevo in 2018. Soil testing in urban areas has demonstrated that these areas are under strong anthropogenic impact and metals appear as the most common pollutants. The content of organic carbon in soil is decreasing and is lower than the originally estimated value.

The results of water, air and soil monitoring have indicated possible risks for human health from these environmental media, thereby introducing the topic into a still insufficiently explored scenario that speaks volumes about a food chain, top of which is occupied by humans.

SERBIAN WATER QUALITY INDEX

The Environmental Protection Agency has developed a *Serbian Water Quality Index*, intended to serve for reporting to the public, experts and policy makers (local government, state bodies). The indicator is based on the methodology according to which ten parameters of physico-chemical and microbiological quality (oxygen saturation, BOD_5, ammonium ion, pH value, total nitrogen oxides, orthophosphates, particulate matters, temperature, electrical conductivity and coliform bacteria) aggregate into a composite indicator of surface water quality, evaluating it in a continuous series from 0 to 100. Surface water quality indicators (SWQIs) are represented by colours on watercourse maps, indicating appropriate control profiles.

The analysis of the ten "best" measuring points (watercourses) by the SWQI method has created a general image of the quality of our watercourses (Figure 29 and 31). It can be concluded that the smallest watercourses running through hilly and mountainous areas are the cleanest ones and that these water resources can be said to be beyond the influence of wastewater from larger urban and industrial centres.

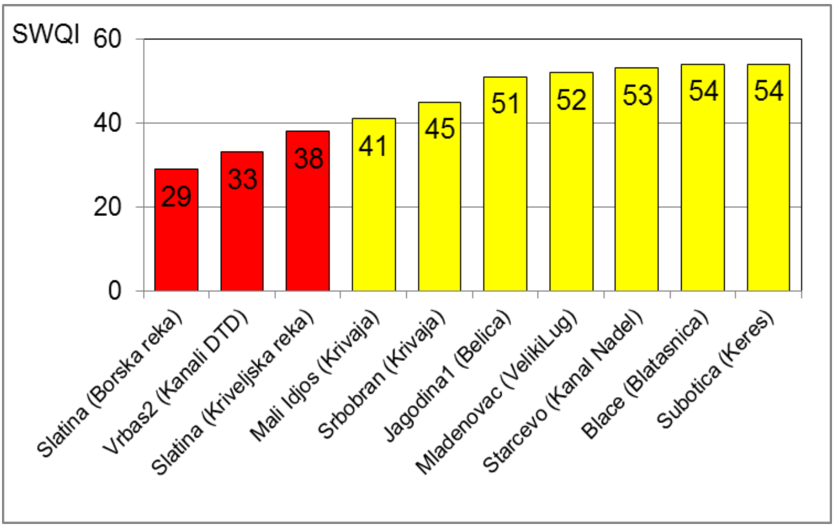


Figure 29. Ten measurement hotspots (water courses) – SWQI mean (1998-2017)

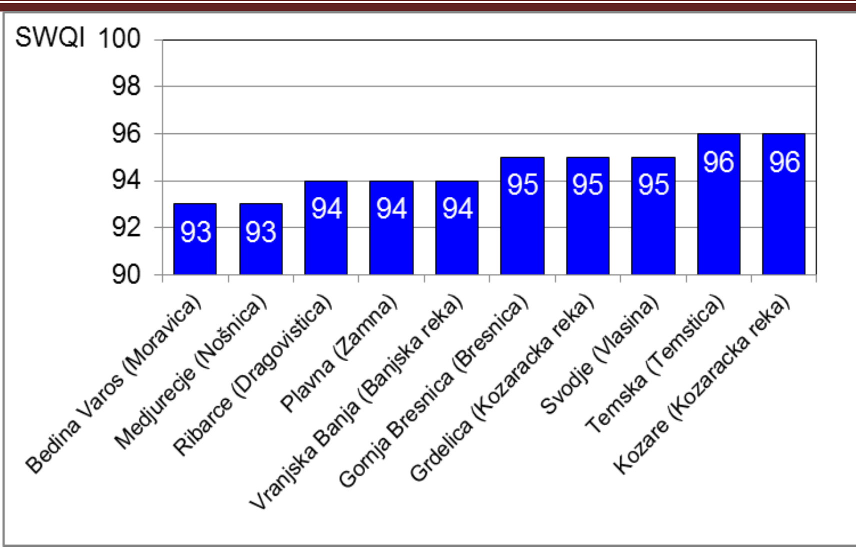


Figure 30. Ten "best" measurement points (water courses) – SWQI mean

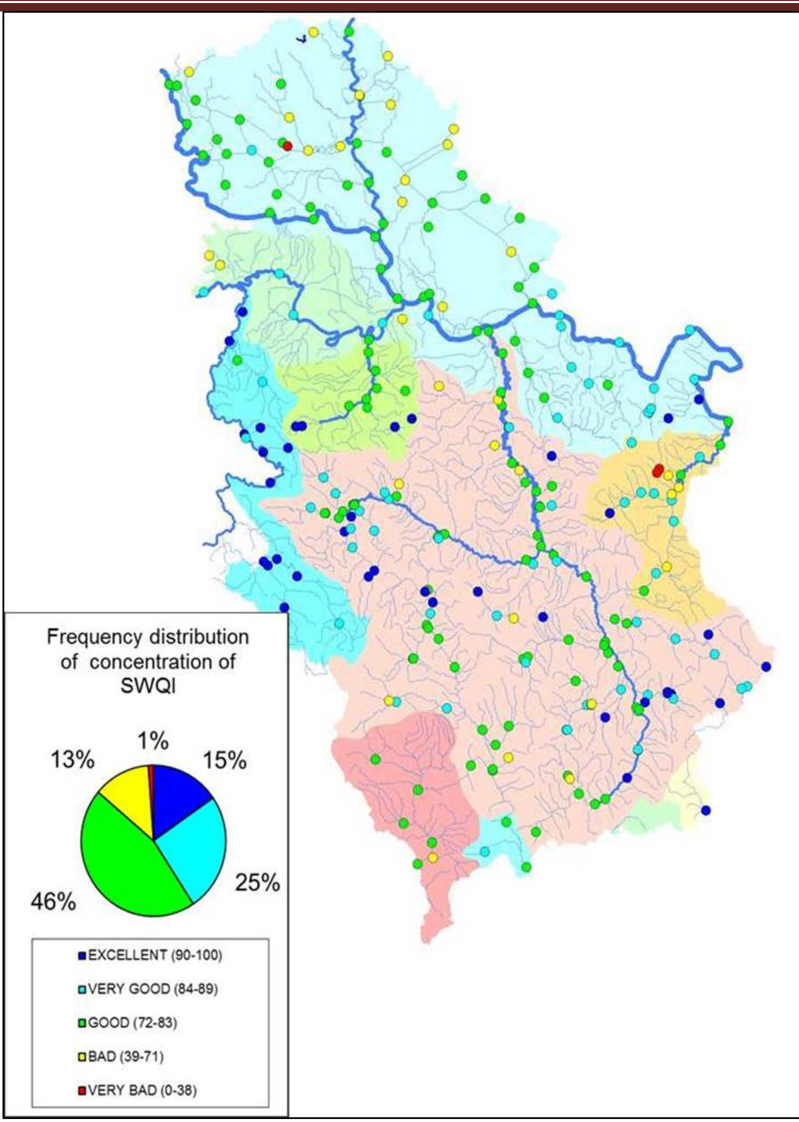


Figure 31. Mean SWQI in water courses (1998-2017) and Autonomous Province of Kosovo and Metohija (1998)

HAZARDOUS AND HARMFUL SUBSTANCES IN SURFACE WATERS AND SEDIMENT

Analysis of specific organochlorine pesticides in river sediment samples in the period 2012-2016 in the Juzna Morava Basin revealed the presence of dieldrin[6] in the Nisava River sediment on the Dimitrovgrad Profile (5.33µg/kg) and of α-HCH in the Juzna Morava sediment on the Ristovac Profile (2.0µg/kg), while other values were lower than the limit of quantification (LOQ). Total DDTs, or the sums of p,p-DDTs, p,p-DDDs, and p,p-DDEs in all tested samples were below the prescribed thresholds for the probable effects level (PEL (DDTs) = 4500µg/kg), effects range median (ERM (DDTs) = 350µg/ g) and severe effect level (SEL (DDTs) = 120µg/kg). Measured values of p,p-DDT in sediment samples taken from the Profiles of Mojsinje (23.0µg/kg), Ristovac (25.8µg/kg), Dimitrovgrad (20.5µg/kg), and Kursumlija_1 (27.0 µg/kg) were higher that limit values for the effects range median (ERM (DDT) = 7.0µg/kg). Assessment of sediment quality based on the criteria defined by the Regulation (Official Gazette of RS no. 50/2012), with respect to the content of p,p-DDT on the Profiles of: Mojsinje/Juzna Morava (23.05µg/kg), Ristovac/Juzna Morava (25.8µg/kg), Dimitrovgrad/Nisava (20.53µg/kg) and Kursumlija_1/Kosanica (27.0µg/kg) indicate exceedance of the maximum allowed concentration.

The results of monitoring implemented to maintain surface water and sediment quality have indicated that the sediment contains a "historical record" of pollutants in qualitative terms and can become a "new" source of secondary pollution in the downstream zones under certain hydrological regimes. The newly deposited material thus becomes a source of food for macroinvertebrates (invertebrates) on the river bed, consequently, food for fish, thus bringing the entire topic of sediment into a still insufficiently explored scenario that speaks volumes about a food chain, top of which is occupied by humans. Our monitoring results and international experience in monitoring the distribution of organic pollutants and their harmful effects on river ecosystems strongly support the introduction of biomonitoring.

[6] *Dieldrin is a synthetic organochlorine insecticide and the main decomposition product of another organochlorine pesticide – aldrin. It was produced to replace DDT, but over time it proved its persistence in the environment and the tendency of "bioaugmentationbioacumulation" while moving along the food chain. It is toxic to many living organisms and is therefore banned in most countries. Like most other pesticides, it enters the aquatic system primarily through runoff from treated surfaces, as well as through primary deposition, followed by evaporation and air transmission.*

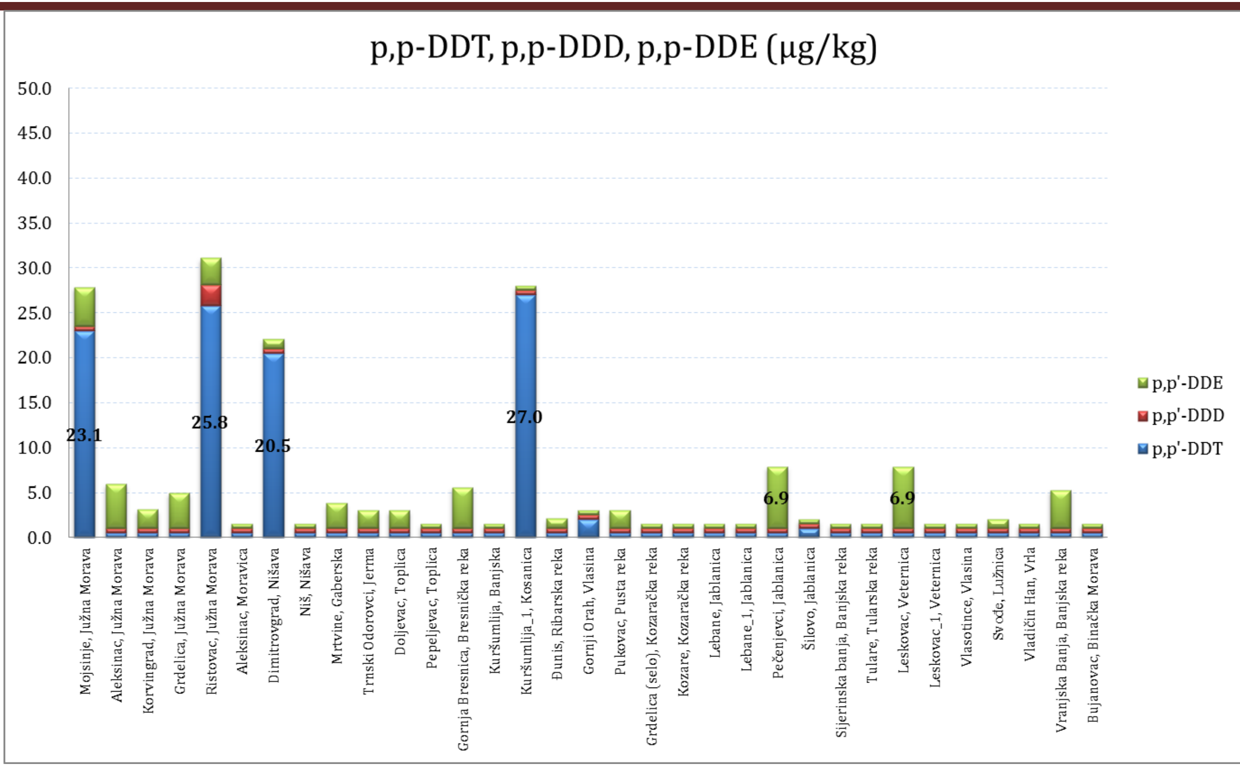


Figure 32. Content of p,p-DDT, p,p-DDD, p,p-DDE in the river sediment, Juzna Morava Basin

AMBIENT AIR QUALITY

CONCENTRATIONS OF POLLUTANTS

Monitoring provides data about concentrations of the following pollutants: sulphur-dioxide (SO_2), nitrogen-dioxide (NO_2), ground-level ozone (O_3), carbon-monoxide (CO), particulate matters smaller than 10 and 2.5 µm (PM_{10} and $PM_{2.5}$, respectively), while content of benzo(a)pyrene and heavy metals is determined for PM_{10}.

Sulphur-dioxide was an unsolvable problem and enormous pressure on human health and the environment in Bor before the construction and commissioning of a new smelter, since when the breaches of limit values prescribed for this pollutant have been reduced by several times. In the previous period, daily limit values had been exceeded even more than fifty times (such exceedance is allowed not more than three times in a calendar year). Mean daily values had hit even twenty times higher values than the allowed ones, so the maximum daily concentration of 2355 µg/m^3 was recorded in 2012 at the Bor-Brezonik station.

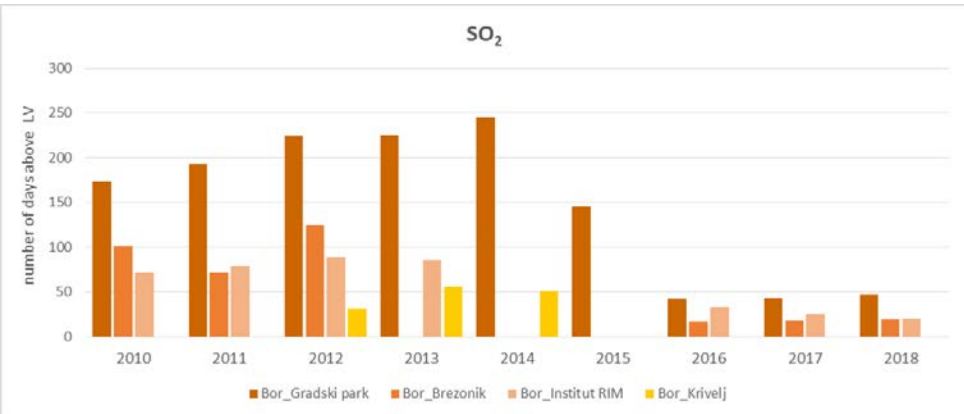


Figure 33. Comparative view of number of days with exceeded daily limit values of SO_2 in measurement points in Bor

Nitrogen dioxide is present in higher concentrations in ambient air on annual, daily or hourly basis, primarily in cities. Stations measuring the level of pollution originating from traffic record excessive pollution, and Belgrade is the city where this phenomenon is the most prevalent (Figure 34).

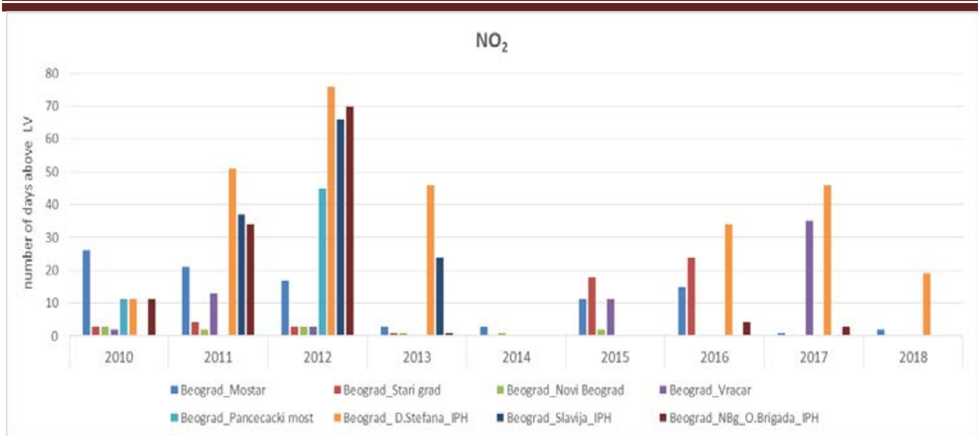


Figure 34. Comparative view of the number of days with exceeded daily limit values of NO_2 in measurement points in Belgrade

Being the largest agglomeration, Belgrade suffers loads every year due to heavy traffic, which can be observed from the average annual, daily and hourly values of this pollutant. Occasional exceedances of NO_2 are recorded in Novi Sad and Nis, somewhat rarely in Valjevo.

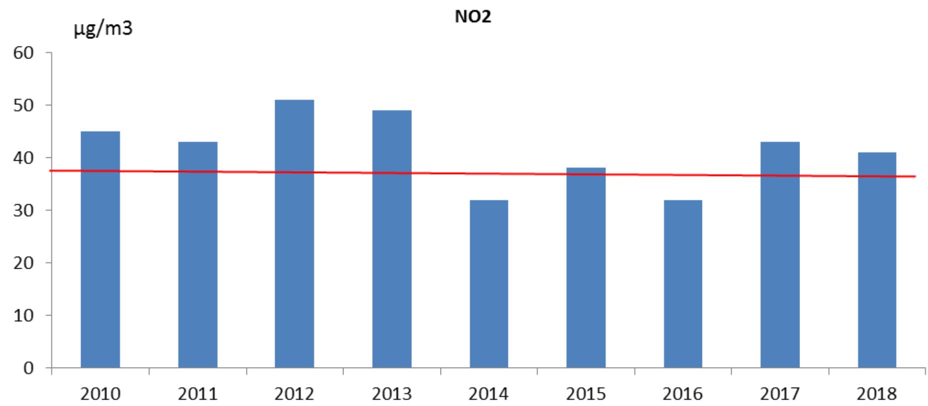


Figure 35. Mean annual value of NO_2 in Uzice in the period 2010-2018

Besides Belgrade, Uzice records almost permanent annual presence of nitrogen-dioxide over the years (except for the period 2014-2016), causing moderately polluted air due to the existence of a tolerable value by 2021.

Ground-level ozone belongs to dominant pollutants that cause poor air quality, but only in the warm part of a year due to its physico-chemical origin. Ground-level ozone records breaches of target value of 120 μg/m³ in both urban and rural areas, and breaches of the prescribed number of days (25 days) are ever more often registered in several stations almost yearly (Figure 36).

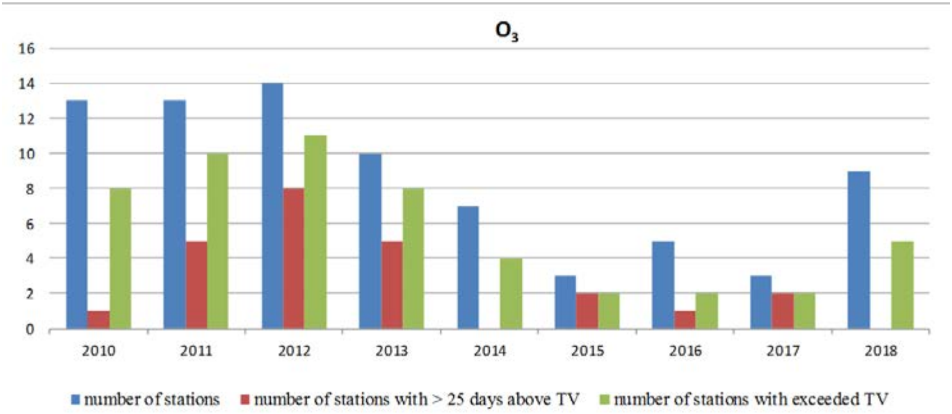


Figure 36. Comparative view of the number of stations measuring ground-level ozone and number of stations with exceeded target values

Carbon-monoxide, a product of incomplete combustion, does not significantly affect air quality at any measuring point (Figure 37), and the cities where maximum daily eight-hour concentrations were exceeded were Vranje and Zajecar, to lesser extent Uzice, Sabac and Krusevac.

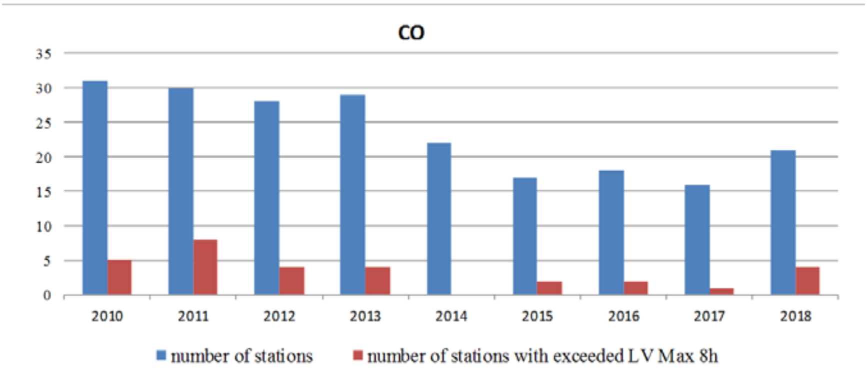


Figure 37. Comparative view of number of stations where carbon-monoxide is measures and number of stations where daily eight-hour limit value is exceeded

Particulate matters PM_{10} are the main reason for air pollution and threats for human health in the Republic of Serbia, as in most European Union (EU) countries, according to current national, EU and World Health Organisation standards.

The results indicate that most frequent excessive air pollution in the Republic of Serbia occurred due to this pollutant – 77% of total number of exceedances in 2018. Far less ground-level ozone pollution was present, only 19%, and the excess of other pollutants – sulphur-dioxide, nitrogen-dioxide and carbon-monoxide – was almost insignificant (Figure 38).

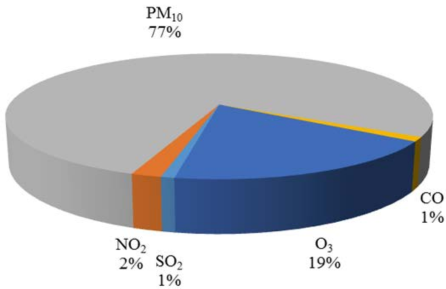


Figure 38. Percentual contribution of SO_2, NO_2, PM_{10} and CO to exceeded daily limit values and target values for O_3 in 2018

In the course of time since the beginning of measuring the PM_{10} concentrations in the state network of stations, the results have indicated almost equal number of stations where measurements are conducted and of unacceptable exceedances in terms of number of days (the allowed number of days within a year is 35) (Figure 39). A large number of stations with mean annual values exceeding the allowed 40µg/m^3 has also been recorded.

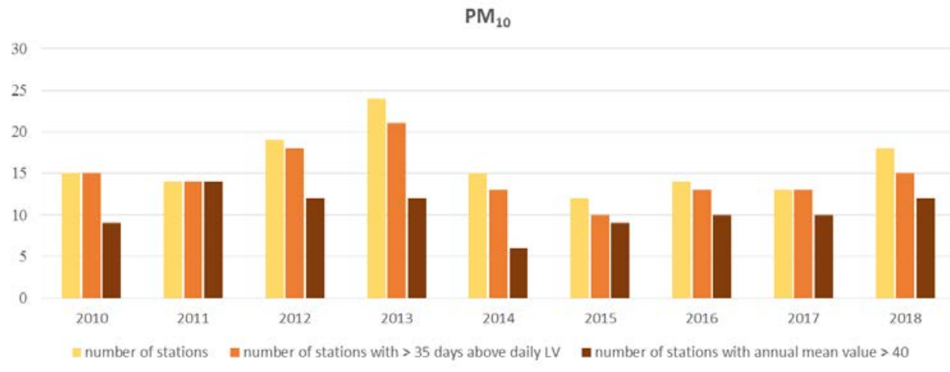


Figure 39. Comparative view of a number of stations where PM_{10} measurements are conducted and number of stations where exceeded daily and annual limit values were recorded

Seasonal differences in pollution levels have been recorded in all stations, except for the Kamenicki vis station, where measurements are carried out for the purpose of assessing long-range transmission of pollutants under the EMEP programme - Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (Figure 40). The most expressed differences between cold and warm seasons are observed in Valjevo and Uzice, with significantly smaller difference recorded in Belgrade and Novi Sad.

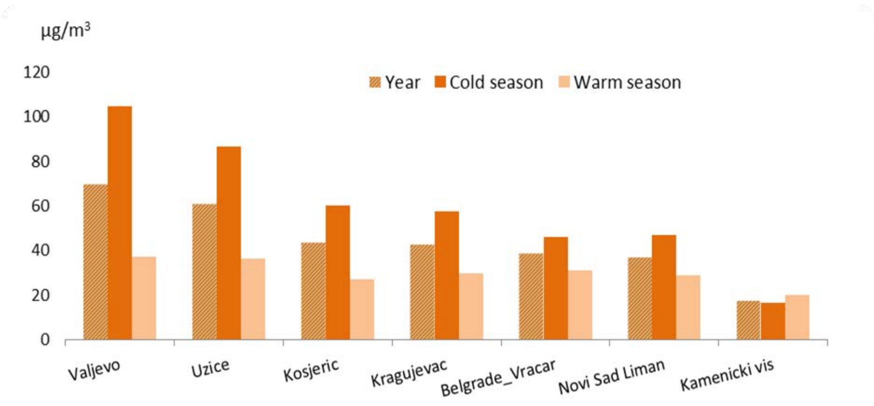


Figure 40. Comparative view of mean concentration values in a year, in cold and warm part of a year in selected stations

Number of days with exceeded daily limit values is a particularly obvious seasonal difference (Figure 41), and this difference is mainly characterised by extremely small number of days with exceedances during the warm part of the year compared to the cold period (the number of days when exceedance is allowed within a year is 35).

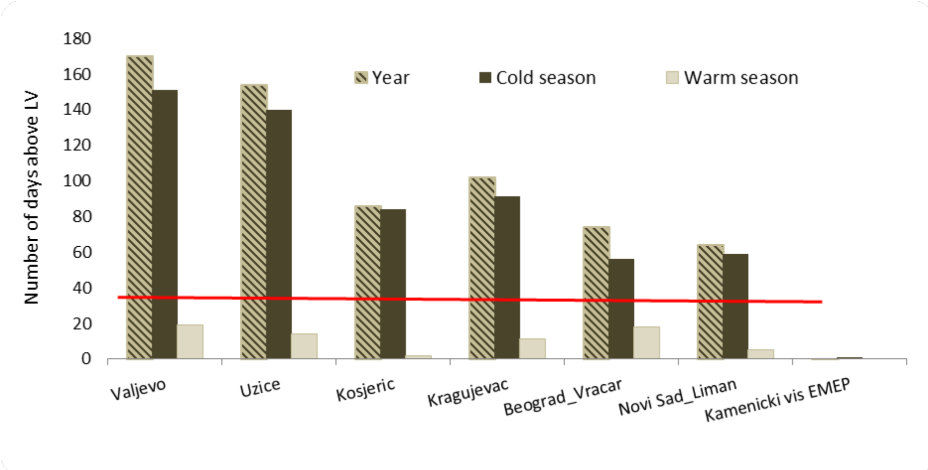


Figure 41. Comparative view of number of days with exceeded limit

Heavy metals: arsenic, cadmium, nickel and lead are tested in the PM_{10} fraction, and annual target values are defined for them, while limit values for lead are prescribed for a calendar year. These mainly indicative measurements taken in 2018 at state and local stations demonstrated that mean annual concentrations did not exceed either the limit values (lead) or target values (arsenic, cadmium, nickel) in most stations (Figure 42).

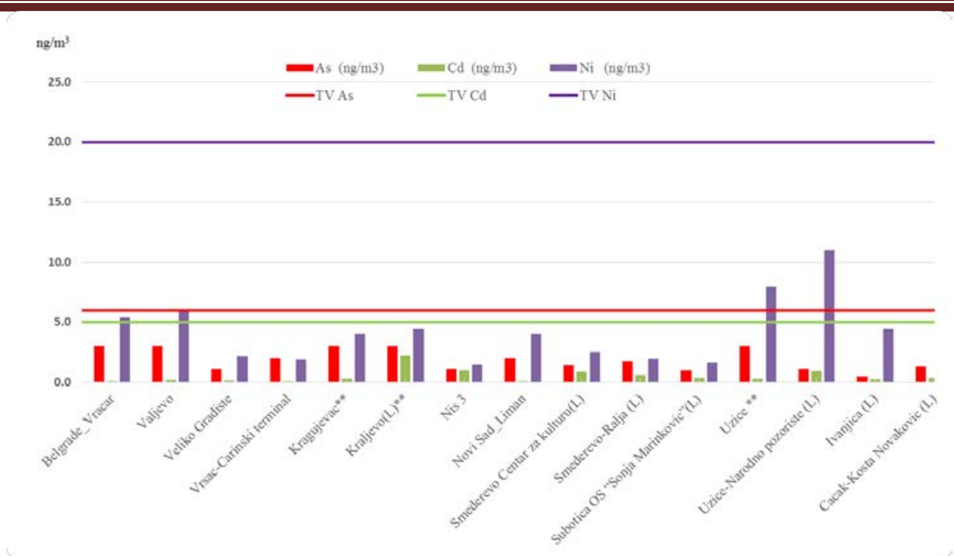


Figure 42. Mean annual concentrations of arsenic, cadmium and nickel in 2018 and their prescribed target values

One exception is the content of arsenic in PM_{10} in Bor, which is present every year, and the mean annual concentrations in 2018 were about ten times the target value (Figure 43).

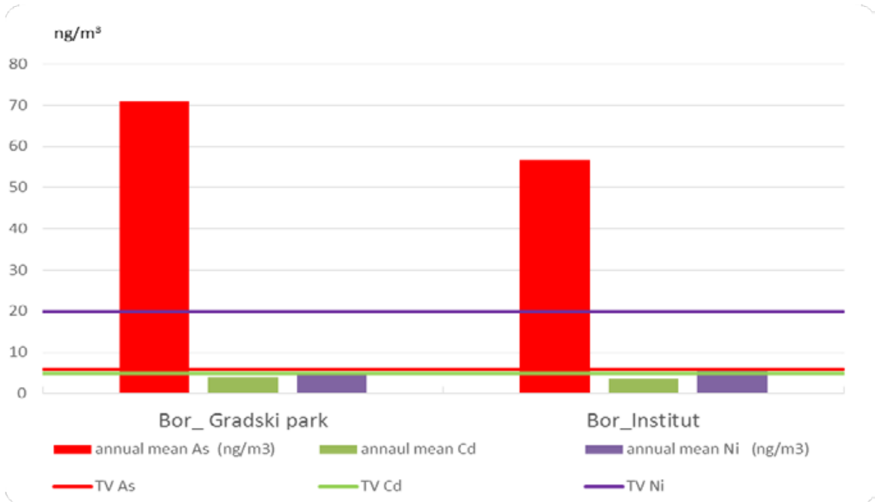


Figure 43. Content of arsenic, cadmium and nickel in PM_{10} in Bor

Benzo(a)pyrene in PM_{10}, as the most prominent representative of polycyclic hydrocarbons, is formed as a product of incomplete combustion of fossil fuels and biomass. The most extensive measurements were conducted in 2018 and showed that benzo(a)pyrene exceeded the prescribed target value (1ng/m^3) at a majority of stations, with the highest presence recorded in Valjevo (5.1ng/m^3).

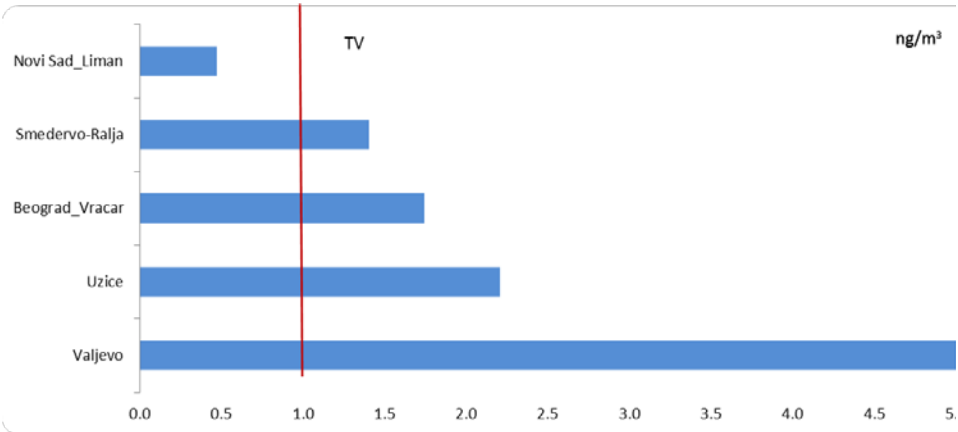


Figure 44. Mean annual value of benzo(a)pyrene in 2018

This pollutant exceeded its target values at other stations, in Uzice (2.2ng/m^3), Belgrade (1.7ng/m^3) and Smederevo (1.4ng/m^3), while annual mean value was lower than the limit one only in Novi Sad, and was measured at 0.5ng/m^3.

CONCENTRATIONS OF ALLERGENIC POLLEN

Pollen is a natural constituent of the air we breathe, created in a phenological phase of flowering plants without which there would be no biodiversity recovery on the Earth. Pollen allergens are the most prominent natural allergens that cause a range of symptoms and diseases known as pollinosis (pollen, conjunctivitis, dermatitis, bronchitis…). In a regular situation, the immune system functions as a defence against harmful agents (e.g. bacteria and viruses), but in most allergic reactions the immune system responds to the allergen as if it were a harmful agent.

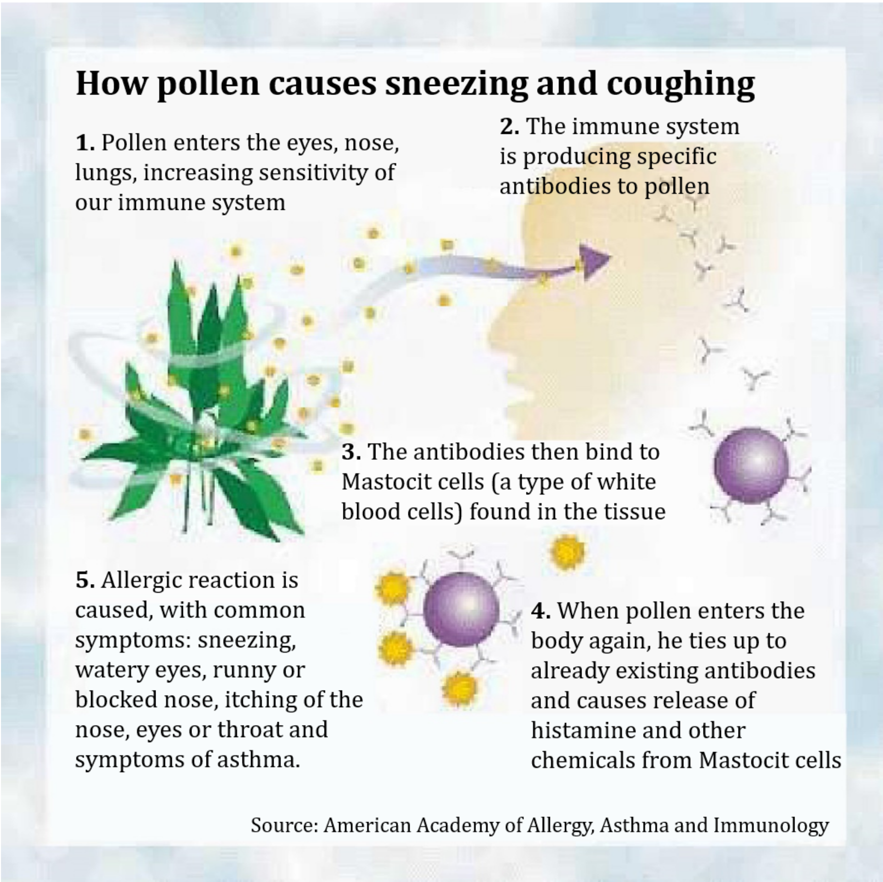


Figure 45. How the immune system functions as a defence against pollen

The economic activity of humans only indirectly affects the increase or decrease in the amount of pollen emissions, such as urbanisation of natural plant habitats or abandonment of urban areas.

Measurement of allergenic pollen concentrations is conducted at 25 measurement points in the Republic of Serbia as a part of air quality monitoring carried out by the Environmental Protection Agency. There are 24 plant species under pollen identification (hazel, alder, yew and cypresses, elm, poplar, maple, willow, ash, birch, hornbeam, platanus, walnut, oak, beech, pine, hemp, grass, linden, juniper, sorrel, nettle, pigweed, artemisia, ragweed). Concentrations are highly variable and are also related to meteorological conditions, especially precipitation during the intense pollen grain emissions.

Spatial distribution of total amount of ragweed pollen in the territory of the Republic of Serbia is presented through data from three spatially representative stations, from the north to the south (Subotica, Belgrade – Zvezdara and Vranje). The presented data covers a period of seven years (2012-2018).

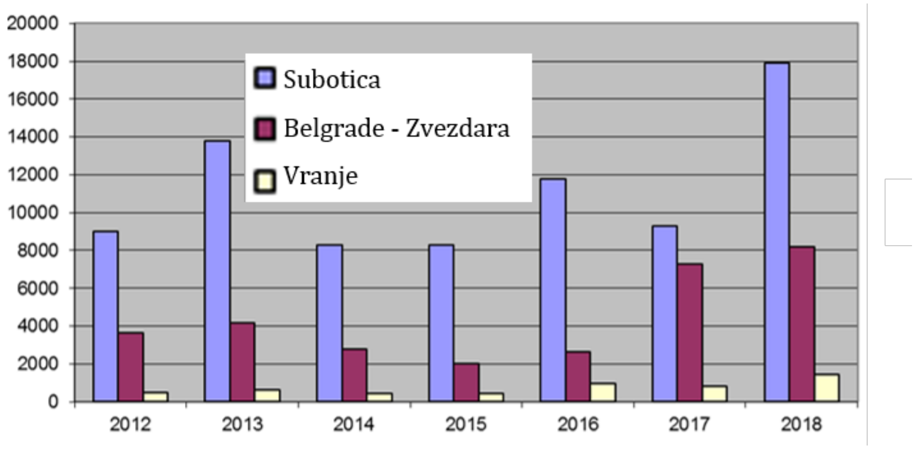


Figure 46. Total quantities of ragweed (Subotica, Belgrade - Zvezdara, Vranje)

Field under ragweed

Information on parameters related to ragweed are shown for the station in Belgrade, Zvezdara - Zeleno Brdo (Figure 48).

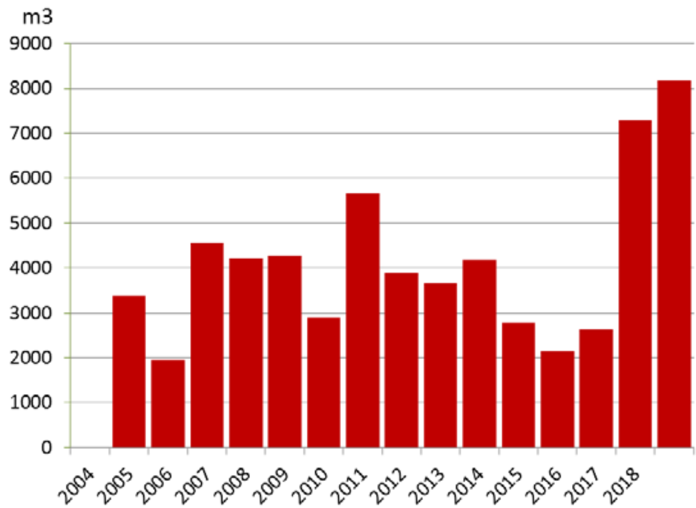


Figure 47. Total quantity of pollen (number of pollen grains per m^3 of air)

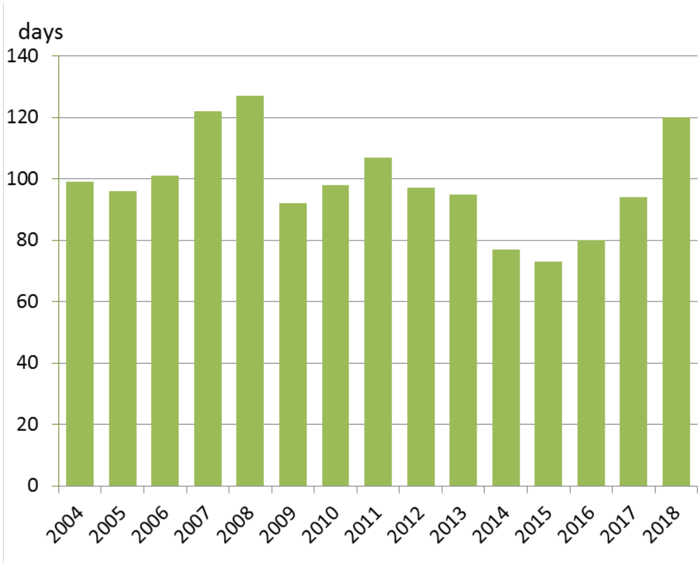


Figure 48. Number of days with pollination present (days)

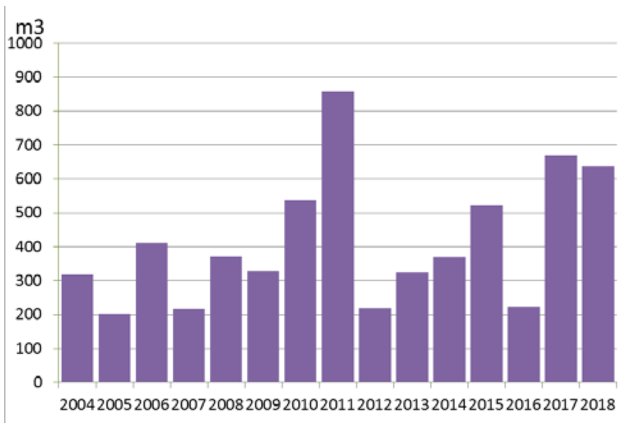


Figure 49. Maximal concentration of pollen in a day

In addition to information on the parameters of total pollen content (Figure 47) and maximum pollen concentration (Figure 49), the number of days with pollination is also significant. This parameter has varied at the same location in the period 2004-

2018, ranging from a minimum of 73 days (2015) to a maximum of 127 days (2018), with an average of 99 days with pollination in the course of those years.

The Agency is the first institution in Europe to have accredited the sampling and testing method for allergenic pollen according to SRPS 17025 standard. Recognising the importance of monitoring the allergenic pollen from the aspects of environmental protection and human health, a network has been expanded to ensure monitoring and cooperation with institutions addressing the same issues. The greatest progress has been made in timely professional information to the general public.

In several European countries, as well as in Serbia, the need to address the spread of this weed plant had been recognised, so the *Regulation on measures for the suppression and destruction of ragweed – Ambrosia artemisiifolia l. (spp.)* (Official Gazette of RS, no. 69/2006) was adopted. The aim was to establish an integrated system for monitoring the distribution of this plant, as well as adequate measures for the control thereof.

In addition to direct control measures (for *Ambrosia artemisiifolia L*), competent authorities must also implement and/or monitor: agrotechnical measures: cultivation, sowing, fertilisation, row cultivation, harrowing, rolling, hoeing and weeding; physical measures: direct destruction of weeds by mowing, using flames, preheated water vapour or soaking; biological measures: use of predators and herbivores that destroy one or more weeds; chemical measures: application of herbicides – chemical substances for direct destruction of weeds.

CONTENT OF ORGANIC CARBON IN THE SOIL

In order to ensure sustainable soil management and protect the soil against degradation, it is essential that organic matter in the soil is preserved and maintained at a satisfactory level. Based on data obtained through systematic fertility control, the content of organic carbon in the surface layer of soil was calculated for Central Serbia in the period 2010-2018. The analysis conducted on a large number of samples from the control of fertility of agricultural land shows that most samples had the content of organic carbon ranging between 1 and 2% (Figure 50).

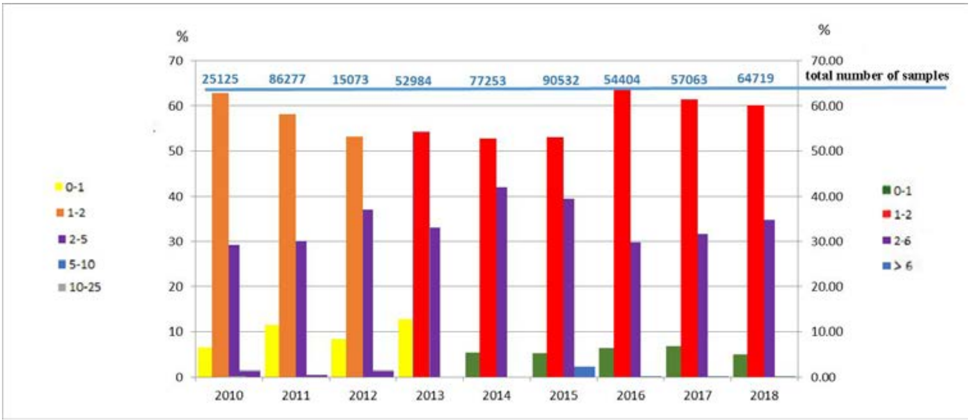


Figure 50. Distribution of samples according to content of organic carbon at 30 cm depth (%)

2.1 Gas chromatograph - time-of- flight - mass spectrometer (GCxGC-TOF-MS)

Gas chromatograph - time-of- flight - mass spectrometer (GCxGC-TOF-MS) for comprehensive gas chromatography with automated sample preparation/sample introduction facility and autosampler system fully compatible with SBSE and LVI techniques

Analytical methods:
1. Pesticides
2. Industrial pollutants
3. PAHs

www.sepa.gov.rs

2.3 Ultra High Performance Liquid Chromatograph (UHPLC) with Diode Array UV Detector (DAD UV) and high resolution MS/MS spectrometer with on-line SPE sample preparation

Ultra High Performance Liquid Chromatograph (UHPLC) with Diode Array UV Detector (DAD UV) and high resolution MS/MS spectrometer with on-line SPE sample preparation system, chromatographic control and data management station with software for analysis of WFD priority substances and identification of river basin specific pollutants.

Analytical methods:
1. Triazine and phenylureate herbicides
2. Necicotinoide pesticides
3. Pharmaceuticals – macrolide antibiotics
4. Estrogens
5. Phtalates
6. PFOS

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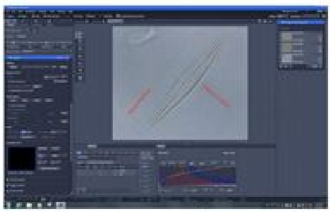
2.9 Inverted microscope with dark and light field and phase contrast with camera and image analysis for phytoplankton analysis, Carl Zeiss GmbH, Axio Observer D1



Biological Quality Elements investigation
-Phytoplankton (including Cyanobacteria) and phytobenthos
-Identification of pressures: eutrophication and organic pollution
-Ecological status/potential assessment according to the Water Framework Directive 2000/60/EC

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2.4. Environmental Impacts

The **impacts** quantify environmental changes that leave consequences in economic and social spheres of society, ultimately on human health. These changes in the physico-chemical or biological state of environmental factors, caused by pressures, have different impacts on ecosystem functioning and on the human community and individuals' well-being.

Key results and recommendations:

Safe drinking water is one of the basic prerequisites for good health and one of the main indicators related to the health status of population, hygienic-epidemiological situation, and socio-economic state of a country. The presented environmentally-related health indicators have been determined as risk of exposure to microbiological and physico-chemical agents, so that they do not exceed the maximum permissible concentrations prescribed by our regulations. An analysis of drinking water quality was conducted in 2017 in 154 public water supply systems in urban settlements under the Programme of General Interest of the Ministry of Health, implemented by Institutes of Public Health.

Physical and chemical quality of water from public water supply systems in urban settlements of the Republic of Serbia, with human health risk levels categorised as bad, very bad and alarming, was in 2017 available to 1,039,365 inhabitants or 16% of those connected to water supply systems. Water quality from public water supply systems in urban settlements in microbiological terms, with human health risk levels categorised as moderate, high and excessively high was in 2017 available to 1,345,935 inhabitants, or 21% of those connected to water supply systems.

Drinking water is generally of the lowest quality in AP Vojvodina in terms of physico-chemical indicators; urban water pipelines with alarming risk are clearly identified on the risk map of the Republic of Serbia. More than 40% of the population of Backa and Banat are supplied with drinking water containing more than 10 μg/L of arsenic.

With the aim of protecting the health of the population, it is necessary to develop adequate technical and technological treatments in the existing water supply systems, primarily in those breaching the set physico-chemical indicators, i.e. it is necessary to provide the population with safe and healthy drinking water.

DRINKING WATER QUALITY

Safe drinking water is one of the basic prerequisites for good health and one of the main indicators related to the health status of population, hygienic-epidemiological situation, and socio-economic state of a country. Physico-chemically and microbiologically unsafe drinking water from public water supply systems in urban areas, as presented on the “risk maps”, are qualitative environmentally-related health indicators, and they also point out to risks of exposure to physico-chemical and microbiological agents, so that they never exceed maximum allowable concentrations (Figures 51 and 52). These two indicators provide information on the risks of adverse effects of drinking water in accordance with sanitary conditions and standards.

Public fountain in city of Nis

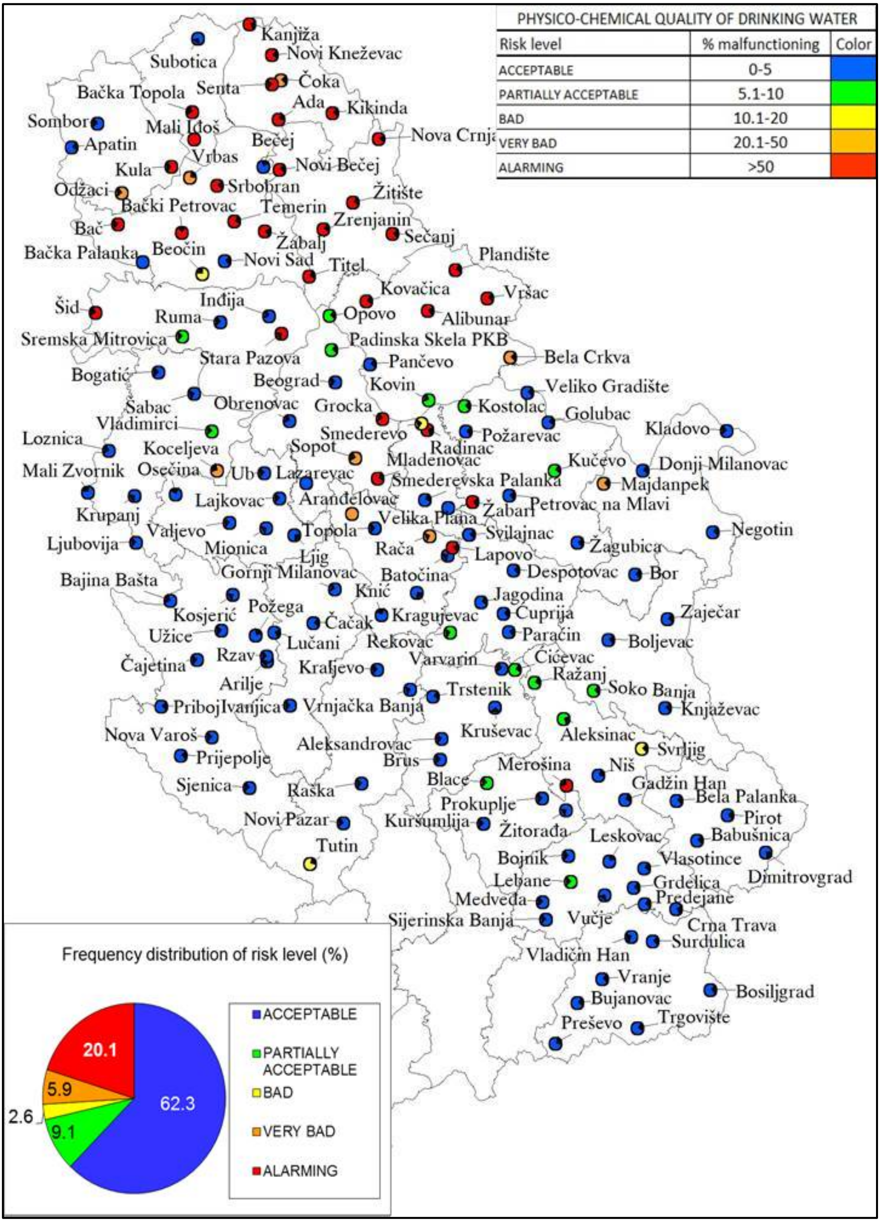


Figure 51. Physico-chemically unsafe drinking water from public water supply systems in urban settlements (2017)

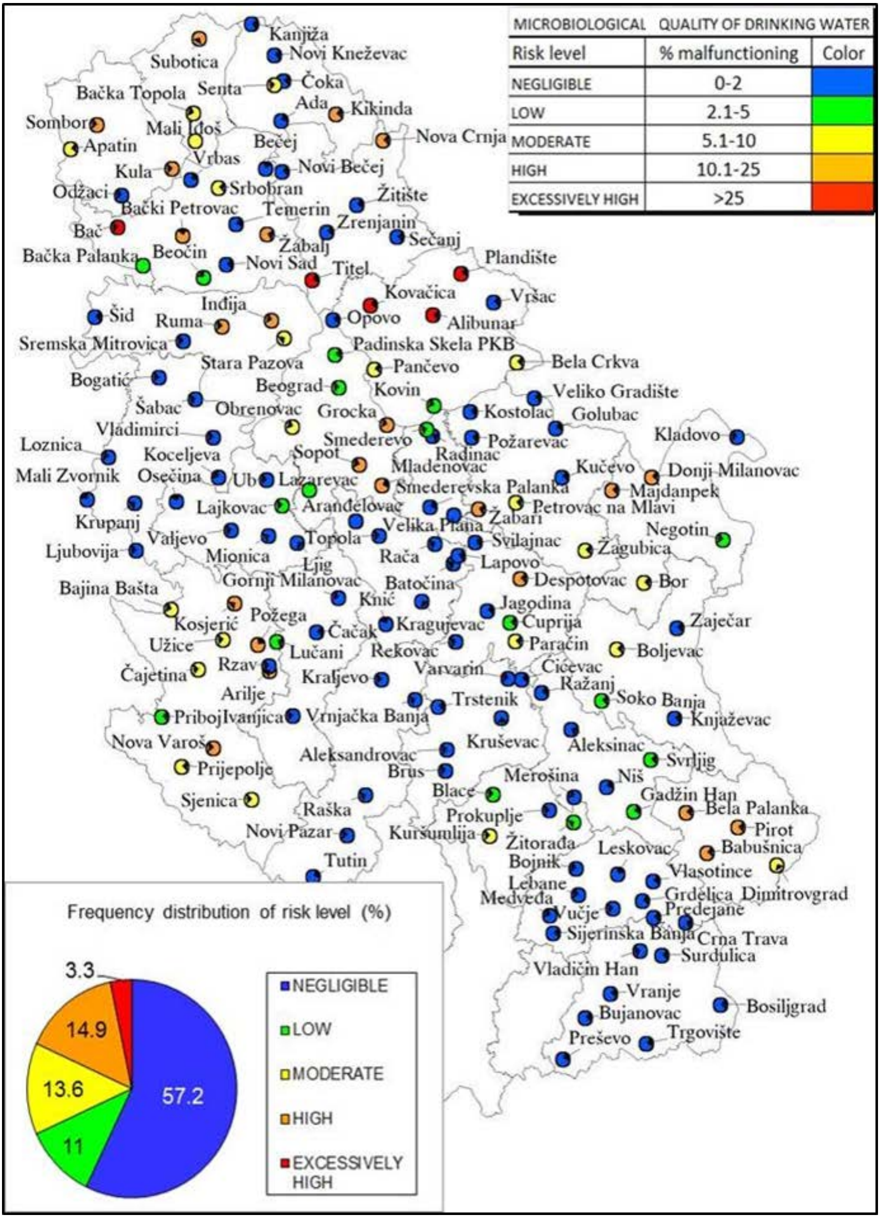


Figure 52. Microbiologically unsafe drinking water in public water supply systems in urban settlements (2017)

An analysis of drinking water quality was conducted in 2017 in 154 public water supply systems in urban settlements. Physical and chemical quality of water from public water supply systems in urban settlements of the Republic of Serbia, with human health risk levels categorised as *bad, very bad and alarming*, was available to 1,039,365 inhabitants or 16.33% of those connected to water supply systems. Water quality from public water supply systems in urban settlements of the Republic of Serbia in microbiological terms, with human health risk levels categorised as *moderate, high and excessively high* was in 2017 available to 1,345,935 inhabitants, or 21.14% of those connected to water supply systems.

Physico-chemically and microbiologically unsafe drinking water is mainly found in public water supply systems in urban settlements on the territory of the Autonomous Province of Vojvodina. Physical and chemical quality of water from public water supply systems in urban settlements in AP Vojvodina, with human health risk levels categorised as *bad, very bad and alarming* was available in 2017 to 761,788 inhabitants (43.68% of those connected to water supply system) (Figure 52). Water quality from public water supply systems in urban settlements in AP Vojvodina, in microbiological terms, with human health risk levels categorised as *moderate, high and excessively high* in 2017, was available to 801,851 inhabitants (45.98% of those connected to water supply system). In 2017, 28.6% of public water supply systems in urban settlements of the Republic of Serbia recorded physico-chemically unsafe drinking water (Figure 51). In the same period, 31.8% of public water supply systems in urban settlements of the Republic of Serbia recorded microbiologically unsafe drinking water (Figure 52).

2.5. SOCIAL RESPONSES

Social responses are *responses* of policy makers to unwanted effects in the economic and social spheres, but also in all interactions on the way from driving forces, pressures, state and impacts. The reaction of society to driving force *transport* is a policy of changing the form of transport, transition from private cars to public transport. The social response to the pressure of air pollutant emissions is the adoption of regulations regarding the permissible level of nitrogen oxides in the exhaust gases of internal combustion engines.

Key results and recommendations:

In the period 2010-2015, energy efficiency measures achieved 93% of projected savings. The target for the share of Renewable Energy Sources in energy consumption is 27% by 2020, and given the potential of renewable sources, the set goal can be achieved.
Growing number of companies with certified environmental management systems, such as ISO 14001, Eco-label and Cleaner Production, indicates that companies are increasingly devoted to environmental protection.
A total of 2,633 species are protected, including almost all mammals, birds, amphibians and reptiles under certain protection regime. Protected sites cover an area of 669,310 ha, or 7.57% of total territory of the Republic of Serbia. Protection and review studies have been developed for another 89 protected sites, surface of which amounts to 110,030 ha, or 8.82% of total territory of the Republic of Serbia.
Areas under organic farming are constantly increasing, but despite the great benefits associated with optimising the use of natural resources, as well as national incentive measures and the promotion of organic production, the overall area is not significant and is not in line with conditions and opportunities.
Since 2010, environmental financing has been around 0.8% of GDP. The main sources of financing are the Republic of Serbia budget (0.3% of GDP) and fees as revenues of budgetary environmental funds (about 0.3% of GDP9). Economic sectors invested about 0.14% of GDP, with the Energy and Mining sector accounting for about 86%. The greatest donor is the European Union and all activities are implemented within the negotiation process related to Chapter 27. In the period from 2000 to 2018, around € 600 million was invested in various environmental protection projects, including EU donations and national funds. Out of the mentioned projects, two thirds were invested into waste water management (41.3%) and waste management, water protection and water supply (25.8%). A total of € 10.7 million was donated to the Environmental Protection Agency from the pre-accession instrument (IPA), CARDS programme and Norway bilateral assistance.

INCREASED ENERGY EFFICIENCY AND USE OF RENEWABLE ENERGY SOURCES

Strategic energy development is based on, *inter alia*, the introduction of more efficient production and use of cleaner energy from renewable energy sources. According to the Third Energy Efficiency Action Plan of the Republic of Serbia (EEAP), the achieved savings amounted to 0.37 Mtoe in the period 2010 – 2015, which is 93% of the envisaged savings for that period, or about 50% of the target to be achieved by the end of 2018.

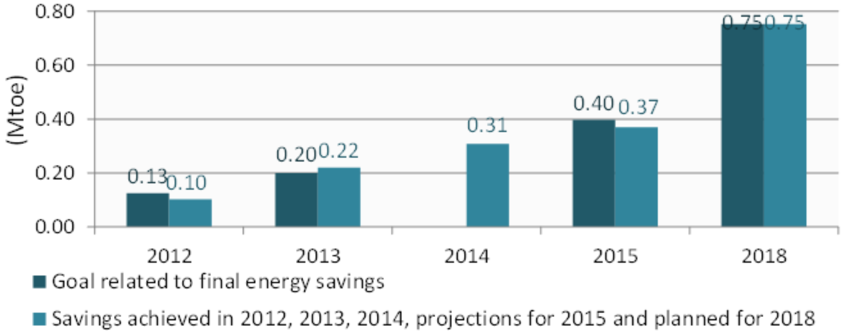


Figure 53. Preview of goals and achieved/planned savings in final energy (Mtoe)

Energy efficiency measures were successfully implemented in the Household and Public and Commercial sectors, where savings even exceeded the target values for 2015, and savings in the Transport sector amounted to 84% of the set goal. The results of savings in the Industry sector deviate significantly from the set indicative goal, and amount to only 37%.

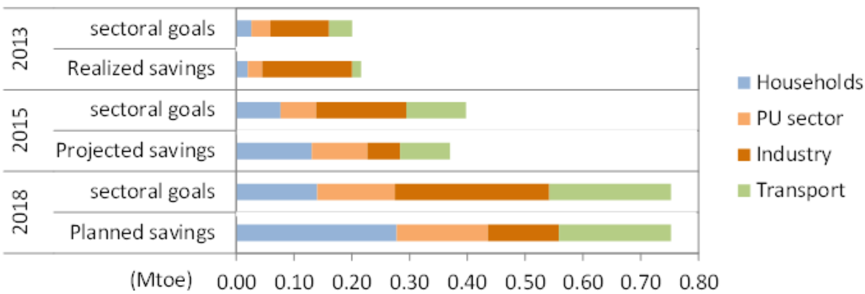


Figure 54. Sectoral goals and the achievement thereof (Mtoe)

Pursuant to Directive 2009/28/EC and Decision of the Energy Community Ministry Council, compared to the baseline 2009, when share of RES in GFEC amounted to

21.2%, a very ambitious binding goal was set for the Republic of Serbia of 27% by 2020. The share of RES in Transport sector should be 10%, making 2.6% of RES in GFEC.

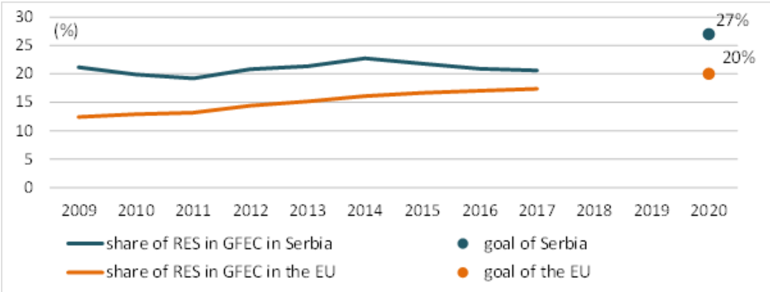


Figure 55. Achieved results by 2017 and national goal for 2020 for Serbia and EU

The share of renewable energy sources in gross final energy consumption amounted to 20.60% in 2017, and the impression is that incentive measures taken do not yield results. However, the year of 2009, set by the Energy Community as the baseline year for calculating the binding goal, was excessively specific, since the share of RES in that very year was 21.2%, significantly higher than the real multiannual average value. In 2014 as well, a significant drop in energy consumption resulted in a significantly higher share of RES in GFEC than in other years (Figure 55).

Observed in terms of consumption sectors, the share of RES in electricity consumption was 28.70% in 2017, in heating and cooling sector 24.40%, while RES participated in the transport sector with only 1.18% (Figure 56).

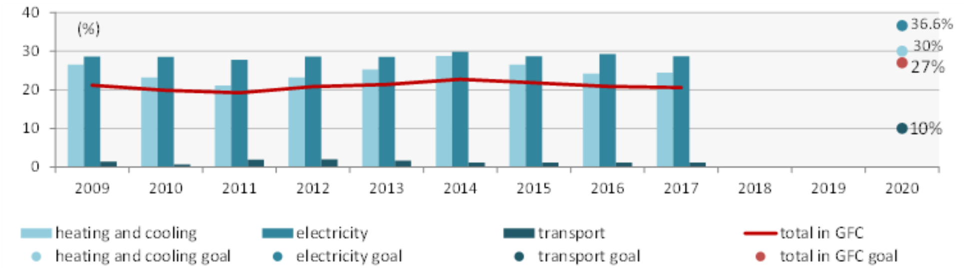


Figure 56. Share of RES in energy consumption per sector, and in total into GFEC

Renewable energy sources with estimated technically usable potential amount to approximately 5.6 Mtoe annually. Out of this potential, 1.06 Mtoe of biomass (mostly as firewood) is used, and 0.91 Mtoe of hydropower (Figure 57).

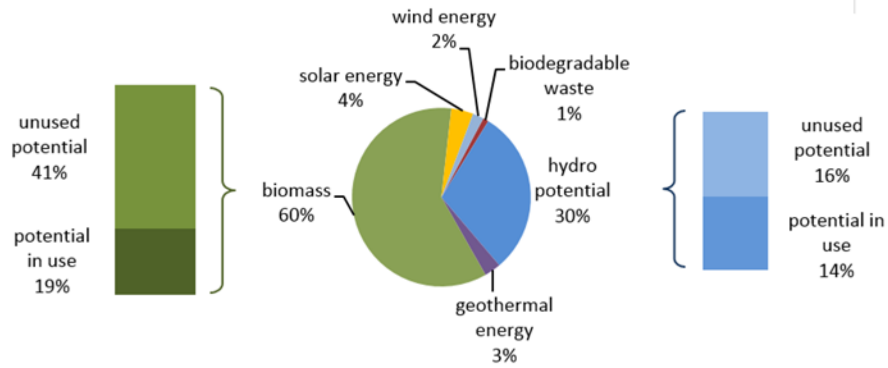


Figure 57. Structure of the estimated RES potential in the Republic of Serbia

Given the available unused RES potential, the goal set for 2020 can be achieved from domestic sources, with the exception of share of biofuels in the transport sector. In the coming period, larger use of biomass is expected in the transport and heating and cooling sectors, while the pace of biofuel use will be slightly slower than the one envisaged in the Action Plan.

ENVIRONMENTAL MANAGEMENT ACTIVITIES IN INDUSTRY

Certified environmental management systems implemented in the Republic of Serbia have been promoted internationally as voluntary measures. The international standard **ISO 14001** defines the requirements for environmental management and addresses the management system in an organisation, that is, the entire production process, not the product itself. Significant increase in the number of organisations In the Republic of Serbia with ISO 14001 certificates indicates that companies are increasingly involved in environmental management.

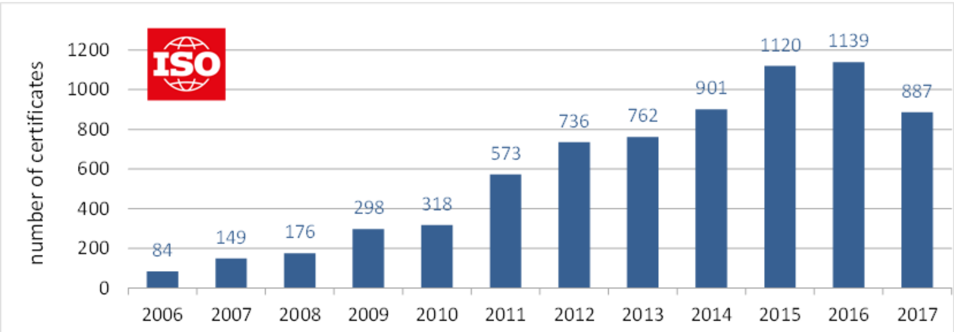


Figure 58. Number of ISO 14001 certificates in the Republic of Serbia

The EU Ecolabel helps to identify products and services with lower environmental impact over the life cycle, starting from the extraction of raw materials, through production and use, to disposal. The EU Ecolabel is a voluntary label that promotes environmental quality. The number of licenses decreased compared to previous years, due to the non-renewal of licenses that are valid for three years (Figure 58).

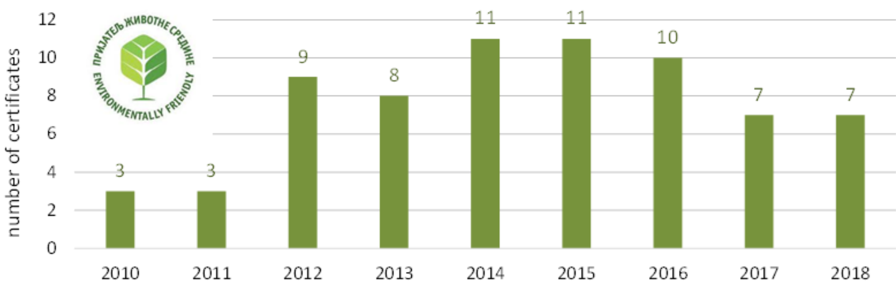


Figure 59. Number of Ecolabel certificates in the Republic of Serbia

Cleaner production means more efficient use of raw materials and energy, reduction of emissions and waste generation. Cleaner production is a preventative environmental strategy applied to processes, products and services to: increase overall efficiency and productivity; improve business opportunities; and reduce risk to humans and the environment.

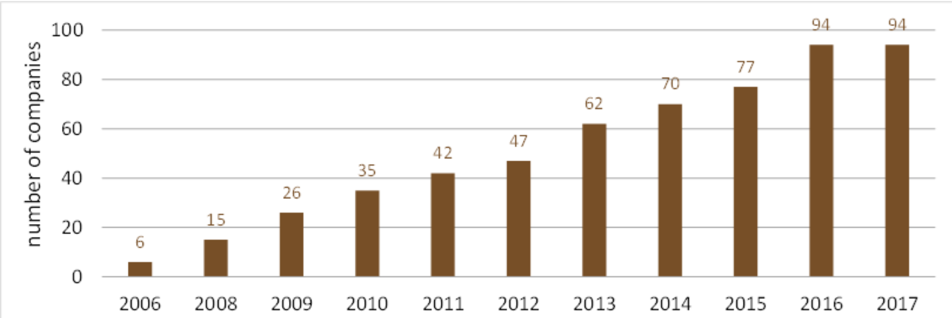


Figure 60. Number of companies that have introduced cleaner production in the Republic of Serbia

The Cleaner Production Centre implemented the Action Plan for the Strategy for Introduction of Cleaner Production in the Republic of Serbia, supported by the Ministry of the Environmental Protection. The Cleaner Production Programme 2006-2017 was participated by 94 companies in total with about 50,000 employees, and 70 national experts were trained during the programme. The companies were of different sizes and activities (Figure 60). The deliverables of cleaner production projects in the period 2006 – 2017 include: average savings per company: EUR 100,000 per year; average reduction of water consumption: 50,000 m^3 per year; average reduction in electrical energy: 500 MWh per year; average CO_2 emission reduction: 500 t per year. This data does not include the results of cleaner production projects in IPPC facilities of the Electrical Power Industry of Serbia, since the aggregate results would not in that case provide a realistic picture of other small and medium-sized enterprises.

AGRICULTURAL AREAS UNDER ORGANIC PRODUCTION

According to the data of the Ministry of Agriculture, Forestry and Water Management, the area certified for organic production under crop and vegetable cultures was 145.68 ha in 2007, with the area of 452.81 ha in the conversion period. The area of 5,885 ha was reached in 2010, slightly increased in the period 2013-2017, up to 19,261 ha in 2018, which is 43% more than in 2017.

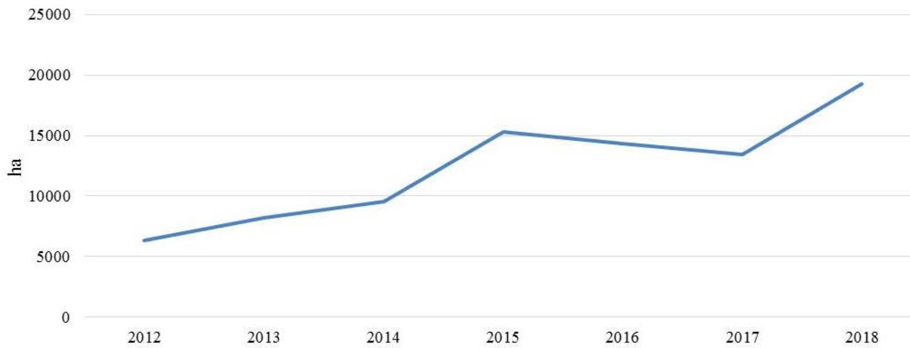
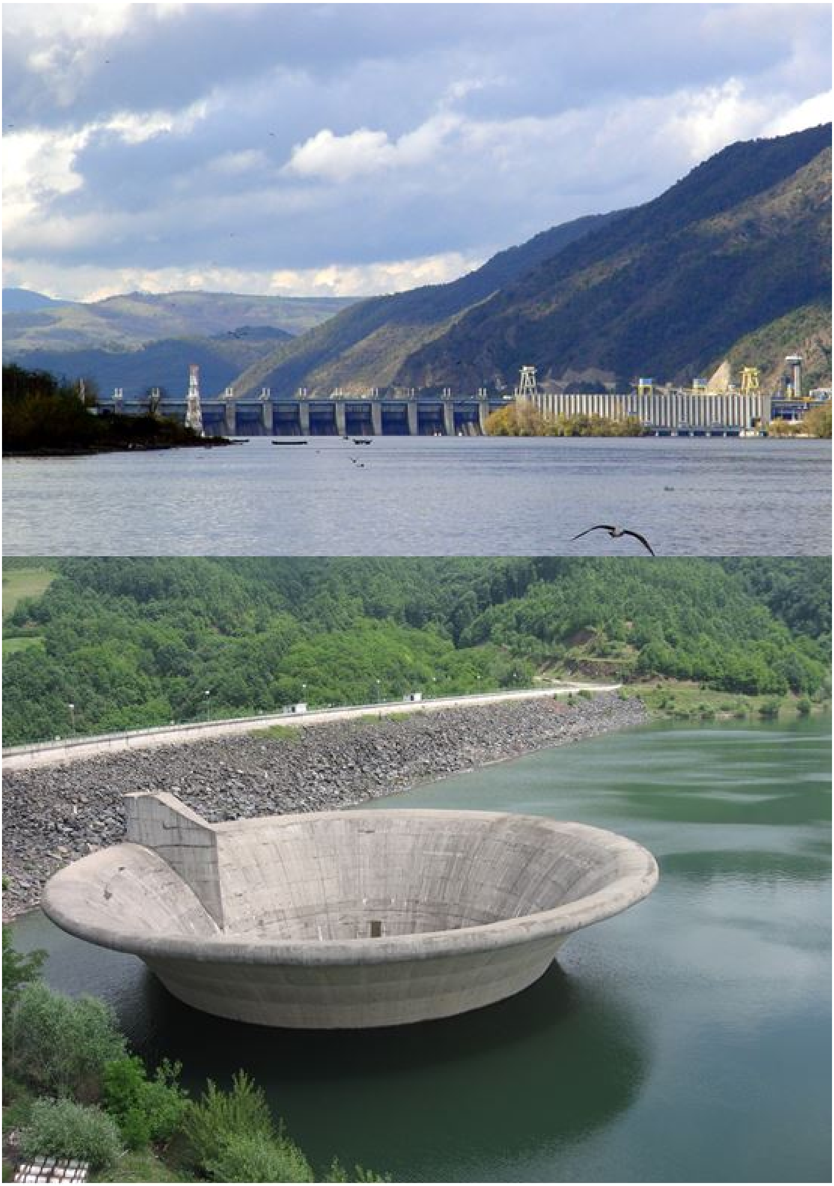


Figure 61. Areas under organic agricultural production in the period 2010 – 2018

Based on data about areas under certain categories of crops cultivated according to the organic production principles, the most represented ones in 2018 were those under fruit production (43%), followed by crop production (26%), industrial plants (14.2%) and fodder plants (10%). The cultivation of organic vegetables is at a very low level, practically negligible. The same applies to cultivated medicinal and aromatic plants, as these plants are mostly collected from nature. The share of area under organic production in the utilised agricultural area was 0.5% in 2018.



HPP Djerdap “EPS”,
The Barje Reservoir **-** the dam and bell-mouth spillway (Photo: D.Jovanovic)

NATURE AND BIODIVERSITY PROTECTION

The total area under protection amounts to 669,310 ha, representing 7.57% of the overall territory of Serbia. The existing statistics related to sites with defined protection regimes are presented in the graph below. Total of 459 protected areas are under protection. In the course of 2018, protected areas increased by 6,416 ha, or about 1%. The total area of protected sites belonging to one of the IUCN categories (I-VI) is 410,798 ha. The percentage of Category IV areas decreased from 37% in 2010 to 25% in 2018. Other categories more or less increased or had retained the same status.

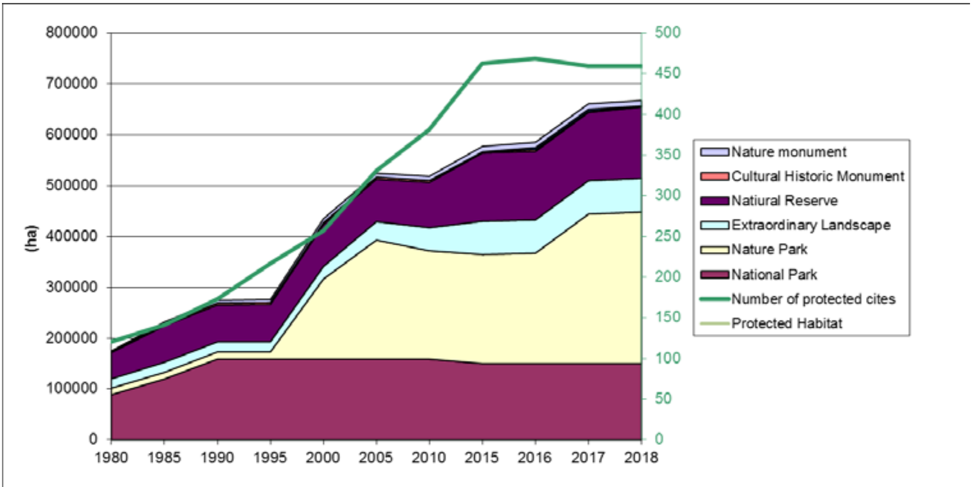


Figure 62. Cumulative area and number of protected sites in the Republic of Serbia

The Spatial Plan of the Republic of Serbia (Official Gazette of RS, no. 88/2010) envisages that about 12% of the territory of Serbia will be under some form of protection by 2021. Some 4.92% of researchers are involved in about 2.33% biodiversity and nature protection projects out of all funded researchers and projects within total number of research programmes. Most projects are implemented in the area of biology, followed by biotechnology and agriculture, landscaping, water, land and air protection and use, environmental protection and climate change. About 2.86% of scientific results in the field of biodiversity were published in internationally recognised journals in the period 2011 – 2018, compared to the overall number of scientific results published by scientists from Serbia involved in projects in the area of biodiversity in the same period.

DEGREE OF WATER SUPPLY AND SEWERAGE INFRASTRUCTURE DEVELOPMENT

The percentage of population connected to public water supply systems had been steadily growing between 2000 and 2017, increasing by 21.9% in the period from 2000 to 2017, so 86.9% of residents were connected to public water supply systems in 2017 (Figure 63).

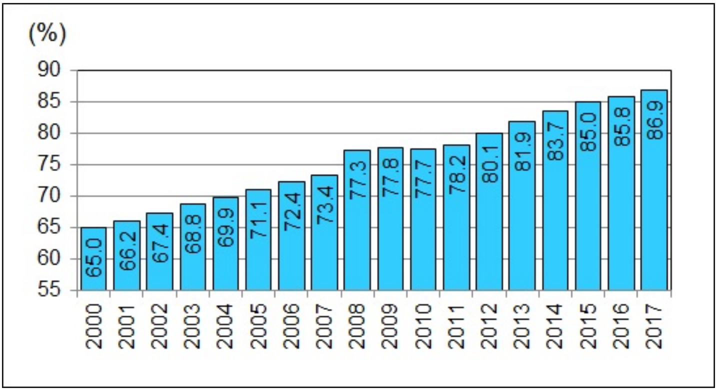


Figure 63. Percentage of residents connected to the public water supply network (2000-2017)

The percentage of residents connected to the public sewerage system had been steadily growing between 2000 and 2017, and increased from 40.2% in 2000 by 22% in 2017, reaching the percentage of 62.2% in 2017 (Figure 64).

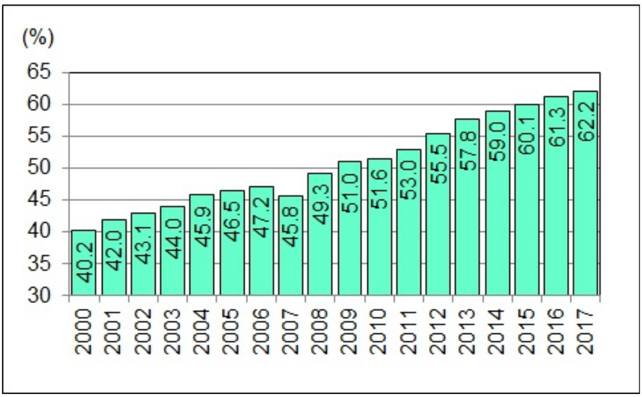


Figure 64. Percentage of residents connected to the public sewerage system Water losses

One of the characteristic of current public water supply in Serbia is high losses, reaching on average 33% and having a growing trend, hitting the maximum of 35.7% in 2016, but in 2017 they decreased and amounted to 35.5%. (Figure 65). A particularly significant piece of information is about the size of losses in Belgrade water supply system, amounting to 33.7%. Reducing this loss by 10% annually would provide for quantities of water equivalent to water demand of the City of Kragujevac.

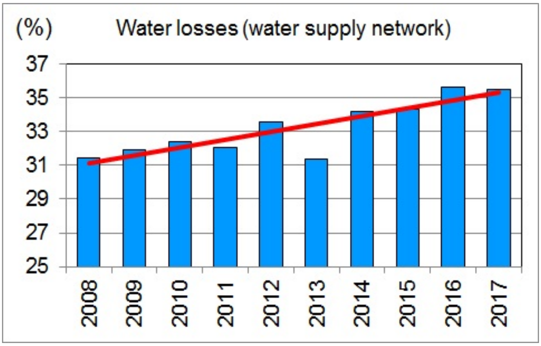


Figure 65. Water losses in distribution of public water supply systems (2008-2017)

ECONOMIC INSTRUMENTS FOR ENVIRONMENTAL PROTECTION

Economic instruments for environmental protection in the Republic of Serbia, presented based on available official data collected by state institutions, provide an indirect view into the achievement of environmental policy goals and measures defined in strategic and planning documents, such as: the National Environmental Programme, the National Sustainable Development Strategy and the National Environmental Approximation Strategy. The main source of environment-related financing is the Republic of Serbia budget, and the allocation of funds depends on the budgetary balance. Other sources of funding include municipal budgets, fees and charges, economic resources; the funds can also be provided through grants, loans, international assistance, instrument funds, EU, UN and programmes and funds of various international organisations. Economic instruments applied in the Republic of Serbia include: fees and charges, incentives and subsidies. The indicator pertains to all expenditures from the state budget disbursed from “environmental protection” budgetary function.

Based on data of the Ministry of Finance, according to the functional classification of expenditures at the state level (Republic, local government and extra-budgetary funds) about 0.3% GDP was allocated for environmental protection in 2018. (Figure 66).

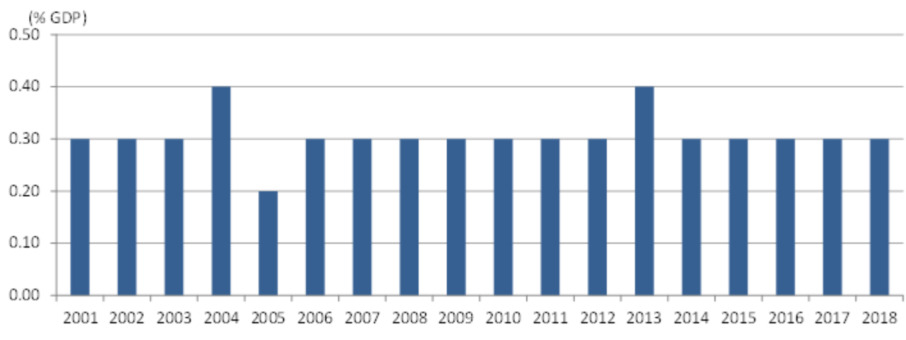


Figure 66. Budget expenditures (% of GDP)

Expenditures from the Republic of Serbia budget allocated to environmental protection amounted to about 0.1% GDP in 2018, while estimates of the Ministry of Finance state that expenditures allocated to environmental protection at local governmental level (Autonomous Province of Vojvodina and municipalities and town/cities) amounted to approximately 0.2% GDP.

Fees are environmental economic instruments aim at promoting the reduction of environmental loads by applying the "polluter pays" and "user pays" principles.

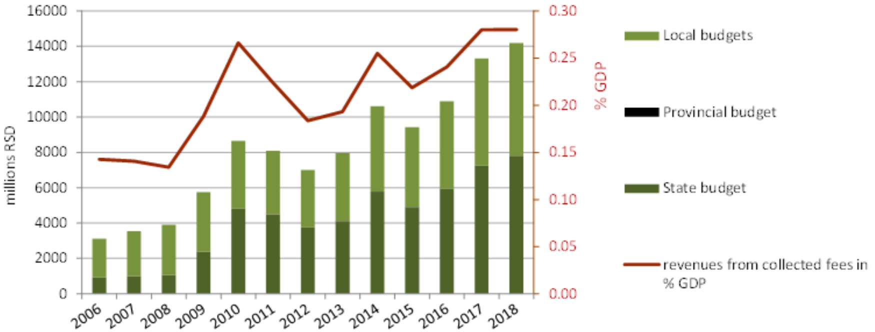


Figure 67. Revenues of environmental budgetary funds at all levels, collected from fees for the protection and improvement of environment

Revenues from collected fees (i.e. revenues of the state budget, environmental budgetary protection fund of the Autonomous Province of Vojvodina and local environment budgetary funds) amounted to RSD 14,186.50 million in 2018 (0.28% of GDP) (Figure 67). The largest contributors were fees charged for SO_2, NO_2 emissions, particulate matters and disposed waste, fees for products that become special waste streams upon their use, and special fee for the protection and improvement of environment (Figure 68).

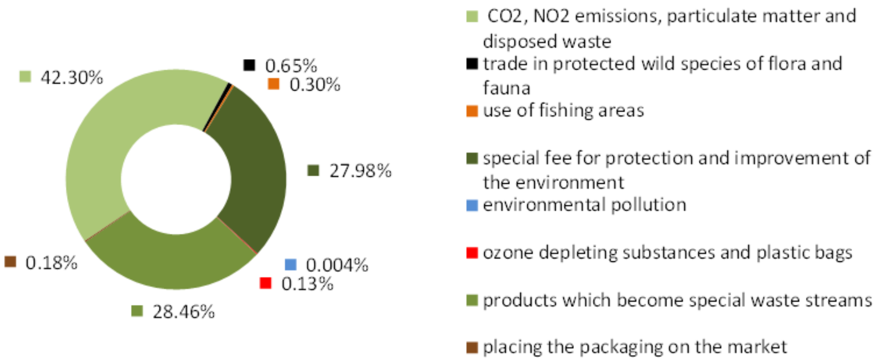


Figure 68. Structure of revenues from collected fees in 2018

According to available data, a total of RSD 3,032.8 million of incentives, subsidies and environmental grants was allocated in 2018, which is 0.06% GDP. The largest incentives were awarded by the Ministry of Environmental Protection – the Green

Fund of the Republic of Serbia, for waste reuse and recovery (recycling industry), in the amount of RSD 2.186 million, the Ministry of the Environmental Protection to the protected natural resources of national interest management programmes (RSD 245 million), and for the support of work of the Institute for Nature Conservation of Serbia and the Radiation and Nuclear Safety and Security Directorate (RSD 265 million). Subsidies and incentives were also allocated by the Ministry of Agriculture, Forestry and Water Management (the Forest Budget Fund, the Hunting Budget Fund), the Ministry of Trade, Tourism and Telecommunications and the Provincial Secretariat for Urban Planning and Environmental Protection of AP Vojvodina (Figure 68).

According to the Ministry of Finance, the estimated value of total international financial assistance for the environment amounted to RSD 27.529 million in 2018. Out of this amount, RSD 1,574 million grant funds were donated to "Environmental Protection" and RSD 16,442 million were loans. "Water Supply and Waste Management" received RSD 1,080 million grant funds and RSD 8,431 million of loans.

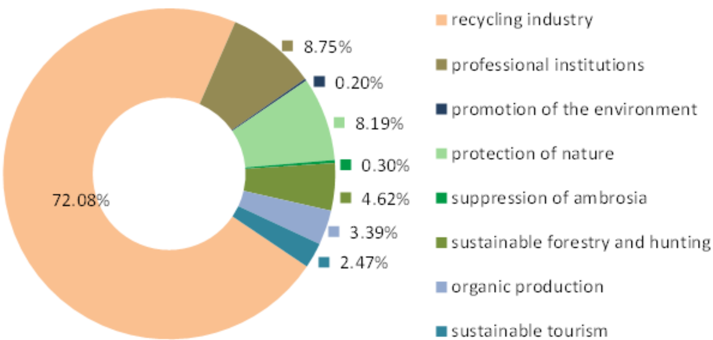


Figure 69. Funds structure in 2018

Expressed through gross domestic product, the value of total international financial assistance is 0.54% GDP, with grants amounting to 0.05% GDP. Compared to total international financial assistance provided to the Republic of Serbia, the one directed to these sectors amounted to 11.30% in 2018.

2.6. DEVELOPMENT OF ENVIRONMENTAL INFORMATION SYSTEM

Since its establishment, the Environmental Protection Agency assumed the role of a central body for collecting environmental data with the aim of drafting a comprehensive report on the state of the environment in the Republic of Serbia, and of integrating all relevant information, earlier generated by a number of institutions at national, regional and local levels. In order to manage such data, the environmental information system components were gradually developed, so, just for the sake of illustration, the first news on the Agency's newly launched website was published on 3 June 2005. This portal, developed in-house, is still the backbone of the Agency's information system, allowing access to other publicly available components (Figure 70).

3.06.2005

5. јун - Светски дан заштите животне средине

Одлуком Генералне скупштине УН, 5. јун се обележава као Светски дан заштите животне средине. Овогодишња прослава се одржава уз мото "Зелени градови - план за планету". Више о прослави Светског дана заштите животне средине можете погледати на званичној презентацији прославе: *WED 2005*

Figure 70. First news published on the Agency's web page (3 June 2005)

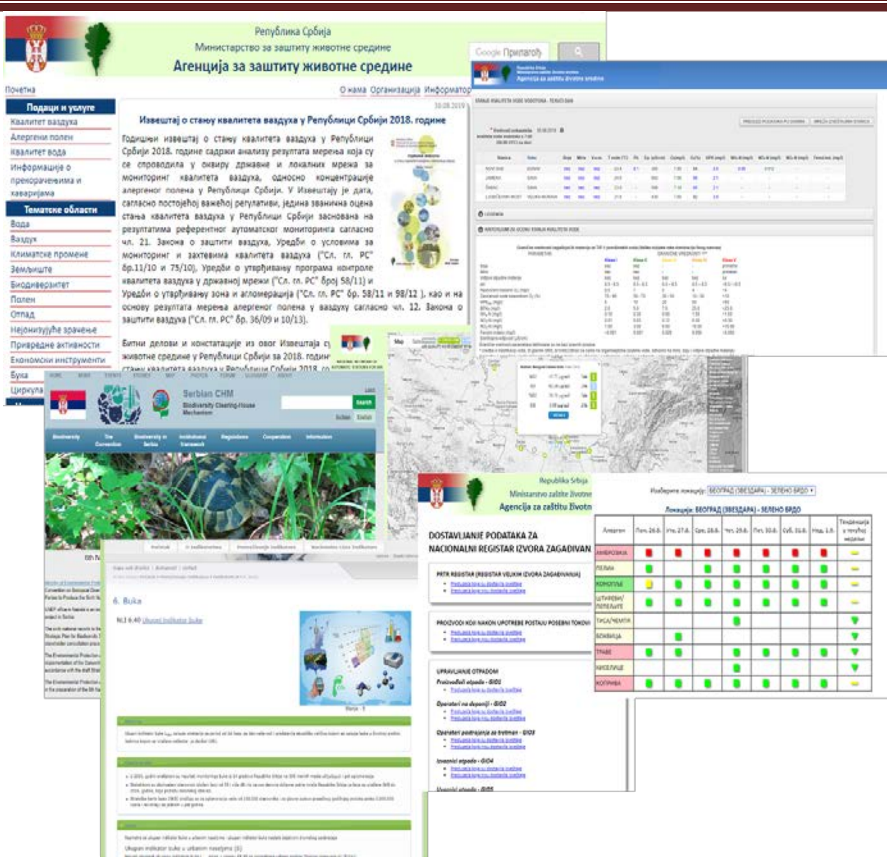
The Agency is managing a series of, at the moment, insufficiently integrated components of the environmental information system that have evolved along with the adoption of relevant legislation, i.e. empowering the Agency to collect and manage environmental data and to prepare thematic and comprehensive reports, sharing them with the European and international organisations. Data is also delivered to stakeholders through specially created web services and open data systems through portals and applications of the Environmental Protection Agency (Figure 71).

Air Quality	• Real time data on ambient air quality
Water Quality	• Daily reports on surface water quality
Register of Pollution Sources	• Register on emissions to air, water and soil
Pollen	• Weekly data on alergen pollen concentrations
Open Data	• Environmental opena data portal
Indicators	• National list of environmental indicators
Eco Register	• Meta-register on environmental information
Waste Management	• GIS on waste management
Biodiversity	• Portal on the Convention on biological diversity
Cadaster of Contaminated Sites	• Management of contaminated sites

Figure 71. Portals and applications of the Environmental Protection Agency

In the coming period, the Environmental Protection Agency will continue to apply concepts and methodologies currently available in the field of information technology at European level through cooperation with the European Environment Agency (EEA) and the European Information and Observation Network (Eionet). Particular attention will be paid to the adoption and implementation of European legislation in this area (INSPIRE Directive, and others), especially through EU initiatives and programmes currently implemented, developed or being created, such as the Shared Environmental Information System (SEIS) or Copernicus.

Integration of already existing databases, improvement of data management, especially development of tools for dissemination and visualisation of data and information produced by the Agency, will be one of the main tasks in the forthcoming years. Developing software solutions that will facilitate access to all relevant environmental data on various platforms (computers, phones, smart devices) while ensuring timely accessibility to available data will promote the Environmental Protection Agency as the implementer of constitutionally guaranteed right of every citizen of the Republic of Serbia – the right to healthy environment and to be timely and fully informed about the state of the environment (Article 74 of the Constitution of the Republic of Serbia).



SEPA's Portals and Environmental Information System Components

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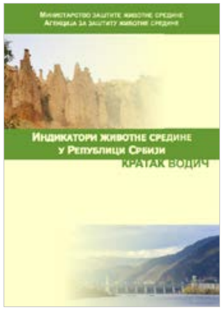

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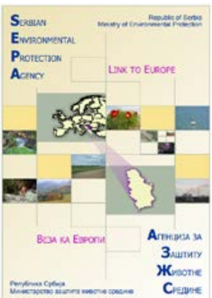

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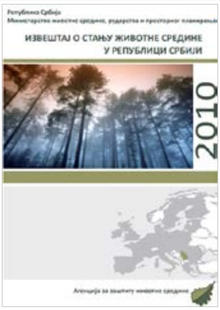		
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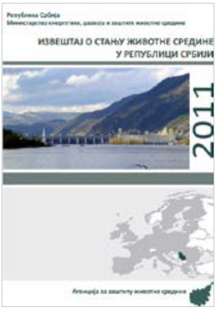
<tr><td>
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		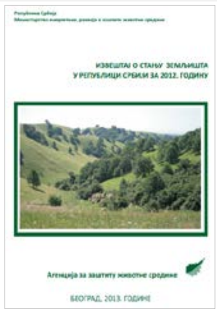
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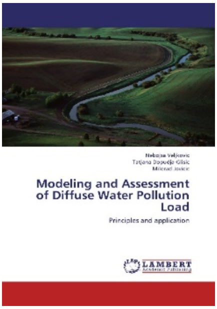		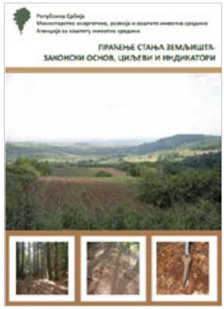
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	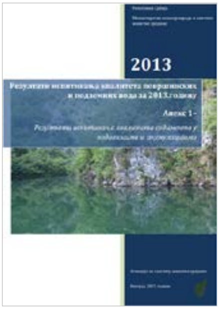	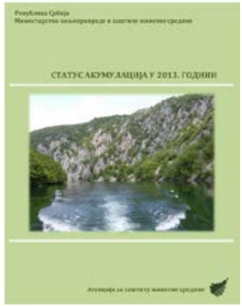
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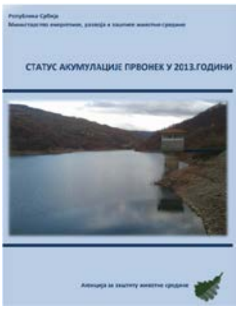	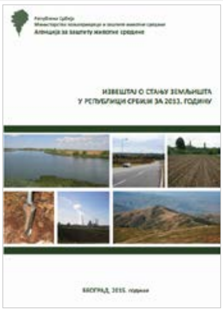	
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	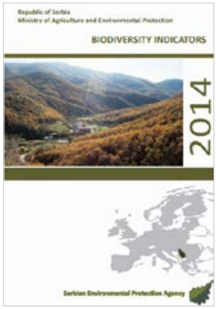	
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	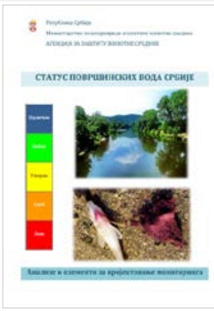	
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	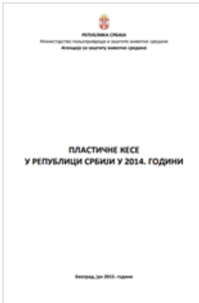	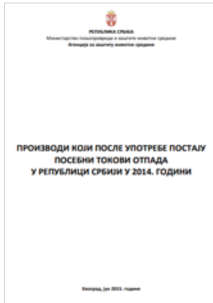
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		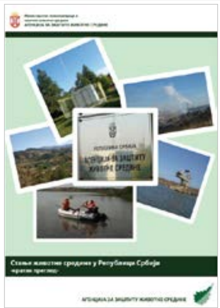
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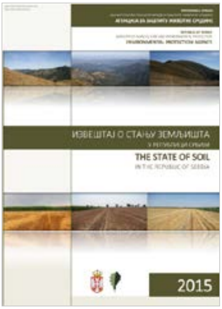	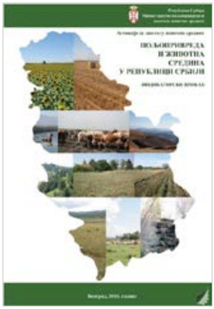	
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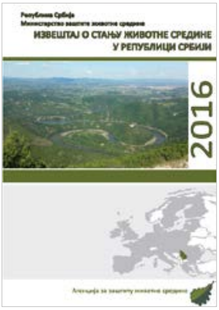		
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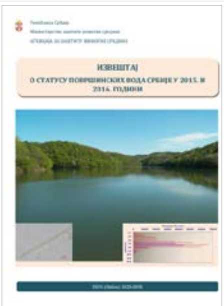		
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	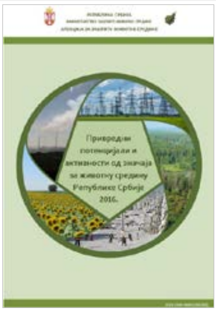	
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	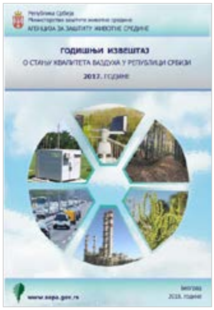	
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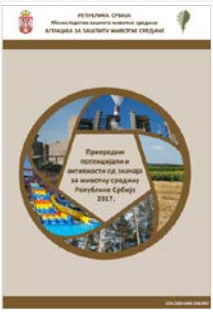		
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	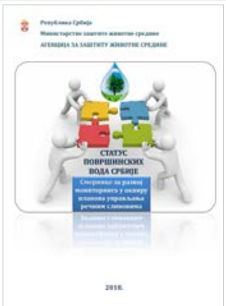	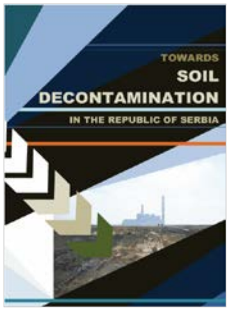
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2019

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ENVIRONMENT IN SERBIA : 2004-2019 / [authors Nebojsa Veljkovic ...
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Naslov originala: Животна средина у Србији. - Podaci o autorima preuzeti iz kolofona. - Tiraz 200. - Str. 3: Foreword
/ Filip Radovic. - Napomene i bibliografske reference uz tekst. -
Bibliografija: str. 78-95.

ISBN 978-86-87159-25-9

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COBISS.SR-ID 280338444

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