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Status of air pollutants and greenhouse gases in the Western Balkans

Benchmarking the accession process progress on environment

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* This designation is without prejudice to position on status and is in line with the UNSCR 1244/99 and the ICJ Opinion on the Kosovo declaration of independence.

Abstract

The adoption, implementation and enforcement of Chapter 27 of the EU *acquis* on Environment is an obligation for accessing countries. Reducing the emissions of air pollutants and greenhouse gases (GHG) is a priority which is strongly interlinked with energy, transport and health policies, among others. This report summarises the current status of air pollution and emission of pollutants and GHG in the countries of the Western Balkans (WB), describing the existing level of knowledge and the gaps with respect to the EU *aquis* in order to benchmark the future progress in this field, during the accession process.

At present, the alignment with the EU *acquis* on environment and climate in the WB ranges from early stage to advanced. The implementation of Ambient Air Quality Directive is not fully effective in all the WB countries and air quality monitoring networks, online data processing and QA/QC procedures are at different levels of development. Often, air pollution reporting in the WB does not fulfil all the required criteria and the number and proportion of reporting stations, time series and data coverage are all quite variable.

Particulate matter (PM_{10} and $PM_{2.5}$), SO_2, O_3 and NO_2 are the air pollutants whose levels are most frequently above the legislation limits in the WB. They are mainly emitted by human activities such as industry (including electricity production), household heating and transport. Agriculture contributes to secondary pollution. In addition, transboundary pollution from within and outside the region makes a considerable contribution to the observed concentrations.

Energy and transport are the main sources of GHG in the region and a steady increase in the emissions is observed in some countries since 1995. The alignment in the field of climate change is at an initial stage.

A continuing commitment is needed in the WB to achieve full alignment with EU environment *acquis*. The initial focus of the air quality management policies should be on the pollutants which are most frequently above the European legislation limit values. Among these are PM_{10}, $PM_{2.5}$ and SO_2 emitted by coal burning in obsolete and inefficient power plants and industrial facilities. The combustion of biomass for residential heating also leads to considerable emissions of particulate matter. Co-benefits between air quality and climate should be better exploited.

More effort should be made to further develop the technical skills in the WB countries in the areas of air quality monitoring and modelling and development of emission inventories for atmospheric pollutants and GHGs.

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Authors

Manjola Banja collected the information about the most recent situation on air pollutants and greenhouse gases in Albania and Kosovo, compiled the data of all the region into a single database, carried out data analysis, prepared the graphs for all the countries, and drafted the report.

Gordana Đukanović collected data on air pollutants and GHG emissions in Serbia, Montenegro, North Macedonia and Bosnia and Herzegovina and prepared reports and database for these countries.

Claudio A. Belis is the overall responsible of the study, defined the working methodology, developed the structure and drafted the report.

Executive summary

This report summarises the current status of air pollution and emission of pollutants and GHGs in the countries of the Western Balkans (WB), describing the existing level of knowledge and the gaps with respect to the EU *aquis* in order to benchmark the future progress in this field, during the accession process.

Policy context:

The adoption, implementation and enforcement of Chapter 27 of the EU *acquis* on Environment is an obligation for accessing countries in the framework the "Stabilisation and association process". Reducing the emissions of air pollutants and greenhouse gases (GHG) is a priority which is strongly interlinked with energy, transport and health policies, among others. In its communication "A credible enlargement perspective for and enhanced EU engagement with the Western Balkans" of February 2018, the European Commission reaffirmed the merit-based prospect of EU membership for the WB. The communication was followed by the launch in April 2018 of the Enlargement package (COM(2018)450) including individual reports assessing the implementation of the EU's enlargement policy. The European Commission political guidelines for 2019-2024 consider the accession process as a unique opportunity to promote EU core values and reaffirm the importance of continuing the reform process of this region.

Key conclusions:

A continuing commitment is needed in the WB to achieve full alignment with **EU environment *acquis***. Moreover, improving the air quality in the WB would also contribute to reduce the levels of pollutants in the EU neighbouring countries. In general, the transposition and implementation of the provisions on air quality are at a more advanced stage than those concerning climate change. Nevertheless, despite the elevated air pollution levels, relatively few action plans have been adopted or implemented, so far.

It is necessary to reduce the fragmentation of **air quality** monitoring and reporting between national and local authorities and the complete set of air quality indicators required by the legislation should be monitored. Moreover, integrated environmental monitoring systems that provide access to both real time and processed data online should be developed to provide timely and comprehensive analyses of the air quality situation. In this regard, the accreditation of bodies in charge of the monitoring networks (maintenance and calibration of instrumentation) would contribute to improve the quality of the data.

To develop complete and accurate **emission inventories** should be a priority in the WB area. In some cases, time series are fragmented and not all the pollutants are covered. In addition, in certain activity sectors more reliable data is needed. Shortcomings in emission data affect the reliability of air quality models, often used to overcome the paucity of measurements, and impair the ability of such models to estimate the real source impacts.

In addition to better emissions inventories, assessing the atmospheric transport processes and the formation of secondary pollutants is needed to quantify the impact of their sources on air quality. **Source apportionment** is a necessary step for the development of effective abatement strategies and air quality plans. Better data collection and application of modelling is needed to support a regular analysis of source apportionment of particulate matter and other priority pollutants.

The initial focus of the **air quality management** policies should be on the pollutants which levels are most frequently above the European legislation limit values. Among these are particulate matter (PM_{10}, $PM_{2.5}$) and SO_2 emissions from coal burning in obsolete and inefficient power plants and industrial facilities. The combustion of biomass for residential heating also leads to considerable emissions of particulate matter and associated pollutants such as black carbon and polycyclic aromatic hydrocarbons. In addition, further investigation is needed on the use of waste as fuel in the residential sector.

Models indicate that the main source of **CO_2 and GHG** in the WB is energy production and that emissions are increasing. Many of the emission abatement measures may have considerable co-benefits for both air quality and climate. However, more effort is needed to catch up with the EU legislation and national Monitoring, Reporting and Verification (MRV) systems should be created.

Capacity building initiatives are important to further develop the technical skills in the areas of air quality monitoring and modelling and development of emission inventories for atmospheric pollutants and GHGs.

Main findings:

WB countries are at **different stages** in addressing air pollution issues in terms of national strategies, policy development, funding, monitoring and reporting. Moreover, progress in the climate sector is slower compared to the one on air pollution.

Despite the progress made, the **implementation** of Ambient Air Quality Directive is not fully effective in all the WB countries and air quality monitoring networks, online data process and QA/QC procedures are at different stages of development. Often, air pollution reporting in the WB does not fulfil all the required criteria and the number and proportion of reporting stations, time series and data coverage are quite variable.

Particulate matter (PM_{10} and $PM_{2.5}$), SO_2, O_3 and NO_2 concentrations are often above the yearly average, daily maximum and hourly maximum limits. Despite the decreasing trend in air pollutant emissions observed in some countries, particulate matter is critical in almost all of them and the hourly SO_2 and NO_2 concentrations are elevated in most areas. Air pollution in the WB is influenced by meteorological conditions, mainly air temperature and humidity. Ozone and particulate matter episodes in the Balkans region in 2017 coincided with elevated air temperatures.

Thermal power plants, industry, residential heating, transport, agriculture and uncontrolled waste burning are the **main sources** of PM_{10} emissions in the WB region. Despite the decreasing trend in yearly average PM_{10} pollution, concentrations are still above the limits. In 2018, yearly average concentrations of fine particles ($PM_{2.5}$), an indicator of health impact, were up to six times the WHO guidelines (10 $\mu g/m^3$). Thermal power plants and industry are among the main sources of SO_2 emissions in the WB region while thermal power plants and transport sector are the main sources of NOx emissions. In most countries, the emissions from large combustion plants are higher than the emission ceilings established in the existing/drafted national emission reduction plans for SO_2 and dust.

Routine work to identify the actual contribution from different sources to atmospheric pollution (**source apportionment**) is still rare in the WB region. Data from some studies identified the combustion of solid fuels as a major responsible for the fine particulate matter. Secondary pollution from the agriculture sector and transboundary pollution, from both within and outside the WB region, are also important drivers.

CO_2 emissions from fossil fuel combustion have been increasing in the WB region since 2000. Despite the growth in renewables since 1990, the energy mix portfolio in the region is still dominated by fossil fuels. CO_2 emissions are well above the 1990 levels in Bosnia and Herzegovina.

After an initial decrease of **GHG emissions** in the WB region following the shocks to their economies after the dissolution of the Soviet Union, a steady increase is observed in some countries since 1995. Energy and transport are the main sources of GHG emissions in the region, covering more than 2/3 of the total.

Related and future work:

The JRC is contributing to fill the information gaps in some of the most critical areas identified in this report by applying modelling tools. The work aims to improve estimates of the different sectoral and spatial sources of pollutants and GHGs and their impacts on climate, health and crops. The JRC is also planning to deliver training on air quality measurements and modelling and on the development of emission inventories dedicated to WB experts and institutions.

Quick guide:

Chapter 2 describes the transposition of EU directives on environment and climate. **Chapter 3** deals with the WB countries reporting on air quality and emissions of pollutants and GHG. In **Chapter 4** an analysis of the status of air pollution in the WB region is provided. In **Chapters 6 and 7** are presented data and trends on air pollutants emissions in the WB region and source apportionment, respectively, while **Chapter 8** summarises the state and trends of CO_2 and GHG emissions in the WB region.

1 Introduction

The Western Balkans (WB) cover an area of about 218 750 km^2 and have a population of 19.9 million with a total GDP of €94.2 billion [1].

The process of joining the EU currently has three stages, candidacy, formal negotiations and on completion of these, accession. Together the WB countries have been involved in the accession process for more than 15 years, however, they are at different stages of this process. Montenegro has been a candidate country since 2010 and began negotiations in 2012; Serbia has been a candidate country since 2012 and began negotiations in 2014; North Macedonia has been a candidate country since 2005 while Albania achieved this status in 2014; Kosovo[1] and Bosnia and Herzegovina[2] have potential candidate status. Opening of accession talks for Albania and North Macedonia is currently under debate. For this reason, it is important to investigate how these countries are moving towards the alignment with the requirements of the EU *acquis*[3].

Chapter 27 – "Environment and Climate Change", is the largest and most demanding of the 35 chapters of the EU *acquis* with more than 200 legislative acts including:

(i) *horizontal legislation* (environmental impact assessments, access to information, strategic environmental assessment, public participation, and environmental liability);

(ii) air quality (ambient air -SO_2, NOx, PM_{10} and Pb - sulphur in fuel, vehicle emissions, emission ceilings, emission trading, ozone, VOCs);

(iii) waste management (hazardous waste, landfill and incineration of waste, sewerage sludge, packaging waste, waste disposal, PCBs/PCTs, battery disposal and labelling, vehicles disposal, hazardous substances);

(iv) water management (drinking water, urban wastewater, nitrates, bathing and groundwater water, Hg, Cd, Hexachlorocyclohexane (HCH) discharges, surface water abstraction, fish water, shellfish water);

(v) nature protection (habitats, zoos, wild birds);

(vi) industrial pollution (solvents, pollution, prevention and control, Large Combustion Plants);

(vii) chemicals (release of dangerous substances and GMOs, animal experiments, biocides, asbestos); and

(viii) noise and civil protection [2].

Completing Chapter 27 will be a long-term challenge for the WB countries involving adjustments and changes to their legal framework related to environment and climate change. This implies systematic adaptation of institutions and access to additional resources, guidance, and technical assistance in order to complete the process [3].

In 2006, North Macedonia adopted its "National Programme for Adoption of the Acquis Communautaire (NAPA)"[4] which is revised and updated annually. In July 2014 Serbia adopted a "National Program for the Adoption of the EU *Acquis* 2014-2020" [4]. In July 2016 Montenegro launched its "National Strategy with Action Plan for Transposition, Implementation and Enforcement of the EU *acquis* on Environment and Climate Change" [5]. In Albania the "National Plans on EU Integration (NPEIs)" are in force since 2015. The last plan covers period 2019-2021 [6]. Bosnia and Herzegovina has an "Environmental Approximation Strategy" since 2017 [7] and the "Environmental Approximation Strategy of Republic of Srpska" was published in November 2016 [8].

(1) This designation is without prejudice to position on status and is in line with the UNSCR 1244/99 and the ICJ Opinion on the Kosovo declaration of independence.
(2) Bosnia and Herzegovina is formed by the Federation of Bosnia and Herzegovina and the Republic of Srpska entities and the Brčko district.
(3) The EU's 'acquis' is the body of common rights and obligations that are binding on all EU countries, as EU Members. https://eur-lex.europa.eu/summary/glossary/acquis.html.
(4) http://www.sep.gov.mk/en/content/?id=13#.XbE8WkYzbIU

In 2018 the EU launched six flagship initiatives to support the efforts of the WB countries to be part of an extended EU Energy Union. In the strategy paper "*A credible enlargement perspective for and enhanced EU engagement with the Western Balkans*" the Commission indicated the steps the WB region countries should take to complete the enlargement process in the forthcoming years [9].

Support for the Environment and Climate action will reach nearly €610 million[5] in 2020, 15% of the total. Almost 40% of this support is dedicated to Serbia, 18.5% to North Macedonia, 16.5% to Kosovo, 10.7% to Albania, 8.6% to Bosnia and Herzegovina[6] and the rest to Montenegro. The overall EU support for WB countries covering period 2014-2020 is expected to reach nearly €4 billion [10].

The Paris Agreement was signed by 195 countries and has been ratified or joined by 187 Parties so far, representing 97% of the global greenhouse gases (GHG) emissions [11]. All the WB countries, except Kosovo, have ratified the Paris Agreement committing to decrease their GHG emissions while maintaining a satisfactory economic performance. Albania joined in September 2016 followed by Bosnia and Herzegovina (March 2017); Serbia (July 2017), Montenegro (December 2017) and North Macedonia (January 2018). The involvement of almost all the WB countries reflects the commitment of the region to contribute to the effective implementation of the Paris Agreement and the 2030 Agenda on Sustainable Development.

Climate change is a huge challenge for the WB region. The recent "Study on Climate Change in the Western Balkans Region" reported the following:

"Climate change in the Western Balkans shows alarming increase of temperature over the whole territory with observed temperature increase of 1.2°C in the near future and destined to warm further by 1.7 – 4.0°C by the end of the century, depending on the global effort in GHG emission reduction" [12].

Reducing GHG emissions should slow down the climate change process and at the same time improve the air quality, since both GHG and air pollutants are often released by the same sources [13]. In 2017 UNEP claimed that air pollution is "*a global public health emergency, and has an equivalent effect to tobacco use, putting everyone from unborn babies, to children walking to school, to women cooking over open fires at risk*" [14].

According to the UNEP report of May 2019, "Air pollution (in Western Balkans) contributes between 4% and 19% of total premature mortality in the selected cities and reduces life expectancy by between 0.4 and 1.3 years. [….] the exposure to fine particulate matter ($PM_{2.5}$) is responsible for 75 per cent of all deaths associated with the exposure. [….]. The sum of all deaths directly attributable to air pollution in the Western Balkan cities covered by this study is nearly 5000 per year". In seven of the studied cities, which includes the capital cities Sarajevo, Podgorica and Skopje, air pollution is responsible for at least 15% of premature deaths, while this figure rises to as high as 19% in Tetovo, North Macedonia [15].

The WB region is one of the air pollution hotspots of Europe. What the WB region countries have in common is that they have inherited old and inefficient thermal power plants, steel smelting plants, ferronickel factories, cement industry, mining industry, petroleum refining industry and chemical industry.

Premature deaths due to emissions from WB coal plants were estimated at nearly 1250 in 2016, 570 of which were in Serbia alone. In the same year, emissions from coal plants caused a total of 8516 cases of bronchitis in children and 2023 cases of bronchitis in adults creating up to €3.6 billion per year in health costs in the region. It is estimated that in 2016 air pollution costs for Serbia were €1.68 billion per year, in Bosnia and Herzegovina €985 million and in North Macedonia €300 million [16].

In the WB, particulate matter, especially fine particles ($PM_{2.5}$), are mainly released by coal plants and biomass burning for household heating [17]. According to the most recent report of the European Environment Agency (EEA), all the WB countries report values above the exposure concentration obligation of 20 $\mu g/m^3$ for the average exposure index (AEI) for $PM_{2.5}$ [18].

Elevated concentrations of acidifying pollutants (S and N) have a negative impact on the ecosystem contributing to eutrophication (mainly N). Modelling results published by EMEP show than in 2017 critical

([5]) The support for Kosovo is mainly focused in the decarbonisation of Energy sector (EC, 2018). In 2017 the share of coal reached 96.6% of electricity production in Kosovo (Energy Community, March 2019).
([6]) The support for Bosnia and Herzegovina covers the period 2014-2017.

loads for eutrophication in the WB region were exceeded in all countries, ranging from 200 to 800 eq ha^{-1} yr^{-1} (elevated exceedances in Serbia, Albania and North Macedonia). The European average exceedance of critical loads for eutrophication is about 277 eq ha^{-1} yr^{-1} [19].

Several high pollution episodes were recorded in the region in 2017. Major particulate matter episodes with levels above the limit value were observed during January and February 2017. An episode of photochemical pollution in August occurred together with an intense heat wave (described as the worst heat wave since 2003) characterised by high levels of humidity. High levels of ozone just below the alert level were also observed in many areas of the WB region [19].

The objective of the report is to summarise the status of air pollution and emission of pollutants and GHGs in the WB, describing the existing level of knowledge and the extent to which the EU *aquis* has been transposed and implemented with a view to benchmark the progress in this field along the accession process.

The data used for this report are from international organisations and from the WB region bodies responsible for environmental monitoring and statistical offices. The data sources are listed in Annex 1. The report covers the analysis of many indicators which are available for different periods. The time window used here for the different indicators is reported below:

- Air pollutants concentrations from the Environmental Information and Observation Network (Eionet), air quality (AQ) annual reports and AQ monitoring networks (data coverage in Annex 2) [20]:
  - (a) Historical trend – the starting date depends on the availability of data from national environmental bodies and their statistical offices;
  - (b) The most recent available year (2017 and/or 2018)
- Air pollutants emissions data available from EMEP/CEIP for period 1990-2017 [21].
- GHG emissions:
  - (a) UNFCCC's GHG data [22] - including the most recent year of data reporting;
  - (b) Emission Database for Global Atmospheric Research (EDGAR) [23] – data available up to 2015 for GHG emissions and 2018 for CO_2 emissions;
  - (c) Primap's (PIK) data [24]]– data available up to 2017[7]:
  - (d) IEA database [25] [–data available up to 2017 for CO_2 emissions from fossil fuel combustion

This report is structured as follows:

- in **Chapter 2** the transposition of EU directives on environment and climate is summarised;
- **Chapter 3** illustrates the reporting performances of WB countries on air quality and emissions of pollutants and GHG;
- An analysis of the status of air pollution in the WB region is provided in **Chapter 4**;
- **Chapters 6 and 7** present the emissions of air pollutants and the amount they contribute to observed pollution levels (source apportionment) in the WB region, respectively;
- Lastly, **Chapter 8** summarises the state and trends of CO_2 and GHG emissions in the WB region.

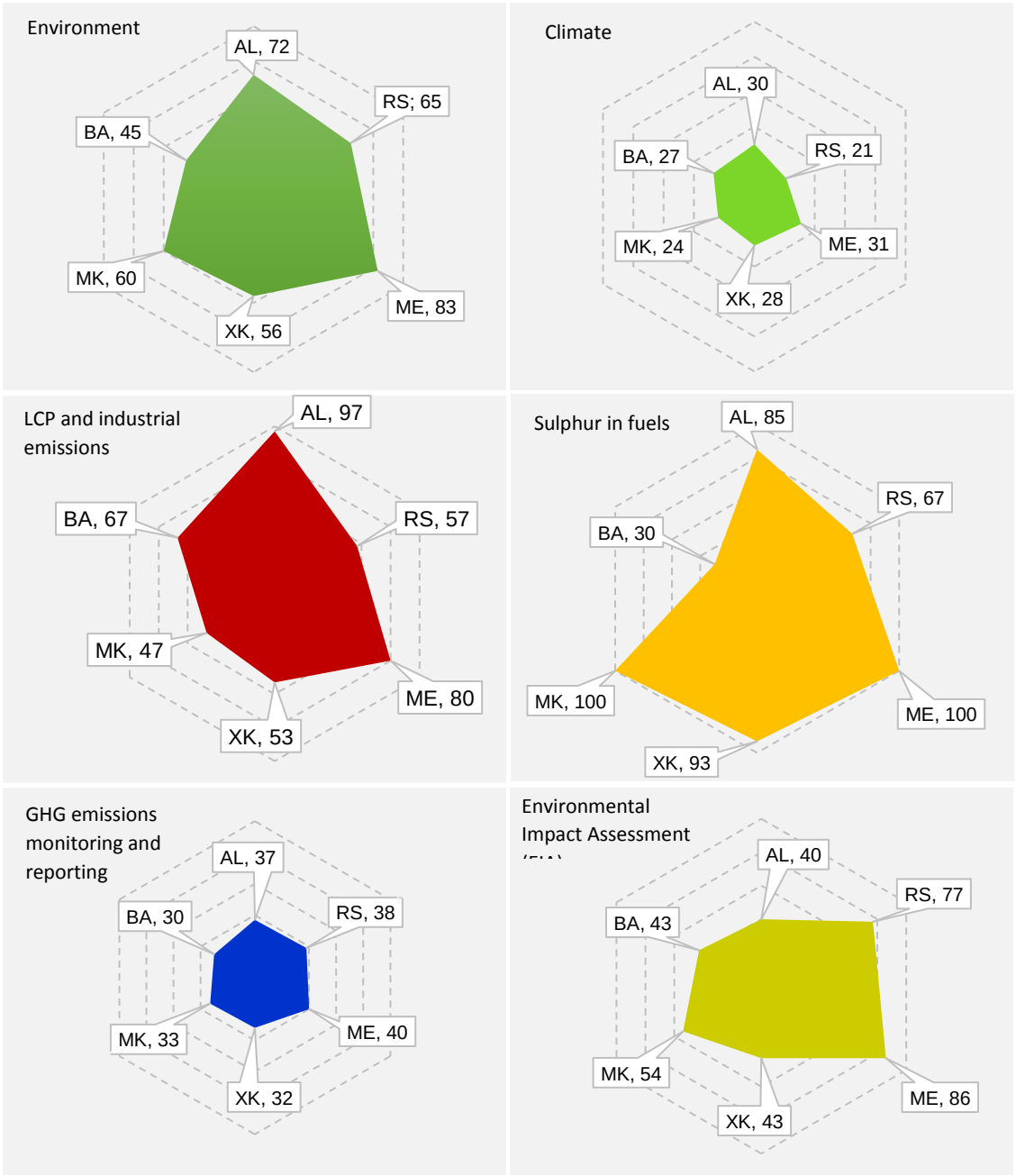
([7]) More on the methodology please visit https://www.pik-potsdam.de/paris-reality-check/primap-hist/#scenario=histcr&id=eu28&entity=kyotoghg

2 The alignment with EU environment and climate acquis in the WB region

The focus on the environmental and climate topics in the Western Balkans countries as Contract Parties of the Energy Community, has mainly concerned the alignment (see Fig. 1) with the EU *acquis* [26] among which:

- Directive 2001/80/EC [27] on the limitation of emissions of certain pollutants into the air from large combustion plants;
- Directive 2010/75/EC [28] of 24 November 2010 on industrial emissions (integrated pollution prevention and control);
- Directive 2016/802/EU [29] relating to a reduction in the sulphur content of certain liquid fuels;
- Regulation (EU) 525/2013 [30] on a mechanism for monitoring and reporting GHG emissions;

Figure 1. The alignment with the EU Environment and Climate acquis in the WB countries (%).



Source: Energy Community [26][8] updated to November 2019

([8])The methodology used for of this assessment is described at https://www.energy-community.org/implementation/IR2018/methodology.html

In Figure 1 is shown the level of alignment with the EU acquis (expressed as percentage according to the Energy Community methodology [26]). The considered legislation is as follows: environment, climate, industrial emissions (LCP), sulphur in fuels, GHG emissions and environmental impact assessment. The overall environmental performance in the WB ranges between 45% and 83% while the one for climate is modest (21-28%). Very high level of alignment is observed for sulphur in fuels in Montenegro and Kosovo (>90%) and for LCP and industry in Albania (97%).

2.1 Albania

The alignment of the Albanian legislation on environment and air quality with the EU *acquis* is an ongoing process. However, a cross-cutting environmental strategy has not yet been adopted [31]. The directive on ambient **air quality** and cleaner air for Europe has been fully transposed. However, current air quality monitoring practice is not completely in line with the EU requirements [32] and the Albanian Ambient Air Quality Strategy adopted in 2014 was not yet fully implemented [33]**. Law No 162/2014 "On protection of ambient air quality"** [34], that entered into force in December 2017, represents **a fully transposition of Directive 2008/50/EC** [35]. The **Decision of the Council of Ministers (DCM) No. 352/2015** [36] "For the assessment of ambient air quality and requirements for certain pollutants related with it", fully transposes **Directive 2004/107/EC** [37]. The Albanian National Action Plan on Ambient Air Quality Management [38] was approved in June 2019.

Although the alignment with the EU legislation has progressed, there is no independent monitoring of **industrial pollution** in Albania [39]. There is one Thermal Power Plant which is switched off and is not capable of complying with the emission limit values defined in the Industrial Emissions Directive [40]. Law 10448/2011 "On the environmental permitting" [41] transposed the Integrated Pollution Prevention and Control Directive (IPPC) [42] and Large Combustion Plants Directive (LCP) [27]. The transposition of Industrial Emissions Directive is now an on-going process that will involve repealing of Law 10448/2011.

The implementation of the legislation on prevention of major accidents involving dangerous chemicals still lags [39]. The national legislation in relation to **Volatile Organic Compound (VOC) Protocol** and **Persistent Organic Pollutant-s Protocol** have transposed the (i) Directive 2004/42/EC [43] through the DCM No. 907/2016 [44]; (ii) the Directive 2010/75/EC [28] through the DCM 908/2016 [45]; (iii) the Directive 2009/126/EC [46] through the DCM 909/2016 [47] and (iv) the Directive 94/63/EC [48] though the DCM 1075/2015 [49]. Regarding **chemicals,** the Law on Chemicals Management No.27 of 17.03.2016 [50] entered into force in March 2018. The **National Emissions Ceilings Directive (2016/2284/EC)** [51] is still awaiting transposition.

Although alignment with the EU acquis is still limited, Albania has made steps in the area of **climate change**. Some progress was made by ratifying the Kigali Amendment to the Montreal Protocol [39]. A Law for Climate Change is still missing. The draft-decision "Establishing a mechanism for monitoring and reporting to the national competent authority, of greenhouse gas emissions and other information relevant to climate change" partially transposes Regulation (EU) No 525/2013. The National Energy Strategy was approved by DCM 480 of 31.07.2018 [52] and was endorsed by the government in July 2019 together with the National Action Plan on Mitigation (NAPM) and the National Adaptation Plan (NAP) [26].

2.2 Kosovo

The main progress to the EU air quality *acquis* in Kosovo is related to alignment with Directive 2008/50/EC while alignment with Directive 2004/107/EC is still to do. Kosovo has a Strategy for Air Quality for period 2013-2022 [53]. However, an air quality plan has yet to be approved [54]. In the field of **air quality** are currently in place the Law on the Environmental Protection Nr.03/L-025[55] since 2009 and the Law on Air Protection from Pollution Nr.03/L-160 [56] since 2010 whereas the Law no.06/L-100 for Air Protection from Pollution is still a draft[9].

([9]) More info at http://ligjet.kuvendikosoves.org/LTS/DraftLawPhase?languageid=2&draftLawId=120

There has been some progress towards the implementation of the EU acquis on **industrial pollution**. A **National Emissions Reduction Plan (NERP) [57]** was already adopted, and its implementation has started in January 2018. However, on 12 July 2019, a Reasoned Request was submitted to the Energy Community (EnC) Ministerial Council for a decision under Article 91 of the Energy Community Treaty about the case (ECS-6/18), concerning the incomplete transposition and lack of implementation of Directive 2001/80/EC on large combustion plants by Kosovo [26].

The legislation on **chemicals** and **sulphur content** in fuels is related to the (i) Law on chemicals - No. 04/L-197 2014 [58]; and (ii) Administrative Instruction (AI) No. 01/2017 of 15.12.2017 [59] on limits of the sulphur content of heavy fuel oil and gasoil. The customs authorities as well as the Market Inspectorate in cooperation with authorised inspection bodies carry out the quality control of the petroleum products falling under the scope of the Directive (EU) 2016/802 [26].

The national legislation related to **VOC Protocol** has almost fully transposed Directive 94/63/EC [60] through the AI - No.04/2009 [61] on the control of emissions of organic, volatile compounds during storage, emptying, refilling and transport of fuels. The implementation of Stage II Petrol Stations Directive is at an early stage.

Kosovo is starting to align with the EU **climate** acquis. A Climate Change Strategy (2019-2028) [62] and an Action Plan on Climate Change (2019-2021) [63] were approved in 2018. According to the latest available information, a Climate Change Concept Paper was expected to be approved by December 2019. The adoption of the draft Climate Change Law is scheduled for 2020. The GHG emissions inventory has been developed up to 2015 and the one for 2016 is expected to be finalised in December 2019 [40]. The national legislation related to **climate change** includes among others (i) AI -No.01/2016 on the GHG Emission Tracking Mechanism [64]; (ii) AI No.20/2013 for application of clean development flexible mechanisms [65];and (ii) AI - No.19 / 2013 on access to information on fuel economy and CO_2 emissions of new vehicles [66]. The AI No. 14/2018 [67] on capture and deposition of carbon dioxide in suitable geological formations has been already approved. By Decision No.09 / 79 of 11 December 2018, Kosovo also adopted two AI partially transposing Regulation (EU) 525/2013, namely the A.I. on a Mechanism for Monitoring Greenhouse Gas Emissions and the A.I. for Monitoring Greenhouse Gas Emissions [26].

2.3 Serbia

Serbia plans to open the negotiations on **Chapter 27 "Environment and Climate Change"** by the end of 2019. In the field of **air quality**, Serbia already has a good level of alignment with the EU *acquis* in the field of air quality. However, this country has not yet developed an air quality protection strategy, despite the 2015 deadline. Air quality plans are developed for Bor (2013), Belgrade (2016), Pančevo (2017), Smederevo and Novi Sad (2018) [68]. **Law on Air Protection** was adopted in 2009 and amended in 2013 [69]. The law represents a full transposition of **Directive 2008/50/EC**. A new Law on Air Protection has been already drafted.

Regarding **industrial pollution** and risk management, alignment with most of the *acquis* is at an early stage, including the Industrial Emissions Directive. The Serbia's NERP [70] is still not adopted by the Government. Serbia started since January 2018 to opt-out four of its seventeen LCPs. The process is expected to end in December 2023. The Regulation on limit values of air pollutant emissions from combustion installations is already approved [71].

The transposition and the implementation of the EU Directive on **volatile organic compound emissions** is still ongoing. In August 2018, Serbia submitted its national plan for the implementation of the Stockholm Convention on **Persistent Organic Pollutants (POPs)**. The Regulation on the methodology for data collection for the national inventory of unintentional emissions of POPs is currently in place [72].

There is a high level of alignment with the acquis on **chemicals**. A national poison control centre and a sanction regime to ensure compliance are in place. In 2019 the electronic platform for the entry of chemicals into the Integrated Register of Chemicals (eIRH) became operative [73]. Law on Chemicals was adopted in 2009 with last amendment in 2015 [74] and the Rulebook on permits for performing business activity of movement and trade, i.e. permits for using particularly hazardous substances is in place [75].

Compliance is pending with Energy Community Treaty requirements on **the sulphur content of liquid fuels**. According to the Energy Community "*a dispute settlement case (Case-ECS 04/13) against Serbia for the incomplete transposition of the provisions of the Directive is open since 2013. Serbia is in breach of the Energy Community acquis by not adopting the necessary measures to limit the sulphur content of heavy fuel oil at 1.00% by mass. Because of non-compliance with the decision of the Ministerial Council, a new case (Case-ECS 03/08S) under Article 92 of the Energy Community Treaty was opened*" [26].

Serbia has made some progress in alignment in the field of **climate change**; however, the implementation is at a very early stage. A national cross-sectoral strategy on climate change, consistent with the EU 2030 framework for climate and energy policies and addressing adaptation to climate change, awaits adoption [76]. The National Climate Change Strategy and Action Plan is in preparation[10]. Work to improving greenhouse gas inventories is also in progress. The legislation on greenhouse gas emissions monitoring, reporting and verification, in line with the EU emissions trading system and Effort Sharing Regulation, was finalised in 2017 and is awaiting to be adopted. According to the Energy Community, the draft Climate Change Law is in line with the acquis and the Monitoring Mechanism Regulation contains specific provisions on the GHG inventory, low carbon development strategies as well as policies, measures and GHG projections [26].

2.4 Montenegro

Montenegro opened the negotiations on **Chapter 27 "Environment and Climate Change"** in December 2018. the level of legislative alignment with the EU acquis in the field of **air quality** is relatively advanced. Amendments to the Decree establishing the air quality monitoring network were adopted in September 2018. Subsequently, the national monitoring network was renovated with new equipment and expanded to 10 stations (2019). All the activities related to the national air quality management strategy for 2017 have been undertaken. An action plan to implement the national strategy on air quality management for 2017-2020 has been adopted. Montenegro already had a National Strategy on Air Quality Management adopted in 2013 and covering 2013-2016. In 2017, the Government of Montenegro adopted the new Action Plan for 2017 - 2020.The following legislation related to air quality is currently in place (i) Law on air protection [77]; (ii) Rulebook on methods and conditions for air quality monitoring [78]; and (iii) Regulation on determination of types of pollutants, limit values and other air quality standards [79].

Montenegro is partially aligned with the EU acquis on **industrial pollution** and risk management. Amendments to the Law on integrated prevention and control of environmental pollution were adopted in July 2018. In March of that year, the Nature and Environmental Protection Agency issued an integrated permit to the national electric power company for the operation of the Pljevlja thermo-power plant. The law on industrial emissions [80] transposes Directive 2010/75/EU on industrial emissions and partially transposes Directive 2015/2193/EU [81] on medium combustion plants (MCP). Montenegro aims to opt-out the thermal power plant of Pljevlja between 1 January 2018 and 31 December 2023 [40].

Regarding **chemicals**, Montenegro is partially aligned with the acquis. Secondary legislation was adopted in October 2018 on methods of use, production and placing on the market of chemicals that represent a risk for human health and the environment, in line with the REACH Regulation. Montenegro ratified the Minamata Convention on mercury in March 2019 [82].

Montenegro's alignment with EU acquis on **climate change** is still at an early stage. In 2017, 'The Rulebook' of the list of gases and method for preparing the GHG inventory and exchange of information was adopted. Montenegro already has a Climate Change Strategy in place which needs to be consolidated. A Law on Climate Change was adopted in December 2019. The National Climate Change Strategy for 2030 (NCCS) [83] is the key strategic overview for climate change in Montenegro for the next decade. It provides guidance and directions for climate-change policies until 2030, as well as an analysis of the mitigation policies measures and actions that are planned for this period in order to reduce GHG emissions.

([10]) Project ID No. Europe Aid/1365966/DH/SER/RS Service Contract No: 2016/375-531 http://www.klimatskastrategija.eu/wp-content/uploads/2019/03/Draft-Scoping-Report_Climate-Strategy-and-Action-Plan_V0.1.pdf

2.5 North Macedonia

Legislative alignment in the field of **air quality** is nearly complete. Almost 93% of the Directive 2008/50/EC and 85% of the Directive 2004/107/EC are transposed in the national legislation [84]. A fund of 1.6 M€ for air quality improvement measures has been introduced in the 2019 state budget for the first time. Air quality plans exist only for the cities of Skopje, Bitola and Tetovo [85]. Law on ambient air quality [86] and Law on Environment [87] are already part of national legislation together with (i) the Rulebook on the methodology for inventory and establishment of the levels of polluting substances emission into the atmosphere in tons per year concerning all types of activities, as well as other data to be submitted to EMEP [88]; (iii) the Rulebook on the limit values of permissible levels of emissions and types of polluting substances in waste gases and vapours released from stationary sources into the air [89]; and (iv) the Decree on determination of large combustion capacities that should undertake measures for ambient air quality protection [90].

Alignment in the field of **industrial pollution** and risk management is moderately advanced with a transposition at 62% of the Industrial Emissions Directive [84]. However, the new law on industrial emission and its related implementing legislation has not yet been adopted [91]. The NERP (adopted in 2017) has been implemented since January 2018. The emission reductions are yet to be carried out in accordance with the timeframes indicated in the emissions reduction plan. There are no plants operating under the opt-out regime in North Macedonia [40].

Regarding the legislation on **VOCs,** there has been a full transposition of the Directive 2004/42/EC [43] for VOCs in paints and varnishes and Directive 2009/126/EC [46] on VOCs in petrol stations. As far as **chemicals** are concerned, the 45% of the legislation has been transposed although not yet implemented. [84]. The alignment of the legislation with Sulphur Content Liquid Fuels Directive is completed [40].

Alignment with the EU *acquis* in the field of **climate change** is still at an early stage. The country has started developing a comprehensive strategy on climate action, consistent with the EU 2030 framework. According to the latest available information, it was planned to start drafting a separate Law on Climate Action (including transposition of Regulation (EU) 525/2013) by the end of 2019 [40]. There was a full transposition of the Consumer Information Directive. The Fuel Quality Directive level of transposition is estimated at 31%. The Directive on geological storage of CO_2 is not transposed and only 5% of the Directive on emission trading is transposed [84]. Directive 2001/81/EC was fully transposed into the national legislation and **national emission ceilings** for NOx, NMVOC, SOx and NH_3 have been defined. The transposition of the new **NEC Directive** in the national legislation was planned for 2019 and some obligations under the new NECD are already performed.

2.6 Bosnia and Herzegovina

The alignment of the environment and air quality legislation in Bosnia and Herzegovina with the EU *acquis* is behind the progress of the other WB region countries and a national programme for the adoption of EU acquis is still missing [92]. The main laws defining the air protection policy are the laws on **air protection** of the subnational entities. The legal framework includes the Law on Air Protection in the Federation of Bosnia and Herzegovina (FBiH) [93], in the Republic of Srpska [94] and in the Brčko District [95].

In the FBiH the Law on Amendments to the Air Protection Act transposes the emission limit values (ELVs) of Directive 2001/80/EC on the limitation of emissions of certain pollutants from large combustion plants. In the Republic of Srpska, the Rulebook on measures for preventing and reducing air pollution and improving air quality [96] transposes the ELVs of Directive 2001/80/EC for both new and existing plants. However, the deadline for existing plants to comply has been extended from 2017 to 2020. In both, the Federation of Bosnia and Herzegovina and the Republic of Srpska, the ELVs of Directive 2010/75/EU on industrial emissions for new plants (IPPC Directive) have not yet been transposed. Because of increasing concentration of pollutant in the air, the Canton Sarajevo adopted an Action Plan for the reduction of particulate matter[11] and

([11]) Air Quality Management in Canton Sarajevo, 2015. https://mpz.ks.gov.ba/sites/mpz.ks.gov.ba/^iles/brosura-upravljanje_kvalitetom_zraka_u_ks.pdf

the Canton Tuzla adopted an Air Quality Action Plan with measures on air pollution episodes[12]. In Banja Luka the local government has a Local Air Protection Program and an Air Quality Protection Action Plan [97].

Legislation related to **industrial pollution** is linked to the laws on Environmental Protection in the two entities and in the Brčko District. However, the procedures for issuing relevant permits are not integrated. A specific Regulation on limit values of emissions from combustion plants [98] is in place. The most important legislation in FBiH and Republic of Srpska related to air quality and industrial pollution is:

- Rulebook on Air Quality Monitoring FBiH [99];
- Rulebook on Monitoring of Emissions of Pollutants into the Air FBiH [100];
- Rulebook on limit values for the emission of pollutants into the air FBiH [101];
- Decree on the values of air quality, on the establishment of the network of measuring stations and points and on the conditions for air quality monitoring in Republic of Srpska [102];
- Decree on limit values of emissions of polluting substances into the air in Republic of Srpska [103].

The **NERP** [104] was adopted. As of 1 January 2018, three large combustion plants out of thirteen, have begun their opt-out period, meaning they can only remain in operation for a maximum of 20,000 hours until 31 December 2023. Currently, an incomplete and not accessible pollution release and transfer register (PRTR) database is in place in both entities despite the legislation on PRTR being in force since 2007. Bosnia and Herzegovina is under infringement procedure since 2017 due to the incorrect transposition and implementation of Directive 1999/32/EC on the reduction of **sulphur content** of certain liquid fuels (lack of national provisions transposing and implementing the 1,00% threshold for heavy fuel oil as well as the 0,10% threshold for gas oil) [26].

The legislation in the field of **chemicals** is listed below**:**

- In the FBiH the laws of the former Yugoslavia (Law on the Transport of Dangerous Goods [105] and Law on the Trade of Poisons [106] still apply. These laws are complemented by the Decision on the Prohibition or Restriction of the Import, Manufacture and Use of Certain Hazardous Industrial Chemicals in the FBiH [107] which prohibits or restricts the import, production, marketing and use of the hazardous industrial chemicals listed in Annex III of the Rotterdam Convention. No register for chemicals exists in and a draft law on chemicals is under preparation [7];
- Law on Chemicals [108] and the Law on Biocides [109] were adopted in Republic of Srpska in 2009. In 2013 the Regulation on the Conditions for Restriction and Prohibition of the Production, Circulation and Use of Chemicals [110] were adopted.

The **National Implementation Plan** (NIP) for Reduction and Disposal of **POPs** was adopted in 2016 and the Republic of Srpska adopted legislation to ban the production and use of persistent organic chemical substances. Progress was also made in the implementation of the POPs Convention [7]. There is no specific legislation on **climate change** at the state level, nor in the entities, nor in Brčko District. Although the Environmental Approximation Strategy of Bosnia and Herzegovina (including air quality and climate change) was adopted in June 2017, there is no state-level strategy on **environment**.

([12]) Air Quality Action Plan with intervention measures in air pollution episodes, Official Gazette of TC, 7/16

3 Environment and Climate reporting in the WB region

The WB region countries are EEA cooperating countries. They are integrated into the European Environment Information and Observation Network (Eionet) [20] and are supported by the European Union under the Instrument for Pre-Accession Assistance (IPA) [111]. Eionet covers seven European topic centres (ETCs) including:

- Air Pollution, transport, noise and industrial pollution;
- Climate change impacts, vulnerability and adaptation;
- Climate change mitigation and energy.

Every year the EEA publishes a briefing describing countries' performance against agreed reporting criteria (timeliness and data quality) in order to help countries identify and prioritise the resources they need for regular reporting procedures. The annual process conducted by the EEA and Eionet is a technical evaluation of data delivery. A score of 100 % indicates timely and high-quality data delivery across all covered data flows. For each data flow, a score of 0.4 points is given according to the timeliness and quality of the delivered data. The scores of all data flows from each country are summed up and expressed as a percentage of the maximum achievable score (no evaluation was made in 2015 because of a review of core data flows) [112]. According to the Eionet core data flows 2018 North Macedonia has made a significant progress reaching a score of 100% ranking in 3rd place among the 39 EEA countries. Serbia also has progressed well reaching a score of 93% in 2018 ranking in the 15th position. Albania ranks 33rd with a score of 64% followed by Kosovo (34th) with a score of 60%. Montenegro occupies the 36th place with a score of 44% whereas Bosnia and Herzegovina is situated in 38th position with a score of 33%.

Table 1. Performance of WB countries reporting to Eionet, 2005-2018 (units = percentage).

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
AL	30	45	21	19	31	53	47	36	56	45	n.a.	21	46	64
BA	22	53	46	58	56	50	53	42	31	10	n.a.	15	25	33
ME	36	56		17	6	44	53	50	56	30	n.a.	46	25	44
MK	69	78	75	75	72	69	69	66	81	81	n.a.	79	70	100
RS	35	56	60	78	75	75	72	78	78	90	n.a.	72	75	93
XK	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	57	66	61	56	n.a.	46	38	60

Source: Eionet [20]

3.1 Ambient air pollution reporting

At the moment of drafting this report, the validated data reported by WB countries on the concentration of ambient air pollutants to Eionet were available until 2017. However, validated data for 2018 are also included in the report when appropriate. Reporting of WB countries to Eionet covers the main air pollutants: SO_2, PM_{10}, O_3, NO_2, CO and C_6H_6. Table 2 shows the number of WB region air quality stations that reported data for each of the main air pollutants in 2017. North Macedonia is the WB country with the largest number of air quality stations reporting to Eionet. This number represents almost 2/3 of the air quality stations in the country. Three classes of air quality stations are reporting to Eionet: background, urban and traffic stations.

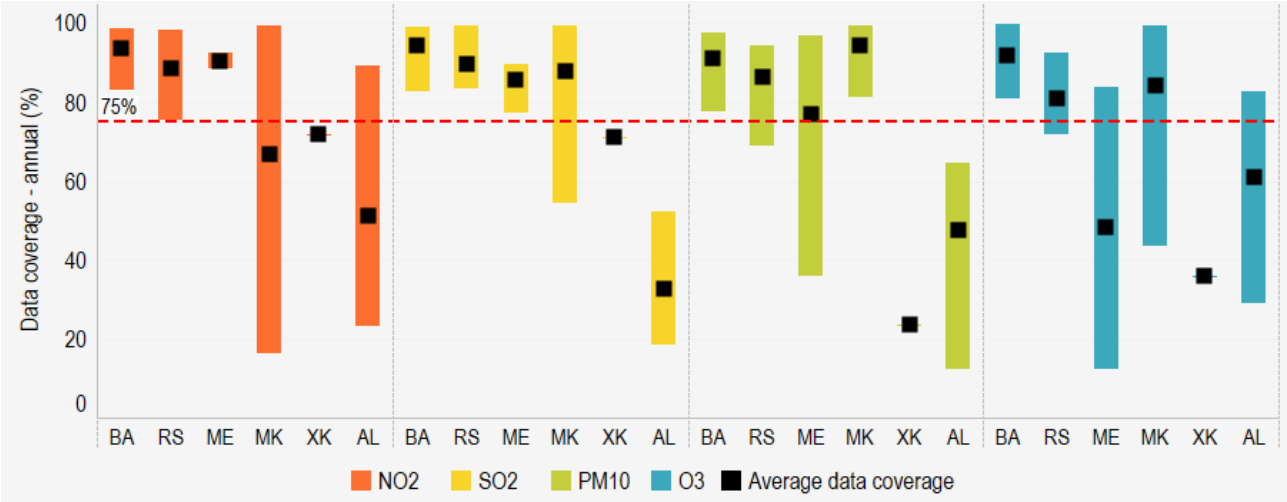
Table 2. Number of WB region air quality stations reporting to Eionet, 2017.

Air pollutant	AL	XK	RS	ME	MK	BA	Total	Nr. stations in WB AQ
SO_2	5	1	8	3	13	9	39	100
O_3	5	1	5	2	13	8	34	78
NO_2	5	1	5	3	11	9	34	91
PM_{10}	4	1	5	4	15	8	37	79
$PM_{2.5}$	4	1			1	5	11	60
CO	5	1	12	3	13	7	41	84
C6H6	5						5	26

Source: Eionet [20] & WB AQ Networks

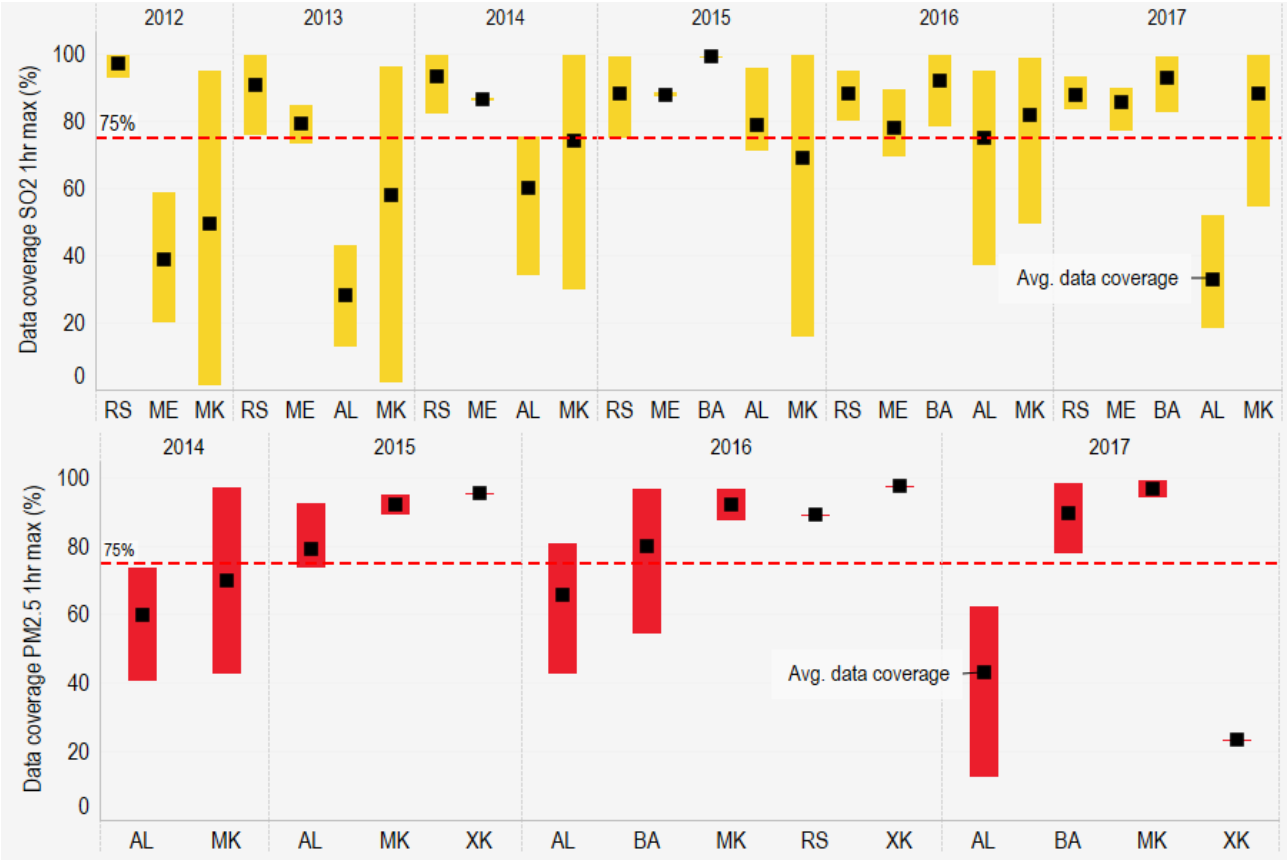
According to Eionet[13] rules, if the data coverage for a pollutant is below 75% throughout the year, it should not be included in the annual statistics. In Figure 2 is displayed the yearly data coverage (average, maximum and minimum) in the different monitoring stations of the WB countries for PM_{10}, SO_2, O_3 and NO_2 in 2017.

Figure 2. Distribution of yearly average data coverage for PM_{10}, SO_2, O_3 and NO_2 in the WB countries reporting to Eionet, 2017.



Source: Eionet [20]

Figure 3. Distribution of hourly average data coverage for SO_2 and $PM_{2.5}$ in the WB countries reporting to Eionet, 2012-2017.



Source: Eionet [20]

The annual average data coverage differs significantly among WB countries. The average data coverage of PM_{10} for the single monitoring stations ranges from 12.4% in Albania to 99.5% in North Macedonia. As for SO_2 reporting, the average data coverage for the single stations ranges from 18.4% in Albania to 99.6% in

(13) Data Coverage in Eionet - Proportion of valid measurement included in the aggregation process within averaging period, expressed as percentage. If Data Coverage < 75% for averaging period of a year, annual statistics should not be included in air quality assessments, if Data Coverage < 85% (in a year), annual statistics should not be included in compliance checks (https://www.eea.europa.eu/data-and-maps/data/agereporting-8/estatistics)

Serbia. Albania average data coverage for yearly average of both PM_{10} and SO_2 is below the 75% criterion in all stations. The NO_2 yearly average data coverage is coherent with the Eionet threshold in the majority of the stations. A wide range of variation in this pollutant was found among the monitoring stations in North Macedonia and Albania. The lowest average data coverage for the O_3 yearly average reporting was observed in one monitoring station in Montenegro (12.4%) and in Kosovo while the station with the highest data coverage was in Bosnia and Herzegovina (99.9%). This country and Serbia presented acceptable data coverage for all the pollutants.

Figure 3 shows the hourly data coverage (average, maximum and minimum) in the different monitoring stations of the WB countries for $PM_{2.5}$ and SO_2 between 2012 and 2017. The average data coverage has improved in North Macedonia, Serbia and Bosnia and Herzegovina while data coverage remained low for both SO_2 and $PM_{2.5}$ in Albania. Kosovo changed the stations used for reporting and since 2015 only one station is available, which in 2017 showed the lowest country average hourly $PM_{2.5}$ coverage.

3.2 Air pollutant emissions reporting

The Western Balkans countries (except Kosovo) are among the 51 parties of the Convention on Transboundary Air Pollution (CLRTAP). They have a reporting obligation under the Article 8 of Convention on Transboundary Air Pollution (CLRTAP) [21]. It includes the associated protocols [113] on pollutants covered by the NECD: SO_2, NOX, NMVOC, NH_3, other pollutants (CO), particulate matter (PM_{10}, $PM_{2.5}$, TSP and black carbon (BC), priority heavy metals (Pb, Cd and Hg), other heavy metals (As, Cr, Cu, Ni, Se and Zn) and POPs, polycyclic aromatic hydrocarbons (PAHs), dioxins (PCDD/PCDF) and polychlorinated biphenyls (PCBs). Emission inventory reporting covers all years from 1990 to n-2 (2000 onwards for PM). Projections should be reported for NOx, NMVOC, SOx, NH_3 and BC (where appropriate).

In accordance with the CLRTAP Executive Body's Decision 2002/10 [114] on emission data reporting under the Convention and the Protocols in force, countries are obliged to report on air emissions in line with the Emission Reporting Guidelines and methodology described in the EMEP/EEA Emission Inventory Guidebook 2016. The reporting of annual emissions under the CLRTAP requires the preparation of (i) Nomenclature for Reporting (NFR) format (emission inventory) and (ii). Informative Inventory Report (IIR).

Albania, Serbia and North Macedonia are reporting regularly under the CLRTAP scheme. By September 2019 Albania had reported the data related to the NFR2019 covering the period 1990-2017, whereas North Macedonia and Serbia had also submitted the IIR 2019. The most recent IIR for Albania was submitted in 2018. The last IIR of Montenegro was submitted in 2013 reporting data of 2011.

Bosnia and Herzegovina does not have an air pollutant emissions inventory. Although the country joined the CLRTAP in 2003 it has not ratified the PRTR. In the FBiH there are no official estimates of main air pollutant emissions after 2005 whereas estimates of emissions of main air pollutants in the Republic of Srpska are being developed by the Republic Hydrometeorological Institute (RHMI), according to the EMEP/EEA Guidelines. An estimation of the main air pollutants emissions for Bosnia and Herzegovina, covering the period 2005-2014 and projections for 2020, was completed by the Centre on Emissions Inventories and Projections (CEIP) [115], allowing Bosnia and Herzegovina to comply with its emission reporting obligations in August 2019 [27].

Table 3. Performance of reporting on air pollutants emissions in WB region, 1990-2016[14] (units = percentage).

	NOx	NMVOC	SOx	NH3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
AL	96.3	96.3	96.3	96.3	58.8	94.1	17.6	n.a	96.3
RS	100	100	100	100	100	100	100	100	100
ME	81.5	81.5	81.5	81.5	70.6	70.6	5.9	n.a	81.5
MK	100	100	100	100	100	100	100	n.a	100

Source: CLRTAP [21]

([14]) In the case the performance for a selected pollutant is below 100 it means that the estimation covers the difference.

The reporting performance under the CLRTAP obligations is presented in Table 3. Only Serbia and North Macedonia reached the highest performance for the period 1990-2016. Albania ranks in third place about NOx, NMVOC, SOx, NH_3, PM_{10}, TSP and CO reporting whilst it lags behind in $PM_{2.5}$ reporting.

3.3 GHG emissions reporting

All WB countries (except Kosovo) have ratified the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the Paris Agreement. National inventories for GHG and other pollutants are used by WB countries in their official reporting under the international policy commitments. National GHG inventories are structured according to the reporting format used by the UNFCCC [116]. GHG inventories are compiled based on the 2006 guidelines of the Intergovernmental Panel on Climate Change (IPCC) [117]. The UNFCCC publishes the national GHG inventories via their database and as the original reporting tables.

Table 4. Most recent year of GHG emissions reported through national communications and updated reports to UNFCCC.

	AL	RS	ME	MK	BA
National Communications & Updated Reports	2009	2014	2015	2014	2013

WB countries have started to develop national Monitoring, Reporting and Verification (MRV) systems as stipulated in the Regulation (EU) 525/2013. However, the establishment of such systems is still at an early stage (see Fig. 1).

Albania prepared a National GHG Emission Inventory in 1998 and completed it in 2001 [118]. The baseline inventory used was that of 1994. Reporting on CO_2 emissions from fossil fuels was available for period 1990-1994. The 3rd National GHG Emissions Inventory of June 2016 [119] covered the time-series for the period 2000 – 2009, using 2005 as base year. A 4th Albanian national GHG Emissions Inventory is under preparation.

Even though Kosovo in not a Party to the UNFCCC, the Kyoto Protocol and the Paris Agreement, the country has developed a GHG emission inventory for 2008-2015. The methods used for calculating of the GHG emissions in Kosovo are in accordance with the Revised IPCC 1996 Guidelines for National Greenhouse Gas Inventories and the IPCC 2006 Guidelines. The Kosovar Environmental Protection Agency (KEPA), collects and prepares the data records by reference year. However, Kosovo has neither prepared a register of sources and emissions of GHGs, nor identified the base year from which GHG emissions will be estimated [62]. Kosovo has developed a GHG inventory covering the periods 2008-2009, 2008 - 2013 and 2012-2014. The 2015 inventory, using 2006 IPCC guidelines, has also been finalised. A GHG inventory report for 2016 is under development and is expected to be published by the end of 2019 [26].

In 2010 the Republic of Serbia adopted and submitted to the UNFCCC its Initial National Communication (INC) [120]. The 1st Biennial Update Report (FBUR) [121] under the UNFCCC was submitted in 2016 and in 2017 Serbia submitted the 2nd National Communication [122] under the UNFCCC. However, all the data for the period 1990-2014 are not available in this document. In this communication the data on GHG emissions with interval of 5-yr are reported until 2010 while for the period 2011-2014 yearly data are reported. The MRV system in Serbia is expected to become operational by 2019.

Montenegro ratified the UNFCCC in 2006, and thus became a non-Annex-1 party to the Convention on 27th of January 2007. The Kyoto Protocol was ratified on 27th of March 2007, and Montenegro became a non-Annex-B party on 2nd of September 2007. Montenegro has so far submitted two national communications (2011 and 2015). The 1st Biennial Update Report [123] was prepared and submitted to the UNFCCC Secretariat in January 2016 and the second report was submitted in April 2019 [124]. The Law on the Doha amendment to the Kyoto Protocol to the UNFCCC was adopted in October 2018. The adoption of a climate change law which, among others, incorporates elements of the EU Emissions Trading System (ETS), the Effort Sharing Regulation and the monitoring and reporting mechanism (MRM), is still pending.

North Macedonia became part of UNFCCC in 1997 and ratified the Paris Agreement in November 2017. In 2018 the country submitted its 2nd Biennial Update Report on Climate Change to the UNFCCC [125]. A 4th

National Communication and the 3rd Biennial Update Report to the UNFCCC are in preparation. North Macedonia has already a portal on the climate change information[15].

In 2010, BiH submitted its Initial National Communication [126] to the UNFCCC Secretariat. In 2013 the 2nd National Communication [127] under the UNFCCC was adopted and forwarded to the Secretariat of the Convention. The 1st Biennial Update Report [128] on GHG emissions was submitted in 2014. The 3rd National Communication, including even the 2nd Biennial Update Report [129], on GHG emissions was submitted in 2017 covering periods 2009-2009 and 2013-2013 having 1990 as baseline.

A GHG emissions inventory is under preparation in the Republic of Srpska. At present, the inventory for the energy and industry sectors in the period 2002-2016 is being finalised and awaiting to be published. The publication of these results is foreseen for the end of 2019. The law on Air Protection of Republic of Srpska aims to harmonise the legislation with the EU *acquis* in the area of greenhouse gas (GHG) inventory and reporting and in the implementation of the Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol on Substances that Deplete the Ozone Layer and amendments.

(15) www.klimatskipromeni.mk

4 Atmospheric pollution in the WB region

All countries in the WB region monitor air pollutants according to the EU standards defined in the Ambient Air Quality Directives (AAQD): Directive 2008/50/EC [35] and Directive 2004/107/EC [37]. The air quality standards lay down by the AAQD are shown in Annex 3.

Table 5 shows the EU legally binding air quality limits as transposed by the WB countries. In Kosovo the limit for ozone is related only to the 1h max (100 µg/m^3) concentration. In Serbia: (i) the 1h limit value for SO_2 is more tolerant that the respective EU limit; (ii) there is a 1Yr limit value of 50 µg/m^3 for SO_2; (iii) the limit value for NO_2 is stricter than the respective EU limit; and (iv) there is a 1Yr limit value of 85 µg/m^3 for NO_2. In Republic of Srpska: (i) the limit value for NO_2 is stricter than the respective EU limit and (ii) the target value for O_3 has not been yet set.

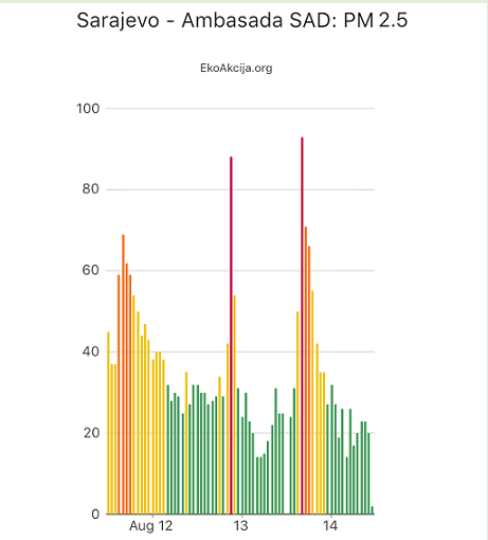
Table 5. Air Quality Standards in the WB countries compared to the EU legislation. Limit values different form EU marked in red.

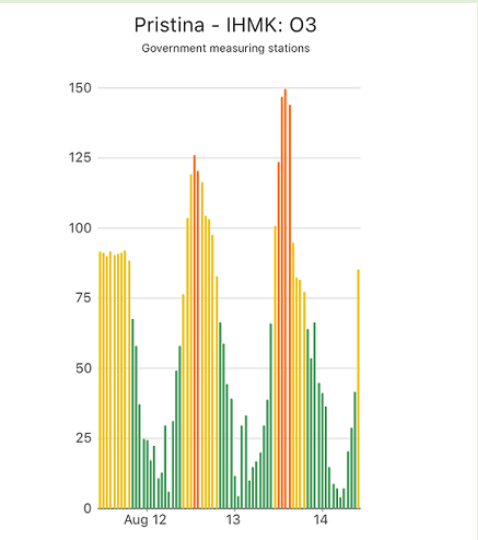
Air pollutant	Mean	EU	AL	XK	RS	ME	MK	FBiH	Rep. Srpska	Brčko District
SO_2	1h	350	350	350	500	350	350	350	350	250-500
	24h	125	125	125	125	125	125	125	125	125
	1 Yr				50			50	50	
NO_2	1h	200	200	200	150	200	200	200	150	200-300
	24h				85			85	85	80-120
	1 Yr	40	40	40	40	40	40	40	40	40-60
O_3	8h	120	120	120	120	120	120	120		120
	1h									
PM_{10}	24h	50	50	50	50	50	50	50	50	50-75
	1 Yr	40	40	40	40	40	40	40	40	
$PM_{2.5}$	24h	25	25	25		25	25			
	1 Yr	20	20	20	25	20	20	25	25	

JRC elaboration

Box 1. An app for citizen access to air quality data in the WB

Air Care app was released in 2014 (born as *MojVozduh*) displaying information from available public data. AirCare app uses data from the official measuring stations that are installed in Balkans. The information and data cover nine Balkan countries: North Macedonia, Albania, Bosnia and Herzegovina, Montenegro, Croatia, Serbia, Kosovo, Greece and Slovenia. The data are displayed in graphs and illustrate the situation within a 24h/48h/72h period. Air Care app provides raw hourly data for air pollutants in North Macedonia available for download from which one can deduct for example how many days have PM_{10} particle levels above the limit set by the EU in the country. Data sources are the official air quality monitoring networks, the Luftdaten network, EkoAkcija.org network, U.S. Department of State network, and Pulse.eco network.

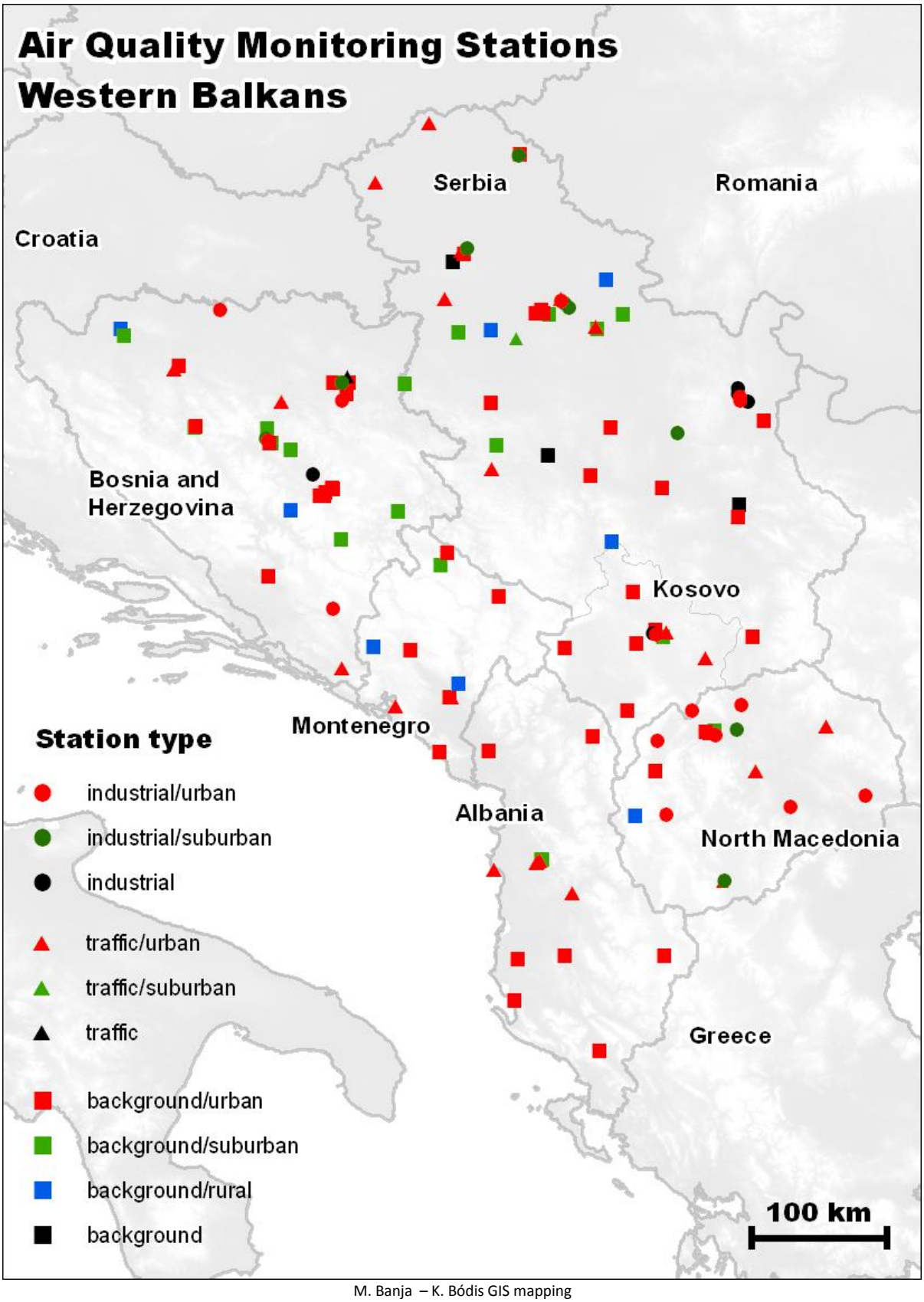




Prepared by M. Banja *Source Air Care (https://theair.app)*

There are 134 air quality monitoring stations in the WB. Figure 4 displays them according to their typology. There are 75 background stations (urban, suburban and rural), 32 industrial stations (urban, suburban and rural) and 27 traffic stations (urban and suburban).

Figure 4. Air Quality Monitoring Stations in the WB region by typology.

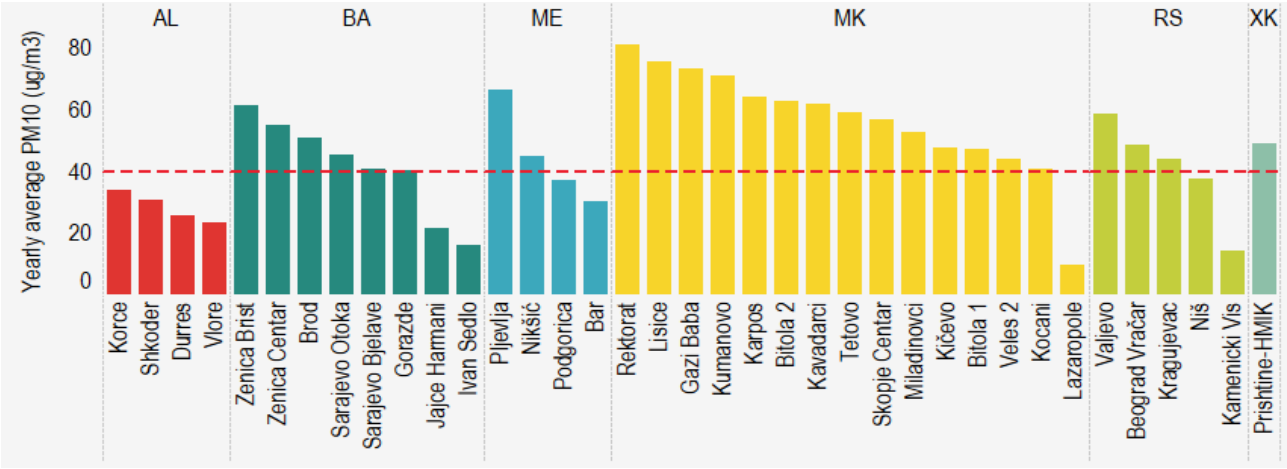


M. Banja – K. Bódis GIS mapping

Unless specified, the analysis of main air pollutants concentrations in the WB region presented in this section **is based on the reporting by countries to the Eionet** (see Table 2 for air pollutants reporting). Data on air pollutants levels provided by the air quality national reported of these countries can be found in the analysis of the single WB countries which is available in a companion technical report (Banja et al., in preparation).

As explained in section 3.1, the threshold of minimum 75% data coverage is applied to the Eionet data in the following analysis. The only exception are the Albanian data included even if falling under this threshold with the caveat that they may not reflect the full year situation and therefore are not fully comparable with the other countries. Figure 5 illustrates the average annual concentrations of PM_{10} in air quality monitoring stations in WB countries as reported to the Eionet by 20th of June 2019. As shown in the figure, the annual PM_{10} level is above the limits set in the legislation in almost all WB countries except Albania. The highest concentrations and the largest number of stations with values above the limits are found in North Macedonia, especially in Skopje, Lisice and Kumanovo sites.

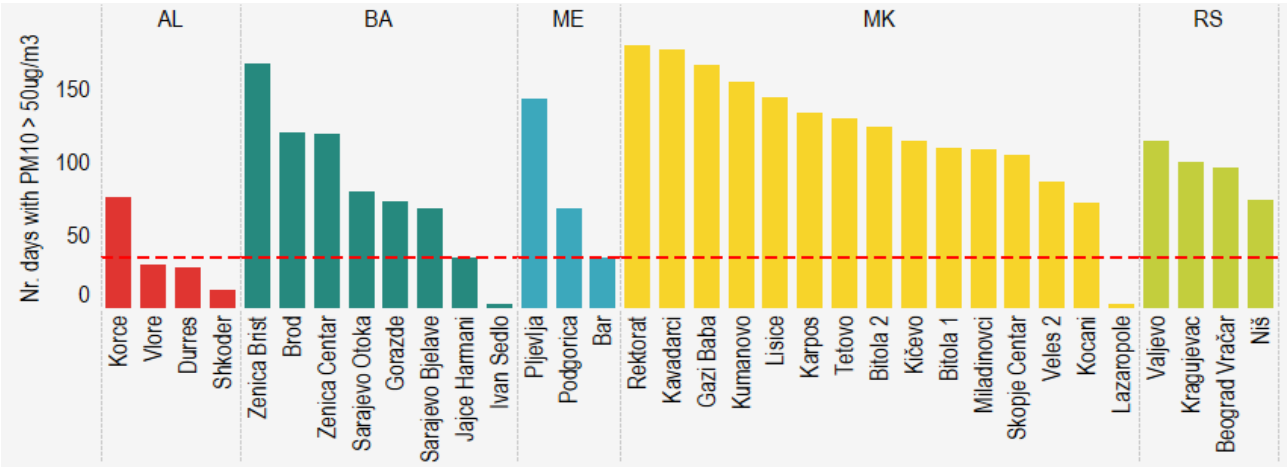
Figure 5. Yearly average PM_{10} concentration (aerosol) in the WB region, 2017. Dotted line = limit value.



Source: JRC elaboration of Eionet data

The daily PM_{10} is above the limit in most of the stations reporting to Eionet (Fig. 6). The highest number of days above the limit of 35 days with PM_{10} concentration higher than 50 µg/m^3 has been found in North Macedonia. A downward trend of this indicator has been observed in almost all the stations reported to Eionet. In Pristina station the number of days with PM_{10} concentration above 50 µg/m^3 almost halved, from 122 days in 2013 to 61 days in 2017. In Skopje Centar station the number of days with PM_{10} concentration above the 24h limit decreased from 168 days in 2013 to 105 days in 2017.

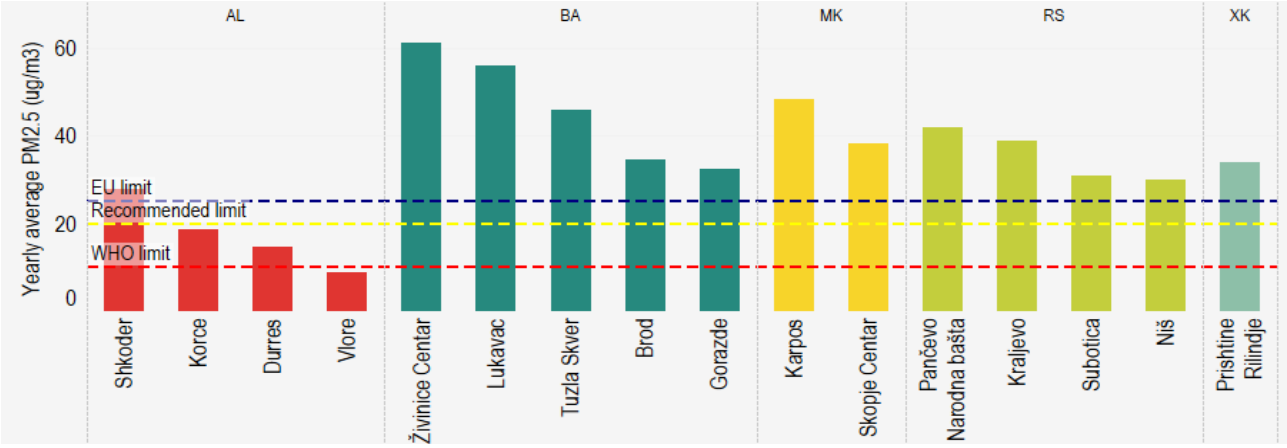
Figure 6. Number of days in the WB region with PM_{10} concentration above 50 µg/m^3, 2017. Dotted line = limit nr. of days.



Source: JRC elaboration of Eionet data

The $PM_{2.5}$ annual average is above the limit of 25 µg/m^3 in the majority of the WB air quality stations reporting to Eionet for 2017. The highest 2017 average yearly level of $PM_{2.5}$ was reported for Živinice Centar (BA) station, 61.3 µg/m^3 (Fig. 7). Moreover, concentrations are above the WHO annual limit of 10 µg/m^3 in all stations except Vlora (AL) station.

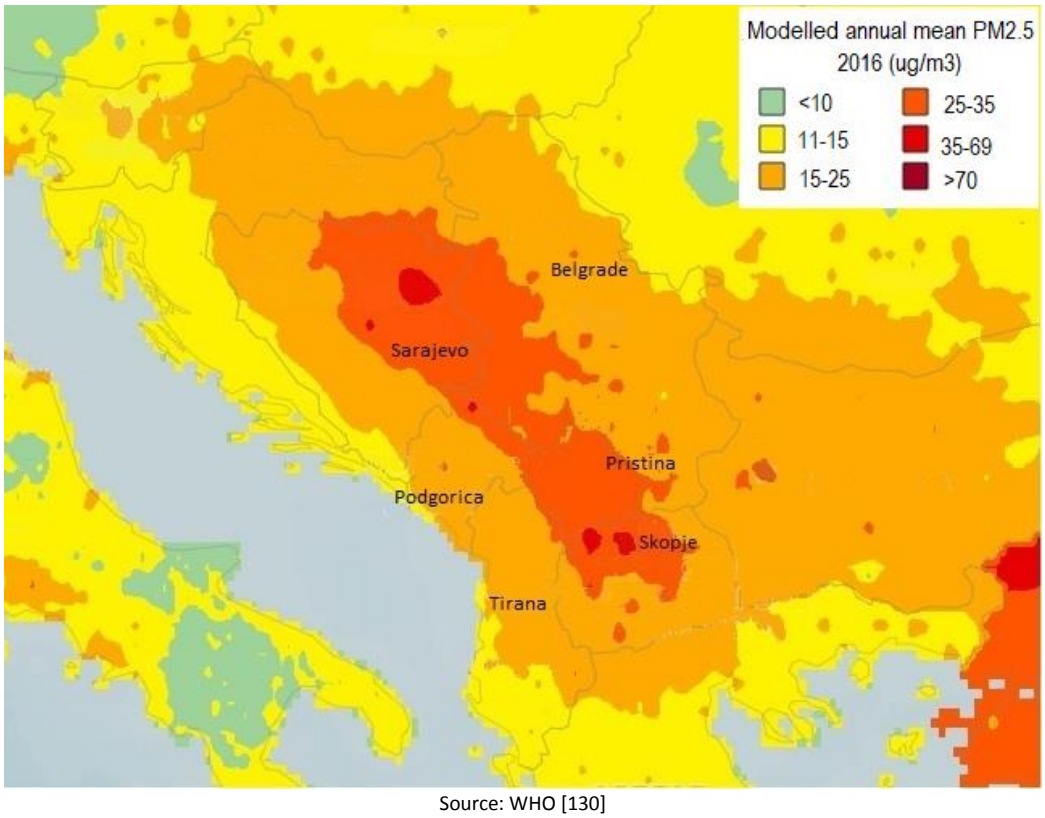
Figure 7. Yearly average $PM_{2.5}$ concentration (aerosol) in the WB region, 2017.



Source: JRC elaboration of Eionet data

Between 2014 and 2017 the $PM_{2.5}$ annual concentration for Shkoder (AL) more than doubled. Karpoš (MK) continues to report the highest hourly maximum $PM_{2.5}$ concentrations. Over the period 2014-2017 the hourly maximum $PM_{2.5}$ concentration reported at this station has increased by 60%; in 2017 the $PM_{2.5}$ hourly maximum concentration was 682 µg/m^3. In Skopje Centar (MK) this pollutant increased by 65% over the above-mentioned period, the hourly maximum $PM_{2.5}$ concentration reported for 2017 was 592 µg/m^3. Tuzla Sever (BA) reported in 2017 the second highest hourly maximum $PM_{2.5}$ concentration, at 659 µg/m^3.

Figure 8. Modelled annual mean concentration of $PM_{2.5}$ in the WB region, 2016.

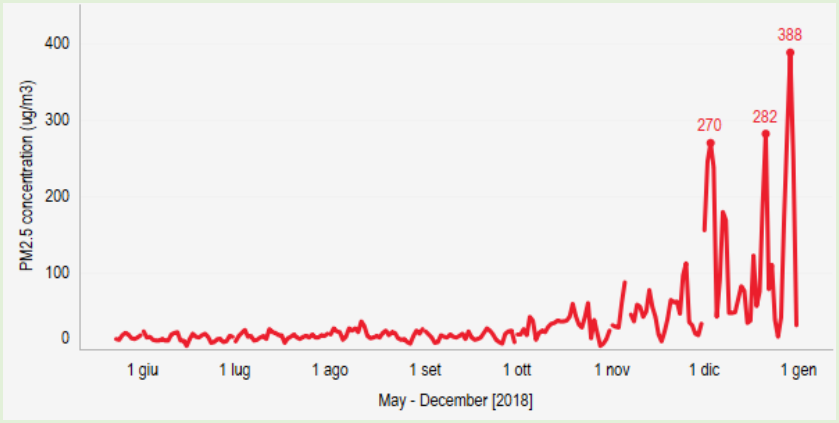


Source: WHO [130]

Figure 8 illustrates the modelled annual mean $PM_{2.5}$ concentrations for year 2016 using the Data Integration Model for Air Quality (DIMAQ) in combination with ground measurements [130]. The combination of models and measurements provides a map where it can be observed the spatial distribution of this pollutant in WB region and the areas with the highest concentrations located at the centre of the region. The area with $PM_{2.5}$ concentrations above the recommended air quality limits and beyond the WHO limit spreads over all the countries.

Box 2. High $PM_{2.5}$ pollution episodes in Sarajevo

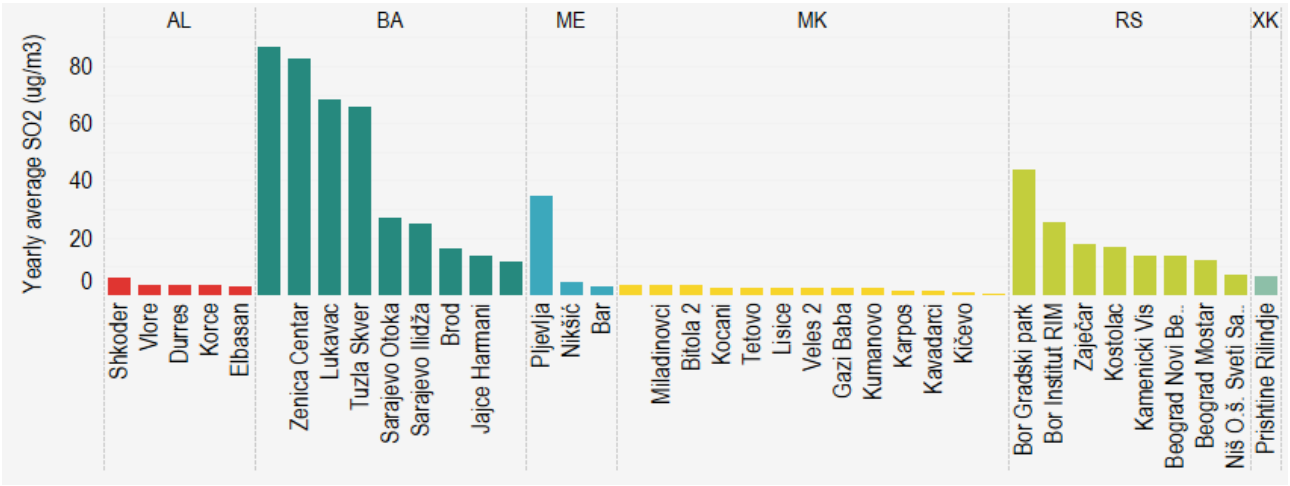
The U.S. Embassy in Sarajevo monitors the fine particulate matter $PM_{2.5}$ concentration as an indicator of air quality in downtown Sarajevo since May 2018. The monitoring results are available at the U. S. Environmental Protection Agency's Air Now website (https://airnow.gov/) in the form of the Air Quality Index (AQI). The data are also reported in the Annual Report on the Air quality in the Federation of Bosnia and Herzegovina [131]. In 2018 (with 61% of measurements coverage) the maximum hourly value of $PM_{2.5}$ measured in this station was 567 µg/m^3; the maximum 24h value was 388 µg/m^3 while the average annual concentration was 38 µg/m^3. In the period May-December 2018 there were 15 days with $PM_{2.5}$ concentrations higher than 100 µg/m^3.



Also, in Pristina the U.S. Embassy in Pristina monitors the fine particulate matter $PM_{2.5}$ since March 2016.

Prepared by M.Banja *Source: FBiH AQ Report, 2018 [131]*

Figure 9. Yearly average concentration of SO_2 in the WB region.

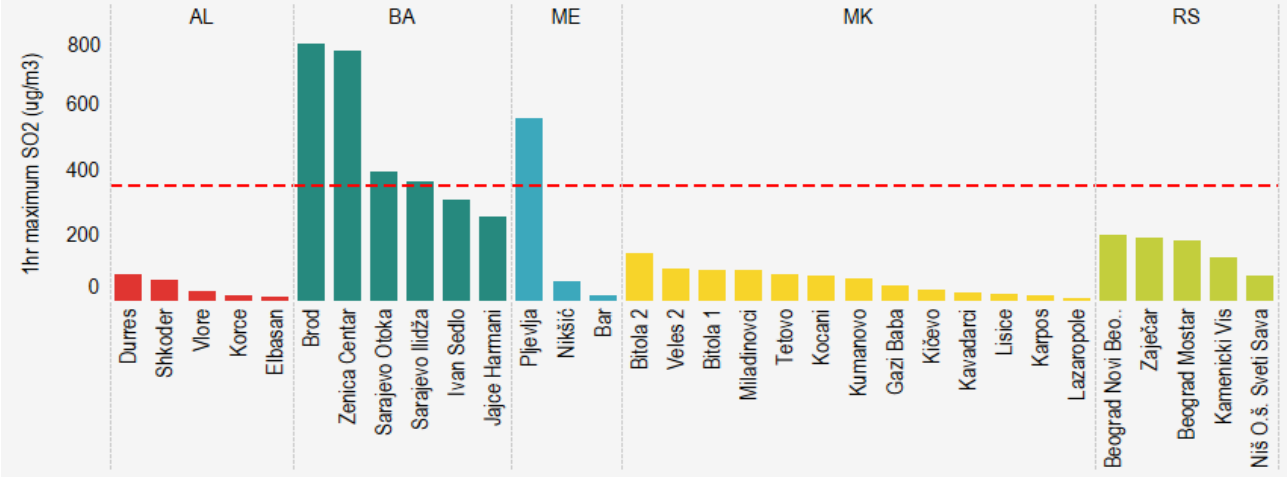


Source: JRC elaboration of Eionet data

The annual and hourly maximum concentrations of SO_2 in the WB region in 2017 reported to Eionet are shown in figures 9 and 10 respectively. The daily maximum levels were above threshold of 125 µg/m^3 almost

all the stations of Bosnia and Herzegovina. Also, concentrations in Pljevlja (ME) and in three Serbian stations situated in Bor and Kostolac were above the limit. As shown in Table 5, Serbia and Bosnia and Herzegovina have introduced also a yearly limit of 50 µg/m^3 for this pollutant. The 2017 data analysis shows that levels in four stations in Bosnia and Herzegovina: Živinice Centar, Zenica Centar, Lukavac and Tuzla Skver were above this threshold. The hourly maximum SO_2 concentrations were above the 350 µg/m^3 level in several reporting stations in Bosnia and Herzegovina and Pljevlja in Montenegro (see Fig. 10). Zenica Centar (BA) had 39 periods of three consecutive hours with SO_2 concentration above 500 µg/m^3 in 2017 and a total of 310 hr with concentrations above 350 µg/m^3. In Lukavac (BA) and Tuzla Skver (BA) were observed 185 hr and 175 hr with SO_2 concentrations above this threshold, respectively.

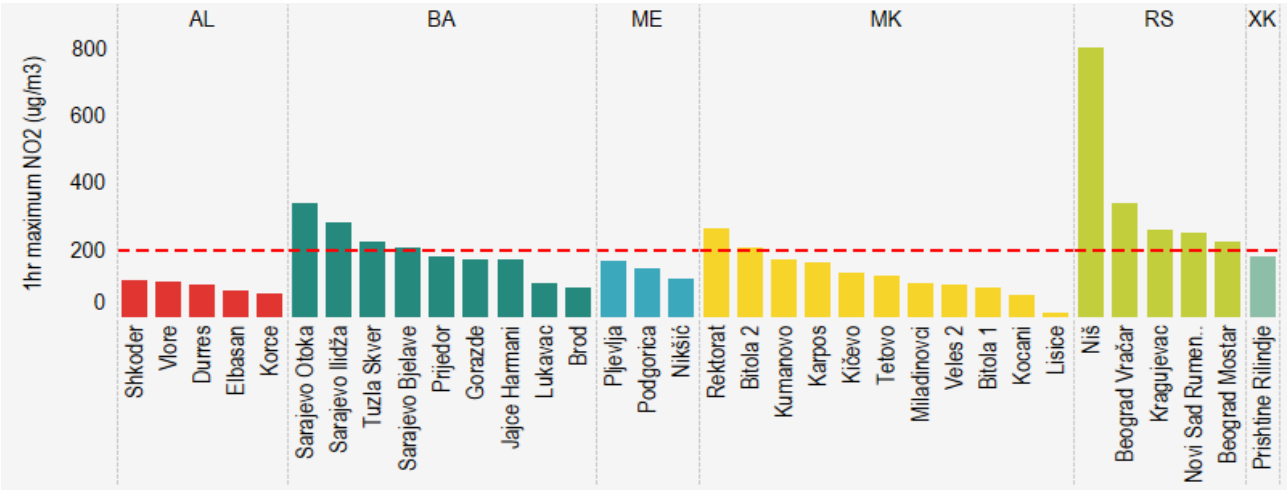
Figure 10. Hourly maximum SO_2 concentration in the WB region, 2017. Dotted line = limit value.



Source: JRC elaboration of Eionet data

In 2017, the highest hourly maximum NO_2 concentration of 800 µg/m^3, four times higher than the limit of 200 µg/m^3 was measured at Niš (RS) (Fig. 11). In 2016 this station also recorded the highest hourly maximum NO_2 concertation of 532 µg/m^3. Beograd Vračar reported the second highest hourly maximum NO_2 concentration in 2017, at 340 µg/m^3. In the same year in this station the NO_2 levels were above the hourly limit for 80 hours.

Figure 11. Hourly maximum NO_2 concentration in the WB region, 2017. Dotted line = limit value.



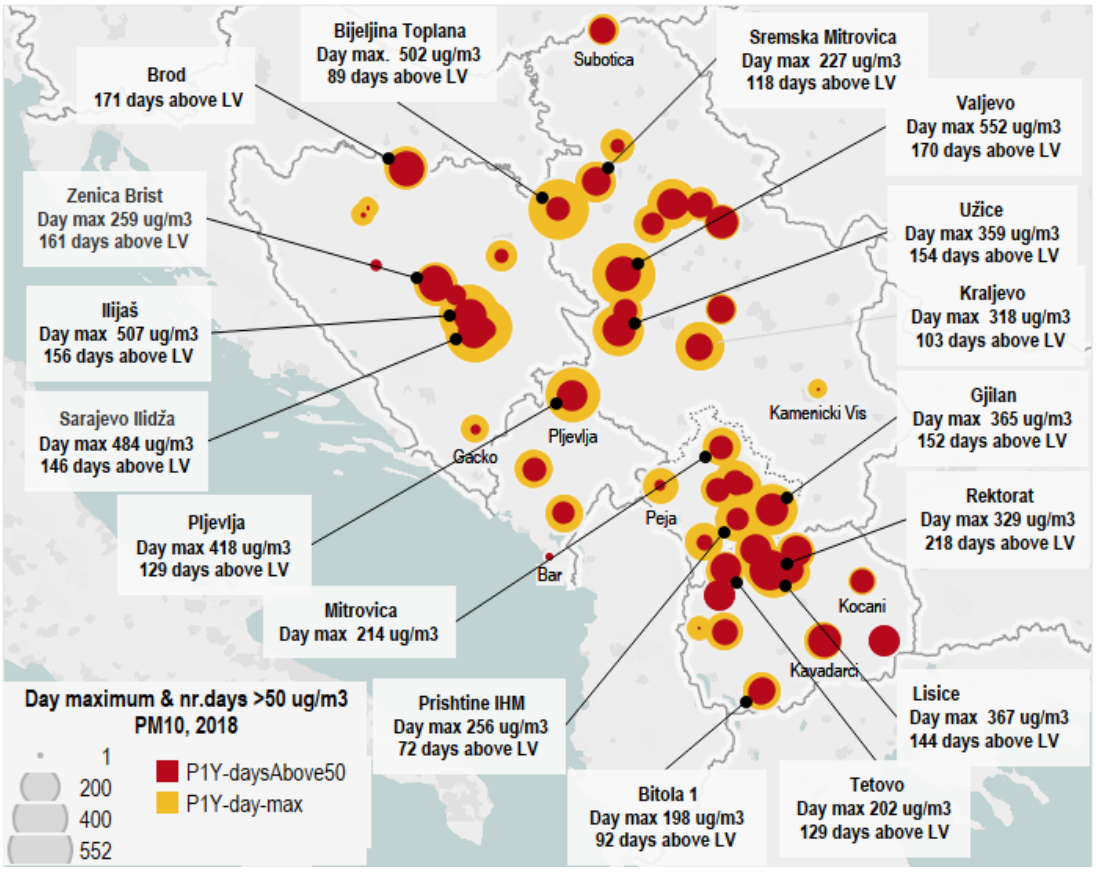
Source: JRC elaboration of Eionet data

Figure 12 illustrates the daily max (8h) of ozone concentration in WB region in 2017. The 8h values in all the WB stations were above the target value of 120 µg/m^3, except Kosovo. The highest 8h value, equal to 202 µg/m^3, was measured in Sarajevo Ilidža (BA) which is well above the target value. There were several regional scale episodes with high levels of O_3 in 2017, caused by the heat wave that hit the southern part of Europe including the Balkans [19].

Figure 12. Daily 8h maximum O_3 concentration in the WB region, 2017. Dotted line = target value.

Source: JRC elaboration of Eionet data

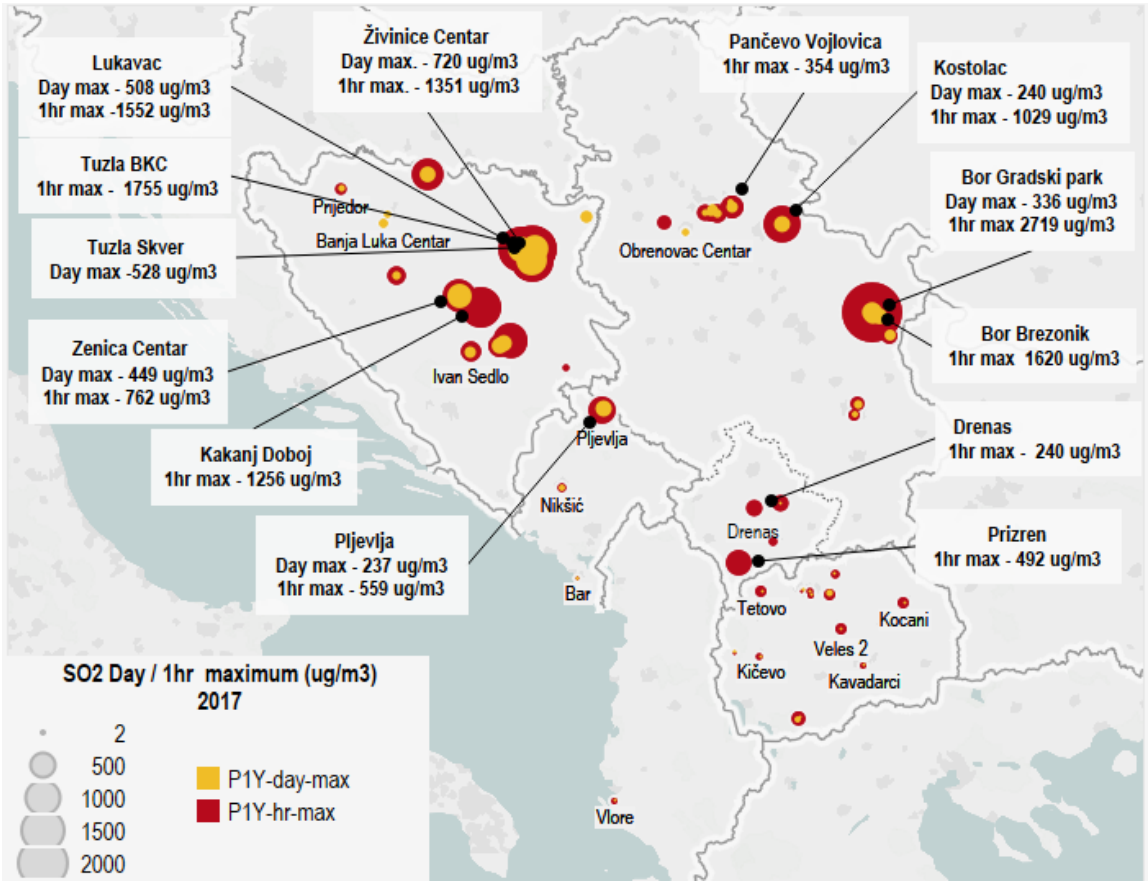
Figure 13 (a). Daily maximum PM_{10} concentration and nr. days above the limit value, in WB, 2018[16]..



Source: Eionet [20] and WB AQ National Networks

([16]) A threshold of 50% data coverage is applied. Because the average data coverage of Albania was below the threshold of 50% this country is missing in Figure 13a

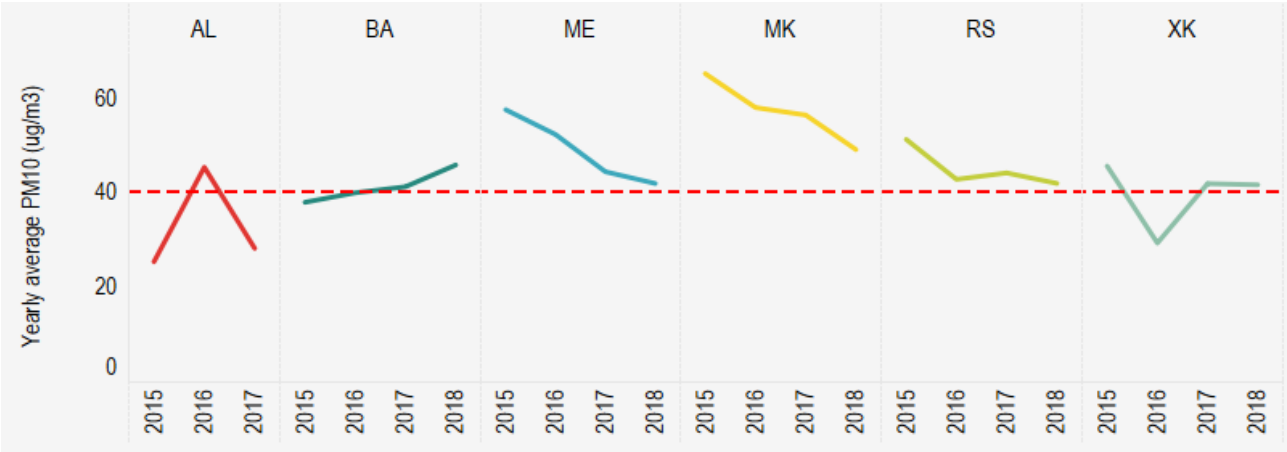
Figure 13 (b). Hourly maximum SO_2 concentration and nr. days above the limit value, in the WB, 2018[17]



Source: Eionet [20] and WB AQ National Networks

Figure 13 (a) shows the spatial distribution of the daily maximum PM_{10} concentrations and the number of days with PM_{10} above the limit value of 50 µg/m^3 in 2018. The daily PM_{10} levels were above the limit value in several sites located in almost all of the WB countries and the number of days with PM_{10} concentrations above 50 µg/m^3 was considerable. Similarly, in Figure 13 (b) is displayed the spatial pattern of the daily and hourly maximum SO_2 concentrations. The sites with very elevated hourly SO_2 concentrations are in Serbia, Bosnia and Herzegovina, Montenegro, and Kosovo.

Figure 14 (a). Trend of yearly average PM_{10} concentrations in the WB region countries in the latest years[18]



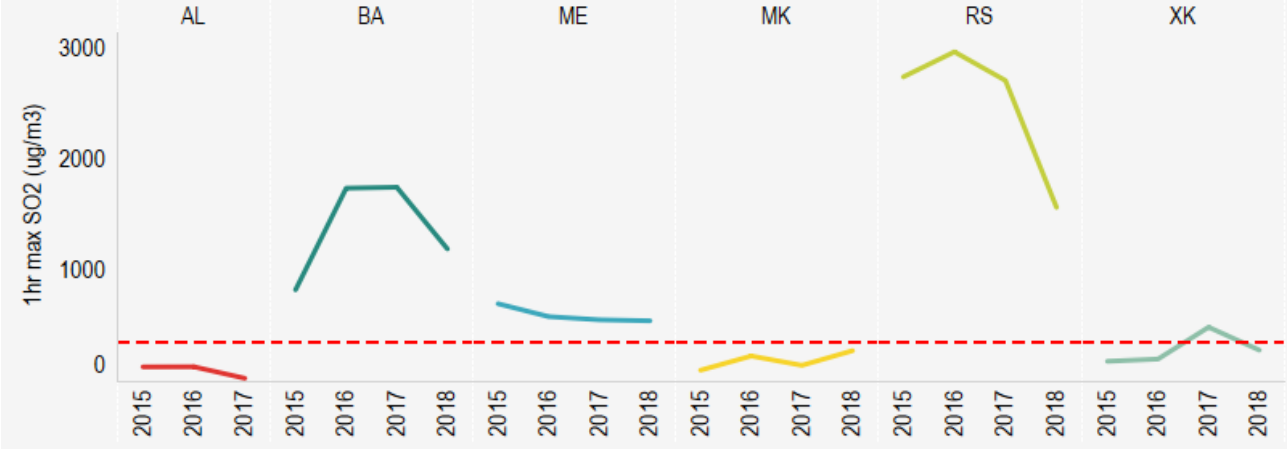
Source: JRC elaboration of Eionet & WB countries AQ Networks data

([17]) . A threshold of 50% data coverage is applied.

([18]) For 2018 local stations from: Serbia (18), North Macedonia (17). Bosnia and Herzegovina (24) and Kosovo (11) were used with a 50% data coverage threshold. No value shown for Albania in 2018 due to the low average data coverage.

In Figure 14 are depicted the 2015-2018 trends for the annual indicators of some pollutants in the latest years on the basis of the data provided by the Eionet and local AQ networks. Even though a decreasing trend of PM_{10} concentrations is observed in Figure 14 (a) in most of the WB area, with the exception of Bosnia and Herzegovina, the levels of this pollutant are above the LV in in the majority of cases.

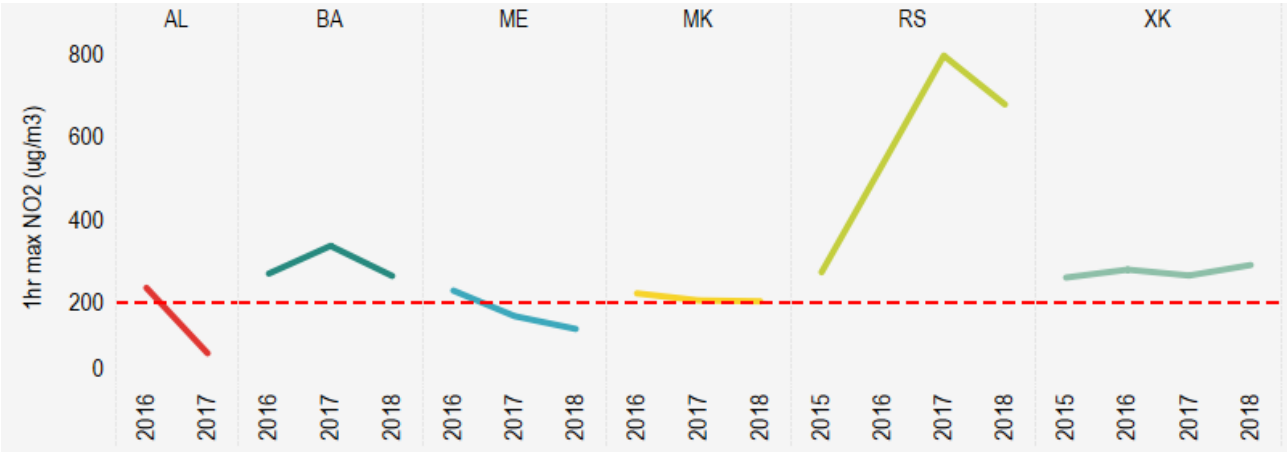
Figure 14 (b). Trend of hourly maximum SO_2, in the WB region in the latest years[19].



Source: JRC elaboration of Eionet & WB countries AQ Networks data

In Figures 14 (b) and (c), stable or decreasing trends are observed in most of the countries for SO_2 and NO_2, with the exception of North Macedonia and Serbia, respectively. However, the levels of SO_2 are persistently above the LV in Montenegro, Bosnia and Herzegovina and Serbia and the same is true for NO_2 in the latter two countries and Kosovo.

Figure 14 (c). Trend of hourly maximum NO_2 concentrations in WB region countries in the latest years[20]



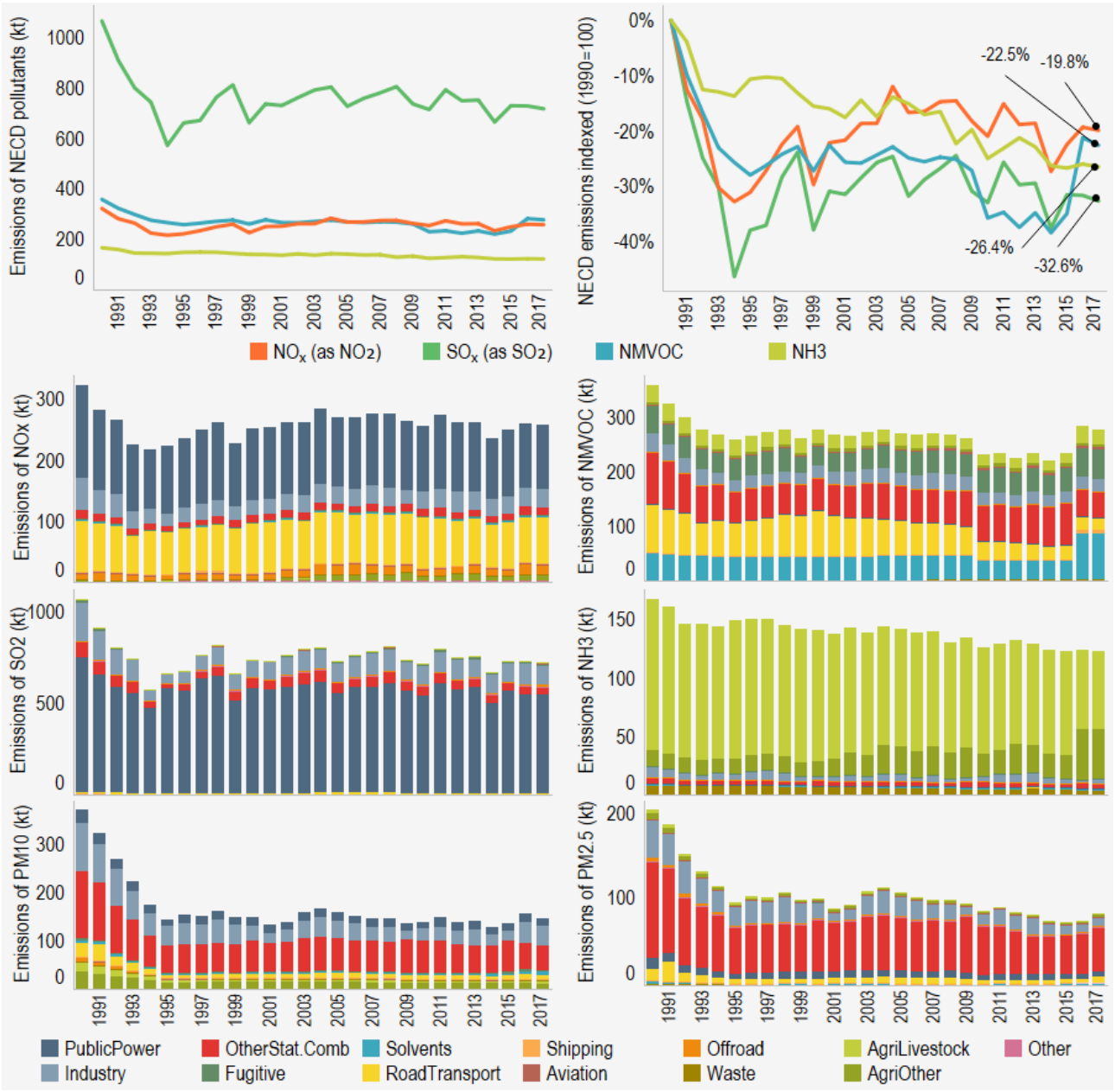
Source: JRC elaboration of Eionet & WB countries AQ Networks data

([19]) For 2018 local stations from: Serbia (16), North Macedonia (13). Bosnia and Herzegovina (22), Kosovo (9) and Montenegro (5) were used with a 50% data coverage threshold. No value shown for Albania in 2018 due to the low average data coverage.
([20])For 2018 local stations from: Serbia (8), North Macedonia (14). Bosnia and Herzegovina (19), Kosovo (10) and Montenegro (5) were used with a 50% data coverage threshold. No value shown for Albania in 2018 due to the low average data coverage.

5 Emissions of atmospheric pollutants in the WB region

The trend in emissions of NECD pollutants in the Western Balkans[21] region (without Kosovo, WB5)[22] the over period 1990-2017 and the relative changes compared with 1990 are presented in Figure 15. The largest decrease in SO_2, NO_2 and NMVOC emissions was observed in 1994. In 2017 the total SO_2 emissions[23] in the WB region were estimated at nearly 720 kt, a reduction of 33% compared to 1990. In the same year, the NO_2 emissions[24] were 259 kt, a reduction of 20% compared to 1990. 2017 emissions of NH_3 were estimated to be 123 kt, 26% below the 1990 level. NMVOC emissions, estimated at 279 kt in 2017, a reduction of 23% compared to 1990 levels. Emissions of PM_{10} are estimated to have reached 146 kt in 2017, a drop of 60% compared with 1990, whereas the $PM_{2.5}$ emissions were nearly 82 kt.

Figure 15. NECD pollutants emissions in WB region and relative change vs 1990 (up) – Breakdown by sectors (down), 1990-2017



Source: CLRTAP [21]

(21) Hereafter in this section referred as WB5 countries: Albania, Serbia, Montenegro, North Macedonia and Bosnia and Herzegovina

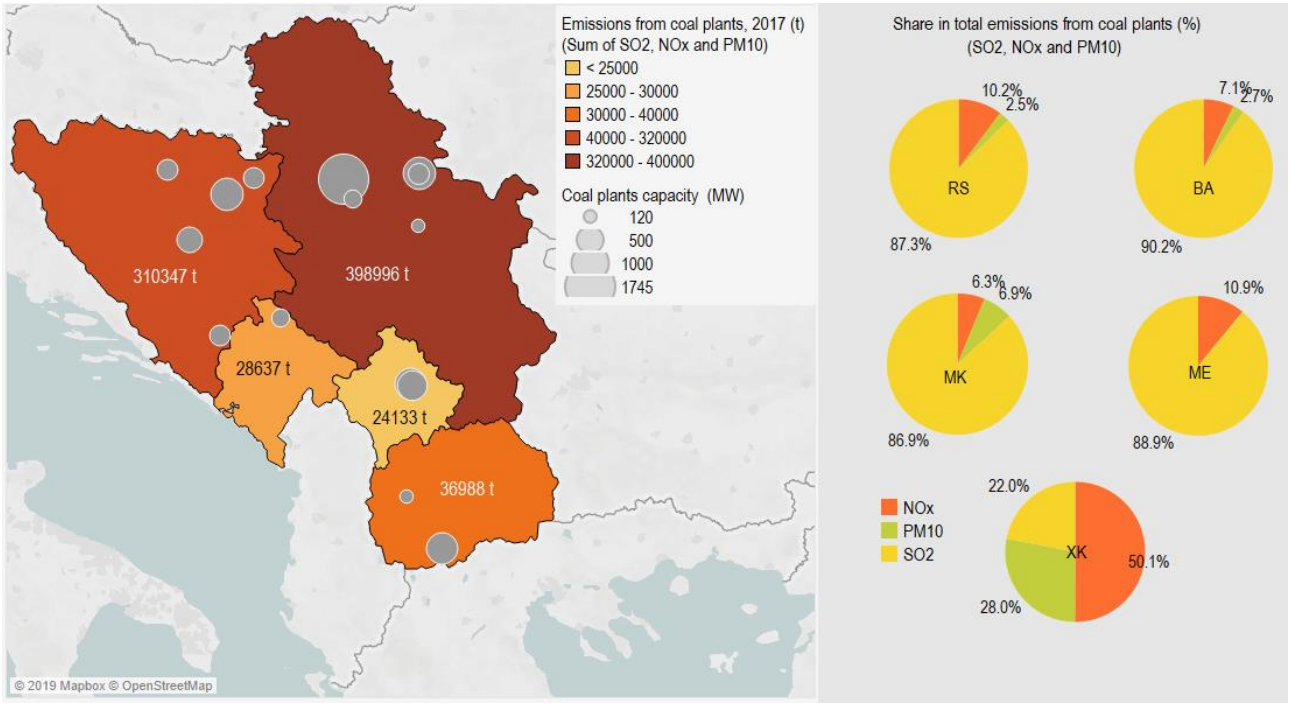
(22) Total emissions of main air pollutants (SO_2, NO_2, PM10, $PM_{2.5}$, CO, NH3 and NMVOC) in WB region (without Kosovo) for period 1990-2017 are presented here as provided by EMEP/CEIP 2018, Emissions as used in EMEP models, Terms of reference: CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/deed.en)

(23) The SO_2 emissions from Kosova A (PPA) and Kosova B (PPB) in 2017 resulted at 12 kt which brings the total emissions of SO_2 to nearly 732 kt.

(24) The NO_2 emissions from Kosova A (PPA) and Kosova B (PPB) resulted at 20 kt which brings the total emissions of NO_2 to nearly 279 kt.

There are 16 coal plants in the region emitting significant amount of pollutants such as SO_2, NOx and PM_{10}. According to a recent study under the Europe Beyond Coal campaign [132] average SO_2 and particulate matter (PM) emissions from these coal plants in the WB region were respectively 20 times and 16 times higher than the EU average for coal plants, for these pollutants. From the same study, the sum of SO_2 and $PM_{2.5}$ emissions from the 16 coal power plants (8.7 GW) in the WB were almost as high as the emissions from other 250 coal plants (156 GW) in the EU.

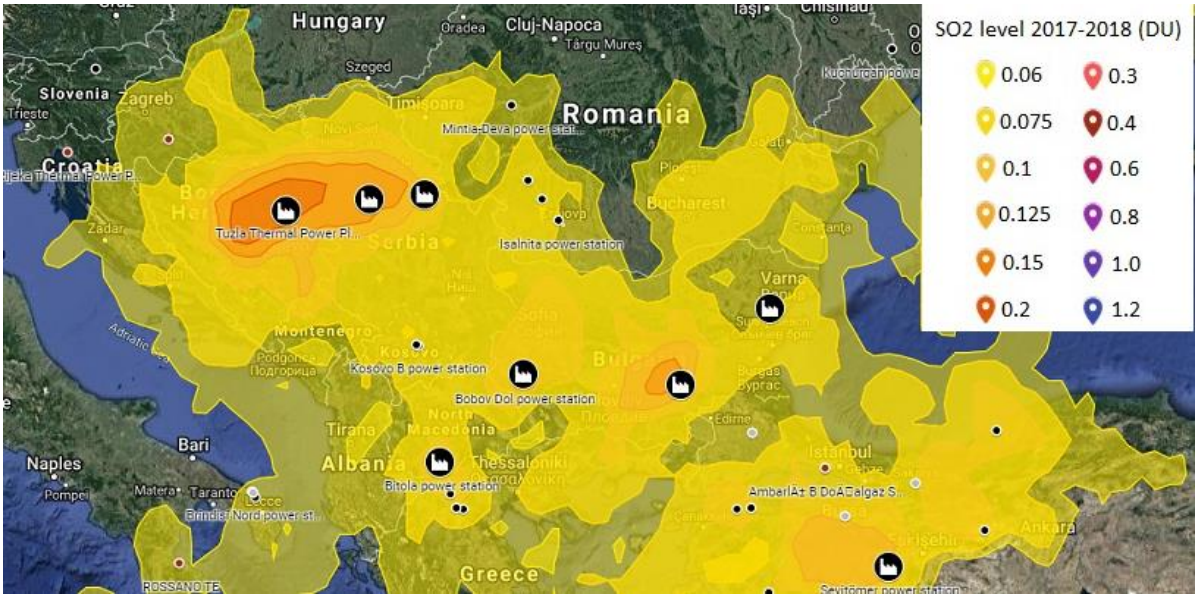
Figure 16. SO_2, PM_{10} and NOx emissions from coal plants in the WB region, 2017 (t).



Source: Europe Beyond Coal: European Coal Plant Database, 12 July 2019 [132]

Figure 16 illustrates the emissions of SO_2, PM_{10} and NOx from coal plants in the WB region. In 2017 the combined emissions from SO_2, PM_{10} and NOx summed up to 799 kt, which represents a drop of 45% (33 kt) compared with 2016, and were equal to nearly 2/3 of the corresponding emissions from coal plants in the

Figure 17. Distribution of SO_2 emissions from coal plants in the WB region, 2017-2018 (Dobson Units[25]).



Source: Greenpeace Environment Trust [133]

([25]) Dobson Unit (DU) measures the total number of molecules in a vertical column which is not the same as the concentrations at ground level

entire EU. In 2016 the PM_{10} emissions from coal plants in WB region were equal to nearly 95% of the PM_{10} emissions from all the EU coal plants. The highest emissions from the WB region coal plants are those of SO_2 which in 2016 exceeded by 16.5% the total SO_2 emissions from coal plants in the entire EU. In 2017 half of the SO_2 emissions from coal plants in the WB region were produced in Serbia. The contribution to the PM_{10} emissions is shared between Serbia (36%), Bosnia and Herzegovina (30%) and Kosovo (24%). In 2017 these emissions covered almost one-fifth of total PM_{10} emissions in the region. The release of NOx emissions from coal plants in the WB region was equal to almost 14% of the total emissions from all the EU coal plants. More than half of the NOx emissions from coal plants in the WB region was produced in Serbia. In 2017 coal plants produced 30% of the total NOx emissions in the region. Under the Industrial Emissions Directive (IED) Annex V Part A, the WB region countries should reach by 2028 [134] a reduction of 90%. 67.5% and 94%, respectively, for SO_2, NO_2 and $PM_{2.5}$ emissions from coal plans.

The high concentrations of SO_2 in Serbia and Bosnia and Herzegovina have been linked to emissions from thermal power plants using low quality lignite with a high sulphur content, as well as other industrial activities in the energy, food production, chemicals, and mining sectors (see Fig. 17). Serbia and Bosnia and Herzegovina are ranked 10^{th} and 13^{th} among the 37 top SO_2 emitters coal plants traced by NASA globally. The Nikola Tesla coal plant was ranked 9^{th} in 2018 among the 37 top coal plants emitting SO_2 while the Kostalac coal plant occupied the 34^{th} position in that list [133].

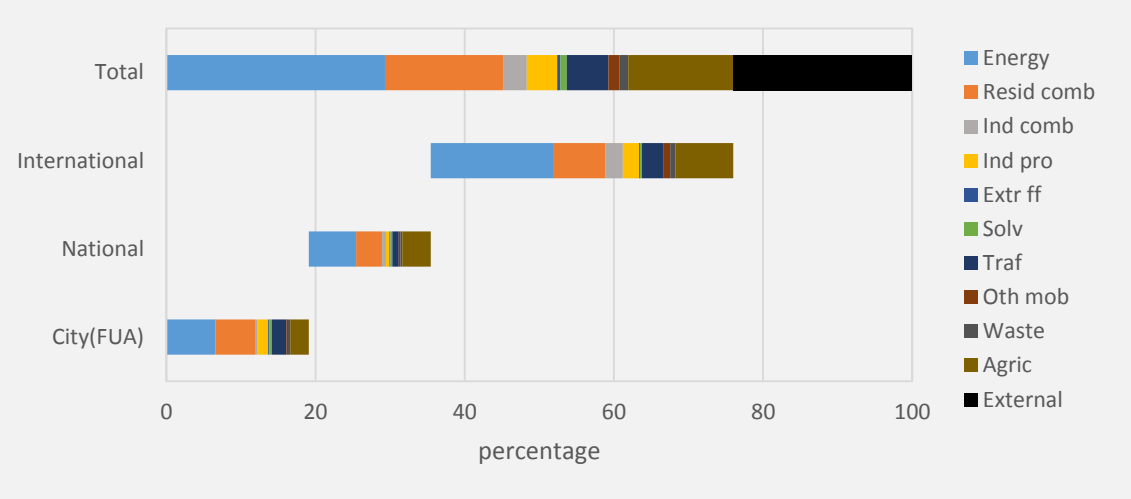
There are 48 Large Combustion Plants (LCPs) (with capacity >50 MW) in the WB region: 13 in Bosnia and Herzegovina, 19 in Serbia, 5 in Kosovo, 10 in North Macedonia and 1 in Montenegro. 40 of these are subject to the NERPs : 10 in Bosnia and Herzegovina, 5 in Kosovo, 8 in North Macedonia and 17 in Serbia. As from January 2018 the WB region countries have started the procedures to opt-out eight LCPs in Serbia (4), Bosnia and Herzegovina (3) and Montenegro (1) [40].

The SO_2, NOx and dust emissions in the WB region from LCPs falling under NERPs reached respectively 643.7 kt, 81.8 kt and 17.94 kt in 2018 [40]. In Bosnia and Herzegovina, the emitted SO_2 emissions from LCPs were nine times higher than the 2018 respective ceilings. In Serbia and North Macedonia, the released SO_2 emissions were respectively more than six and three times higher than their 2018 ceilings while in Kosovo the emissions of this pollutant were nearly 30% above its ceiling. North Macedonia dust emissions more than doubled the 2018 ceiling while those in Serbia and Bosnia and Herzegovina were respectively 52% and 12% higher than theirs [40].

6 Source apportionment of pollutants in the WB main cities

Source apportionment is a technique to allocate the concentration of pollutants in one given area to their emission sources. Source apportionment in the WB is only available from studies focusing on specific areas for limited time windows [135]. The contribution from emission sources and geographic areas to $PM_{2.5}$ in the largest 13 cities of the WB was estimated with the SHERPA tool based on the EMEP model for 2014 [17].

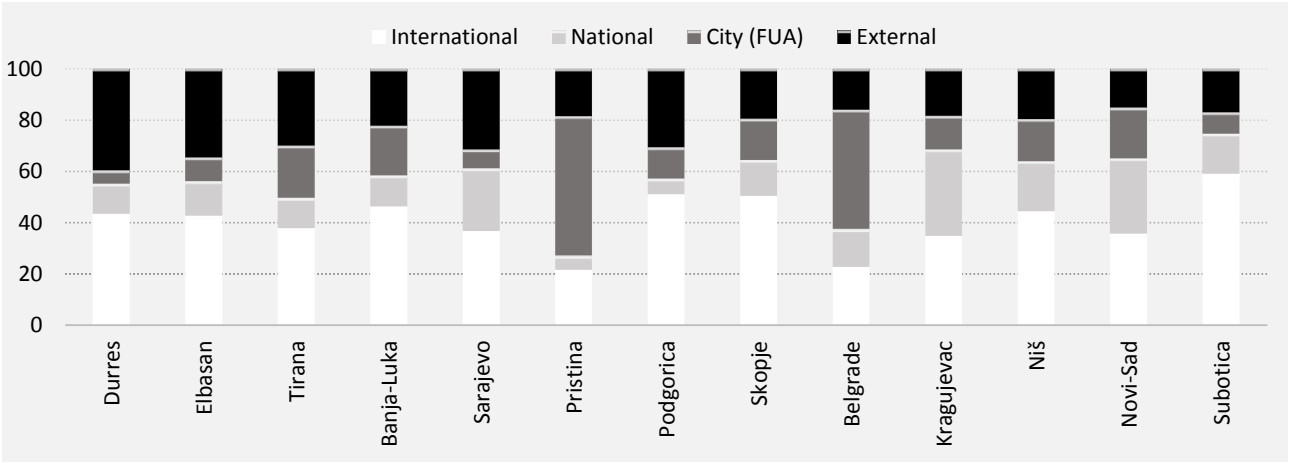
Figure 18. Average percentage impact of sources and geographical areas on $PM_{2.5}$ in the main WB cities (13) [26].



Source: JRC

Transboundary (=international) pollution is, on average, the main geographical source of $PM_{2.5}$ in the cities of the WB (40%) followed by the city and commuting area (FUA) own emissions (19%) and the national emissions (16%) as shown in Figure 18. These results point out the limited impact of cities own emissions on their air pollution and should be taken into account when developing abatement measures. In addition, there is a considerable variation between the cities in the share of sources emitted at the local level, suggesting there is no single set of measures appropriate for all of them. The influence of national emissions on the studied cities is the highest in Serbia and Bosnia and Herzegovina (Fig. 19). It is between 20% and 30% in two of the studied Serbian cities (Kragujevac and Novi Sad) and Sarajevo. On the contrary, national emissions contribute less than 5% in both Pristina and Podgorica, both belonging to small countries.

Figure 19. Percentage impact of geographical areas to $PM_{2.5}$ in the 13 studied cities. [15]



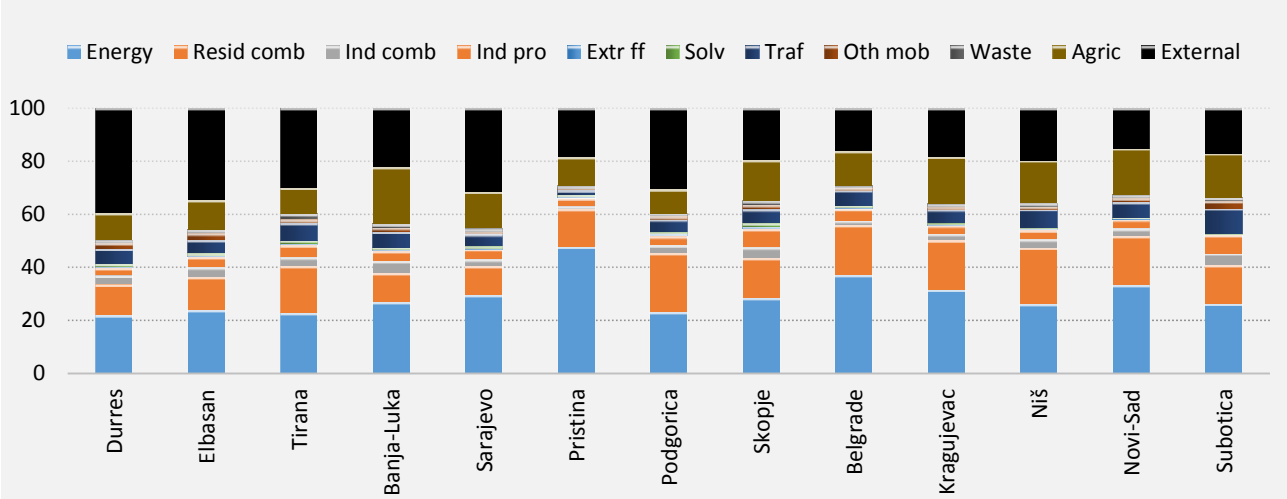
Source: JRC

Transboundary $PM_{2.5}$ pollution is the highest in the Serbian city of Subotica which is explained by its location very close to the Hungarian border. The external fraction (24%) encompasses the influence of sources outside the model domain and those from sources not allocated to a specific source. It is conspicuous only in the

([26])FUA: functional urban area, national, international (within the model domain) and external (areas beyond the domain and sources not considered).

Albanian cities likely due to the impact of international maritime traffic. As shown in Figure 18, the activity sectors influencing $PM_{2.5}$ levels most in the cities of the WB are energy production, (29%), residential combustion (16%) and agriculture (19%). These three sources alone represent almost 60% of the total modelled $PM_{2.5}$. Road traffic impacts on average 6% while the remaining identified sources are responsible for only 10% of the total modelled $PM_{2.5}$ in the studied cities. In Figure 20 the relative impact of the most important activity sources in the 13 cities is displayed. The highest relative impacts of the **energy sector** are observed in Serbia, Kosovo and Bosnia and Herzegovina. In the period 2010 - 2015, coal represented between 50% and 58% of the total mix of fuels for energy supply expressed as kton/y [25] in these three countries. The impact of this source reaches almost 50% of the $PM_{2.5}$ in Pristina followed by three Serbian cities (Belgrade, Novi Sad and Kragujevac) and Sarajevo where it ranges from 30% to 40%.

Figure 20. Percentage impact of selected activity sources to the $PM_{2.5}$ in the 13 studied cities [27].



Source: JRC

The cities with the highest impact from **residential** combustion are Podgorica and Niš, both above 20%. Conversely, residential combustion impact drops to 10% in the cities of Bosnia and Herzegovina. A comparison of these estimations with those of source apportionment techniques based on measurements (receptor models) suggest that biomass burning is the dominant fuel used in the residential sector and that the contribution of this source is likely underestimated due to the limitations of the emission inventories. The impact of **industrial combustion and industrial processes** is the highest in Skopje and Subotica (11%).

The **road transport** impact is highest in Subotica 9% and lowest in Pristina 2%. The impact of **agriculture** ranges from 9% in Podgorica to 21% in Banja Luka. The smallest influence of this source is observed in the South-West (Albania, Montenegro and Kosovo) where the contributions are below 12%. The same pattern is observed in the absolute values ($\mu g/m^3$) suggesting that it is not dependent on the relative importance of this source compared to others. One possible explanation is the influence of long-range transport of aerosol from areas with high NH_3 emissions such as Northern Italy, Switzerland and Southern Germany [136].

Box 3. Biomass fuel and Energy Policy

Central and Eastern Europe are the European regions with the highest proportion of $PM_{2.5}$ emissions derived from residential heating with solid fuels (21% and 13%, respectively in 2010). In South-East Europe, biomass is traditionally used as fuel for residential heating because of its accessibility and low costs, especially in rural areas. Since the combustion of biomass in outdated small appliances has considerable emissions of particulate matter, black carbon and PAHs, this type of source impacts negatively on air quality and, consequently on human health. Nevertheless, considering that biomass is an important source of renewable carbon-neutral energy source, its use is generally promoted by the climate and energy policies. Therefore, the biomass use for energy and heat generation, and consequently the consumption of this fuel is expected to increase.

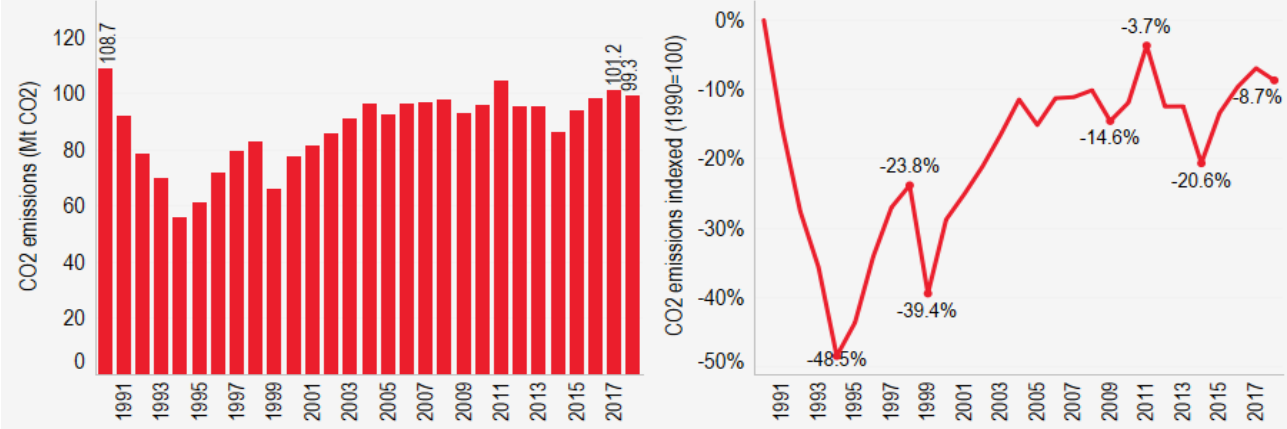
More details in: Monforti-Ferrario and Belis, 2018 [137]

([27]) Resid comb = residential combustion, Ind comb = combustion in Industry, Ind proc= industrial processes, Extr ff = extraction of fossil fuels, Oth mob = other mobile sources, Agric = agriculture.

7 Emissions of greenhouse gases in the WB region

The WB[28] region produced almost 100 Mt CO_2[29] emissions from fossil fuel combustion and processes in 2018 (Fig. 21), equivalent to almost 3% of the EU CO_2 emissions in that year (3457 Mt CO_2) [138]. This total is close to that for 1990, although there were large changes in the intervening years. CO_2 emissions in the WB region fell significantly after 1990, due to the decrease in the energy demand following the political changes that took place in all countries of the region. This fall was most pronounced (by nearly 49%) between 1990 and 1994. After a short increase between 1994 and 1998, in 1999 CO_2 emissions fell again to 39% less than in 1990. After 1999 the CO_2 emissions in the WB region have followed an increasing trend with small oscillations. A further fall in emissions after 2011 led to a third minimum of -20.6% in 2014. Subsequently, the CO_2 emissions in the region returned to the levels pre- 2011 until 2017 where CO_2 emissions reached ca. 100 Mt CO_2. In 2018 the CO_2 emissions in the region were 8.7% below the 1990 level.

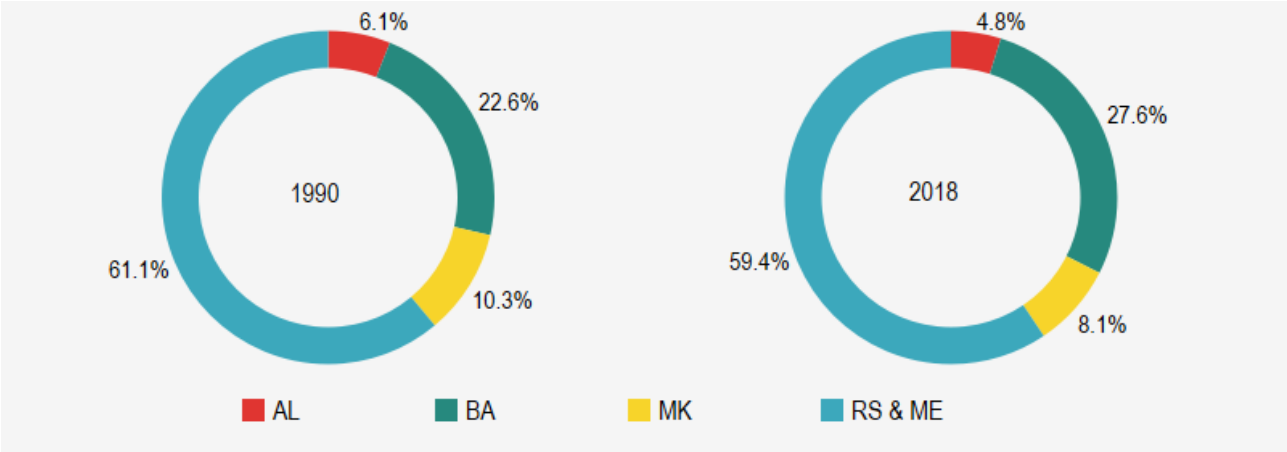
Figure 21. Trend of CO_2 emissions in WB region: 1990-2018 (left) – relative change vs. 1990 (right).



Source: EDGAR JRC [138]

Serbia and Montenegro produced nearly 60% of the CO_2 emissions in the WB region in 2018. This contribution is slightly below the contribution of these two countries in 1990. In the same period, the contribution of Bosnia and Herzegovina increased from nearly 23% in 1990 to nearly 28% in 2018 while the contributions of Albania and North Macedonia decreased in 2018 compared with their contributions in 1990 (Fig. 22).

Figure 22. CO_2 emissions shares of the WB countries, 1990 (left) – 2018 (right).

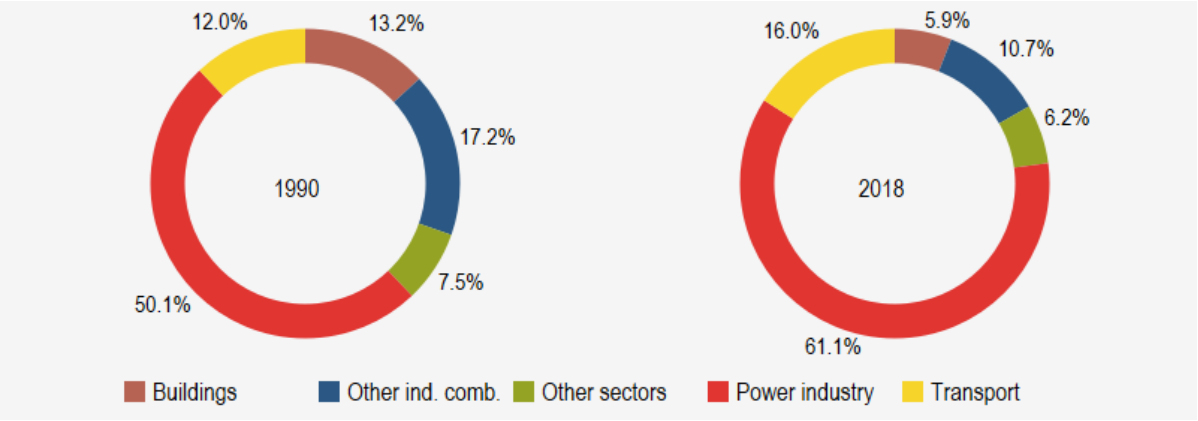


Source: EDGAR JRC [138]

([28]) WB region in this section does not include Kosovo in the selected datasets related with GHG emissions and CO_2 emissions from fossil fuel combustion and processes. Kosovo is included only in the section of CO_2 emissions from fossil fuel combustion.
([29]) The main greenhouse gas emitted in the WB is CO_2. Its share in total emissions ranged from 76.5 % in 1990 to 78 % in 2015 (EDGAR JRC).

Half of the 1990 WB region CO_2 emissions[30] from fossil fuel combustion and processes originated from the power industry (Fig. 23), while the other industrial combustion sectors represented more than 17% of these emissions. In 2018 the relative contribution of the power sector increased to 61%. The transport sector was the second source of these emissions in that year reaching a share of 16%. The contribution of the building sector more than halved in 2018 compared with 1990. The share of other industrial combustion sector decreased to nearly 11%.

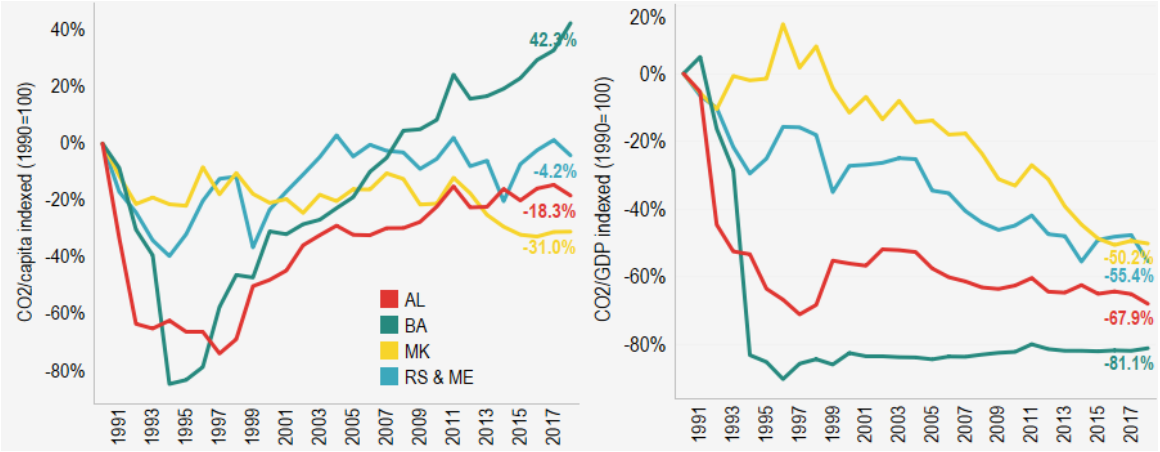
Figure 23. Breakdown of CO_2 emissions from fossil fuel combustion and processes in the WB region, 1990 (left) – 2018 (right).



Source: EDGAR JRC [138]

CO_2 emissions in the WB region are affected by drivers such as population, economic growth and energy supply. Figure 24 illustrates two of these drivers expressed as CO_2 intensities: per capita and per unit of GDP. Per capita CO_2 emissions in WB region reached 4.9 t CO_2/capita in 2018, which is higher than in 1990 (3.6 t CO_2/capita) but lower than the respective indicator for the EU in that year (6.78 t CO_2/capita). There is a broad range of this indicator in the WB region from Albania with 1.94 t CO_2/capita to Bosnia and Herzegovina with 7.3 t CO_2/capita.

Figure 24. Trends in some CO_2 emissions intensities in the WB countries, 1990 – 2018.



Source: EDGAR JRC [138]

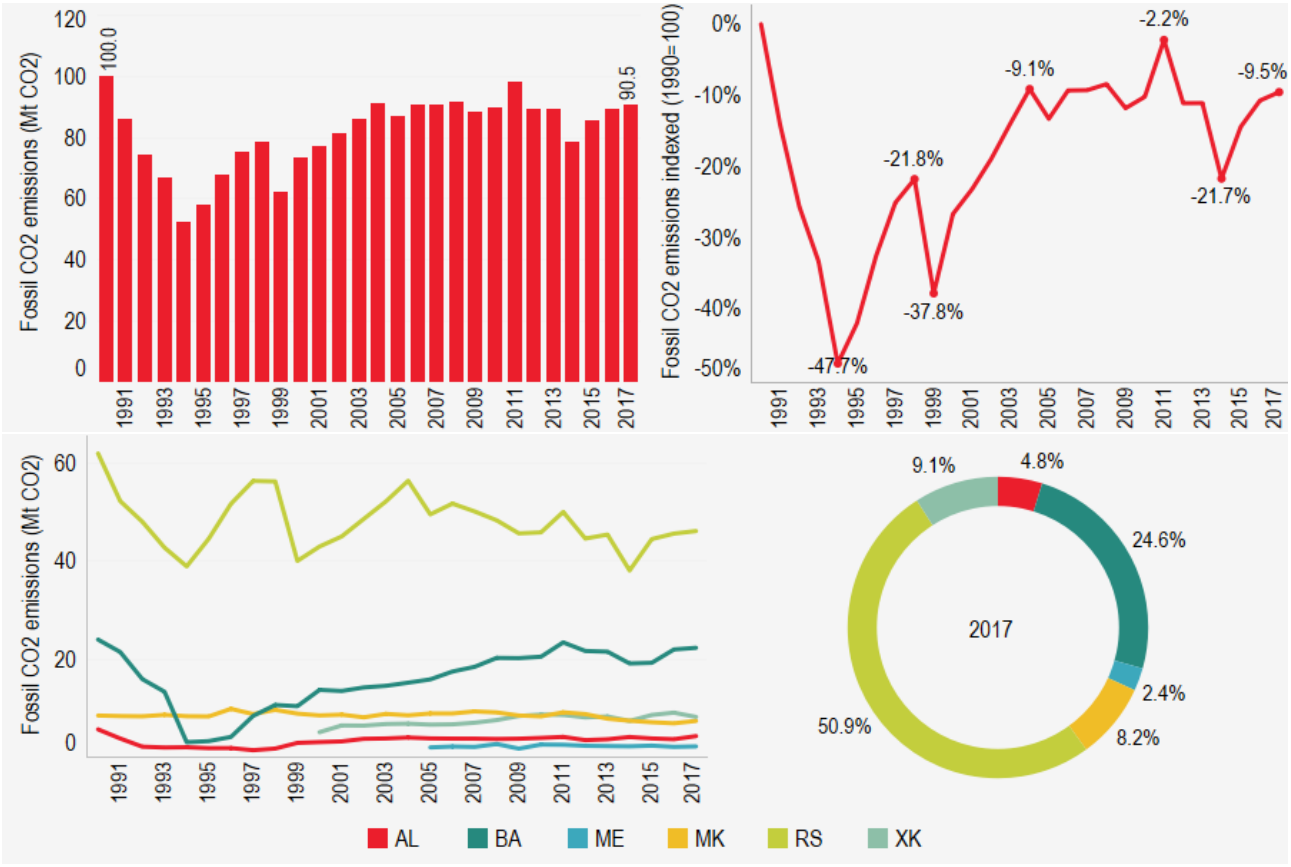
CO_2 emissions per capita in both Albania and Bosnia and Herzegovina increased after the period 1994 -1997. This trend was most pronounced in Bosnia and Herzegovina, where CO_2 emissions per capita were four times higher than in Albania and higher than the EU average CO_2 emissions per capita in that year (6.97 t CO_2/capita). In North Macedonia CO_2 emissions per capita remained almost linear with a slight decrease only after 2011. In 2018 this indicator was 3.97 t CO_2/capita, a fall of 31% compared with 1990. CO_2 emissions per unit of GDP decreased in all economies of the WB region indicating there was a decoupling between economic performance and CO_2 emissions. Overall, the CO_2 emissions per unit of GDP more than halved in 2018 (0.26 t CO_2/1000 USD) compared with 1990. This decrease was more pronounced in Bosnia and

([30]) The description of the emission sectors can be found in the original report [138]

Herzegovina and less in North Macedonia such that the intensity of CO_2 emissions per unit of GDP in the latter almost doubles the EU average.

CO_2 emissions only from **fossil fuel combustion** in the WB region[31] summed up to 90 Mt CO_2 in 2017, a fall of nearly 10% compared with 1990. The overall trend of fossil fuel CO_2 emissions in the WB region since 1990, shown in Figure 25, reached a minimum in 1994 (48% below 1990 level). In 2017 Serbia, Bosnia and Herzegovina, and Kosovo represented nearly 85% of CO_2 emissions from fossil fuel combustion in the region.

Figure 25. Trend of fossil fuel combustion CO_2 emissions in the WB region: 1990-2017 (left) - relative change vs. 1990 (right).



Source: IEA [25]

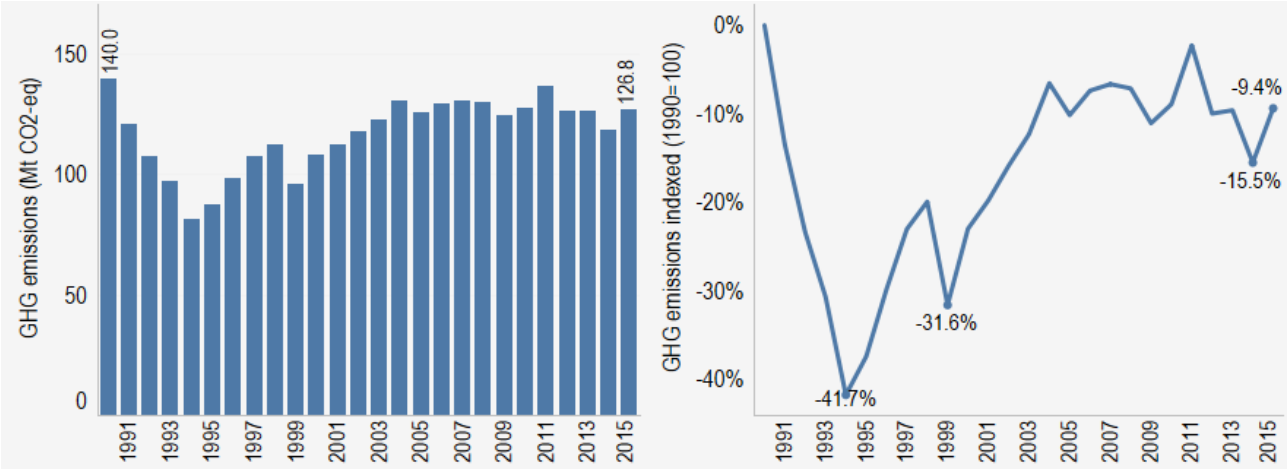
Figure 26 shows the overall trends of GHG emissions (excluding land use, land-use change, and forestry - LULUCF) in the WB region from 1990 to 2015 and relative changes by comparison with 1990. GHG emissions in the WB region fell by 9% between 1990 and 2015 reaching 127 Mt CO_2-eq and remained substantially stable from 2003 to 2015 [138] and very small changes are observed between 2015 and 2017 [24]. Despite the stability of the GHG in the WB region over the period 2008-2017 its economy grew by 15% [139].

Figure 27 illustrates the GHG emissions in WB countries in 1990 and 2017 as well as the breakdown of these emissions by IPCC 2006 categories. Energy is the main source of GHG emissions in the WB region, a contribution that slightly decreased from 75% in 1990 to 69% in 2017 (Fig. 27). In 2017, industrial processes was the second category (with 15%) after it switched the position with agriculture that was the second GHG source (with 12%) in the region in 1990. Although the contribution of waste management remains marginal it increased from 5% in 1990 to 6.5% in 2017.

Energy related GHG emissions covers more than 2/3 of total GHG emissions in almost all WB countries. Only in Albania energy related GHG emissions share is below 50% showing the difference of its energy system compared with that of the other WB countries.

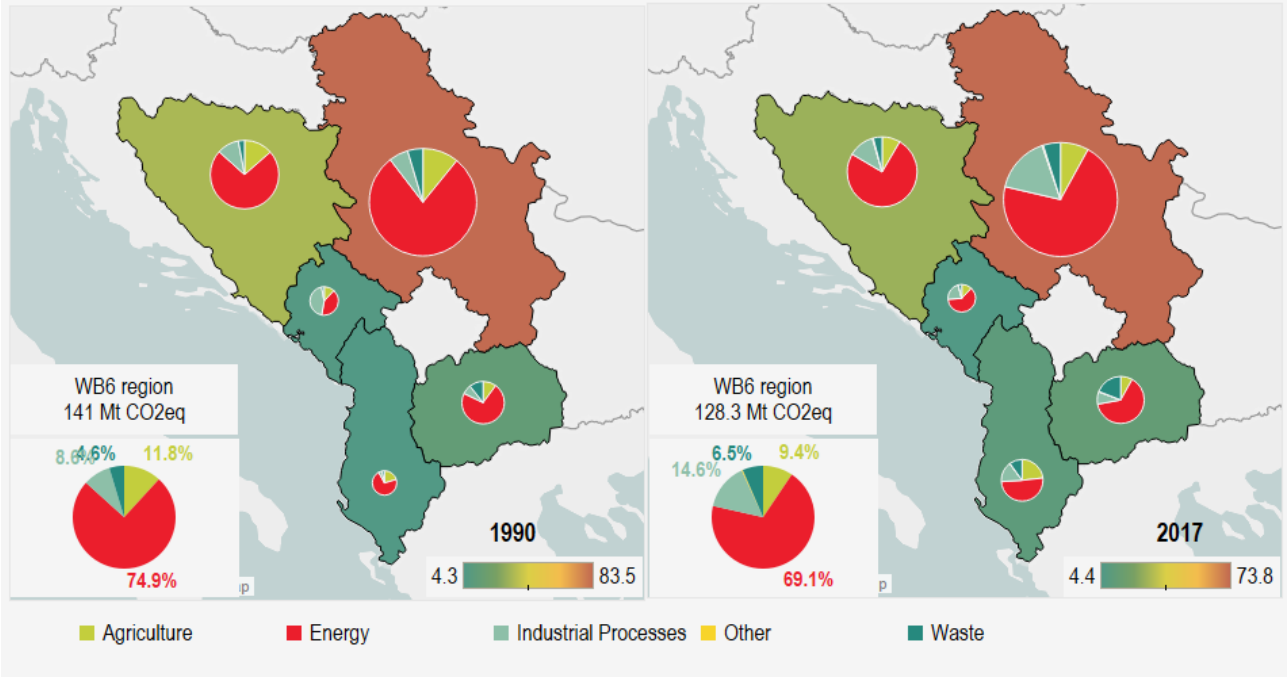
([31]) Serbia includes Montenegro until 2004 and Kosovo until 1999.

Figure 26. GHG emissions in the WB region (1990-2015) – relative change vs. 1990.



Source: EDGAR [138]

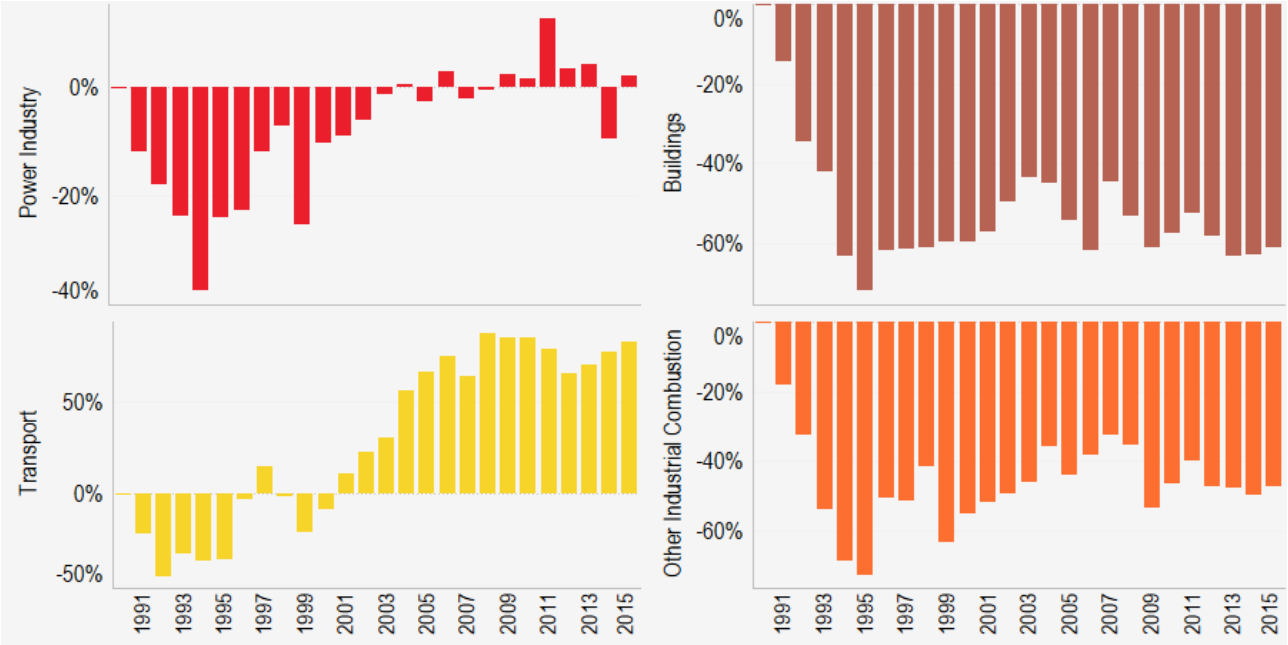
Figure 27. GHG emissions in the WB countries and breakdown by IPCC 2006 categories: 1990 UNFCCC (left) – 2016 PIK (right).



Source: WRI – Climate Watch (UNFCCC & PIK) [22], [24]

Figure 28 illustrates the relative changes in GHG emissions in other sectors such as buildings, transport and power industry. The emissions from the power industry sector dropped significantly after 1990, reaching the minimum in 1994 (37.5% below the 1990 level). After 2003, these emissions followed an increasing trend reaching 59 Mt CO_2-eq in 2015. GHG emissions from buildings remained below the 1990 level all over the 1990-2015 period with the largest drop (by 72%) in 1995. In 2015, these emissions reached 6.4 Mt CO_2-eq being more than 61% below the 1990 level. GHG emissions from other industrial combustion sector in the WB region have remained below the 1990 level with the largest drop (by 73%) in 1995. In 2015 these emissions were estimated at 10 Mt CO_2-eq. The transport sector emissions increased considerably after 2000 reaching their maximum values in 2008, corresponding to 87% higher than 1990. These emissions reached 15 Mt CO_2-eq in 2015 after a slight decrease that took place in 2013. GHG emissions released from other sectors accounted for 36 Mt CO_2-eq.

Figure 28. Changes in the WB GHG emissions relative to 1990, by sector (1990-2015).



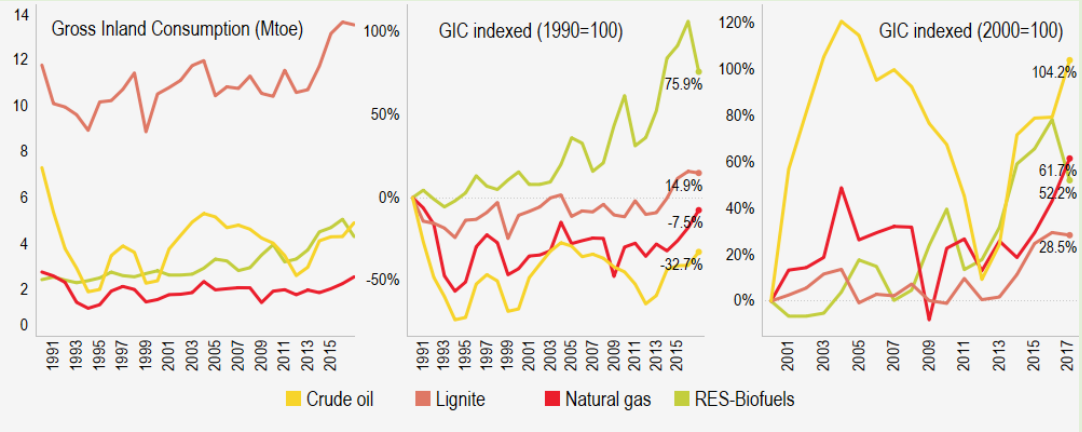
Source: EDGAR [138]

GHG emissions form agriculture presented a steady decreasing trend until 2017, reaching levels 40% lower than 1990 [24]. On the contrary, the emissions from the waste sector, which grew steadily until 2016 reaching 40% increase with respect to 1990, halved their levels in 2017 with respect to the previous year [24].

Box 4. Box Energy sources in the WB region

The energy system of the WB region strongly relies on fossil fuels. As shown in the figure below lignite has been the main source of gross inland consumption of energy (GIC) in the WB region between 1990 and 2017 [139]. The use of lignite represented nearly 54% of the WB GIC in 2017. The shares of other fossil fuels were 19.4% for crude oil and 10.2% for natural gas. Renewables (mainly hydropower) deployed five times faster than fossil fuels, however, accounted for only 17.1% of the GIC. The share of oil-derived products in the WB GIC rose by 104%, after 2000, especially due to its increasing use in the transport sector. In the same period, the share of natural gas grew by 61% whereas renewables and lignite increased by 52% and 29%, respectively.

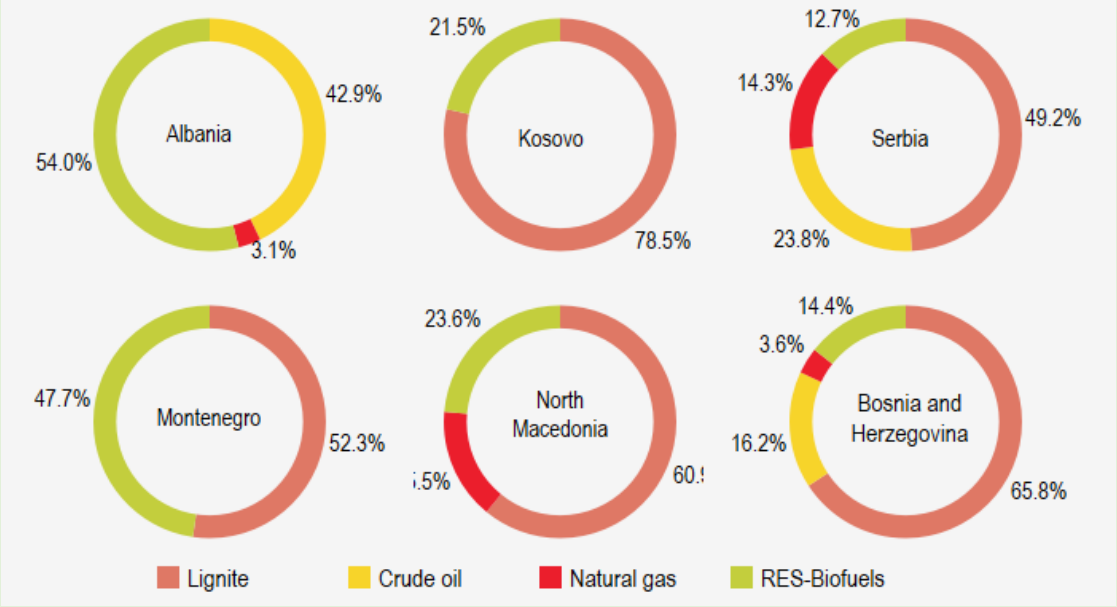
Trend of GIC of fossil fuels and renewables in WB region, 1990-2017 - relative change vs 1990 and 2000



Source:Eurostat [139]

With the exception of Albania, the energy use within the WB region is quite homogeneous. In 2017, lignite covered half or more of the GIC in Kosovo, Serbia, Montenegro, North Macedonia, and Bosnia and Herzegovina. Only in Albania the deployment of renewables (almost totally hydropower) represented more than half of country's GIC (see figure below). The time trend of the GIC portfolio varies among the different countries of the WB region. For instance, in Albania solid fuels (lignite) decreased from 18% of its GIC in 1990 to zero in 2017 while in Serbia the share remained more or less stable at one half of its GIC. On the contrary, in North Macedonia the share of lignite in the GIC has increased from 50% in 1990 to 61% in 2017.

Gross Inland Consumption in WB region countries breakdown by fuel, 2017



Source: Eurostat [139]

8 Conclusions

This report critically discusses the status of air pollutants' concentrations and emissions and GHG emissions in the WB with a view to summarise the existing level of knowledge and the extent to which the EU *aquis* has been implemented for benchmarking the future progress in this field along the accession process.

As a matter of fact, opening the negotiations with EU on Chapter 27 – "Environment and climate change" is so challenging for the countries in the region that only a few have succeeded so far. At present, only Serbia and Montenegro have opened the negotiations for the association process and Montenegro those specific on this chapter.

The alignment with **EU environment and climate change *acquis*** is an ongoing process and some milestones have already been achieved: the transposition of the AAQD is at a satisfactory level in almost all WB region countries. Conversely, progress is slower in the alignment with EU *acquis* related to climate change, especially in monitoring, verification and reporting of GHG emissions (including the compilation of GHG emissions inventories).

It is necessary to reduce the fragmentation of the **air quality monitoring and reporting** among the national and local authorities and the complete set of indicators required by the legislation should be covered. Accreditation of the bodies in charge for the monitoring networks (maintenance and calibration of instrumentation) is an important step in improving the quality of the data. Inevitably in some cases, the effort to achieve higher quality standards may require an alignment of resources.

The daily maximum PM_{10} **concentrations** and the SO_2 both daily maximum and hourly maximum concentrations are among the air quality indicators that are most frequently above the legislation thresholds in the WB. These pollutants reached very elevated and persistent levels, especially in Bosnia and Herzegovina (SO_2, PM_{10}), North Macedonia (PM_{10}) and Serbia (PM_{10}), with high exposure for the population. Also NO_2 and O_3 levels were above the hourly or 8h maximum thresholds in several areas (Serbia, Bosnia and Herzegovina, North Macedonia, Albania only the latter)

The establishment of efficient national **air monitoring systems** that fulfil all the criteria to provide precise and detailed information on air pollutants concentrations and help to plan measures for the reduction of air pollution, should be a priority.

Complete and accurate data on **air pollutant emissions** are still missing for the entire WB region. In some countries, like Bosnia and Herzegovina, Montenegro and Albania the time series and the list of reported pollutants need improvements. In addition, the GHG emissions inventories of WB countries do not match the same time window or do not use the same year as baseline. Due to the limitation of the country reports, estimates from independent institutions (e.g. JRC - EDGAR, WRI - CAIT and PIK) are useful to build a complete picture of the temporal trends in CO_2 and other GHG emissions.

In addition to the obligations due to the accession process, the implementation of the EU air quality legislation in the WB would also contribute to reduce the levels of pollutants in the neighbouring countries. The focus of the **air quality management** policies should be on the pollutants which levels are most frequently above the European legislation limit values. Among these are PM_{10}, $PM_{2.5}$ and SO_2 primarily from coal combustion in obsolete and inefficient power plants and industrial facilities. The combustion of biomass for residential heating leads to considerable emissions of particulate matter and associated pollutants such as black carbon and polycyclic aromatic hydrocarbons. In addition, further investigation is needed on the use of waste as fuel in the residential sector.

To make further progress in alignment it would be useful to integrate the **environmental measures** into the specific sectorial policies where the drivers that affect the environmental matrices lie. The analysis of the emissions and source apportionment provide evidence that points into the direction of Energy policies in particular the use of solid fuels in both the industrial (including energy production) and the domestic sectors. In the industrial sector more effort is needed to meet the emission ceilings for the large combustion plants. Another important driver, even though less relevant than in EU countries, are the emissions from the

transport sector particularly for its role in both primary and secondary processes. In this regard, emissions of ammonia from the agricultural sector also play a crucial role, especially in the formation of secondary aerosol.

Despite a decoupling between CO_2 emissions and GDP has been observed, models indicate that the main source of **CO_2 and GHG** is the energy production and the emissions show an increasing trend after 1995. The available information suggests there is ground for measures with considerable co-benefits between air quality and climate. However, more effort is needed to catch up with the EU legislation and national Monitoring, Reporting and Verification (MRV) systems should be created.

More **capacity building** initiatives would contribute to further develop the technical skills in the Western Balkans countries in the areas of air quality monitoring and modelling and development of emission inventories for atmospheric pollutants and GHG.

Recommended policy action areas to take advantage of the lessons learnt with this study are listed below.

Summary of main action areas

- Strengthen the progress towards the implementation of the already transposed EU acquis;
- Reinforce the air quality monitoring systems to ensure statistical coherence and improve the data coverage;
- Enhance quality assurance schemes to increase the accuracy and the availability of elaborated data;
- Implement source apportionment of particulate matter as part of the regular monitoring program;
- Extend the use of modelling and predictive analysis to provide a long-term perspective on environmental problems by identifying key issues and uncertainties;
- Develop air quality plans for all critical sites;
- Attract and deploy adequate financial resources to support the implementation of measures;
- Increase the use of best available technologies for the emission abatement;
- Promote a sustainable use of biomass for heating purposes in combination with energy-efficient solutions;
- Adopt a cross-sectoral and multilevel governance approach involving the civil society;
- Increase the pace in the alignment with EU climate change acquis;
- Adopt comprehensive and coherent air quality and climate change strategies;
- Decarbonise the WB energy portfolio adopting the smart specialisation approach.

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List of abbreviations and definitions

AAQD - Ambient Air Quality Directives
AEI - Average Exposure Indicator
AI – Administrative Instruction
AL – Albania
AQ – Air Quality
BC – Black carbon
BAU - Business as usual scenario
BiH/BA – Bosnia and Herzegovina
BTX – Benzen/Toluen/Xylene
CEIP - Centre on Emission Inventories and Projections
CLRTAP – Convention on Long Range Transboundary Air Pollution
CO – Carbon Monoxide
DIMAQ - Data Integration Model for Air Quality
ECMWF - European Centre for Medium-Range Weather Forecasts
EEA - European Environment Agency
Eionet – Environmental Information and Observation Network
ELV - Emission limit value
EMEP - European Monitoring and Evaluation Programme
EnC – Energy Community
EPA - Environment Protection Agency of Montenegro
EUROSAI - European Organization of Supreme Audit Institutions
FBiH - Federation of Bosnia and Herzegovina
FBiH HMI - Federal Hydrometeorological Institute of FBiH, BiH
GHG – Greenhouse gas
GIS – Geographical Information System
H2020 – Horizon 2020 (EU Research and Innovation programme)
HCFCs – Hydrochlorofluorocarbons
HCH - Hexachlorocyclohexane
IEA - International Energy Agency
IED – Industrial Emissions Directive
IIR - Informative Inventory Report
IPA - Instrument for Pre-Accession Assistance
IPCC - Intergovernmental Panel on Climate Change
KEPA - Kosovo Environmental Protection Agency
KEK – Kosovo Energy Corporation
KS/XK – Kosovo
LCP – Large Combustion Plant
ME – Montenegro
MK – North Macedonia
MoEPP - Ministry of Environment and Physical Planning of North Macedonia
MRM - Monitoring and Reporting Mechanism
MRV - Monitoring, Reporting and Verification system
NAPA - National Programme for Adoption of the Acquis Communautaire
NDC – Intended Nationally Determined Contribution
NEA – Albanian National Environment Agency
NECD – National Emissions Ceiling Directive
NERP - National Emissions Reduction Plan
NFR – Nomenclature for Reporting
NH_3 – Ammonia
NMVOC - Non-methane volatile organic compound
NO_2 – Nitrogen Dioxide
O_3 – Ozone
PAH - polycyclic aromatic hydrocarbons
PCB - polychlorinated biphenyls
PCDD/PCDF- Polychlorinated dibenzo-p-dioxins/ dibenzofurans
PIK – Potsdam Institute for Climate Impact Research
PM – Particulate Matter
PM_{10} – Particulate matter size 10 micrometers or less
$PM_{2.5}$ – Particulate matter size 2.5 micrometer or less
PMF - Positive Matrix Factorization Model
POP – Persistent Organic Pollutants
PRTR - pollution release and transfer register
QA/QC – Quality Assurance/Quality Control
RHMI - Republic Hydrometeorological Institute, Republic of Srpska, BiH
RHMI- Hydrometeorological Institute of Republic of Srpska, BiH
SEPA - Serbia Environmental Protection Agency
SO_2 – Sulphur Dioxide
SoAQ – State of Air Quality Report
SoE – State of Environment Report
TPP – Thermal Power Plant
TSP – Total suspended particulate
UNECE - United Nations Economic Commission for Europe
UNEP - United Nations Environment Programme
UNFCCC - United Nations Framework Convention on Climate Change
UNFCCC - United Nations Framework Convention on Climate Change
VOC – Volatile Organic Compound
WB – Western Balkans
WHO – World Health Organization
WMO – World Meteorological Organization
WRI - World Resource Institute

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Annexes

Annex 1. Data sources

The data on air pollutant concentrations, air pollutant emissions and GHG emissions used for this report are from international organisations and from the WB region bodies responsible for environmental monitoring and statistical offices. The data sources are listed below:

WB region data sources

- Albanian National Environment Agency [140]
- Albanian Institute of Statistics [141]
- Federation of Bosnia & Herzegovina, Federal Hydrometeorological Institute [131]
- Kosovo Environmental Protection Agency [142]
- Kosovo Ministry of Environment and Spatial Planning [143]
- Kosovo Agency of Statistics [144]
- Montenegro Environment Protection Agency [145]
- North Macedonia Ministry of Environment and Physical Planning [146]
- Republic of Srpska BiH, Republic Hydrometeorological Institute [147]
- Serbian Environmental Protection Agency (SEPA) [148]

International data sources

- Centre on Emission Inventories and Projections (CEIP) [115]
- Energy Community (EnC) [26]
- European Commission, Joint Research Centre (JRC) [23]
- Eurostat [139]
- European Environment Agency (EEA) [18]
- International Energy Agency (IEA) [25]
- United Nations Economic Commission for Europe (UNECE) [114]
- United Nations Environment Programme (UNEP) [15]
- United Nations Framework Convention on Climate Change (UNFCCC) [22]
- World Bank (WB) [3]
- World Health Organisation (WHO) [130]
- World Resource Institute (WRI) [11]

Annex 2. Data representativeness and average coverage

The analysis on air pollutants in the WB is based on data from the Environmental Information and Observation Network (Eionet), air quality (AQ) annual reports and AQ monitoring networks. The primary year of analysis is 2017 due to the fact that Kosovo has not submitted the data for 2018 yet and the Albanian data average coverage in 2018 is too low (even lower than in 2017) to be included in the analysis. When appropriate validated data for 2018 are included in the report.

The air quality monitoring network in the WB region comprises 134 stations: 75 of which are background (urban, suburban or rural); 32 are industrial (urban, suburban or rural) and 27 are traffic (urban or suburban) stations.

As of September 2019, based on countries declarations in their annual air quality reports, SO_2 monitoring is carried out in 100 stations; NO_2 in 91 stations; O_3 in 78 stations; PM_{10} in 79 stations; $PM_{2.5}$ in 60 stations; CO in 84 stations; Benzene in 26 stations and Toluene in 21 stations. In Table A2.1 is shown the number of stations monitoring each pollutant and the pollutant share of the total number of stations in all the WB AQ networks.

Table A2.1. Number of reported stations for each pollutant and share of the AQ network

	AL	XK	RS	ME	MK	BA	Total	Share in AQ network
SO_2	8	7	36	3	17	30	100	75%
NOx	8	6	26	5	18	28	91	68%
PM10	8	8	16	5	18	23	78	59%
$PM_{2.5}$	6	7	14	3	6	19	60	44%
O_3	7	5	17	3	17	29	78	59%
CO	8	7	26	3	17	23	84	63%

The data from 99 stations, out of a total of 133, that satisfy a data coverage criteria of 50% are included in the analysis of year 2017. This number for year 2018 is 111. The number of stations satisfying the data coverage criteria is shown in Table A2.2.

Table A2.2. Number of stations satisfying the data coverage criteria

	AL	XK	RS	ME	MK	BA	Total	Coverage of AQ
2018	5	11	42	7	17	29	111	83%
2017	5	11	31	7	15	30	99	74%

Annex 3. EU air quality standards

The Air quality limit values set in the ambient air quality directives are reported in Table A3.1

Table A3.1. Air quality standards Directive 2008/50/EC and Directive 2004/107/EC

Pollutant	Concentration	Avg. period	Permitted exceedances/year
Fine particles ($PM_{2.5}$)	25 µg/m³	1 year	n/a
Sulphur dioxide ($S0_2$)	350 µg/m³	1 hour	24
	125 µg/m³	24 hours	3
Nitrogen dioxide ($N0_2$)	200 µg/m³	1 hour	18
	40 µg/m³	1 year	n/a
PM_{10}	50 µg/m³	24 hours	35
	40 µg/m³	1 year	n/a
Lead (Pb)	0.5 µg/m³	1 year	n/a
Carbon monoxide (CO)	10 mg/m³	Maximum daily 8 hour	n/a
Benzene	5 µg/m³	1 year	n/a
Ozone	120 µg/m³	Maximum daily 8 hour	25 days avg over 3 years
Arsenic (As)	6 ng/m³	1 year	n/a
Cadmium (Cd)	5 ng/m3	1 year	n/a
Nickel (Ni)	20 ng/m³	1 year	n/a
PAHs	1 ng/m³ (expressed as Benzo(a)pyrene)	1 year	n/a

Directive 2008/50/EC introduced additional $PM_{2.5}$ objectives targeting the exposure of the population to fine particles. These objectives are set at national level and are based on the average exposure indicator (AEI). This is determined as a 3-year running annual mean $PM_{2.5}$ concentration averaged over the selected monitoring stations in agglomerations and larger urban areas, set in urban background locations to best assess the $PM_{2.5}$ exposure of the general population. Depending on the value of AEI in 2010, a percentage reduction requirement (0, 10, 15, or 20%) is set in the Directive. If AEI in 2010 is assessed to be over 22 µg/m³, all appropriate measures need to be taken to achieve 18 µg/m³ by 2020 (see Table A3.2).

Table A3.2. Standards for fine particles ($PM_{2.5}$) set in Directive 2008/50/EC

Title	Metric	Averaging period	Permitted exceedances
$PM_{2.5}$ Exposure concentration obligation	20 ng/m³ (AEI)	Based on 3-year average	n/a
$PM_{2.5}$ Exposure reduction target	Percentage reduction* + all measures to reach 18 ng/m³ (AEI)	Based on 3-year average	n/a

The 2005 WHO Air quality guidelines [149] offer global guidance on thresholds and limits for key air pollutants that pose health risks (see Table A3.3). The WHO Air quality guidelines are currently under revision and expected to be published in 2020.

Table A3.3. WHO ambient air quality guidelines

Pollutant	Averaging period	Guideline value (µg/m³)
Sulphur dioxide (SO_2)	24 hour	125 (Interim target1), 50 (Interim target2), 20 (guideline)
	10 min	500 (guideline)
Nitrogen dioxide (NOx)	1 year	40 (guideline)
	1 hour	200 (guideline)
Particulate matter (PM_{10})	1 year	70 (Interim target1), 50 (Interim target2), 30 (Interim target3), 20 (guideline)
	24 hour	150 (Interim target1), 100 (Interim target2), 75 (Interim target3), 50 (guideline
Particulate matter ($PM_{2.5}$)	1 year	35 (Interim target1), 25 (Interim target2), 15 (Interim target3), 10 (guideline)
	24 hour	75 (Interim target1), 50 (Interim target2), 37.5 (Interim target3), 25 (guideline
Ozone	8 hours daily max	160 (Interim target1) 100 (guideline)

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