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STATUS OF ENVIRONMENT AND CLIMATE IN THE WESTERN BALKANS

BENCHMARKING THE ACCESSION PROCESS PROGRESS ON ENVIRONMENT

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Contents

Abstract

Accurate and complete environmental information is at the basis of any effective sustainable development policy. This report summarises for the first time the status of air, climate, water and soil in the Western Balkans (WB), describing current knowledge as of 2021 and gaps with respect to the *EU aquis* in order to: a) benchmark the progress during the accession process, and b) support the implementation of the Green Agenda for the WB with particular reference to depollution and decarbonisation priorities. This information is also relevant for the EU Green Deal zero pollution ambition, as depollution in WB also reduces pollutant levels in neighbouring EU Member States.

Despite significant improvements in the alignment of the climate and GHG emissions monitoring and reporting legislation and the good progress in the areas of air and water pollution in the latest two years, the *EU aquis* implementation is still lagging.

The overall WB air quality situation is still critical and the pollution trend is often upwards, despite PM_{10} and $PM_{2.5}$ concentration have decreased in certain areas. Due to its dominant impact on mortality, $PM_{2.5}$ can be considered the main pollutant to target in the WB. The energy sector, in particular coal-fuelled power plants, is the major source of SO_2 and CO_2 emissions and an important source of other pollutants. It offers a concrete opportunity for co-benefits between air quality and climate policies.

The increase in intensity and frequency of summer heatwaves in the latest decades is an indicator of climate change in the WB and the need to design appropriate adaptation plans to cope with it.

The status of waterbodies in the WB can generally be assessed as unsatisfactory. In the case of chemical status, 45% of waterbodies assessed failed to reach good status, while in the ecological assessment 54% failed to reach good status. Case studies on antibiotic resistance, as well as effect-based studies on mixtures of pollutants confirmed that aquatic ecosystems, particularly large fluvial rivers, are under considerable anthropogenic pressure.

Soil degradation is prevalent and extensive throughout the WB region. Soil erosion is the most relevant degradation process followed by soil pollution. Unsustainable land management practices and natural causes of soil degradation in the region are interlinked.

In order to make progress in the implementation of the environmental legislation it is necessary to improve the integration of the environmental measures into key sectorial policies (e.g. energy production, energy efficiency, industry, transport). This principle is reflected in the Green Agenda for the WB and the new EU Soil Strategy. Due to the relatively small area of the WB and the interconnections between ecosystems across and beyond the region, strengthening regional and international cooperation is essential to involve all the relevant actors and stakeholders in the design and implementation of environmental policies.

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Executive summary

This report summarises for the first time the status of air, climate, water and soil in the Western Balkans (WB), describing current knowledge as of 2021 and gaps with respect to the *EU aquis* in order to a) benchmark the progress in this field, during the accession process and b) support the implementation of the Green Agenda for the WB with particular reference to depollution and decarbonisation priorities. This information is also relevant for the EU Green Deal zero pollution ambition, as the pollution status in WB also impacts the pollutant levels in the neighbouring EU Member States.

Policy context

The adoption, implementation and enforcement of Chapter 27 of the *EU acquis* on Environment is an obligation for countries under the "Stabilisation and Association Agreement" process". 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 while the EU Green Deal (COM(2019)640) sets out several concrete actions in the field of climate, depollution, energy, biodiversity, circular economy, among others. The Guidelines for the implementation of the Green Agenda for the WB (SWD(2020) 223), accompanying the Economic and Investment Plan for the WB (COM(2020) 641), define priority areas for interventions and identify initiatives to fulfil the principles of the EU Green Deal in this region. More recently the European Commission has launched the EU Action Plan: "Towards Zero Pollution for Air, Water and Soil" COM(2021) 400 which aims to protect ecosystems and human health.

Key conclusions

Achieving full **alignment** with EU environment acquis requires a strong political commitment. Despite a significant improvement in the alignment of the climate and GHG emissions monitoring and reporting legislation and the good progress in the areas of air and water pollution, implementation is still lagging. Moreover, implementing depollution provisions in the WB also reduces pollutant levels in neighbouring EU countries.

More effort is needed to improve the coverage and completeness of the **environmental monitoring networks** in the WB. Field data are the basis for both the identification of critical situations and the development of effective and efficient policies. Therefore, the establishment of monitoring networks with sufficient data coverage in space and time and a set of analysed parameters in line with the legislation requirements is a cross-cutting priority for all the environmental matrices considered in this report.

Addressing **transboundary pollution** in South-East Europe is relevant for the achievement of the EU zero pollution targets in the frame of the EU Green Deal. Due to the relatively small area of the WB and the high interconnections between the ecosystems across and beyond this region, strengthened regional and international cooperation is essential to involve all the relevant actors and stakeholders in the design and implementation of environmental policies. The Air Convention is a successful example of international partnership in the environmental area while at the regional level, the Energy Community, the Regional Cooperation Council, the International Commission for the Protection of the Danube River and the International Sava River Basin Commission are similar successful examples. Pan-EU **soil initiatives**, such as LUCAS, EUSO, Clean Soil Outlook, should be expanded to cover the WB region.

In order to make progress in the implementation of the environmental legislation it is necessary to improve the **integration of the environmental measures into key sectorial policies** (energy, industry, mobility, waste treatment, etc.). This principle is reflected in the Green Agenda for the WB that aims to promote green measures in sectors of energy production, energy efficiency, sustainable transport and wastewater management, among others. Also the new **EU Soil Strategy** aims to integrate the sustainable use of soils across EU policies on agriculture, biodiversity, circular economy, climate, urban development and pollution.

Designing appropriate adaptation plans to cope with the increasing intensity and frequency of **summer heatwaves** in the WB, including monitoring and early warning systems authorities should be accomplished with the appropriate timing and involving the competent sanitary.

In a context of continuous improvement, efforts to promote **capacity building**, as a key element of the WB institutions preparedness for the implementation of legislation with highly specialised technical content, should be maintained and strengthened. In this regard, collaboration among experts at the technical level (e.g. exchange of best practices) both within the region and with EU expert networks should also be promoted.

Main findings

The overall **air quality** situation in the WB is still critical and the pollution trend is often upwards despite local improvements in PM_{10} and $PM_{2.5}$ concentrations in parts of the WB. Due to its dominant impact on mortality, $PM_{2.5}$ is the main pollutant to target in the WB. The energy sector, in particular coal-fuelled power plants, is the major source of SO_2 and CO_2 emissions and an important source of other pollutants. It offers a concrete opportunity for co-benefits between air quality and climate policies.

The **status of waterbodies** in the WB is largely unsatisfactory. In the case of chemical status, 45% of waterbodies assessed failed to reach good status, while in the ecological assessment 54% failed to reach good status. Case studies on antibiotic resistance, as well as effect-based studies on mixtures of pollutants confirmed that aquatic ecosystems, particularly large fluvial rivers, are under considerable anthropogenic pressure.

Soil degradation is prevalent and extensive throughout the WB region. **Soil erosion** is the most relevant degradation process followed by **soil pollution**. Unsustainable land management practices and natural causes of soil degradation in the region are interlinked.

The magnitude of **climate change** in the WB is demonstrated by the increase in **summer heatwaves** during recent decades, with highest intensity in southern Bosnia and Herzegovina, Montenegro and northern Albania.

The **lockdowns** adopted to deal with the Covid-19 pandemics in the first half of 2020 made it possible to quantify with precision the impact of road traffic on pollution, confirming the dominant role (up to 80%) of this source on the observed levels of nitrogen oxides. Also the CO_2 emissions from the energy, transport and residential sectors presented a drop in 2020 with respect to previous five years.

Related and future JRC work

Environment and Climate protection are essential elements of the EU Green Deal and the related Green Agenda for the Western Balkans. The JRC project "Supporting the Green Agenda for the Western Balkans" analysed and summarised the available information on Climate and Environment (air, water and soil) in the Western Balkans to measure progress and identify critical issues and knowledge gaps. Moreover, foresight analysis is in progress to anticipate the implications of future policy options with a view to inform the policy cycle. In this regard, an important indicator for the management of air quality is the impact of pollution on health and the associated costs.

The JRC participates regularly in programmes to monitor the quality of water bodies in the Western Balkans from the chemical and ecological point of view to assess their status with respect to the standards set in the EU Water Framework Directive. In addition, the JRC contributes through the "watch list" to constantly update the information on important pollutants like pesticides, antibiotics and other pharmaceuticals, among others.

Healthy soils are at the basis of our economy and are key components of the climatic system. The JRC contributes to the new Soil Strategy and carries out a holistic investigation of the soil health in the Western Balkans by analysing a complete set of parameters: level of nutrients, content of organic carbon, erosion, pollution, soil sealing, salinisation, desertification and pressures on soil biodiversity.

Quick guide

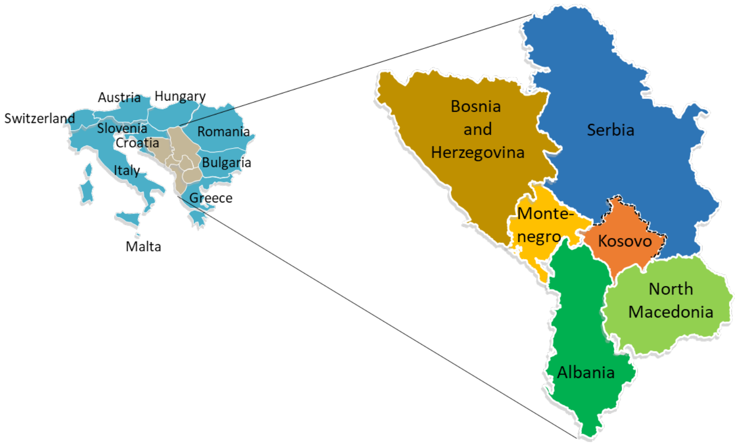
Chapter 2 describes the alignment with EU legislation on environment and climate. **Chapter 3** deals with the status of air pollutants levels and emissions and GHG emissions including impact estimations and projected future trends. In **Chapter 4** the implementation of the EU legislation for water protection is presented and discussed with an emphasis on the monitoring networks and exploratory studies in the WB. In **Chapter 5** the concept of soil health is introduced and the status of WB soils is described with particular reference to the EU Soil strategy for 2030.

1 Introduction

The Western Balkans (WB) is an area of 218,750 km^2 located at the heart of the Balkan Peninsula and next to the Adriatic Sea. The Dinaric ridge runs across the region from north to south parallel to the Adriatic Sea. The WB climate is Mediterranean in the coast and continental in the inlands. The WB are characterised by a dense hydrological network and precipitation is not evenly distributed during the year, leading to dry or partially dry periods that contribute to water scarcity in some parts of the region. The area is quite heterogeneous in terms of geological substratum, relief, hydrology, climate, etc. and consequently the spatial distributions of flora and fauna are rather complex with high biodiversity (Lopatin, 1995; Bănărescu, 2004). In line with the other components of the WB ecosystem, also the soils present a remarkable variety. Grasslands and croplands are found in alluvial plains next to the main rivers while relatively fertile soils, thanks to their high calcium content, are present in the inlands. The WB region is also rich in mineral resources and boasts some of the largest European deposits of copper, chromite, lead and zinc (UNEP, 2010).

The population of the WB is ca. 20 million and its GDP in 2020 was US$ (current) 112 billion (World Bank, 2021). The WB comprises six economies: Albania (AL), Bosnia and Herzegovina (BA), Kosovo[1] (XK), Montenegro (ME), North Macedonia (MK) and Serbia (RS), with the common perspective of accessing the European Union (EU) (**Figure 1**).

Figure 1. Geographical setting of the Western Balkans



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The EU accession process requires the alignment of the national legislations with the EU body of rights and obligations that binds all the EU Member States, known as *EU acquis*. Chapter 27 – "Environment and Climate Change", is the largest of the 35 chapters of the *EU acquis* with more than 200 legislative acts including: air quality, waste management, water management, nature protection, industrial pollution, chemicals and noise. At present, Montenegro and Serbia have opened the accession negotiations with the EU while North Macedonia and Albania, that have the candidate status, are awaiting the negotiations to be opened. Bosnia and Herzegovina and Kosovo are potential candidates.

The present report is the follow up and extension of a study focused on air quality and climate in the WB (Banja et al., 2020). The objective is to summarise the knowledge about key environmental compartments (air, water and soil) together with climate in the WB, to benchmark the progress along the accession process in this field and to provide indicators of environmental status to informing the implementation of the Green Agenda for the Western Balkans (EC, 2020) which is inspired in the principles of the EU Green Deal.

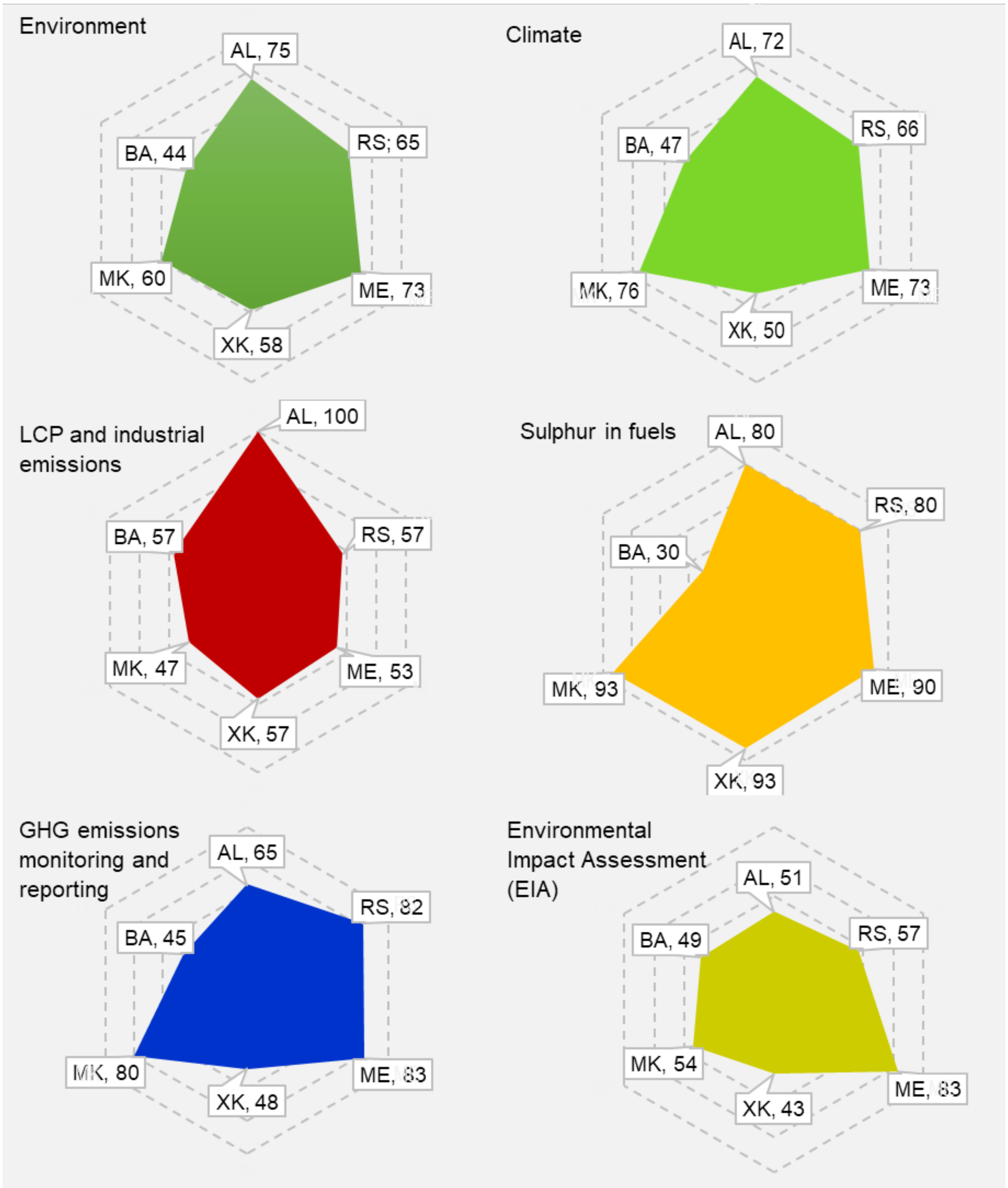
The data used for this report are from international organisations, WB region bodies responsible for environmental monitoring and technical and scientific literature.

[1] *This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence, as on the official website of the European Union.

2 Alignment with EU environment and climate *acquis* in the Western Balkans

In this section the alignment with the *EU acquis* in the areas of environment, climate, pollutants' emissions from large combustion plants (LCP), sulphur in fuels, GHG emissions and environmental impact assessment, is discussed. The level of alignment is expressed as percentage of the target legislation according to the Energy Community methodology (EnC, 2021). The overall environmental performance in the WB ranges between 44% and 75% (**Figure 2**). A considerable progress has been made in the alignment concerning the climate legislation in most WB economies. In 2019 the advancement in this sector was 21% -31% (Banja et al., 2020) while the latest values are in the range 47% - 76%.

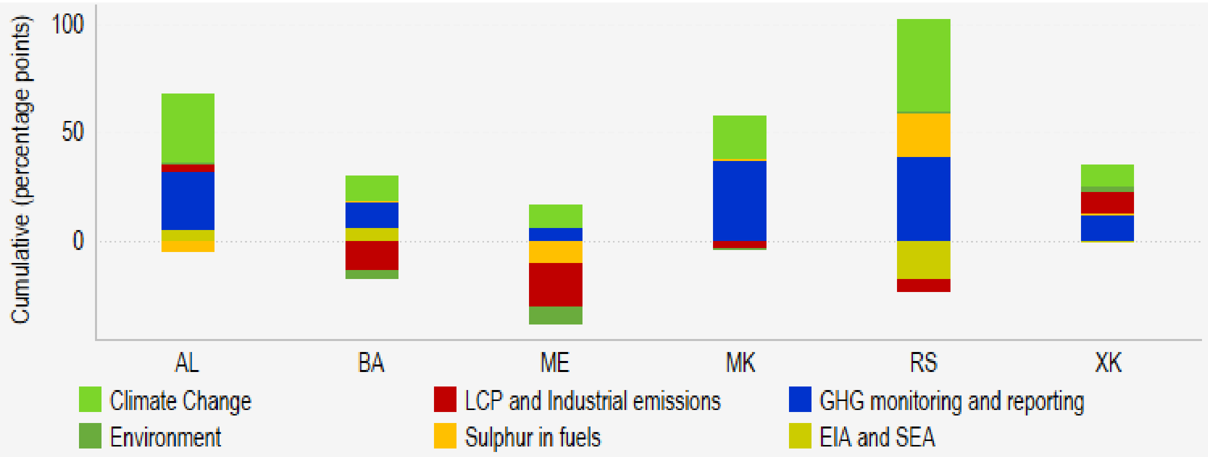
Figure 2. Alignment with the EU Environment and Climate acquis in WB (%), updated to 11.2021 (EnCS, 2021)



Source: Energy Community (JRC elaboration)

The progress of Serbia in climate legislation alignment is mainly due to the adoption of the Climate Law in March 2021. Much headway has been also made for sulphur in fuels in North Macedonia and Kosovo (93% each). Regarding large combustion plants (LCP), only Kosovo has progressed significantly with the adoption of the legislation compliant with the provisions of the LCP and Industrial Emissions Directive in July 2021. Montenegro has performed better especially in approaching the legislation for GHG monitoring and reporting and climate change. However, the opt-out provisions under Article 4(4) of LCP Directive for the Plevlja I power plant were not fulfilled and a case under the Article 91 of the Energy Community Secretariat has been opened. North Macedonia has also progressed in the climate field being the first Energy Community Contract Part to submit the draft of National Energy and Climate Plan (NECP) (EnC, 2021).

Figure 3. Progress towards alignment with EU legislation in WB countries between 2020 and 2021 in % (EnCS, 2021)



Source: Energy Community (JRC elaboration)

As shown in **Figure 3**, all the WB economies made considerable progress in the alignment with the EU legislation between 2020 and 2021, especially in the area of climate change. Serbia, Albania and North Macedonia, made significant advancement in climate change and GHG monitoring and reporting. Most of the progress made by Montenegro in these two areas is counterbalanced by the negative developments in the area of LCP and industrial emissions and Sulphur in fuels. Delays or other developments that impacted negatively on the alignment process was also observed in Bosnia and Herzegovina (LCP and industrial emissions) and in Serbia (environmental impact assessment and strategic environmental assessment).

In synthesis, the levels of alignment concerning the environmental legislation observed in 2019 were substantially maintained in 2021 and significant improvement is observed in the areas of climate and GHG emissions monitoring and reporting, in the latest two years.

3 Status of Air Quality and Climate

The main aspects of air quality and GHG emissions were described in Banja et al. (2020). In this chapter an update about the status of air pollutants levels and emissions and GHG emissions is presented, including impact estimations and projected future trends. Firstly, the current situation and trend of air quality and its impact on health is described including an overview of the connexion between air pollution and lockdown in 2020. Subsequently, the emission of air pollutants and GHG is depicted, with particular attention to the national emission reduction plans and the role of coal power plants. GHG emissions and projections are also presented with an emphasis on the role of the Energy sector. Finally, the trend of heatwaves is analysed under the light of the recent climate evolution.

3.1 Ambient air quality

The WB data coverage of ambient PM_{10}, SO_2, O_3 and NO_2 concentrations in 2017 and 2020, and their variations, are described in **Table 1**. Serbia and Kosovo improved their data coverage for all the considered air pollutants while North Macedonia improved all but PM_{10}.

Table 1. Data coverage and their relative changes (%) for air pollutants in WB countries, 2020 vs. 2017. Green: > 75%; Yellow: 50-75%; Red: < 50%. *Source: JRC elaboration of EEA data.*

	PM_{10}			SO_2			O_3			NO_2		
	2017	2020	%	2017	2020	%	2017	2020	%	2017	2020	%
AL	47	16	-66	33	27	-18	62	19	-69	51	25	-51
BA	81	88	+9	81	95	+17	92	86	-6	84	9	-89
ME	80	66	-18	85	66	-23	64	66	+4	90	66	-27
MK	94	85	-10	88	89	+1	84	93	+11	65	86	+32
RS	89	92	+3	92	96	+4	84	97	+16	91	96	+5
XK	30	96	+220	50	93	+86	35	95	+170	51	94	+83

In 2020, Serbia, Kosovo and North Macedonia performed above the 75% threshold for all pollutants while Bosnia and Herzegovina missed this objective only for NO_2. In the same year, Albania and Montenegro did not reach such threshold for any of the considered pollutants. The trend of yearly PM_{10} and $PM_{2.5}$ concentrations (yearly average of all relevant measuring stations in a country) was analysed to summarise the situation with respect to the limit value and the trend in the latest years (**Table 2).**

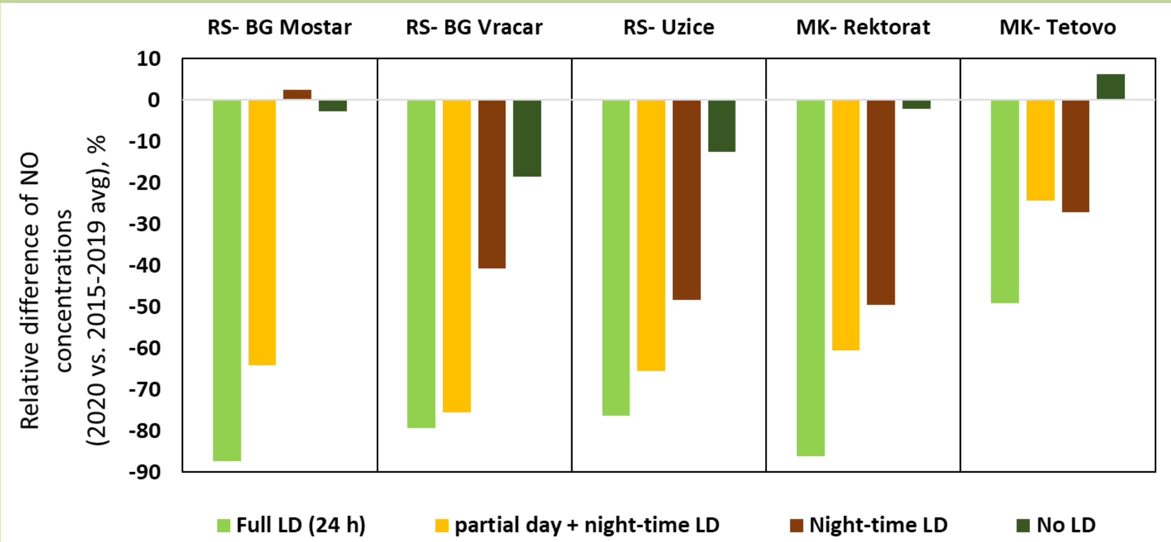
Table 2. Situation with respect to the limit value in 2020 and trend in the latest years. Above limit value: >LV; below limit value: <LV; downward trend: ↓, stable trend: →, upward trend: ↑. *data coverage >50%. *Source: JRC.*

	PM_{10} P1Y	PM_{10} P1Y-day-max	$PM_{2.5}$ P1Y	SO_2 P1Y-hr-max	NO_2 P1Y-hr-max	O_3 daily 8h max
AL						
BA	> LV ↑	> LV ↑	> LV ↑	> LV ↑		> LV →
ME*	< LV ↓	> LV ↓	> LV →	> LV →	> LV ↑	< LV ↓
MK	> LV ↓	> LV ↓	< LV ↓	< LV →	> LV ↑	> LV →
RS	< LV ↓	> LV ↓	< LV ↓	> LV ↑	> LV ↑	> LV ↓
XK	< LV ↓	> LV ↓	< LV ↓	> LV ↑	> LV ↑	> LV ↑

The trends of air pollutants' concentrations in the WB from 2015 to 2019 are based on data reported to EIONET (EIONET, 2021), or published by national air quality networks, that fulfil the 75% data coverage threshold, in exceptional cases 50%. Albania is not assessed in this table due to the low data coverage in 2020. Bosnia and Herzegovina present values above the limit in all the parameters and the trend is upwards in almost all of them (except for O_3). Most countries have achieved values below the limit and show decreasing trends of PM_{10} and $PM_{2.5}$ annual averages. However, no country in average terms is below the PM_{10} daily maximum limit. All the countries with enough data coverage present average values above the NO_2 hourly limit and upward trends. The SO_2 hourly maximum values are below the limit only in North Macedonia and the levels are increasing in most countries. Similarly, the O_3 eight hour daily maxima are below the limit only in Montenegro.

Box 1. Influence of COVID-19 lockdown on air quality in the Western Balkans

To test the impact of restrictions due to COVID-19 lockdown (LD) on air quality, the relative differences between 2020 daily values from 01.02 to 31.05 and the "2015 - 2019 average" in the same days in three urban monitoring stations from Serbia (BG Mostar– traffic; BG Vracar–background; Uzice–traffic) and two from North Macedonia (Rektorat–traffic; Tetovo– traffic) we analysed. The days were flagged according to the kind of lockdown: full (24h), partial day and night, partial night-time and no-lockdown. The influence of COVID-19 lockdown on air quality was observed in two pollutants typically originating from traffic (NO and NO_2). The bar plots in this box show that NO concentrations were reduced by more than 80% during the full lockdown at sites with congested traffic (BG Mostar and Rektorat). Considerable reductions were observed also in the other urban sites (50% to 80%). Similar situation is observed for NO_2 (not shown) with the exception of the background site of Vracar, likely due to the higher distance to the source. On the contrary, during the days without restrictions (no LD), 2020 values were less than 30% lower than previous years and in certain cases even higher (see also **Box 4** on CO_2 emissions changes in 2020).



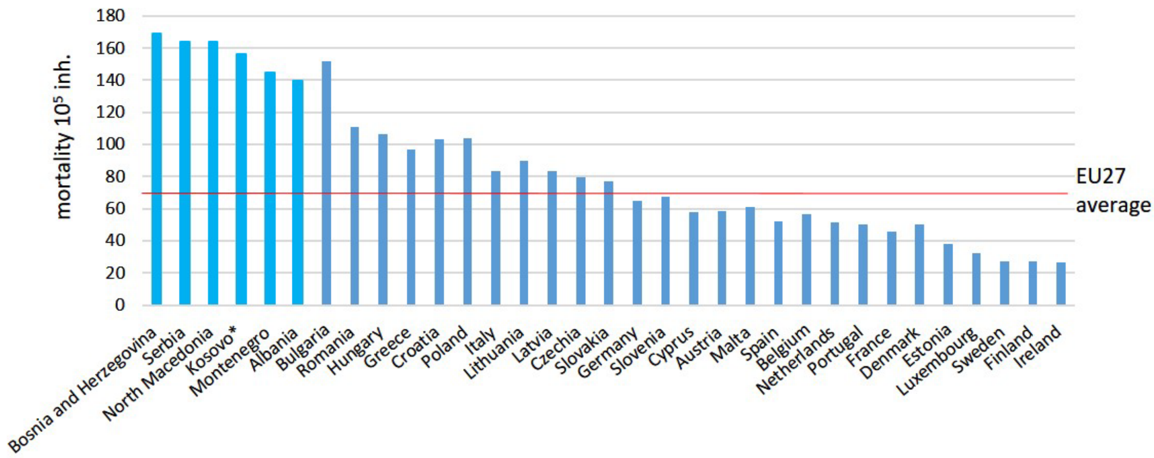
Source: Serbian Environment Protection Agency and Macedonian Ministry of Environment and Physical Planning (JRC elaboration)

3.1.1 Air quality impact on health

In 2019, the annual mortality rate (premature deaths per 100,000 inhabitants) attributable to air pollution (mainly $PM_{2.5}$) in the Western Balkans was considerably higher than the EU27 average and in certain cases more than doubled it (**Figure 4**). Moreover, the EU Member States with higher air pollution related mortality rates are WB neighbours (Bulgaria, Romania, Hungary, Greece and Croatia), clearly indicating the presence of a transboundary hotspot in the area. Such geographical pattern is confirmed in **Figure 5** (EEA, 2020b) where the $PM_{2.5}$ attributable years of life lost (YLL– years of potential life lost because of premature death), another indicator of the impact of air pollution on health, is shown. Also in this case, the highest impact is observed in the WB and nearby EU Member States. The only exception is Poland where high YLL values do not present a geographical continuity with the hotspot in SE Europe.

The Zero Pollution Action Plan, one of the EU Green Deal key policies, aims to reduce the health impacts (premature deaths) due to air pollution by more than 55% in 2030 (EC, 2021). Therefore, addressing the air pollution in the WB is relevant for both the transposition of the *EU acquis* in the frame of the Neighbourhood policy and the achievement of the EU Zero Pollution Action Plan targets.

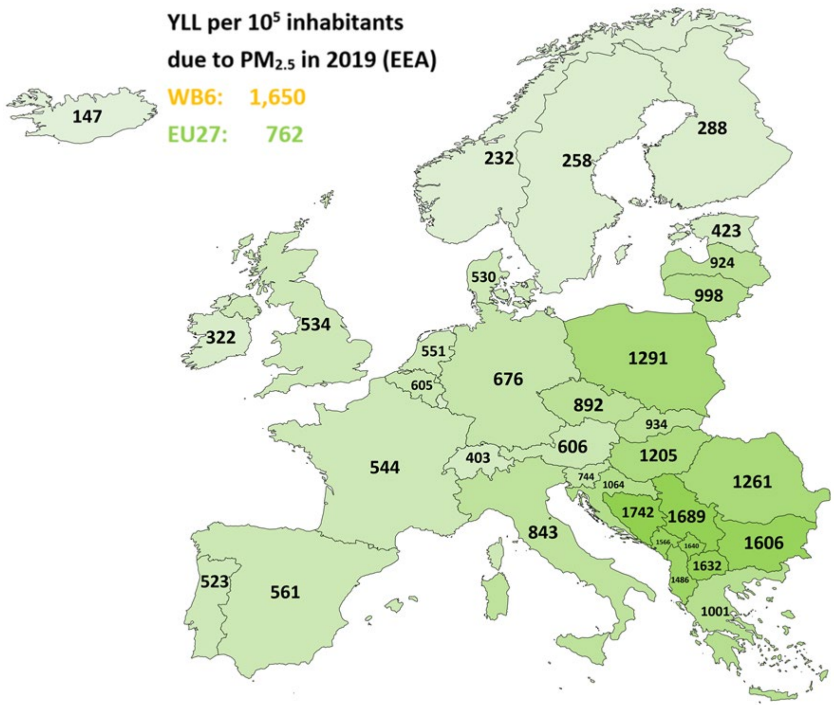
Figure 4. Annual mortality rate due to $PM_{2.5}$ in WB in 2019 and comparison with EU27 average (EEA, 2021)



Source: EEA, 2021 (JRC elaboration)

Air quality policies in the EU27 led to a decrease in the annual mortality rate due to air pollution between 2012 and 2019 while the opposite is true for the WB (**Figure 6**). The highest mortality rate in both considered regions is attributed to $PM_{2.5}$. In 2019 this pollutant caused 307,000 and 28,400 premature deaths due to air pollution in the EU27 and WB, respectively. In 2019, the mortality rates due to $PM_{2.5}$ and NO_2 in EU27 decreased by 16% and 35%, respectively, compared to 2012 while in the WB the $PM_{2.5}$–related mortality increased by 30% and that of NO_2 showed a downward trend (22%). The O_3-related mortality remained relatively stable in both regions over the considered time window.

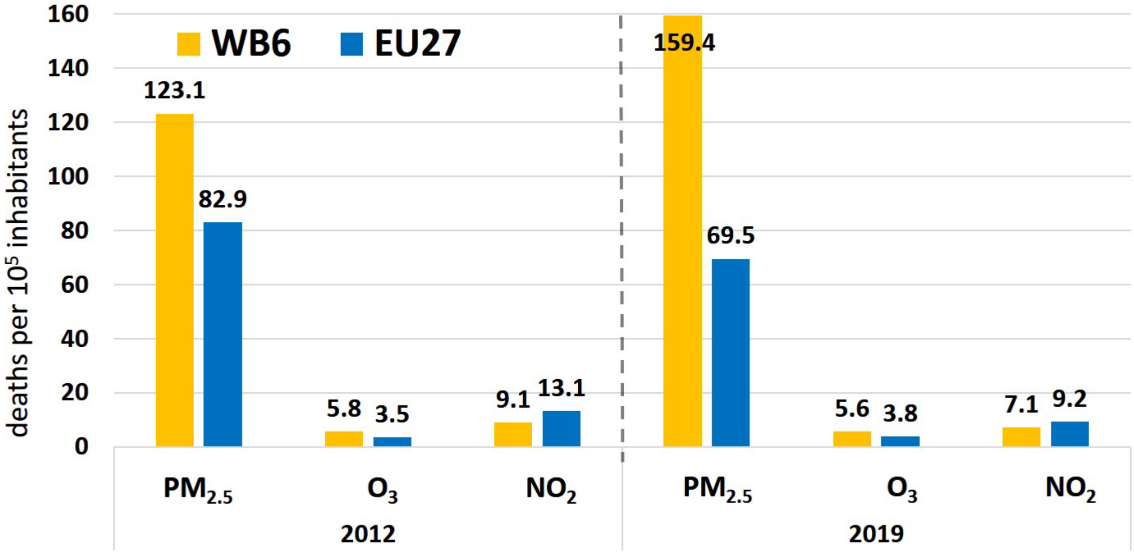
Figure 5. Years of life lost (YLL) per 10^5 inhabitants attributable to $PM_{2.5}$ in 2018 (EEA, 2020b)



Source: EEA, 2021 (JRC elaboration)

According to the projections elaborated with the JRC TM5–FASST tool (**Figure 7**) the implementation of the planned measures (current legislation scenario, CLE) in the WB would not reduce the $PM_{2.5}$ related mortality and lead to an increase in the one related to O_3 by 2050 compared to 2020 (Belis et al., 2022).

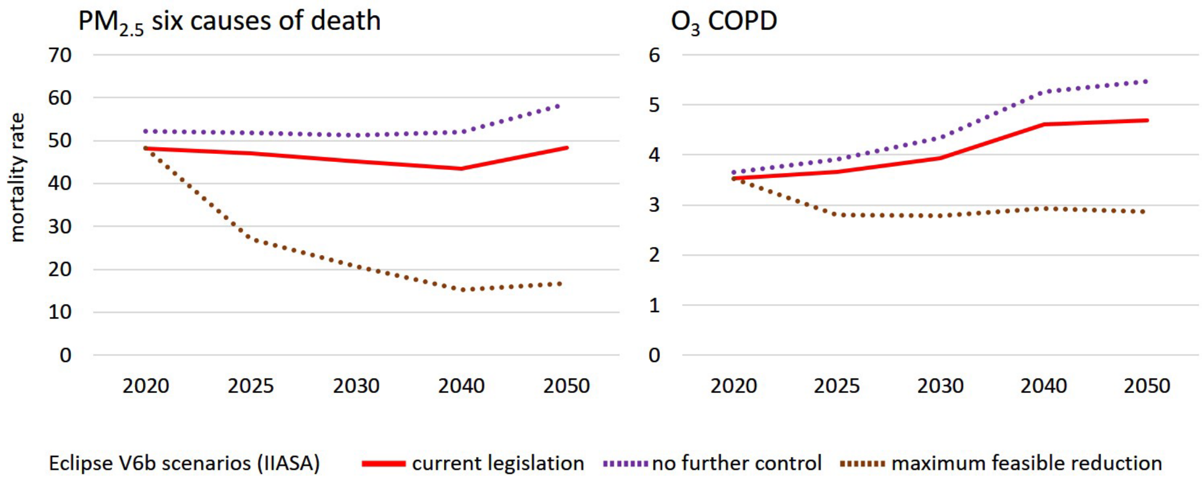
Figure 6. Annual mortality rates in 2012 and 2019 in WB and EU27 due to air pollution (EEA, 2015; 2021)



Source: EEA (JRC elaboration)

The $PM_{2.5}$ mortality encompasses six causes of death (COD): chronic obstructive pulmonary disease (COPD), lung cancer (LC), lower respiratory airway infections (LRI), diabetes mellitus type 2 (DMT2), ischemic heart disease (IHD), and stroke, while only the first one is associated with O_3. The lack of action, represented in **Figure 7** by the "no further control" scenario would lead to a 19% and 14% increase in the $PM_{2.5}$- and O_3-related mortality, respectively, by 2050 compared with the CLE. On the contrary, the implementation of measures to abate air quality and GHG emissions in line with the UN sustainable development goals and the Paris agreement objective of maintaining the global temperature increase below 2° (maximum feasible reduction) leads to a reduction in the mortality related to these pollutants of 65% and 37%, respectively, in 2050 compared to the current legislation scenario.

Figure 7. Projected trends of annual mortality rate (per 100,000 inh.) due to air pollution in WB (Belis et al., 2022)



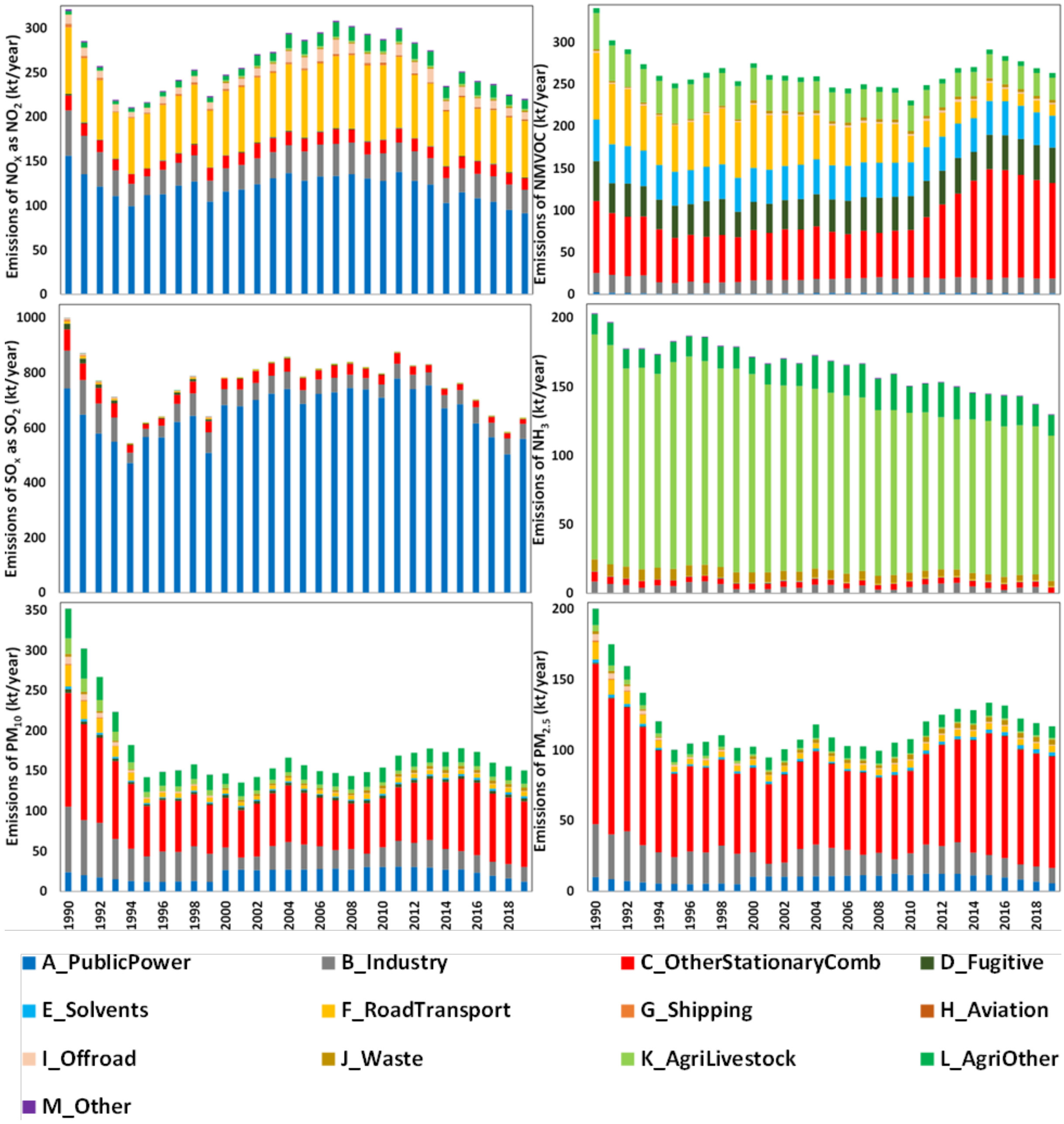
Source: JRC

Due to the dominant and increasing impact on mortality, $PM_{2.5}$ can be considered as the main pollutant to target in the WB.

3.2 Air pollutants' emissions

The trend in emissions of pollutants by sector in the WB5 region (excluding Kosovo) over the period 1990-2019 is presented in **Figure 8** (CLRTAP, 2021). In 2019, the highest reductions in emissions comparing to 1990 were achieved for PM_{10} (57.2%), $PM_{2.5}$ (41.6%), SO_x as SO_2 (36.3%) and NH_3 (36.0), whereby the remaining air pollutants were reduced between 22.7% and 31.4%.

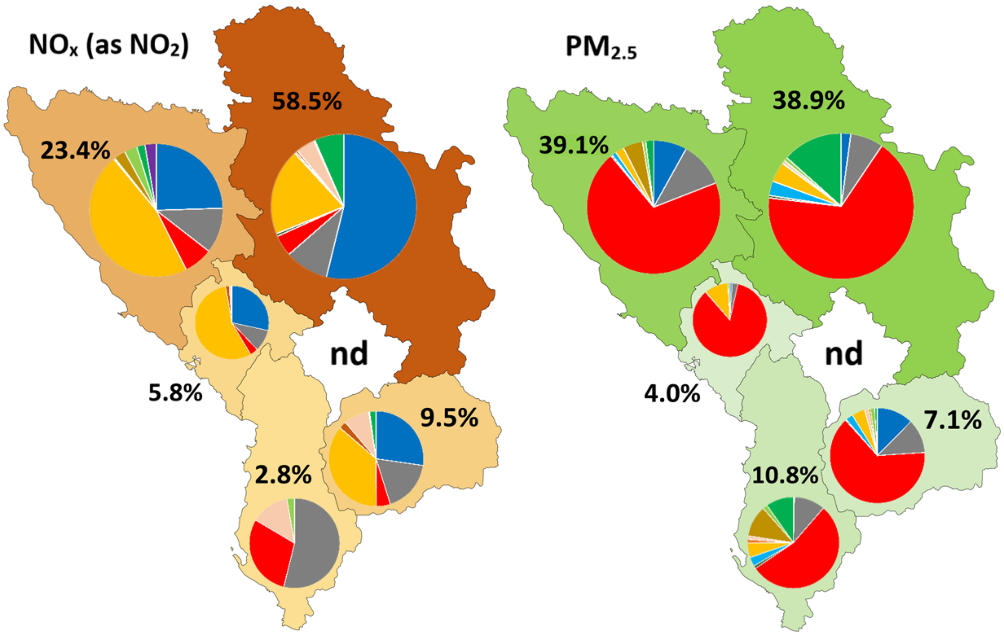
Figure 8. NECD pollutants emissions in WB5 region 1990-2019 (CLRTAP, 2021)



Source: Convention on Long Range Transboundary Air Pollution (JRC elaboration)

Nearly 60% of the total NO_X emissions in 2019 from the WB5 region were emitted in Serbia (**Figure 9**), mainly from the public power sector (54%), followed by Bosnia and Herzegovina with around 23% of total WB5 NO_X emissions originating mainly from road transport (46%). This sector was a dominant source of NO_X emissions also in other countries (from 36% in North Macedonia to 56% in Montenegro). Serbia, Bosnia and Herzegovina and Albania contributed to nearly 90% of the total $PM_{2.5}$ emissions in the WB5 region. Other stationary combustion is a dominant source of $PM_{2.5}$ emissions in all the WB5 countries, ranging from 54% in Albania to 85% in Montenegro.

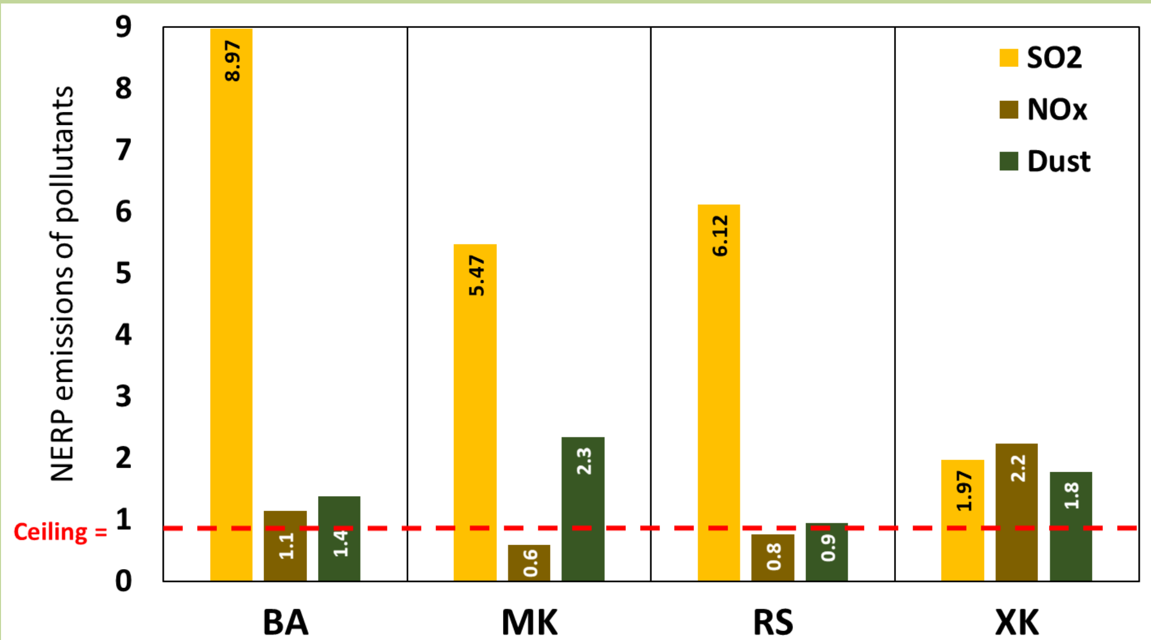
Figure 9. Contribution of countries to the total NO_X and $PM_{2.5}$ emissions and breakdown by sectors (pie chart) in 2019 in WB5 (CLRTAP, 2021). Same legend as **Figure 8**.



Source: Convention on Long Rage Transboundary Air Pollution (JRC elaboration)

Box 2. National Emission Reduction Plans– actual emissions vs ceilings

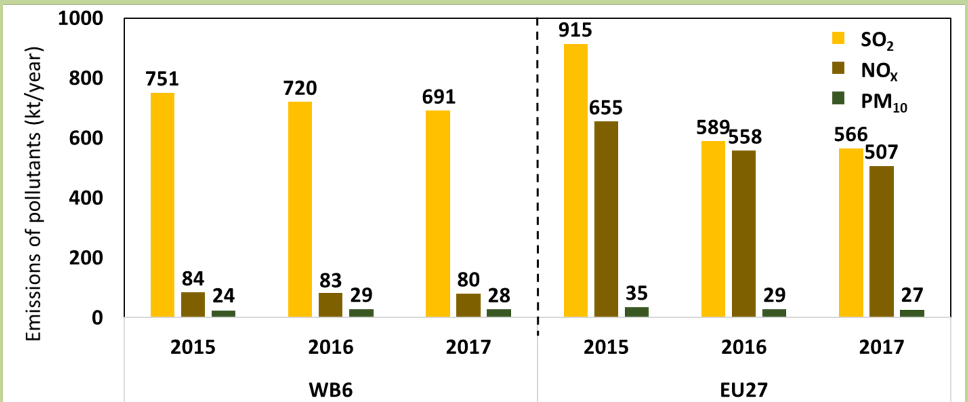
The SO_2, NO_X and dust emissions reported in the NERP (National Emission Reduction Plan) under the Energy Community treaty in Bosnia and Herzegovina, Kosovo, North Macedonia, and Serbia are discussed in this box (EnC, 2021c, EnC, 2021d). As shown in the figure, in 2020, NO_X emission ceilings are met only in North Macedonia and Serbia and those for dust only in Serbia. SO_2 emissions are higher than the ceiling everywhere and often the levels are several times the ceiling value. Moreover, between 2018 and 2020 all the three pollutants showed an increasing trend, with increments with respect to the ceilings ranging from 9% (SO_2) to 40% (NO_X).



Source: Energy Community (JRC elaboration)

Box 3. Emissions and health impacts of coal power plants

In the WB region there are in total 16 coal-based power plants with the total capacity of 8,768 MWe and fuelled with a high sulphur content lignite. Consequently, SO_2 and PM emissions in the WB countries are higher than similar plants in the EU. On the 30th of June 2021, North Macedonia joined the Powering Past Coal Alliance (PPCA) at the London Climate Action Week and committed to close its two plants by 2027. Also Montenegro joined the alliance, and committed to close its only plant by 2035, as well as Albania, although no coal is used in the electricity mix in this country.

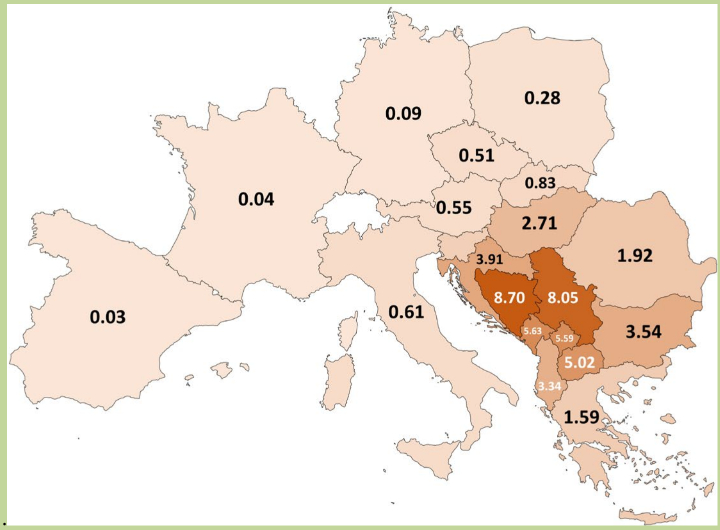


Source: Europe Beyond Coal (JRC elaboration)

In 2017, according to the Europe Beyond Coal campaign (EBC, 2021), SO_2 emissions from the WB plants exceeded by 22% the total SO_2 emissions from the EU27 plants (see figure above). In the period between 2015 and 2017, the SO_2, NO_X and PM_{10} coal-based power plants emissions in WB changed very little (-8%, -4% and +14%, respectively) while those in the EU27 drop between 25% and 38%. In 2017, more than 90% of the SO_2 emissions from coal-based power plants in the WB region were produced in Serbia, and Bosnia and Herzegovina, while similar shares of the NO_X and the PM_{10} emissions originated in these two countries and Kosovo (EBC, 2021).

Premature deaths caused by coal power plants' pollution

According to the Health and Environment Alliance– HEAL (Matkovic Puljic et al., 2019). More than half (51%) of the 3,906 premature deaths in 2016 caused by emissions from coal-based power plants were in the EU, 32% in the WB and the remaining 17% in other European countries, premature deaths. The highest mortality rate in 2016 was observed in Bosnia and Herzegovina and Serbia, while annual mortality rates were high in EU Member States such as Hungary and Romania. These emissions also caused 8,516 cases of bronchitis in children (38% in EU) and 2,023 cases in adults (50% in EU).

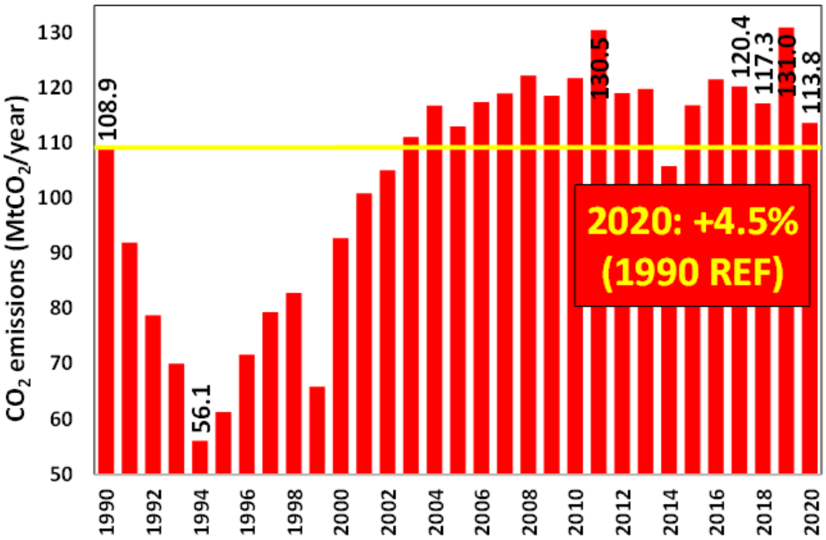


Source: Health and Environment Alliance (JRC elaboration)

3.3 GHG emissions

Considering its importance as global warming indicator, CO_2 emissions are first discussed separately and then together with the other GHGs. In 2020, the fossil CO_2 emissions in the WB5 region (excluding Kosovo) rated nearly 114 Mt (**Figure 10**), about 4.5% higher than those in 1990. These emissions are equivalent to 4% of the EU27 fossil CO_2 emissions in the same year (2,622 Mt).

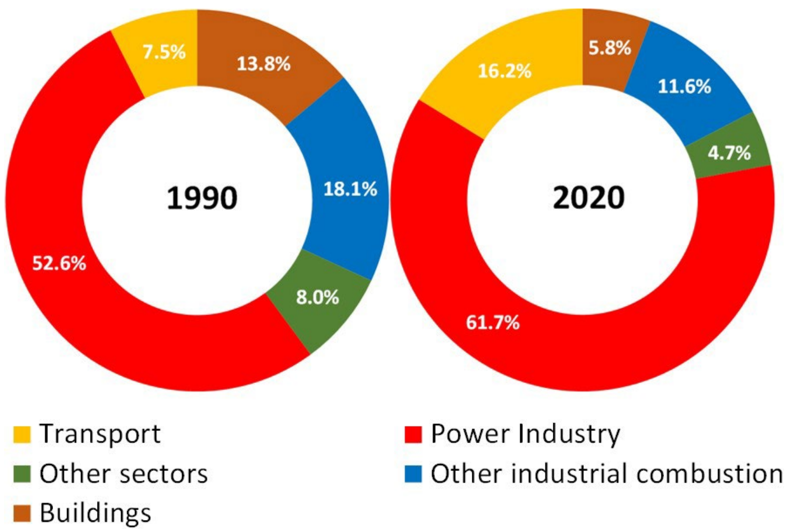
Figure 10. Trend of "fossil CO_2 emissions" in WB5 region 1990-2020 including fossil fuel and processes and excluding LULUCF (land use, land-use change, and forestry; Crippa et al., 2021a)



Source: EDGAR JRC

More than half of the WB5 fossil CO_2 emissions in 1990 originated from the power industry (**Figure 11**), while the industrial combustion contributed with more than 18%. In 2020, the relative contribution of the power industry increased to nearly 62%, followed by transport that reached a share of 16%. The contribution of buildings more than halved in 2020 compared with 1990. In the same period the share of the industrial combustion decreased from 18% to nearly 12% (Crippa et al., 2021a).

Figure 11. Breakdown by sectors of "fossil CO_2 emissions" (fossil fuel and processes) in WB5 region: 1990-left and 2020-right (Crippa et al., 2021a)

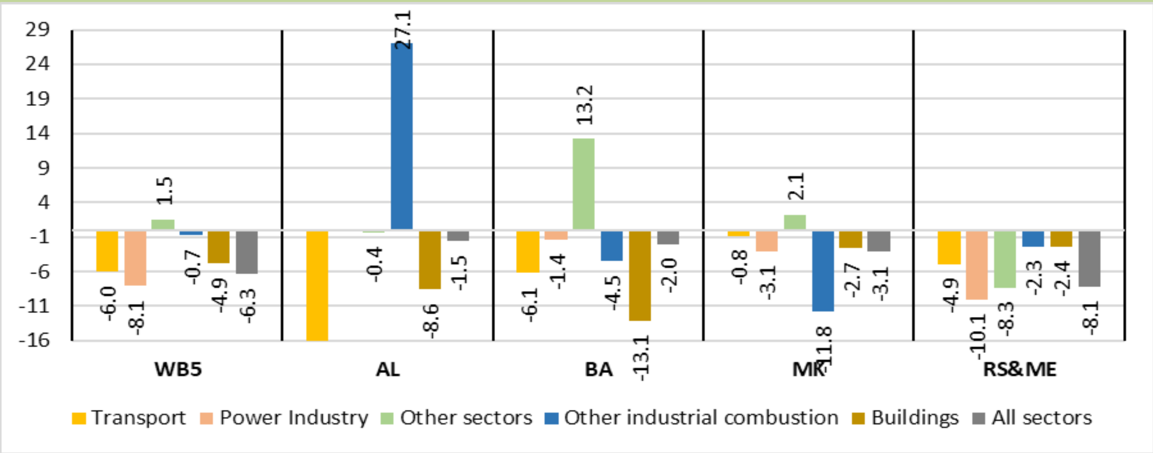


Source: EDGAR JRC

The CO_2 emissions from coal-based power plants in WB5 region and their share in the emissions of this gas from the power industry increased considerably in the 2000's and reached a relative minimum in 2020 (Crippa et al., 2021a). In this year, the region coal fuelled power plants emitted 95 Mt of CO_2 corresponding to 94% of the CO_2 emissions from the entire power industry in this region. Considering that the power industry contributed to more than 60% of the fossil CO_2 emissions, these figures highlight the importance of addressing this sector to tackle the CO_2 emissions in the region effectively. According to IEA (2021), that considers the six WB economies, more than half of these emissions were generated in Serbia, followed by Bosnia and Herzegovina, Kosovo and North Macedonia. Albania and Montenegro shares were less than 5% each.

Box 4. Changes in CO_2 emissions in 2020 compared to previous years

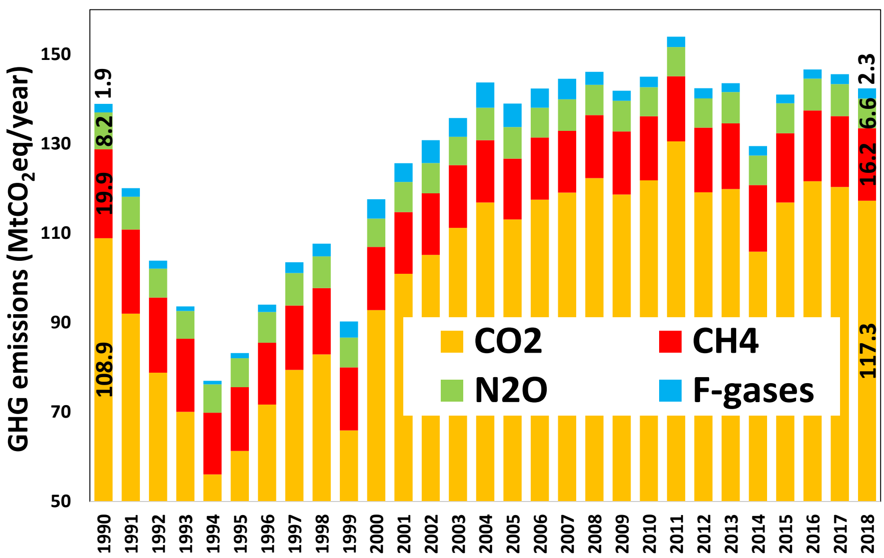
In 2020, the WB5 fossil CO_2 emissions were in all sectors lower than the average 2015- 2019, with the exception of the sum of minor sectors (other). Reductions of more than 10% were observed in transportation in Albania, emission from buildings in Bosnia and Herzegovina, industrial combustion in North Macedonia and Power industry in Serbia and Montenegro (presented together). On the contrary, industrial combustion increased in Albania and other minor sectors rose in Bosnia and Herzegovina and North Macedonia. Although the results showed in the figure below suggest a connection between the impact on human activities of Covid-19 lockdown measures and the observed changes in annual 2020 emissions, establishing a cause-effect relationship requires a more complex analysis to isolate the effect of other variables (see also **Box 1** on traffic emissions in 2020).



Source: EDGAR JRC (Crippa et al., 2021a)

In 2018, the GHG emissions, including fossil CO_2, CH_4, N_2O, and fluorinated gases (F-gases) in the WB5 increased by 2.5% compared to those in 1990 and were 3.6% compared with the EU27 emissions in the same year (3,924 Mt; Crippa et al., 2021b, **Figure 12**). CO_2 and F-gases emissions

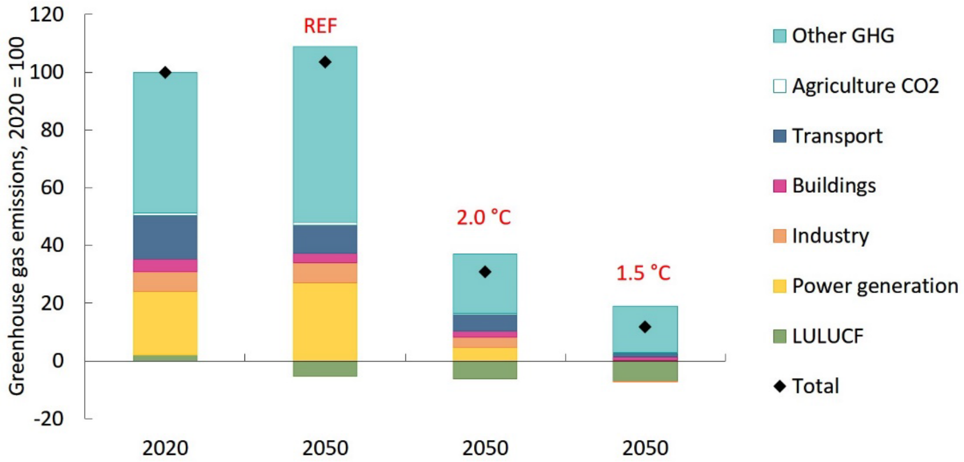
Figure 12. Trend of overall GHG emissions in WB5 region 1990-2018 (Crippa et al., 2021b)



Source: EDGAR JRC

increased by 8% and 19%, respectively, whereby those of CH_4 and N_2O decreased by 19% compared to 1990. Since fossil CO_2 emissions are the main contributor to the overall GHG emissions the overall trend is similar to the one in **Figure 10**.

Figure 13 Projection of WB GHG emissions according to three climate scenarios (Global Energy and Climate Outlook; EC-JRC, 2020)



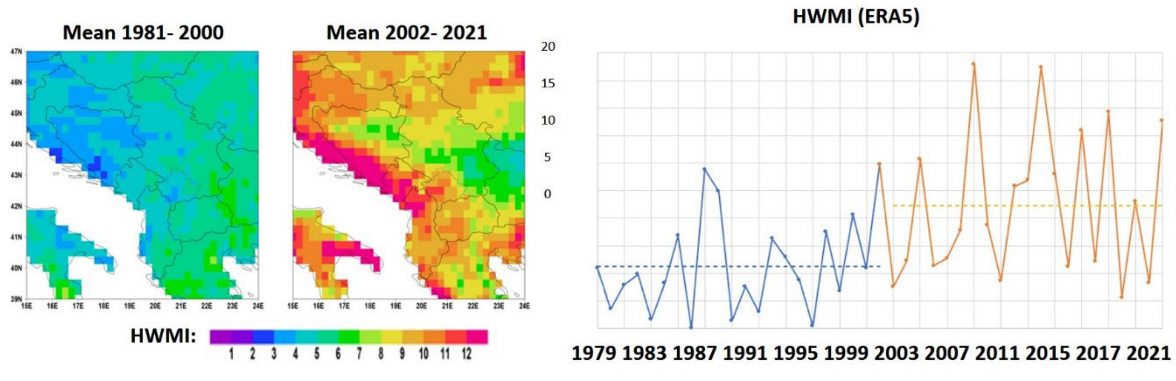
Source: GECO 2020 report (EC-JRC, 2020)

The projected Western Balkans GHG emissions in 2050 according to the reference scenario (current legislation) are 4% higher than those in 2020 mainly due to the increase in the energy sector and other unspecified sources that counterbalance the drop in the transportation and the sinks associated with the LULUCF sector (**Figure 13**; Global Energy and Climate Outlook; EC-JRC, 2020). On the contrary, the scenarios involving measures to keep global average temperature increase below 2.0°C and 1.5°C compared with pre-industrial levels, lead to 70% and 90% reduction of GHG emissions, respectively, with particular reference to energy and other sectors/GHGs.

3.4 Heat Waves

In a warmer climate, heat waves will very likely become more frequent, more intense and of longer duration causing severe impacts on human health, wildlife, wildfires and human activities such as agriculture and power generation. In the Western Balkans summer heatwaves with increasing magnitude were observed during the last decades.

Figure 14. Heat Wave Magnitude Index (HWMI) over WB region 1979-2021



Source: ERA5 atmospheric reanalysis from the ECMWF

As shown in **Figure 14**, the magnitude of extreme heatwaves described with the heat wave magnitude index (HWMI) increased over the entire Western Balkans region in particular along the eastern Adriatic Sea coasts (Russo et al., 2014, 2015). The largest increments are observed in southern Bosnia and Herzegovina, Montenegro and northern Albania. Other pronounced increments are found in northern Serbia, Kosovo and the Republic of North Macedonia. On average the magnitude of extreme heatwaves over the Western Balkans has doubled during the last two decades compared to the period 1981-2000. The worst heatwave before year 2000, occurred in 1987 with a magnitude index of about 12. After 2000, this value was exceeded already seven times with record-breaking heatwaves magnitude 50% larger than the 1987 record.

3.5 Final remarks on air quality and GHG in the Western Balkans

The availability of air quality measurements in the WB is still patchy. In most countries the data coverage has improved in the latest two years while, in others, the situation has worsened and the minimum coverage is not met preventing a proper evaluation of the air quality status. Most countries have achieved values below the legislation limits and show decreasing trends in the yearly PM_{10} and $PM_{2.5}$ average. However, no country-average is below the PM_{10} daily maximum and NO_2 hourly limits. The SO_2 hourly maximum values are below the limit only in North Macedonia and the levels are increasing in most countries. Bosnia and Herzegovina present values above the limit in all air pollutants and the trend is upwards in almost all of them.

The high annual mortality rates attributable to air pollution (above EU27 average) in the Western Balkans confirm the presence of a hot spot in SE Europe that involves also some EU Member States. Therefore, the transboundary pollution in this region is relevant for the achievement of the EU Zero Pollution Action Plan targets in the frame of the EU Green Deal. Moreover, according to a scenario analysis, the implementation of the planned measures (current legislation scenario, CLE) in the WB may not reduce the $PM_{2.5}$ related mortality and may lead to an increase in the one related to O_3 by 2050, compared to 2020.

The lockdowns adopted to face the Covid-19 pandemics in the first half of 2020 made it possible to quantify with precision the impact of road traffic on pollution, confirming the dominant impact (up to 80%) of this source on the observed levels of nitrogen oxides. Also, the CO_2 emissions from the energy, transport and residential sectors presented a drop in 2020 with respect to previous five years.

In 2020, SO_2 emissions were mainly from the power sector, in particular from coal fuelled power plants, and higher than the NERP ceilings everywhere in the WB. The energy sector is also responsible for 62% of the fossil CO_2 emissions in the WB with an increasing trend between 1990 and 2020 and the projections for such emissions under the current legislation scenario are to remain near the present levels until 2050. According to the evidence presented in this chapter, addressing the energy sector to abate both air pollutants and GHG emissions offers a concrete opportunity for co-benefits between air quality and climate policies. However, the energy transition would require accompanying measures to mitigate possible social impacts. The magnitude of climate change in the WB is depicted by the increase of summer heatwaves over the latest decades, with highest intensity in southern Bosnia and Herzegovina, Montenegro and northern Albania.

Proposed actions

- 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.
- Prioritise actions on the energy sector taking advantage of opportunities for co-benefits between air quality and climate policies.
- Promote international and interregional cooperation in the framework of existing international partnerships to address transboundary pollution in SE Europe.
- Favour the integration of the environmental measures into key sectorial policies (energy production, energy efficiency, industry, transport etc.) to tackle relevant sustainability drivers.
- Ensure coherence of financial and technical support with the Green Agenda for the Western Balkans and Coal Regions in Transition initiative.
- Continue capacity building and involvement of WB experts in EU networks taking advantage of the association of WB partners to the Horizon Europe programme.

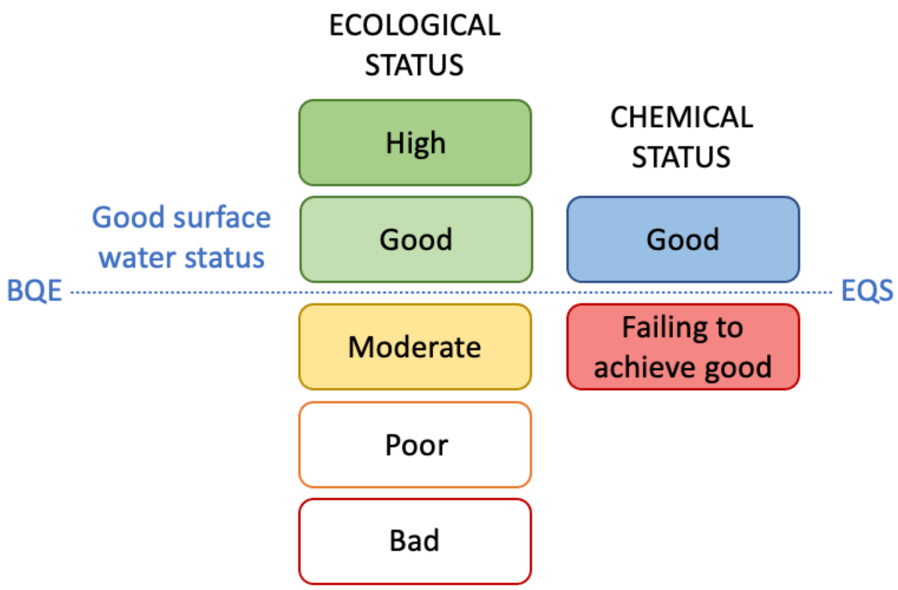
4 Status of water

In this section the implementation of the EU legislation for water protection is presented and discussed with an emphasis on the monitoring networks and exploratory studies in the WB. The status of the Zero Pollution Action Plan is illustrated with reference to the assessment of mixtures of chemicals and antimicrobial resistance.

4.1 Introduction to the Water Framework Directive (WFD)

The EU Water Framework Directive 2000/60/EC (WFD) has established a strategy for water protection, including specific measures for pollution control through the Programme of Measures with the objective of achieving good status in all the European waterbodies. It relies on an innovative approach for water management based on natural geographical and hydrological districts, setting specific deadlines and a methodological framework for EU Member States to achieve environmental objectives for aquatic ecosystems.

Figure 15 Classification of the chemical and ecological status under the WFD. EQS: environmental quality standards; BQE: biological quality element (see explanation in the text).



Source: JRC

Water status refers to both surface and ground waters. The status of surface waters under the WFD involves the assessment of fresh (inland), transitional and coastal waters. Marine waters are primarily addressed by the Marine Strategy Framework Directive (Directive 2008/56/EC). Surface water status is the general expression of the status of a body of surface water as determined by its ecological and chemical parameters (**Figure 15**). Good surface water status means that the ecological status is at least “good”, and that its chemical status is also “good”.

Chemical status assessment is based on the concentration of priority substances and other substances of concern in surface waters (lakes, rivers, transitional and coastal). Priority substances are identified as posing a significant risk to the water environment, while priority hazardous substances (PHS), being persistent, toxic and with the ability to bioaccumulate, may evoke an equivalent level of concern. For those substances, Directive 2008/105/EC (EQSD) has set the values for environmental quality standards (EQS) in water, sediment, and biota, referring to concentrations of single chemicals that may elicit adverse effects in aquatic organisms and humans. The EQS relies on a framework methodology that considers all relevant and reliable information on the (eco)toxicological effects of individual chemicals (EC, 2011).

Directive 2013/39/EU, which amends the WFD and EQSD, provides a list of newly-identified priority substances for priority action at the EU level, along with EQS values set for those substances or revised for some previously included substances, according to scientific progress.

For compliance checking under the WFD, chemical monitoring is critical for determining the chemical status of a waterbody, which is obtained by comparing measured concentrations of a substance with its EQS. The WFD indicates three modes of monitoring to inform management decisions: surveillance monitoring to assess long-term water quality; operational monitoring to characterise the quality of waterbodies, and investigative monitoring to define the main causes of non-compliance.

The ecological status describes the quality of the structure and functioning of aquatic ecosystems associated with surface waters based on biological quality elements (BQE) organised in main groups as follows: phytoplankton, macrophytes and phytobenthos, benthic invertebrate fauna, fish fauna. BQE are described with regard to the structure and sensitivity of a population described by abundance, diversity and tolerance, which are expressed as values between zero (worst class) and one (best class). Ecological monitoring is therefore performed at the community level, representing critical aspects of different biological compartments of the ecosystem, and reflecting physicochemical and hydromorphological conditions of the habitat. In this approach, protecting the most sensitive trophic level assumes the protection of other groups of organisms as the structure and functioning of the ecosystem are preserved.

In the determination of the chemical status, technical and economic limitations restrict the chemical analyses to already-regulated substances assessed one-by-one without considering the multitude of compounds coexisting in environmental matrices, which may lead to an underestimation of the risk. The combined effects of substances in chemical mixtures in the first place threaten aquatic biota and indirectly human health via food consumption and drinking-water intake.

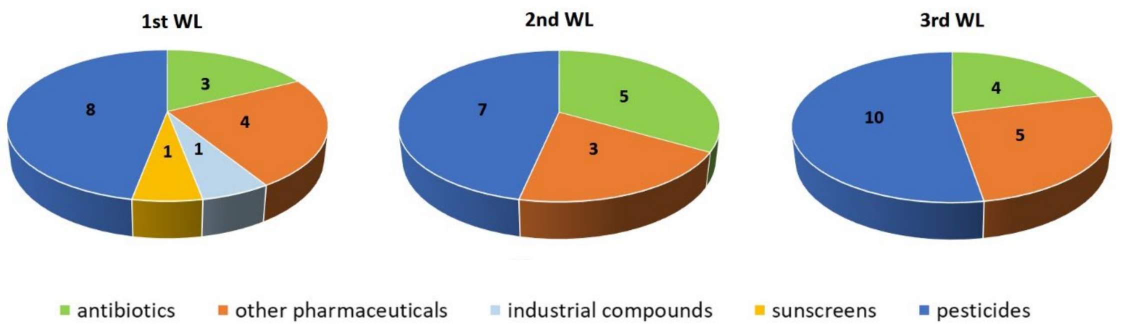
The implementation of the WFD in the WB region started in 2003 (Ninković et al., 2010; Paunović et al., 2016) and since then, much progress has been achieved in typology and waterbody identification, establishment of monitoring networks, development of assessment systems, etc.

4.1.1 Watch List (WL) and criteria for data quality analysis

The Watch List (WL) (Article 8b of Directive 2013/39/EU) is an instrument of the WFD for collecting high-quality, EU-wide monitoring data on potential water pollutants for the purpose of supporting prioritisation exercises. The WL is a “living”, dynamic EU instrument aimed at a constant updating of the information on important pollutants across Europe, specifically bearing in mind the rising concern related to particular groups of pollutants, the detection of new pollutants, but also increased analytical capacity that enables more confident assessment of the situation.

The substances included in the first WL (Carvalho et al., 2015; EU 2015/495), second WL (Loos et al., 2018; EU 2018/840) and third WL (Gomez et al., 2020; EU 2020/1161) are shown as groups in **Figure 16**. During the 5th reporting year of the WL, a total of 19 individual substances were monitored by the EU Member States (MS). This includes amoxicillin, ciprofloxacin and metaflumizone transferred from the 2nd WL (EU 2018/840), and 16 new substances added to the 3rd WL.

Figure 16 Substances included in the first, second and third WL according to their functional group. In the 3rd WL, antimicrobials other than antibiotics are included among other pharmaceuticals.

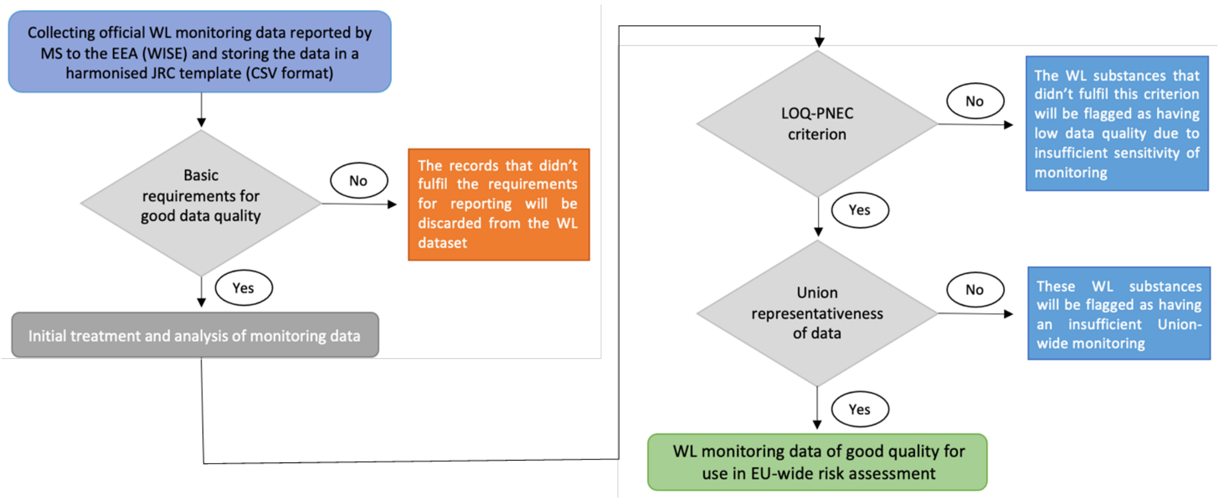


Source: JRC

The quality of monitoring data is crucial for a reliable risk assessment. Generally, the analysis of monitoring data follows the established approach for evaluating data quality (Carvalho et al., 2016; Loos et al., 2018). A schematic view of the procedure for data quality check is shown in **Figure 17**. Data that respect the basic requirements and fulfil the criteria for sufficient monitoring quality and EU representativeness could be confirmed as being of good quality to perform a reliable risk assessment.

The procedure for data quality includes basic (general) requirements and two specific criteria – the ''Level of Quantification - Predicted No Effect Concentration (LOQ-PNEC)'' criterion for a sufficient sensitivity of monitoring and the criterion for EU representativeness of data.

Figure 17 A schematic view of the procedure for data quality check that includes the basic requirements to monitoring data and criteria for a sufficient quality of monitoring and EU representativeness of data for making reliable risk assessment.



Source: JRC

Since the WL needs to cover a large geographical area, it is of fundamental importance to involve WB in the exercise. Due to differences in pollution types, economics and production in WB compared to EU countries, investigative monitoring of pollutants may provide new data for future WL updates based on the WB case. On the other hand, it is important for WB to collect comparable information on pollutants to provide an effective water management practice.

4.1.2 Monitoring of Watch List parameters in the Western Balkans

Although monitoring the WL's parameters is not a part of routine water quality monitoring in WB, information on potentially significant pollutants in surface and groundwater is available from specific projects (Liška et al., 2021, 2015). In the Joint Danube Survey 3 results from 2013, 17β-estradiol and diclofenac were found among the pharmaceuticals of importance for surface waters in large rivers of the Danube River Basin (Liška et al., 2015). The recent Joint Danube Survey from 2019 (Liška et al., 2021) covered the screening of 10 WL substances, including amoxicillin, ciprofloxacin and metaflumizone from the first WL update, showing that only some exceed the defined Predicted No Effect Concentration (PNEC) values for diclofenac, 17β-estradiol and imidacloprid. Several compounds, including amoxicillin, ciprofloxacin, sulfamethoxazole, trimethoprim, venlafaxine and fluconazole that are listed in the most recent EU Watch List (EU 2020/1161), were detected in river water samples. All compounds were detected at concentrations up to tens of ng/L, except 4-acetamido-antipyrine, 10,11-dihydro-10,11-dihydroxy carbamazepine, tenofovir, corticosterone and 19-norandrosterone, whose concentrations ranged from 114 ng/L (tenofovir) to 1171 ng/L (19-norandrosterone). The investigation also revealed that analytical improvement is needed for the quantification of 17α-ethinylestradiol, a substance with a highly oestrogenic effect. Based on the results of the GLOBAQUA project (Navarro-Ortega et al., 2015), only the neonicotinoids were quantified in surface water samples from the Sava River (Milačič et al., 2018).

A broad range of chemical substances that are not usualy a part of routine monitoring of groundwaters is available from the Joint Danube Survey 4 (Liška et al., 2021) and results of this study should be used for design of effective groundwater monitoring in the WBCs.

4.2 Water monitoring programs in the Western Balkans

Water monitoring programs in WB are at different levels of development as regards WFD requirements. Since the WFD came into effect in 2000, significant efforts in the EU and at regional and local levels have focused on the upgrade of water management in the WBs, particularly to raise institutional capacity and to improve water management systems, including water monitoring and status assessment. Transposition of a relevant legislation has been made in all countries with different degrees of accomplishment (Blinkova Donchevska et al., 2019; Cullaj et al., 2005; ICPDR, 2015; ISRBC, 2011; Keci, 2020; KEPA, 2020; Paunović et al., 2016; Weller and Liska, 2011). WB have recognised the necessity to coordinate water management upgrades with EU Member States, following the basin-wide approach to water management.

Descriptions of the typology and waterbodies, obligatory under WFD, are in progress in Bosnia and Herzegovina, Montenegro and Serbia, while in Albania, Kosovo and North Macedonia waterbodies have not yet been delineated nor characterised in accordance with the WFD Annex II. In Bosnia and Herzegovina 1,251 waterbodies were reported for the Sava River Basin (the Danube River Basin District) (FBiH-SavaRBMP, 2016; RS-SavaRBMP, 2017). In Montenegro, 48 surface waterbodies were identified for the Danube River Basin (MNE-RBMPDanube, 2019), while for the Adriatic Basin were described 41 surface inland waterbodies, five transitional and five coastal waterbodies (MNE-RBMPADR, 2019). The recently-developed 2021-2027 River Basin Management Plan (RBMP) for Serbia reported 3,216 waterbodies (RSDW, 2021). The delineation of the typology and waterbodies in Albania, Kosovo and North Macedonia was discussed partially for particular water catchments within the framework of scientific studies (Blinkova Donchevska et al., 2019), or provided as results of specific projects, such as the Preparation of two RBMPs for the Drini-Buna and Semani basins in Albania (the World Bank Water Resources and Irrigation Project P121186), the Bregalnica RBMP[2], the Vardar RBMP[3], both in N. Macedonia, the RBMP for Drini River in Kosovo[4], etc.

Most of the WB water quality networks are not fully compliant with the WFD requirements. Bosnia and Herzegovina, Montenegro and Serbia have developed, completely or partially, surveillance and operational monitoring networks, while in Albania, Kosovo and North Macedonia this task is still pending. Although the grouping of waterbodies is applied in accordance with the guidance for the implementation of the WFD (EC, 2003), surveillance monitoring networks in the three mentioned countries has limited coverage of waterbodies and monitoring frequency for a reliable status assessment.

4.2.1 Monitoring programs for chemical pollutants in the Wester Balkans

WFD compliant programs for monitoring chemical pollution were developed to some extent in Bosnia and Herzegovina, Montenegro and Serbia, while in Albania, Kosovo and North Macedonia, monitoring covers the physicochemical water quality parameters that are considered in the framework of ecological status assessment, as well as metals (Fe, Mn, Pb, Zn, Cd, Cr and Cu) in North Macedonia. An overview of the monitoring of physicochemical and chemical water quality parameters is presented in **Table 3**. Although the laboratories responsible for routine monitoring in Bosnia and Herzegovina, Montenegro and Serbia are generally well equipped, not all quality parameters regulated by the Directive 2013/39/EU are monitored.

Table 3. List of physicochemical and chemical parameters covered by routine national water quality monitoring in WB. *Source: JRC.*

Parameter	Albania	Bosnia and Herzegovina	Kosovo	Montenegro	North Macedonia	Serbia
Basic physicochemical parameters	✓	✓	✓	✓	✓	✓
Metals and metalloids		✓		✓	✓	✓
Priority substances		✓		✓		✓
Other pollutants						✓
Monitoring of biota						✓

Routine water quality monitoring in Albania and Kosovo currently covers only basic physicochemical parameters, so the information is not available for priority substances (Keci, 2020; KEPA, 2020). In addition to basic physicochemical parameters, routine water quality monitoring in North Macedonia also involves the

[2] https://www.moepp.gov.mk/wp-content/uploads/2015/01/RBMP_Bregalnica_Final.pdf
[3] https://www.moepp.gov.mk/?page_id=4749&lang=en
[4] http://kepweb.org/components/component-7/

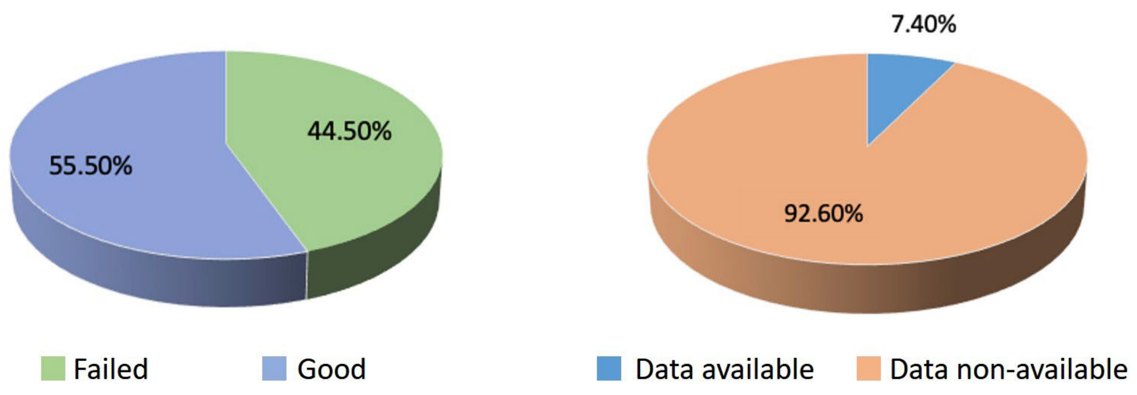
measurement of metals in water (Fe, Mn, Pb, Zn, Cd, Cr and Cu) (HSRNM, 2021). In 2020 and 2021, Mn and Cd exceedances were recorded in 10 sites out of 20.

Monitoring of priority substances in Montenegro is under development. A baseline chemical survey from 2018 (EI, 2018) revealed that 8 out of 10 monitored sites failed to achieve good chemical status, with exceedances of Ni, DEHP (plasticizer) in water, and Hg in biota. The same investigations indicated that the plasticizer bisphenol A and the pesticide malathion exceeded their PNEC and should be included among the Montenegrin River Basin Specific Pollutants (RBSP). Surveys and risk assessment studies report that more than 50% of waterbodies failed to achieve good chemical status in Montenegro (MNE-RBMPADR, 2019; MNE-RBMPDanube, 2019).

The Serbian national regulation (RS, 2014) lays down the EQS for 52 chemical substances or groups of substances. Besides the substances set by the Annex I of Directive (2008/105/EC, amended by 2013/39/EU), this regulation includes EQS for a group of pesticides, DDTs, tetrachloroethylene, trichloroethylene and PCBs, due to past pressures. Exceedance of the threshold value was recorded for Ni, Pb, Cd, Hg fluoranthene, endosulfan, benzopyrene (RSDW, 2021), and 78 out of 185 analysed waterbodies failed to achieve good chemical status. Investigative monitoring of biota and sediment according to Directive 2013/39/EU started in Serbia in 2019 in a limited number of sites.

A rough summary on the chemical status in WB based on low percentage of waterbodies from Bosnia and Herzegovina (FBiH-SavaRBMP, 2016; RS-SavaRBMP, 2017), Montenegro (MNE-RBMPADR, 2019; MNE-RBMPDanube, 2019), North Macedonia (HSRNM, 2021) and Serbia (RSDW, 2021), revealed high pressure of chemical pollution in the WB (**Figure 18**).

Figure 18 Chemical status of waterbodies in WB based on the data from Bosnia and Herzegovina, Montenegro, North Macedonia and Serbia (left). Data availability on chemical monitoring (right).



Source: IBISS (Institute for Biological Research „Siniša Stanković", National institute of Republic of Serbia, University of Belgrade)

None of the WB have developed specific background values for specific pollutants in river catchments, which additionally diminishes the confidence in chemical assessment. This action is one of the priorities.

4.2.2 Monitoring programs under ecological status

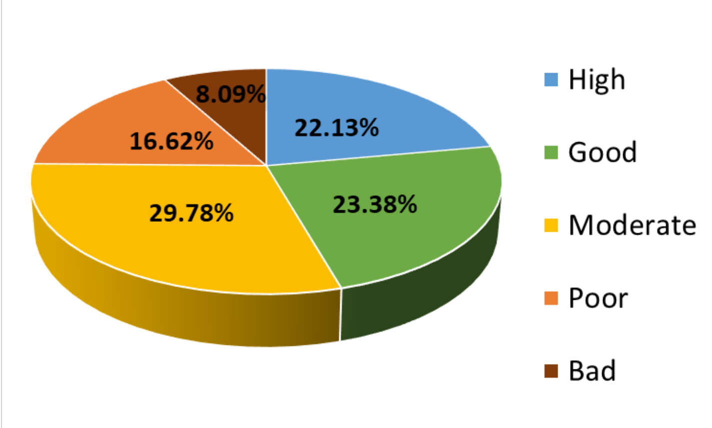
Monitoring of ecological status in the WB is not fully developed. The federation of Bosnia and Herzegovina (FBiH, 2014), Montenegro (MNE, 2019) and Serbia (RS, 2011) adopted type-specific systems for assessing the ecological status, while in other countries the system is still under development. Partial BQE monitoring was undertaken in Bosnia and Herzegovina, Montenegro, North Macedonia and Serbia (FBiH-SavaRBMP, 2016; MNE-RBMPADR, 2019; MNE-RBMPDanube, 2019; RS-SavaRBMP, 2017; RSDW, 2021). In most countries, monitoring involves algae and aquatic macroinvertebrates, while the aquatic macrophytes and fish have been studied in the framework of investigative monitoring.

Assessment of the hydromorphological status of waterbodies across the WB is still ongoing and is not a part of routine national monitoring practice in the WB. Hydromorphological assessments were performed for a considerable number of waterbodies in Bosnia and Herzegovina, Montenegro and Serbia (FBiH-SavaRBMP, 2016; MNE-RBMPADR, 2019; MNE-RBMPDanube, 2019; RS-SavaRBMP, 2017; RSDW, 2021). It should be underlined that hydromorphological degradation has been identified as one of the most important management issues across the Balkans, including the WB (Piria et al., 2019; Schiemer et al., 2020; Simonović et al., 2021).

An ecological status assessment in North Macedonia has been performed using the system developed for Serbia (HSRNM, 2021), considering that the same types of running-waterbodies are present in both countries. However, North Macedonian ecosystems require specific attention because are characterised by specific lake systems and the presence of endemic and relict species (Hadzisce, 1953; P. Simonović et al., 2015; Slavevska-Stamenković et al., 2016; Stanković, 1962). In addition, international collaboration is needed since Lake Ohrid is shared with Albania, while Prespa and Dojran lakes are shared with Greece.

A rough estimate of the ecological status based on 1,125 waterbodies from Bosnia and Herzegovina, Montenegro and Serbia presented in **Figure 19**, indicates that 54.49% of them failed to achieve good ecological status and, therefore, measures need to be undertaken.

Figure 19 Overview of the ecological status in WB based on the data for Bosnia and Herzegovina, Montenegro, and Serbia (FBiH-SavaRBMP, 2016; MNE-RBMPADR, 2019; MNE-RBMPDanube, 2019; RS-SavaRBMP, 2017; RSDW, 2021).



Source: IBISS (Institute for Biological Research „Siniša Stanković", National institute of Republic of Serbia, University of Belgrade)

The possibility of developing effective systems for monitoring the ecological status in WB entails the use of advanced methods of molecular taxonomy, as well as eDNA methods, to increase the effectiveness of data collection. This implies the use of (i) DNA barcoding (COI) analyses, (ii) DNA metabarcoding analyses of homogenised bulk sample, and (iii) environmental DNA (eDNA) metabarcoding of water and/or preservation liquid samples used for macroinvertebrate preservation (Beermann et al., 2021; Leese et al., 2020; Liška et al., 2021; Weigand and Jonas, 2021).

4.2.3 Monitoring of ground waters under the WFD

The WFD also defines the good chemical status and good quantitative status of groundwater (GW). EU Member States should focus on actual risks identified by the analysis of pressures and impacts under Article 5 of the WFD. In addition, they establish own quality standards and threshold values for GW, taking into account identified risks and the list of pollutants/indicators given in Annex I (threshold values for nitrates and pesticides) and Annex II of the Groundwater Directive (GWD – Directive 2006/118/EC). The development of the WFD compliant monitoring of ground waters in WB is an ongoing process. Bosnia and Herzegovina, Montenegro and Serbia have delineated groundwater bodies (FBiH-SavaRBMP, 2016; MNE-RBMPADR, 2019; MNE-RBMPDanube, 2019; RSDW, 2021), and development of related methodology has been initiated. The implementation of GW monitoring networks in the WB is unsatisfactory, in terms of frequency and number of parameters, and requires prompt improvement.

4.2.4 Monitoring of transitional and coastal water bodies under the WFD

Transitional and coastal water bodies are relevant for Albania, Bosnia and Herzegovina and Montenegro. The WFD compliant monitoring of transitional and coastal waters started in Montenegro in 2018, with the methodology still needing further development. Montenegro has identified five distinct types of transitional waters and two types of coastal water bodies. In an assessment of low confidence level, both coastal and one transitional water body failed to achieve good status (MNE-RBMPADR, 2019). The assessment methodology for coastal and transitional water bodies in the WB could be developed based on the available systems applied to Mediterranean countries. Worth mentioning that Montenegro has the capacity to fully implement the monitoring of coastal and transitional water bodies, thanks to the work of the Institute of Marine Biology in Kotor (https://www.aquariumboka.ucg.ac.me/en/institute-marine-biology/).

4.2.5 Monitoring of protected areas under the WFD

The national legislation related to protected areas in WB is not fully harmonised with EU standards. Additionally, the registers of protected areas relevant for water management, as well as their monitoring according to WFD requirements, have not been accomplished in WB. Thus, the establishment of proper monitoring of protected areas according to the principles established in the WFD is one of the priorities for this region (FBiH-SavaRBMP, 2016; MNE-RBMPADR, 2019; MNE-RBMPDanube, 2019; RS-SavaRBMP, 2017; RSDW, 2021).

Box 5. Water Status Monitoring deficiencies

General weaknesses:

The WFD-compliant monitoring systems in WB are still not developed for chemical and ecological status appraisal;

Typology and waterbody delineation have not been realised in all countries;

Monitoring networks have not been developed according the WFD requirements, which refers to both surveillance and operational monitoring;

Low coverage of monitored waterbodies;

Frequency of monitoring is not sufficient;

Monitoring of protected areas according to the WFD in WB is not established.

Monitoring of chemical status difficulties:

Priority parameters are not fully covered by the monitoring practice;

Relevant legislative is not fully established in WB;

Background values for river catchments are not identified;

Analytical capacity is missing.

Monitoring of ecological status shortcomings:

Systems of the assessment of ecological status are not developed in all countries;

Assessment of the level of hydromorphological degradation is missing;

Not all biological quality elements are covered by the monitoring.

Recommendations and perspectives

To continue with programs that increase institutional capacity for water management in WB;

To provide more possibilities for collaboration among WB in the field of water management, including activities aimed at developing monitoring practice, assessment systems, training on the use of biological quality elements, etc.

To support the use of experience from neighbouring countries in the development of typology and water-body delineation, as well as development of assessment systems and monitoring practice;

To support activities in the identification of background values for specific pollutants for significant river basins in the region;

To actively participate in WL exercises;

To support activities in the identification of river-basin specific pollutants in WB;

To support activities in the assessment of hydromorphological degradation;

To focus efforts on both ecological status assessment and identification of the state of biodiversity in aquatic ecosystems;

To work on the application of advanced methods in ecological status assessment – e.g. molecular taxonomy and eDNA methods;

To develop the methodology of ecological status assessment of transitional and coastal water bodies based on the experience of Member States, specifically in the Mediterranean Region (e.g. Greece, Croatia and Italy – Adriatic and Ionian seas);

To establish monitoring of water-relevant protected areas according to WFD requirements;

To involve the research community more actively in the development of status assessment methodology.

4.3 Current state of play on Zero Pollution Action Plan in the Western Balkans for water

4.3.1 Mixture assessment of chemicals

A large body of scientific evidence confirms that the association between the ecological status and hazards from heterogeneous contaminants generate complex interactions altering diverse biological pathways. With thousands of chemicals released daily into water environments, instrumental analyses of individual substances including pollutants of emerging concern, metabolites, and transformation products, are incapable of providing a realistic picture of the simultaneous exposure to multiple compounds. Additionally, the lack of guidelines and safety threshold values that consider the interactions of co-occurring substances, complicates risk assessment. EU environmental regulatory frameworks, such as the WFD and REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals), consider primarily the toxicity assessment of single chemicals.

Simultaneous exposure to substances, acting through the same or different modes of action (MoAs), affect the same biological function of an organism to an extent that is not attained by exposure to a single substance, thereby eliciting cumulative effects. The cumulative approach has the advantage of covering the combined effects of co-occurring substances with the same toxicological endpoints that might not exceed safety values when measured individually. In the EU legislation, the cumulative risk from exposure to chemical mixtures is covered only in a few instances based on grouping substances belonging to a similar chemical class and MoA, among which are pesticide residues (EFSA, 2008 and 2009) and per-/polyfluoroalkyl substances (PFAS) under the Drinking Water Directive (Recast DWD, 2020). As part of the European Green Deal, the Chemicals Strategy for Sustainability aims at developing assessment approaches to cover multiple substances instead of one-by-one measurements (COM(2020) 667).

The available knowledge on groups of substances classified according to their MoA has been combined with the most suitable effect-based methods (EBMs) to detect the overall response in organisms according to the cumulative approach (Napierska et al., 2018). EBMs have the advantage of detecting the effects of substances in a chemical mixture acting on specific endpoints without requiring a priori knowledge of the exact substances to be assessed. Currently, validated and standardised EBMs are employed for the analysis of mixture effects in aquatic organisms at various levels of biological complexity. EBMs can be used for quality assessment of water and sediment, including initial screening of surface waters with an unknown pollution profile based on the main ecotoxicological endpoints, for the prioritisation of waterbodies, restricting the chemical analysis in the areas of concern or for the establishment of early warning systems (Wernersson et al., 2015).

4.3.2 Chemical mixture issue in the Western Balkans

Freshwater ecosystems are under significant threat due to the impact of multiple stressors, including pollution, hydromorphological degradation, invasive alien species, and pathogens. The interaction of stressors can result in complex effects on organisms and ecosystems (De Castro-Català et al., 2020; Navarro-Ortega et al., 2015). Knowledge gaps limit the capacity to understand this complex interactions. This is particularly critical in the WB where, as previously emphasised, the confidence of chemical status assessment is generally low because of low coverage of waterbodies, lack of required parameters, missing data on river-basin specific pollutants, low frequency of monitoring, etc.

Recent studies (De Castro-Català et al., 2020) report that the main drivers for diatom community structure include the toxicity level of pharmaceutical compounds, with the antibiotics clarithromycin, azithromycin and sulfamethoxazole as the main contributors to toxicity. The same study presents evidence of the effects of pharmaceuticals PhACs on the algal community. In the case of macroinvertebrates, the main variables affecting macroinvertebrate community structure were found to be a set of hydromorphological parameters such as hydrology, habitat homogenisation, alteration of riversides and loss of the riparian corridor. These findings indicate that community structure parameters can be used for the assessment of the influence of chemical mixtures on aquatic ecosystems in WB. In the case of the Danube River, the study of Popović et al. (2020)

showed that the distribution of 2,4-dinitrophenol, chloroxuron, bromacil, dimefuron, amoxicillin, bentazon and fluoranthene is highly correlated with macroinvertebrate communities. The measurement and assessment of river ecosystem processes can also be used to evaluate the influence of mixtures of pollutants, as described in von Schiller et al. (2017). The use of a set of indicators, as well as examination of different tissues, was reported as an effective approach for assessing the possible effects of multiple stressors on the aquatic environment in the Sava River (Kostić et al., 2017). All abovementioned studies point to the potential wide use of a selected battery of tests for more accurate assessment of the effects of mixtures of pollutants in aquatic ecosystems.

Box 6. Current status of the effect of multiple stressors on aquatic environments – the Western Balkan Case

Unequivocal evidence for the effects of multiple stressors in waterbodies of the WB;

Currently, there is insufficient capacity to measure all pollutants of concern and to analyse their joint influence in aquatic ecosystems.

Recommendations

— Implementation of effect-based methods should be one of the priorities; the methods could be applied based on ongoing activities in the implementation of the WFD in the EU and with the support of European countries;

— It is possible to measure the influence of multiple stressors by using a set of indicators, including those that reflect riverine processes, as well as biological indicators on different levels of biological organization (molecular, organismic, community);

— Methods are under development and a certain level of knowhow in WB exists;

— Procedures for measuring the influence of multiple stressors should be used in WB as an effective tool for understanding complex processes in aquatic systems;

— Training and transfer of scientific knowledge of effect-based assessment are of importance for WB; training activities could be organised in European scientific centres; the JRC could provide such expertise (please, see Gomez et al., 2020).

4.3.3 Antimicrobial resistance

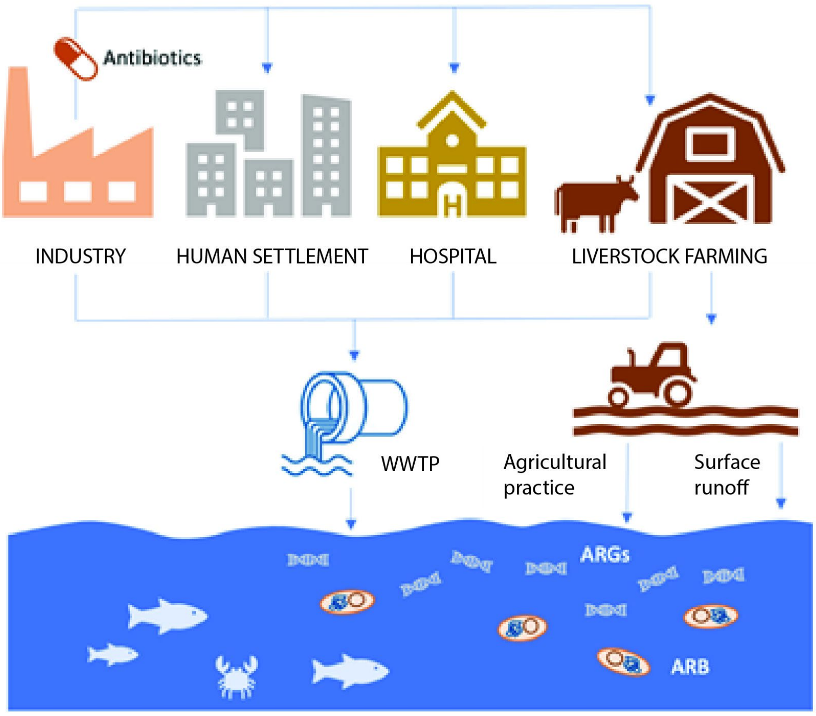
Antimicrobial resistance (AMR) defines the ability of microorganisms to withstand the effects of antibiotics and other antimicrobial compounds (Sanseverino et al., 2018). It results from either overuse or misuse of antimicrobials in medical healthcare and livestock farming, and it spreads in the environment mainly through agricultural practice and release from wastewater treatment plants (WWTPs). As shown in **Figure 20**, antibiotic residues from the pharmaceutical industry, human settlements, hospitals, livestock farms discharged to the WWTP where incomplete removal processes lead to further release of the remaining antibiotic fraction to the outflow waters. Upon exposure to antibiotics, antibiotic resistant bacteria (ARB) are established already at the source or further along the pathway. At the same time, antibiotic resistance genes (ARGs) are transferred among bacteria or released from dead cells forming an extracellular pool of ARGs which can be taken up by sensitive microorganisms.

Aquatic environments are considered critical in the spread of AMR, being reservoirs of antibiotic resistance genes (ARGs) that determine the resistant phenotypes of microorganisms. In surface waters and wastewaters, the concentrations of antibiotics are highly variable and traditional WWTPs remove them partially or degrade them to products that may be as toxic as their parent compounds or even more (Sengelov et al., 2003). Elimination of ARB and ARGs has limited efficiency, leading to their increase in WWTP effluents (Ferreira et al., 2006 and 2007; Zhang Y et al., 2009; Łuczkiewicz et al., 2010; Novo et al., 2013; Rodríguez-Chueca et al., 2019).

Antibiotic resistance can be promoted by non-antibiotic biocides (e.g. triclosan) (Gilbert and McBain, 2003; SCENIHR, 2009; Webber et al., 2017; Sanseverino et al., 2018; Carey and McNamara, 2015). Metal contamination can act as a long-term selective pressure for antibiotic resistance due to the persistence of metals in the environment (Sanseverino et al., 2018).

The need for global surveillance of antimicrobial consumption in humans and animals has been highlighted by the European Commission (EC COM(2011)748) and other international authorities (WHO, 2014; O'Neill, 2016). More recently, One Health European strategies and joint recommendations of the WHO, Food and Agriculture Organisation (FAO) of the United Nations and World Organisation for Animal Health (OIE) have brought attention to the role of polluted waterbodies in the contribution to AMR (EC COM(2017)339; WHO et al., 2020).

Figure 20 Antimicrobial resistance (AMR) in surface waters. WWTP: wastewater treatment plant (see explanation in the text).



Source: JRC

At the EU regulatory level, antibiotics and other antimicrobials were selected for the WL of the WFD. The first WL included three antibiotics belonging to the macrolide class: azithromycin, clarithromycin and erythromycin, the 2nd WL included amoxicillin and ciprofloxacin, followed by sulfamethoxazole, trimethoprim and azole antifungal agents in the 3rd WL (Carvalho et al., 2015; Loos et al., 2018; Gomez Cortes et al., 2020; EU 2020/1161). The monitoring of these substances should provide high quality data on their concentrations introduced to or via the aquatic environment. Actions to better characterise the relationship between the presence of antibiotics in the environment and the spread of AMR through enhanced environmental monitoring, as well as advanced environmental risk assessment of medicinal products encompassing antibiotics and ARGs, are covered by the EU Strategic Approach to Pharmaceuticals in the Environment (COM(2019) 128, EC 2020).

4.3.4 Antimicrobial resistance in the Western Balkans

Studies of AMR in the WB are restricted to research activities mainly in large rivers (Kolarević et al., 2020). Investigations in the Danube River in 2013 (Liška et al., 2015) and 2019 (Liška et al., 2021) showed a modified resistance pattern of *Escherichia coli*. The investigation in 2013 also indicated antibiotic resistance in *Pseudomonas* spp. only in the case of the combination of trimethoprim-sulphamethoxazole (resistance corresponds to wild type). At the same time, more than 50% of the *E. coli* isolated showed a modified resistance pattern, but most of the isolates (47) were only resistant to one or two tested antibiotics. The frequency of multidrug resistance increased at the downstream sampling points indicating either a more problematic resistance situation in clinical settings in downstream countries (including Serbia) or a cumulative effect. All *E. coli* isolates were susceptible to last-line antibiotics. Furthermore, the 2019 survey indicated an increase of 42% in the number of multidrug-resistant *E. coli* as compared to the 2013 survey when multidrug-resistance occurred in 9.7% of the analysed samples. Both surveys indicated resistance to ampicillin and tetracycline (21.8% of isolates resistant to ampicillin and 24.0% to tetracycline). In addition, all isolates were resistant to meropenem, imipenem, amikacin, colistin and tigecycline.

Comparison of data for the Danube for a six-year period revealed a significant increase in multidrug-resistance and the extended spectrum beta-lactamase phenotype for *E. coli*. The accumulation of resistance mechanisms in the *E. coli* population in the largest river in the region, the Danube, confirmed that antibiotic resistance is a significant issue in WB and that it should be seriously considered in future water monitoring.

Box 7. Current status in monitoring antibiotic resistance – Western Balkan Case

The aquatic environment is an important player in the spread of AMR being a reservoir of antibiotic resistance genes;

Studies of antimicrobial resistance in the WB are scarce.

Recommendations

It is important to provide evidence for AMR in WB as this is an important water management and health issue;

The task could be fulfilled based on collaboration of research communities and management structures, on projects supporting the activities of AMR monitoring AMR, as well as on close collaboration with European countries;

An exchange of training and knowledge is needed to establish a basis for effective AMR monitoring in WB

4.4 Final remarks on water in the Western Balkans

Typology, waterbody delineation, development of analytical procedures for chemical status assessment, development of type-specific systems of ecological status assessment are valid preparatory steps in the development of monitoring networks, monitoring practice and reporting.

Despite the lack of data, the status of waterbodies in the WB could generally be assessed as unsatisfactory. In the case of chemical status, 44.5% of assessed waterbodies failed to reach good status, while in the case of ecological assessment 54.49% failed to reach good status.

Case studies on antibiotic resistance, as well as effect-based studies on mixtures of pollutants additionally confirmed that aquatic ecosystems, particularly large fluvial rivers, are under considerable anthropogenic pressure.

To overcome the lack of water management practice in WB, it is important to:

- Continue with programs aimed at raising institutional capacity for water management in WB;
- Cooperate closely with Member States in the establishment of an effective water management practice in WB at different levels – water management, scientific research, raising public awareness, etc.;
- Organise training and the exchange of scientific knowledge using existing capacities in Member States, particularly JRC capacities;
- Provide platforms for more effective collaboration of WB in the field of water management;
- Support the use of experience from neighbouring countries in the development of typology and waterbody delineation, as well as development of assessment systems and monitoring practice;
- Organise activities on the identification of background values for specific pollutants for significant river basins in the region;
- Support activities on the identification of river basin-specific pollutants in WB;
- Promote activities on the assessment of hydromorphological degradation;
- Focus efforts on both ecological status assessment and identification of the state of biodiversity in aquatic ecosystems;
- Support the use of advanced methods in ecological status assessment – e.g. molecular taxonomy and eDNA methods, and
- Involve the research community more effectively in developing status assessment methods.

5 Status of soil

In this section the concept of soil health is introduced and the status of WB soils is described with particular reference to the EU Soil strategy for 2030. The interconnection between soil health and other thematic areas is also discussed in detail.

5.1 Introduction

Protecting soil at the same level as that for air, inland water bodies and the marine environment is considered the solution to improving the degraded state of soils across Europe. However, progress in establishing an effective level of protection has been limited since the 2006 Soil Thematic Strategy called for it. At present, the need has become more pressing as proven by the the significant advancement in the knowledge about soils and the recognition of their value. The pressures, expectations and claims on soil have intensified, while the climate and biodiversity crises are aggravating the situation. It should be noted that soil degradation has impacts beyond national borders, which means that a lack of action in one Member State may lead to environmental degradation in another one. Equally, soil degradation, and an uneven and fragmented response by Member States to tackle it, has led to a disruption of the internal market and an uneven playing field for economic operators who have to go by different rules on soil protection.

With this in mind, the European Commission published in November 2021, a new Soil Strategy for 2030, entitled "Reaping the benefits of healthy soils for people, food, nature and climate" (EC, 2021), which sets out a framework for protecting, restoring and the sustainable use of soils. The vision for the strategy is that by 2050, all EU soil ecosystems are in healthy condition and fully address the major societal challenges of achieving climate neutrality and becoming resilient to climate change, developing a clean and circular (bio)economy, reversing biodiversity loss, safeguarding human health, halting desertification and reversing land degradation (**Figure 21**).

Figure 21 Main policy focus for the soil strategy.

Source: JRC

Box 8. What are healthy soils?

Soils are healthy when they are in good chemical, biological and physical condition, and thus able to continuously provide as many of the following ecosystem services as possible:

• provide food and biomass production, including agriculture and forestry;

• absorb, store and filter water and transform nutrients and substances, thus protecting groundwater bodies;

• provide the basis for life and biodiversity, including habitats, species and genes;

• act as a carbon reservoir;

• provide a physical platform and cultural services for humans and their activities;

• act as a source of raw materials;

• constitute an archive of geological, geomorphological and archaeological heritage.

In this respect, understanding the health of a soil is highly relevant. Degraded soils have partially or completely lost their capacity to provide the functions and services listed above. In some cases, the adoption of sustainable soil management practices can lead to a full recovery after some years (e.g. in case of loss of carbon and biodiversity or compaction and erosion of the top fertile layer). In other cases, active restoration measures are needed for sometimes only partial recovery (e.g. for sealed, desertified, salinised or acidified soils). In some cases, degradation can be irreversible in terms of human timescales.

There is an increasing interest for a refined soil health index. This requires the definition of common ranges or thresholds beyond which soils cannot be considered healthy anymore. Such indicators for soil health and their range of values that should be achieved by 2050 to ensure good soil health will need to be developed and agreed. In addition, they should be considered at EU level in the context of the Soil Health Law to ensure a level playing field and a high level of environmental and health protection.

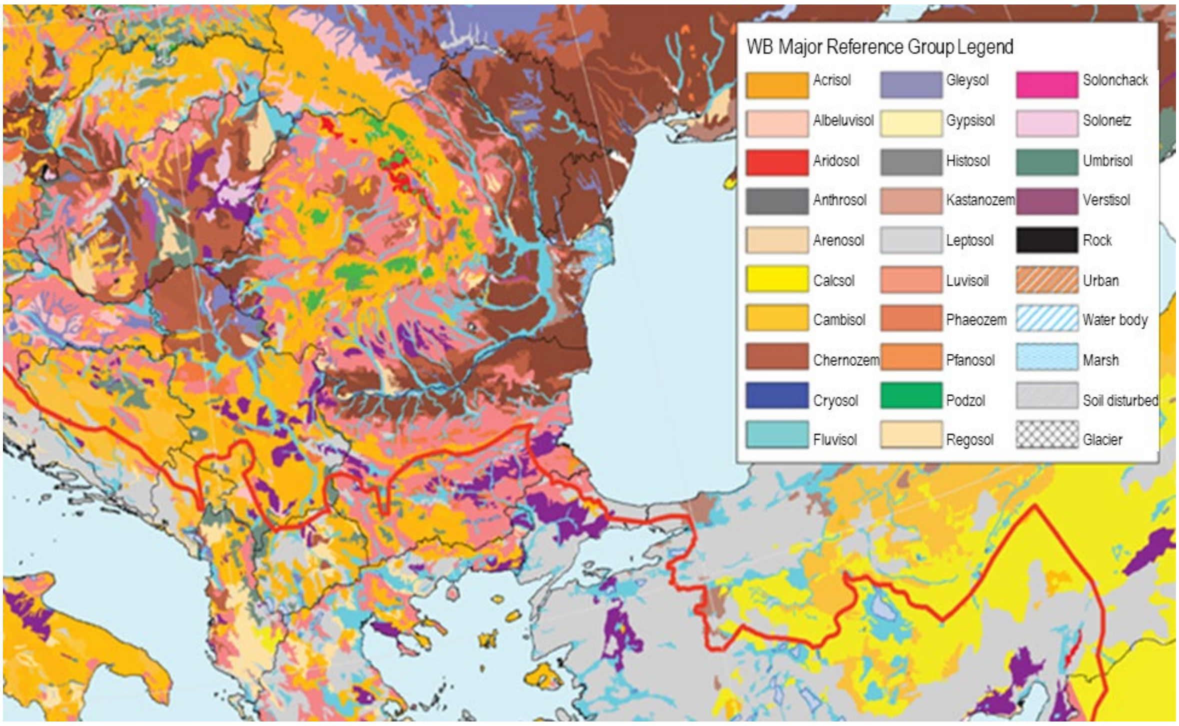
5.2 Soil health in the Western Balkans

As defined in the Green Agenda for the Western Balkans (EC, 2020a), five pillars of action have been identified targeting: (1) climate action, (2) circular economy, (3) biodiversity, (4) fighting pollution of air, water, and soil and (5) sustainable food systems and rural areas. These are fully mirrored in the new EU Soil Strategy.

A holistic investigation has been performed in the WB following the assessment presented in Annex 1 of the proposal for a Soil Health and Food Mission (Zdruli et al 2022, in preparation). The study assessed the areal extent for a range of indicators that singly, or in combination, could pinpoint a decline in soil condition and health (land/soil degradation). These include:

- Soil nutrient assessments (e.g. Gross Nutrient Balance, excess nitrogen/vulnerable zones, phosphorus)
- Organic carbon fluxes (in organic soils and cropland mineral soils)
- Erosion (by water and wind, coastal erosion, agricultural land under severe erosion)
- Compaction
- Pollution (local and diffuse – with as much breakdown as possible, evidence on microplastic and emerging contaminants) and waste streams with relevance to soil
- Soil sealing and net land take

Figure 22 General representation of the soil distribution in the Western Balkans. (The red line shows the delineation of the Mediterranean watershed).



Source: Soil Atlas of Europe (Jones et al., 2005)

- Salinisation
- Desertification
- Pressures on soil biodiversity (if available).

The WB soils are the result of the pedogenetic process with lithology, topography and climate playing a dominant role as soil forming factors. The large diversity is represented by Cambisols, Luvisols, Chernozems, Kastanozems, Phaeozems, Umbrisols, Fluvisols, Gleysols, Histosols, Arenosols, Calcisols, Leptosols, Regosols, Vertisols, Solonchacks, Solonetz, Anthrosols, and Technosols (**Figure 22**).

To evaluate different pressures on soils and the soil health in WB, land use and land cover must be taken into consideration. The latest data are available as for 2020 (**Table 4**)

With relevance to "*Soil nutrients and Nitrate Vulnerable Zones*", it is estimated that the area of agricultural land with failure due to direct inputs of nutrients in agricultural systems (excluding air pollution issues) to be in the range of **5% - 15% of the total agriculture area**.

Regarding "*Organic carbon*", it is estimated that the land with failure due to low and declining carbon stocks to be in the range of less than **5% of the total land area of the region and about 10% for agriculture land**.

The soil health indicator "*Soil erosion*" is the most relevant and aggressive process for the Western Balkan region. It is estimated that the area of **agriculture land with failure due to water erosion to be in the range of 30% while about 45% of the total land area is affected by unsustainable soil erosion**.

Data are not available on the extent and degree of "*Compaction*". Except for very few sporadic case studies (i.e., Jakšić et al., 2021, in Serbia) no other sources are available. Therefore, it is suggested that **soil compaction should be included without delay both in the national and EU research projects**.

The issue of "*Pollution including risks to food*" is very relevant in the Western Balkans where a total of **2,735 contaminated sites are reported**. But it is likely that the actual number could well be higher. This is the result of mining and industrial activities and to a lesser extent from agriculture practices. However, their areal extent is unknown, except for a few countries. Some soils are also naturally contaminated with **heavy metals** due to geological formations from where they derive. Contamination, and waste management remain problematic as data relevant to them are scarce and often unknown. They include local hotspots (e.g., ex-industrial land, landfills, military compounds, etc.), agricultural land (pesticides, metals, sewage sludge, plastics) as well as unquantified emerging pollutants.

A first assessment of "*Soil sealing*" in the Western Balkans shows that **0,87% of the total land area in the region is artificially covered**. Agriculture land appears to have experienced the biggest loses. Land take and sealing is driven by rapid economic expansion and housing needs.

"*Salinisation*" was combined also with sodicity and a special soil type typical for the Western Balkans or the magnesial rich soils, locally known as Smonitsa or Chromic Vertisols characterised by their very dark colour and high clay content. They cover large areas in Serbia, North Macedonia, and Albania and are being cultivated for many years, despite their poor chemical and physical properties. Salinity in the region is both caused by natural conditions and unsustainable irrigation practices. Overall, it is estimated that these areas cover less than **10% of the whole territory of the Western Balkans**.

Regarding "*Desertification*", none of the countries meet the criteria of aridity index as described by the United Nations convention to combat desertification (UNCCD), although all are signatories. In Albania and Montenegro, about 25% of the territory could be subject to desertification. Furthermore, land degradation in the general context is present in all the countries with soil erosion as the most prominent factor affecting large areas (overlap with soil health indicator 3).

No data were available for "*Soil biodiversity*".

Additionally, *organic farming* in the Western Balkans covers only 2.6% of the total farming area which is far too low compared with the EU Green Deal target to make 25% of the farming in the EU organic by 2030.

Table 4. Summary of land use/land cover for the Western Balkans countries as of 2020. *Source: Zdruli et al 2022, in preparation.*

Countries	Population In million	Total territory Km^2	Agriculture land[1] (against total territory) — Cropland		Permanent crops		Total (cropland and permanent crops)		Organic farming[2] (against total agric. land)		Forest and areas with forestry biomass including shrubs (against total territory)		Permanent meadows and pastures (against total territory)		Other areas[3] (against total territory)	
			ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Albania	2.8	28,748	614,350	21.37	84,650	2.94	696,000	24.31	653	0.10	1,077,113	37.46	478,080	16.63	623,607	21.60
Bosnia and Herzegovina	3.3	51,130	1,228,860	24.03	5,465	0.11	1,234,325	24.14	896	0.07	3,126,317	61.14	650,581	12.72	110,100	2.00
Kosovo	1.8	11,000	310,962	28.27	20,651	1.88	331,613	30.15	160	0,04	450,000	40.90	155,000	14.09	163,394	14.86
Montenegro	0.6	13,888	9,214	0.66	2,657	0.19	11,872	0.85	870	7.32	827,536	59.59	208,226	17.48	306,674	22.83
North Macedonia	2.0	25,436	413,049	16.23	40,134	1.58	453,184	17.82	3,957	0.16	1,153,451	45.35	803,809	31.60	129,199	5.22
Serbia	6.9	88,407	2,569,932	29.07	206,228	2.33	2,776,160	31.40	21,265	7.70	2,850,000	32.23	675,314	7.64	2,539,933	28.73
TOTAL	**17.4**	**218,609**	**5,146,367**	**19.93**	**359,785**	**1.50**[4]	**5,503,154**	**21.44**[4]	**27,801**	**2.56**[4]	**9,484,417**	**46.11**[4]	**3,005,501**	**16.69**[4]	**3,873,180**	**15.87**[4]

Notes

[1] Agriculture land includes cropland (i.e., cereals, industrial such as sugar beet, sunflower, horticulture in open field and greenhouses, forage crops), and permanent crops (fruit trees, olives, vineyards, citrus).

[2] Data from FiBL & IFOAM- ORGANICS INTERANTIONAL, 2020

[3]Includes land occupied by buildings, infrastructure, quarries, tracks, ponds, water bodies, infertile land impossible for agriculture use, rocky areas, etc. Sealed areas cover a small fraction, but mostly in the best soils of the country.

[4] Weighted percentages at regional level considering the countries surface areas.

Table 5. Summary of soil health indicators and their pressures on agriculture land for the Western Balkans countries. *Source: Zdruli et al 2022, in preparation.*

Countries	Agriculture land	**Soil health indicators: pressures on agriculture land**											
		Excess use of Nitrogen[1]	**Soil Organic Carbon losses from**[2]		**Compaction**	**Erosion**		**Pollution**	**Salinisation/** sodification magnesial soils (Smonitsa)	**Soil Acidity**: ≤5pH topsoil	**Soil sealing** and land take (2000 2020)	**Desertification**	Pressures on **soil biodiversity**
		Kg/ha/yr^{-1}	Mineral soils	Organic soils		Water >10t/ha/yr[1]	wind						
	ha	ha	ha	ha	ha	%	%	ha	ha	ha	ha	%	%
Albania	696,000	N/A	595,900	100	N/A	93	N/A	N/A	42,000	90,000	50,000[3]	25,00	N/A
Bosnia and Herzegovina	1,234,325	N/A	1,228,154	6,171	N/A	80	N/A	300,000	N/A	850,000	7,000	-	N/A
Kosovo	331,613	N/A	331,613	-	N/A	60	N/A	N/A	-	N/A	1,000	N/A	N/A
Montenegro	11,872	N/A	N/A	-	N/A	90		N/A	N/A	N/A	N/A	N/A	
North Macedonia	453,184	N/A	453,184	-	N/A	90	N/A	43,000	71,343	32,585	36,194	13,74	N/A
Serbia	2,776,160	N/A	N/A	N/A	N/A	86	85[3]	32,400	233,000	N/A	13,354	N/A	N/A
TOTAL	**5,503,154**												

Notes

[1] Provides the extent both in open fields and greenhouses. The indicator Gross nutrient balance expressed as nitrogen added to and removed from agricultural land

[2] Estimates the extent of SOC losses both in mineral and organic soils due to unsustainable management practices and/or natural conditions

[3] refers to Vojvodina

Compaction, pollution (local and diffuse) and salinization/sodification, magnesial soils (Smonitsa) on existing data or estimates.

Soil sealing and land take data for the 2000-2020 period. [3] for Albania the area refers to the period 1990-2020

Estimates the percentage of agriculture land affected by desertification based on the aridity index and land degradation impacts on the reduction of land to fulfil ecosystem functions

Provides a percentage of the area affected by soil biodiversity losses

Based on the results of this study it is concluded that **soil degradation is prevalent and extensive throughout the WB** region. Soils are under pressure, but the intensity of various soil health indicators varies between them and among the countries. Climate change was not part of this study, nevertheless its impact will be relevant in the next decades, unless preventive mitigation, remediation, and adaptation actions are taken to lessen their impacts.

Summarising, it is very difficult to make a regional assessment on the extent of unhealthy soils in the WB (**Table 5**) because of the limited data availability. The overwhelming literature review conducted in this study points out that **soil erosion** is the most relevant degradation process followed by **soil pollution**. All other factors are present but with a lesser extent and intensity. Unsustainable land management practices and natural causes of soil degradation are interlinked and is very hard to make a distinction between them. Better alignment of soil protection policies with the new EU Soil Strategy, through improving legislation and enforcing its implementation, is needed to ensure that the WB meet the targets being established for the EU.

5.3 Healthy soils for biodiversity

Soil biodiversity greatly contributes to human health. Since the discovery of penicillin from a soil fungus, antibiotics produced by soil microbes have saved millions of lives (Brevik et al., 2020). Recently, certain soil bacteria have been instrumental in a breakthrough in the development of much needed new antibiotics (Yu Imai et al., 2019). Several cholesterol-lowering drugs were developed from soil fungi. It has been shown that children often playing in healthy forest soils have a stronger immune system. The 'One Health' principle (One Health - who.int) clearly recognises that the health of the planet is closely linked with human and animal health.

A key element of the EU Soil Biodiversity Strategy is the development of a **Nature Restoration Plan** with **binding targets to restore degraded ecosystems**, in particular those with the most potential to capture and store carbon and to prevent and reduce the impact of natural disasters. Specifically for soil, the Nature Restoration Law foresees actions that deliver:

- significant areas of degraded and carbon-rich ecosystems are restored;
- at least 25% of agricultural land is under organic farming management, and the uptake of agro-ecological practices is significantly increased;
- three billion additional trees are planted in the EU, in full respect of ecological principles;
- significant progress has been made in the remediation of contaminated soil sites.

5.4 Healthy soils to fight pollution

The Zero Pollution Action Plan's goal is that by 2050, soil pollution should be reduced to levels which are no longer expected to pose risks and which respect the boundaries our planet can cope with, thus creating a toxic-free environment.

Preventing diffuse and point-source soil pollution remains the most effective and cheapest way to ensure clean and healthy soils in the long-term. In fact, contamination should be prevented at the source (Pathway to a Healthy Planet for All, EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil', COM(2021)400 (EC, 2021b). This can be reached, for instance, by having clean industry, sustainable product design, improved recycling, waste management and nutrient recovery, more efficient fertiliser application or reduced pesticide use and risk (EEA, 2021a), Land and soil pollution — widespread, harmful and growing), as well as implementing the **Strategic Approach to Pharmaceuticals** in the Environment and reducing the use of antimicrobials.

In this context, the Soil Strategy aims to review the rules on industrial emissions while improving and harmonising the consideration of soil health and soil biodiversity in **EU risk assessments for chemicals**, food and feed additives, pesticides, fertilisers and other chemicals.

A significant new development will be the establishment of a **priority watch list for soil contaminants**, together with an effective screening and soil pollution monitoring and outlook mechanism.

Specifically addressing contaminated sites (generally ex-industrial sites) require remediation with often complex and costly techniques, although in certain cases low-cost, bioremediation techniques have been shown to be effective. Nonetheless, in some cases soils have been degraded to such an extent that they cannot be fully restored to a healthy condition at a reasonable cost. Reporting on progress in managing soil contamination is currently voluntary, irregular and based on a changing methodology, different national definitions, screening values and risk assessment methodologies.

In light of this lack of level playing field, the Commission will therefore consider proposing legal provisions to make such reporting mandatory and uniform across the EU in the context of the **Soil Health Law**.

When efforts to prevent and control the source of pollution have failed and contaminants reach the soil and pose risks for the environment and human health, the soil must be remediated and the polluter should pay for it. The **Environmental Liability Directive** 2004/35/CE (EU, 2004) obliges certain operators to remediate contaminated land that poses risks for human health if pollution occurred as the consequence of activities carried out after 2007 or, if carried out before, not yet finished at that date (Judgment in Joined Cases C-379/08 and C-380/08, ERG aos.). The **Industrial Emissions Directive** 2010/75/EU (EU, 2010) requests operators of certain installations to establish the state of soil and groundwater contamination at the start of operations, apply for a permit that includes conditions to prevent soil pollution through application of the best available techniques and to take necessary action upon definitive cessation to return the site to its initial status.

However, for **historical or orphan** (Historical contamination was caused before the entry into force of national or EU legislation). On orphan (the polluter cannot be identified, no longer exists or cannot bear the remediation cost, e.g. due to bankruptcy) **contaminated sites**, a common approach is lacking in the EU, which is a very important legal gap.

5.5 Healthy soils for the circular economy

As outlined in the **Circular Economy Action Plan**, soil is a key component of a resource-efficient and circular economy. Soils recycle water, carbon and nutrients, while decompose and filter pollutants. In addition, soil deposits are used as raw material by many economic sectors, e.g. sand, gravel or clay for the construction industry. Yet, soil formation is so slow that prudent use is necessary. Prioritising a circular use of land over greenfield development will limit the pressure from soil sealing and land take.

Most excavated soils are clean, fertile and healthy and should be reused in the same or another appropriate location. If it is not possible to reuse excavated soils, e.g. due to unacceptable levels of pollution, such soils should be prioritised for recycling or some other form of recovery rather than landfilling, in line with the waste hierarchy. In 2018, more than 530 million tonnes of excavated soils were generated and reported as waste (In accordance with Article 2, 1(c) of Waste Framework Directive 2008/98/EC (EU, 2008), uncontaminated soil and other naturally occurring material excavated in the course of construction activities where it is certain that the material will be used for the purposes of construction in its natural state on the site from which it was excavated, is excluded from the scope of this Directive. Two thirds of reused excavated soil, which is not reported as waste, is recovered in operations bringing it back into the economy (EC, 2020b). To separate contaminated from clean soil, these streams have to be monitored more closely throughout the value chain, with traceability and quality control from the excavation site up to the receiving end.

As part of the development of the Soil Health Law, assess the need and potential for legally binding provisions for a '**passport for excavated soil'**, and provide guidance, based on Member States' experiences, to put in place such a system. The passport should reflect the quantity and quality of the excavated soil to ensure that it is transported, treated or reused safely elsewhere.

If the EU is to achieve a no net land take status by 2050, there is a need to apply a **hierarchy in land planning** that reuses and recycles land through appropriate regulatory initiatives and by phasing out financial incentives that would go against this hierarchy. Such an approach would avoid additional land take and sealing as much as possible, reuse land already sealed, minimise the impact of land take by using land in a less favourable condition (e.g. no agricultural and forest land) and finally, compensate for loss of ecosystem services when land is taken for sealing (e.g. green urban infrastructure projects).

Recycling organic waste streams such as compost, digestate, sewage sludge, processed manure and other agricultural residues, has many advantages. These materials, after appropriate treatment, can be used as organic fertilisers, helps to replenish depleted soil carbon pools, and improves water retention capacity and soil structure. In this way, closing the nutrient and carbon cycles.

For that reason, the Commission will by 2022 **revise the Urban Wastewater Treatment Directive** and the list of surface water and groundwater pollutants, evaluate the **Sewage Sludge Directive** and adopt an **Integrated Nutrient Management Action Plan** for the safer use of nutrients on soil. Through the proposed

Soil Health Law, the Commission will assess options to ensure the reduction of nutrient losses by at least 50% (resulting in the reduction of use of fertilisers by at least 20%), with a view to making this target legally binding.

5.6 Healthy soils for the new EU Climate Package

Healthy soils will make the EU more resilient and reduce its vulnerability to climate change. Achieving net-zero greenhouse gas emissions by 2050 relies also on carbon removals through the restoration and better management of soils to absorb the emissions that will remain at the end of an ambitious decarbonisation pathway. Targeted and continued sustainable soil management practices can significantly help in achieving climate neutrality by eliminating the anthropogenic emissions from organic soils and by increasing the carbon stocked in mineral soils.

New Regulation on **Land Use, Forestry and Agriculture (LULUCF)** sets an overall EU target for carbon removals by natural sinks, equivalent to 310 million tonnes of CO_2 emissions by 2030. National targets will require Member States to care for and expand their carbon sinks to meet this target. By 2035, the EU should aim to reach climate neutrality in the land use, forestry and agriculture sectors, including also agricultural non-CO_2 emissions, such as those from fertiliser use and livestock.

In this context, the Commission will consider proposing legally binding objectives, possibly in the context of the Nature Restoration Law, to halt further drainage of **wetlands and organic soils and to restore managed and drained peatlands and increase the carbon stocks in mineral soils**.

Finally, the Commission will propose a **carbon farming initiative and a legislative proposal on carbon removal certification** in 2022 to promote a new green business model rewarding land managers, such as farmers and foresters, for climate–friendly practices.

Box 9. Soil for healthy water resources

Soils, sediments and water are intimately connected. Soils filter, absorb and buffer water, which are compromised when sealed. Methods that allow floodwaters to infiltrate soils are important for water management in order to reduce the risk of flooding and drought. Also, some highly fertile and carbon-rich soils are eroded and deposited downstream in river basins, dams and the sea, where often this sediment is dredged to facilitate the passage of ships. These sediments could be reused again, provided they are clean.

Hence, coordinating better soil and water management is essential to achieve healthy soils and aquatic ecosystems, including reducing the impact of floods on people and the economy. There is a comprehensive body of EU water law in place, and the new EU strategy on adaptation to climate change highlights the importance of healthy soils in minimising climate change related risks, such as floods and droughts.

In this context, the Commission will consider addressing the adequate integration and coordination of soil and water management and facilitate the exchange of practices among the Member States on the nexus between soil, water and sediment and publish a guidance on the sustainable management of sediment.

Member States should better integrate soil and land use management in their river basin and flood risk management plans where possible by deploying nature-based solutions such as protective natural features, landscape features, river restoration, floodplains, etc.

5.7 Healthy soils in preventing desertification

The United Nations Convention to Combat Desertification (UNCCD) has recognised the link between desertification, land degradation and drought, and the need to take urgent action by reversing land degradation with the eventual target of land-degradation-neutrality. Already in 2008, extensive processes resulting in desertification were observed both in Mediterranean and Central and Eastern European countries, and a study from 2017 confirmed this trend. Whilst thirteen Member States have declared themselves as 'affected party' under the UNCCD (Bulgaria, Croatia, Cyprus, Greece, Hungary, Italy, Latvia, Malta, Portugal, Romania, Slovakia, Slovenia and Spain (ECA, 2018a), the EU has not yet done so. While the risk of desertification in the EU relates to specific regions, the environmental, social and economic impact concerns the whole EU. The European Court of Auditors (ECA, 2018b) concluded that the steps taken by the Commission and Member States to combat desertification lack coherence and that there is no shared vision in the EU on how land degradation neutrality will be achieved by 2030.

Member States should, in line with the actions envisaged in the EU climate adaptation strategy (EC, 2021c**), adopt appropriate long-term measures to prevent and mitigate degradation**, notably by reducing water use and adapting crops to the local water availability, coupled with wider use of drought management plans and application of sustainable soil management. To support this, the Commission **will establish a methodology and relevant indicators**, starting with the UNCCD's methodology, **to assess the extent of desertification and land degradation in the EU** (outcomes will be published every five years about the state of land degradation and desertification in the EU).

5.8 Increasing the knowledge base on soils

It is essential to continue the development of our knowledge and data about soils. Access to soil research data should be easier through the creation of a Green Deal dataspace (EC, 2020c) and the implementation of the Horizon Europe Mission 'A Soil Deal for Europe'. Building on the INSPIRE Directive 2007/2/EC (EU, 2007), open standards for data, data platforms such as ESDAC, knowledge platforms such as the European Soil Observatory (EUSO) or Land Information System for European (LISE) and the increased use of digital technologies should improve the interoperability of national, EU and global soil monitoring frameworks.

5.9 Soil data and monitoring

In relation to the collection of soil data, the Commission's **LUCAS** soil initiative is the only monitoring system that provides harmonised and systematic on-the-field measurements for all Member States. But it needs to be **better integrated with activities in Member States and other data flows**. Soil monitoring systems in the Member State level are fragmented, incomplete and in general not harmonised. Data are often not publicly shared in accordance with the mechanism of the INSPIRE Directive (EU, 2007) while there is no systematic comprehensive monitoring of policy-relevant issues in many countries due to a lack of capacity or resources. While the EEA provides indicators such as on soil sealing and land take, better data resolution, together with more frequent measurements and harmonisation of approaches between Member States would benefit the assessments of policy impact. In this context, an **integrated soil indicator system** is needed to serve as an umbrella for further **monitoring and reporting** (EEA, 2021a). Reporting on the condition of soil together with provisions on monitoring soil biodiversity will be considered as part of the Soil Health Law, that builds on existing schemes in Member States, such as the LUCAS soil module, and other key data flows in connection with national reporting under the NEC Directive 2016/2284, Article 9 (EU, 2016) and LULUCF Regulation (EU, 2018). The EU Soil Observatory will identify soil monitoring gaps, in dialogue with Member States and other key stakeholders as a roadmap for an **integrated soil monitoring system** to feed a soil dashboard and a set of reliable soil indicators, integrating trends and foresight.

5.10 Soil research and innovation

The Horizon Europe framework programme for research and innovation will facilitate knowledge creation, collaboration and thereby accelerate the transition to healthy soils. Relevant instruments will be available through Cluster 6, Food 2030 priorities, (https://ec.europa.eu/info/research-and-innovation/research-area/environment/bioeconomy/food-systems/food-2030_en) and the Horizon Europe Partnerships (Food

Figure 23 EU framework for soil monitoring and reporting and effective research-policy and research-practice interfaces to achieve healthy soils

Source: JRC

System, Biodiversity, Agroecology, Agriculture of Data, etc.). In addition, the Horizon Europe Mission 'A Soil Deal for Europe' provides a comprehensive framework for research and innovation and contributes to creating a harmonised EU framework for soil monitoring and reporting and effective research-policy and research-practice interfaces to achieve healthy soils (**Figure 23**).

5.11 Soil and societal engagement

As described in the beginning of this document, soil is probably the most undervalued element of nature. Increasingly urbanised populations are generally unaware of its relevance to their daily lives. In turn, this reflects a lack of emphasis in **education** and highlights the need to increase public **awareness** and societal **engagement** and finally increase soil literacy for which the Commission will work together with the Member States and other stakeholders, notably through the Stakeholder Forum of the EUSO.

5.12 Final remarks on soil in the Western Balkans

Soil degradation is prevalent and extensive throughout the WB region. Soil erosion is the most relevant degradation process followed by soil pollution. In this region, unsustainable land management practices and natural causes of soil degradation are interlinked. Better alignment of soil protection policies with the new EU Soil Strategy, through improving legislation and enforcing its implementation, is needed

Perspective

- Implementation of a soil protection framework to ensure heathy soils is a priority for the implementation of the Green Deal across the Western Balkans. This requires coherent action across a broad policy base.
- Knowledge on soil health and factors causing pressures on soil conditions across the region is disjointed and fragmented.
- The Soil Strategy announces measures for sustainable soil use, the avoidance of land sealing, a halt to the drainage of peatlands, restoration of contaminated sites and tighter monitoring and reporting obligations.

Recommendations

- Pan-EU soil initiatives, such as LUCAS, EUSO, Clean Soil Outlook, should be expanded to cover the Western Balkan Regions.
- The Soil Mission should implement a targeted programme to support the implementation of lighthouses and living labs in the Western Balkans.
- National policies should take note of the developments described above.
- Harmonsised soil monitoring and testing programmes should be established.
- Developping new usage for degraded lands (fast growing biomass, solar panels, etc.)

6 Conclusions and outlook

The present study is the first overall analysis of the status of air, climate, water and soil in the WB as of 2021. It provides an overview of the progress in the alignment with the chapter 27 of the *EU acquis* to support monitoring the EU accession process. In addition, the information summarised in this study provides the basis for the implementation and monitoring of the actions included in the Green Agenda for the WB, with particular reference to the chapters on depollution and decarbonisation.

Some of the findings of the present study are common to all the studied environmental matrices. One common shortcoming encountered when assessing the status of the environment in the WB is the scarcity and fragmentation of environmental data in terms of both spatial and time coverage. Field data are the basis for both the identification of critical situations and the development of effective and efficient policies. Therefore, the establishment of monitoring networks with sufficient data coverage in space and time and completeness of the analysed parameters is a cross-cutting priority for all the environmental matrices addressed in this report. Due to the relatively small area of the WB and the high interconnections between the ecosystems across and beyond this region, networks for regional and international cooperation are essential to involve all the relevant actors and stakeholders in the design and implementation of environmental policies. In this regard, also the collaboration among experts at the technical level (e.g. exchange of best practices) both within the region and with EU expert networks should be promoted. In a context of continuous improvement, the efforts to promote capacity building, as a key element of the WB institutions preparedness for the implementation of legislation with highly specialised technical content, should be maintained and strengthened.

Air and Climate

Significant improvement was made in the latest years in the alignment of the climate and GHG emissions monitoring and reporting legislation. However, implementation of the adopted legislation is lagging behind.

Although some progress is observed for certain pollutants in certain areas, the overall air quality situation in the WB is still critical. As the main responsible for SO_2 and CO_2 emissions and important contributor to other pollutants the energy sector, in particular coal-fuelled power plants, offers a concrete opportunity for co-benefits between air quality and climate policies.

Favouring the integration of the environmental measures into key sectorial policies (energy production, energy efficiency, industry, transport, etc.) is needed to tackle relevant sustainability drivers effectively.

Considering the transboundary effects of pollution in South-East Europe, international and interregional cooperation in the framework of existing or international partnerships (e.g. Air Convention) or regional consortiums (Energy Community, Regional Cooperation Council) should be prioritised.

The increase in intensity and frequency of summer heatwaves over the latest decades is clearly indicating the magnitude of climate change in the WB and the need to design appropriate adaptation plans to cope with it.

Water

Although a significant share of EU legislation in water and environment sectors has already been transposed into national regulations in WB, a considerable effort is still needed in order to establish fully operational water management practices.

The modernisation of water monitoring is a key action achievable in the short term with the existing resources by optimising the network setup and implementing well designed surveillance and operational monitoring schemes.

Since pollution from urban wastewaters is recognised as one of the most important pressures on waterbodies across the WB (EC, 2020a), investments in wastewater collection and treatment are a priority in this region.

The implementation of the EU regulation (EU 2020/741) on water reuse is of particular importance in WB due to growing water needs on the one hand, and the general lack of available water on the other, especially in view of the expected influence of climate change on the WB region.

The increase in hydropower capacity across the region as an important action (EC, 2020a) that should be carried out with extreme caution to preserve the fragile aquatic ecosystems in hilly and mountainous regions.

Regional cooperation and joint efforts with Member States are preconditions for the general development of the water sector in WB (EC, 2020a). The work of the International Commission for the Protection of the Danube River – ICPDR (https://www.icpdr.org) and the International Sava River Basin Commission – ISRBC (https://www.savacommission.org) are examples of good practice in regional cooperation involving WBC participation.

Soil

There is heightened policy interest in soils because of the range of ecosystem goods and services that they provide and their relevance to the objectives of the European Green Deal. The new EU Soil Strategy has the objective of bringing all EU soils into a healthy condition by 2050 on the basis of a broad range of actions that should generally be implemented by 2030. In this context, the Commission will look to integrate the sustainable use of soils across all relevant EU policies, be it agriculture, biodiversity, circular economy, climate, urban development, or pollution. Implementation of a soil protection framework to ensure heathy soils is a priority for the implementation of the Green Agenda for the Western Balkans. This requires coherent action across a broad policy base.

Making sustainable soil management the new normal requires coordination as well as action at local, regional, national, EU and global level to promote and implement such practices. A key element will be the identification and adoption of practices, including regenerative farming in line with agro-ecological principles, which are relevant to the target area reflecting inherent soil characteristics and land use needs. Close links are foreseen with the work of the Mission 'A Soil Deal for Europe' on the establishment of Living Labs and Lighthouses of as flagships of best practices. The Soil Mission should implement a targeted programme to support the implementation of lighthouses and living labs in the Western Balkans.

The EU Soil Observatory, together with the EEA, will establish a roadmap for an integrated soil monitoring and indicator framework that should collect data to feed a soil dashboard that assesses the effectiveness of policies and their respective instruments in reaching critical targets. Such a framework should look to bring together pan-EU and national initiatives while supporting the reestablishment or reinforcement of monitoring systems that for a variety of reasons, are no longer operational. Pan-EU soil initiatives, such as LUCAS, EUSO, Clean Soil Outlook, should be expanded to cover the WB region.

In parallel, the Commission will consider setting legal requirements for healthy soils so that their capacity to deliver ecosystem services are not hampered. In this regard, the Commission is working to adopt a new Soil Health Law by 2023 to give soils the same EU-wide legal basis as air and water.

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List of abbreviations and definitions

AL	Albania
AQ	air quality
AMR	antimicrobial resistance
ARB	antibiotic resistance bacteria
ARGs	antibiotic resistance genes
BC	black carbon
BiH/BA	Bosnia and Herzegovina
BQE	biological quality element
CLE	current legislation scenario
CLRTAP	Convention on Long Range Transboundary Air Pollution
DEHP	Di(2 ethylhexyl)phthalate
EBMs	effect based methods
ECMWF	European Centre for Medium Range Weather Forecasts
EEA	European Environment Agency
EGD	European Green Deal
EIONET	Environmental Information and Observation Network
EMEP	European Monitoring and Evaluation Programme
EnC	Energy Community
EnCS	Energy Community Secretariat
EPA	Environment Protection Agency of Montenegro
EQS	environmental quality standards;
FBiH	Federation of Bosnia and Herzegovina
FBiH HMI	Federal Hydrometeorological Institute of FBiH, BiH
GHG	greenhouse gas
GW	groundwater
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
KEPA	Kosovo Environmental Protection Agency
KS/XK	Kosovo
LCP	large combustion plant
LULUCF	land-use, land-use change and forestry
ME	Montenegro
MK	North Macedonia
MoEPP	Ministry of Environment and Physical Planning of North Macedonia
MoAs	modes of action
NEA	Albanian National Environment Agency
NECD	National Emissions Ceiling Directive
NERP	National Emissions Reduction Plan
NH_3	ammonia
NMVOC	Non methane volatile organic compound
NO_2	nitrogen dioxide
O_3	ozone
PCB	polychlorinated biphenyls
PFAS	per-/polyfluoroalkyl substances
PHS	priority hazardous substances ()
PM	particulate matter

PM_{10}	particulate matter size 10 micrometers or less
$PM_{2.5}$	particulate matter size 2.5 micrometer or less
PNEC	predicted no effect concentration
RBSP	river basin specific pollutants
RHMI	Republic Hydrometeorological Institute, Republic of Srpska, BiH
SEPA	Serbian Environmental Protection Agency
SO_2	sulphur dioxide
UNEP	United Nations Environment Programme
WB	Western Balkans
WFD	Water Framework Directive
WL	watch list
WHO	World Health Organization
WWTP	wastewater treatment plants
YLL	years of life lost

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