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Outlook on Water and Climate Change Vulnerability in the Western Balkans

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Bajina Bašta accumulation on river Drina between Serbia (left side of the picture) and Bosnia and Herzegovina (right side of the picture)
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Contents

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Units, abbreviations and acronyms

ARSO	Agencija Republike Slovenije za okolje (Slovenian Environment Agency)
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe (Federal Institute for Geosciences and Natural Resource)
CEP	Collinwood Environmental Planning
CIESIN	Center for International Earth Science Information Network
DEM	Digital Elevation Model
CLC	Corine Land Cover
DPPI SEE	Disaster Preparedness and Prevention Initiative for South Eastern Europe
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECA&D	European Climate Assessment & Dataset
ECRINS	European catchments and Rivers network system
EEA	European Environment Agency
EIONET	European Environment Information and Observation Network
ENVSEC	The Environment and Security Initiative
ESM2M	Earth System Model 2M
ETC/ICM	European Topic Centre on Inland, Coastal and Marine Waters
EU	European Union
EU-27/28	The 27/28 Member States of the European Union (depending on the period in question)
EUR	Euro
EUROSTAT	The Statistical Office of the European Union
EURO-CORDEX	Coordinated Downscaling Experiment — European Domain
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign Direct Investments
FLIS	Forward looking information system
GDP	Gross domestic product
GFDL	Geophysical Fluid Dynamics Laboratory
GI	Green infrastructure
GIS	Geographic Information System
GMT	Global Megatrend
GWI	Global Water Intelligence
GWP	Global Water Partnership
HBV	Hydrologiska Byråns Vattenbalansavdelning
HDI	Human Development Index
IFRC	International Federation of Red Cross and Red Crescent Societies
IHME	International Hydrogeological Map of Europe
IMF	International Monetary Fund
IPA	Instrument for Pre-Accession Assistance
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JRC	Joint Research Centre
KEPA	Kosovo Environmental Protection Agency
kWh	Kilowatt hour
LISFLOOD	GIS-based hydrological rainfall-runoff-routing model

MARS	Managing Aquatic ecosystems and water Resources under multiple Stress
NGO	Non-governmental organisation
NRC	National Reference Centre
OECD	Organisation for Economic Co-operation and Development
OSCE	Organization for Security and Co-operation in Europe
RCP	Representative Concentration Pathway
RNA	Recovery Needs Assessment
SMHI	Swedish Meteorological and Hydrological Institute
SoE	State of Environment
SOER	State of Environment report
STEEP(L)	Social, technology, economic, environment, political and legislative (drivers)
UNDP	United Nations Development Programme
UNEP/ENVSEC	United Nations Environment Programme/ The Environment and Security Initiative
UNISDR	United Nations Office for Disaster Risk Reduction
USD	US dollar
UWWTD	Urban Waste Water Treatment Directive
WB	Western Balkans
WEI	Water Exploitation Index
WFD	Water Framework Directive
WHO	World Health Organisation
WISE	Water Information System for Europe
WSI	Water Stress Index
WQI	Wilderness Quality Index
ZHMS	Zavod za hidrometeorologiju i seizmologiju (Institute of Hydrometeorology and Seismology of Montenegro)

Executive summary

The report “Outlook on Water and Climate Change Vulnerability in the Western Balkans” has been prepared in the frame of the service contract 3437/B2016/IPA2015/EEA.56649 ‘Water Use in the Western Balkans: Regional Outlooks and Global Megatrends’ between the European Environment Agency (EEA) and its Topic Centre on Inland, Coastal and Marine Waters (ETC/ICM).

The report presents the state and future of water resources in the Western Balkan region in the context of climate change and socio-economic developments. The extensive knowledge base provided by the EEA and ETC/ICM experts has been combined with the knowledge from the local experts. In addition, the outcomes gathered in previous similar projects (notably “Security implications of future water use in the Western Balkans: challenge of hydropower development”) have been also included in the report. However, there is still a lack of available information from the West Balkan region, which in many cases can hinder preparing reliable assessments of environmental and socio-economic state and trends.

The report aims to support forward-looking knowledge in the Western Balkan region by exploring different plausible futures and contributes to forward-looking analyses for the region. It presents current state, trends and future estimates that shape water availability, water uses, opportunities and water related risks in the region, and as such complements the overall aims of the project “*Water Use in the Western Balkans: Regional Outlooks and Global Megatrends*” by providing quantitative analysis that supports projections of global megatrends in the region. In addition, the report connects global megatrend implications and scenarios, which can alter these implications.

- Demographic trends of the last two decades in the Western Balkans are rather unstable. Demographic trends observed until 2013 were showing population growth (only) in Albania and Kosovo (under UNSCR 1244/99) where the shares of young people are the highest, however available data since then show negative growth despite previous population projections that still predict slow to moderate population growth at least in Kosovo (under UNSCR 1244/99).
- Population trends are therefore unstable and hard to predict throughout the region. Overall, out of roughly 18.69 million people who had been living in the Western Balkans in 2001, the population has decreased by 2.2% to 18.29 million in 2015 and projected to decline further to 16.37 million (12.4% decrease compared to 2001) by 2050. The average gross domestic product (GDP) per capita (nominal) of the region in 2015 was 4279 EUR, which is much lower than the EU-28 average. The GDP per capita (nominal) is projected to increase by 23% on average by 2020, however with large regional differences.
- While access to improved water source is granted to 98.5% of the regional population and rising, there are downsides to the water distribution system in the Western Balkans. More than 50% (and up to 75%) of water extracted for water supply networks does not reach end users (in comparison to the average of 25% for EU Member States). Therefore, further investments in improving the water infrastructure are needed.
- Wastewater treatment in the Western Balkans has been improving steadily since 2001, with an average per-country share of the population connected to a waste-water treatment plant rising to 6.5%. This share varies between countries and within them ranging from almost none in Kosovo (under UNSCR 1244/99) to around 10% in the Former Yugoslav Republic of Macedonia, Montenegro and Serbia. The share is significantly lower than the EU average of 86%.
- Technological innovations are the economic potentials of the Western Balkans. Given the fact that there is a relatively high level of education within the population in the region, but a low share of research and development funding, the existing human capital is not optimally used for development and implementation of technologies within the region. Moreover, mobilisation of highly educated

diaspora (result of brain drain) could be a tool in developing an environment of innovations in the region. Technological breakthrough in the field of energy is also supported by incentives of the EU.

- National economic policies and processes will shape the Western Balkans and could have a different impact on the environment as well as water use. On the one hand, economic growth can increase environmental pressure through increased production and consumption, while on the other hand it can provide resources to address some environmental issues that have proven to be in correlation with the economic developments of richer countries – such as waste-water treatment or waste disposal.
- Agriculture remains an important economic sector of the Western Balkans accounting for almost 10% of the total GDP of the region. No radical changes in the regional agriculture are expected, and critical resources would be needed to create basic preconditions for establishing a market-based economy in the field of agriculture.
- Electricity production and consumption in the Western Balkans are lower than the average of neighbouring countries or the whole EU-28. Due to the low costs of producing the electricity the region exports electricity to the neighbouring countries with higher electricity prices. The electricity export might even increase in the future.
- The water resources per inhabitant in the Western Balkans are almost twice as abundant as in neighbouring countries. Freshwater resources in the region vary between 2100 m^3/inhabitant/year and 31,000 m^3/inhabitant/year – more than double that of the EU-28 average. On the other hand, in the last two years hydropower constructions have increased by 300% across the Western Balkans affecting wildlife, river morphology and biodiversity. More than 30% of these dams are set to be built in protected areas such as national parks or Natura 2000 sites. The number of construction sites where water is being channelled has increased from 61 (2015) to 187 (2017) in only two years. Since water at these sites is now diverted through pipelines from the rivers, many species are at great risk.
- The water use in the region is 328 l/day/person which is higher than in the neighbouring countries or the average in the EU-28. Water consumption per person is not always in accordance with the quantity of freshwater resources. There is a pronounced contrast between urban water supply and supply in rural areas.
- The freshwater quality is on average lower compared to the EU – concentrations of nitrates and ammonium in rivers are relatively high due to insufficient sewage systems and absence of waste-water treatment plants.
- The intensive expansion of urban land is evident also in land use changes within the Western Balkan region. The most widespread changes in the extent of land-use categories in the Western Balkans between 2006 and 2012 were the extension of artificial surfaces, followed by expansion of cropland, and decline of forest areas and pastures.
- Extreme weather and climate related events in the West Balkan region have been increasing since 1980. Since 2010 the region has been affected by extreme droughts, floods and wildfires. In particular, the series of floods that affected the region in recent years had had very high economic costs in terms of damages to infrastructure, housing and disrupting economic activity across all sectors.
- The level of preparedness and prevention varies in the West Balkan region. The floods in Bosnia and Herzegovina and Serbia in 2014, floods in the Former Yugoslav Republic of Macedonia as well as floods in Albania in 2010 and extreme drought in Kosovo (under UNSCR 1244/99) in 2013 have shown that people and institutions in the Western Balkans are not sufficiently prepared for the expected impacts of climate change in spite of generally improving transboundary collaboration and considerable investments in disaster preparedness and prevention.
- The climate change projections showed increases in extreme events in the coming decades. In the short-term future (here defined as the period 2031–2060), the land use change is likely be the

dominant factor in determining water availability, while in the long-term future (the period 2061–2090) the climate change intensity is likely to become dominant. As expected, changes through time between short-term and long-term future are accentuated in all scenarios, with discharges almost always lower in the long-term future. A general reduction of annual flow from 5 to 30% is projected depending on the period, extent of climate change scenario, and land use changes. Numerous rivers which are already facing water shortages and droughts in the summer months will face yet additional water deficit in the long-term future, in summer (for up to 20%) and autumn (for up to 25%) seasons.

- Foreseen impacts on society can affect public water supply in urban centres, seasonal water shortages and in-turn population migration. The reduced discharge presents an important threat to hydropower plant development, public water supply, irrigation, biodiversity, fisheries and aquaculture and may severely affect freshwater ecosystem goods and services.
- The changes will affect the tourism (which is an emerging sector in the region) with negative impacts due to higher energy consumption and a consequent lack of water resources, but with more favourable conditions for the development of the mountainous part of the region.
- Impacts on the natural resources include degradation of unique ecosystems of the Western Balkans, increased pollution from populated areas, natural disasters (floods, forest fires etc.), interrupted equilibrium of soil etc.

1. Introduction

The Western Balkans is a region in Southeast Europe, a group of countries not part of the European Union, with all countries pursuing policy and actions of integration to the EU. In parallel, extensive social processes are taking place in the region and are often connected to the use and management of natural resources. Although the region is not part of the European Union, it is not immune to European and global trends; it is influenced by global megatrends (GMTs) such as intensified global competition for resources, consequences of climate change, pressures on ecosystems and diversifying approaches to governance.

The preceding report "*Security implications of future water use in the Western Balkans: challenge of hydropower development*" (Globevnik et al., 2014) has shown that natural resources are abundant but will be exploited in unknown ways, bringing different consequences depending on unknown factors in the future; at the same time, there have been no robust strategies that would indicate where these countries aim to develop, let alone common strategy of the region which would join regional stakeholders in a relationship with external influences.

The choices that governments in the region make concerning these and other pressing questions today will influence not only the region's environment in the coming decades, but also that of other European countries. Therefore, the region could make use of future perspectives defined by GMTs projected at the regional scale, including understanding potential risks and implications regarding water and climate change vulnerability in the region.

Are the countries of the Western Balkans actually vulnerable to climate change and consequent issues of water availability, or are there other factors of larger importance? Following the integrated water resources management approach (as defined by Global Water Partnership in 1992 (GWP, 2017)) and also supported by the Water Framework Directive (WFD) principles, water, land and related resources are interconnected and should be managed integrally to maximise the resultant socio-economic welfare without compromising the sustainability of vital ecosystems.

The report is aiming to present current state, trends and future estimates that shape water availability, uses, opportunities and water related risks in the region, to support forward-looking knowledge by exploring different plausible futures, and contributes to forward-looking analyses for the region. In addition, the project aims complement the overall aims of the project "*Water Use in the Western Balkans: Regional Outlooks and Global Megatrends*" by providing quantitative analysis that support projections of global megatrends in the region. In addition, the report connects global megatrend implications and scenarios which can alter these implications.

The current state and trends are assessed through the framework of selected STEEP(L)[1] indicators. With a focus on water availability in light of forward-looking perspectives and scenarios, the research is streamed towards indicators related to water availability. Two content blocks are essential for developing forward-looking indicators: (a) defining and refining scenarios, based on developments of the preceding project (Globevnik et al., 2014) as well as other scenario-development projects commissioned by the EU organisations – see chapter on data sources; and (b) establishing a hydrological model of water availability in the future, based on different scenarios. State, trends and perspectives will be supported by brief case studies of selected extreme hydrological events (floods and droughts) in the region. Assessment of global megatrend implications for the region is included with the purpose of establishing a relationship between global megatrend implications, scenarios and quantitative models of water availability. All three are presented in forward-looking indicators. The scope of outlook on water and climate change vulnerability in the Western Balkans (the conclusion part of the report) is to provide an

[1] Social, technology, economic, environment, political and legislative (drivers).

overview of risks and implications that we can foresee when looking at developed indicators, as well as to propose adaptation measures. Adaptation measures have been investigated at the EU level and at some country levels and described in the EEA reports (EEA, 2013a; EEA, 2017a) from which the regional measures will be extracted and adapted – downscaled to regional conditions.

1.1. Introduction to this report

This report is one of the two publications resulting from the project Water Use in the Western Balkans: regional outlooks and global megatrends. While the other report focussed on the Global megatrends affecting the Western Balkans (White et al. 2018), this report focusses on water and climate change vulnerability in the Western Balkans. It links to the outcomes and key messages from the report on global megatrends, when applicable. This report sets out:

- an overview of the methodology and data sources used and how it was applied to a water availability regional study in the Western Balkans (Section 2);
- a description of the present state and trends in the Western Balkans in scope of social, technological, economic, environmental and political factors with a focus on water availability and hydrological extremes (Section 3);
- assessment of near and long-term future water availability for the 12 selected catchments in the context of scenarios (Section 4);
- synthesised outlook on water in climate change vulnerability with identified impacts on society, economy and environment and proposed adaption measures (Section 5);
- finally the report summarises the key outcomes and presents risks and opportunities from the study (Section 6).

1.2. Background

The preceding project “*Security implications of future water use in the Western Balkans*” from 2014 (Globevnik et al., 2014), undertaken by the European Topic Centre on Inland, Coastal and Marine Waters (ETC/ICM), provided an explorative analysis of the possible security implications of water use development in the region. With the help of local and regional experts, four different scenarios for the future were described, depending on climate impact and economic development. The vision on how hydropower should be managed and developed was made for the near- and long-term future. This served as the basis for the assessment of different scenario risks which could obstruct achievement of the vision. The risks to hydropower development are thus different under different scenarios and were elaborated accordingly, supported by indicators of state and trends.

The aforementioned project was funded on the basis that future-oriented discussions and actions in the Western Balkans should be encouraged by providing an analysis of forces that are shaping the future of the region's environment (EEA, 2010a). The same study also identified future climate change which will affect water resources and biodiversity, as well as trends in a range of economic sectors, including agriculture and energy, being heavily reliant on hydroelectricity, to be the factors shaping the region in the future. Also pointed out, global environmental change would affect the environment in the Western Balkans. Climate change is expected to bring higher summer temperatures and lower rainfall and to shape agriculture, hydroelectricity production and energy use.

The studies of the Western Balkans done in cooperation between the ETC/ICM and the EEA had shown that there is a poor base of region-wide information which hinders reliable assessments of environmental and socio-economic state and trends in the region. Information is difficult to obtain, data are often scarce, incompatible or missing. In many cases there is also a lack of qualitative information (EEA, 2010a; EEA, 2017a). The same is true for forward-looking information, and since this region is experiencing extremely dynamic changes and many uncertainties, it is important to develop structured and sound information support for the future (EEA, 2010a). With this in mind, regional experts cooperating as a joint team of the project are of valuable help in providing the input of information that can be used in synergy with EU or global datasets (such as climate models).

An important element of the planned State of Environment Report 2020 is the projection of global megatrend (GMTs) (see chapter 2) implications to regional and national scales. The methodology was recently published in an Eionet Report (EEA, 2017b) which proposes the development of indicators that would be suitable for monitoring future change at national level driven by or resulting from the implications.

The 2016 indicator-based report on climate change impacts in Europe (EEA, 2017a) shows that climate change will interact with other socio-economic developments. The water sector, agriculture, forestry and biodiversity are interdependent and also related to changing land use patterns. South-eastern and southern Europe are projected to be hotspot regions, having the highest numbers of severely affected sectors and domains. The report points out precipitation changes that are projected to be more spatially and temporally varied than temperature changes, thus affecting water cycle. Annual precipitation is projected to decrease in most of southern Europe, particularly in summer – in some parts of southern Europe a decrease of up to 90 mm per decade is projected.

River flows are expected to change likewise – for Europe, they are to be increased in winter and decreased in summer since the 1960s, however with substantial regional and seasonal variation. The severity and frequency of droughts appear to have increased in parts of Europe, in particular in southern and south-eastern Europe. Climate change is an important factor in these observed changes (among others, in increasing water temperature of rivers and lakes, as well as impacting quality of water and its ecosystems), but other factors, such as river engineering, also have a strong influence (EEA, 2017a).

The natural cycle of water availability is coming under threat from a variety of different pressures, exposing water ecosystems and societies to shortages and excesses of water – a situation known as water vulnerability (EEA, 2012a). The report on water resources in Europe in the context of vulnerability (EEA, 2012a) points out three human-induced causes of vulnerability: change in land use; water abstraction; and climate change.

1.3. Policy context

All countries of the Western Balkans are cooperating countries of the EEA. They are publishing State of Environment reports (SOER) and provide their National Reference Centres (NRC) for the Forward-Looking Information and Services (FLIS) platform. National legislation of these countries regarding water use and other aspects of environment is harmonised or in the process of harmonisation with EU legal acts.

The partners of EIONET are building the knowledge base for SOER 2020 which is – in contrast with SOER 2015 – being developed from mainly a problem-focused knowledge to a more solutions-oriented knowledge (Pirc Velkavrh, 2017). The format of including a forward-looking approach to SOER 2020 is still being developed; the present paper aims to offer a methodology of integrating the following SOER elements for the Western Balkans: GMT, forward-looking analysis and indicators of state and trends.

Adaptation described in the concluding parts of the report is a complementary action and EU priority area for tackling climate change. Some transnational regions (such as the Danube, the Baltic, the Alps and the Pyrenees) and cities have developed adaptation strategies or are currently developing them (EEA, 2013a). The preceding report of the current project (Globevnik et al., 2014) indicates that transnational cooperation is of essential importance in the Western Balkans; this should encourage the stakeholders of the region to develop adaptation strategies together.

2. Methodology

The report is based on four elements that constitute the integral outlook on water and climate change vulnerability:

- an overview of the present state and trends, including an assessment of how these are to affect the future;
- an assessment of global megatrends that are affecting the region;
- development of scenarios – different illustrations of the Western Balkans in the future; scenarios are frameworks in the context of which specific parameters – such as water availability and use – are described;
- development of hydrological models of water availability.

The building of four elements is achieved by the following methods:

- review of available publications and data sources, focused on the work of the EEA and Eurostat, national sources (e.g. statistics agencies) and international organisations (e.g. World Bank);
- statistical and geographic information systems (GIS), analysis of available quantitative data in order to establish credible indicators;
- participative work with Delphi method – cooperation of national and international experts on the topic to develop credible scenarios for the future; a qualitative method that provides a basis for developing quantitative hydrological models;
- streamlining quantitative climatic and hydrological records to a hydrological model of water availability, including calibrating results of correlation, in order to run statistical calculations of water availability in the future.

An **overview of the present state and trends** is an indicator-based assessment. An indicator is a measure, generally quantitative, that can be used to illustrate and communicate complex phenomena simply, including trends and progress over time (EEA, 2005). Through research of existing publications and data sources, the main environmental, natural resource, socio-economic and technological characteristics of the region are described. Judging by elemental factors that give an image of the whole sector (e.g. population dynamics showing future workforce for the developing economies, or volume of renewable water resources co-indicating success of the developing agricultural sector), the indicators are presented through text, graphs and maps. Quantitative data for indicator-based assessment are listed next to each indicator and in sources, while a brief assessment of available sources is given in section 2.3.

The Western Balkans is bound to the rest of the world through multiple systems, enabling two-way flows of materials, financial resources, innovations and ideas. As a result, the region's ecological and societal resilience will be significantly affected in coming decades by a variety of global megatrends[2] (GMTs) — large-scale, high impact and often interdependent social, economic, political, environmental or technological changes. (EEA, 2015a). With different likeliness and magnitude, various GMTs are expected to affect the Western Balkans (**Error! Not a valid bookmark self-reference.**). For example, globalised supply chains mean that global energy use contributes to pressures on ecosystems and communities in the region, for example through threats to freshwater quality and quantity, and the degradation of habitats and landscapes.

[2] See https://www.eea.europa.eu/themes/sustainability-transitions/global-megatrends/global-megatends for more about global megatrends.

An **assessment of global megatrends that are affecting the region** is based on a review of available publications and data sources as well as – and focused on – the participative approach of experts in this topic that have provided their input on the project workshops as well as through individual correspondence.. The methodology of assessment of global megatrends for the Western Balkans has been the scope of the report 'Water Use in the Western Balkans: regional outlooks and global megatrends' (White et al. 2018) – the applicable results are taken and used in this report.

Figure 2.1: Impacts of global megatrends on the Western Balkans resource systems.

Source: EEA, 2015a.

Development of scenarios for the region is again based on a combination of reviewed sources and expert cooperation. The basic scenarios had been taken from the Organisation for Security and Co-operation in Europe (OSCE)/EEA framework and later refined in a series of regional workshops:

- Explorative scenario workshop on Opportunities for Development in the Western Balkans in the context of climate change impacts and water scarcity, 24–27 October 2011, Belgrade, Serbia;
- Future water use and the challenge of hydropower development in the Western Balkans, 11–13 February 2013, Ljubljana, Slovenia;
- Use of explorative scenarios, modelling and visions in forward-looking assessment – Methodological discussion to support forward-looking assessment in the project "Future water use and the challenge of hydropower development in the Western Balkans", 29 April 2013, Copenhagen, Denmark;
- Security implications of future water use in the Western Balkans: Challenge of hydropower development – final workshop, 30 September – 1 October 2013, Ljubljana, Slovenia.

The scenarios are based on two basic premises: intensity of climate change and sustainability of economy. See section 4.1 for details.

Development of hydrological models of water availability in the future is described in the corresponding section 5.

2.1. Delineating spatial and time frame

The geographical scope of the report is the Western Balkans – the regional delineation defined by the EU as the group of the countries in south-eastern Europe that are not part of the EU. Originally within the region, Croatia became the first of the seven countries to join the EU in 2013, while Montenegro, Serbia, the Former Yugoslav Republic of Macedonia and Albania are official candidates. Accession negotiations and chapters have been opened with Montenegro and Serbia. Bosnia and Herzegovina (which submitted its membership application in early 2016) and Kosovo under UNSCR 1244/99 are potential candidate countries. The region is 208 thousand square kilometres in area, inhabited by almost 18 million people and generating an annual GDP of roughly 76 billion euro (EUR) or 4280 EUR per inhabitant on average (**Error! Reference source not found.**). Purchasing power-balanced GDP is considerably higher than the nominal GDP.

Table 2.1: Basic socio-economic figures of the Western Balkan countries

	Albania	Bosnia and Herzegovina	The Former Yugoslav Republic of Macedonia	Monte negro	Serbia[a]	Kosovo under UNSCR 1244/99	Total
Area [km²]	28 750	51 210	25 710	13 810	77 474	10 887	**207 841**
Population [million][b]	2.89	3.51	2.07	0.62	7.08	1.77	**17.94**
GDP (nominal) [million EUR][c]	10 218	13 789	9 072	3 625	33 491	5 807	**76 001**
GDP/capita (nominal) [EUR][b]	3 540	3 922	4 380	5 825	4 733	3 278	

Note: [a]Serbia excluding Kosovo under UNSCR 1244/99.
Data source: [b]Eurostat, 2017f; [c]Eurostat, 2017g.

The time frame of the report expands from the current state and trends to the future of 2031–2060 and 2061–2090, respectively. The assessment of the current state and trends is based on the data for the most recent available year – 2016 where possible, extending to 2011 where no data from a more recent period are available or where an older data point is more appropriate in terms of credibility or representation. The source of the data along with the year/period for which it is valid is noted along the individual content section of the report. The periods for which the scenarios and models of water availability are described are selected to represent present state (1971 to 2000), mid-term (2031 to 2060) and long-term future (2061 to 2090). Mid-term future is the period in which the current strategies and trends can be effectively implemented, while the long-term future is the period in which the trends of climate change will be accentuated to render essential differences in water availability according to each scenario.

2.2. Participative approach – workshops

The involvement of stakeholders (policymakers, non-governmental organisations (NGOs), businesses, citizens) is important in creating a sense of 'ownership' in adaptation policy, a critical factor in the success of adaptation implementation. Stakeholder involvement also helps to improve the coherence of adaptation actions and builds adaptive capacity in the wider society (EEA, 2013a). Especially in the Western Balkans, it is essential to connect different levels of participants within the country and

transboundary, regarding low participation of NGOs on the one hand and a crumbled sector of regional experts that nevertheless have historical experience of cooperation on the other hand.

The project – specified participation of topic experts as part of the methodology. The experts supported the work throughout the project by: providing detailed knowledge on topics of (a) global megatrends and their downscaling to the country/region, (b) scenario shaping, and (c) regional water sector with a focus on resources and their management; forming an expert group to identify GMT implications and shape scenarios with Delphi method; providing national data sources and align them with project standards; reviewing results of the project to confirm their credibility. This report mostly focuses on scenario shaping and regional water resources, but also links to the outcomes and key messages associated with identified GMTs implications.

The major number of participating experts was coming from the network of EEA, e.g. the EEA's National Reference Centres (NRCs) for Water quality and ecological status; NRC for Water quantity; NRC for State of Environment; NRC for Land Use and Spatial Planning; and NRC for Forward looking information and services. NRC members from all regional countries were participating. Additional experts have been invited to participate based on their specific knowledge of GMT methodology, scenario development or regional water sector. Participating experts were involved in identifying the scope of the project, as well as in further phases of work, with cooperation highlighted in the two workshops.

2.2.1. *Workshop 1 "Implications of global megatrends in the Western Balkans region" – Ljubljana, 10–11 April 2017*

The scoping workshop offered the EEA and regional experts to have a better understanding of existing GMT links to the Western Balkans region; ideas on how GMTs may be integrated into regional and national situations and analysis; a possibility to connect national level SoE[3] activities to and feed into the EEA SoE Report 2020 process; and to get an overview of forward-looking methods in the framework of other EU projects dealing with scenarios and water availability.

The invited participants were NRC experts from Albania, Bosnia and Herzegovina, Kosovo (under UNSCR 1244/99), the Former Yugoslav Republic of Macedonia, Montenegro and Serbia, as well as experts from governmental institutions of Hungary and Slovenia and an expert from Wageningen University in the Netherlands. For the full list of 28 participants, see Annex 3.

The preceding project (2013–2014) was briefly presented by ETC/ICM Waters, including its four explorative scenarios, developed indicators and country profiles, hydrological model for the two basins of Morača and Vardar, and the conclusions of the project. A share of workshop participants had already been involved in the preceding project and were able to refresh their knowledge of the work done, while the rest became familiar with the content basis of the work at that point.

The latter part of the working session was hosted by the Wageningen University expert who put the work in the context of other projects funded by the EU which are developing the topic of water use and stress arising from it. It was shown how the work of two connected projects MARS[4] and Globaqua[5] could be used in conjuncture; especially since the case study within the latter project was done on the Sava river basin, part of the Western Balkans region. This includes using envisioned scenarios and a downscaling framework to develop them further in the context of the region. The descriptors of different scenarios for various sectors (society and economy, energy, environmental effects, water management,

[3] State of Environment.

[4]Managing Aquatic ecosystems and water Resources under multiple Stress (http://www.mars-project.eu/index.php)

[5] http://www.globaqua-project.eu/en/home/

agriculture, industry, residential, tourism and recreation, policies) were discussed with participants to identify the most important ones.

2.2.2. *Workshop 2 "Assessment of risks and opportunities, policy gaps and needs" – Belgrade, 7–8 September 2017*

The second project workshop was held in Belgrade in September 2017. The main objectives of the workshop was to bring together regional experts to: discuss the risks and opportunities for the Western Balkans region and countries arising from GMT implications, which felt to be the most relevant and likely to have the strongest effects in the region, to assess the likelihood and magnitude of these risks and opportunities as well as to identify corresponding policy gaps. The workshop also included discussion of needs related to GMT implication, data gaps and uncertainties. Draft results of short-term and long-term water and climate change vulnerability in the context of scenarios calculated for the 12 selected catchments within the Western Balkans have been presented to workshop participants. The discussion which followed was much appreciated and gradually improved the quality of final results; it has been proposed and decided that longer time periods should be used for in modelling.

Since the majority of participants in the second workshop also participated in the first workshop, this was also an opportunity for regional experts to follow-up on the discussions held in the first scoping workshop.

Participants invited were NRC experts from Albania, Bosnia and Herzegovina, Kosovo (under UNSCR 1244/99), the Former Yugoslav Republic of Macedonia, Montenegro and Serbia, as well as experts from governmental institutions of Hungary and Slovenia and 2 experts from Wageningen University in the Netherlands. For the list of 29 participants, see Annex 3.

2.3. Data sources

The main parts of the literature used for development of the project are the EEA reports centred on two topics: the Western Balkans or water resources and climate change in general.

Among others, the following EEA literature on the Western Balkans is used:

- *Environmental trends and perspectives in the Western Balkans: future production and consumption patterns (EEA, 2010a)* – a thorough overview of the regional state and trends, focused on socio-economic indicators; due to strong trends in the transitioning region, figures listed in the report are updated for the purpose of the current work;
- *West Balkan Environmental Core Set of Indicators (ZOI Environment Network and EEA, 2012)* – the source of indicator data, including data on the topic of water resources, connecting data from national statistics agencies to one report and providing a starting point to search for the most recent data sources;
- *The European Environment – State and Outlook 2015 – Countries and Regions (EEA, 2015c)* – country-level assessment of state of environment, including the countries of the Western Balkans.

The literature not authored by the EU institutions is complementary and provides an important source of data on water management practices and climate change theory and specific topics of the Western Balkans. The regional issues have been well-covered by international, NGO or foreign government-sponsored projects in the past decade.

In terms of quantitative data, the EU, national or international organisations' databases are used:

- *Eurostat* – good availability for the EU area and less available for the countries of the Western Balkans; however, a positive trend in data availability is observed in comparison to past decades;

some figures – especially in the area of water resources – do not align with national or other international data sources and cannot be designated credible;

- *EEA* – Water Information System for Europe (WISE) State of Environment database is extended to freshwaters of the Western Balkans, based on voluntary reporting of countries; some data can be used to understand the basic state of water quality and quantity; however, it is not possible to establish a credible time series yet;
- *World Bank* – where no data are available from Eurostat, they are supplemented by World Bank databases *World Development Indicators* and *Worldwide Governance Indicators*; the first offers 1504 different indicators at country level, covering the topics of demography, economy, environment and technology; for the Western Balkans, the database sometimes lacks uninterrupted time series or most recent data;
- *International Monetary Fund (IMF) World Economic Outlook* – used for basic forward-looking economic figures;
- *Climate data databases* – modelled future temperature and precipitation data covering the Western Balkans have been obtained from Geophysical Fluid Dynamics Laboratory (GFDL). Past temperature and precipitation data have been obtained from E-OBS database which includes daily gridded observational dataset for precipitation, temperature and sea level pressure in Europe based on European Climate Assessment & Dataset (ECA&D) information.

Data availability is substantially better than five years ago in terms of statistical offices' web portals, national state of environment reports and reporting to EU institutions. However, a look at available data sources regarding water use indicates that monitoring and categorisation of water use categories are not consistent neither at national and/or regional level (comparing between national statistics agencies) nor with international databases (Eurostat, World Bank etc.). Giving a credible assessment of water use through the region may therefore be challenging.

3. Present state and trends in the Western Balkans

Key messages

- Demographic trends in the Western Balkans are unstable and hard to predict. In the last 15 years the overall population has, also due to high unemployment (23%) and emigration of young and highly educated people, declined by 2.2%. Even though the share of urban population in the region as a whole increased from 46% in 1990 to 55% in 2015, the region still identifies its rural character, also shown by the large share of the agricultural sector in the economies of the region.
- Wastewater treatment is improving steadily; 6.5% of the population is connected to waste-water treatment plants, however this is still far below the EU average of 86%.
- Remittances sent by emigrants living abroad are high; almost 10% of GDP. They not only present a significant income for the region but also dependency of many households on income from outside the region.
- Wilderness Quality Index in the Western Balkans is considerably high compared to neighbouring countries and Europe overall, meaning that wilderness areas in the region are largely intact and supporting rich biodiversity.
- The water resources per capita in the Western Balkans region are almost twice as abundant as in neighbouring countries and the hydropower potential is large. Moreover, regions and catchments of the Western Balkans have retained many more largely intact river landscapes than western and central European river basins.
- Construction of new dams and reservoirs on the rivers in the region would significantly impact many rivers since the dominant portion of the planned hydropower plants is planned on river stretches with a very high conservation value. Their construction will especially influence the currently still free flowing rivers.
- The region is highly exposed to natural hazards (e.g. floods, droughts, forest fires) and has a high vulnerability index.

3.1. Overview

This section provides an overview of the key factors of development, presented in a concise format of indicators. Starting with the historical and geographical context of the region, key factors that shape the current state and trends that will be likely shaping the future are categorised into social, economic, environmental, political and technological. State and trends are presented in respective national State of Environment reports composed by all countries of the region, while the following content summarises cross-cut factors of state and trends in the region, with highlights of some of the cases.

The six countries of the Western Balkans – Albania, Bosnia and Herzegovina, Kosovo (under UNSCR 1244/99), the Former Yugoslav Republic of Macedonia, Montenegro and Serbia (Figure 3.1) – cover the area of 208 thousand square kilometres, against the much larger European Union that fully surrounds the Western Balkans. Nevertheless, it is distinguished from the EU by various aspects, predominantly by the fact of being a geographical island in the south-eastern part of the EU. The Western Balkans countries are newly independent states with developing state institutions. The institutional fragility is often connected to the post-conflict situation and social tensions. Continuing international aid remains important in preserving the *status quo* in some republics. Nevertheless, the region's economic, social and environmental conditions vary significantly.

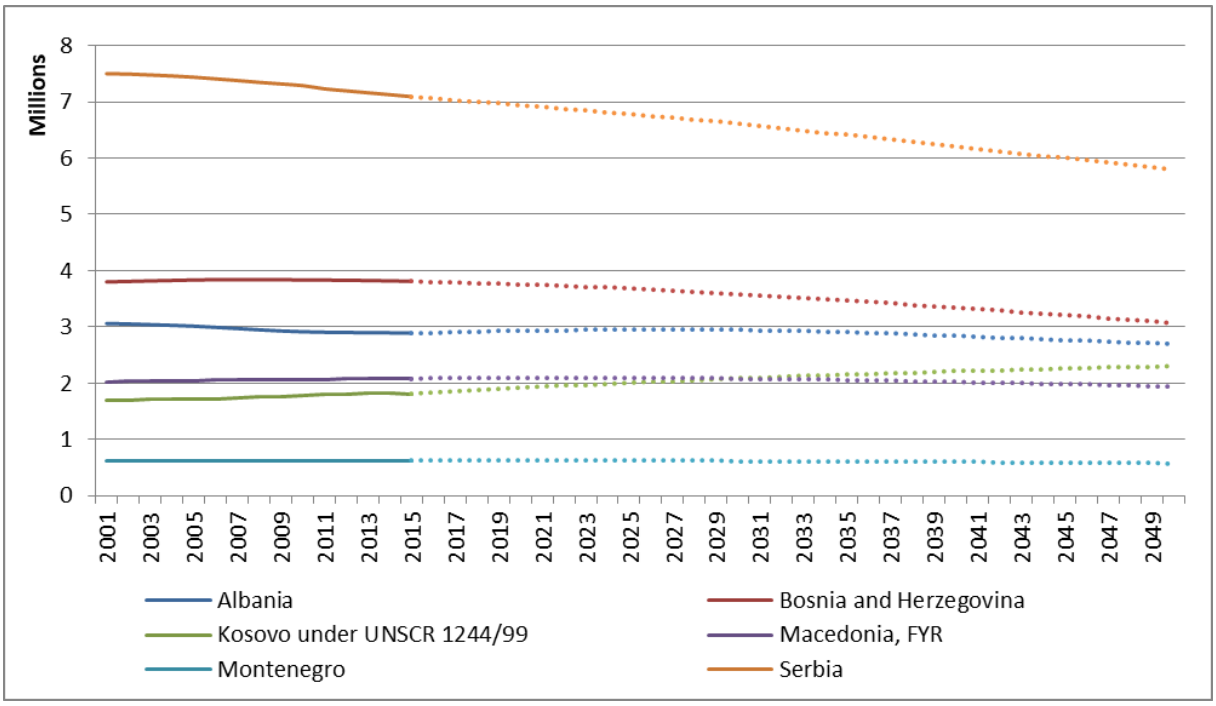
Figure 3.1: The Western Balkans countries

Data source: Eurostat, 2010 (Country borders); EEA, 2013c (Digital Elevation Model (DEM)); EEA, 2017f (Marine Subregions).

3.1.1. *Social factors*

Population count and its structure are directly linked to environmental pressures: larger populations have higher resource requirements and generate more emissions. Especially in terms of food production and consumption, water use and energy, the link between population size and environment is very close (EEA, 2010a). However, links to other factors of economic conditions, technology, values etc. need to be kept in mind.

Figure 3.2: Population trend in millions (full lines; 2001–2015) and projection (dotted lines; 2015–2050) by country

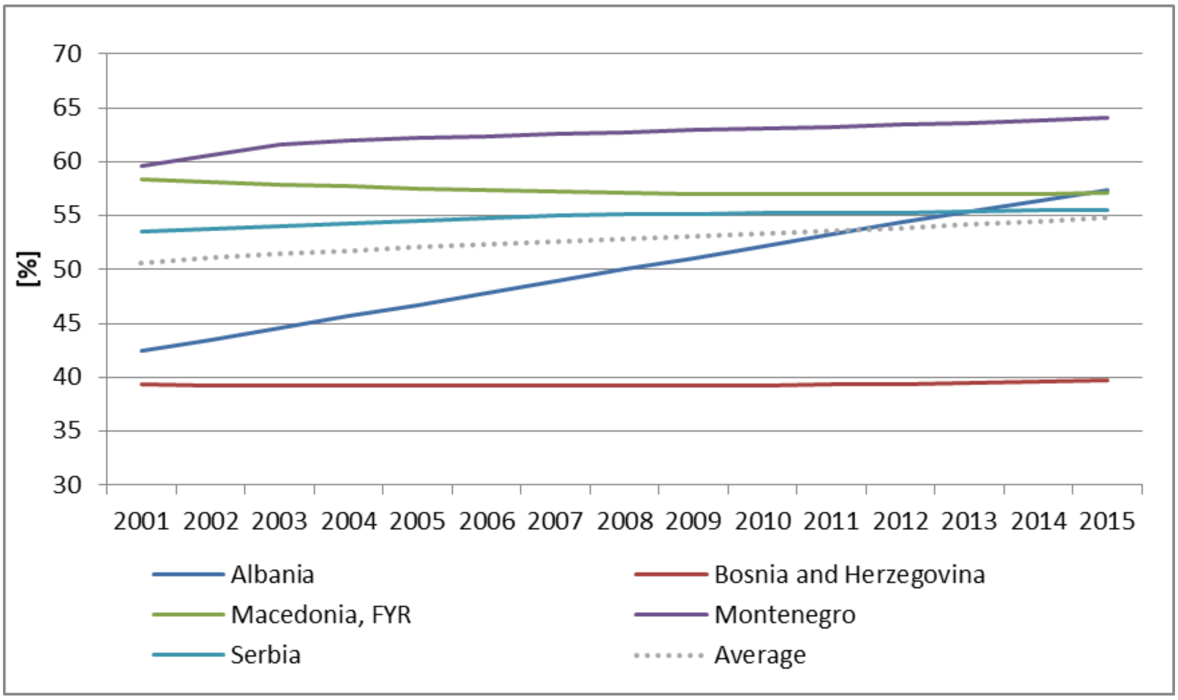


Data source: World Bank, 2017b; World Bank, 2017c.

Demographic trends of the last three decades in the Western Balkans are rather unstable. Allowing for considerable regional differences, however, they have settled after the 1990s and are now more stable than in neighbouring countries which are part of the EU (Figure 3.2). Demographic trends observed until 2013 were showing population growth (only) in Albania and Kosovo (under UNSCR 1244/99) where the shares of young people are the highest, however available data (World Bank, 2017b) since then show negative growth despite previous population projections (World Bank, 2017c) that still predict slow to moderate population growth at least in Kosovo (under UNSCR 1244/99). Population trends are therefore show general decline throughout the region, with possible less predictable trends by specific country. The population decreased from 18.69 to 18.29 million between 2001 and 2015 (2.2% decrease) and is projected to further decrease to 16.37 million (12.4% decrease compared to 2001) by 2050.

The Yugoslav wars hindered development of towns across the region: they were devastated and abandoned, with significant ethnical migration. There was a decrease in the pace of urbanisation and new town statuses were granted based on administrative concerns, mainly because the former centres became part of other states (Rácz, 2014).

Figure 3.3: Share or urban population 2001–2015, with linear trend (dotted line).



Data source: World Bank, 2017b.

The share of urban population in the region as a whole indeed increased from 46% in 1990 to 55% in 2015 (World Bank, 2017b), showing steady but slow development of urban societies (Figure 3.3). Nevertheless, the region still identifies its rural character, also shown by the large share of the agricultural sector in the economies of the region (Globevnik et al., 2014) and the share of the rural population in the region. The latter – reaching around 49% of the total population share – is almost twice as high as the share of the rural population in the EU (25%), and is decreasing in favour of the urban population only at a slower pace (World Bank, 2017b). The average population density of 83 inhabitants per square kilometre in the region is lower than in the EU and neighbouring countries. The largest urban population growth has been observed in Albania.

Nevertheless, the recently created nation states consider developing their capital cities as a top priority (Rácz, 2014), but natural population growth is low (except for urban settlements of Albania and Kosovo (under UNSCR 1244/99) and population growth mainly depends on national and international immigration. Similar than with migrations during the crises of the 1990s when more than 600 thousand people emigrated to other European countries and around 4 million were internally displaced (EEA, 2010a), further emigration is already observed and can be predicted for the future. Founded mostly on economic (Kovtun et al., 2014) but also political reasons (Bibic, 2015), it can be observed in all countries of the region and has most probably also reversed Kosovo's population increase. Emigration of the young and highly educated population is of special significance and might slow down economic developments of the region even to lower levels. Under such changing circumstances, the assessment of society's and economy's environmental footprint is less credible. The three unpredictable variables are population count, population activity (economy) and type of economy in terms of environmental pressures.

Photo 3.1: Young population of Peć, Kosovo under UNSCR 1244/99.

Photo: © Gašper Šubelj, 2017

Achievements in health, knowledge and standards of living, presented through IMF (HDI) by the United Nations Development Programme (UNDP) ranging between 0.739 and 0.807 between countries of the region, are not significantly lower than in neighbouring countries of the region, although a growing inequality observed in income levels is of concern (World Bank, 2017b), the same as large regional disparities in life satisfaction both between and within countries.

Scenarios[6] of social trends (see section 4.1)

Scenario 1 & 2: young people not moving out any more, or with lower pace; higher density, especially in urban centres; such a scenario would first have to be supported by economic and political elements.

Scenario 3 & 4: young people emigrating faster, much less (especially educated) workforce, decrease of overall population, social tensions due to an ethnically unbalanced active population within the region.

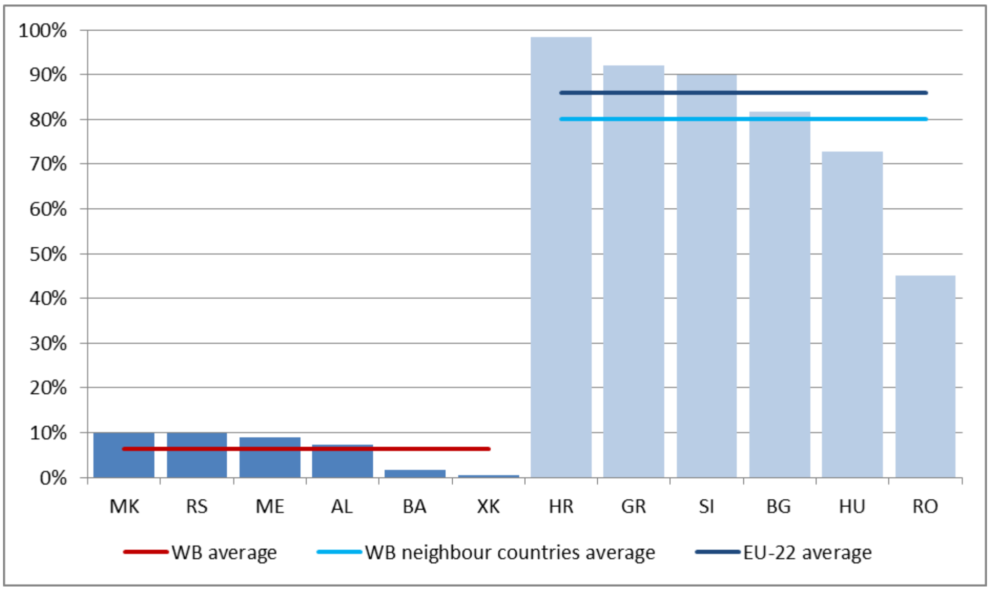
[6] Four plausible scenarios applicable for the Western Balkans were developed with a combination of reviewed sources and expert cooperation. The scenarios are based on two uncertainties: intensity of climate change and sustainability of economy. Considering different combinations of these two variables, four different plausible futures may unfold. The first scenario (good economy and moderate climate change) is the most pleasant whereas the fourth scenario (unsustainable economy and high climate change) is the least pleasant. The scenarios were refined and consolidated at four regional workshops.

3.1.2. *Technological factors*

Technological means are an important factor defining water availability for human use on one hand, and making optimal use of this water on the other. Technological advancements can increase water availability and supply but can also lead to unpredicted consequences including decrease of available water quality and quantity (Committee on Sustainable Water Supplies for the Middle East, 1999). These pressures include hydro-engineering means such as large dams and exploitation of groundwater for irrigation, while technological improvements can be achieved through installation of waste-water plants, optimisation of water supply networks etc.

While access to an improved water source is granted to 98.5% of the regional population and rising (World Bank, 2017b), there are downsides to the water distribution system in the Western Balkans. An average of 56% of water extracted for water supply networks does not reach end users (in comparison to the average of 25% for EU Member States for which data are available from the World Bank (2017b) database), and as such the non-revenue water share in waterworks is sometimes as high as 75% (World Bank, 2017b). This leaves a large potential for improvements in water extraction and supply efficiency throughout the region.

Figure 3.4: Share of population connected to waste-water treatment



Note: EU-22 average: Belgium, Bulgaria, Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Austria, Poland, Romania, Slovenia, Finland and Sweden.
Data source: Eurostat, 2017b (Albania, EU Member States); Eurostat, 2017c (Bosnia and Herzegovina, Kosovo (under UNSCR 1244/99, Serbia); WHO, 2015 (The Former Yugoslav Republic of Macedonia); World Bank, 2015 (Montenegro).

Wastewater treatment in the Western Balkans has been improving steadily since 2001, with an average per-country share of population connected to waste-water treatment plants rising to 6.5% in 2012 (Figure 3.4). This share varies between countries and within them (ZOI Environment Network, 2012), ranging from almost none in Kosovo (under UNSCR 1244/99) to around 10% in the Former Yugoslav Republic of Macedonia, Montenegro and Serbia. The share is significantly lower than the EU average of 86% (data for 2012, available for 22 Member States; Eurostat, 2017b). Countries of the region are aligning national legislation with the Urban Waste Water Treatment Directive which is expected to increase investments in waste water treatment. However, considering the fact that the Urban Waste Water Treatment Directive (UWWTD) is the single most expensive directive ever adopted by the EU

(Heider, 2015), it will have implications on the financially weak public and water sectors in the Western Balkans. Some large projects of waste-water treatment development are planned in cooperation with stakeholders from outside Europe – for example, the construction of a centralised waste-water treatment plant in the capital of Belgrade has been won by a state-owned company from China (GWI, 2017). The GMT implication foresees the increase in cost of wastewater treatment in the coming decades, which is likely to make meeting the cost of ensuring adequate wastewater treatment even harder for countries in the region. Moreover, a lack of resources for investments and maintenance is a common problem (EEA, 2010a). This was also identified as a potentially important issue for the Western Balkans region during the expert workshop held in Slovenia (April 2017). The experts also emphasized that much of the water infrastructure in the region is quite old, not well maintained and of deteriorating quality, meaning that there may be an increased need for investment in infrastructure just to maintain the current levels of water management and treatment.

According to the European Bank for Reconstruction and Development (EBRD), technological innovation is one of the economic potentials of the Western Balkans (Sanfey et al., 2016). Given a relatively high educational level of population in the region and the low share of research and development funding, the existing human capital is not optimally used for development and implementation of technologies within the region. Moreover, mobilisation of highly educated diaspora (result of brain drain) might be a tool in developing an environment of innovations in the region (Stanković, 2014). Technological breakthrough in the field of energy is also supported by incentives of the EU: for example, investments in smart metering, the lack of which is identified as a significant downside of the regional energy and water infrastructure, contributing to energy losses (Pyrkalo, 2017).

An *accelerating technological change*[7] as the global megatrend (GMT4 as defined in SOER 2015 (EEA, 2015a)) is believed to drive information exchange in the Western Balkans, and coupled with the growth of developing regional economies, rising levels of education and urbanisation, it bears the power of being able to narrow the gap between costs of technologies and their availability to the wider population and institutions.

Scenarios of technological trends (see section 4.1)

Scenario 1 & 2: technological breakthrough in energy production, water abstraction and use; this includes new mainstream methods of energy production from renewable sources and smart public water supply systems and irrigation infrastructure with minimal losses; this leads to an increase in water use without an increase in water abstraction.

Scenario 3 & 4: minimal adoption of technologies due to inaccessible licensing (privatised technologies on a global level) with further deteriorating infrastructure; water abstraction increases, with minimal increase in water consumption at the cost of losses and irrational use of resources.

3.1.3. *Economic factors*

Economic growth causes increases in water demand for household, industrial, and agricultural uses. Urbanisation contributes to dietary changes, with a general trend toward more water-intensive diets (Ringler, 2017).

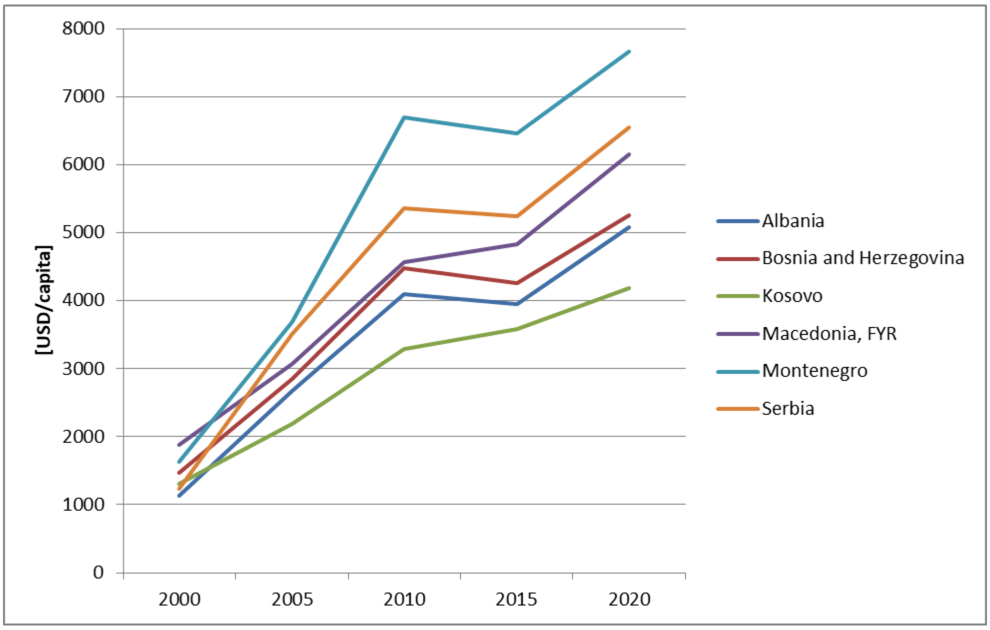
Although explored in several studies, links between water availability and economic growth are not clear. Past analyses linking water and economic growth have focused on the impact of economic growth on water use, generally trying to assess the existence of an Environmental Kuznets Curve, assuming an inverted u-shape relationship between per capita income and the use of natural resources. Nevertheless,

[7] See https://www.eea.europa.eu/soer-2015/global/technology for more about GMT4.

water use and availability also directly affect economic growth, with growing water scarcity limiting desirability or potential for investments (Ringler, 2017).

National economic policies and processes will shape the Western Balkans and could have a different impact on the environment as well as water use (EEA, 2010a). On the one hand, economic growth can increase environmental pressure through increased production and consumption, while on the other it can provide resources to address some environmental issues that have proven to be in correlation with the economic developments of richer countries – such as waste-water treatment or waste disposal.

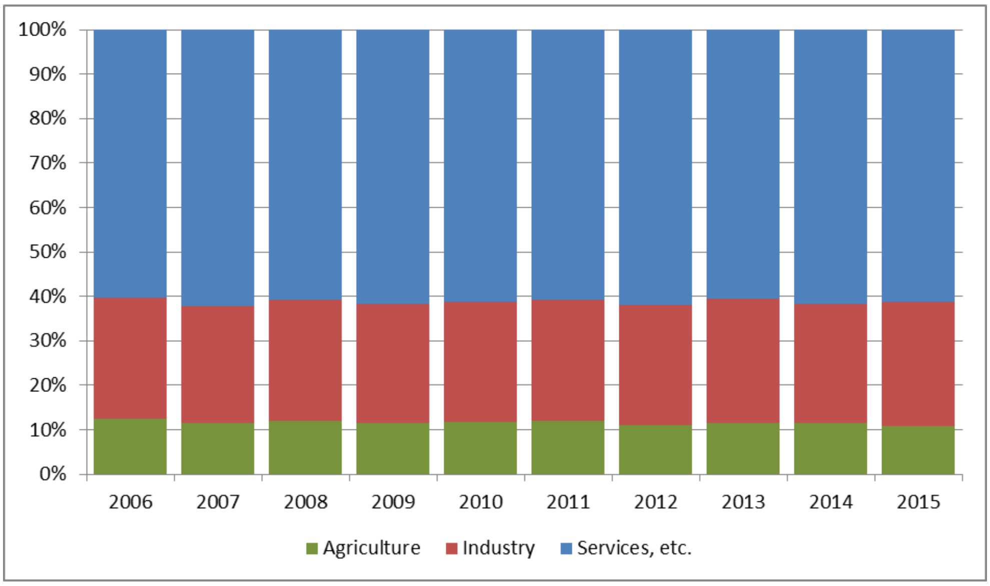
Figure 3.5: GDP per capita by country, with projections for 2020



Data source: IMF, 2017.

Economic growth is in correlation to environmental pressures, and is therefore of special significance in the Western Balkans, since some countries or parts of countries are among the least economically developed regions of Europe. The Gross Domestic Product (GDP) (Figure 3.5) per capita (nominal) of the region in 2015 was 4279 EUR on average, therefore falling far behind the EU average. The IMF economic outlooks (IMF, 2017) predict economic growth, increasing GDP per capita (nominal) by 23% in five years, however with ever-increasing differences between the countries of the region.

Figure 3.6: Share of economic sectors in the economy of the Western Balkans – GDP by sector.



Data source: World Bank, 2017d.

With more than a 10% share of the total GDP of the region as a whole (World Bank, 2017b), agriculture remains an important economic sector of the Western Balkans (Figure 3.6) with significantly larger cultural and economic dimensions compared to the EU. No radical changes in the regional agriculture are expected, and critical resources would be needed to create basic preconditions for establishing market-based economy in the field of agriculture, should that be the aim of regional policies. Among the reasons are disclosure of agricultural enterprises and fragmentation of small farm lands, unstable internal market, global competition with cheap agricultural products etc. (Nikolić et al., 2017).

Unlike the Single Market of the EU, the Western Balkans is fragmented and often lacks infrastructural management which was disintegrated in the 1990s. The economies of the region remain fragile, and underdeveloped, the middle and small enterprise sectors makes them highly dependent on the whims of international markets. Furthermore, large energy imports mean that the regional economies are vulnerable to potential hikes in oil and gas prices (OSCE, 2010). High unemployment reveals both the importance of international aid in preserving the status quo, as well as its inability to bring development to post-conflict regions. Unemployment is especially high and problematic among the youth at 48% in 2013 (World Bank, 2017e).

The countries of the Western Balkans had little foreign direct investment before the 1990s, and even more limited investments in the dissolution wars period (Rácz, 2014). Starting in the 2000s, foreign direct investments in the region have represented a significant share of the regional GDP, however they are unevenly distributed among countries – averaging from 4–5% (period 2000–2015) in Bosnia and Herzegovina, Croatia and the Former Yugoslav Republic of Macedonia to 16% in Montenegro. The average is higher than the average of the EU (share of GDP) for the same period, but a substantial decrease has been observed after the economic downturn of 2008 (World Bank, 2017b). Moreover, in spite of the larger share in GDP, absolute investment per capita is still lower than the EU average (Sanfey et al., 2016). Foreign Direct Investments (FDI) might improve in the future, by the use of the common potentials of the region such as a strong macroeconomic stability, strategic geographic location, diverse economies, and low unit labour costs combined with a relatively well-educated population (Sanfey et al., 2016). Combined with this, the EBRD also foresees exploitation of the region’s energy resources as one of the pillars of economic growth.

Important foreign investment goes to energy and infrastructure projects. High-voltage underwater electrical cable between Italy and Montenegro is being constructed with partners from Italy, Montenegro and the EU (EBRD), further opening up the regional market towards markets of a high request (Sanfey et al., 2016).

Existing human capital in the region is relatively high but not used for the purpose of raising national economies. Though with a decreasing trend since 2001, the unemployment rate of 23% of the total labour force in 2015 was more than twice as high as in the EU-28. Living standards and the low share of research and development funding are driving highly educated people to seek employment outside the region (Bonifazi et al., 2015).

Consumerism has become a global phenomenon, and its developing patterns can be seen in the Western Balkans as well. However, traditional consumption patterns continue in the region, especially in terms of local food production – strong ties to rural areas and family farms. New consumption patterns, facilitated by new supermarkets and processed food products, are spreading quickly and are expected to raise environmental impacts related to food (EEA, 2010a).

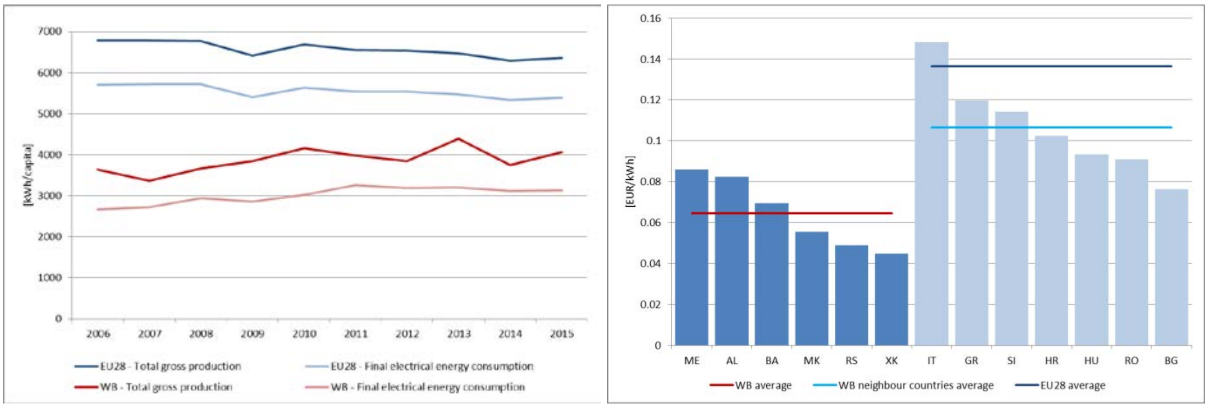
Remittances sent by emigrants living abroad are a significant source of income (EEA, 2010a). Ranging from 3.0% of total GDP in The former Yugoslav Republic Macedonia to 15.1% in Kosovo (under UNSCR 1244/99) (data for 2015; World Bank, 2017b), they represent a significant income for the nations of the region but also the dependency of many households on income from outside the region (Petreski et al., 2013).

Water and electricity as economic resources

Economic conditions may affect water supply and demand. World energy prices also affect the quantities of water used by boosting the price of water that must be pumped or treated before it can be used (Committee on Sustainable Water Supplies for the Middle East, 1999). Both energy and water tariffs affect availability of water for household as well as industry users, consequently having an effect on water use for any of these purposes.

Electricity production and consumption in the Western Balkans are lower than the average of neighbouring countries or the whole EU-28, in absolute as well as per inhabitant terms. As trends indicate, per inhabitant figures are drawing closer, given that 28 Member States of the EU produced and consumed 6% less electrical energy than produced and consumed ten years ago, while countries of the Western Balkans increased production by 12% and consumption by 18% (Figure 3.7). In the water-rich region of the Western Balkans, this brings implications to energy-related water use.

Figure 3.7: Electricity production and consumption in kWh/capita (left), electricity prices for domestic customers in EUR/kWh (right) (average 2013–2016)



Data source: Eurostat, 2017e; Eurostat, 2017d.

While due to global, European and regional oscillations in energy mix prices, there are no pronounced trends in tariffs for electricity, the important factor is its low price – 6.5 euro cents per kilowatt hour (kWh) excluding taxes and levies – in the Western Balkans compared to the EU average. This is 47% of the EU average and 61% of the average in neighbouring countries. Low electricity prices provide a potential for electricity export to countries with generally higher electricity prices, and indeed even at present electricity export makes up a 1.4–8.0% share of the total export for countries of the region (data for 2015 by Simoes, 2017). Only Kosovo (under UNSCR 1244/99) does not export any electrical energy (data for 2015 by Kosovo Ministry of Foreign Affairs, 2017).

Likewise, average water tariffs fall significantly below the EU average and averages of all EU Member States neighbouring the Western Balkans. The average tariffs per cubic metre of water supplied to a household range from as low as 0.32 EUR value-added tax included in Tirana (Albania), followed by Podgorica and Sarajevo with 0.41 EUR, Prishtina with 0.43 EUR, Belgrade with 0.47 EUR, to 0.77 EUR in Skopje (the Former Yugoslav Republic of Macedonia) which is the most expensive capital of the region regarding household water supply. Compared to an average of 0.87 EUR in Italy or 2.97 EUR in Germany, the regional tariffs for water supply are low even when accounted for purchasing power. Nevertheless, water is a commodity whose real value so far exceeds its nominal price and whose price is often unreflective of the real cost of providing it (Maxwell, 2012). In line with this and an overall EU trend, upward trends in water tariffs are observed throughout the region and are expected to affect intensity of water use in the future, both in households and the economy.

Despite the trend of growing tariffs, governments may have difficulty correcting market prices and pursuing ambitious greenhouse gas mitigation due to opposition from businesses and consumers in the globalised market, in the context of *Continued economic growth* (GMT5)[8] and *Intensified global competition for resources* (GMT7)[9]. Such approaches are especially difficult to implement in the Western Balkans due to low buying power, and the current economy relying on depreciated technologies, with a likely continuation of doing so.

The growing economies in the region are likely to use more renewable biological resources and non-renewable stocks of minerals, metals and fossil fuels. This is expected to increase pressure on local natural resources and add to the growing volume of imported resources and could result in tensions regarding competing claims over resource stocks.

Scenarios of economic trends (see section 4.1)

Scenario 1 & 2: growing GDP and achieving two thirds to three quarters of the EU average, at which point the countries can be grouped together with developed economies, impacting the corresponding water use; larger purchasing power, coupled with an increased need for energy; increased foreign investments in sectors that service regional population and needs; such economic dynamics drive water abstraction and use increase in all categories: agriculture, manufacturing industry, public water supply and hydropower generation.

Scenario 3 & 4: stagnating GDP; increased foreign investments in sectors that service societies and economies outside the region; consequentially increased economic disparities within the region, with depleted water resources exploited by investors from outside the region.

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[8] See https://www.eea.europa.eu/soer-2015/global/economic for more about GMT5.
[9] See https://www.eea.europa.eu/soer-2015/global/competition for more about GMT7.

3.1.4. *Environmental factors*

The Western Balkans is known for its remarkable biodiversity, making it a unique biogeographical and ecological phenomenon in Europe. This environment is, however, threatened by a lack of sewage systems and urban waste water treatment plants, insufficient waste disposal, heavy industry and poor environmental awareness.

Ecosystems

Ecosystems provide services that are instrumental in achieving sustainability of water supplies, including runoff control by vegetation, water filtering by plants and soil layers, reducing flood vulnerability, preventing erosion, dilution of waste-water by surface streams, storage of freshwater in lakes etc. On the other hand, water is an essential element sustaining ecosystems that provide other services to humans. These ecosystems are a critical legitimate user of water resources (Committee on Sustainable Water Supplies for the Middle East, 1999).

Freshwater quality is averagely lower compared to the EU – concentrations of nitrates and ammonium in rivers are relatively high due to insufficient sewage systems, an absence of waste-water treatment plants and lacking environmental awareness. However, there are more intact rivers in the Western Balkans than in Western and Central Europe.

Wilderness Quality Index (WQI) in the Western Balkans is considerably high compared to neighbouring countries and Europe overall, meaning that wilderness areas in the region are largely intact and supporting rich biodiversity.

Photo 3.2: The wetlands of Hutovo blato in Bosnia and Herzegovina are an example of riparian ecosystems depending on adequate water resources.

Photo: © Gašper Šubelj, 2013

Globally, the trend of deteriorating water-dependent ecosystems has been observed. As the climate changes and temperatures increase (*Increasingly severe consequences of climate change* – global

megatrend 9)[10], the need for ecosystem-based adaptation will increase (EEA, 2015a). Such implication for the region can be expected. Global degradation of ecosystems is to pronounce climate change which affects climate and water circle stability in the region. In turn, regional ecosystems get an even larger role in mitigating extreme events (disaster risk etc.) – the need for ecosystem-based adaptation is therefore believed to increase.

Scenarios of environmental trends (see section 4.1)

Environmental factors – focused on climate change – are the essential element of two-axis scenario matrix.

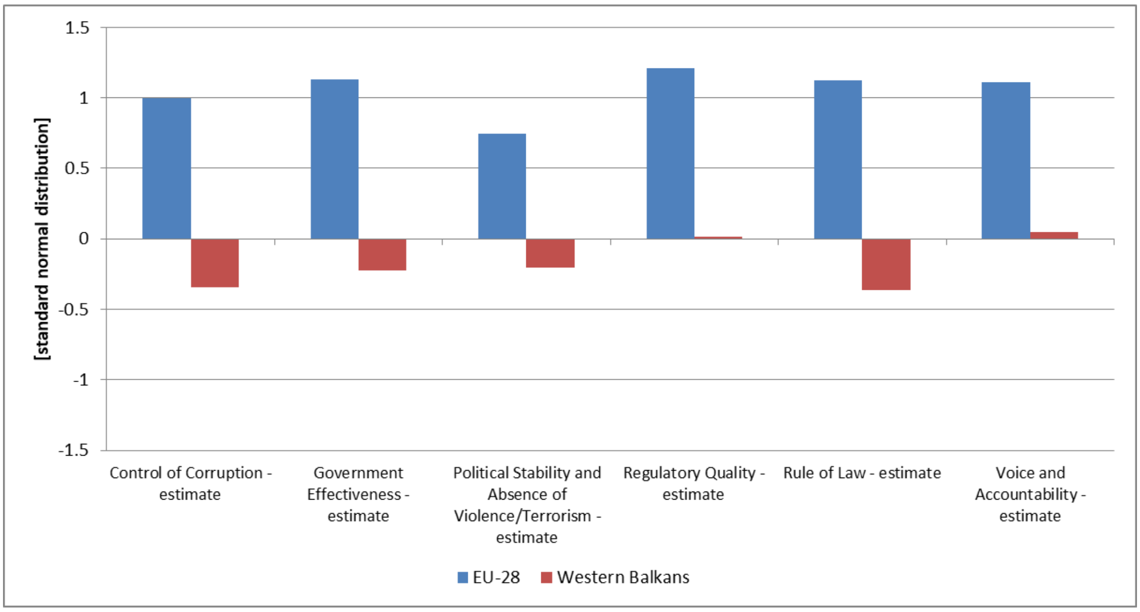
Scenario 1: temperature increases but with an acceptable rate; sustainable ecological footprint and land take, increased designated areas; waste-water treatment improves.

Scenario 4: temperature increases to high levels, disturbing water cycle, imposing further pressures on land use; the ecological footprint therefore increases due to the decreased capacity of the environment, although the economy does not develop.

3.1.5. *Political factors*

Governance indicators developed by the World Bank (2017a) show a considerably lower score aggregated for the countries of the Western Balkans compared to the EU-28 average (Figure 3.8). Scores are particularly low in the field of rule of law, corruption control and government effectiveness. The time series of all indicators show some improvements in indicators, however the aggregated trends of the region are not substantial.

Figure 3.8: Worldwide governance indicators – 2006–2015 average of aggregate indicator score, aggregated by the EU-28 and the Western Balkans



Note: See source for methodology description.
Data source: World Bank, 2017a.

Due to the lack of such research, it is challenging to find credible and measurable data on international relations of specific countries within the region, especially in terms of strategic alignments with foreign

[10] See https://www.eea.europa.eu/soer-2015/global/climate for more information about GMT9.

political entities – country/national as well as international. However, review of available literature shows diverse directions of international relations, much different from foreign relations of the EU and its Member States. Despite the fact that all countries of the Western Balkans aim for EU membership (having either status of a candidate country or potential candidate country), international cooperation and ties are often based on cultural and historical backgrounds that are oriented towards at least four geopolitical directions, depending on country or even sub-national entity of the Western Balkans: European Union, USA, Russia and the Middle East (Nič, 2017; Simurdić, 2016). This is also reflected by international trade where the largest trade partners of the region as a whole are Germany and Italy, followed by China, Russia, Greece and Turkey (Simoes, 2017; Kosovo Ministry of Foreign Affairs, 2017). Partners, however, vary significantly between countries of the Western Balkans.

Given the geographic characteristics of the region and in light of integrated river basin management principles, regional cooperation is essential. Although regional politics in past decades has been dominated with ideological issues such as nationalism and only regional cooperation was largely limited, various sources show a potential especially of civil society in the majority of countries that might support better regional cooperation.

For example, the share of citizens judging the breakup of Yugoslavia (and consequential deteriorated regional relationships) as unbeneficial ranges from 61% to 81% in Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia, Montenegro and Serbia. Only in Kosovo (under UNSCR 1244/99) such perception is extremely low (10%), with majority of citizens judging the breakup as beneficial (Keating, Ritter, 2017). There are also political initiatives to support the Western Balkans' connectivity agenda: the EBRD is aiming at forming a regional economic area (part of the Berlin Process) which should ideally forge links between markets, strengthen commercial ties and improve the business climate (Williams, 2017).

A political initiative for cooperation also comes from within the region, also with calls to for a common approach of the regional countries towards pre-accession negotiations with the EU, to articulate the common interest of the region and change the position from passive applicants to active partners (Burzić, 2017). This is of special importance when it comes to management of common resources such as cross-border water bodies.

Scenarios of political trends (see section 4.1)

The decisive factor of political and governance state and trends is cooperation between countries of the region.

Scenario 1 & 2: rule of law is strengthened, considering that many legislative aspects are harmonised throughout the region – according to EU practices; likewise, better cooperating governments address issues of corruption; voice and accountability of the non-governmental sector are developed and play an important role in developing the region and its water resources management.

Scenario 3 & 4: varied political alignments that are dividing the region apart; governance is ideologically burdened and negatively affects cross-border cooperation, even using water resources as a political means.

3.2. Water resources

Water resources can only be assessed through an integral relationship between water availability and water use. According to Water Resources Group (Schelmetic, 2012), global water demand in 2030 is expected to exceed the current water supply by 40%. The purpose of this section is to provide a more detailed insight into the water resources of the Western Balkans and how their availability and use will combine with global megatrends.

The correlation between present water use and future water availability and consumption rates is proven difficult to estimate accurately. International cross-sectional data indicates that agricultural water use follows an Environmental Kuznets Curve, however both household and industrial water withdrawals were more linearly correlated with income (Katz, 2015).

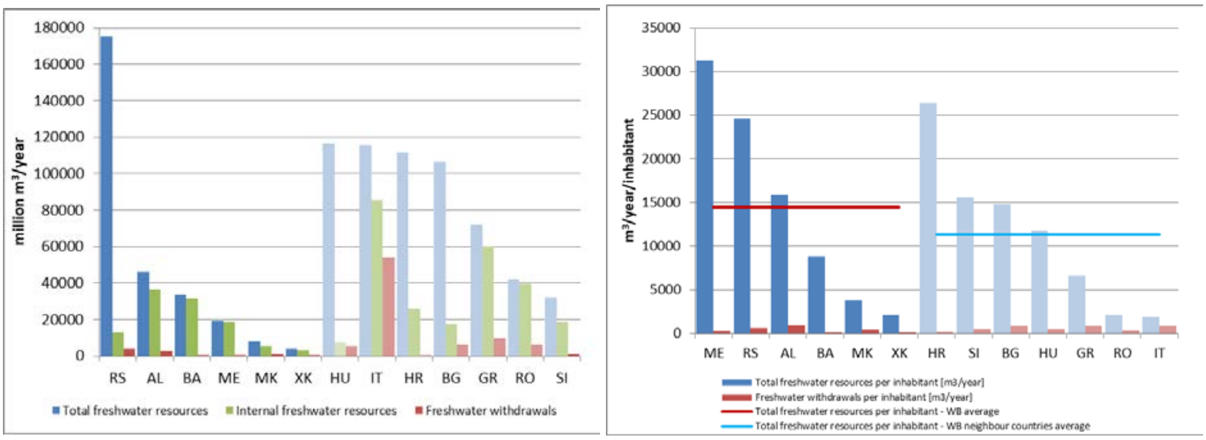
Water Stress Index (WSI), the ratio of water withdrawal to internal renewable water resources, can be used to identify development outcomes that put both populations and economic development at risk from water stress, with high criticality ratios (values above 40%) signifying severe water stress (Ringler, 2017).

3.2.1. *Water availability*

Ecosystems and socio-economic systems will be affected by changes in water availability. For example, agricultural output will be affected during alternating episodes of drought and flooding, and adapted crops may be required over the long term due to less water availability (Sanfey et al., 2016).

Owing to climatic conditions (described in section 3.1.4) as well as topography, the Western Balkans is one of the richest European regions in terms of water resources. Summed internal water resources for the region are about 112 billion m^3 annually or more than 17000 m^3 per inhabitant annually.

Figure 3.9: Freshwater resources and withdrawals, total (2005–2014 average in million m^3/year) (left) and per inhabitant (2005–2014 average in m^3/year) (right).



Data source: Eurostat, 2016a; Eurostat, 2016b; Pllana et al., 2010; World Bank, 2017b; ZHMS, 2017.

Amongst renewable resources, water is most probably the most strategically important resource in the region. The water resources per inhabitant in the Western Balkans are almost twice as abundant as in neighbouring countries (

Figure 3.10). Freshwater resources vary in terms of quantity, ranging from as low as 2100 m^3/inhabitant/year in Kosovo (under UNSCR 1244/99) to as high as 31000 m^3/inhabitant/year in Montenegro. The regional average accounts for more than double the European average. Taken as a whole, the Western Balkans has relatively abundant freshwater resources, but in many parts of the region water is scarce, particularly in summer months (EEA, 2010a). Competition for water is expected to increase as demand is likely to rise resulting from implications of climate change (Ruettinger, L., 2013).

Share of internal resources in total water resources varies between countries, with Serbia – the country with the highest freshwater flow in the region – having the smallest share of internal resources and Albania and Bosnia and Herzegovina the largest. An important volume of the region's water resources are shared between countries, including the Danube basin and tributaries such as the Sava River. Even though some countries in the region have modest internal water resources, most originate within the wider region or neighbouring countries. This high dependency on external sources makes regional countries highly vulnerable and prone to water shortages, and places transboundary river-basin management at the centre of their water policy development (Globevnik et al., 2014).

Total renewable water resources in **Albania** are about 41.7 km^3/year or 13300 m^3/inhabitant/year, out of which 65% having a source within the country. The remaining are external inflows from Serbia, Montenegro and the Former Yugoslav Republic of Macedonia (World Bank, 2003). Seven main rivers cross the territory of the country, with flows oriented from the mountainous eastern part to the coastal flatlands of the west.

There are considerable water resources in **Bosnia and Herzegovina** amounting to 33.6 km^3/year, with 94% of this volume generated within the country, or 8790 m^3/inhabitant/year. These volumes are unevenly distributed spatially as well as temporally, varying in annual flow from 14.6 km^3 to 53.9 km^3, with a moderately rising trend (data for the period 2000–2016; Agencija za statistiku Bosne i Hercegovine, 2017). With regards to surface waters, numerous courses are categorised as international rivers, either because they are boundary rivers (such as the River Sava) or because they cross borders between Bosnia and Herzegovina and its neighbours. Groundwater is an extremely important resource for water supplies (Globevnik et al., 2014).

In the Former Yugoslav Republic of **Macedonia**, the overall water resources amount to 6.4 km^3/year during an average year, corresponding to a water availability of 3150 m^3/inhabitant/year. 69% of renewable water resources are internal. During a dry year, however, annual water resources are limited to approximately 75% of an average year – to 4.8 km^3/year (World Bank, 2003). Most of this water comes from rivers, while groundwater, although not a major component of the water balance, is the dominant source of drinking water. About 98% of the territory is in international basins shared with neighbours – Serbia, Montenegro, Greece, Albania and Bulgaria – with the majority of flow sourcing within the country and outflowing to neighbouring countries. There are regions with regular water shortages in the country, such as the Strumica catchment. Water stress is pronounced during dry years, when about 40% of demand is not met (World Bank, 2003).

With 3.8 km^3/year of total renewable freshwater resources (KEPA, 2015), **Kosovo** (under UNSCR 1244) does not have sufficient water resources to meet the needs of its population and economy. This is a limiting factor for the socio-economic development of the country which has a large potential for irrigated agriculture (World Bank, 2003). The majority of resources are sourced internally, outflowing to the neighbouring countries of Albania, Serbia and the Former Yugoslav Republic of Macedonia. Seasonal variations are significant and very low stream flows are observed during the June–July growing season.

With average total renewable freshwater resources of 19.5 km^3/year, **Montenegro** ranks among the top 4% of world countries by average outflow. Given that at least 95.3% of Montenegro's flow originates in its territory, it is safe to say that water is the country's greatest natural resource. The average availability per inhabitant is 31339 m^3/year.

The waters of **Serbia** discharge into the Adriatic, Aegean and Black Sea. The total renewable resources amount to 175.4 km^3/year, of which about 127.8 km^3/year are of external origin (73% of the total). Serbia is therefore the country with the largest renewable resources in the region and the most dependent on external inflow at the same time. The water availability of around 1800 m^3/inhabitant/year is insufficient due to unequal spatial and temporal distribution and variability in water quality. The most populated lowland area of Vojvodina has the richest land and the poorest water resources, while high quality water resources are mostly located along the country's perimeter (Globevnik et al., 2014).

Photo 3.3: Accumulation on the Uvac River has altered natural hydromorphological and ecological conditions.

Photo: © Gašper Šubelj, 2014

In the case of deep karst aquifers that are covered by sediments, accumulation of groundwater occurs in one country with springs located in the neighbouring country. This is the case with the Dinaric karst aquifers of Bosnia and Herzegovina and Croatia (Darnault, 2008).

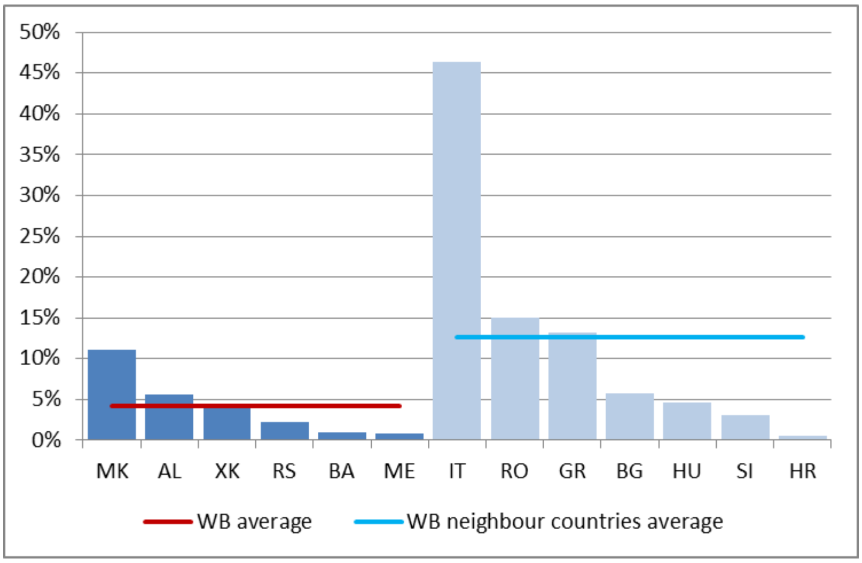
3.2.2. *Water use*

In Europe, the most important uses in terms of total abstraction have been identified as urban (households and industry connected to the public water supply system), industry, agriculture and energy (cooling in power plants) (EEA, 2017d).

Owing to large volumes of available water resources and modest withdrawals as well as other use, the regional Water Exploitation Index (WEI)[11] is low, averaging at 4.19%, therefore leaving large reserves of water for potential use (Figure 3.10). Nevertheless, specific regions of the Western Balkans and seasons of the year can be exposed to water stress – situations in which WEI exceeds 20%. The largest shares of total renewable water resources are exploited in the Former Yugoslav Republic of Macedonia, Albania and Kosovo (under UNSCR 1244/99), whereas less than 1% is used in Bosnia and Herzegovina and Montenegro.

[11] The Water Exploitation Index (WEI) in a country is the mean annual total demand for freshwater divided by the long-term average freshwater resources. It gives an indication of how the total water demand puts pressure on the water resource (EEA, 2013b).

Figure 3.10: Water Exploitation Index

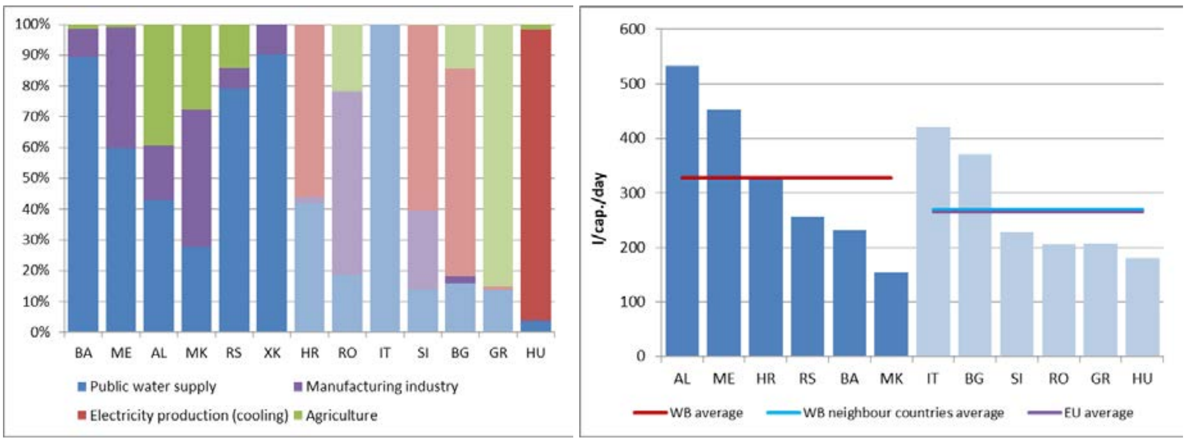


Data source: Eurostat, 2016a; Eurostat, 2016b; Pllana et al., 2010; World Bank, 2017b; ZHMS, 2017.

The Western Balkans region has a high average per person water use of 328 l/day which is higher than in the neighbouring countries or the average in the EU (Figure 3.11). Water consumption per person is not always in accordance with the quantity of freshwater resources – per person consumption in Albania is above average, but its resources are below average.

The manufacturing industry consumes more than two thirds of the abstracted water in the Former Yugoslav Republic of Macedonia and Montenegro (Figure 3.11). Cooling for electricity production consumes 75% of abstracted freshwater in Serbia. Irrigation consumes 58% of abstracted freshwater in Albania and 29% in the Former Yugoslav Republic of Macedonia. Irrigation is also a large consumer in neighbouring Greece. All these countries with substantial irrigation systems are impacted by a modest rainfall and such discrepancies might be more pronounced with changed precipitation patterns and more developed irrigation which is a part of national strategies.

Figure 3.11: Water use by sector (left) and water use per inhabitant (right) from the public water supply (l/cap/day)



Data source: ZOI Environment Network, 2012; EEA, 2010b.

Institutional, financial and political organisations for water management lack capacity. The variety of stakeholders is often poor, as is the public transparency of their underlying interests. Additional threats and opportunities are emerging from the region's increasing energy needs, including proposals in new energy policies such as market opportunities for additional hydropower exploitation (EEA, 2010a).

In terms of global megatrends, *Intensified global competition for resources* (global megatrend 7)[12] in combination with an *Increasingly multipolar world* (global megatrend 6)[13] and *Diversifying approaches to governance* (global megatrend 11)[14] is likely to have an impact on resources of the Western Balkans, especially regarding their international exploitation. Global materials use is estimated to have increased almost ten-fold since 1900, accelerating from an annual growth rate of 1.3% in 1900–1949, to 2.6% in 1950–1999, and 3.6% annually in 2000–2009. The International Energy Agency projects that global energy consumption will increase by 31% in the period 2012–2035, based on energy policies in place in 2014. Developing regions account for an increasing proportion of global resource use (EEA, 2015a). The Western Balkans is both a developing region and a part of Europe with abundant natural resources that are planned to be used, moreover knitted into the influence of increasingly multipolar global powers. The region has never exercised the influence of production, consumption and prices of global commodities, nor resources. It is therefore likely to follow the EU and global dynamics, adapting national policies and practices to them.

Public water supply

More than 98% of households in the region have access to an improved water source, with the exception of Albania with a 95% share and rising (World Bank, 2017b). An essential issue of water supply infrastructure in the Western Balkans is its dire condition. An important goal will be to achieve the stringent EU standards for drinking water supply and waste water treatment (EEA, 2010a).

There is a pronounced contrast between urban water supply and supply in rural areas. For example in Serbia, about half of the nation lives in urban areas and is supplied by the three largest (Belgrade, Novi Sad and Niš) or medium-sized water supply systems, reflecting a centralised nature of water distribution and easier control over quantity and quality of resources (Vujović *et al.*, 2017). On the other hand, due to a lack of piped water supply, rural households often dig their own wells without the monitoring of water quality, sometimes located on the banks of heavily polluted rivers. Seasonal water shortage is another problem affecting the sector. There are a large number of cities and villages that face drinking water shortage during the dry season (World Bank, 2003).

The International Community is an important investor in water supply infrastructure within the region. It is estimated that from the time period of the 1990s to 2030, around 850 million EUR are to be invested in water supply infrastructure (World Bank, 2003).

As illustrated in section 0, water losses from distribution systems are very high, surpassing 50% of abstracted water in many systems.

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[12] See https://www.eea.europa.eu/soer-2015/global/competition for more information about GMT7.
[13] See https://www.eea.europa.eu/soer-2015/global/trade for more information about GMT6.
[14] See https://www.eea.europa.eu/soer-2015/global/governance for more information about GMT11.

Irrigation

In Europe, irrigation is and will remain the largest single user of water, but its share of water consumption is projected to decline. As such, large gains can be made from saving water in irrigated agriculture (Ringler, 2017).

In the region, Albania is the largest consumer of water for irrigation – about 50% of arable land is irrigated, mostly in the coastal plains. These are mainly irrigated by diverted rivers supplemented by over 600 irrigation dams. Engineering connected to irrigation projects has been endangering wetlands along the coastline (World Bank, 2003). Other prospective users of considerable water resources for irrigation are the Former Yugoslav Republic of Macedonia and Kosovo (under UNSCR 1244/99). Both nations heavily rely on agriculture which represents an important part of national GDP while renewable water resources are the lowest in the region, with pronounced seasonal variations. Large irrigation systems have been developed since the 1950s, but not used to its full potential at the present, considering the high costs of maintenance. There are plans to rehabilitate economically viable irrigation infrastructure, including multipurpose reservoirs to secure volumes of water needed for irrigation as well as to facilitate the maintenance of minimum water flows in rivers (World Bank, 2003). Limits of irrigation development also lie within the nature of agricultural economies in the region: family farms with a small amount of arable land are found to be the major contributor to the overall productivity growth in agricultural sector, despite their small and heterogeneous features (Hristov, 2014). In Kosovo (under UNSCR 1244/99) there are no exact figures on volumes abstracted, stored or transferred for irrigation (World Bank, 2003).

In Bosnia and Herzegovina, Montenegro and Serbia, irrigation infrastructure is not substantial, with a small percentage of agricultural lands being irrigated. There are strategies for irrigation development in all countries – favourable conditions of Bosnia and Herzegovina show a potential of extension from the current 3000 ha irrigated land to at least 170 000 ha (World Bank, 2012).

Photo 3.4: The flatlands of Pelagonia, Macedonia (the Former Yugoslav Republic) receive little precipitation, relying on irrigation systems to sustain crop culture. The city of Prilep is the national centre of tobacco production.

Photo: © Gašper Šubelj, 2017

Industrial water use

In the Western Balkans' industries, the largest portion of abstracted water is used for the manufacture of basic metals (e.g. 34.9 million m^3 annually in the Former Yugoslav Republic of Macedonia), food products and beverages (e.g. 21.6 million m^3 annually in Serbia), and as cooling water (e.g. 18.2 million m^3 annually in Serbia) (Eurostat, 2016c).

Developments have shown that, although costly, large water savings in industry (and the domestic sector) can be achieved if the right incentives and regulations are put in place (Ringler, 2017).

Freshwater-related ecosystem services

The Balkan Peninsula is known for its remarkable richness in plant and animal species, a unique biogeographical and ecological phenomenon in Europe. Complex geological history, geographical variety of regions, interactions between species, ecosystems and populations have all resulted in biodiversity – abundance of animals, plants and ecosystems within the region. Spatial density of threatened bird and fish species from the International Union for Conservation of Nature's (IUCN) red list is approximately three times higher for fish when compared to the EU-27 average. There are also unique ecosystems such as deep and large tectonic lakes with endemic fish species and karstic lakes, caves, sink holes and valleys with rare endangered amphibians, dragonflies, birds, fish etc. (Globevnik et al., 2014).

The three distinct ecosystems of the region where water resources are of essential importance are lakes and freshwater streams (such as lakes Ohrid and Prespa in the Former Yugoslav Republic of Macedonia), wetlands (such as poljes of Bosnia and Herzegovina and wetlands along the Danube and Sava rivers) and dinaric karst areas (such as the dinaric karst of Herzegovina and Montenegro) (Photo 3.5).

Photo 3.5: Dinaric karst in Durmitor national park in Montenegro.

Photo: © Luka Snoj, 2015

3.3. Land use change

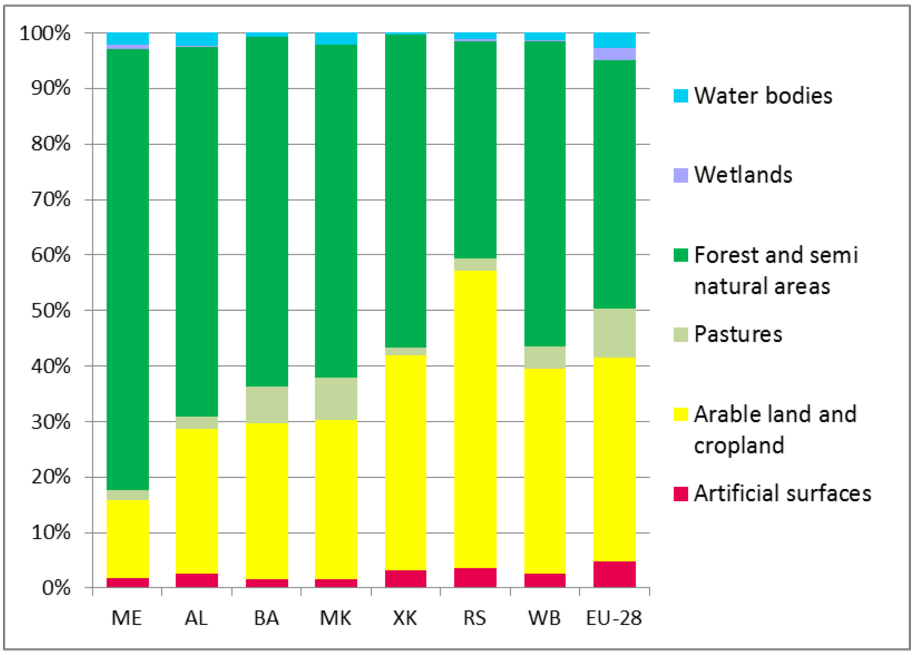
Land is a finite resource and the way it is used is one of the principal drivers of environmental change because of the significant impacts on quality of life and ecosystems as well as on the management of infrastructure that land use can have (EEA, 2017c). Assessing changes in the extent and management intensity of land use is important to understanding land-system dynamics and their environmental and social outcomes (Kuemmerle et al., 2016). Europe is one of the most intensively used continents on the globe, with the highest share of land used for settlement, production systems (including agriculture and forestry) and infrastructure (Eurostat, 2017a).

Land take by urban areas and infrastructure is generally irreversible and results in soil sealing, roads or other infrastructure (EEA, 2017c). The intensive expansion of urban land is evident also in land use changes within the Western Balkan region. The most widespread changes in the extent of land-use categories in the Western Balkans between 2006 and 2012 were the extension of artificial surfaces

(106 km²), followed by the expansion of cropland (65.7 km²), and the decline of forest areas (21 km²) and pastures (20.5 km²). The least common conversion among broad land-use categories was expansion of water bodies (6.8 km²) and the reduction of wetlands (6.2 km²). Intense urbanization in the Western Balkans between 2006 and 2012 can be explained by the high increase of foreign investments, GDP/capita increase, GDP/sector increase and other socio-economic factors.

As noted by Metzger et al. (2006), there is a strong connection between economic growth in southern Europe and land use change. Socio-economic scenarios with the largest economic growth also output the most pronounced land use changes and negative impact on ecosystem services such as the reduction of wetlands and forests. In spite of evident urban sprawl and the extension of croplands which are causing deforestation, forests are remaining the most represented land use category in the region. Urban land take does not consume only forests and pastures but it also reduces space for habitats and ecosystems that provide important services such as the regulation of the water balance and protection against floods, particularly if soil is highly sealed. Nevertheless, since the share of artificial surfaces does not exceed 4% in any of the Western Balkans countries (Figure 3.12), the region is as a whole significantly less urbanized than the EU-28. Montenegro is, mainly due to its unique karst and mountainous landscape with high slopes, and also due to the fact that it is the most forested country in Europe, where forests and semi natural areas cover almost 80% of the national territory. Arable land and croplands are exceeding the EU-28 share only in Serbia (54%) mainly due to intensive farming crop areas covering the Vojvodina region.

Figure 3.12: Share of land use categories in the Western Balkans countries, aggregated by the EU-28 and the Western Balkans, 2012 percentage



Data source: EEA, 2016a (Corine Land Cover).

Growing global competition for productive land and freshwater resources is apparent in the recent rapid increase in large-scale transnational land acquisitions, mostly in developing countries (EEA, 2015a). This global megatrend of *Growing pressure on ecosystems* (global megatrend8)[15] is likely to be a factor in the Western Balkans as well, considering its large areas of arable land in the region, already under pressures of land market liberalisation by the EU. Intensified agriculture on such lands is likely to increase development of irrigation infrastructure, putting its share of pressure on water resources especially in fertile regions of the Pannonian flatlands (Bosnia and Herzegovina and Serbia).

[15] See https://www.eea.europa.eu/soer-2015/global/ecosystems for more information about GMT8.

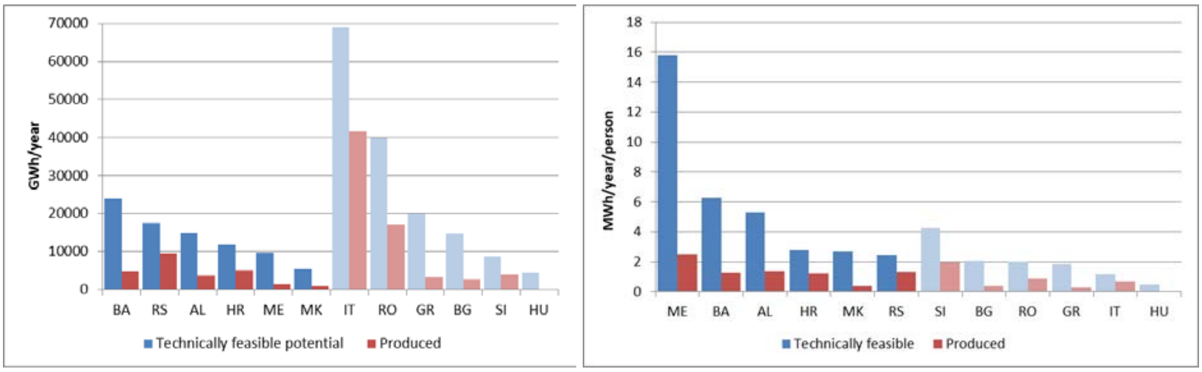
3.4. Energy

Zarfl et al. (2014) point out that the combination of population increase and economic development affected by climate change leads to the need to close the electricity access gap, which in turn stimulates the search for new sources of renewable energy. The result being the major new initiatives in hydropower development where at least 3700 major dams, each with a capacity of more than 1 MW, are either planned or under construction globally, primarily in countries with emerging economies. One of the global hotspots of such development is the Western Balkans.

Hydropower is a key potential source of energy in the Western Balkans, though the impacts of climate change on this are varied. Hydropower generation in the Western Balkans could increase by 15–30% overall, but the negative impacts of climate change could decrease potential in southeast Europe by 20–50%, especially in the Mediterranean region. The decrease could reach 50% in Croatia, which would then need major infrastructure investment to ensure energy provision (Globevnik et al., 2014).

The hydropower potential is large compared to neighbouring countries and the EU-28 average (Figure 3.13), and especially so when assessed on a per person basis: this is by far the highest in Montenegro where it could reach almost 16 MWh/year, of which only 2 MWh/ year are currently produced (Globevnik et al., 2014).

Figure 3.13: Hydropower potential in GWh/year (left) and production in MWh/year/person (right)



Data source: Aqua Media International, 2008; World Bank, 2017b.

The total present net maximum electrical capacity of the region is at around 17,000 MW, almost evenly divided between hydropower and thermo-power plants, while power generation from non-hydro renewable sources is negligible. The largest power-generating capacity is installed in Serbia with about 7000 MW, mostly coal-fired. The second is Bosnia and Herzegovina with an installed capacity of about 4000 MW, equally divided between hydro and coal-run power plants. The country is the largest exporter of electricity from the Western Balkans. Both Albania and the Former Yugoslav Republic of Macedonia have an installed capacity of about 2000 MW, with different sources: almost entirely hydro-powered in Albania and a mix of hydro- and coal-powered plants in the Former Yugoslav Republic of Macedonia. Kosovo (under UNSCR 1244/99) possesses an installed capacity of around 1200 MW based almost entirely on coal power. Montenegro with around 900 MW installed capacity relies on coal for almost one-third of power supplies, with the rest coming from hydro resources (Sanfey et al., 2016).

There are common synergies and trade-offs in competing uses of water and land use in the region that could increase tensions over their use among different sectors such as hydropower generation, agriculture, drinking water, environmental management, tourism, etc. One area of tension could be water infrastructure projects, producing hydropower and providing water storage for irrigation and urban uses, which might impact downstream agro-ecological systems with social implications, such as resettlements (FAO, 2014).

According to the Guardian (2017), hydropower constructions have increased by 300% across the Western Balkans in the last two years affecting wildlife, river morphology and biodiversity. More than 30% of these dams are set to be built in protected areas such as national parks or Natura 2000 sites. The number of construction sites where water is being channelled has increased from 61 (2015) to 187 (2017) only in two years. Since water at these sites is now diverted through pipelines from the river, many species such as dragon flies and stoneflies are at great risk. According to an EU funded study (HELP-CSO, 2017), property conflicts between big energy companies and small farmers have led to dozens of arrests and one murder in the last five years.

Photo 3.6: Hydropower dam Mratinje on the Piva River in Montenegro (left) and accumulation lake before the dam (right).

Photo: © Luka Snoj, 2016

3.5. Hydrological extremes

Natural hazards such as heat waves and heavy precipitations have become more frequent and/or intense in Europe. Along with socio-economic changes and hazard exposure, an increase in damage and economic losses has also taken place. Extreme events are nearly all projected to increase in severity, duration and/or extent, e.g. heat waves are projected to become more intense and to last longer, and extreme precipitation events will increase in both frequency and intensity (IPCC, 2012; EEA, 2017a; EEA, 2017e). The frequency of heat waves (Russo et al., 2014; EEA 2017e) and floods with 100 years return period is projected to be strongest in southern and south-eastern Europe (EEA, 2017e). The Western Balkans as such have been along the Iberian Peninsula, southern France and northern Italy assessed as a European natural disaster hotspot which will face a progressive and strong increase in overall climate hazards (Forzieri et al., 2016; EEA, 2017e).

The Western Balkans have a history of devastating earthquakes, floods, landslides, droughts, extreme temperatures, wildfires and windstorms that have caused economic as well as human losses across the region (UNISDR, 2008). The region has been in recent years affected by droughts, floods and wildfires. Albania, for example, experiences large variations between normal and drought years, the Former Yugoslav Republic of Macedonia experienced severe droughts almost every year. Flood risk in Bosnia and Herzegovina is permanent, with 4% of the total area and 60% of the lowland areas being threatened

(World Bank, 2003). The region has also experienced damaging and catastrophic earthquakes in the recent past (e.g. Skopje 1963). Seismological studies show that there is a high probability of future occurrence (EC, 2014).

The region is characterized by significant human and economic exposure to these types of natural hazards and has a high vulnerability index (i.e. on a scale from 1 to 10, the vulnerability index is: 7 for Albania, Montenegro and the former Yugoslav Republic of Macedonia and 6 for Bosnia and Herzegovina, and the Republic of Serbia). Moreover, the level of preparedness and prevention varies from country to country, and regional cooperation does not exist to the extent necessary. There has been an increase in the number of disaster events, particularly due to hydrometeorological hazards (floods, droughts, heat waves), in most of the countries in the region.

According to the European past floods database (EEA, 2016b), Floodlist (2016) and Reliefweb (2014) almost 200 people in the Western Balkans region lost their lives due to floods since 1980. This number might be even higher since not all flood hazards and their consequences were documented.

3.5.1. *2014 Southeast Europe floods*

One of the most recent floods which impacted the region (especially Bosnia and Herzegovina and Serbia) was the 2014 Southeast Europe floods which struck the region in May 2014.

In May 2014, a cyclone created over the area of south-eastern and Central Europe brought heavy and especially long-term precipitation to the Western Balkans (Kobold et al, 2015). Continuous precipitation resulted in extremely high river flows and surface runoffs (ARSO et al., 2014). As an outcome of continuous rainfall lasting several days, extensive and severe floods and landslides occurred in the lower part of the Sava river basin. The highest precipitation value between the 13th and 17th was measured at the meteorological station Tuzla where 250 mm of rain had fallen in three days (Kobold et al., 2015). In the areas with the highest precipitation intensity, more rain had fallen in three days than usually falls during the whole of May (Obnova, 2014). In the western parts of the Republic of Serbia more than 200 mm of rain fell in a week, which is the equivalent of 3 months of rain under normal conditions (Obnova, 2014). A probability analysis of the three-day precipitation event in the Bosnia river catchment has shown that the recurrence period was between 100 and 200 years, locally even over 500 years (ARSO et al., 2014). Surface runoff coefficients in the Bosnia catchment were high because the soil was already saturated with water due to precipitation which had already occurred at the beginning of May (Kobold et al., 2015). The combination of heavy rainfall, high soil saturation before the intense rains began, and the presence of unstable soils in hilly regions, caused the subsequent occurrence of landslides and mudflows. These landslides and mudflows occurred in both inhabited and uninhabited areas and caused fatalities, destruction of houses, roads, bridges and other infrastructure works. The heavy rainfalls led to a rapid and substantial increase of water levels on the territory of Croatia, Republic of Serbia and Bosnia and Herzegovina of the rivers Sava, Tamnava, Kolubara, Jadar, Zapadna Morava, Velika Morava, Bosna, Drina, Una, Sava, Sana, Vrbas and their tributaries (ILO, 2014; Obnova, 2014).

In the simulation of the event, the peak discharge of the Bosna River at the mouth of the Sava River reached the maximum flow of 4900 m^3/s. It has been assessed that the flow of the Bosna River in Malgaj exceeded the return period of 500 years, in some parts even more than 1000 years. In the Bosna catchment, the floods reached their maximum volume on the 15th of May during the day when the total flooded surface was estimated at 99 km^2 with a volume of 401 million m^3 (ARSO et al., 2014). This is potentially the most serious natural disaster experienced by Bosnia and Herzegovina in the past 120 years (ILO, 2014).

The heavy rainfall and rising water levels had three immediate and direct effects (Obnova, 2014):

- intensive flash floods resulting in the total destruction of houses, bridges and other infrastructure;

- rising water levels resulting in the widespread flooding of both urban and rural areas;
- increased flow of underground waters leading to widespread landslides.

The disastrous impacts of devastating floods happened in the Republic of Serbia and Bosnia and Herzegovina and to a minor extent in Croatia. The floods caused extensive damage, loss of human life and the death of animals and environmental degradation (Kobold et al., 2015).

In Serbia alone there were over 50 fatalities and more than 1.5 billion EUR of reported damage (Obnova, 2014a). More than one and a half million people were directly or indirectly affected in the country and almost 32,000 civilians were temporarily evacuated from their homes. The most affected sectors in Serbia were mining industry and (consequently) electricity production (Obnova, 2014a). Bosnia and Herzegovina reported more than 23 fatalities and more than 2 billion EUR of damage (EEA, 2016b; ILO, 2014). Considering the fact that this is equivalent to nearly 15 percent of Bosnian GDP (ILO, 2014), the national economy, livelihoods as well as environment were impacted severely taking years to fully recover. Most of it impacted the private sector; families, small, medium and large businesses, and agricultural producers, including an undefined number of vulnerable sectors of the population. Urban, industrial and rural areas were completely covered with water, cut off and left without electricity and communications with damage to roads and transport facilities. Consequently, a vast number of houses were destroyed, damaged or were underwater leading to a significant number of displaced households (ILO, 2014). The disaster brought also problems related to living and environmental conditions. Due to the flooding, several health facilities sustained damage and had to be temporarily closed, health care had to be suspended, many schools were damaged and/or were used as temporary shelters for evacuees, and classes were suspended with an early closing of the school year. It has been estimated that more than 100,000 jobs have been temporarily lost in the Republic of Serbia and Bosnia and Herzegovina because of productive activities interruption. Furthermore, it has been assessed that the disaster has led more than 150,000 people to fall below the poverty line in the Republic of Serbia and Bosnia and Herzegovina (Obnova, 2014; ILO, 2014).

A relevant security hazard is landmine contamination: over 70% of the flood affected areas in Bosnia and Herzegovina are contaminated by landmines which have been relocated by flooding and landslides.

The disaster has made evident a number of vulnerabilities of the population and economy that – in respect to climate change – deserve special attention and require the reduction of disaster risks. Investment in sufficient floods forecasting systems is prerequisite to reduce disaster risks, which may be approached on a regional basis through cooperation with neighbouring countries. Improved strengthening, collaboration and expansion of floods control systems, prevention activities (Obnova, 2014), effective early warning systems, transboundary river management and sufficient spatial planning to avoid locating homes and production activities in flood-prone areas, are some of the required activities to be carried out in the near future.

Photo 3.7: Flooded areas around Šamac, Bosnia and Herzegovina, in one of the hotspots of 2014 Southeast Europe floods.

Photo: © Gašper Šubelj, 2014

3.5.2. *2016 floods in the Former Yugoslav Republic of Macedonia*

Made up of vast mountain chains, grasslands and large river systems, the Former Yugoslav Republic of Macedonia is particularly vulnerable to natural disasters (EC, 2016). Between 2014 and 2016, three flash floods causing extensive damage have impacted the country (UNDP, 2016).

The strongest storm in the past years (Meteopro, 2016) occurred on the 6th of August 2016 (Meteopro, 2016). Torrential rain in the Former Yugoslav Republic of Macedonia caused major flash floods (EC, 2016; Reliefweb, 2016). The floods and landslides severely affected the populated areas and agricultural regions in Skopje and Tetovo. According to the official data, almost 100 mm of rain fell in the capital Skopje during the storm which is more than the average for the whole month of August (Milevski, 2016; Reliefweb, 2016). The most intense precipitation lasted for about half an hour when 35 mm (or more than 1 mm/minute) has fallen. The reasons for such intensities are in specific regional meteorological conditions which include penetration of moist air mass from the west, and the development of a powerful cumulonimbus. Since the clouds were moving towards Skopska Crna Gora which is a 1651m high, above sea level, natural barrier, the greatest amount of precipitation fell precisely on the southern slopes of this mountain. The southern slopes of Skopska Crna Gora are very steep, without vegetation, and with narrow, torrential catchments, which caused an abrupt precipitation collection and a high surface runoff heading towards the foothill and further in the direction of Skopje and the river Vardar. One can assume that if the extent of forest would be larger or the plant cover would be thicker, a significant part of the precipitation would be intercepted by vegetation and infiltrated in the soil.

The intensive rainfall has been accompanied by strong winds at around 100 km/h. The storm went on for about five hours in total, in the first two hours of the storm more than 800 lighting strikes were recorded by meteorologists (Meteopro, 2016). The longevity of the storm was prolonged because the cloud cells were replenished one after the other. Large amounts of lightning strikes to the land surface happened due to differential electricity within the vertically huge cumulonimbus (Milevski, 2016). As a consequence of this extreme meteorological and hydrological extreme situation, floods, mudflows and landslides caused loss of human lives and great material damage such as destroyed ring-roads, streets, demolished vehicles and infrastructure, including water channels (IFRC, 2016).

The northern part of Skopje was the most affected. In this region more than 70% of the houses had been flooded, with completely destroyed pieces of furniture, personal belongings, food stocks and accompanying infrastructure. In the Skopje outskirts where a new ring round is being built, most of the water channels were sealed during the construction works, which has caused massive water quantities to gather and to form a natural dam along the road side blocks. When accumulated water reached a critical level, the road collapsed and the water spilled towards the neighbouring villages. (Reliefweb, 2016). The floods caused more than 20 human casualties and 60–70 injured persons (Reliefweb, 2016; IFRC, 2016), 7000 houses were flooded (Reliefweb, 2016) and over 1000 persons had been evacuated throughout the city (EC, 2016).

The flood impacts were pronounced by clogged discharge drainage channels, low and poorly permeable bridges, high groundwater level which significantly decreased infiltration capacity of the soil and deforestation (Milevski, 2016).

3.5.3. *Disaster preparedness and prevention in the Western Balkans*

Disaster risk reduction is aimed at preventing new and reducing existing disaster risk (exposure, hazard or vulnerability) and managing residual risk in order to strengthen resilience and achieve sustainable development (IPCC, 2014; UNISDR, 2017).

At global, European and national levels there is an emerging need between adaption to climate change and disaster risk reduction by taking account of their similar objectives and differences. Successful coherence in policies, knowledge base, various levels of governance such as cross-sectoral cooperation contributes to better preparedness and response to disasters as well as to sustainable development (EEA, 2017e).

Due to the relatively high hazard potential, high vulnerability and relatively small size of the countries, as well as historical links between them it is more efficient and economically prudent for the region's countries to cooperate in the areas of civil protection and disaster preparedness and prevention (UNISDR, 2008). In 2000, the Stability Pact for South Eastern Europe launched the "Disaster Preparedness and Prevention Initiative for South Eastern Europe" (DPPI SEE) in an effort to contribute to the development of a cohesive regional strategy for disaster preparedness and prevention for its 12 Member States (beside the Western Balkan countries, the members are also Bulgaria, Croatia, Greece, Romania, Slovenia and Turkey). DPPI SEE provides a framework for South Eastern European nations to develop programs and projects leading to strengthened capabilities in preventing and responding to natural and man-made disasters (DPPI SEE, 2017). Since its formation, DPPI SEE's partners have initiated and developed various project proposals, strengthening regional cooperation through the utilization of coordinated action and using internationally accepted methodology as well as having conducted dozens of training events. Collaboration capabilities in scope of natural hazards were enhanced also by establishing a common regional education platform, using the identical firefighting and communication equipment, initiating regular regional exchange of information and implementing the same international standards (UNISDR, 2008).

Photo 3.8: Regional training in transitional camp management in Skopje. Almost 200 people from the Western Balkans and neighbouring countries attended a week long exercise of transitional camp planning and management in case of disaster.

Photo: © Luka Snoj, 2015

Occurrence of extreme weather events and climate-related hazards has increased noticeably during the past two decades. A series of floods that affected the region in recent years had very high economic costs in terms of damaged infrastructure and housing, and more generally the disruption to economic activity across all sectors (Sanfey et al., 2016). It is expected that such trends will continue and increase in the coming decades. Moreover, the level of preparedness and prevention varies from country to country, and regional cooperation does still not exist to the extent necessary (UNISDR, 2008). The above mentioned floods in Bosnia and Herzegovina and the Republic of Serbia in 2014, floods in the Former Yugoslav Republic of Macedonia as well as floods in Albania in 2010 and extreme drought in Kosovo (under UNSCR 1244/99) in 2013 have shown that people and institutions in the Western Balkans are not yet sufficiently prepared for the expected impacts of climate change (GIZ, 2017) in spite of enhanced transboundary collaboration and considerable investments in disaster preparedness and prevention.

4. Water availability in the context of scenarios

Key messages

- In the future, water resources will change in quality and quantity. The decrease in water availability is expected to be especially sharp in the catchments in the western and south-western part of the region. Numerous rivers which are already now facing water shortages and droughts in the summer months (e.g. Vardar) will face yet additional water deficit.
- All modelled catchments feature accentuated seasonal water discharge lows in autumn and summer. Due to regional diversity, there are no generalised regions within the Western Balkans where specific trends would take place in adjacent catchments.
- In short-term future, land use change is shown to be the dominant factor in determining water availability, while in long-term future, climate change intensity is to become dominant.
- In scenarios with moderate climate change impacts (scenarios 1 and 3), the average reduction of mean annual flow for 10-12% is foreseen in the long-term future whereas in scenarios with high climate change impacts (scenarios 2 and 4), average reduction is significantly higher (20-22%).
- At the local level, reduction for 30% of present mean annual flow may occur in the long-term future (e.g. Morava, Seman).

This section explores the future water vulnerability assessed as modelled future discharge in selected catchments as well as changes in temperatures and precipitation patterns. Due to the high level of uncertainty and the significant effect of other driving forces, climate change extent and economic (un)sustainability are considered as key driving forces that can be quantified and explored in relationship with each other.

4.1. Scenarios

Analysing the security risks resulting from climate change is essential for effective policymaking but it also means significant challenges because climate models lack the precision to assess national or regional impacts of climate change (EEA, 2012b) especially in the regions as diverse as the Western Balkans. While general trends may be identifiable, impacts may vary significantly between regions especially in the long-term perspective. Identifying the security implications of climate change therefore requires a case-by-case approach at the regional level.

For these reasons, the OSCE and EEA have adopted a participatory scenario-building approach to project implementation, with the aim of improving understanding of the issues and providing a basis for discussing strategies to avoid the main risks identified (EEA, 2012b; Globevnik et al., 2014).

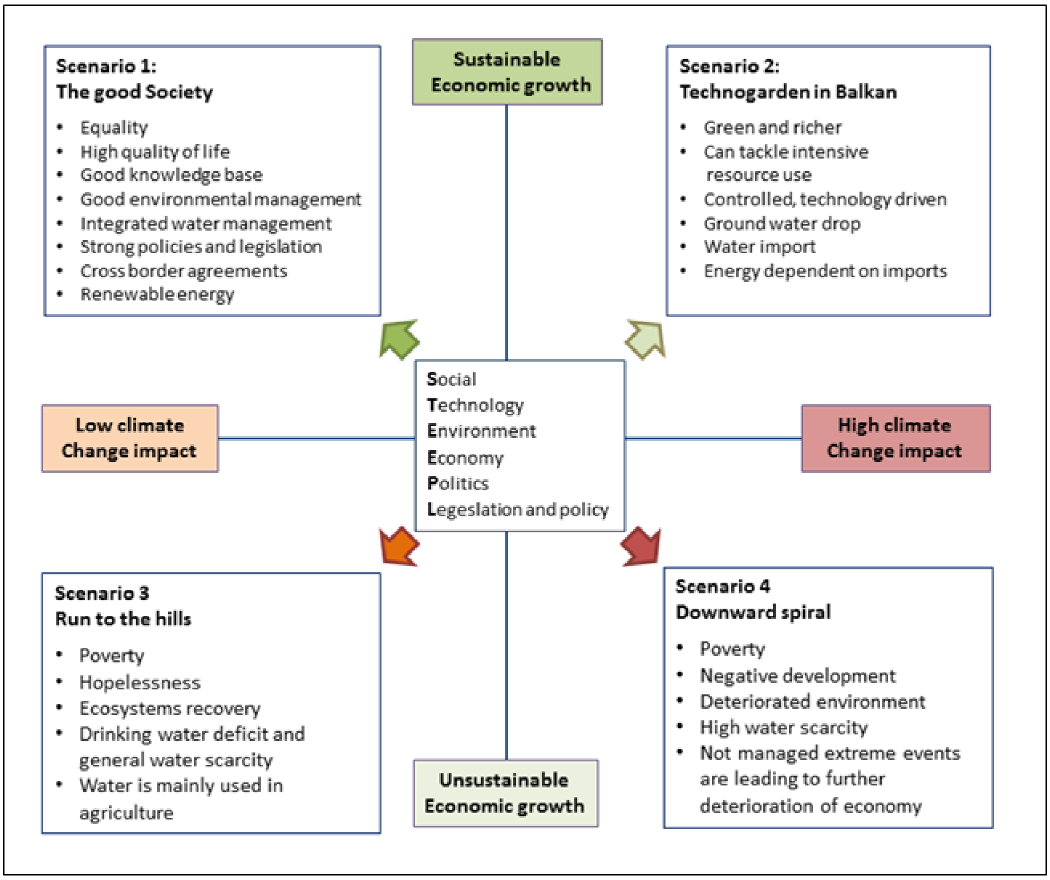
Scenarios are mechanisms that can provide a valuable foresight into climate-related (OSCE, 2010) as well as other security risks. Scenarios are narratives of alternative environments in which today's decisions may be played out. They are neither predictions nor strategies. Instead they are more like hypotheses of different futures specifically designed to highlight the risks and opportunities involved in specific strategic issues (Ogilvy, Schwart, 2004).

Scenarios are structured stories or narratives of how the world might look in the future. Drawing upon the best available scientific data and regional expertise, scenarios are a process of illustrating how changes might occur, what pathways those changes might take, and what the repercussions might be. Scenarios do not attempt to predict the future, but rather help to uncover what is not known, expected or monitored. In this way they help decision-makers deal with uncertainty, and plan for risks that might come as surprises (OSCE, 2010).

Although the development of some GMTs and related impacts over coming decades is becoming better understood, many uncertainties associated with multiple drivers and change factors that unfold differently between regions and over time persist. Moreover, global megatrends can also be perceived in contrasting ways by different social groups and stakeholders (EEA, 2015a). Using scenarios, different GMTs characteristics in terms of likelihoods and magnitudes can be explored as well as security implications, potential impacts and associated adaption measures.

Different GMT implications can be identified and assessed through plausible scenarios which differ according to various combinations of two variables. In the OECD – EEA project, climate change impact was identified as the first variable for all regions analysed. At the workshop[16] held in Belgrade in 2010, sustainability of economic growth has been identified as the second variable (EEA, 2012b) by the experts from the Western Balkans region, neighbouring countries and European/international organisations. The scenarios where further refined and consolidated at the workshop[17] held in Ljubljana in 2013. Considering different combinations of these two variables four different plausible futures may unfold (Figure 4.1).

Figure 4.1: The Western Balkans explorative scenarios



Source: Globevnik et al., 2014.

What will be the consequences of (un)sustainable economic development of the Western Balkans in terms of water resources? How does different climate change extent impact on water availability? The

[16] Explorative scenario workshop about Opportunities for Development in the Western Balkans in the context of climate change impacts and water scarcity, 24-27.10.2011 Belgrade, Republic of Serbia.

[17] Future water use and the challenge of hydropower development in the western Balkans workshop, 11-13 February 2013, Ljubljana, Slovenia (https://forum.eionet.europa.eu/eea-west-balkans-cooperation-interest-group/library/etc-inland-coastal-and-marine-waters-activities-wb/etc-icm-west-balkan-ipa_hydropower-water-use_2013/2013_regional-workshop-hydropower-water-use-ljubljana).

scenarios allow for a prognosis of possible trends supporting the selection of appropriate mitigation measures. Using scenarios we also explore how different GMTs may unfold under different circumstances. The multiple combinations of pressures and drivers for a given watershed for the current situation are shaped by its historical and present climatic, managerial as well as socio-economic conditions. The future combinations of drivers and pressures depend on the future climatic and socio-economic scenarios considered plausible for this system.

Considering the framework of these plausible futures, four different catchment-based hydrological models have been developed in order to assess water availability in the Western Balkans within different scenarios. Scenarios deliver a qualitative framework and where possible, quantitative data that is run in models and simulations.

The multiple combinations of pressures and drivers for a given watershed for the current situation are shaped by its historical and present climatic, managerial as well as socio-economic conditions. The future combinations of drivers and pressures depend on the future climatic and socio-economic scenarios considered plausible for this system. The radiative forcing scenarios (RCPs) have been used to define our storylines. The radiative forcing scenarios (RCPs) are four and are defined depending on the total radiative forcing in the future (i.e. 2100) relative to the past (i.e. 1750). For example, in RCP4.5 scenario the total radiative forcing reaches approximately 4.5 watts per square metre (W/m^2) in 2100 and stabilize afterwards while in RCP8.5 scenario, the total radiative forcing reaches approximately 8.5 watts per square metre (W/m^2) in 2100 and continues to increase afterwards. The four RCP scenarios and their link to the Western Balkans explorative scenarios are listed in Table 4.1, the Western Balkans scenarios storylines are given in Table 4.2.

Table 4.1: Representative concentration pathways in the year 2100 and their links to the Western Balkans explorative scenarios.

RCP	Radiative forcing [W/m^2]	CO_2 equivalent concentration [ppm]	Radiative forcing change	Mean global mean surface temperature change (2046–2065 vs 1986–2005) [°C]	Used in the Western Balkans scenario
RCP 2.6	2.6	450	Declining	1.0	
RCP 4.5	4.5	650	Stabilizing	1.4	The Good Society, Run to the Hills
RCP 6.0	6.0	850	Stabilizing	1.3	
RCP 8.5	8.5	1350	Rising	2.0	Technogarden in the Balkans, Downward Spiral

Data source: RCP (van Vuuren et al, 2011).

Table 4.2: The Western Balkans scenarios storylines

The good society (Scenario 1)

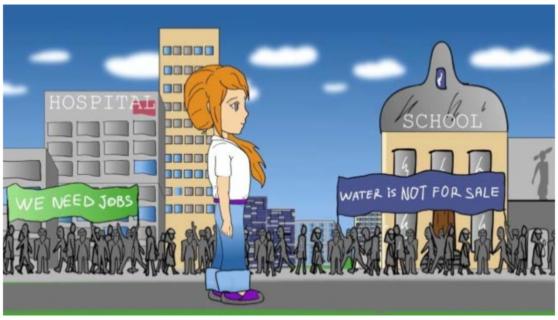
Low climate change impacts and sustainable economic development are providing safe, stable and environmentally friendly living conditions in the Western Balkans. Population is increasing, education system is at a high level, GDP is high and so is its level of health care. There is strong environmental legislation which is positively contributing to good environmental awareness. Water resources are being exploited in a sustainable way with an emphasis on good drinking quality water and efficient hydropower energy production. Transboundary cooperation within the Western Balkans is good and successful. Scenario RCP 4.5 has been identified as the most suitable climate scenario to describe this narrative.

Technogarden of the Balkans (Scenario 2)

In this storyline the Western Balkans is part of a global world which relies on environmentally sound technology. Higher impacts of climate change are partly mitigated with sustainable economic growth and adopted strategic measures. Basic characteristics of this scenario are controlled technology drive, ground water drop, green economy, sprawl of urban areas, use of renewable resources and water re-use. Benefits of new technologies are often outweighing their risks. Water shortage is mitigated with high-tech technological measures. Environmental concerns are connected with water availability, biodiversity loss, and introduction of invasive, high temperature resilient species. Scenario RCP 8.5 has been identified as the most suitable climate scenario to describe this narrative.

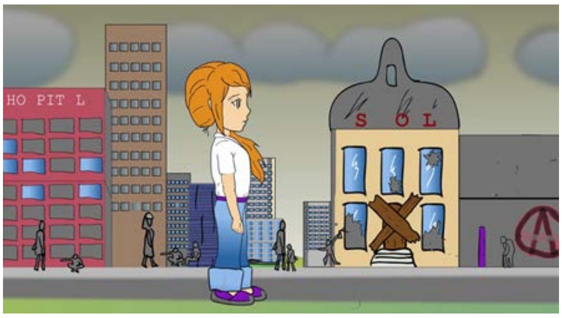
Run to the hills (Scenario 3)

The Western Balkans can't make an economic and technological breakthrough and is engaged with poverty, polarization, migration, technological stagnation, corruption etc. Unsustainable economic growth is providing an unstimulated environment for economic transition, and technological as well as educational development. That is resulting in migrations of young and highly educated people, population decline, high inflation and general public dissatisfaction. In spite of a low climate change impact, problems with quality and quantity of water persist due to unsustainable water management. Repressive control and unsustainable legislation enforcement are causing unstable political conditions and social tensions. Since climate change impacts are relatively low, climate scenario RCP 4.5 has been found as the most suitable scenario.



Downward spiral (Scenario 4)

Poverty, high water scarcity, extreme events such as floods and droughts, bipolarization, conflicts, biodiversity loss, political weakness and insecurity are causing unpleasant living conditions which are encouraging inhabitants to migrate and seek for a better life outside of the Western Balkans. Especially young and highly educated people are migrating into wealthy northern countries. Reduced water flows have a negative impact on terrestrial and freshwater ecosystems respectively. Climate change impacts are poorly mitigated. Conflicts and disagreements between West Balkan countries are constantly slowing down political effectiveness and economic sustainability as well as causing an unstable socio-economic environment. Scenario RCP 8.5 has been identified as the most suitable climate scenario to describe this narrative.



5. Catchment-based modelling of water availability in the context of scenarios

Climate change in terms of temperature and precipitation as well as future water availability in terms of modelled flow has been assessed for 12 representative catchments (Figure 5.1). The Cetina River catchment was also included in the modelling but left out later due to the strong influence of hydropower plants on the hydrological regime, making the hydrological model impossible to calibrate. Significant impact of hydropower plants was also observed at the Drina River and most of the rivers in Albania for which the models were sufficiently calibrated, but the efficiency of the model is slightly worse.

Figure 5.1: Selected catchments used in scenario future water availability modelling and locations of hydrological stations used for model calibration

Data source: EEA, 2012c (ECRINS Catchments), TC Vode, 2017 (Hydrological station locations), EEA, 2013c (DEM), EEA, 2017f (Marine Subregions), Eurostat, 2010 (Country borders).

5.1.1. *Factors of modelling water availability*

Future water availability in terms of discharge depends on atmospheric factors (precipitation, temperature), physical geographic factors (geology, soil capacity, relief, slope etc.) as well as human

factors (land use, water abstractions, accumulations etc.) (Ace Geography, 2017). Availability of water resources in the near (2031–2060) and long-term future (2061–2090) for the purposes of this task has been assessed using catchment based hydrological modelling.

The highest specific runoffs are observed in the Morača, Neretva and Black Drim river catchments, whereas the Morava and Vardar river catchments have the smallest specific runoff. Karst is also playing an important role in the hydrological regime of the Western Balkans' rivers. Share of karst area was assessed by overlaying limestone geology derived from International Hydrogeological Map of Europe (IHME) spatial database (BGR, 2017) with selected catchments. Morača, Una and Neretva River Catchments have more than 50% limestone area, Vrbas and Drina River Catchments have around 50% limestone area, whereas all other catchments have significantly lower share of limestone area in their drainage area (Table 5.1). In the previous chapter, four plausible explorative scenarios focusing on water availability were described. Transformation of otherwise narrative scenarios into quantity data can provide valuable parameters which can be used as inputs in climate and hydrological modelling. In order to assess future water availability in the Western Balkans, hydrological model has been developed on 12 distinct catchments scattered over the Western Balkans by translating four different narratives into technical parameters as discussed in section 4.1. All catchments together cover almost 80% of the Western Balkans territory.

Table 5.1: Geographical characteristics of selected catchments

Catchment	Area	Population[a]		Elevation[b]		Temperature		Precipitation		Specific runoff	Share of karst area
	km^2	Total	Density (per km^2)	Min	Max	C° (avg 50-00)[c]	C° (avg 01-10)[d]	mm (avg 50-00)[c]	mm (avg. 01-10)[d]	mm/year	%
Morava	36395	4 216 580	116	75	2213	9.4	10.2	755	730	201	14
Vardar	24397	2 044 319	84	0	2592	9.8	10.8	625	632	292	3
Una	19750	1 254 862	64	91	1821	7.9	8.8	1098	1277	699	65
Drina	19293	1 373 924	71	77	2374	7.9	8.5	1074	1213	619	45
Neretva	13122	1 020 256	78	0	2168	9.4	10.4	1188	1650	742	64
Black Drim	13067	1 540 972	118	0	2623	9.1	9.9	1081	1297	727	29
Bosna	10669	888 045	83	83	2019	9	9.7	953	1024	506	16
Seman	7106	829 280	117	0	2390	11.4	12.3	1017	1274	577	7
Vjosa	6640	306 381	46	0	2430	11	12.1	1146	1126	452	22
Vrbas	4867	365 288	75	139	2030	8	8.6	1029	1123	453	50
Morača	3339	172 586	52	0	2267	10.3	9.9	1384	1827	1118	73
Shkumbini	3005	476 901	159	0	2158	11.3	12	1029	1658	592	17

Data source: [a]CIESIN (2005); [b]EU-DEM (EEA, 2015b); [c]WorldClim (2015); [d]The British Atmospheric Data Centre (2016).

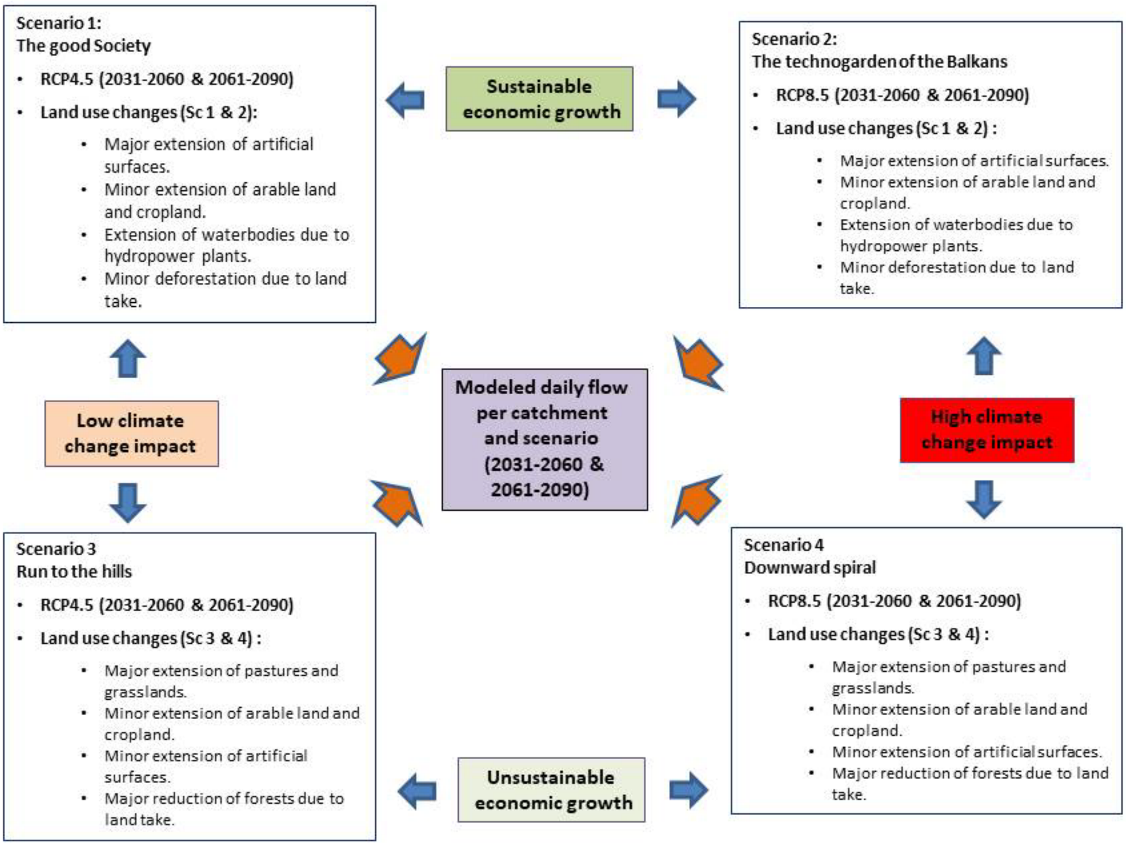
(Un)sustainability of economic growth variable has been translated into scenarios by modelling land use changes in the analysed catchments. Land use has a significant effect on evapotranspiration and soil water capacity. Two different land use change scenarios have been developed considering the scenarios characteristics as well as descriptive plausible future land use changes developed by Globevnik et al. (2014). The present land use (EEA, 2016a) was expanded or reduced according to descriptions of explorative scenarios with sustainable economy (scenarios 1 & 2) and scenarios with unsustainable economy (scenarios 3 & 4). For each scenario, hierarchy of land use expansion or reduction was set up in

the first step while in the second step, expansion or reduction intensity was assessed and quantified. Considering the hierarchy and quantified intensity of specific land use category (Annex 2), two spatial models were developed. Corine Land Cover (CLC) (EEA, 2016a) data for year 2012 have been used as a reference land cover spatial data.

In both models expansion of artificial surfaces and croplands is foreseen (Figure 5.2). Urban expansion is greater in scenarios with sustainable economic growth whereas expansion of croplands is greater in scenarios with unsustainable economy. Due to economic transition and development of tertiary sector, pastures and grasslands are reduced in scenarios with sustainable economic growth due to expansion of artificial surfaces and croplands whereas they are expanded in scenarios with unsustainable economy. Deforestation is foreseen for both scenario groups although it is much more intense within scenarios with unsustainable economy. In scenarios with sustainable economy, deforestation happens due to urban land take and expansion of croplands whereas the mean cause for extensive deforestation in scenarios with unsustainable economy is expansion of pastures and grasslands.

Simulation of future discharges in selected catchments has been done using HBV[18] light model. The HBV model (Bergström, 1992) is a rainfall-runoff model which includes conceptual numerical descriptions of hydrological processes at the catchment scale (SMHI, 2017).

Figure 5.2: Hydrological modelling of short-term (2031–2060) and long-term future (2061–2090) discharge scheme considering different scenarios



The period 2001–2010 has been used as a reference period for hydrological modelling calibration. Gridded agro-meteorological data on daily precipitation, daily mean air temperature and monthly evapotranspiration data cropped to the analysed catchments for the reference period obtained from

[18] Hydrologiska Byråns Vattenbalansavdelning.

Joint Research Centre (JRC) (2017) and E-OBS[19] (Haylock et al., 2008) have been used to calibrate the hydrological model. Measured daily flow data for the reference period used in calibration process have been obtained from annual national reports on river discharges. Analysed catchments have been divided into elevation zones of 300 m. Since some catchments have a direct outflow to the sea and highest altitude in some catchments exceeds 2700 m a. s. l., the catchments were divided to up to 9 elevation zones. When different elevation zones are used, temperature is corrected for elevation above sea level with usually –0.6 °C per 100 m. Precipitation is similarly corrected according to its increase with elevation above sea level (usually 10–20% per 100 m) (Seibert, 2005). Furthermore, catchments were divided into two vegetation zones: forest zone and non-forest zone. Forest zone consists of mixed forest, broad-leaved forest and coniferous forest as reported in the Corine Land Cover spatial database (EEA, 2016a) whereas the non-forest zone contains all remaining areas.

Future river discharge has been simulated using atmospheric data modelled by GFDL (2017a). The Earth System Model 2M (ESM2M) for RCPs 4.5 and 8.5 has been used. The atmospheric component of the model includes physical features such as aerosols (both natural and anthropogenic), cloud physics, and precipitation (GFDL, 2017b). Temperature and precipitation data for the periods 2031–2060 (short-term future) and 2061–2090 (long-term future), respectively, and future projections for RCPs 4.5 and 8.5 have been (together with modelled land use changes) expressed as the changed share of forested areas within vegetation zones, used as an input for atmospheric data into the already calibrated HBV light model.

5.1.2. *Uncertainties, data gaps and information needs*

In order to accurately assess trends in temperature changes, precipitation patterns river discharges and climate at local scales, comprehensive datasets are required. Some regions have shorter data records than others, and within the Western Balkans, not all data from river stations are shared freely. As a result, there are considerable data gaps in the modelling results. Limited data availability is particularly detrimental for the detection of long-term discharge trends in extreme events. Furthermore, availability of rain gauge data is particularly low in southern and Eastern Europe with discontinuities at country borders. Precipitation statistics are dominated by inter-annual to inter-decadal variability and are less spatially coherent compared to temperature data (EEA, 2017e). Uncertainties in trends are overall larger in southern Europe and the Mediterranean region where the confidence in projections is thus lower. Increased data sharing by meteorological and hydrological services would improve the accuracy of regional climate change assessments, including understanding of past and future climate as well as weather extremes and future water availability. Despite these constrains, the outcomes of this task still provide valuable inputs when exploring a different plausible future water vulnerability, changes in temperatures and precipitation patterns, as well as identifying risks and opportunities emerging for different explorative scenarios.

5.1.3. *Climate change*

Climate change is affecting water availability and use through increasing temperatures and changes in spatial and seasonal distribution of rainfall, including more frequent and severe flooding and droughts (Ringler, 2017).

Temperatures across Europe will continue to increase throughout this century. European land areas are projected to warm in the range of 1 to 4.5 °C in the middle emission scenario (RCP4.5) and in the range of 2.5 to 5.5 °C for high emission scenario (RCP8.5) over the 21st century (2071–2100 compared to 1971–2000) which is more than the projected global average increase. The strongest warming is projected

[19] E-OBS is a daily gridded observational dataset for precipitation, temperature and sea level pressure in Europe based on European Climate Assessment & Dataset (ECA&D) information.

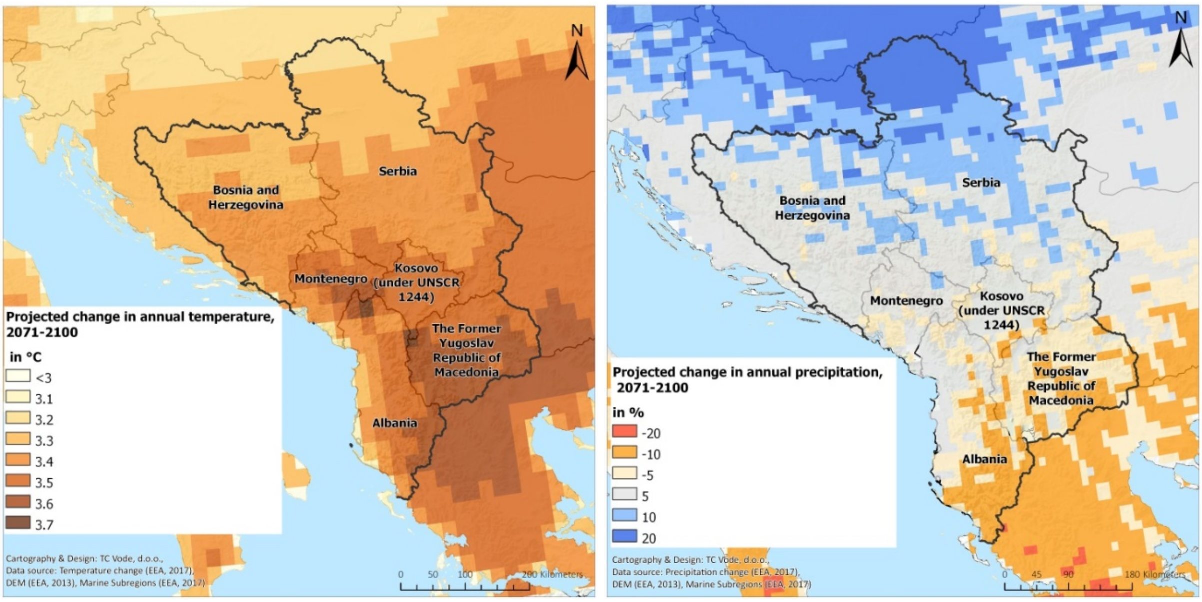
across north-eastern Europe and Scandinavia in winter and southern Europe – including the Western Balkans – in summer (Figure 5.3).

The increase in the global surface temperature is expected to affect the frequency and intensity of extreme events, such as heat waves (Fischer and Schär, 2010; Stott et al., 2015; Russo et al., 2014). Under a high emissions scenario (RCP8.5), very extreme heat waves are projected to occur as often as bi-annually in the second half of the 21st century. The impacts are projected to be particularly strong in southern and south-eastern Europe (Russo et al., 2014). The most severe health risks are projected for densely populated river basins in southern Europe and Mediterranean coastal regions (Fischer and Schär, 2010). All countries in the Western Balkans conform to the general warming trend, with Serbia and Albania expecting more frequent droughts (UNEP/ENVSEC, 2012).

Heat extremes are causing droughts because dry soil reduces evaporative cooling and thus increases the magnitude of a heat wave (Mueller and Seneviratne, 2012). Heat extremes can on the other hand, increase the frequency and intensity of heavy precipitation events because warmer air can hold a greater quantity of water (Kendon et al., 2014). Heat extremes also affect human well-being, human health as well as society (e.g. decreased labour productivity), agriculture and ecosystems (e.g. forest fires) (EEA, 2017e).

Despite the length of precipitation records, a precipitation change pattern cannot be detected with certainty in all European regions owing to the high spatial and temporal variability of precipitation. Difficulties in detecting trends can also arise from the small sampling area of rain gauges, calibration errors in instrumentation and erroneous measurements during snow or gales (Hofstra et al., 2009). Global warming is projected to lead to a higher intensity of precipitation as well as longer dry periods in Europe (EEA, 2017e). Studies have shown that globally a warming atmosphere has an intensifying effect, with wet regions becoming wetter and dry regions getting drier, and extremes of precipitation increasing in both the wettest and driest regions (IPCC, 2013). For a high emissions scenario (RCP8.5), the models project an increase in annual precipitation in central and northern Europe (of up to about 30%) and a decrease in southern Europe (of up to 40%) from 1971–2000 to 2071–2100 (Figure 5.3). For a medium emissions scenario (RCP4.5), the magnitude of change is smaller (Jacob et al., 2014). Assessment of local, catchment based precipitation change in the Western Balkans has shown that there are significant differences in precipitation change patterns for a medium (RCP4.5) as well as high (RCP8.5) emission scenario between catchments within the region. Precipitation in both Serbia and Bosnia and Herzegovina has increased in some areas, and declined in others. Precipitation patterns will most probably continue to vary according to terrain, elevation and proximity to the sea (UNEP/ENVSEC, 2012).

Figure 5.3: Change in annual temperature (left) and precipitation in the period 2071–2100 compared with the baseline period 1971–2000.



Note: These maps show projected changes in annual temperature and precipitation in the period 2071–2100 compared with the baseline period 1971–2000 for the emission scenario RCP8.5. Model simulations are based on the multi-model ensemble average of many different RCM simulations from the EURO-CORDEX[20] initiative.
Data source: EEA, 2017a (Temperature & precipitation change).

Now, as the Western Balkan countries strive for individual and collective stability, they face the additional challenges brought by climate change (UNEP/ENVSEC, 2012). The region is vulnerable to climate change well beyond its contribution to such trends, and a series of studies have shown that it might be the most vulnerable in Europe, especially in its Mediterranean part (Sanfey et al., 2016). The vulnerability however varies within the region. In the analyses conducted by UNEP/ENVSEC (2012), Albania was recognized as the most vulnerable country to climate change in the region. The capacity of the region to respond to the climate change effects depends to a large extent on its political stability and the effectiveness of its governance (UNEP/ENVSEC, 2012).

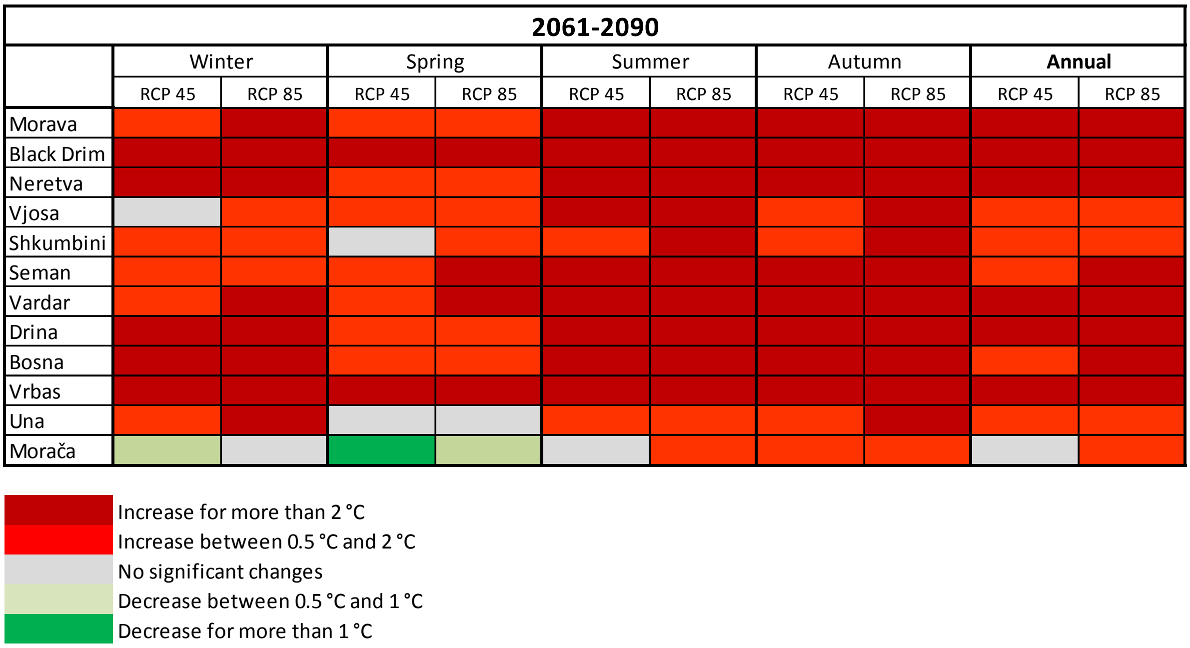
Temperature change has been assessed by comparing present period 1971–2000 mean seasonal catchment temperature as documented and future mean seasonal catchment temperature for middle (RCP4.5) and high (RCP8.5) emission scenario for the periods 2031–2060 and 2061–2090 modelled by GFDL and applied to selected catchments. Since the differences between scenarios are more prominent in the long-term future in comparison with the near future, we are paying higher attention to long-term changes in temperature, precipitation and discharge characteristics.

Temperatures in the Western Balkans will continue to increase. There are no significant differences between RCP4.5 and RCP8.5 for the projected period 2031–2060. This is in line with projected temperature differences between RCP4.5 and RCP8.5 which are not so significant until 2050. There are, however, significant differences between RCP4.5 and RCP8.5 for the projected period 2061–2090. This is in line with projected temperature differences between RCP4.5 and RCP8.5 which become significant after 2050. The vast majority of the analysed catchments are projected to warm up in the range of 1–2.3 °C under the RCP4.5 scenario and 1.6–3.2 °C under the RCP8.5 emission scenario before the end of the century (2061–2090 compared to 1971–2000). This is more than the projected global average increase. The most significant warming is projected in autumn (average increase of 2.5 °C under RCP4.5

[20] Coordinated Downscaling Experiment — European Domain.

and 3.2 °C under RCP8.5) and summer (average increase of 2.3 °C under RCP4.5 and 3 °C under RCP8.5) seasons (Figure 5.4). In the Vrbas, Black Drim, Neretva, Drina and Vardar catchments, mean autumn temperature is projected to increase to more than 3 °C under RCP4.5 in the long-term period. Under RCP8.5, mean autumn temperature in Black Drim and Vrbas is projected to increase by more than 4 °C in the long-term period. Seasonal decrease in temperature by more than 1.0 °C is significant only for the Morača catchment where the spring temperature is projected to decrease by about 1.2 °C. Nevertheless, on the annual basis no significant changes are projected for Morača under RCP4.5 whereas an increase of about 0.5 °C is projected under the RCP8.5 scenario.

Figure 5.4: Ensemble mean changes in temperature between 1971–2000 and long-term future (2061–2090), middle (RCP4.5) and high (RCP8.5) emission scenario, average over catchments



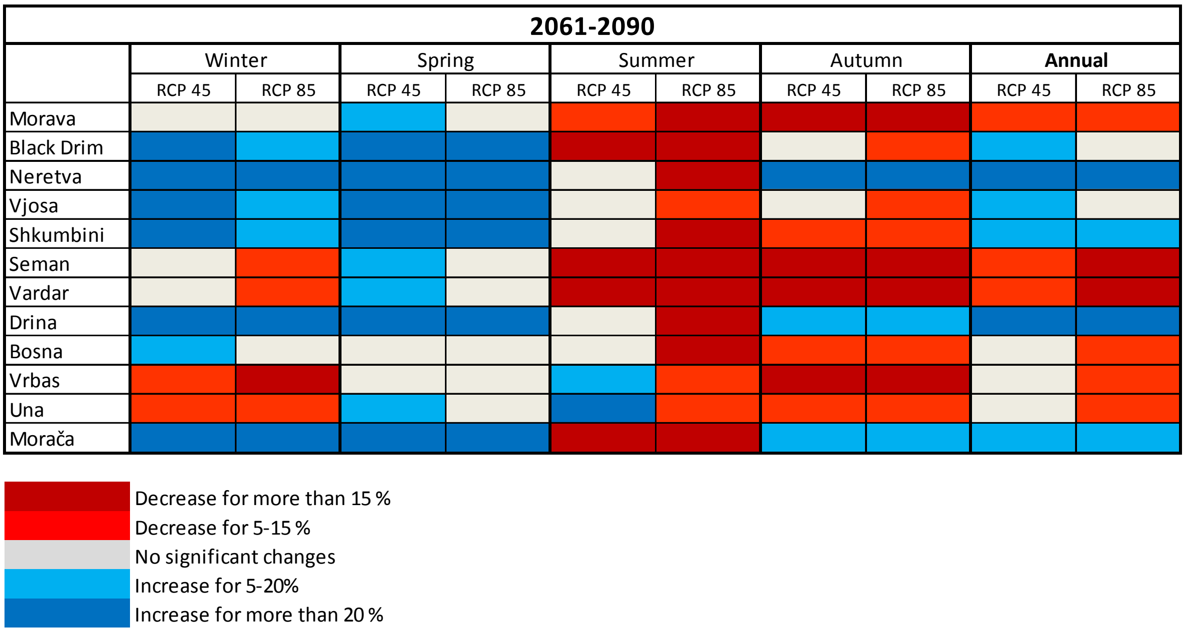
Data source: GFDL, 2017a.

Global warming is projected to lead to a higher intensity of precipitation as well as longer dry periods in Europe (EEA, 2017e). Future precipitation change pattern in the selected catchments cannot be detected with such certainty owing to the high spatial and temporal variability. Nevertheless, essential changes in precipitation patterns are expected in all catchments (Figure 5.5). Precipitation increase in winter and spring periods is predicted for the majority of catchments, while the trend of summer and autumn precipitation goes into decrease especially for the long-term projection 2061–2090 of the high emission (RCP8.5) scenario.

Spatially, an increase in precipitation is predicted to be the most pronounced in the catchments of Morača, Drina and Neretva with dominating increases of up to 20% throughout the year. On the opposite, Seman, Vardar and Morava catchments are predicted to receive decreased precipitation throughout the year, with the largest decrease in summer and autumn seasons. Substantial decrease in precipitation is foreseen in all catchments in summer months in the high emission (RCP8.5) scenario.

Even though the precipitation in autumn and summer months will, especially in the autumn and spring seasons, most likely decrease in almost all analysed catchments, modelled projections indicate an increase in the frequency and intensity of extreme precipitation events. Events currently considered as extreme can thus occur even more frequently in the future (EEA, 2017e, IPCC, 2013). Extremes of precipitation will most probably increase in both, the wettest and driest regions (IPCC, 2013).

Figure 5.5: Changes in precipitation between 1971–2000 and long-term future (2061–2090), for middle (RCP4.5) and high (RCP8.5) emission scenario, by catchment



Data source: GFDL, 2017a.

5.2. Water availability

The results of the model are **catchment-based simulated discharges (m³/s) for all four scenarios**. Discharges are calculated for the same hydrological stations which were used for calibration. In short-term future (2031–2060), land use change is shown to be the dominant factor in determining water availability, while in the long-term future (2061–2090), climate change intensity is to become dominant. Due to regional diversity, there are no generalised regions within the Western Balkans where specific trends would take place in adjacent catchments.

As expected, changes in short-term (2031–2060) and long-term future (2061–2090) are accentuated in all scenarios, with discharges almost always lower in long-term future. Since the differences between scenarios in regard to water availability are more prominent in the long-term future in comparison with the near future, in the following subchapters we describe the water availability characteristics of the long-term future scenario.

5.2.1. *Spatial overview of future water availability*

With the exception of the Bosna River, a decrease in discharge is the least prominent in the north-western part of the region. In the Neretva, Drina, Una, Morača and Vrbas catchments a reduction from 8–18% of the present annual discharge is foreseen depending on the catchment and scenario. The decrease is expected to be especially sharp in the catchments in the western and south-western part of the region which is in line with projected changes in precipitation patterns. Present annual discharge in Seman, Shkumbini, Vjosa, Vardar and Black Drim could thus be in the long-term periods in scenarios 2 and 4 reduced from 20 to 30% depending on the catchment. Considering the fact that the hydropower potential in some of these catchments is to be exploited (e.g. Vardar, Vjosa) this presents a significant risk to hydropower production and overall water use.

5.2.2. *Scenario overview of future water availability*

Differences in predictions by scenarios are as much important as spatial and seasonal differences. In all four scenarios the overall reduction of discharge is foreseen for both time periods. In the short-term period (2031–2060) the differences in scenarios is not as much pronounced as in the long-term period (2061–2090). In the short-term period the average reduction for 10–13% of the discharge is foreseen in comparison with the present state with rather minor differences between scenarios whereas in the long-term period the differences, especially between the scenarios with different climate change impact, become more prominent. In the long-term scenarios 1 and 3, the average reduction of mean annual flow for 10–12% is foreseen whereas in scenarios 2 and 4, the average reduction is significantly higher (20–22%). At the local level, reduction for 30% of the present mean annual flow may occur in some catchments (e.g. Morava, Seman) in the scenarios 2 and 4.

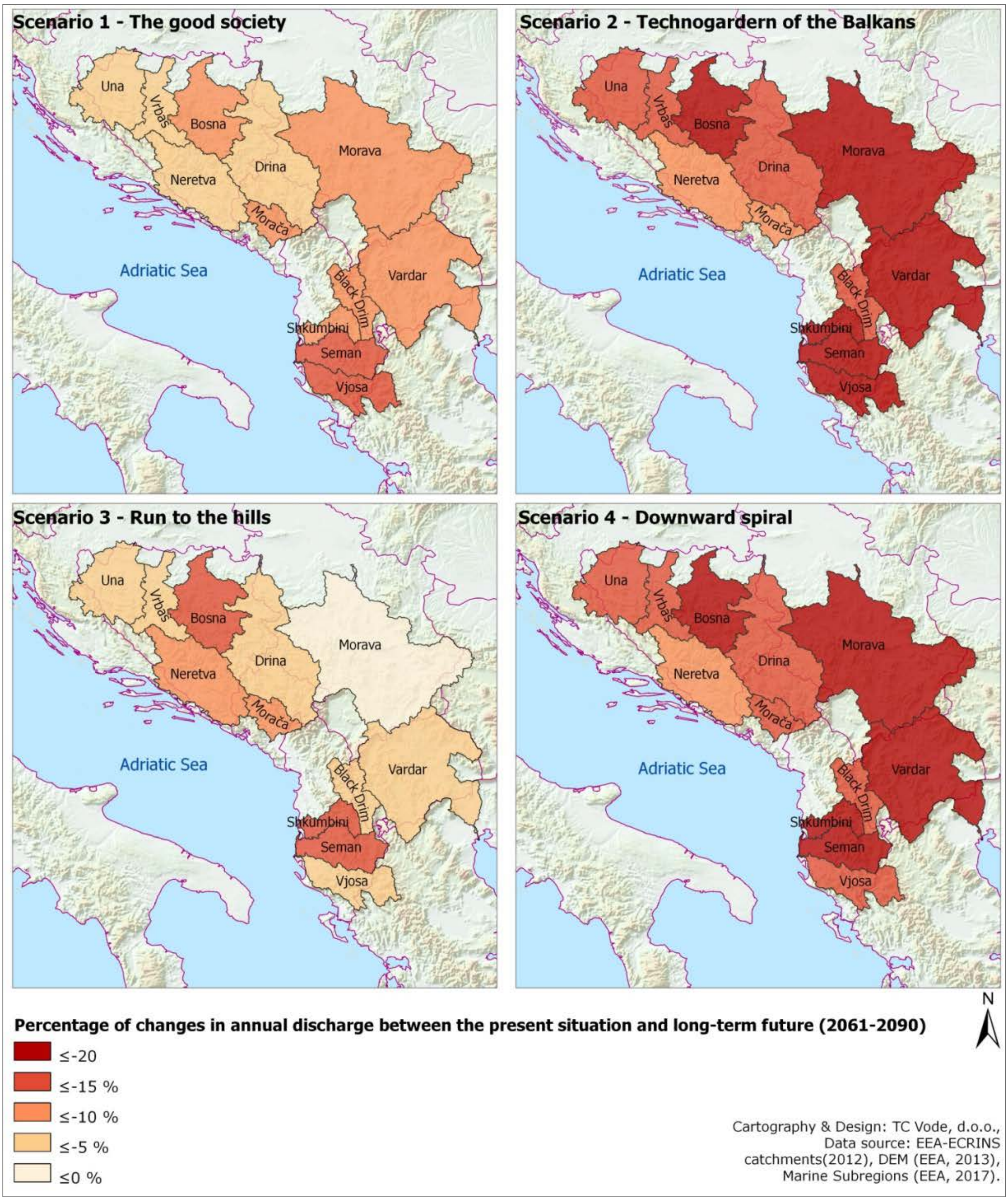
Due to the intense urbanization, hydropower development and rather low deforestation, the scenarios with sustainable economy in general offer slightly less water than scenarios with unsustainable economy where urbanisation is not as intense, hydropower potential not fully exploited and large extent of now forested areas is cut due to the expansion of croplands and pastures.

In the short-term future, when the differences between climate change are not so prominent, land use change is shown to be the dominant factor in determining water availability, while in the long-term future, climate change intensity is to become dominant; therefore, the majority of catchments is predicted to have more water available in scenarios 3 and 4 in short-term future (2031–2060), compared to scenarios 1 and 3 in the same period; this changes in long-term future (2061–2090) when more water is discharged in scenarios 1 and 3 and less in scenarios 2 and 4; this expectedly means that high climate change impact will be more pronounced in long-term, becoming more dominant over the factor of land use change that affects water availability in the short-term.

In the long-term (Figure 5.6), respective scenario groups 1 and 3 show similar pattern of predicted water availability (reduction from 5–18%), as well as scenario groups 2 and 4 (reduction for 15–33%), both due to the same extent of climate change impacts in terms of temperature and precipitation changes that affect evapotranspiration, runoff and other parameters. Although they are following the same path through the season, scenario 3 is usually predicted to provide more available water compared to scenario 1, and scenario 4 and more water than scenario 2.

The greatest difference between scenarios is significant for the Morava catchment where the reduction of the average annual flow by 4% is foreseen in scenarios with moderate climate change impacts and unsustainable economy (scenario 3). Combination of less favourable climate and unsustainable economic growth (scenario 4) makes discharge reduction much more drastic (for 25%). Economic growth in terms of intense urbanisation, increased water use for hydropower, additionally reduces the discharge for approximately 10%. In scenario 2, the annual discharge is thus reduced for 33% and in scenario 4 for 25% in comparison with the present situation. There are plans to establish a functional irrigation system in the Morava catchment in order to enhance annual crop yield. Future reduction of water availability in the Morava catchment thus presents a threat to intensive farming and any developments to an irrigation system.

Figure 5.6: Percentage of change in annual discharge between the present situation (1970–2000) and long-term future (2061–2090) in the selected catchments



Data source: EEA, 2012c (ECRINS Catchments); EEA, 2013c (DEM); Eurostat, 2010 (Country borders); EEA, 2017f (Marine Subregions).

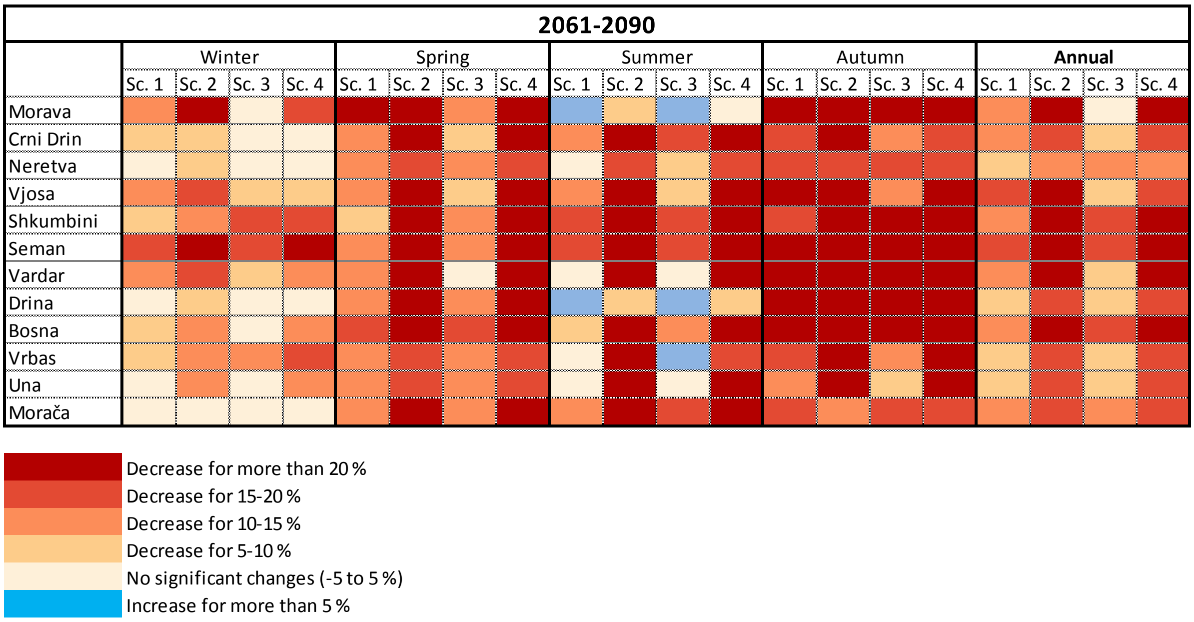
5.2.3. *Seasonal overview of future water availability*

In all the seasons, water discharges are higher in the scenarios with moderate climate change impacts which are directly connected to the different temperature and precipitation patterns.

All modelled catchments feature accentuated seasonal water discharge lows in summer and autumn and peaks in spring. Spring peak is especially significant in the short-term period (2031–2060) for scenarios with the moderate emission scenario (scenario 1 and scenario 3) and less prominent in the long-term future. The piano table (Figure 5.7) illustrates changes in discharge between the 1970–2000 average and long-term period of 2061–2090 grouped by the four seasons and four scenarios for each season.

Depending on various factors including groundwater retention capacities and seasonal precipitation rates, large-scale decreases in water discharge are predicted for the autumn and summer periods which is especially significant for the scenarios 2 and 4 (high climate change impacts). In these scenarios, seasonal discharge is foreseen to be reduced for approximately 30% in the autumn and 25% in the summer in the vast majority of the assessed catchments. The reduction of the discharge is the least prominent in the winter season where seasonal discharge is foreseen to be reduced for approximately 10–13% in scenarios with a high climate change impact and 4–8% in scenarios with a moderate climate change impact.

Figure 5.7: Percentage of change in seasonal discharge between the present situation (1970–2000) and long-term future (2061–2090)



Even though discharges will particularly in autumn and summer, most likely decrease in almost all analysed catchments, modelled projections indicate an increase in the frequency and intensity of extreme hydrological events. Events currently considered as extreme (e.g. fluvial and pluvial floods), can thus occur even more frequently in the future. In the long-term future, the greatest increase in floods with 100 years return period is projected for the Western Balkans. The results computed by LISFLOOD[21] suggest that a high climate change scenario could increase the socio-economic impact of floods in more than three-fold by the end of the 21st century (EEA, 2017e). The shifts in the extremes, rather than the trends in the averages, are likely to become a significant challenge for the Western Balkans adaptation considering the fact that many regions have not yet develop flood hazard management plans.

[21] GIS-based hydrological rainfall-runoff-routing model.

6. Outlook on water and climate change vulnerability

Key messages

- Climate change impacts will in combination with socio-economic instability have significant impacts on society (drinking water deficit, migrations, heat stress), economy (disruption of food production, irrigation, hydropower production) and environment (fragile ecosystems are at risk due to temperature increase and environmental mismanagement).
- Lack of environmental awareness, low investments in sewage systems and urban waste water treatment plants are in combination with climate change impacts presenting a significant risk to ecosystems, water quality and public health.
- Unfavourable implications can be mitigated by the implementation of sustainable energy development strategies, adoption of EU water legislation, improving efficiency of existing hydropower infrastructure, green infrastructure (reintegration of former floodplains as retention basins, urban forestry) as well as soft measures (promotion of environmental awareness, further investigation of climate change and its impacts, enhanced institutional, transboundary and cross-sectoral collaboration etc.).

This chapter synthesises the present state in the Western Balkans (Chapter 3) and plausible futures as described by scenarios (Chapter 4). Risks and implications that were identified through state and trends are connected to different scenarios and corresponding water availability. For each scenario, risks that are predicted to emerge are assessed. Some risks and implications are relevant for more scenarios and are therefore the most important.

The natural cycle of water availability is coming under threat from a variety of different pressures, exposing water ecosystems and societies to man-made shortages and excesses of water, a situation known as 'water vulnerability' (EEA, 2012a). As described in Chapter 3, human-induced causes of water vulnerability are changes in land use, water abstraction and climate change; the latter has an indirect effect which is more complex to assess. Water vulnerability affects society, economy and freshwater-dependent ecosystem services (EEA, 2012a).

6.1. Impacts on society, economy and ecosystems

6.1.1. *Impacts on society*

Even though the population density in the Western Balkans is generally lower than in the European Union, demographic trends of the last two decades in the Western Balkans are rather unstable with considerable differences. The share of urban population in the region as a whole indeed increased in the last years (World Bank, 2017b), showing steady but slow development of urban society. Despite the fact that the Western Balkans is one of the richest European regions in terms of water resources, numerous implications associated with mismanagement and climate change impacts can be expected to impact the society:

- decreasing economic opportunities plus increased risks of disasters such as flash floods may provide incentives for migration. The EU could be among the primary destinations. Migration, however, could also take place within the region, thus aggravating already noticeable differences within the region regarding development;
- growing urban areas can face a growing drinking water demand which can result in drinking water deficit;
- summer water shortages can affect public water supply and present health risk;
- climate change impacts could cause long-term (e.g. because of decreased water availability) but also short term population movements (e.g. because of natural disasters). Such movements,

overlapping with previously unresolved conflicts and political tensions, could create new conditions for violence;

- Europe (including the Western Balkans) is attracting increasing numbers of migrants from Africa, the Middle East, and Asia. The impacts of climate change as well as other global trends may add to this.

6.1.2. *Impacts on economy*

Economic growth is in correlation to water availability, and is therefore of special significance in the Western Balkans, since some countries or parts of countries are among the least economically developed regions of Europe. National economic policies and processes will shape the Western Balkans and could have different impact on the environment as well as water use (EEA, 2010a). The economies of the region remain fragile, and underdeveloped middle and small enterprise sector makes them highly dependent on the whims of international markets. Considering current socio-economic situation in the region and results provided by scenario modelling following implications are applicable:

- change in agricultural yields due to the reduced water availability could have grave consequences on food security throughout the region. Substituting domestic loss, however, will be difficult as global food availability is also likely to decline and thus food prices likely to increase;
- water use in agriculture is expected to increase as crops will require more water due to hotter, drier, longer summers;
- tourism is a key emerging sector particularly in coastal areas (e.g. Croatia, Montenegro), but will be challenged by sea-level rise, increased climate variability such as heat waves, and more unfavourable conditions in some parts of the year;
- climate change may also create more favourable conditions in mountainous part of the region, the current economic structures prevent making effective use of it;
- high energy consumption due to growing economy can cause higher demand for construction of new hydropower plants. Conflicts between different economic sectors and stakeholders in regard to water use may occur;
- too high dependency on hydropower energy can present a risk of electrical energy blackouts when there is not enough water in reservoirs for the power stations to function;
- water shortage in all seasons but especially in summer can affect agriculture extension of the growing season;
- warmer temperatures, longer and more frequent droughts and heat waves can cause heat stress, increase tree mortality and can have a large adverse effect on crop yields and productivity especially in the eastern part of the region where significant amount of GDP is produced due to intensive farming;
- unsustainable farming practices combined with higher rates of evaporation from topsoil are causing soil degradation as one of the major threats;
- there is a high chance that there will be a shortage of water for irrigation. Certain crops which are currently not-irrigated will be forced to become more dependent on extra water;
- the projected lengthening of the thermal growing season would allow a northward expansion of warm season crops to areas that were not previously suitable. This is especially applicable for mountainous regions such as Dinaric Arc;
- electricity production and consumption in the Western Balkans are lower than the average of neighbouring countries or the whole EU-28, in absolute as well as per inhabitant terms. In comparison with EU-27, Western Balkan countries significantly increased electric energy production and consumption in the last ten years. In the water-rich region of the Western Balkans, this brings implications to energy-related water use.

6.1.3. *Impacts on the environment*

Environmental value of the Western Balkans is considerably high, not just from a regional perspective but also from a global one. Complex geological history, influence of Atlantic cyclones, geographical variety of regions, interactions between species, ecosystems and populations have all resulted in enormous biodiversity, abundant water resources and richness of other natural resources such as coal, copper, lead, zinc. Implications associated with environmental mismanagement and climate change impacts that can be applied to society and applied to the environment are:

- abundant natural resources of the region are in risk of over-exploitation, abuse and mismanagement due to the socio-economic instability of the region;
- unique ecosystems such as deep and large tectonic lakes with endemic fish species and karstic lakes, caves, sink holes and valleys with rare endangered amphibians, dragonflies, birds and fish are at risk due to the temperature increase and environmental mismanagement;
- absence of urban waste water treatment plants, sufficient sewerage systems, insufficient waste management and lack of environmental awareness are in combination with climate change impacts presenting significant risk to ecosystems which can result in biodiversity loss. The GMT implication foresees the increase in cost of wastewater treatment in the coming decades, which is likely to make meeting the cost of ensuring adequate wastewater treatment even harder for countries in the region;
- up to 30% of large rivers are still near-natural, some even pristine and of a very high conservation value (Globevnik et al., 2014). However, more than 480 hydropower plants are currently planned. Considering the fact that the water availability will due to the climate change and land use changes most likely be limited, their construction would significantly impact many rivers and their ecosystems since the dominant portion of the planned hydropower plans will be located on river stretches with very high conservation value. Their construction will especially influence the currently still free flowing rivers (e.g. Vjosa);
- higher temperatures combined with more frequent and intense droughts increase the risk of forest fires. The Western Balkans is already experiencing more fires over larger areas. Environmental damage due to forest fires includes loss of habitat, soil erosion and greenhouse gas emissions (UNEP/ENVSEC, 2012);
- changes in precipitation affect the equilibrium of the soil. In the Western Balkans, soil water content is projected to decline; saturation conditions and drainage will be increasingly rare and restricted to periods in winter and spring. Soil erosion is expected to increase over the next century as intense precipitation and flooding increase flow of underground waters causing widespread landslides. This can further induce pollution of waterways and reduce the functioning of reservoirs and irrigation infrastructure (Čustović et al., 2012);
- the region's exposure to more frequent and intense floods also has implications on the environment as heavy rains can overwhelm the wastewater and sewage systems. Moreover, the mining legacy in the West Balkans raises the spectre of a flood resulting in an environmental catastrophe. Many mine tailing facilities in the Western Balkans are abandoned, neglected or orphaned. Without routine monitoring and maintenance these facilities deteriorate and become vulnerable to failure and the consequent release of toxic contamination. The combination of river flooding and tailings management facility failure poses a major threat in the region (UNEP/ENVSEC, 2012).

6.2. Adaption measures

Different measures exist for addressing the pressures. These measures are part of a risk management approach that considers risks such as flooding and drought as inevitable events but tries to mitigate their effects with preventative action. For such an approach, water as a resource has to be managed in an

integrated fashion, bringing together all aspects of water management and policy areas that have traditionally been considered as separate. Preventative measures can decrease the impact of extreme hydrological events or insufficient water quality, and mostly do so at a lower societal cost compared to a crisis approach that focuses on response and recovery actions to limit damage during and after an event (EEA, 2012a). Adaption measures are different preventative or preparedness practices which can be classified as follows: 'grey' measures (physical infrastructure), 'green' measures (nature or ecosystem based solutions) and 'soft' measures (enhancing adaptive capacity, information platforms, climate adaption and risk services and insurance schemes) (EEA, 2017e).

Western Balkan countries need to continue rebuilding roads, sewage systems, urban waste water treatment plants and other "grey infrastructure" elements. Despite being essential for economic growth, these infrastructure investments are significant and put heavy burdens on governments. Now, new and in many cases more affordable approaches are emerging that use natural processes or green infrastructure (GI) rather than concrete and steel. Nature-based infrastructure solutions can thus provide a good return on investment (EEA, 2015d), especially in sprawling urban areas of the Western Balkans. The Western Balkans remarkable biodiversity, unique biogeographical and ecological phenomenon in Europe is already now under threat of mismanagement and (un)sustainable spatial planning. When exploring how to accommodate infrastructure demands in the future with respect to climate change impacts, the lesson is clear: "think about green before investing in grey".

6.2.1. *Grey measures*

From a functional perspective, grey infrastructure facilitates include the production of goods and services, and the distribution of finished products to markets. Grey infrastructure also facilitates the provision of basic social benefits such as accessibility to services, and enables the transportation of raw materials by road etc. (EEA, 2014). Considering the implications identified through explorative scenarios, the following grey measures are proposed:

- sustainable energy development strategies should include a wider spectrum of non-hydropower renewable energy sources such as sun, geothermal water, wind etc. Countries of the region should continue to align national legislation with WFD and UWWTD and increase investments in waste water treatment and sewerage systems;
- water levels should be regularly monitored for developing effective risk mapping for drinking water deficit and urban floods;
- irrigation efficiency should be improved with introduction of low water demand drip irrigation techniques from local water resources. Monitoring and warning systems should be established for surveying fires, diseases, insects and other possible disturbances in agriculture and forestry sectors;
- existing hydropower plants should be modified to be more energy efficient in respect to less abundant river flows. Water management should allow multipurpose use of hydropower infrastructure and implements all measures to allow fish passes, water transport and efficient use of water in all sectors. Existing hydropower plants and reservoirs should be modified/enlarged to be more efficient regarding less abundant river flows;
- coastal cities which are at risk of flooding due to rise of sea level should implement proper measures regarding coastal protection to avoid sea flooding such as seawalls, land acquisition and creation of marshlands as buffer zones against rising sea levels;
- new tourist facilities and infrastructure should be planned with minimal environmental footprints, with emphasize on ecologically sound waste management and renewable energy such as the installation of solar panels on new buildings. Rather than focusing on large-scale coastal developments, investors and planners should focus to develop lower-impact ecotourism facilities and infrastructure in national parks and mountainous regions.

6.2.2. *Green measures*

Climate change and infrastructure development in the Western Balkans make disaster-prone areas more vulnerable to extreme weather events such as floods, forest fires, storms, droughts etc. The impacts of such events on society, economy as well as environment can be reduced using green infrastructure (GI) solutions (EEA, 2015d). One of the key attractions of GI is its multifunctionality; the fact that it can perform a number of functions and provide several benefits for the same spatial area (EC, 2012). Considering the potential impacts and risks identified through scenarios, the following green measures are applicable to the assessed region:

- as a result of expected climate change and plausible changes in land use, there is a strong evidential basis for increased landslide activity especially in the regions where over exploitation of natural resources and deforestation, as well as growing urbanisation and uncontrolled land use is happening. GI, particularly forests but also other vegetation can sizeably reduce the occurrence of shallow landslides (Stokes et al, 2014). Apart from reducing vulnerability to landslides, forest cover can also decrease the occurrence of avalanches by stabilising the snow on the ground (EEA, 2015d);
- floods are natural hazards that incur the highest economic losses in the Western Balkans. Progressing urbanisation and soil sealing of flood-prone areas located close to major rivers threaten to intensify flood risk, in addition to climate change. Floodplains are on the other hand hotspots of ecosystem services provision, playing an important role for freshwater supply (EEA, 2015d). In order to improve the multifunctionality of wetlands and floodplains as well to enhance flood protection capacities (wetlands reduce or delay peak discharge), green basin-wide solutions such as reintegration of former floodplains as retention basins, restoration and rehabilitation measures are proposed. Further floodplain degradation should be stopped, and the natural wetlands and floodplains should be restored where economically efficient (Verhoeven, 2014). Human-made infrastructure (grey measures) can be combined with GI (Kryžanowski et al., 2014);
- in the Western Balkans, climate change is expected to bring higher summer temperatures and heat waves (EEA, 2010a). Due to increasing urbanisation, urban GI and its management plays a key role in mitigating urban heat island affect as well as global climate regulation (EEA, 2015d). Additional green space (urban forestry, green alleys and streets, parks, eco-roofs) could significantly reduce rising temperatures associated with climate change and the urban island effect (Carter et al., 2014). This is especially applicable for large urban settlements (e.g. Belgrade, Skopje) which are already now in the summer months often hit by heat waves and are under a significant influence of urban heat island effect.

6.2.3. *Soft measures*

Emergency plans should be developed at international (basin), national, regional and local levels for various types of hazard, in particular floods but also forest fires, landslides and earthquakes. Such early warning systems not only reduce disaster risk but also raise awareness and build capacity by emphasising the increases of risks with climate change.

When rivers cross international boundaries, water resource issues become increasingly more complex, with political dimension dominating over legal and technical aspects, and a complicated coordination of different institutional, regulatory and planning procedures (World Bank, 2006).

It is recommended that responsible national and international institutions take a regional approach to water resources planning by the following means:

- collect data on water availability and water use by employing standardised methods;
- monitor both quantity and quality conditions of the area's water resources;

- encourage open exchange of scientific research relevant to these water resources and the conduct of scientific research on a regional and collaborative basis (Committee on Sustainable Water Supplies for the Middle East, 1999).

Lack of environmental awareness is in combination with climate change impacts presenting a significant risk to ecosystems, water quality and public health. The fragility of environment and the importance of its protection have to be promoted in all societies and generations through the education system, environmental books, brochures, social media, forums, religious podium, information, inspirational seminars and other means. Web-based information systems are a popular way to increase awareness and preparedness among vulnerable actors in society.

Research and investments into new ways of obtaining useful information as well as the assessment of soil fertility and water levels using remote sensing should be encouraged. Investments in climate change investigation and future water availability should remain a high priority with a strong collaboration coming from the energy, agricultural, environmental and water consuming sectors.

The Western Balkans itself is one of the most vulnerable regions to climate change and has to strengthen its resilience. Going beyond preparedness, resilience should be improved also through a systematic, holistic approach with stakeholder participation that addresses disaster risk reduction and climate change adaption in a much wider context, aiming at maintaining business continuity and improving quality of urban life (EEA, 2017e). Climate change adaption strategies and disaster risk reduction measures should be thus tackled also by developing cross-sectorial agreements/policies at transboundary level.

Photo 6.1: Discussing and illustrating the implications of global megatrends in the Western Balkans region at the regional workshop in Ljubljana.

Photo: © Luka Snoj, 2017

7. Future opportunities in the region

The water resources in the region will face challenges such as risks of droughts and floods due to climate change, pressure on the water due to socio-economic and technological developments, and the political situation. However, there are many opportunities for the region to step ahead and evolve in the economically and politically stable and technologically advanced region to adapt to changes in society, environment and climate.

The region has a large natural capital which with the careful management of mitigation emerging risks and trade-offs can be preserved. The Western Balkans is known for its remarkable biodiversity, making it a unique biogeographical and ecological phenomenon in Europe. Due to the regional geopolitical and socio-economic instability this environment is threatened by a lack of sewage systems, urban waste water treatment plants, insufficient waste disposal, heavy industry, poor environmental awareness, construction of dams in the protected areas etc. Regional stability cannot be reached instantly but needs a transition process involving political and societal changes. Abundant natural resources will most probable be exploited in unknown ways, bringing different consequences depending on unknown factors in the future. Furthermore, there is a lack of robust strategies that would indicate where these countries aim to develop a common strategy for the region which would join regional stakeholders into a relationship with external influences. Consider the long-term outlooks for water availability in their country (and the region) when developing policy and strategy across a range of policy spheres e.g.: agriculture and food; land-use and spatial planning; mining; energy production; manufacturing.

Unexploited freshwater resources are one of the most important natural potentials for regional development. Owing to climatic conditions and topography, the Western Balkans is one of the richest European regions in terms of water resources. Freshwater resources per inhabitant in the Western Balkans are almost twice as abundant as in neighbouring countries with considerable differences between the regions. Taken as a whole, the Western Balkans has relatively abundant freshwater resources, but in many parts of the region water is scarce, particularly in summer months. The sustainability of future hydropower use and its security implications depends not only on severity of climate change impacts, but also on cross-sectoral, regional and international cooperation as well as economic development of the whole region and neighbouring countries.

The quality and quantity of water will be significantly affected by climate change and socio-economic developments. The increasingly severe consequences of climate change are likely to exacerbate all regional long-term environmental challenges around the water-energy-food nexus. The water availability is projected to decrease in catchments in the western and south-western part of the region where average discharge could be reduced from 10 to 30% until the end of the century. The reduction will be the most prominent in autumn (30%) and summer (25%) months. Numerous rivers which are already now facing water shortages and droughts in the summer months (e.g. Vardar) will face yet additional water deficit. The reduced discharge presents a serious threat to hydropower plant development, public water supply, irrigation, biodiversity, fisheries and aquaculture and may severely impact freshwater ecosystem goods and services. On the other hand, the projected lengthening of the thermal growing season would allow a northward expansion of warm season crops to areas that were not previously suitable. The increasingly severe consequences of climate change are likely to exacerbate all regional long-term environmental challenges around the water-energy-food nexus. A deep understanding of future economic developments is needed to make further conclusions on water vulnerability and propose suitable adaptation measures.

The frequency and intensity of extreme events such as floods and droughts are projected to increase. Even though the river discharges will most likely decrease, modelled projections indicate an increase in the frequency and intensity of extreme hydrological events**.** A series of floods that affected the region in recent years (e.g. 2014 Southeast Europe floods) had very high economic costs in terms of damaged infrastructure and housing, and disrupted economic activity across all sectors.

The recent events (like the flooding in 2014) have shown that people and institutions in the Western Balkans have not yet been sufficiently prepared for the impacts of climate change in spite of the enhanced transboundary collaboration due to historical connections and large investment by the EU into better disaster preparedness and prevention. Yet in the future these events are projected to become more frequent and severe. Progressing urbanisation and soil sealing of the flood-prone areas located close to major rivers threaten to even exaggerate flood risk, in addition to climate change. In order to reduce or delay peak discharges, improve the multifunctionality of wetlands and floodplains and enhance flood protection capacities, the region should consider the implementation of green basin-wide solutions such as reintegration of former floodplains as retention basins, restoration and rehabilitation. There is a need to improve the resilience of society to all kinds of extreme events by lessons learned from the past events and involving the society in reducing the disaster risks and at the same time adapting to climate change. This has to be done in a wider context for example aiming at maintaining business continuity and improving the quality of urban life.

The global demands on certain resources are expected to change dramatically to 2030 and beyond. The global demand on certain resources assessed will drastically increase and affect availability also in the Western Balkans where abundant natural resources of the region are already now at risk of over-exploitation, abuse and mismanagement. Regional institutions / policy makers should consider measures such as undertaking modelling or other research into the resource implications of different policy or strategic options, in particular exploring current supply and demand characteristics in the context of medium and long term global and regional socio-economic changes. The long-term water needs of investment strategies related to water-food-energy nexus should be compared to existing knowledge on likely future water availability (also from scenario studies completed under this task) and associated risks.

Environmental and water-use strategies should be developed in close cooperation with other countries in the region and common interests identified. Governments in the region still view threats as having a military nature, and are only slowly starting to pay attention to concepts of "human security" and to integrate new notions such as environmental risks and implications. Despite the fact that all countries of the Western Balkans are aiming for EU membership (having either status of a candidate country or potential candidate country), international cooperation and ties are often based on cultural and historical backgrounds that are oriented towards at least four geopolitical directions, depending on country or even sub-national entity. Transboundary water management in the Western Balkan is often considered as weak with low political prioritisation, insufficient institutional capacity, limited information exchange and joint monitoring. In the light of potential conflict linked to water quality, availability and competition in the future this is a significant risk for the region. Given geographic characteristics of the region and in light of integrated river basin management principles, regional cooperation is essential. A relatively simple practical step could be to seek further regional, transboundary and cross-sectoral workshops and meetings.

National institutions or ministries with responsibility for water, energy and agriculture should be brought together to discuss and explore common challenges and opportunities for cooperation at the basin, national and local levels. The close proximity to the EU and the potential of many countries to join it provides the region with additional opportunities to cope with the challenges of climate change. Common foreign policies should make the region stronger in relationship with international partners who are interested in using natural resources of the region. Strategies developed in such a way can also better deal with transboundary and complex issues, such as sustainable hydropower development, mitigating natural hazards impacts, preserving biodiversity, ensuring a high level of water quality for society, coping with climate change impacts and poverty.

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Annex 1: Land cover categories per catchment and scenario

Land cover category	Scenario	Morava	Bosna	Vrbas	Una	Morača	Black Drim	Neretva	Vjoša	Shkumbini	Seman	Vardar	Drina
Artificial surfaces	present state (%)	2.7	3.0	1.2	0.8	2.8	1.3	1.1	0.2	2.3	2.1	2.5	0.5
	sc. 1 & 2 (%)	8.3	8.7	3.6	2.9	5.9	4.6	3.6	0.8	6.8	8.7	6.6	1.8
	sc. 3 & 4 (%)	5.9	6.4	2.7	2.0	4.7	3.2	2.6	0.5	5.0	5.8	4.8	1.3
Arable land and permanent crops	present state (%)	39.8	26.2	20.5	24.6	11.2	14.5	12.9	5.0	23.2	30.1	27.3	18.4
	sc. 1 & 2 (%)	40.4	32.1	27.6	32.7	15.0	15.6	14.8	5.9	24.8	28.2	28.3	27.4
	sc. 3 & 4 (%)	52.4	39.2	32.9	38.4	19.0	22.4	22.6	8.9	34.8	36.5	37.6	33.5
Coniferous forest	present state (%)	2.1	9.1	11.3	2.7	1.6	1.7	1.9	16.8	0.4	6.1	1.5	10.6
	sc. 1 & 2 (%)	2.0	8.1	10.9	2.5	1.4	1.6	1.8	16.7	0.3	5.8	1.4	9.5
	sc. 3 & 4 (%)	1.4	5.9	7.7	2.1	1.1	1.1	1.3	15.2	0.2	4.4	0.9	6.7
Broad leaved forest	present state (%)	38.6	33.1	31.1	38.0	32.2	30.4	34.1	25.6	35.7	17.3	34.0	29.0
	sc. 1 & 2 (%)	33.9	25.9	25.3	31.3	29.7	28.9	32.1	25.1	34.3	16.5	31.6	23.6
	sc. 3 & 4 (%)	22.8	19.5	16.0	22.0	26.0	19.1	23.0	20.3	22.5	9.5	21.9	16.8
Mixed forest	present state (%)	2.4	17.4	13.7	11.1	6.2	1.8	2.5	10.1	0.3	2.5	1.4	10.4
	sc. 1 & 2 (%)	2.2	15.9	13.0	10.8	6.0	1.7	2.4	10.0	0.3	2.4	1.3	9.4
	sc. 3 & 4 (%)	1.6	13.6	9.7	10.0	5.6	1.2	1.9	9.0	0.2	1.6	0.8	7.3
Scrub and herbaceous vegetation	present state (%)	8.9	3.8	4.6	6.6	38.3	20.9	29.0	32.2	25.6	24.4	18.1	17.0
	sc. 1 & 2 (%)	8.1	3.3	4.2	5.8	35.2	19.4	27.4	31.4	22.6	22.8	16.8	15.3
	sc. 3 & 4 (%)	5.1	2.2	2.3	3.2	30.7	9.2	18.3	25.4	12.0	12.9	9.8	9.8
Pastures and grasslands	present state (%)	5.2	7.2	17.4	15.7	6.8	20.7	17.5	9.8	12.4	17.5	15.0	13.5
	sc. 1 & 2 (%)	4.7	5.8	15.2	13.4	5.8	19.5	16.9	9.6	10.8	15.5	13.8	12.3
	sc. 3 & 4 (%)	10.3	12.9	28.7	21.9	12.1	35.3	29.4	20.4	25.3	29.3	24.1	24.2
Inland waters	present state (%)	0.3	0.3	0.1	0.4	0.6	8.6	1.0	0.3	0.1	0.0	0.2	0.5
	sc. 1 & 2 (%)	0.4	0.3	0.2	0.5	0.7	8.6	1.1	0.6	0.1	0.0	0.2	0.7
	sc. 3 & 4 (%)	0.3	0.2	0.1	0.4	0.6	8.5	0.9	0.3	0.0	0.0	0.2	0.5
Wetlands	present state (%)	0.0	0.0	0.1	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	sc. 1 & 2 (%)	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	sc. 3 & 4 (%)	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Annex 2: Decision rules for expansion of land cover categories

Land use category	**Sustainable economic growth (scenarios 1 & 2)**		**Unsustainable economic growth (scenarios 3 & 4)**	
	Expansion buffer	Expanding Hierarchy	Expansion buffer	Expanding Hierarchy
Artificial Surfaces	350 m	1	200 m	1
Inland Water	50 m	2	/	2
Arable Land and Permanent Crops	100 m	3	170 m	3
Wetlands	/	5	/	5
Coniferous forest	/	4	/	6
Broad Leaved Forest	/	7	/	7
Mixed Forest	/	6	/	8
Transitional Woodland and Scrub	/	8	/	9
Pastures and Grasslands	/	9	300 m	4
Wetlands	/	5	/	5

Annex 3: Participating experts at the project workshops

Workshop 1 "Implications of global megatrends in the Western Balkans region" – Ljubljana, 10–11 April 2017

Participant name	Institution
Dragana Vidojević	Serbian Environmental Protection Agency (NRC for Land Use and Spatial Planning in Serbia)
Milorad Jovičić	Serbian Environmental Protection Agency (NRC for Water quality and ecological status in Serbia, NRC for Water quantity in Serbia)
Katerina Nikolovska	Ministry of Environment and Physical Planning (NRC SOE), Former Yugoslav Republic of Macedonia
Ivica Tasiḱ	Ministry of Environment and Physical Planning, Former Yugoslav Republic of Macedonia
Azemine Shakiri	Ministry of Environment and Physical Planning (NRC Water), Former Yugoslav Republic of Macedonia
Tihomir Predić	Institute of Agrochemistry and Agroecology at the Agricultural Institute of the Republic of Srpska (NRC soil and agriculture)
Andrea Muharemović	Federal Ministry of Environment and Tourism (NFP assistant coordinator Bosnia and Herzegovina)
Đorđije Vulikić	Ministry of Sustainable Development and Tourism (NRC for FLIS), Montenegro
Milica Vukčević	Ministry of Agriculture and Rural Development (NRC For WISE river and lake quality), Montenegro
Neda Dević	NRC Land cover Montenegro
Oriana Hanxhari	NRC FLIS Albania
Rozana Bineri	NRC Water Quantity Albania
Arben Luzati	Institute of Public Health Albania
Afrim Berisha	Kosovo under UNSC Resolution 1244/99
Mariann Nemes	Földművelésügyi Minisztérium, Budapest
Fedor Černe	Republic Slovenia Ministry for Ministry of Infrastructure
Philippe Ker Rault	Wageningen University and Research
Anita Pirc Velkavrh	European Environment Agency, Copenhagen
Lidija Globevnik	Organiser; ETC/ICM – TC Vode, Ljubljana
Gašper Šubelj	Organiser; ETC/ICM – TC Vode, Ljubljana
Luka Snoj	Organiser; ETC/ICM – TC Vode, Ljubljana
Owen White	Organiser; CEP, UK
Rolands Sadauskis	Organiser; CEP, UK
Anita Künitzer	Organiser; ETC/ICM – UFZ, Magdeburg (Germany)
Urška Kušar	Slovenian Water Agency (DV), Slovenia
Barbara Simonič	Ministry of the environment and spatial planning (MOP), Slovenia
Darja Piciga	Ministry of the environment and spatial planning (MOP), Slovenia
Nataša Kovač	Slovenian Environment Agency (ARSO), Slovenia

Workshop 2 "Assessment of risks and opportunities, policy gaps and needs" – Belgrade, 07–08 September 2017

Participant name	Institution
Dragana Vidojević	Serbian Environmental Protection Agency (NRC for Land Use and Spatial Planning in Serbia)
Milorad Jovičić	Serbian Environmental Protection Agency (NRC for Water quality and ecological status in Serbia, NRC for Water quantity in Serbia)
Katerina Nikolovska	Ministry of Environment and Physical Planning (NRC SOE), Former Yugoslav Republic of Macedonia
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Tihomir Predić	Institute of Agrochemistry and Agroecology at the Agricultural Institute of the Republic of Srpska (NRC soil and agriculture)
Andrea Muharemović	Federal Ministry of Environment and Tourism (NFP assistant coordinator Bosnia and Herzegovina)
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Milica Vukčević	Ministry of Agriculture and Rural Development (NRC For WISE river and lake quality), Montenegro
Neda Dević	NRC Land cover Montenegro
Oriana Hanxhari	NRC FLIS Albania
Rozana Bineri	NRC Water Quantity Albania
Arben Luzati	Institute of Public Health Albania
Afrim Berisha	Kosovo Environmental Protection Agency, Kosovo under UNSC Resolution 1244/99
Sabit Restelica	Kosovo Environmental Protection Agency, Kosovo under UNSC Resolution 1244/99
Barbara Bernard Vukadin	Ministry of the Environment and Spatial Planning, Environmental Agency of the Republic of Slovenia
Marton Miklós	Földművelésügyi Minisztérium, Hungary
Samo Grošelj	International Sava River Basin Commission
Tarik Kupusović	Hydroengineering institute Sarajevo
Kasper Kok	Wageningen University
Darja Kragić Kok	Wageningen University
Anita Pirc Velkavrh	European Environment Agency, Copenhagen
Lorenzo Benini	European Environment Agency, Copenhagen
Lidija Globevnik	ETC/ICM – TC Vode, Slovenia
Gašper Šubelj	ETC/ICM – TC Vode, Slovenia
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