Security implications of future water use in Western Balkans: the challenge of hydropower development

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Executive summary

The *Security implications of future water use in Western Balkans: the challenge of hydropower development* project seeks to encourage discussion and action in Western Balkans by providing an explorative analysis of the possible security implications of water-use development in the region. The European Environment Agency (EEA) is also developing and testing a methodology on how to use scenarios and vision building for assessment of possible future risks within different scenarios.

The project has provided a participatory-based explorative analysis of security implications of water-use development in the region. An examination of general socio-economic, environmental and sector-specific data was made to produce relevant indicators, which support the assessment of the present situation and future possible scenarios. According to these, the region has valuable natural resources, biodiversity and significant hydropower potential. Its socio-economic situation is less encouraging although the levels of education and social capital are high, and the ecological footprint low. The region does not only have the potential to develop its hydropower use, but also a significant potential for sustainable tourism and organic food production. These facts can be the starting point for strengthening its economy, sustainable development and political co-operation between countries, as well as possible integration with the European Union (EU).

In addition, four different scenarios were developed with regional stakeholders, depending on climate change impacts and economic development. Scenarios were developed within the project *Security Implications of Climate Change in the OSCE region (*EEA and Organisation for Security and Co-opertation in Europe – OSCE project), which identified the need to understand and manage systemic issues and future risks at all scales of governance. The scenario workshop in the Western Balkans focused on future water availability, especially with regard to sustainable economic development and the potential impacts of climate change. The workshop prioritised hydropower development as a common and important issue for the future development of the Western Balkan region, influencing also the availability of water, natural resources and ecosystem services. Regional stakeholders developed the visions on hydropower development until 2050. This served as the basis for an assessment of different scenario risks which could obstruct the achievement of visions. The risks of hydropower development are different depending on the scenario, and were elaborated accordingly and supported by some available indicators.

To complement this explorative and mostly qualitative forward looking assessment, as well as to better understand possible future changes on a basin level, the case studies for the Morača and Vardar river basins were made. Two climate models were used to predict future rainfall, runoff and temperatures, as well as altered land cover data, based on changes expected according to each scenario. The case studies have confirmed scenarios' assumptions that decrease of available water resources can be expected in the future, while resource needs will increase. Nevertheless, the differences between different scenarios can be observed in water availability for the future.

The combined results show that future risks of hydropower development in the Western Balkans depend on socio-economic, environmental and technological factors. The following conclusions can be derived:

1. **Abundant natural resources of the region are at risk of abuse and mismanagement due to the socio-economic instability of the region**. Stability cannot be reached instantly but needs

a transition process involving political and societal changes, including the strengthening of regional and international co-operation, which would among others provide the sharing of knowledge and experience with the EU countries.

2. **In the future, natural resources will change in quality and quantity.** Further management measures will have to be implemented in order to save them from depletion due to climate change. Management of possible future risks depends on the whole region and neighbouring countries.
3. **Hydropower development is big and important natural potential for development of the Western Balkans.** It is crucial, therefore, to work towards a common vision with hydropower being developed in a sustainable way: strong regional and international co-operation, efficient trans-boundary water management, and collaboration and sharing of knowledge and experience with the EU countries.
4. **Environmental and water-use strategies should be developed in close cooperation with other countries in the region and with clearly identified common interests.** A common position of the regional stakeholders towards international partners should make the region stronger in securing its interests when opening access to natural resources internationally. Strategies developed in such a way can also deal better with transboundary issues, such as sustainable hydropower development, preservation of biodiversity and high level of water quality for society, coping with climate change impacts and poverty.

The process of scenarios and vision building and outcomes of this report also contribute to the EEA's European knowledge base for forward-looking information and services (FLIS) in terms of capacity building and possibly using information in national state of the environment reporting.

1 Introduction

The Western Balkans is a region of many natural assets as well as cultural variety, which combine into rich potentials. Such potentials have traditionally attracted various international and regional powers which have tried to develop or use them throughout the history as well as today. The countries of the Western Balkans are at a turning point in the development of their economies, societies and environment.

However, the complex region and its potentials have been challenging to understand and even more challenging to manage. After the turbulent past decades, dynamic socio-economic changes are underway and many uncertainties synergise with larger factors such as climate impact and related security issues.

Conclusions from the analysis of environmental trends and perspectives in the Western Balkans done by the EEA (2012b) pointed among others at rich water resources and their potentials. The focus of the project arises from findings that the EEA identified in the project *Security Implications of Climate Change in the OSCE region* [1] about the needs to understand and manage systemic issues and future risks at all scales of governance (EEA, 2012b). Water resource issues have been identified as the most relevant topic. Available water resources are considered as an important development potential and recent hydropower development activities show that this will shape future environment and society of the region in an important way. International stakeholders – institutions and foreign governments as well as international corporations – already invest in the region's natural resources. Moreover, further investments are planned for the development of hydropower to use promising geographical and hydrological conditions.

Do such developments come without future risks? Are there enough water resources available, and will the region need such hydropower capacities in the future? In the uncertain setting of the Western Balkans, policy-making has to consider as much challenges and options for the future as possible.

In order to explore possible answers to these questions, a common vision with focus on hydropower development until 2050 is developed as the basis. Present socio-economic and environmental state of the region is elaborated through indicators, presented in the STEEP framework. Indicators are an important tool to identify trends which are to shape the plausible future(s).

The common vision of the regional stakeholders is the ultimate goal for the future. With credibility of the present state, we use the method of forward-looking assessment to describe plausible futures and

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[1] Organization for Security and Co-operation in Europe (OSCE) aims to develop scenarios for different OSCE regions in order to assess the impact of climate change on energy and food availability, on natural resources and other repercussions. European Environment Agency (EEA) contributes with approaches on developing forward looking studies and linking to environment.

their threats to prevent the region in achieving its common vision, or even expose it to security risks due to hydropower development. Scenarios for climate change in the Western Balkans up to 2050 that were conceptualised in 2011 (EEA, 2012b) are therefore developed into four explorative scenarios with focus on hydropower development, water availability and the environment in the region.

This serves as the basis for assessment of different scenario risks which could obstruct the achievement of the vision. Identified threats and risks arising from four explorative scenarios and in the context of the common vision provide guidance for policymaking. The present project *Security implications of future water use in Western Balkans: the challenge of hydropower development* aims to encourage discussion and action in the Western Balkans by providing an explorative analysis of possible security implications of water use development in the region.

2 Background: climate change and security

Many studies have identified climate change as a threat multiplier that may contribute to insecurities and destabilisation. Climate change particularly affects water availability and food security, but also energy security and economic development. Under certain conditions, this may lead to regional political instability and crisis (WBGU, 2007). These issues, among others, were highlighted by the UN Secretary-General (UNSG, 2009) and also by the UN Security Council (UNSC, 2011).

A particularly complex global challenge is the water-food-energy nexus: water is essential not only for drinking, but also for food production and electricity generation, such as in the case of hydropower or when it is used as a coolant in power plants. Globally growing populations and increasing demand in food, energy and other resources converge with climate change impacts, aggravating its impact.

Regional assessments are necessary to identify potential region-specific security implications. Despite regional variations, several overarching aspects of climate change can be identified:

- Climate change is transforming basic conditions. Thus, history is becoming a bad reference for the future as the boundary conditions are changing. With this transformation, climate change is altering the livelihood foundations of societies.
- Climate change rarely results in direct security threats. It is rather the complex interaction of different forces and factors that lead to increased insecurity. Global warming can, for example, affect local harvests that in turn leads to food insecurity and unemployment.
- Finally, current climate change is taking place in times of rapid global change with high population growth, rising demand for energy and food, emerging new technologies and shifts in political power on regional and international levels. These changes could amplify potential security risks.

The OSCE identifies three dimensions of security: the economic and environmental dimension, the political-military dimension, and the human dimension. A scoping study commissioned by the Office of the Co-ordinator for Economic and Environmental Affairs (OCEEA) identified different pathways, showing how climate change might affect the dimensions of security (

Figure 1) **(**Maas et al., 2010).

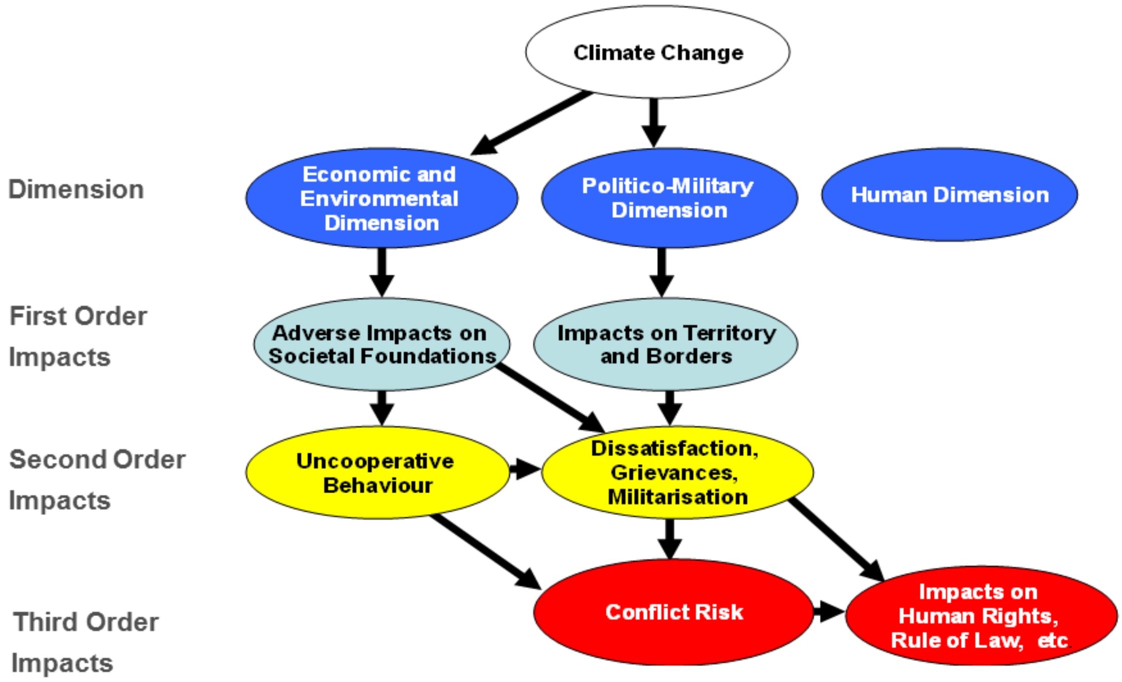

Figure 1: Impacts of climate on OSCE security dimensions

Source: Maas *et al.*, 2010

However, this conceptual model needs to be grounded in more detailed regional analysis. Though climate change impacts are already visible today (UNSG, 2009), it is necessary to look into the future and identify preventive and adaptive measures.

Feedback effects can accelerate these processes, greatly decreasing the effective response time of governments. Complex systems can exhibit abrupt changes that occur after a longer period of relatively slow change, and certain responses can quickly worsen the initial condition.

The complexity of these impacts is visualised in Figure 2. While there are plenty of factors which may interact with climate change effects, it may set in motion a chain of events requiring intervention to avoid potentially drastic impacts (OSCE, 2010).

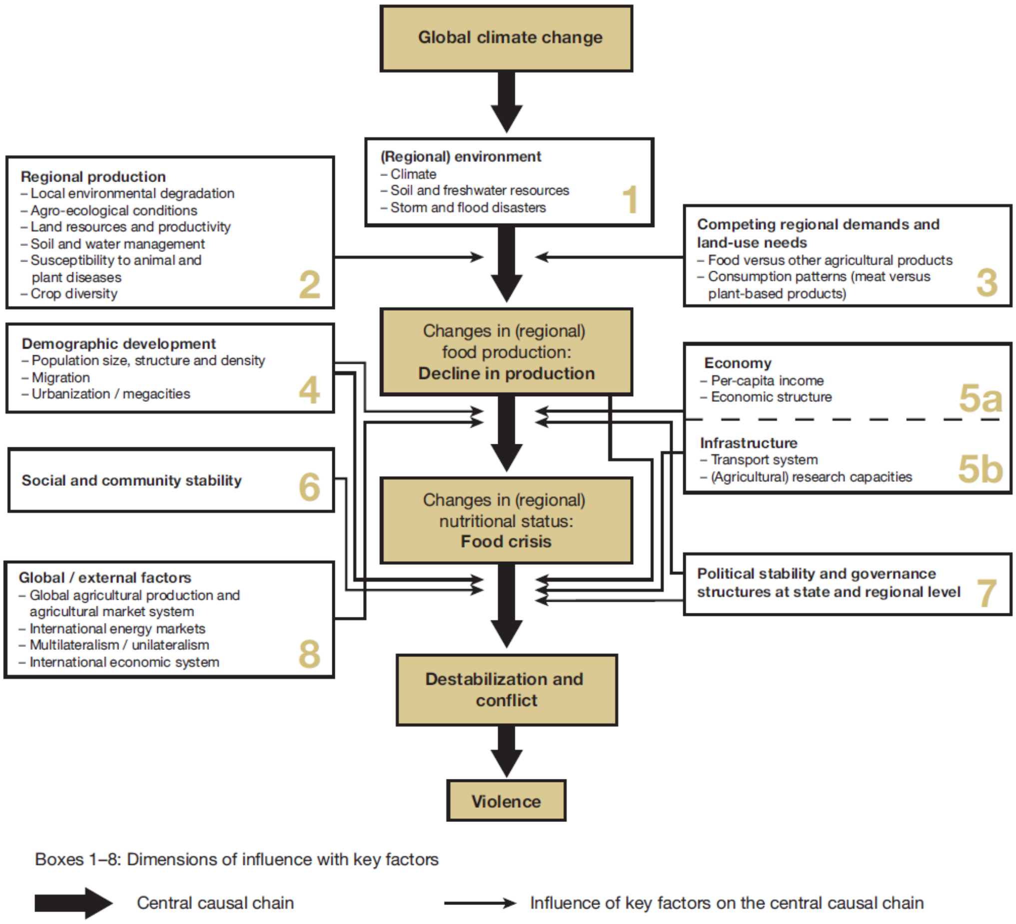

Figure 2: A conflict constellation centred on climate-induced food crisis

Source: WBGU, 2007

In our society, we face challenges of great complexity, uncertainty and dynamism. If society is going to adapt to a more sustainable path, we need to understand these challenges and their long-term implications better. Moreover, it is important not to delay action. Preparedness and timely action need a base of information on possible future pathways.

In order to strengthen long-term information for policymakers and encourage international cooperation in response to shared environmental challenges, several needs must be addressed:

- undertaking well-designed and sound future-oriented assessments that integrate environmental and socio-economic issues;
- including outlooks in national environmental reporting processes more frequently and adapting data information systems to capture forward-looking perspectives and emerging issues more regularly;
- increasing the expertise and resources available to carry out forward-looking studies at national, European and international levels. Co-operation between countries and international organisations is indispensable in facilitating the sharing of experiences in forward-looking assessments (EEA, 2011a).

3 Explorative scenarios as policy guidance – the methodological approach for regional scenario workshops

The scenarios and forward-looking assessment approach has been used to examine possible future security implications of water use, hydropower development and climate change.

Scenarios and scenario studies can provide a framework for assessing future policies and management options. They can also be educational, raising awareness and understanding of future perspectives. Even though these can be described with qualitative and quantitative data, scenarios are neither forecasts nor predictions.

Key elements of scenarios include:

1. representation of the initial situation, or baseline;
2. description of drivers of change and uncertainties;
3. description of changes, typically in time steps;
4. description of the end-state and an image of the future situation over a specified time;
5. description of alternative pathways to the future – scenarios are generally developed in sets (Alcamo, 2009).

To study future issues and concerns, a wide range of methods such as quantitative projections or forecasts, narrative scenario studies in combination with quantitative tools, horizon scanning, system dynamics, sensitivity analysis, probability analysis, mega-trend analysis and back-casting can be used (EEA, 2010d; Figure 3).

The time horizon of analyses may also influence the kind of foresight method used, as there are a number of different approaches for forward-looking assessment. Short time-horizons tend to be more suitable for low levels of uncertainty, endowing projections of future implications with some confidence. Conversely, where high levels of uncertainty exist, especially in assessments of a long-term future, precise projections can sometimes be meaningless and even create a misleading sense of certainty about future trends. In such cases, exploratory scenario-based approaches can help to explore key uncertainties and their implications across a wider range of contrasting futures (EEA, 2007).

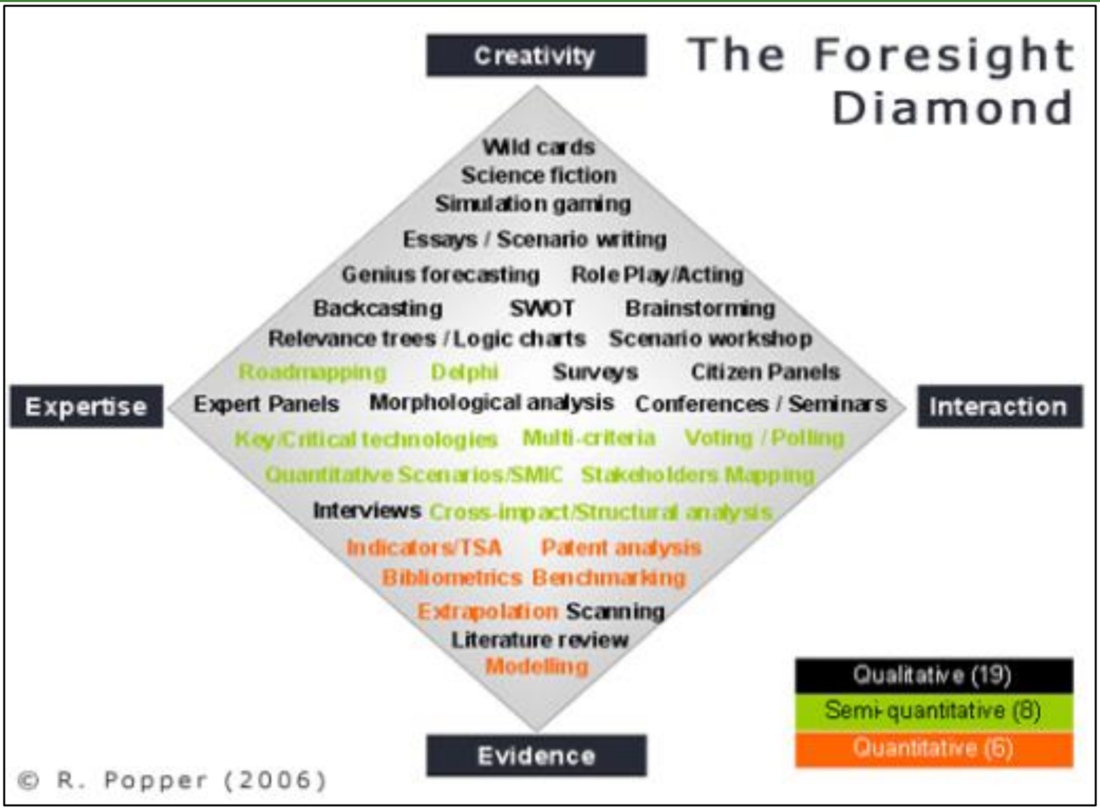

Figure 3: The foresight diamond

Scenario and regional assessments are mechanisms that can provide valuable foresight into climate-related security risks. By illustrating how regions might look in the future, scenarios can provide advance warning to help decision makers to deal with security risks.

A basic starting point is deciding what the key concern or issue to be addressed will be. Scenarios only work effectively when they answer a key question for the organisation and its members. A potential question could, for example, be how could a climate-induced decrease in precipitation result in instability?

Potential pitfalls of the scenario process

Security scenarios and regional assessments can be quite valuable, but if not developed properly they can serve to reinforce pre-existing beliefs rather than provide greater flexibility in policy response. Two instructive cases can be drawn from the RAND Corporation, a think tank, and oil company Shell, who frequently apply scenario techniques – this issue was discussed by Lučka Kajfež Bogataj, a member of the Intergovernmental Panel on Climate Change (IPCC) committee, in the project's methodological workshop.

A potential error in conducting climate security scenarios is in adhering too closely to formats used in the past by the defence establishment, such as Herman Kahn's work at the RAND Corporation (Kahn, 1967). The what-if scenarios for exploring future security risks often assume a fairly constant background or context, taking existing conditions and projecting them into the future. But as the RAND and Shell understood as early as the 1970s, **sometimes the context of the problem itself changes** (DeWeerd, 1973). In this contextual shift, we do not simply consider that existing problems grow worse. Rather, unique challenges can emerge from new background conditions, especially if those changes are abrupt and rather unexpected. Most scenarios of future political developments in the

1980s understandably became out-dated in just a decade later. It may also be the case that issues normally considered mundane could be transformed into international security risks. Natural disasters, if occurring frequently and/or severely, could create conditions necessitating calls for military involvement beyond the typical disaster-relief practices of most states.

In this project it was decided to use scenarios as a tool to help illustrate how regions might look like in the future, understand how and what changes might occur and the possible repercussions. Their goal was not prediction but rather to help uncover what is not known, expected or monitored (EEA, 2012b). Explorative scenarios for the Western Balkans are the outcome of two workshops. Firstly, scenarios, their characteristics and key driving forces were developed in workshop held in Belgrade, Serbia, in 2011. They reflect the key uncertainties regarding the sustainability of economic growth and the extent of climate change impacts (EEA, 2012b). Secondly, these were adjusted and improved with impact analyses on water, energy and security at the workshop in Ljubljana, Slovenia in 2013.

3.1 Terms used

Terms used in this project are defined as follows:

SCENARIO

Scenario is a mechanism that can provide valuable foresight into climate-related security risks (OSCE, 2010).

Scenarios are structured stories or narratives of how the world might look in the future. Drawing on the best available scientific data and regional expertise, scenarios are a process for 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, rather they 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 otherwise come as surprises (OSCE, 2010).

For the needs of our research we designed a set of scenarios by providing answers to a questions such as: "*how would the Western Balkans look if the extent of climate change were low and economic growth sustainable?*" or "*how would low climate change impacts and sustainable economic growth affect the social, technological, environmental, economic and political sectors?*".

VISION

A vision is an image of desirable future that inspires people to action.

It can also include descriptions of development towards a desirable future. The role of visions is to leverage change by targeting potential change agents and/or mobilising resources (Cost, 2006; Alvarenga, 2012).

A vision refers to a shared mindset held by the principal actors (Holstius and Malaska, 2003). It sets the broad outlines of a strategy, while leaving the specific details to be worked out. In other words, the broad perspective may be deliberate but the specific positions can emerge. So when the unexpected happens, assuming the vision is sufficiently robust, the society can adapt – it learns. A certain level of change is thus easily accommodated (Mintzberg, 1993).

ENVIRONMENTAL SECURITY

Environmental security is the relative public safety from environmental dangers caused by natural or human processes due to ignorance, accident, mismanagement or design, and originating within or across national border.

Environmental security can be also defined as the state of human–environment dynamics that includes restoration of a damaged environment which could lead to social disorder and conflict. Environmental security requires that we work to prevent and repair the damage we cause, in order to protect life on Earth, including our own. As a global issue there is substantial concern regarding how one country's abuse of its resources may impact people and systems elsewhere (Millennium Project, 2014).

The relationship between the environment and the security has only recently become an important focus of international environmental policy (Institute for Environmental Security, 2014).

HAZARD/RISK/THREAT

Hazard is a property, situation or potential to cause harm (Royal Society, 1992).

Hazards considered in disaster risk assessment are limited – dormant or potential – and rather well known. Their probability is often unknown and uncertain (EEA, 2012). The hazardous physical events referred to in the definition of disaster may not be only natural but also socio-natural, originating from the human degradation or transformation of the physical environment, or purely anthropogenic (IPCC, 2012). A hazard can cause a **threat** if exposure and vulnerability conditions are changed.

In this report we interpret *threats* and *hazards* as equal notions with an emphasis on hydro-meteorological events, including climate change; a subset of broader spectrum of physical events that are defined as hazards if vulnerability and exposure conditions convert them into a threat.

Risk is a combination of the probability of occurrence of a defined threat, and its negative consequences. Risk can be mitigated.

VULNERABILITY

Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC, 2007).

Vulnerability assessment is the analysis of the expected impacts, risks and the adaptive capacity of a region or sector to the effects of climate change. Vulnerability assessment encompasses more than the simple measurement of the potential harm caused by events resulting from climate change: it includes an assessment of the region's or sector's ability to adapt. In climate change publications, vulnerability is often defined as a function of the character, magnitude, and rate of climate variation and change to which a system is exposed, together with its sensitivity and adaptive capacity (European Climate Adaption Platform, 2014).

The term is also generally used to describe a valued characteristic of a system that is threatened due to exposure to one or more stressors (EEA, 2012) – in our case, stressors are consequences of climate change impacts and (un)sustainable economic development. Vulnerability includes the characteristics of an element and their situation that influences their capacity to anticipate, cope with, resist and recover from the adverse effects of the impacts (EEA, 2012).

ADAPTABILITY/ADAPTIVE CAPACITY

In the context of both natural and social systems, **adaptive capacity is the ability of a system to adjust to climate change, including climate variability and extremes, to moderate potential damage, to take advantage of opportunities or to cope with the consequences** (Economic Commission for Europe, 2009).

3.2 Workshops on scenario-building for Western Balkans

The Western Balkans regional workshop, held in **Belgrade, Serbia on 24–26 October 2011** was attended by participants from Albania, Bosnia and Herzegovina, Croatia, the former Yugoslav Republic of Macedonia, Kosovo (under UNSCR 1244/99), Montenegro and Serbia, as well as representatives of Hungary, Slovenia, the EU, the EEA, the OSCE and other international organisations. More than 40 participants analysed ways to manage the water security implications of climate change in the Western Balkans. Scenarios were developed reflecting the key uncertainties of the extent of climate change impacts and the sustainability of economic growth. The workshop identified risks of a spatially and temporally uneven water supply as a result of changing climate patterns and extreme events, and water-management decisions such as planned cuts in water storage and the increasing use of hydropower.

The regional workshop held in **Ljubljana, Slovenia on 11–13 February 2013** was attended by around 25 experts, but not official representatives, from all Western Balkan countries as well as from some neighbouring ones: Slovenia, Hungary, Italy, the EEA and other international organisations, Energy Community Secretariat, WWF Mediterranean Programme, Research and Innovation Centre at Edmund Mach Foundation, Branch Office of the Permanent Secretariat of the Alpine convention – Bolzano. The workshop was organised by the EEA and supported by the European Topic Centre on Inland, Coastal and Marine Waters (ETC/ICM) consortium members. Its main aim was to build the vision for hydropower/energy development in the Western Balkans and to refine and consolidate existing scenarios and identify impacts. Expert inputs were facilitated with web-based software tool for vision building (see Box 1). Scenarios and visions were refined by discussions within smaller groups.

Box 1: Vision building canvas tool

For vision building, a computer based vision-building tool, or vision canvas, which had been developed in the frame of EU Volante project[2] was used and adapted to the needs of this project.

The goal of the canvas tool was to elicit rich visions, defined as multifaceted expressions of ideas on the future. This includes images, graphs indicating trends, explanations of relationships between

[2] VOLANTE is a large collaborative project under European Commission's Research Development 7th Framework Programme consisting of 14 partners (running until 2015).

elements, statements and narrative descriptions (Volante, 2014).

The concept behind this tool is that of idea mapping: the materials and functionality support the structuring ideas, create relationships between them, and explain the elements of the vision (Volante, 2014). The tool uses pictures, which is good for overcoming language barriers, as well as text. Pictures are easy to recognise and (re)position; with text the meaning is specified. The functionality of the tool helps participants to structure, group and explain their ideas. This is valuable both in an explorative phase, and in a phase when visions are compared. The tool helps to create a common understanding and knowledge exchange among the participants, by supporting discussion during the creation of 'their canvas'. The tool creates reports and saves the results digitally.

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At the methodological workshop in **Copenhagen, Denmark on 29 April 2013**, key experts with knowledge of methodologies discussed:

- using regional climate models for assessing possible future water availability for four Western Balkans scenarios;
- embedding scenarios in policy making and dealing with uncertainties;
- climate change as a problem of national and international security and an environmental issue;
- risks of the scenarios being misunderstood by policy makers and politicians.

The second and final regional workshop, held in **Ljubljana, Slovenia on 30 September–1 October 2013** was attended by smaller group of experts from the Western Balkan countries. The workshop was organised by ETC ICM consortium. The discussion focused on the consistency of data presented as indicators, trends, climate models used for future water availability analysis, case studies, risk assessment and key messages.

Results of all workshops provide inputs to further forward-looking analyses, discussed in the rest of this report.

3.3 Forward-looking assessment - the methodological approach for identification of risks

Forward looking assessment is the method for identification of potential risks for each explorative scenario and for proposal of mitigation measures. A two-step approach is applied. The first stage is a present-to-future view; the second is a future-to-present view (Figure 4).

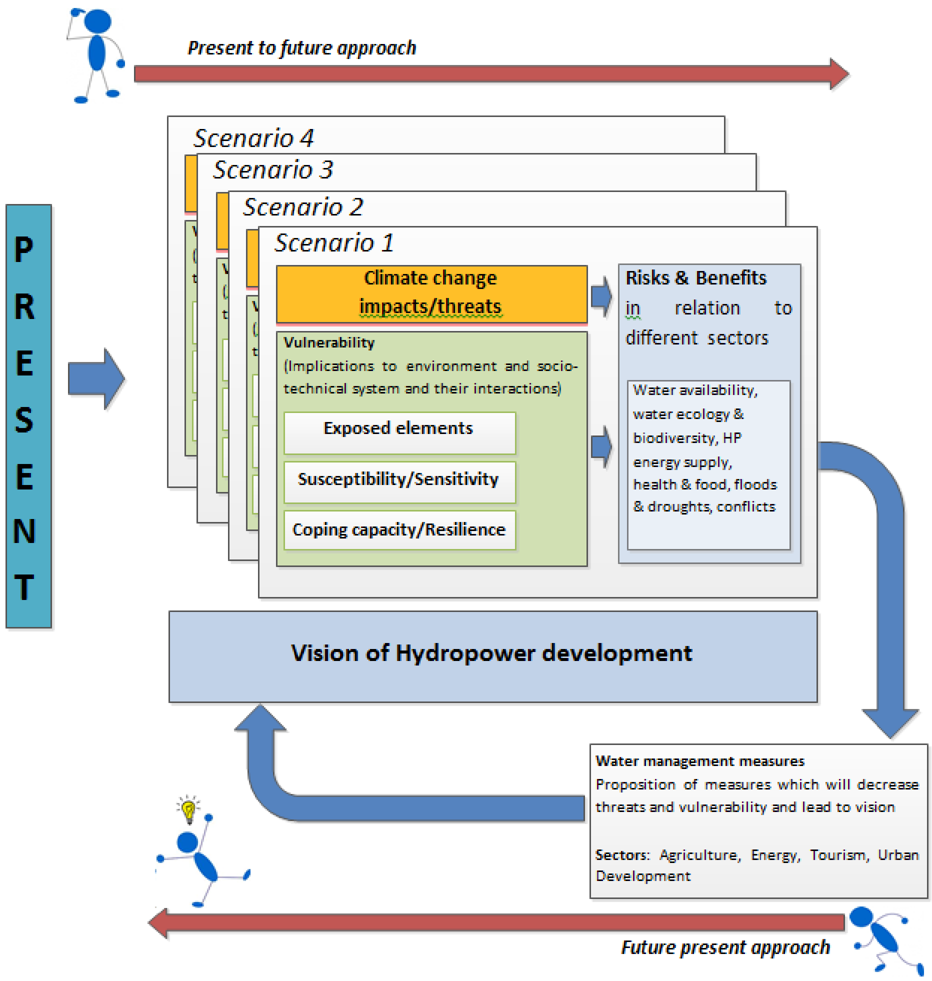

Figure 4: Scheme of two-step approach: present-to-future and future-to-present.

Source: TC Vode, 2013

Present-to-future step

In the first stage we analyse the present state of water resources in the environmental and socio-economic context. Possible futures of water availability are explored and described in four explorative scenarios, with an emphasis on possible development of water uses.

The basis for this phase are the indicators produced in line with the EEA's system of indicators: measure, generally quantitative, that can be used to illustrate and communicate complex phenomena simply, including trends and progress over time (EEA, 2005a). The concept is used with collected data for the Western Balkans, which gives a synthesised overview of factors shaping the future of the region. The results are available in Chapter 4.

Future-to-present step

In the second step we analyse different threats to agriculture, hydropower energy, tourism and urban development which arise from each explorative scenario. The management options for water resources are further proposed. For two regional sub-catchments, the river Vardar in the Former Yugoslav Republic of Macedonia and the river Tara in Montenegro, near-future water availability is estimated using climate and hydrological models.

In the future-to-present step we focus on the desired vision of hydropower development. The risks which might arise and opportunities which can help to achieve the vision might be different depending on scenario, therefore they were described for each of these separately. Developed scenarios are described in Chapter 5, while identified risks and mitigation of these are described in Chapter 6.

4 Overview of the Western Balkans and key factors of development

4.1 Historical and geographic context

The region of Western Balkans in this report and as defined by EU institutions, comprises those southeast European countries that are not members of the EU: Albania, Bosnia and Herzegovina, Croatia[3], Kosovo (under UN resolution 1244/99), the Former Yugoslav Republic of Macedonia, Montenegro and Serbia. Croatia has been an EU member state since 1 July 2013, while also others plan to join the EU in the future.

Box 1: Key information about the general situation in the Western Balkans

Table 1: Statistical data by country

	AL	BA	HR	XK	MK	ME	RS
Area [000 km^2]	>28.7	51.2	56.6	10.9	25.7	13.8	77.5
Population[1] [million]	2.8	3.8	4.3	1.7	2.1	0.6	7.2
GDP (PPP)[2] [billion $]	24.9	31.6	80.3	12.9	22.1	7.3	79.7
GDP/capita (PPP)[4] [$]	8 853	8 133	18 191	7 043	10 718	11 717	10 528

Data source: [1] National statistics agencies; data for 2011; [2 3 4] World Bank; data for 2012 in current USD/EUR.

The Western Balkan countries are newly independent states with developing state institutions. The institutional fragility is often connected to the post-conflict situation and social tensions. Continuing EU international aid remains important in preserving the *status quo*. Nevertheless, the region's economic, social and environmental conditions vary significantly.

The Western Balkan countries experienced rapid economic growth between 1995 and 2008, as well as a steady, though less intense, increase in energy consumption. The energy sector is based on hard fossil fuels as the area is rich in coal and lignite and, given abundant water resources, hydropower.

The water resources per person are almost twice those in neighbouring countries. Due to favourable topography and abundant water resources, the region's hydropower potential is relatively high and mostly unexploited. Hydropower potential per person is by far the highest in Montenegro. In spite of generally rich water resources, karstic and coastal areas of the region are facing water

[3] At the time of writing Croatia was not a member of the EU.

scarcity, particularly in the summer. For the Western Balkans, a 10-30 % fall in annual runoff is projected while the hydropower potential could decrease up to 50 %. Water stress is likely to jeopardize hydropower generation, agricultural production and tourism as well affecting public health.

Western Balkan 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, heavy industry and poor environmental awareness.

In summary, the region is an emerging market with a large population, rich natural resources and numerous opportunities. On-going socio-political processes could, however, lead to abuse, either by other states or foreign investors. It is therefore important that investments are managed by proper institutions and the civil sector, in a smart and sound way

The countries of the Western Balkans are at a turning point in the development of their economies, societies and environment. The region's economies are, however, facing the task of shifting from their industrial past to advanced, post-industrial and service oriented economies. The choices that governments in the region make today concerning these and other pressing questions will influence not only the region's environment in the coming decades, but also that of other European countries (EEA, 2010d).

Figure 5: Regional map of the Western Balkans

Forces shaping the future of the environment in the Western Balkans, in particular in the role of consumption and production patterns, were assessed by the EEA's *Environmental trends and perspectives in the Western Balkans: future production and consumption patterns* (EEA, 2010d).

The brief *West Balkan environmental core set of Indicators* (EEA and Zoi, 2012) assesses the region through selected set of environmental indicators, derived from environmental data collected and compiled by the national authorities as well as the private sector and civil society.

Representatives of governments, international organisations, civil society organisations, research institutions and other experts from the region compiled *Climate change in the West Balkans* (ENVSEC *et al.*, 2012) with the objective of revealing and explaining the links between people and the environment with a focus on climate change.

The physical geography of the Western Balkans is characterised by three distinct and largely different landscapes: mountainous topography of the Dinaric Alps, flat terrain of the Pannonian basin and marine setting of the Adriatic sea. Even though a large part of the region is remote and difficult to access, its strategic geographical position is the basis for the region's historical and geopolitical significance. The Balkans has traditionally been known as a cultural crossroads, where west meets east and still mix their influences. In this sense, it is characterised by many different nations and ethnic groups, often until recently, living without or living outside their own nation states; a complex mix of religions, with major groups of Eastern Orthodox Christians, Roman Catholic Christians, Muslims and Jews; the presence of strong political entities exercising control and influence over the region – traditionally the Ottoman, Habsburg, Venetian and Russian empires, with their respective cultural backgrounds. In the past five hundred years, the Balkans were a political periphery of Europe and the Orient.

Twentieth-century Yugoslavia, which covers large part of today's Western Balkans, was founded on autonomous local resistance against occupation by yet another large power of Germany and its World War II allies. Entering the Cold War as part of Soviet bloc, it soon broke relations with Soviet Union to start its own, non-aligned status with political and economic elements of both blocks. Once again, the strategic geopolitical position between two major alliances enabled Yugoslavia to establish a brief, but influential political union of South Slavic nations. The state comprised all countries as defined in this report as Western Balkans except Albania, plus Slovenia.

However, decades of industrialisation and general welfare were followed by economic hardship in the 1980s. Differences in religion, culture and political ideologies ensued to set ethnic and political groups against each other. With around 140 000 fatalities, the Yugoslav Wars of 1990s disintegrated cultural, economic and institutional ties throughout the region.

What remains after political fragmentation are a number of politically unstable countries that are often non-cooperative with one another. Corruption, bureaucracy and inefficient implementation of law are known problems, which is why polls show low public confidence in politics. Political extremism, usually based on nationalism, is common in region. Economic decline in the future could, therefore, pose new threats for unrest. However, the divisions between government politics and society are typically large in the Western Balkans, and personal as well as cultural connections between people from now-divided-republics can certainly be seen as a great potential of future cooperation.

Unlike single market of the EU, Western Balkans is fragmented and often lack strong infrastructural companies as these were disintegrated in the 1990s. The economies of the region remain fragile, and the underdeveloped middle and small enterprise sector 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[4] (OSCE, 2010). High unemployment[5] reveals both the importance of international aid in preserving the *status quo*, as well as its inability to bring development to post-conflict regions.

This means that Western Balkan markets are open to and in need of foreign investment. However, this are not necessarily transparent, as the governments in the region are still weak. A number of international organisations from southeastern Europe and EU have provided substantial funds to support development programmes in Western Balkans. The region is thus an emerging market with a large population, rich natural resources and numerous opportunities. On-going socio-political processes could, however, lead to abuse, either by other states or foreign investors. It is therefore important that investments are managed by proper institutions and the civil sector, in a smart and sound way.

4.2 Key social factors

Box 2: Key messages on social factors

Demographic trends of the last two decades in the Western Balkans are rather unstable due to consequences of Yugoslav wars. Allowing for considerable regional differences, however, they have settled in recent years and are now more stable than in neighbouring countries which are part of the EU. The largest urban population growth has been observed in Albania, while the urban population in Croatia is falling. If the current demographic trends continue we can expect demographic growth only in Albania and Kosovo (under UNSCR 1244) where the shares of young people are the highest (Figure 5).

Achievements in health, knowledge and standards of living are not significantly lower than in neighbouring countries, although a growing inequality observed in income levels is of concern as are large regional disparities in life satisfaction both between and within countries.

Existing human capital in the region is relatively high but not used for the purpose of raising national economies – the unemployment rate in 2009 in the Western Balkans was twice as high as in the EU-27. Living standards and the low share of research and development funding (World Bank, 2013a) are driving highly educated people to seek employment outside the region (Bonifazi et al., 2015, Privredna komora Srbije, 2015, RTL, 2015).

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[4] Global demand of primary energy is projected to rise between 44 % and 55 % by 2030 compared to 2005. Fossil fuel will make up 84 % of primary energy source at that time (IEA, 2007). Refs has only 2012

[5] Unemployment in 2009 was 24 % in Bosnia-Herzegovina, 32 % in the Former Republic of Macedonia, 4 % in Kosovo (under UNSCR 1244; World Bank, 2013).

The Western Balkans region has a total population of **22.8 million –** equal to 4 % the total population of the EU-27. Demographic trends of the past two decades have been rather unstable with population decline in early 1990s due to emigration from war-torn Bosnia and Herzegovina and Croatia, and, similarly, in the 1999–2000 due to the Kosovo war. Recently, however, they have settled and are currently more stable than in neighbouring countries (

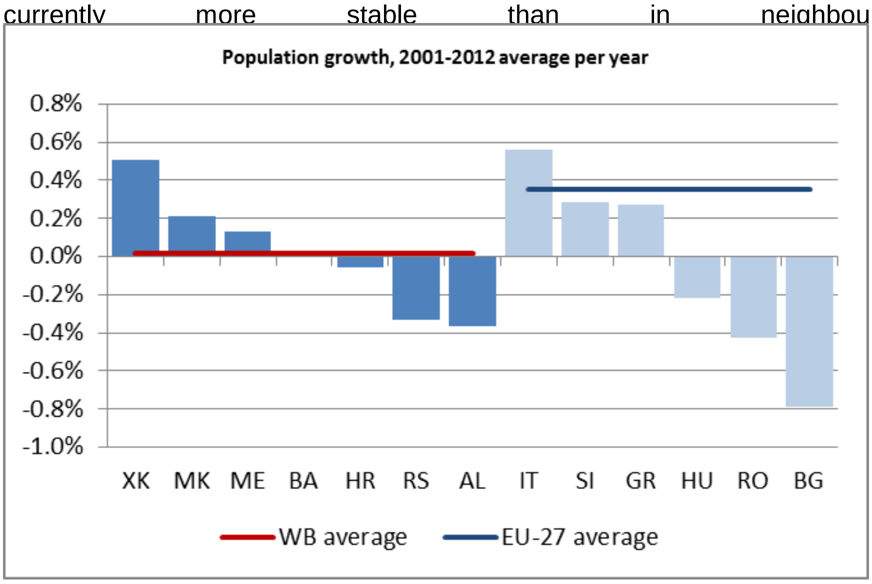


Figure 7:).

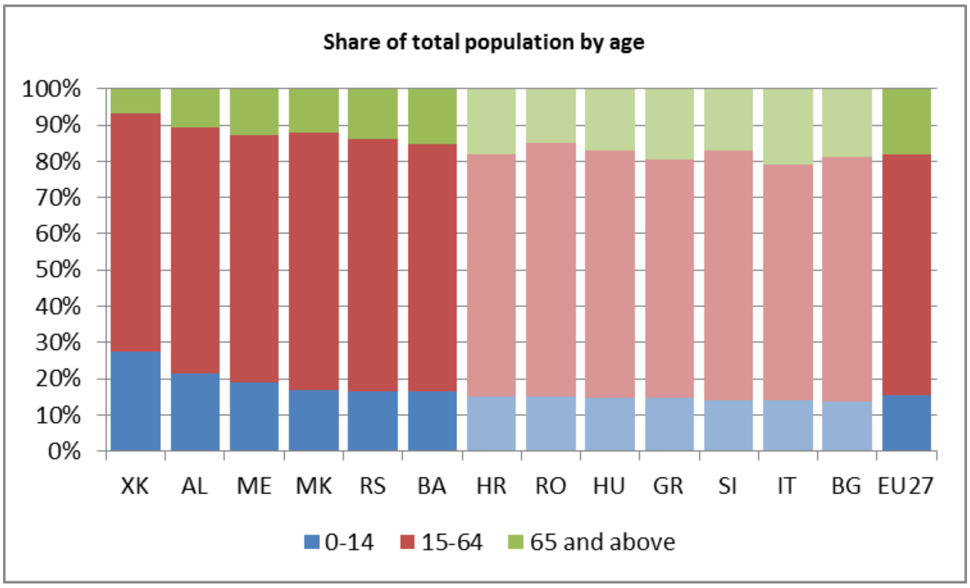


Figure 6: Share of total population by age, 2012.

*Source: World Bank, 2013a. Note: *Data for Kosovo (under UNSCR 1244) for 2010.*

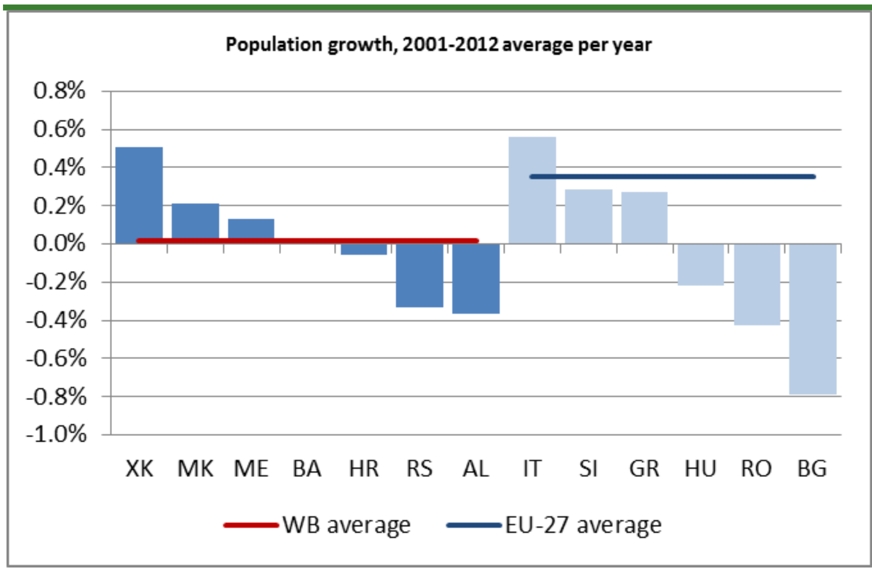


Figure 7: Annual population growth, 2001–2012.
Data source: Share of total population by age in 2012. Data source: World Bank, 2013a. Note: *Data for Kosovo (under UNSCR 1244) for 2008.*

The average **population density** of 83 inhabitants per square kilometre in the Western Balkans is lower than in the EU-27 and neighbouring countries. It is the highest in Kosovo (under UNSCR 1244), where it is more than a third higher than in the EU-27. The average **urban population growth** is almost 0.6 % (2007–2012 average), although there are significant regional differences. The largest share of **young people** is in Kosovo (under UNSCR 1244) and Albania, while Croatia has the lowest share.

The Western Balkans are strongly rural, with the 40 % share of rural population - larger than in the EU-27. However, it is lower than in neighbouring Slovenia and Romania. With 65 %, the highest share of rural population is in Kosovo (under UNSCR 1244), followed by Bosnia and Herzegovina with more than 50 % and Albania with more than 45 % of the population living in rural areas. Montenegro is the most urbanized Western Balkan country, but its rural population share of 35 % is still higher than the EU-27 average. In Albania, 64 % of the population was rural at the beginning of the 1990s, and 58 % in 2001 (World Bank, 2013) and has decreased by further 13 % by 2012. This has resulted in uncontrolled land take and urbanization around big cities.

Human and social development

Average achievements of the Western Balkans in health, knowledge, and standards of living are not significantly lower than in neighbouring countries. Income distribution among individuals, however, is less equal.

Inequality is growing in all countries except Serbia. The largest rise has been recently observed in the Former Yugoslav Republic of Macedonia – from GINI 34.44 in 2000 to 43.56 in 2010. There are also large regional disparities in life satisfaction, even within countries. Therefore, regional policies should play an important role in the future, possibly with financial incentives provided by the EU (Bartlett *et al.*, 2010).

Labour force and education

Given the high educational level of workers in the Western Balkans (World Bank, 2013a) and the low share of research and development funding (World Bank, 2013a), it can be concluded that the existing human capital in the region is not being used for the purpose of raising national economies and living standards.

The highest percentage of the labour force with primary and tertiary education is in Bosnia and Herzegovina, where the level of the highly educated labour force is the same as in the EU-27. On the other hand, research and development expenditures of Bosnia and Herzegovina are the lowest in the region. The highest percentage of labour force with secondary education is in Croatia and Serbia. Not only Bosnia and Herzegovina, but also Croatia, the Former Yugoslav Republic of Macedonia and Serbia have larger shares of a highly educated labour force than Italy, Romania and Slovenia (World Bank, 2013a).

Box 3: Outsourcing of services to the Western Balkans

The Western Balkans has recently proved an attractive setting for outsourced services, due to its well-educated workforce, high literacy levels and lower costs. Customer-care services have been a known example of overseas outsourcing, with India a leading way. Now, Belgrade, Serbia is attracting customer-care companies for European customers as it is geographically closer, located in the same time zone thus eliminating the need for night shifts, and provides a workforce with an array of languages, including English, French, German, Italian and Russian. Online companies such as the Amazon.de direct their customer calls to Belgrade, where German-speaking staff offer help for a much lower price than in Germany. A Unite States based customer-care corporation, Sitel, plans to create 2 000 jobs in Belgrade, this comes at the cost of governmental incentives. Such incentives play an essential role in stimulating the economy of the Western Balkan countries; however they have to negotiate clear conditions in order to avoid unfavourable relations with investors.

Sources:
RTS, 2011
Sitel, 2011.

4.3 Key economic factors

Box 4: Key messages on economic factors

The gross domestic product (GDP) of the Western Balkan is one-fifth of EU-27 per person average, but has more than one third of its purchasing power parity. There was a significant increase of GDP in all sectors, with the largest increase in service sector, but, because of the global economic crises, GDP has stagnated or declined since 2008.

Political and economic transition since the 1990s aims to turn structure of national economies to become more liberal and open to global market. The governments of the Western Balkan countries are introducing principles of the EU legal system, however implementation is slow due to financial limits and cultural differences.

Well-established heavy industry was abandoned in many regions while the remaining infrastructure is nothing more than a relic and a reminder of the industry-based socialist era. Today, the Western Balkans is becoming service-oriented society. In spite of growing service and industrial sectors, agriculture remains an important way of life for a considerable proportion of the population and important contributor to national GDP. Additionally, a notable share of GDP arises from personal remittances – income sent by the diaspora, those working outside the region.

Energy production and consumption are both increasing but are still lower than in the EU-27 and neighbouring countries. Fossil fuels remain the dominant energy source in total energy consumption. Nevertheless, renewable energy, mostly hydropower and biomass, are an important energy sources with big unexploited potential. There are considerable differences in the shares of renewable energy production: from 13 % in the Former Yugoslav Republic of Macedonia to 100 % in Albania.

Electricity in the Western Balkans costs as little as 50 % of that in neighbouring countries and the EU-27 as a whole, providing a significant opportunity for electricity exports.

Although the structure of sectors and trends in the Western Balkans national economies are similar, there are large differences in GDPs per person, which, overall, is only 18 % of that in the EU-27 (World Bank, 2013a, IMF, 2012). In Croatia, the nominal GDP per person is 42 % of the EU-27 average, whereas in Kosovo (under UNSCR 1244) it is just 10 % – reflecting the fact that the largest national economies are Croatia and Serbia while the smallest are Montenegro and Kosovo (under UNSCR 1244). The purchasing power parity of GDP in the Western Balkans averages 35 % of the EU-27, ranging from 62 % in Croatia and 43 % in Montenegro to 22 % in Kosovo (under UNSCR 1244). Overall, GDP growth has been lower than in EU-27 and neighbouring countries, despite a significant increase of GDP in all sectors, and the largest in the service sector, up until 2008 global crisis that that brought economic stagnation or decline.

The **agricultural sector** represents almost 10 % of GDP in the Western Balkans, whereas in EU-27 it is only 1.5 %. The share of **industry**, however, is similar to the EU-27 at around 26% of the GDP share. In nominal terms, the industry and service sectors have increased more than in the EU-27 in 2000 2010, but their share in the overall economy has remained more or less the same (World Bank, 2013a).

Foreign investment in the Western Balkans makes up a significant share of GDP, albeit unevenly distributed, ranging from 4 % and 5 % in Bosnia and Herzegovina, Croatia and the Former Yugoslav Republic of Macedonia, to 23 % in Montenegro. It has, however, fallen sharply overall as a consequence of economic crisis.

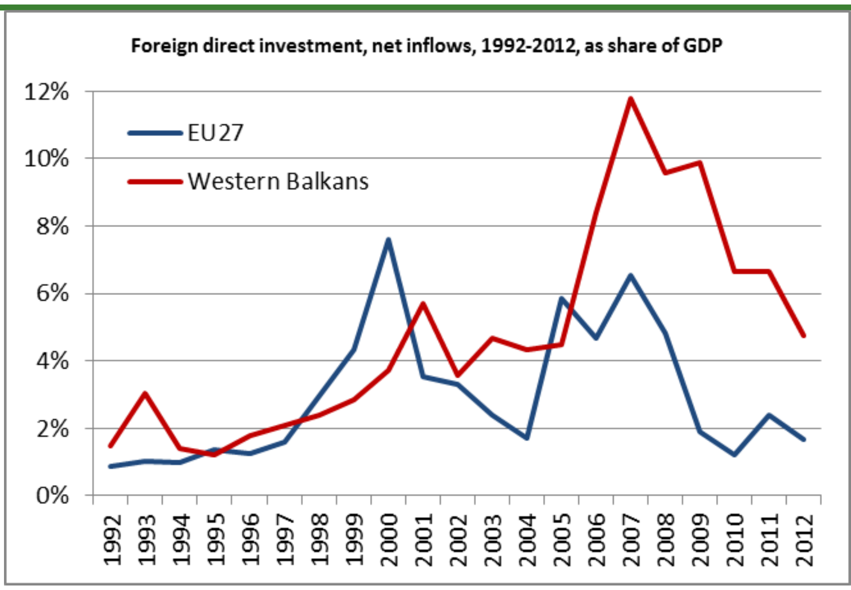


Figure 8: Average foreign direct investment (net flows) by country, 2000–2012 period.
Source: World Bank, 2013a.

Average foreign direct investment in the Western Balkans, as net flows expressed as a share in GDP, for 2000–2012 was twice that of EU-27. On average, foreign investment in the region represented 8 % of GDP. In the last decade Montenegro has attracted almost three times as much foreign direct investment as other Western Balkan countries and even twice as much as Bulgaria and Hungary, whose foreign direct investment for 2003–2013 was 19.5 % of GDP. Investment was the lowest in Bosnia and Herzegovina, but even there higher than EU-27 average, and indeed the share in GDP since 2004 in the Western Balkans is twice the share of investment in GDP in EU-27.

Changes of foreign direct investment sources have been similar across the region in the last decade: the dominant investments by companies from Austria and Germany at the beginning of 2010s have superseded by investments from Russia, the Middle East and Turkey (ISR, 2013). Although foreign investment in the Western Balkans, supported by tax incentives and well-educated workforce, has the potential to decrease unemployment and support economies, it is held back by limited financing systems, lack of financial discipline, political instability, corruption and complicated administrative procedures (ISR, 2013).

Unemployment in the Western Balkans in 2009 was twice as high as in the EU-27. Albania's unemployment was less than 10 % of the working age population, whereas in both Serbia and Montenegro it exceeded 15 %, in Bosnia and Herzegovina almost 25 %. Kosovo (under UNSCR 1244), which also has the highest proportion of rural population and the largest share of the labour force with primary education has the highest unemployment rate in the Western Balkans, at 45 % (World Bank, 2013a).

Personal remittances represent almost 10 % of GDP in the Western Balkans and are a very important source of income in Albania, Bosnia and Herzegovina and Croatia (Figure 9).

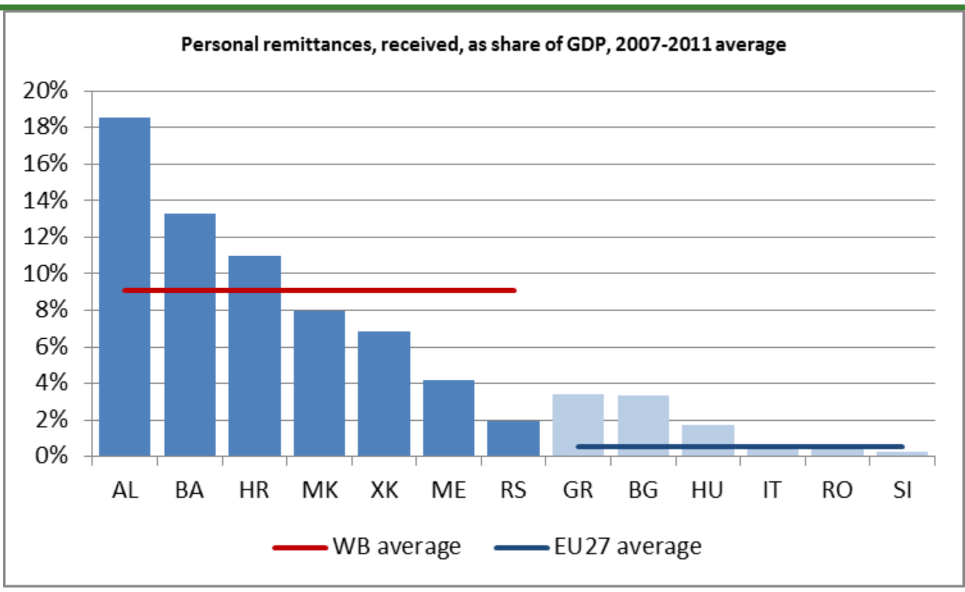


Figure 9: Personal remittances received.
Source: World Bank, 2013a.

Albania has the highest, 18.5 % share of the GDP, along with the second lowest unemployment rate, while Serbia has the lowest at 2 %, which is lower than Bulgaria and Greece but slightly higher than Hungary.

Energy production and consumption

Western Balkan countries produce, as well as consume, less energy than neighbouring countries and the EU-27, in both absolute and per person terms (Figure 10). Energy production has been generally stable but suffered disturbance due to regional socio-economic instability in the 1990s.

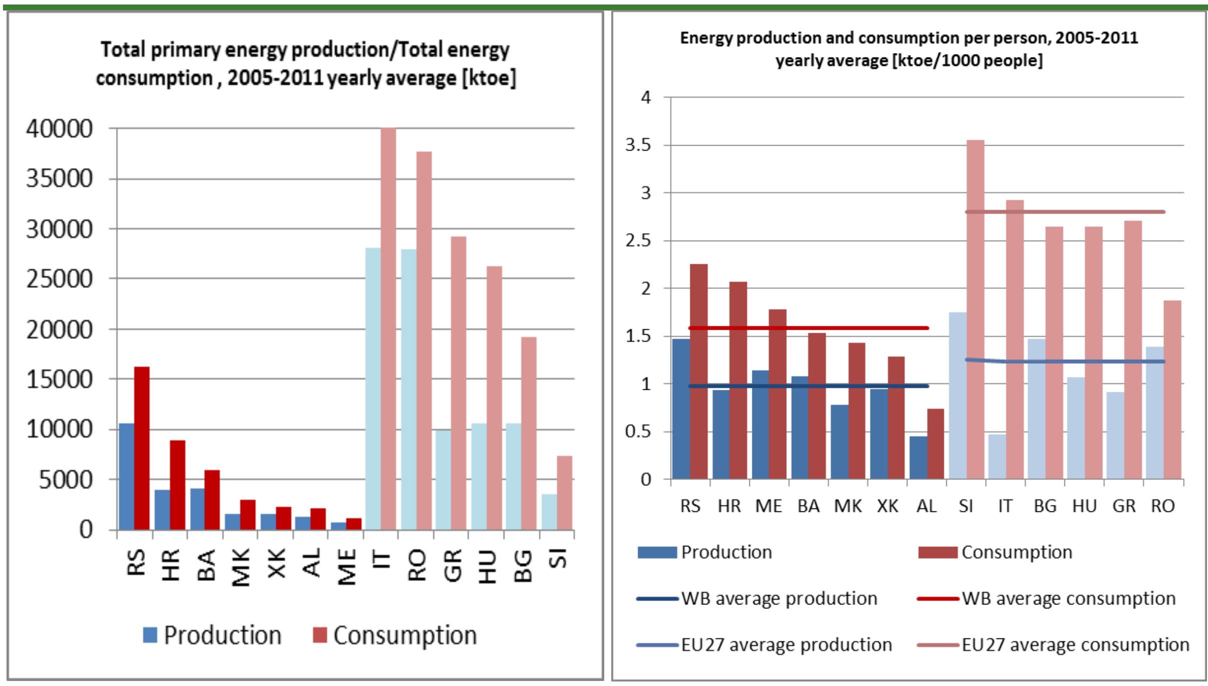


Figure 10: Energy production and consumption in the Western Balkans, compared to neighbouring countries.

Data source: Albania, Bulgaria, Croatia, Greece, Hungary, Italy, the Former Yugoslav Republic of Macedonia, Romania, Slovenia, EU-27: Eurostat, 2012; Bosnia and Herzegovina, Montenegro, Kosovo (under UNSCR 1244), Republic of Serbia: World Bank, 2013a.

The energy independence of the Western Balkan countries is higher than in neighbouring countries and the EU-27; however the demand could change if regional economies develop. Consumption of imported oil fuels is moderately low due to lower transport demand.

Final energy consumption increased by 47 % in 1995–2008, despite a fall of 9 % in 1999. Energy use in industry, which more than doubled, is growing fastest, and reached a total share of almost 35 % of total consumption in 2008, making it the highest consuming sector (EEA, ZOI Environment Network, 2011).

Fossil fuels remain dominant in total energy consumption in the Western Balkans with a share of almost 87 % in 2008, compared to 84 % in 1995. Renewable energy sources, with a share of 11 %, were somewhat higher than the EU-27 average of 7.8 % in 2007, due mainly to abundant hydropower, which is the main source of electricity in Albania and plays an important role in several other countries (**Error! Reference source not found.**).

Electricity production and consumption in the Western Balkans are smaller than the average in neighbouring countries and the EU as a whole, in absolute as well as per person terms, while the electricity consumption and production gap in the Western Balkans is smaller than in EU-27 average. Albania and the Former Yugoslav Republic of Macedonia are the main exports while Bosnia and Herzegovina, Kosovo (under UNSCR 1244) and Serbia are both exporters and importers of electricity depending on the market circumstances and water resource availability. Croatia mainly imports electricity.

Photo 1: Bajina Bašta hydropower plant on Drina river.

Source: Gašper Šubelj, 2012.

The Western Balkans has a higher share of **renewable electricity** compared to the EU-27 (15.6 %) and has already exceeded the EU target of 21 % for 2020. The share of renewable fuels in the region is not increasing, in contrast with EU-27; that is especially the case for new renewable sources – wind, solar power etc.

The Western Balkan countries experienced rapid economic growth between 1995 and 2008, as well as a steady though less intense increase in energy consumption – GDP grew at an annual average rate of 3.17 % and total energy consumption at 1.95 %. As a result, total energy intensity in the region fell at an annual average rate of 2.19 %.

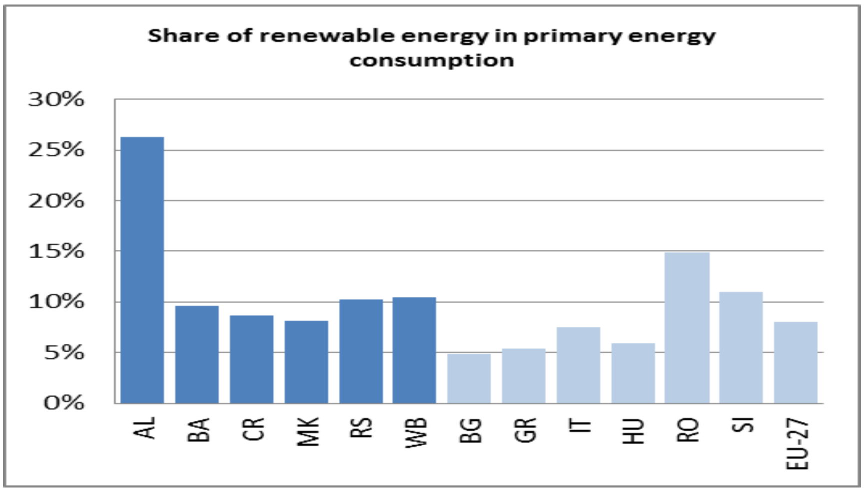


Figure 11: Renewable energy in the Western Balkans, compared to neighbouring countries in 2009.

Source: Albania, Bosnia and Herzegovina, Croatia, the Former Yugoslav Republic of Macedonia, Republic of Serbia: EEA, ZOI Environmental Network, 2011; Bulgaria, Greece, Italy, Hungary, Romania, Slovenia, EU-27: EEA, 2012c.

There are more than 80 large hydropower dams in the Western Balkans. Serbia has the most as a high proportion of technically feasible hydropower potential has been already exploited. Spatial distribution of hydropower dams is shown in Figure 12.

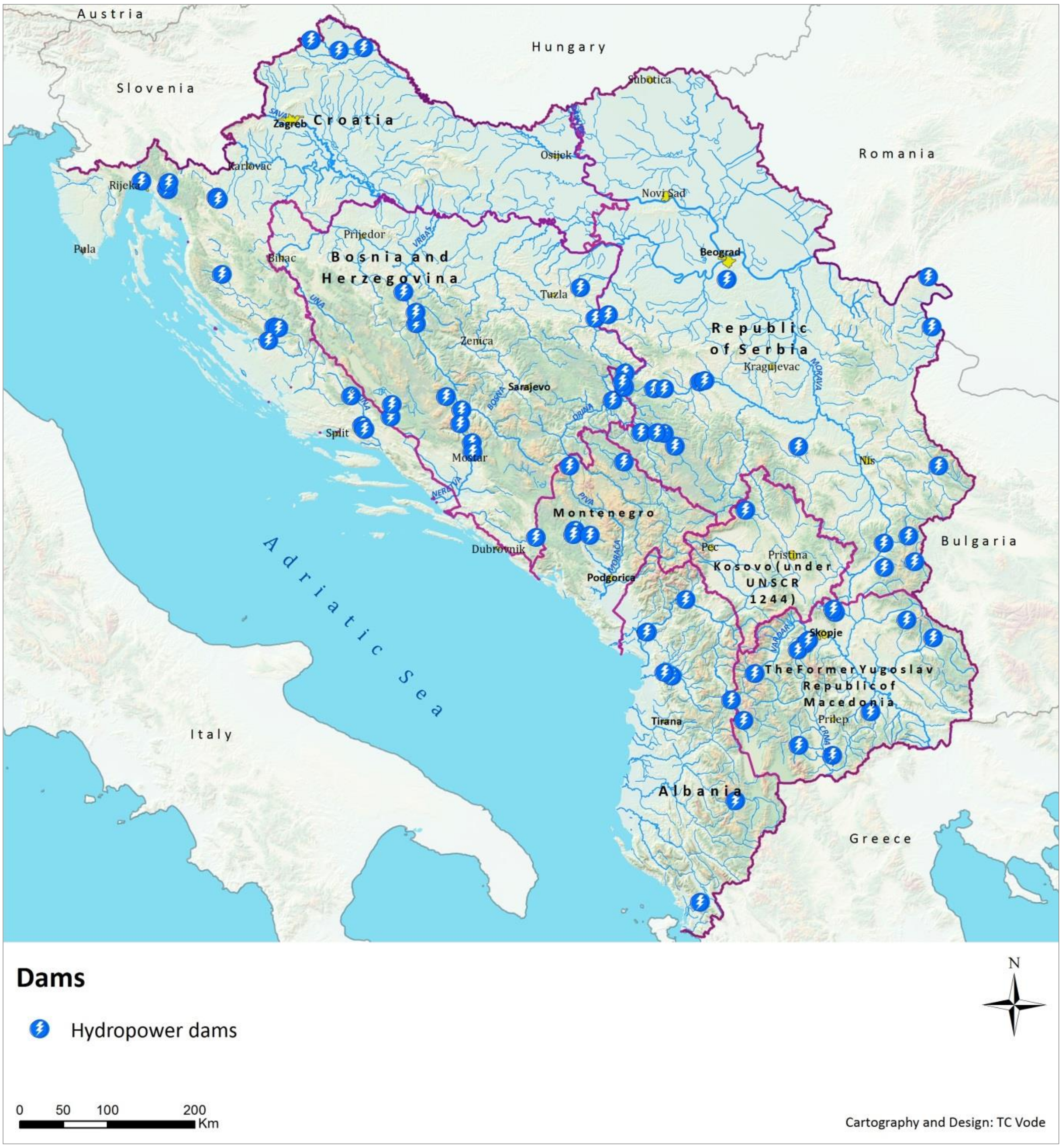


Figure 12: Existing large hydropower dams.

Data sources: ICOLD, 2013, Tanchev et al., 2013; spatially referenced and compiled by TC Vode, 2013..

However, more than 480 new hydropower plants are planned (Fluvius, 2012) **Error! Reference source not found.**), which would significantly impact many rivers. Schwarz (2012) pointed out that the dominant portion of the planned hydropower dams will be located on very high and high conservation value river stretches. As an example, 60 % of all planned dams are located on small rivers with at least good nature conservation value and 17 large new dams are planned on the rivers Mura and Sava in Slovenia and Croatia (Fluvius et al., 2012).

Electricity prices

An average electricity price of 0.07 EUR/kWh in Western Balkans region is less than half the EU-27 average of 0.17 EUR/kWh and almost half that of neighbouring countries, 0.13 EUR/kWh (Figure 13). The variation within Western Balkans is smaller than in neighbouring countries; prices are the highest in Croatia and Albania. Electricity prices are, however, rising in the Western Balkans in common with the neighbouring countries and EU-27 as a whole.

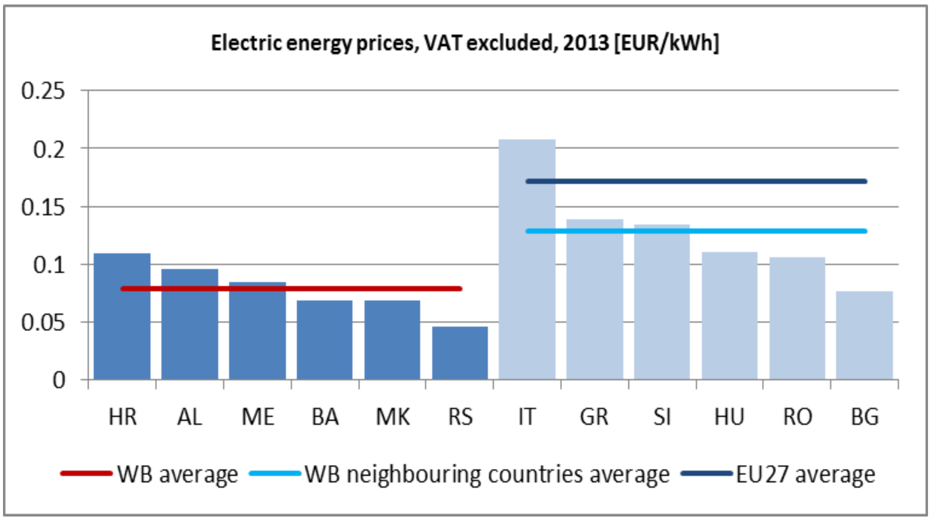


Figure 13: Electric energy prices, VAT excluded.

Sources: Albania, Bosnia and Herzegovina, Kosovo (under UNSCR 1244), the Former Yugoslav Republic of Macedonia, Montenegro, Bulgaria, Greece, Hungary, Italy, Romania, Slovenia: Eurostat, 2013; Republic of Serbia: Tesla sistemi, 2010, Serbia Energy, 2013.

4.4 Key environmental factors

The following section includes description of water resources, hydromorphological alteration; land resources; biodiversity and nature conservation; and climate change in Western Balkans.

Box 5: Key messages on environmental factors

From European perspective, the environmental value of Western Balkans is high. A complex geological and climatic variety of Western Balkan regions, interactions between species, ecosystems and populations have all resulted in large biodiversity, abundant water resources and richness of other natural resources including forest, coal, copper, lead, zinc, and more.

Water resources per person in the Western Balkans are almost twice as abundant as in neighbouring countries, but with considerable differences within the region. With more than 30 000 m^3/year of water per person, Montenegro is one of the most water-rich European countries while Macedonia (the Former Yugoslav Republic) has barely 3 000 m^3/year per person. In spite of the abundant water resources, the availability of sufficient water can be a problem in karstic regions in Croatia, Bosnia and Herzegovina, which lack surface water but have remarkable groundwater resources.

Freshwater quality is in general lower than in EU – concentrations of nitrates and ammonium in the rivers are relatively high due to insuffficient sewage systems, an absence of waste-water treatment plants and relatively low environmental awareness. However, there are more intact rivers in the Western Balkan than in western and central Europe.

Relatively high unemployment, low economic activity, strong rural character, low fertiliser consumption and high levels of personal remittances synergise into relatively low ecological footprints. Urban land take, however, has been intense in recent years and, in many cases, is unplanned, uncontrolled and without investment in infrastructure.

In spite of relatively low share of protected areas (ranging from 6% of the territory in Serbia to 12% in Croatia; EEA, 2011b), the region's biodiversity is rich. Projected future changes in temperature – +1.0–2.5 °C, and precipitation – -20–30 % – for 2021–2050 could jeopardize both biodiversity and agricultural production.

Due to favourable topography and abundant water resources, region's hydropower potential is relatively high and mostly unexploited. Regional differences are important.

The region is now rebuilding their economies and energy demand is rising. Countries are intensively developing their energy sectors, either for domestic use or the export of electricity. The region has rich water resources[6] due to abundant precipitation, favourable topography and a well-developed hydrological network and thus ralying a lot on hydropower.

However, southeastern Europe is predicted to face water stress. As presented in Chapter 5.4, annual runoff in 2030–2040 will be decreased by 20–30 % compared to 1975–1984. Significant drop in annual river runoff has also been simulated with LISFLOOD[7] (EEA, 2009). Decrease in annual runoff of 20–30 % is projected precipitations decreases in southern Europe, but increases in northern Europe. Some projections for 2050 estimate annual runoff to decrease up to 25 % compared to 1990 (Westphal, 2008). Water stress could have grave effects on public health, as well as economic activities. The cultivation of the cereal crops that dominates the current agricultural production will fall in the new climatic conditions, and this is likely to be permanent – or example, winter-crop yields may decrease by 22–50 % by 2050 (UNDP, 2009a).

Water resources

The **water resources per person** in the Western Balkans are almost twice as abundant as in neighbouring countries. Freshwater resources vary in terms of quantity, ranging from as low as 3 000 m^3/person/year in the Former Yugoslav Republic of Macedonia to as high as 18 000 m^3/person/year in Serbia and Montenegro, and with an average of about 12 000 m^3/person/year across the region, which is more than twice the average for the whole of Europe (World Bank, 2003a). Taken as a whole, the

6 Montenegro is one of the countries with the most abundant water resources per person (31 419 m3/year) relative to the EU, which are mostly unexploited.

7 LISFLOOD is a model for simulation of catchment hydrology, described by Van Der Knijff e tal. (http://www.tandfonline.com/doi/abs/10.1080/13658810802549154#.VeQMKZeNPs4)

Western Balkans has relatively abundant freshwater resources, but in many parts of the region water is scarce, particularly in summer months (EEA, 2010).

Share of internal resources in total water resources varies between countries, with Serbia having the smallest share of internal resources and Albania and Bosnia and Herzegovina the highest.

Table 2: The Water exploitation index (WEI)

Country	WEI (%)	Reference Year of Abstraction data	Source of data (used for the calculation of the WEI)
Albania	3.14	2006	Aquastat
Bosnia and Herzegovina	0.87	2011	Eurostat and Aquastat
Croatia	1.16	2009	Eurostat and Aquastat
The Former Yugoslav Republic of Macedonia	13.30	2009	Eurostat
Kosovo (under UNSCR 1244)	n/a	n/a	
Montenegro	0.83	2010	Aquastat and Božović, 2013
Serbia	2.38	2011	Eurostat

Much of the region's water resources are shared, including from the Danube basin and tributaries such as the Sava river. Even though some countries in the region have small internal water resources, most originate within the wider region or neighbouring countries. This high dependency on external sources makes Western countries highly vulnerable and prone to water shortages, and places transboundary river-basin management at the centre of their water policy development.

The Western Balkans has been affected by both droughts and floods. Albania, for example, experiences large variations between normal and drought years. In the Croatian agricultural regions of Slavonia and Baranja, 60 % of the years were dry during the 1990s, while in the same period the Former Yugoslav Republic of Macedonia experienced severe droughts almost every year (World Bank, 2003b). Flood risk in Bosnia and Herzegovina is permanent, with 4 % of the total area and 60 % of the lowland areas being threatened, while much of Croatia is subject to frequent flash floods, groundwater/overspill of water channels in valleys, or flooding of poljes[8] (World Bank, 2003b).

Albania has plentiful water resources, used for urban, industrial and agricultural purposes as well as hydroelectricity generation, but often quality is a problem due to pollution, especially in low-lying areas where most of the population lives and he majority of industrial and agricultural activities take place (EEA, 2010f). The overall renewable water resources in Albania are about 41,700 million m^3/year or 13,300 m^3/person/year, out of which 65 % are generated within the country. The remaining 35 % are external inflows from Serbia, Montenegro and the Former Yugoslave Republic of Macedonia (World Bank, 2003b).

Bosnia and Herzegovina has considerable water resources that represent an important economic opportunity – they include thermal and mineral-rich waters with a high potential in the fields of eco-tourism and health tourism (World Bank, 2003b). The internal renewable water resources are

[8] a large flat plain found in karstic geological regions of the world, with areas usually 5 to 400 km² (Wikipedia, http://en.wikipedia.org/wiki/Polje (accessed 27 Feb. 2015).

35 500 million m^3/year, equivalent to 9,041 m^3/person/year. However, these volumes are unevenly distributed through space and time (EEA, 2010f)

With regards to Bosnia and Herzegovina's surface waters, numerous courses are categorised as international rivers, either because they are boundary rivers, such as Sava, or because they cross borders between Bosnia and Herzegovina and its neighbours. Groundwater is an extremely important resource for water supplies.

The total quantity of water available in **Croatia** is approximately 156 320 million m^3/year, out of which 23 % are internal. There is significant seasonal and annual variability in river runoff, with the annual runoff in the dry years being around 21 % of the average yearly flow, especially in the Adriatic basin. Despite the abundance of groundwater, which represents about 20 % of the total renewable resources, there are quantity problems at key locations such as the Adriatic islands, which constantly experience shortages during the summer. Additionally, water-table declines have been observed in the aquifer below Zagreb and in the Drava River aquifer (World Bank, 2003b).

In **the Former Yugoslav Republic of Macedonia**, the overall water resources amount to 6 400 million m^3/year during a normal year, corresponding to water availability of 3,150 m^3/person/year. During a dry year, however, annual water resources are limited to approximately 75 % of an average year – to 4,800 million m^3/year (World Bank, 2003b). Most of this water comes from rivers, while groundwater, although not a major component of the water balance, is the dominant source for drinking water.

About 98 % of the territory is in international basins shared with neighbours – Serbia, Montenegro, Greece, Albania and Bulgaria – and the water resources are unevenly distributed, leading to water shortages in many regions, such as the Strumica catchment. Water stress is pronounced during the dry years, when about 40 % of demand in unmet (World Bank, 2003b).

Kosovo (under UNSCR 1244) has insufficient water resources to meet the needs of its population and agriculture and what does exist is unequally distributed, This is a limiting factor for the economic and social development of the country which, for example has a large potential for increased irrigation but this could lead to serious lack of water (World Bank, 2003b). It is estimated that Kosovo (under UNSCR 1244) only has available resources of 1 600 m^3/person/ year. Seasonal variations are significant and very low stream flows are observed during the June–July growing season.

With an average outflow of 19.5 billion m^3/year, **Montenegro** ranks among the top 4 % of countries by average outflow. Given that at least 95.3 % of Montenegro's waterways originate in its territory, it is safe to say that water is the country's greatest natural resource. The average water resources availability is 30,425 m^3/person/year which makes Montenegro one of the water-richest countries in Europe (EEA, 2010f).

Serbia waters discharge into the Adriatic, Aegean and Black, Seas. The total outflow is around 178 500 million m^3/year, of which 176 000 million m^3/year, 93 % of the total, flows into the Black Sea, 2 000 million m^3/year into the Adriatic, and around 500 million m^3/year into the Aegean. The total external inflow is about 162 500 million m^3/year, while inland water runoff is around 16 000 million m^3/ year (EEA, 2010f).

The inland water availability of around 1 800 m^3/person/ 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 resources but the poorest in water resources, while high quality water resources are mostly located along the country's perimeter (EEA, 2010f)

Hydropower potential

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 negative impacts of climate change could decrease potential in southeast Europe by 20–50 % especially in the Mediterranean region (UNDP, 2008). The decrease could reach 50 % in Croatia (UNDP, 2008), which would then need major infrastructure investment to ensure energy provision (OSCE, 2010).

The hydropower potential is large compared to neighbouring countries and the EU-27 average, and especially so when assessed on 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 (Figure 14).

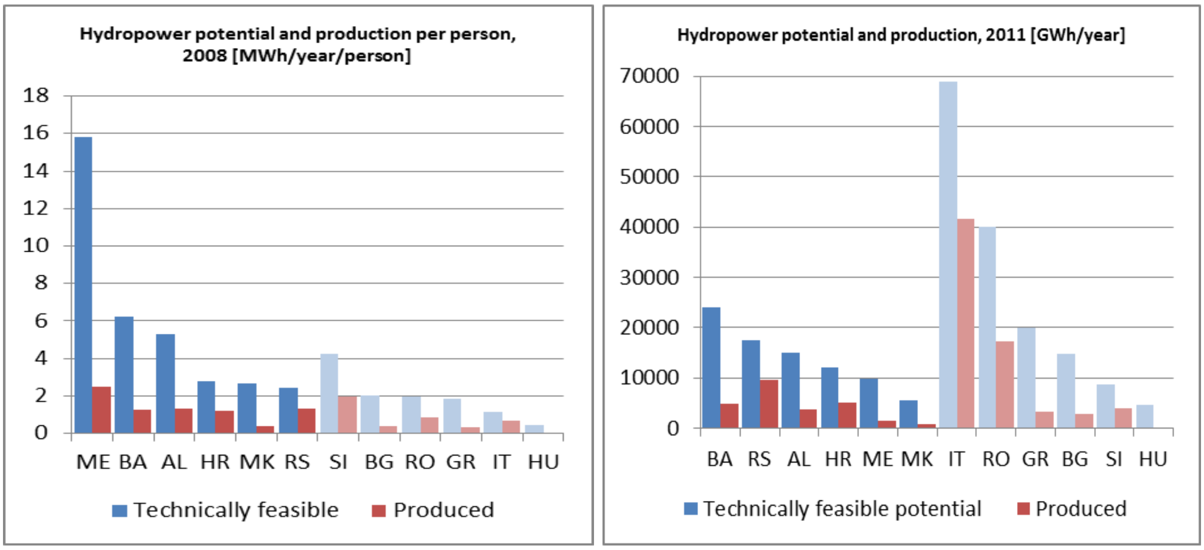


Figure 14: Hydropower potential and production in the Western Balkans, compared to neighbouring countries.

Data source: Technically feasible potential: Aqua Media International, 2008; Production: World Bank, 2013a; Population: Albania, Bulgaria, Croatia, Greece, Hungary, Italy, the Former Yugoslav Republic of Macedonia, Romania, Slovenia, EU-27: Bosnia and Herzegovina, Montenegro, Kosovo (under UNSCR 1244), Republic of Serbia: World Bank, 2013a.

Water Use

Western Balkan countries have larger share of freshwater resources available for public supply and consume larger share than their neighbouring countries (

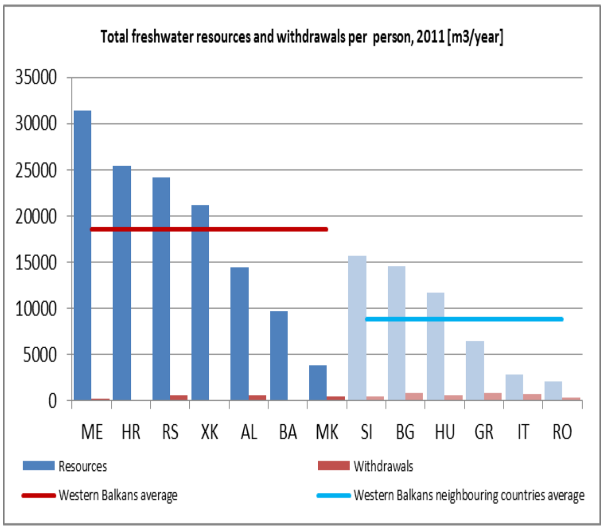
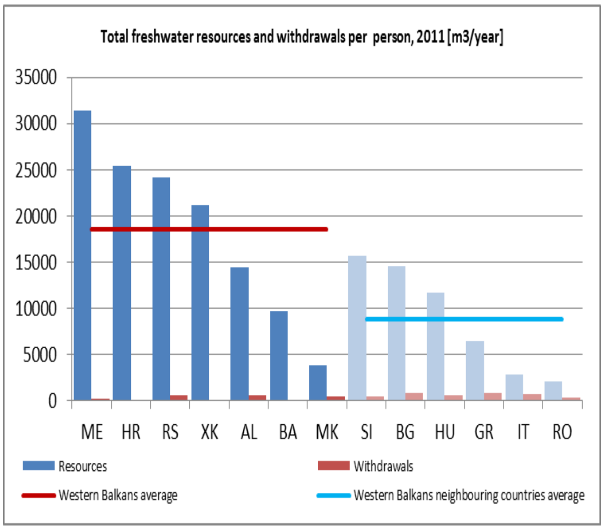


Figure **15**). Manufacturing industry consumes more than two thirds of abstracted water in the Former Yugoslav Republic of Macedonia and Montenegro. Cooling for electricity production consumes 75 % of abstracted freshwater in Republic of Serbia and 54 % in Croatia. Irrigation consumes 58 % of abstracted 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 important irrigation systems are impacted by a modest rainfall.



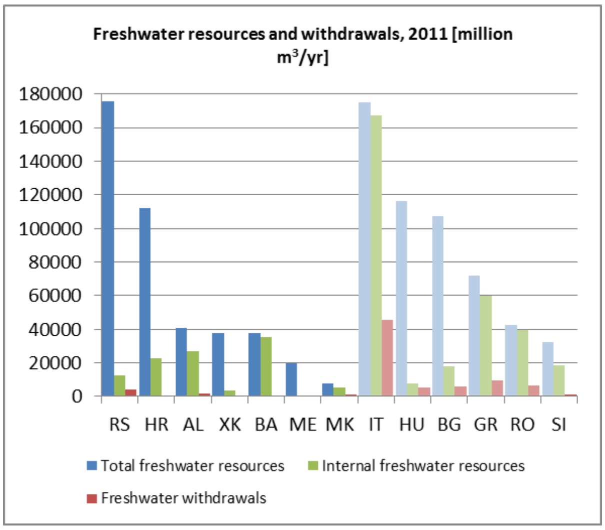


Figure 15: Freshwater resources of the Western Balkans compared to neighbouring countries.

Source: Total freshwater resources: Republic of Serbia, Bulgaria, Greece, Italy, Romania, Slovenia: Eurostat, 2013a; Albania: Hanxhari, 2013; Bosnia and Herzegovina: CIA World Factbook, 2013; Croatia: Švonja, 2013; Kosovo (under UNSCR 1244): KEPA, 2013; the Former Yugoslav Republic of Macedonia: EEA, 2011; Montenegro: Božović, 2013; Internal freshwater resources: Croatia, Republic of Serbia, Italy, Hungary, Bulgaria, Greece, Romania, Slovenia: Eurostat, 2013a; Albania: World Bank, 2013a; Kosovo (under UNSCR 1244): Pllana et al., 2010; Withdrawals: World Bank, 2013a.

The Western Balkans region has a high average **per person water use** of 328 l/day – regional variances, however, are significant – which is higher than in neighbouring countries or EU-27 as a whole. 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.

Institutional, financial and political organisations for water management lack capacity. The involvement 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, 2010).

In **Albania**, surface waters are a major asset for the economy, but subject to very high annual variability: the annual runoff during dry years is about 10 % of that during wet years, while seasonal flows are also irregular with a summer runoff less than 10 %, or even zero, of the corresponding winter average runoff (World Bank, 2003b). Groundwater resources – the estimated renewable groundwater is 1,250 million m^3/year – are a vital source of drinking water for Albania's people, well distributed throughout the country, and exploited by wells and springs. Overall, groundwater supplies 70 % of demand in the main cities. Intensive exploitation of groundwater often creates hydro-dynamic and hydro-chemical disequilibriums that result in a permanent pollution risk to nature and humans alike (EEA, 2010f).

Box 2: Public drinking water fountains in Balkan culture

Public fountains, *česma* in major South Slavic languages as well as Turkish are a landmark in many villages and towns of the Western Balkans, part of the cultural influence inherited from the Ottoman empire, under which water was regarded as an architectural element of private gardens, mosque yards and public squares (Culture Trip, 2014). There have been 600 public fountains in Belgrade in Ottoman period (Elsergany, 2010). Even in modern times, numerous fountains offer a constant flow of drinking water. Public fountains are a distinct evidence of the fact that constantly accessible drinking water is essential for people of the Western Balkans.

Source: Elsergany, R. 2010; Culture Trip, 2014.

The elaboration of water management strategies in **Bosnia and Herzegovina's** has only become an obligation since the introduction of the Water Act in 2006. This includes the assessment of the current state of water management, objectives for water protection, flood protection and sustainable usage of water, priorities for achieving objectives in water management, the provision of the necessary funds for implementing programmes, and relevant deadlines for achieving objectives and identifying the necessary actions (EEA, 2010f).

Water availability in **Croatia** is sufficient, but its spatial and annual distribution is unfavourable, which is more evident in the Adriatic Sea basin district. The negative effects of the lack of availability of sufficient quantities of water, use of water of inadequate quality, and natural disasters are multiple and include the deterioration of human and animal health and biodiversity and economic losses. Croatia applies an integrated water management policy in order to ensure sufficient quantities of water of appropriate quality for current and future needs, taking into account the renewability of sources (EEA, 2010f.

In **the Former Yugoslav Republic of Macedonia**, the main legislation on water resources management is the 1998 Law on Water, and its by-laws, which is currently under revision to harmonise it with the EU's Water Framework Directive amongst others. Knowledge on groundwater resources is limited and needs to be strengthened, water management plans need to be developed through a participatory approach, while measures to balance supply and demand, especially for agriculture, have to be established.

Although **Montenegro** records high levels of precipitation, a large part of its territory does not have enough water because it pours into the karst underground aquifer. Overall, 35 % of the country's territory suffers from a chronic lack of water, caused by inadequate infrastructure, which can only be resolved by means of expensive hydraulic procedures. As a consequence of climatic conditions, the uncontrolled use of water, huge losses in water supply system and inadequate infrastructure, water consumption is double than that in Western Europe. Moreover, there is insufficient provision for drinking water in the coastal region during the tourist season (EEA, 2010f).

In **Serbia**, groundwater resources are important, estimated to meet 90 % of domestic and industrial demand, and 70 % of drinking water needs (World Bank, 2002b). In 2008, a total of 4 000 million m^3 of water was abstracted for people, industry and crafts, agriculture, the energy sector and other commercial users.

Box 3: Irrigation plans in the Neretva delta

Croatian agriculture only uses modest amounts of available freshwater, compared to the region or Europe as a whole. This is one of the reasons the Croatian government has proposed the National Irrigation and Agricultural Land Management Project (NAPNAV), which aims to improve natural resources management and organise a structure for irrigation (Vlada, 2005).

The Neretva river valley and delta is a specific environment of about 12 000 hectares, featuring favourable climatic and soil conditions for agriculture (Hrvatske vode, 2010), out of which 4492.5 hectares are included in NAPNAV (Vlada, 2005). Even though there was little public debate in recent years, the project is large and will importantly affect the lower Neretva region.

The most important part of the project is irrigation of Opuzen locality, which proposes pumping 100,000 m^3 of water from the Neretva to 60 m above sea level. It would be supplemented by a dam 1 800 metres downstream which would block sea water influx and increase the Neretva's water level in summer and other dry seasons.

The quantity of water needed for effective irrigation is 4.6 m^3 per second. Since these are to be taken from Neretva stream, biological minimum flows should be considerd. The positions on what is the biological minimum differ between investors and various experts who warn of possible salinization of arable land.

Another issue is charging of water for irrigation, something that has not been practiced in Croatia in the past, and against which the agricultural sector is appealing. The local news source from Metković in Neretva delta region is critical of public participation in the project proposals. It concludes that the consequences of passive people unwilling to participate in public debate are often the most dangerous for every society (Matijevići i Neretva, 2010).

Sources: *ICID, 2013; Matijevići i Neretva, 2010; Rupčić, 2013; Vlada, 2005/*

Urban wastewater treatment in the region is still in its early stages, but has been slowly increasing since 2001, with the percentage of the population connected rising to 12 % in 2008. However, both the level of treatment and the extent of progress varies across the region (EEA, ZOI Environment Network, 2011).

Freshwater quality

Compared to decreasing nutrient concentrations in European rivers, concentrations in rivers of the Western Balkans are significantly higher. This can be illustrated with values of biological oxygen demand (BOD) and ammonium. The 2011 average ammonium concentration measured on river quality stations of Albania is 2180 micrograms per litre, being significantly higher than the lowest regional averages measured in rivers of Bosnia (50 micrograms per litre). Likewise, BOD concentrations in Albania are high (14.55 miligrams per litre on average), and comparatively low in Croatia (1.75 miligrams per litre on average). These differences once again show large regional differences on freshwater quality topics as well.

Rivers draining land with intensive agriculture, high fertiliser consumption or high population density have the highest **nitrate concentrations**, while **phosphate concentrations** in rivers depends on the efficacy of sewage systems. Mean annual nitrate concentrations are relatively low in the Western Balkans, while mean phosphate annual concentrations are higher than in neighbouring countries.

Hydromorphological alteration of rivers

There are more than 340 hydro accumulations in Western Balkans, mostly for hydro-power production but also for other purposes, of which more than half are lower than 25 m. The highest in Western Balkans is the Mratinje dam, 220 m, on the Piva river, Montenegro, while the highest number of dams is in Albania, with more than 200 dams on more than 160 rivers.

Overall, regions and catchments in the Balkans have retained many more largely intact river landscapes than in western and central Europe. Up to 30 % of large rivers are still near-natural, some even pristine and of very high conservation value and in Albania and Montenegro the figure is more than 60 %, while in Germany only 10 %, in Switzerland 7% and in Austria 6% of rivers are in such high state. Almost 50 % of Balkan rivers are only slightly or moderately altered – in Germany this is the case for only 30 % rivers (Fluvius *et al.*, 2012).

There are 127 hydropower plants with capacity of more than 1 megawatt (MW) operating in Western Balkan countries. In the seven countries, 36 hydropower plants are considered as large dams, having capacity 50 MW or above. About half of the large dams are on rivers flowing towards the Adriatic and the other half are in the Danube River Basin District.

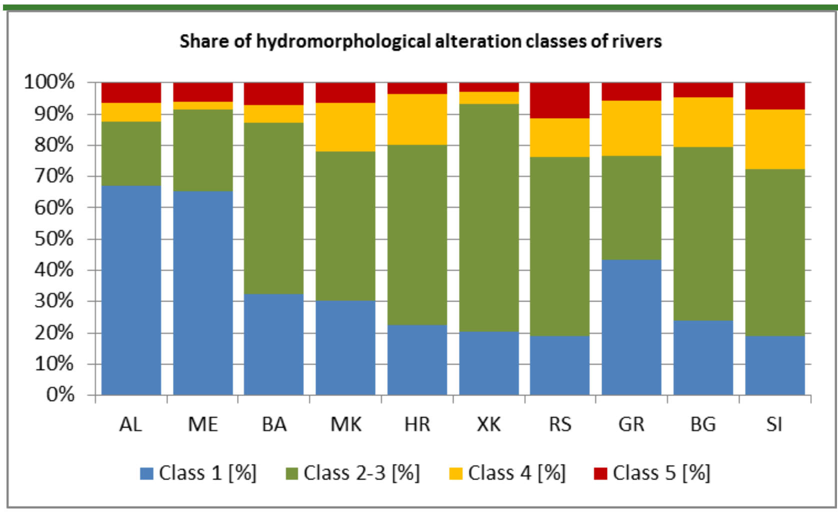


Figure 16: Hydro-morphological alteration of rivers.

Source: Fluvius et al.*, 2012.*

Currently rivers and water courses are still in good hydro-morphological condition, with 82 % of the length of rivers and water courses in near-natural (Class 1) and slightly and moderately modified (Class 2-3) categories (Figure 17).

Figure 17: Map of hydro-morphological alteration classes of rivers.

Source: Fluvius et al.*, 2012*

Flood protection issues in lowland areas

Large areas of the Western Balkan lowlands, especially in the Banat and Bačka regions, are potentially endangered by floods along the Tisza River. Until the middle of 19th century, the Tisza and its tributaries repeatedly inundated some 26 000 km^2 along their courses in the lowlands. A major part of Vojvodina was covered with marshes, swamps and bogs, and was full of mosquitoes, with 2–3 inhabitants/km^2. That was a time when great efforts to drain swamps, protect properties from frequent flooding and prevent water-related diseases were started.

The construction of dykes associated with the river regulation, including those along its tributaries, made reliable agricultural production possible in the Tisza valley, as well as the development of settlements, transportation and public hygiene.

The flood protection system on the Serbian part of the Tisza River is relatively satisfactory. But, under the influence of new structures or works in its basin, design flood characteristics might be changed and reduce the level of flood protection in the region. Any river or floodplain engineering activities on the Tisza or the Moris (Maros) river, particularly those contributing to the unfavourable timing of their coinciding flood waves, would threaten flood protection lines.

Land resources

The average ecological footprint in the Western Balkans, 3.2 global hectares[9] per person (gha/person), is lower than the EU average, 4.75 gha/person, and neighbouring countries, 4.2 gha/person (

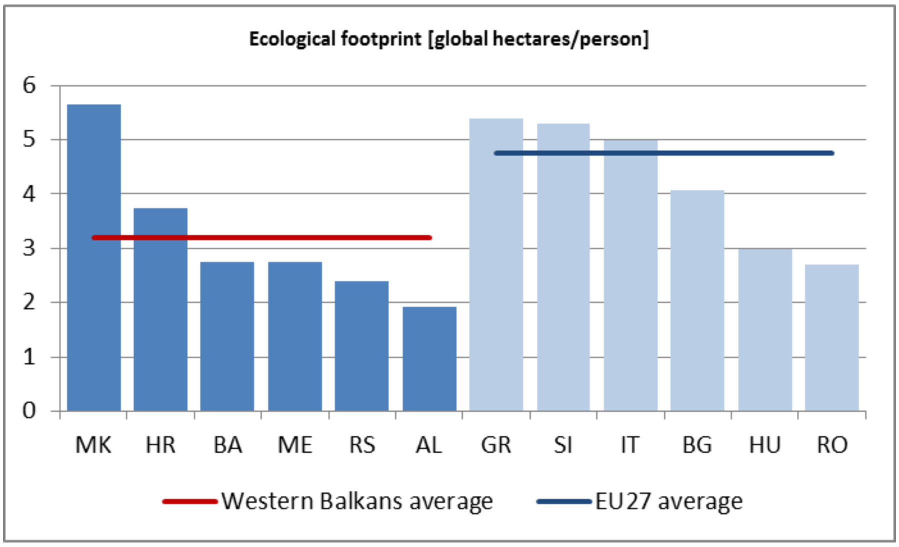


Figure 18). The highest ecological footprint, which exceeds EU-27 average, is that of the Former Yugoslav Republic of Macedonia, 5.7 gha/person. As reported in *The Future of the Mediterranean –*

9 The **global hectare** (gha) is a measurement unit for quantifying both the Ecological Footprint of people or activities as well as the biocapacity of the Earth or its regions. One **global hectare** represents the average productivity of all biologically productive areas (measured in **hectares**) on Earth in a given year.

Tracking Ecological Footprint Trends (Global Footprint Network, 2013), the carbon footprint was the main ecological footprint component, 72 %, followed by the cropland footprint at 15 %. The lowest overall ecological footprint is for Albania where it did not exceed 2 gha/person.

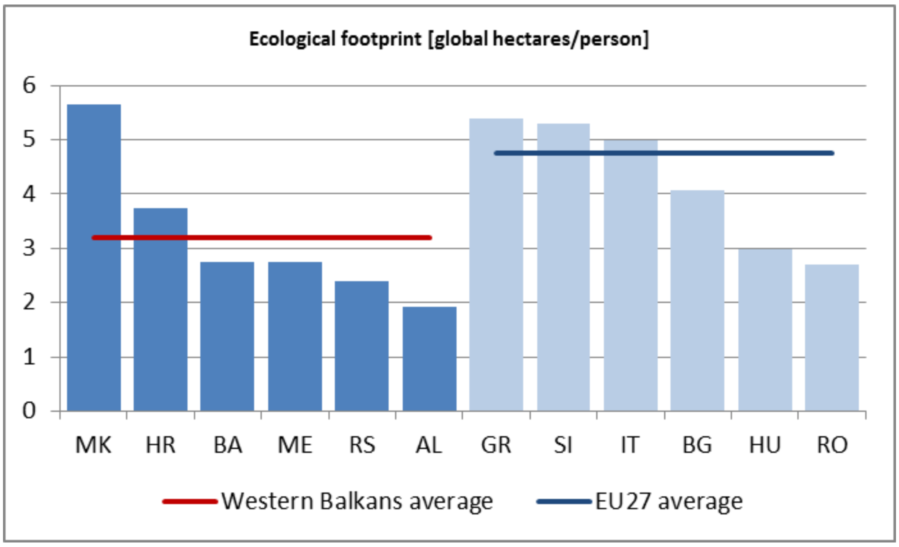


Figure 18: Ecological footprint.
Source: Global Footprint Network, 2010.

Average **fertilizer consumption** in the Western Balkans at 87 kg/ha of arable land is lower than in the EU-27, 144 kg/ha, and neighbouring countries, 132 kg/ha. This indicates a good potential for organic and ecological farming.

Shares of **land cover** are similar to shares in EU-27 (

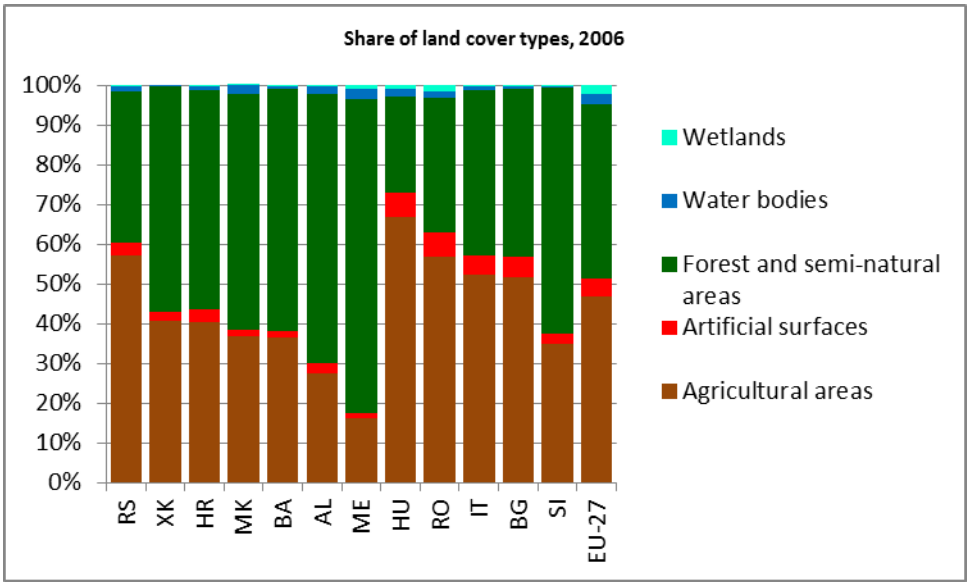


Figure 19), but there are slight differences between the more forested Western Balkans and the more agricultural and urbanised EU-27 countries. Montenegro is, mainly due to unique karst mountainous landscape with high slopes, the most forested with forests and semi natural areas covering 79 % of the region. The country with the highest share of agricultural areas, 57 %, due to intensive farming in the Vojvodina region, is Serbia. Croatia has the highest share of artificial surfaces, 3.1 %, but this does not exceed the EU-27 average of 4.5 %.

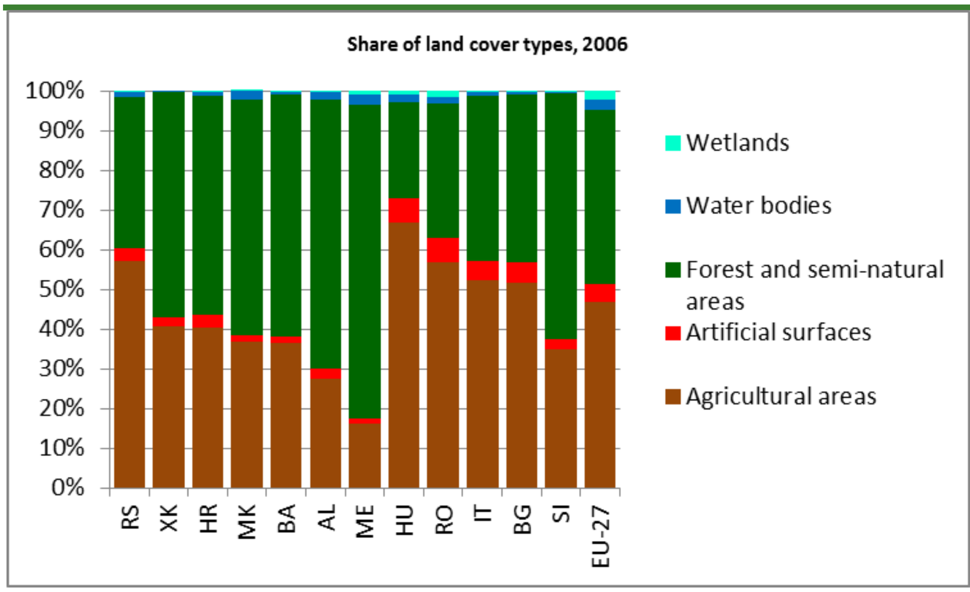


Figure 19: Land resource indicators.

Source: EEA, 2010.

Box 4: Environmental impacts of the Yugoslav Wars

Although the Western Balkans have great environmental potential, the unpredictable socio-economic factors affect the environment and use of its resources in ways which were hardly anticipated from a Western European point of view. The example of the Yugoslav wars' environmental impacts shows that unexpected events pose a greater threat to environment than in more stable societies.

During the Yugoslav wars from 1991 to 1999, human rights and Geneva conventions were violated, including the environmental standards that are also described in these. Land blocked by landmines, physical damage due to aerial bombing and environmental pressures brought about by refugee migration are the most studied environmental consequences.

Land inaccessibility due to landmines

During the wars in Croatia, Bosnia-Herzegovina and Kosovo (under UNSCR 1244), more than 5,000 km^2 were landmined according to first official estimates after the war. By 2012 there were still an estimated 746 km^2 of mine fields in Croatia and 1 263 km^2 in Bosnia-Herzegovina, while Kosovo (under UNSCR 1244) has been largely demined.

Minefields block various environmental resources, including forests, agricultural areas and protected areas of natural beauty and conservation importance. Because demining efforts have prioritised areas around human settlements and arable lands, the largest uncleared minefields are in forests, particularly in the forested Dinaric region of the Western Balkans.

Environment degradation due to aerial bombardment

The large-scale aerial bombardment of an area that is today split between Kosovo (under UNSCR 1244), Montenegro and Serbia took place in 1999. The NATO forces carried out 2 300 aerial attacks and dropped an estimated 22 000–79 000 tonnes of explosives (Edeko, 2011). Seventy-eight industrial and 42 energy-producing plants were destroyed, releasing toxic emissions into the atmosphere and rivers. The raids also caused physical damage to ecosystems, surface streams and groundwater aquifers. The oil-polluted Danube river has spread environmental degradation trans-boundary and the ecosystems of 13 nationally protected areas were hit. NATO explosives also included depleted uranium elements, which are believed to have increases the incidence of cancer and congenital disease among the inhabitants of the areas affected, as well as among the members of the armed forces serving in these areas (Council of Europe, 2001).

Refugee migration

The social crisis brought on by the Yugoslav wars caused massive movements of people within the countries as well as internationally. The regional congestion of refugees in cities or camps put pressure on infrastructure, environmental resources and adaptive capacities of the environment (Council of Europe, 2001).

Sources: Council of Europe, 2001; Edeko, 2011; Grgić., 2008; Miko, et al., *1995; Šubelj, 2013*

Urban land take in the region, 1.25 % annually, between 2000 and 2006 was twice as intense as in 38 European countries (

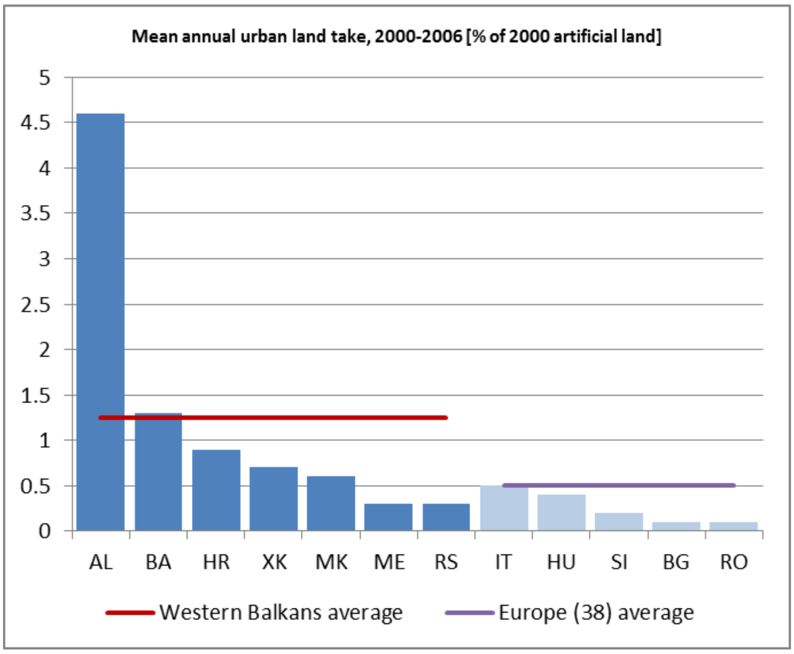


Figure 20), and is most intensive in Albania where the mean annual urban land take is higher than 4.5 %. This is due uncontrolled rural to urban migration, without investment in urban infrastructure, and is most intense in the capital Tirana and its surroundings. All Western Balkan countries except Montenegro and Serbia have mean annual urban land takes higher than the Europe-38, which can be can be explained by the increase of foreign investments, GDP and other socio-economic factors. The intense urbanisation in Bosnia and Herzegovina – 1.3 % mean annual land take between 2000 and 2006 – can be explained by post-war household reconstruction and intense infrastructure renovation.

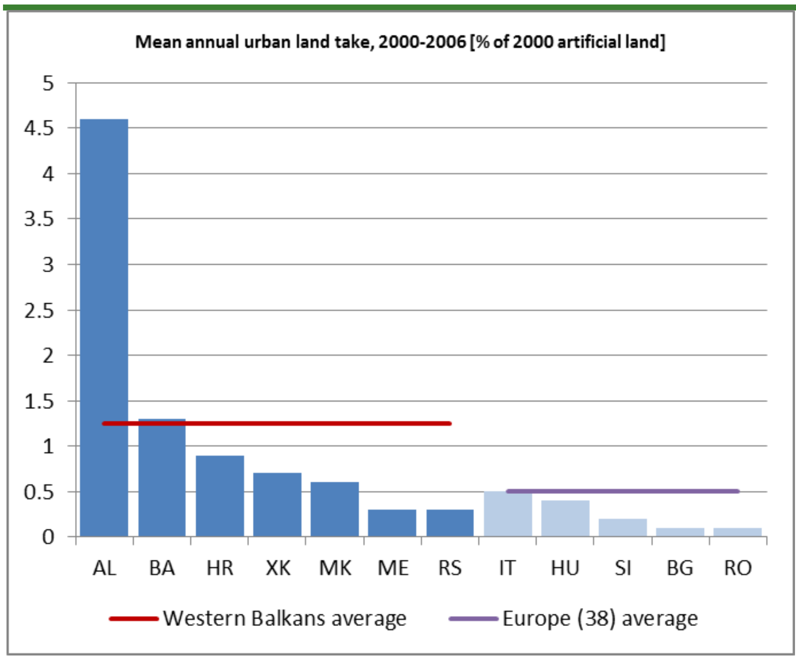


Figure 20: Land take.

Source: EEA, 2013a.

Note: The average is calculated for Western Balkans region and 38 countries in Europe. There is no data available for Greece.

Biodiversity and nature conservation

Even though the biodiversity in the region is extremely rich, the share of land which is designated for protection – national parks, natural reserves, protected landscapes, wilderness areas etc. – is significantly lower than in neighbouring countries. The only two countries in which designated areas exceed 10 % of the land area are Croatia, 12 %, and Kosovo (under UNSCR 1244), 11 %; the country with the lowest share is Bosnia and Herzegovina with 2.17 %. There is an initiative under way to protect a large part of Dinaric Arc, extending over more Western Balkan countries, as a UNESCO World Heritage site.

Box 5: Biodiversity in Western Balkans

The Balkan Peninsula is known for the remarkable richness of plant and animal species that makes it a unique bio-geographical and ecological phenomenon in Europe. Complex geological history, geographical variety of regions, interactions between species, ecosystems and populations have led to this abundance of animals, plants and ecosystems. The region's importance is emphasised not only through the large number of endemic and relict species but especially because of their different ecological characteristics, distribution and origin. It can be safely said that the Balkan Peninsula is unique as a treasure trove of geo-heritage (Savič, 2008).

Ancient lakes

Worldwide, ancient lakes have been a major focal point of biological, geological and ecological research (Albrecht, Wilke, 2009). The Former Yugoslav Republic of Macedonia's Ohrid and Prespa lakes are believed to have been formed more than 3 million years ago, potentially qualifying them as ancient lakes. An assessment of the fauna and flora of Lake Ohrid shows that the it harbours incredible endemic biodiversity – 1 200 native species, including more than 580 animals (Albrecht, Wilke, 2009).

Karst phenomena

A significant share of the Western Balkans is covered with a karst landscape where such specific geo-morphological processes as limestone corrosion and groundwater runoff resulting in a unique landscape with fracturing, caves, sinkholes, underground rivers, absence of surface water streams, karst poljes and other landscape forms (EEA, 2010). A high degree of localised endemism can be found on karst landscapes due at least in part to a diversity of microclimates (Hamilton-Smith, 2001). In spite of many karst areas around the world, Dinaric karst still remains one of the most important karst areas.

Wetlands

Marshy land areas where the soil is saturated with water are crucial incubators of species diversity. Wetlands help filter pollutants and soil runoff from upstream sources and keep rivers, bays and oceans downstream clean. It is well known that wetlands – lakes, swamps, bogs rivers, etc. – are some of the most productive ecosystems on Earth, preserving unique biodiversity (Green Balkans, 2013). Crna mlaka, Lonjsko polje, Kopački rit, Gornje Podunavlje, Obedska bara, Skadar lake, Hutovo blato and Blidnje are important wetlands located in the Western Balkans.

Kopački rit Nature Park was designated as a Wetland of International Importance established under the Ramsar Convention in 1993, because of its great biodiversity. It situated in north-eastern part of the Croatia on confluence of the Danube and Drava rivers. It is an important floodplain that developed due to activities of two rivers. (Park Prirode Kopački Rit, 2013).

Sources:
EEA, 2010f; Green Balkans, 2013; ICPDR, 2013; Kostoski, et al.*, 2010; Mihevc,* et al.*, 2010; Park Pridode Kopački Rit, 2013; Savič, 2008; Wagner and Wilke, 2011; Hamiltion-Smith, 2001.*

The average **wilderness quality index** (WQI) in the Western Balkans is high compared to neighbouring countries and Europe overall (

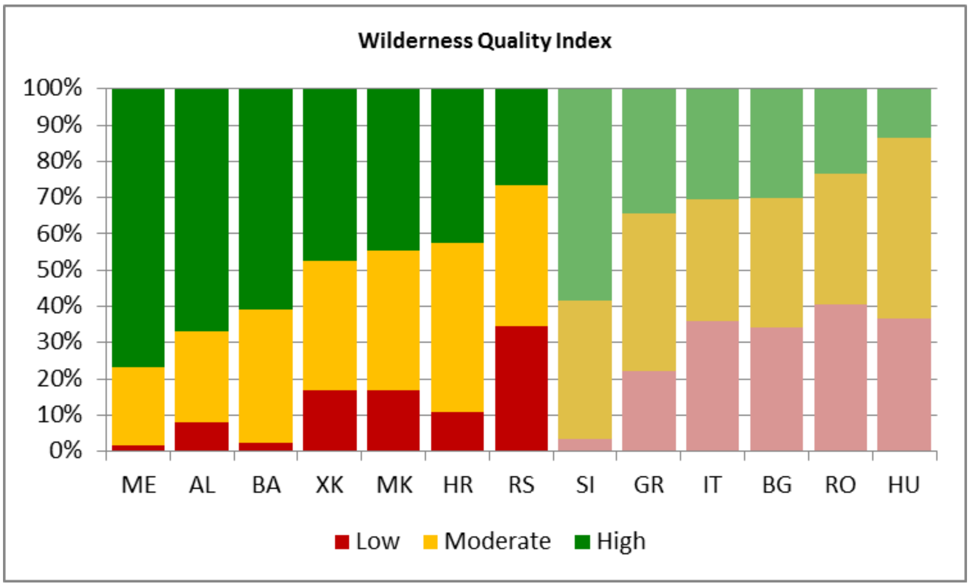


Figure 21), meaning that wilderness areas in the region are largely intact. The WQI is higher in mountainous areas, which is why Montenegro, Albania and Bosnia-Herzegovina have the largest shares of areas with a high WQI. The largest share of low WQI is in Serbia, due to large agricultural areas in lowlands of Vojvodina and central Serbia in the Morava river valley.

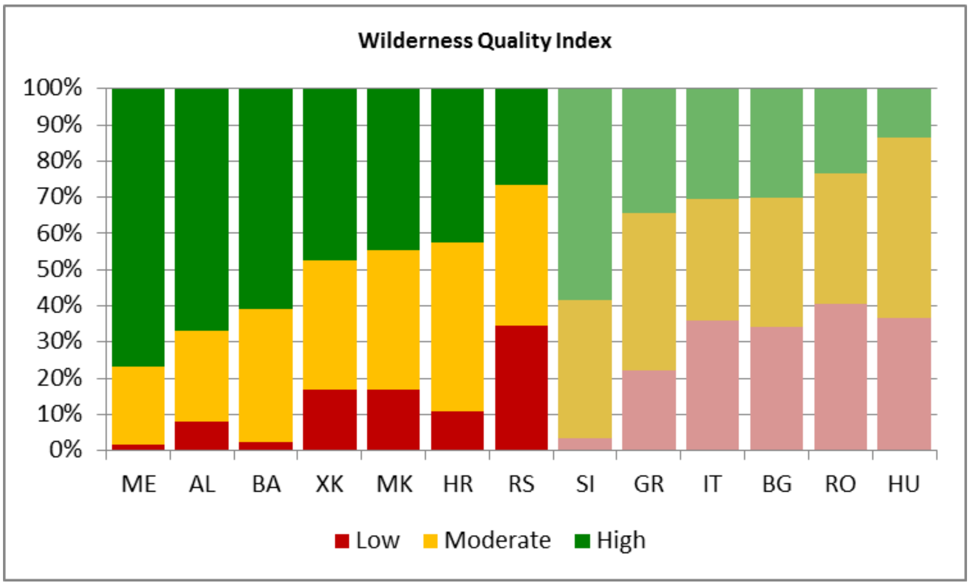


Figure 21: Wilderness quality index.

Source: EEA, 2011 (adopted by TC Vode).

Climate change in the Western Balkans

Climate shocks and the emergence of new pests due to warming could destabilise agriculture, with economic and social consequences: in Serbia, agriculture provides 9 % of GDP (World Bank, 2013a) and jobs for 22 % of the workforce (CIA, 2013) and in Albania 19 % of GDP (World Bank, 2013a) and 48 % of employment (CIA, 2013).

Tourism is another key sector that could be impacted by climate change. In Croatia, it is projected that up to one third of the national workforce will be employed in the tourism sector by 2018[10]. Existing studies expect changes in tourism conditions, from a deterioration in the summer season, to improvements in the spring and autumn (UNDP, 2008). Firthermore, a sea-level rise of 0.5–0.8 m puts a number of coastal regions at risk, with land loss values estimated at 2.7–7.1 billion EUR (UNDP, 2008).

A temperature rise of 2 °C will raise both risks and opportunities in the region. The risks include a decrease in precipitation in southern regions, longer heat waves and changes in agricultural productivity and food security. Natural catastrophes such as forest fires, heat waves and landslides will increase, and all Western Balkan countries are likely to be affected by more frequent floods. An increase in the intensity and frequency of such climatic events are may also causr population movements that could generate friction in politically sensitive regions, such as in Bosnia and Herzegovina and Kosovo (under UNSCR 1244).

According to the ensemble mean of different models from the ENSEMBLES[11] project, the average annual temperature over Europe is likely to continue increasing throughout the 21st century. The largest increases are projected for southern Europe, especially south-eastern Europe for which the models suggest increases in annual mean air temperature of more than 5 °C by the end of 21st century.

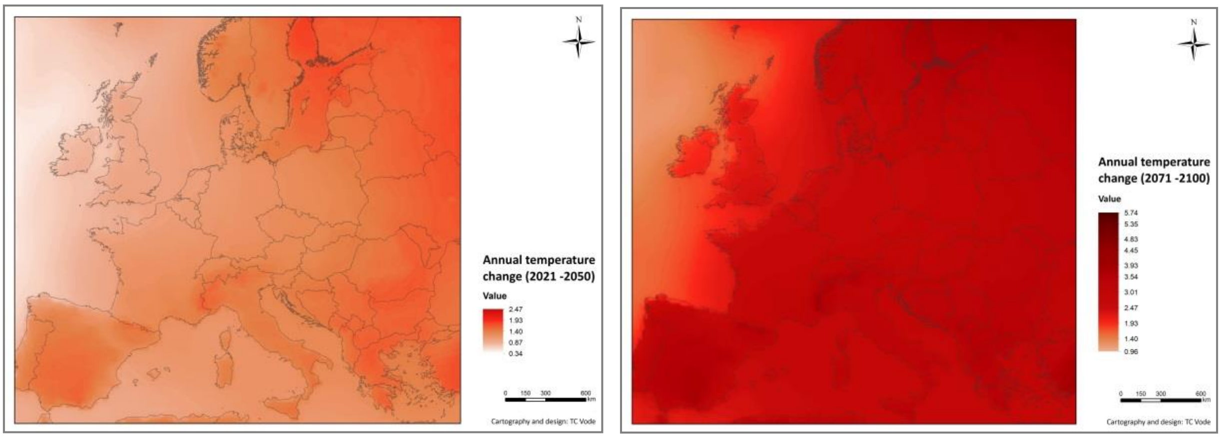


Figure 22: Changes in annual mean air temperature, 2021–2050 (left) and 2071–2100 (right).

Projected precipitation changes in Europe show south-north patterns, with projected decreases in the south and increases in the north (Figure 23). Towards the end of the 21st century, these changes are likely to be more pronounced (EEA, 2012). For the period 2021–2050 the models project the highest decreases in south-western and south-eastern Europe with decreases of more than 20 % (Figure 23,

[10] In 2007, the Croatian tourism sector generated some 20 % of GDP, with a value of 6.7 billion EUR, and provided 336 000 jobs (UNDP, 2008).

[11] ENSEMBLES is the project supported by the EC's 6th Framework Programme, addressing the topic of global change and ecosystems (http://www.ensembles-eu.org/).

left). For the period 2071–2100 projected decreases greater than 30 % are expected in most of the Mediterranean regions (Figure 23, right).

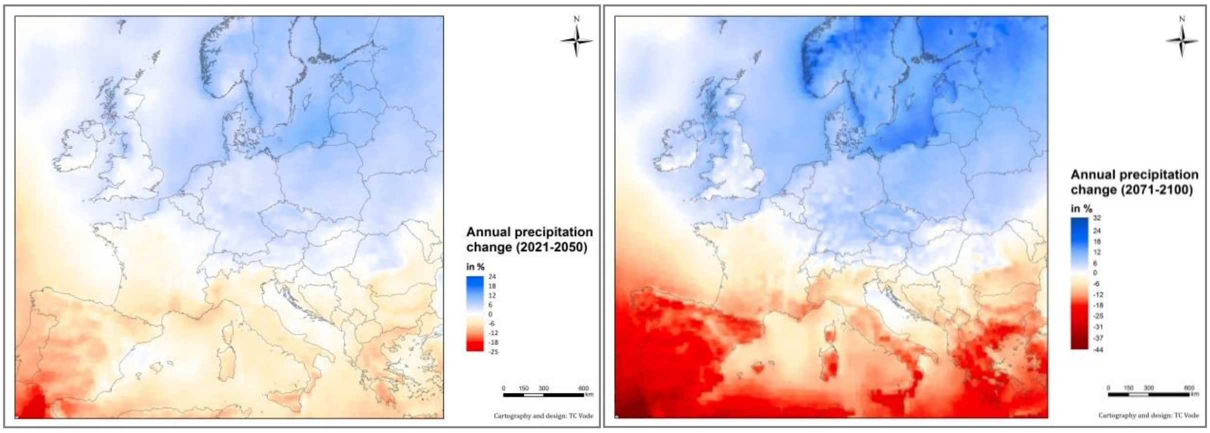


Figure 23: Projected changes in annual precipitation, 2021–2050 (left) and 2071–2100 (right).

4.5 Key political factors

Box 6: Key messages on political factors

Environmental policy, action and laws in the future will most likely be set by politics at all levels: national, regional, EU and global. The Western Balkans has been burdened by ethnic tensions and political instability for the past five centuries. They are connected with historical migrations and unique geographic position between Western and Middle-Eastern political powers that introduced diverse ethnic and religious structures. Though Western Balkan countries have taken important steps towards EU co-operation, many issues of the Yugoslav wars remain unresolved.

Research and development expenditure in the Western Balkans has been rising since 2008, although it remains below the EU-27 average.

Research and development expenditures

Research and development expenditure in the Western Balkans is below the EU-27 average and the negative trend from 2001–2008 has now turned, returning to 1999 levels. Montenegro spends the highest share of GDP, whereas Bosnia and Herzegovina lies far below other Western Balkan countries although it has the largest number of people with tertiary education in the region.

4.6 Key technological factors

Box 7: Key messages on technological factors

Although indicators show abundance of freshwater resources in the region, as well as their use, the energy sector in the Western Balkans is based on hard fossil and hydro-power, while transport relies on oil imports from abroad.

Much of the technology used in the region is out-dated and badly maintained, and thus represents a threat to environment. With implementation of new, sustainable and environmentally sound technology and foreign assistance, these threats could be successfully mitigated.

Upon disintegration of Yugoslavia, successor states have inherited traditional heavy industry, coal mines and strong civil engineering sector. The technology of Yugoslavia has been developing at a fast pace during 1960s and 1970s, supported by branched economic ties with the Western and the Eastern sphere as well as the third world which was providing a big market to consume industrial products.

The region had well-developed metal manufacturing; early electronics; pharmacy; automobile industry; wood processing; power-plant technologies, including nuclear; and military technologies used in industrial production (Rodić, 1986). The economic crisis of the 1980s slowed down technological developments, and completely stopped these in large part of the region during wars of 1990s. Successor states which emerged from these processes were left with little potential to re-use or further develop old technologies.

Today, institutional support for technological transfer is a particular challenge in the Western Balkans, and collaboration between public research organisations and economic stakeholders is typically ad hoc, depending on opportunities and rather short-term objectives (World Bank, 2013b).

5 Scenarios for future water availability in Western Balkans and vision of hydropower development

5.1 Scenarios building

In this section, the main drivers and uncertainties that will most likely play a major role in shaping the future of Western Balkans in the next decades are reviewed. The work is built on analyses carried out in recent and on-going EEA work, including the reports *The pan-european environment: glimpses into an uncertain future* (EEA, 2007) and *Environmental trends and perspectives in the Western Balkans: future production and consumption patterns* (EEA, 2010d). The drivers are described with the STEEP framework.

Table 3: STEEP driving forces framework and Western Balkans key driving forces

Driving forces categories (STEEP framework)	
Social	Regional/global**: immigration, emigrants form other countries coming back** Regional/local: **population change (growth-decline?)** Regional: **migration** Local: **population distribution, aging, household decline, rural-urban migration, unsustainable consumption patterns, consumption patterns (water consumption),** **urbanisation, less farming**
Technological	Global: **technologies acceleration process** Regional: **regional co-operation on technologies** National/local: **technologies for water use in industry, access to eco-efficient technologies and affordability, innovation (in the water sector), using best available technologies** Local: **technologies for accessing water, water treatment, efficient use of water transfer technologies, industrial modernisation, new technologies, investment in technologies, emigrants coming back and investing in technologies**
Economic	Global: **depth repayments (rich pay for poor), global wealth distribution**, **unipolar to multipolar worlds –outsourcing**, **intensified global competition for natural resources.** Regional**: energy dependency** Local**: competition for water and other resources, polluter-pays principle, import-export-domestic energy resources, economic recovery (growth, investment), agricultural production, intensity of agricultural production, inspection, economic diversification**
Environmental	Global: **trans-boundary pollution**, **climate change impacts, severity** Regional: **transboundary water flows management** Regional/local: **environmental water demand**, **distribution and allocation of ground water (quantity and quality)** Local: **land use, quick land-cover change**, **water availability, illegal use of water (no permits), increased water demand due to industrial growth, increased water pollution, industrial pollution of water resources, scarcity of energy sources, climate change, change in precipitation patterns, getting to know better state of the regional/local environment**
Political	Global and EU: global convention about environmental and historic responsibility, influence of legislative framework, organisational set up and functions, role of EU at all levels Regional: existence and strengthening of regional co-operation in general and in water management (incl. transboundary legislation), geopolitical stability in region National/local: weak-strong governance (accountable, fragmented), legal

Driving forces categories (STEEP framework)	
	framework for water management, fragmented legal framework with gaps, weak implementation/enforcement, awareness of water usage and need for planning, safety/security/war, political influence on water competition, price of resources, democratic political prioritization processes, independent prioritization at national level, capacity building, policy decisions take in account environment, spatial planning and documentation, inclusion of international conventions in priorities, strengthening of justice in states

After identifying the main drivers of change, a scenario logic was developed based on the Global Business Network (GBN) deductive scenario building approach (based on Ogilvy and Schwartz, 2004) which uses simple techniques of prioritisation of driving forces and uncertainties to construct a 2 x 2 scenario matrix based on the two most critical uncertainties. According to that approach, a set of key driving forces is identified in the first phase. In the second phase two driving forces, regarded by the participants to be most important and most uncertain in terms of their future development, form the axes of a matrix.

The most important and uncertain driving forces recognised by stakeholders for future water availability in Western Balkans are:

- political will for co-operation (low-high);
- land-use changes (favourable-unfavourable);
- climate change impacts;
- water technology efficiency (low-high);
- sustainability of economic growth;
- regional/national governance (strong-weak);
- geopolitical stability;
- real-resources cost and affordability (availability);
- autonomy in defining priorities;
- recognised need to strengthen local/national capacities.

Climate changes impacts and (un)sustainable economic growth were recognised as the main driving forces due to their significant effect on other driving forces and high level of uncertainty. Regarding the precedent extent, scale and characteristics of two main most uncertain driving forces, four different future scenarios for 2050 were developed (**Error! Reference source not found.** and Figure 25). For each scenario, characteristics are described in the context of the STEEP framework with an emphasis on their influence on changing water resources.

Box 8: Key messages of different scenarios for the period until 2050

Considering the extent of climate change and the sustainability of economic growth, different futures may unfold. As a result, four scenarios were developed:

- The good society – low climate change impacts, high economic sustainability),
- Technogarden – high climate change impacts, high economic sustainability,
- Run to the hills – low climate change impacts, low economic sustainability,
- Downward spiral – high climate change impacts, low economic sustainability.

Through sustainable development, good regional co-operation, implementation of environmentally sound technology, sustainable transboundary water management and other actions, successful adaption to low and even high climate changes becomes feasible. Implementation of strategically planned mitigation measures is indispensable especially in case of high climate change impacts.

If some measures are not implemented, economic and technological breakthroughs might become unattainable resulting in poverty, social tensions, polarisation, migration and environmental problems such as insufficient water quality and quantity, biodiversity loss etc. Those processes would be exaggerated if climate change impacts were high.

Reflecting on the key uncertainties of the extent of climate change impacts and the sustainability of economic growth, four plausible explorative future scenarios were developed for the years up to around 2060.

5.2 Key factors and uncertainties

Climate change impacts, described on the extremes as low and high climate change impacts:

- **Low climate change impacts –** temperature rise is not high and does not have a major impact on ecosystems, the amount and distribution of precipitation and water availability. Probability and intensity of threats and hazards is relatively low.
- **High climate change impacts–** temperature rise is high and has a significant impact on ecosystems, the amount and distribution of precipitation and water availability. Probability and intensity of threats and hazards is relatively high.

The IPCC has developed a series of global emission scenarios – the one that sees the smallest increase in global temperature of 1.8 °C is called B1 that it describes as an integrated world that focuses on sustainability and resource-efficient technologies. Conversely, a market-focused world in which future technologies are based on fossil fuels could cause a temperature rise of 4 °C by the end of this century (EEA, 2010d).

Sustainability of economic growth, described on the extremes as sustainable and unsustainable economic growth:

- **Sustainable economic growth -** high economic growth ensures the sustainability of natural systems and the environment so that needs can be met not only today but also for future generations. High public participation and involvement in strategic planning brings socio-political sustainability.
- **Unsustainable economic growth –** insufficient strategic planning with low public participation and involvement causes low or stagnating economic growth with socio-political instability. Exploitation of natural resources is unsustainable and there is low environmental awareness.

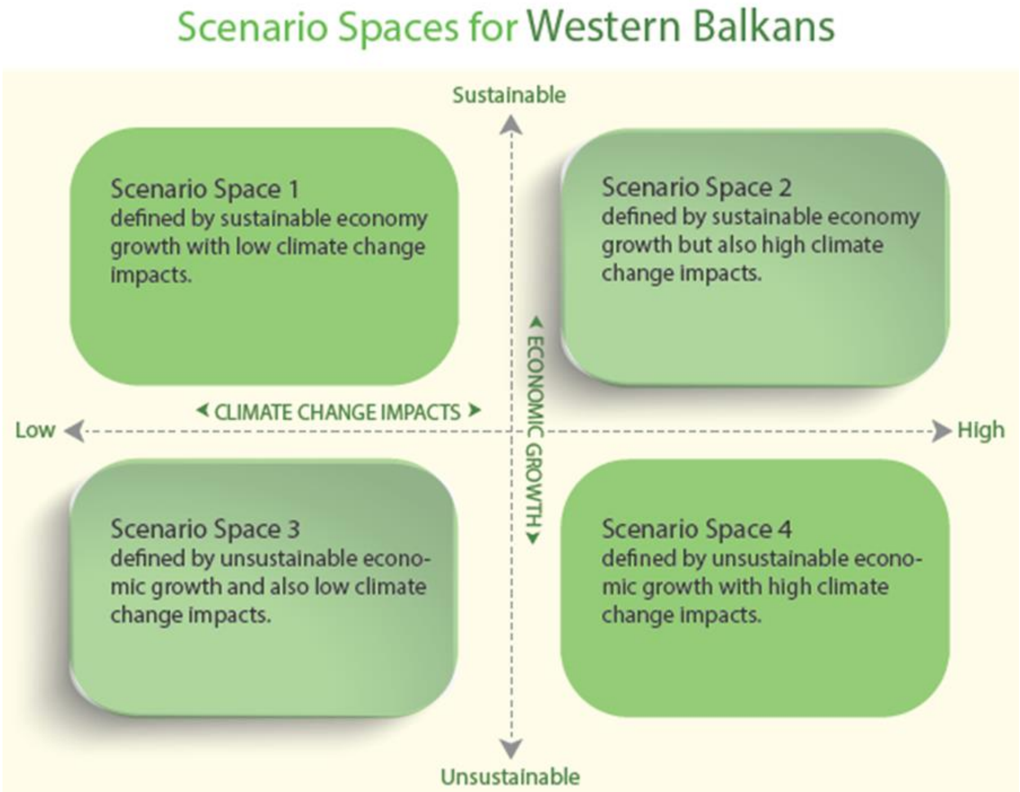


Figure 24: Scenario spaces for the Western Balkans

5.3 Scenarios

The Western Balkans explorative scenarios focus on water availability in 2060 and were developed along the two key uncertainties of economic growth and climate change. These axes result in four scenario spaces (Figure 25).

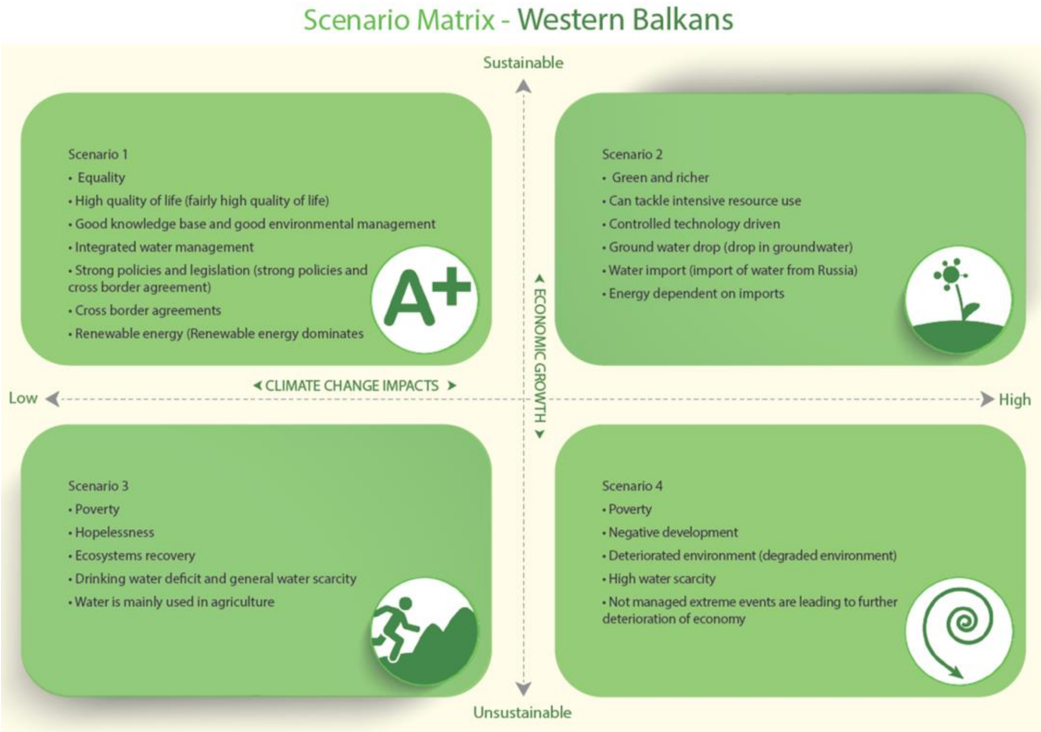


Figure 25: Scenario Matrix – Western Balkans

Scenario 1 – The good society

The good society scenario is the most pleasant one with low climate change impacts and sustainable economic growth.

The good society scenario storyline:

Low climate change impacts and sustainable economic development provide safe, stable and environmentally friendly living conditions in the Western Balkans. Population is increasing, the education system is on high level, GDP is high and so it is level of health care. There is a strong environmental legislation, which positively contributes to generally good environmental awareness. Water resources are being exploited in a sustainable way with an emphasis on good quality water and efficient hydropower energy production. Transboundary co-operation within the Western Balkan is good and successful.

Social conditions – people are migrating to urban areas; farmlands are abandoned especially in mountain areas. Migration within a region is not rare, urban areas, especially coastal ones, are sprawling. Population is increasing especially in Albania and Kosovo (under UNSCR 1244), and the ageing of the population may occur as well. Levels of education are high due to a good educational system. Returning emigrants bring new skills and are contribute positively to economic development and general well-being. Coastal and other scenic areas such as mountains and spas are becoming a new Europe-wide destination for elderly people seeking retirement homes in warmer climates.

Technology conditions – technology is developing fast and becomes a very important driving force in the region. A good and stimulating environment for developing best available technology (BAT) is established. Industry is declining while service-oriented economies are contributing a significant share to GDP. Important opportunities to mitigate climate change impacts encourage the development of new energy technologies. Political and social acceptance of new technologies is closely tied to perceived risks and impacts. New technologies, such as genetically modified organisms, are introduced following the investigation of risks and the precautionary principle adhered to. Acceptance of new technologies is dependent on the public perception of risks and assessed opportunities. New energy and manufacturing technologies are reducing greenhouse gas emissions, regional pollution and the use of natural resources. There is a constant public eye which weights the technological benefits versus estimated potential risks.

Environment conditions – there is no water scarcity due to the low impacts of climate change and sustainable water management, and biodiversity is not endangered. The vulnerability of different habitat types, species and water resources is low due to high adaptive capacities and low susceptibility. Good environmental status is achieved. Due to determination and protection of areas with hehighest environmental and ecological value, hydropower plant no-go areas are declared. The Western Balkans are ecologically diverse with good and sufficient monitoring systems and case-by-case impact studies. The quality of drinking water is not endangered due to sufficient water supply infrastructure, de-industrialisation and the construction of treatment plants. The highest impacts on environment might occur on coastal areas where sprawl of urban areas is the highest due to the development of tourism. The EU requires regular monitoring of environmental condition and inspections to ensure sustainable operating of industrial plants and other facilities.

Economy – all Western Balkan countries are members of EU, with the integration and accession process supporting economic growth and co-operation in the region. Gross domestic product is high but with some regional differences. There is good transboundary economic co-operation within the Western Balkans, and with surrounding countries and European Union. Future global agreements are opening EU markets, as well as those in the Western Balkans, to a higher level of agricultural imports from distant countries such as Australia and those in South America, forcing small farmers out of business and encouraging large agricultural enterprises to integrate more intensive methods such as irrigation.

Hydropower, water use and energy capacity – new dams for hydropower are built in sustainable ways. Due to new introduced technologies, the efficiency of hydropower plants can be improved significantly, lowering energy loses. The share of hydropower increased in all Western Balkan countries but with big regional differences in its share of electricity production. Not all hydropower potential is exploited by 2030. There is strong transboundary co-operation within the Western Balkans on hydropower issues.

Politics – high public participation and involvement in strategic planning is bringing socio-political sustainability. The Western Balkans is part of global politics, which is setting the scene and determining the agreements to tackle major environmental problems, such as climate change and biodiversity loss. There is high motivation for providing international aid. European Union accession involves the introduction of stronger environmental policies and laws as well as harmonising national legislation with the EU's. Sustainability and environment are at the centre of policy making. Strong EU legislation on such issues as household heating and the regulation of car pollution is changing energy systems in the Western Balkans.

Scenario 2 – The Technogarden

Less pleasant than Scenario 1 due to higher climate change impacts which are partly mitigated by sustainable economic growth and adopted strategic measures.

Western Balkans is part of a global world that relies on environmentally sound technology. Basic characteristics of this scenario are a controlled technology drive, a drop in groundwater, the green economy, urban sprawl, the use of renewable resources and water re-use. Research is moving fast, due to a stimulating environment for technological innovations. Reuse and recycling are integrated into all sectors of life. Benefits of new technologies often outweigh their risks. Water shortage is mitigated with high-tech technological measures. Environmental concerns are connected with water availability, biodiversity loss and the introduction of invasive high-temperature-resilient species. Political stability, transboundary collaboration and the integration of EU legislation provide safe and stable living conditions.

Social conditions – social patterns for Scenario 2 are similar to those in Scenario 1. Urban sprawl is causing the abandonment of mountainous and rural areas. Urbanisation of coastal cities is uncertain due to higher temperatures and possible sea-level rise. The level of social and environmental awareness is high due to an efficient education system and consumption is decreasing. Urban areas are densely populated and ultra-efficient. Returned emigrants are bringing new skills and contribute positively to economic, social and environmental development and general well-being.

Technology conditions – technological development is one of the main driving forces in the region. With environmentally-friendly technology, impacts of climate change are successfully mitigated even though the promise of new technologies occasionally outweighs their risks. Research moves fast, nano- and other high-tech technologies have been used to develop low-cost photovoltaic cells and other products that are close to market. The environment for technological development is stimulating and smart technologies have been integrated into all sectors. Genetically modified organisms, which are resilient to higher temperatures, are used in the agriculture sector. Key technological characteristics are high efficiency, low energy losses, reuse and recycling.

Environment conditions –concerns are related to water quantity, the introduction of invasive and higher-temperature resilient species. Urban sprawl and the abandonment of extensive, high-nature-value farms represent a threat to environment. The habitat losses in Africa and Western Europe can affect the populations of migratory birds that pass through the Western Balkans. Climate change presents major threats to ecosystems; reduced water flows have a negative impact on freshwater ecosystems, warmer sea temperatures are allowing new invasive species to prosper into Adriatic and Ionian Sea etc.

Economy conditions – all countries of Western Balkans are members of the EU. The economy is based on transboundary collaboration within Western Balkans, the EU and global markets. Due to high climate change impacts, the economy is developing sustainably and providing resources to address environmental issues respectively. Investment by returning emigrants make a significant contribution to economic development. There is a steady progress towards regional co-operation and economic reforms. Reforms are building trade and investment links between countries as well as common regional infrastructure. Markets in Western Balkans are open to foreign investments but with active public participation and strategic regulations. Heat waves and droughts are reducing yields of some crops.

Hydropower, water use and energy capacity – The quality of drinking water is good due to efficient treatment and modern infrastructure. Climate change impacts did cause water shortages but these are successfully mitigated with efficient technological measures. Everyone has safe access to good-quality drinking water, which is mainly provided by the public sector. Water-supply and sewage systems are modern and efficient. Wastewater is purified through treatment plants. There is an expansion of mostly big but also small hydropower plants. The share of hydropower energy is about 50 % with the remaining energy coming from other, preferably renewable, energy sources.. Most rivers are exploited. Multi-purpose water management is promoted, and there is a strong emphasis on education and public awareness.

Politics – The Western Balkans are politically stable, and there are strong integrated transboundary water agreements between countries. The region is part of global politics that are setting the scene and determining agreements to tackle major environmental problems, such as climate change and biodiversity loss. Environmental ministries, agencies and inspectorates are successfully implementing EU legislation and pursuing effective policies. Legislation, strong control and enforcement are guaranteeing sustainability and successful climate change mitigation and adaption.

Scenario 3 – Run to the hills

Scenario 3 is shaped by unsustainable economic development and low climate change impacts.

Western Balkans cannot make economic and technological breakthroughs and is facing poverty, polarisation, migration, technological stagnation, corruption etc. Unsustainable economic growth does not provide a stimulating environment for economic transition,or technological and educational development – resulting in the migration of young and highly educated people, population decline, high inflation and general public dissatisfaction. In spite of low climate change impacts, problems with the quality and quantity of water persist due to unsustainable water management. Imports exceed exports. The Western Balkans are becoming dependent on foreign investment and aid. Tourism is an important source of GDP, but is causing uncontrolled sprawl of urban areas, especially coastal ones. Repressive control and unsustainable legislation enforcement are causing unstable political conditions and social tensions.

Social conditions – ageing of the population is posing important challenges for government social programmes and finances, with unadjusted pension systems increasing the risk of bankruptcy. Albania and Kosovo (under UNSCR 1244) are the only two parts of the region in which the population is not declining. These problems are only partly tackled by policy reforms such as changing employment, tax and pension policies. The migration of young and highly educated workers to wealthier economies, such as those in Western Europe, is having a negative impact on the Western Balkans economy and social pattern. Social polarisation is causing an unstable social environment and conflicts.

Technology conditions – technological development is stagnating. New technology is not regulated; governments are slow in developing policies and the private sector does not introduce its own codes. European Union technological regulations are introduced into national legislation but insufficiently implemented. Although technological production is stagnating in the region, new, environmentally-friendly technologies are spreading quickly to the Western Balkans and reducing environmental impacts.

Environment conditions – due to unsustainable economic growth which results in pollution and degradation, the vulnerability of ecosystems, habitats and species is relatively high even though climate change impacts are relatively low. Overfishing and invasive species are a threat to marine ecosystems in the Adriatic and Ionian seas. The greatest impacts on the environment occur on coastal areas where urban sprawl is the highest, mainly due to uncontrolled development for tourism.

Economy conditions – poverty remains an important concern and drives people to leave their homes, either moving internally from rural to urban areas, abandoning their land, or leaving the country. Poverty is causing higher demand for fuel wood especially in rural areas and forests are consequently reduced and biodiversity threatened. Due to a lack of government resources, adequate environmental infrastructure, such as a safe drinking water supply, effective solid waste management and sufficient wastewater treatment are not maintained well. There is insufficient co-operation between Western Balkan countries, and as they do not reach peace agreements, the legacies of war, institutional concerns and a lack of engagement by external power such as the EU block progress. Economic development is threatened by a shifting political environment, separatist groups looking for opportunities for liberalisation, high unemployment, dependency on foreign aid and investment as well as internal shocks. Economic transition, with means of developing capacities to adapt and successfully compete in a globalised world, is slow. Privatisation of state-owned enterprises is occurring , with the restructuring of some having negative consequences such as cutting staff and closing plants. There are big differences in economic development within the region.

Hydropower, water use and energy capacity – water use and the energy supply is endangered due to poor water infrastructure and inefficient irrigation techniques. Water is not privatised and is used by all sectors but prioritized for drinking, irrigation and hydropower. Existing hydropower capacity is partly maintained with improved efficiency, new hydropower plants are built as well. Thermal power plants remain an important source of electricity, Use of such renewable energy sources as the sun and wind is slowly increasing as well. Water quality is low due to the insufficient and poor water-supply and sewage systems. The quantity of water is reduced despite low climate change impacts due to the poor efficiency and unsustainability of water infrastructure. Early warning systems are not operational. Insufficient water quality and scarcity are also causing health problems. The prices of water is generally high.

Politics – the Western Balkans are politically unstable. There are weak integrated transboundary water agreements between countries. All countries have joined the EU or are in the accession process. Integration and accession are supporting economic growth and regional cooperation, though the harmonisation of legislation is rather difficult and not always successful, especially regarding strong environmental laws and policies such as the requirements for drinking water and wastewater treatment. Repressive control and insufficient legislation enforcement are causing unsustainability and unpleasant living conditions.

Scenario 4 – Downward spiral

Scenario Downward Spiral is the least pleasant scenario with high climate change impacts and unsustainable economic development.

Poverty, high water scarcity, extreme events such as floods and droughts, bi-polarisation, conflicts, biodiversity loss, political weakness and insecurity are causing unpleasant living conditions which are encouraging inhabitants to migrate and seek better lives outside the Western Balkans – particularly young and highly educated people are migrating to wealthy northern countries. Technological development is depended on foreign investments and guidance. The introduction of renewable energy generation is rather slow and insufficient. Moreover, there is a general shortage of water which is aggravating hydropower development and irrigation systems. Fossil fuels remain the most important source of energy. Reduced water flows have a negative impact on both terrestrial and freshwater ecosystems. Climate change impacts are poorly mitigated. Heavy industry is based on domestic natural resources whose exploitation is unsustainable and is causing additional environmental damage. Many plant and animal species are moving northward and uphill in response to observed climate change. Conflicts and disagreements between West Balkan countries are not rare and connected with the exploitation of natural resources and water management. They are constantly slowing down political effectiveness and economic sustainability as well as creating an unstable socio-economic environment. This is neither attractive for foreign investors nor for encouraging emigrants to return.

Social conditions– the growth of coastal cities is uncertain due to higher temperatures, potential sea-level rise and low adaptive and coping capacities of coastal areas. There is strong societal bi-polarisation between rich and poor which causes conflicts and an unpleasant social environment. Emigration, especially of young and highly educated people, to wealthy northern countries with lower climate change impacts is causing significant population decline. Climate change is also contributing to the burden of diseases and premature deaths. Unpleasant living conditions have a wider effect on society and are causing social tensions.

Technology conditions – technological development is stagnating or even declining. Introduction of new technologies is rare and not regulated. The EU's technological regulations are slowly introduced but rather insufficiently implemented and executed. Technological development is dependent on foreign capital, investment and guidance. Investment in renewable energy sources, technological research and development are low mainly due to a lack of capital.

Environment conditions – impacts on the environment are severe due to high climate change which results in increased probability and intensity of hazards and high vulnerability, mainly a consequence of unsustainable economic development. Water quality and quantity are endangered. Climate change presents the biggest threat to ecosystems; reduced water flows have a negative impact on terrestrial and freshwater ecosystems, warmer sea temperatures allow invasive species to prosper in the Adriatic and Ionian seas etc. Climate change is also causing marine acidification, which affects many marine organisms and alters marine ecosystems and fisheries. Temperatures of lake and river surfaces have increased alongside air temperatures, resulting in marked changes in species composition and functioning of aquatic ecosystems, earlier and larger phytoplankton blooms, and increased nutrient and dissolved organic concentrations. Unsustainable environmental management is only partly mitigating climate change impacts. Many plant and animal species move northward and up hill in response to change, but for many the changes exceeded their ability to adapt or migrate, especially where landscape fragmentation has restricted their movement.

Economy conditions – agriculture remains economically important but is slowly adapting to new environmental conditions. Water scarcity has negative impacts on agriculture, especially on irrigated areas. Economic and political co-operation within the Western Balkans is weak and tense. The service sector is weak but developing slowly. Industrial sector remains important and is based on domestic natural resources the exploitation of which is unsustainable and causes additional environmental damage. There are significant differences in economic development within the region. An unattractive economic, social and political environment deters potential foreign investors. Forestry and wood exports have become an important economic activity, which results in deforestation and land degradation. Deforested areas are partly turned into shrublands and pasture; grazing is becoming an important activity especially in remote rural areas. Coastal tourism is endangered due to high summer temperatures, heat waves, sea-level rise and summer water shortages; on the other hand, mountain tourism is growing.

Hydropower, water use and energy capacity – there is a general shortage of water due to lower precipitation and higher annual temperatures. Higher annual temperatures result in reducing demand for heating but increasing demand for cooling and exacerbating peaks in electricity supplies in the summer. Changed temperatures, rainfall patterns and storms all negatively impact electricity energy generators, whether conventional or renewable, and the availability of cooling water for thermal power generations. Energy efficiency and consumption are low due to old and poorly maintained power plant technology and a lack of capital. Nevertheless, hydropower is still an important energy source and new large hydropower plants are constructed on big rivers where there is still enough water. Thermal power plants remain as an important source of electricity. The quality and quantity of water are low due to insufficient water-supply and sewage systems, biodiversity loss and the impacts of climate change. The price of water is generally high but with big regional differences. Water supply and drainage systems are insufficient, reduced water availability is leading to the disintegration of irrigation systems, lower agriculture production and reduced river transport. River flows have increased in winter and decreased in summer. Knowledge of good water management is poor, which causes a big gap between energy production and research.

Politics – political instability and weak integrated transboundary co-operation are hampering political efficiency. All countries have joined the EU or are in the accession process but are having difficulties with the harmonisation of legislation, especially for environmental laws and policies. Conflicts and disagreements between West Balkan countries over natural resources and water management are constantly slowing down political effectiveness and sustainability. Environmental ministries, agencies and inspectorates are hardly handling climate change impacts; mitigation measures are rather slow and insufficient. Mismanagement and lack of knowledge are causing conflicts between different sectors such as agriculture, energy production and flood prevention.

5.4 Modelling of the impact of two scenarios to future water availability for two local case studies

The case studies of the future outlooks for Morača and Vardar river basins were made to better understand the expected changes for two scenarios on the basin level (see Annex 2). This was implemented by using two climate models for predicting the future rainfall, runoff and temperatures as well as using altered land cover data, based on changes expected in defined scenarios.

Key messages

Climate and hydrological modelling suggest that in 20 years time there will be 12 % less water in the soil than at present and that up to 79 % of the analysed area will be affected by this decrease. Especially in the already drier Vardar catchment area, which together with the Morača catchment area was used in this case study, this decrease could jeopardise agricultural production, irrigation systems, hydropower production, biodiversity, etc.

It is likely that low water availability in rivers and ground water will extend from the current three months (mid-June to mid-September) to four or even five months. Furthermore, it is estimated that annual water availability in the observed catchment areas will be at least 5 % lower in 2040 in the case of the most positive Scenario 1 (The good society) compared to 1975–1984, and 35 % lower if Scenario 4 (Run to the hills) is realised.

5.5 Vision of /hydropower development in Western Balkans

The vision is to increase the **exploitation of natural resources** from the current 40 % to 80 %, without jeopardizing the ecosystem's health, integrity and functioning. Energy production and supply in the region are inter-connected. Good efficiency in energy use is achieved. Gas for energy generation will cross the Western Balkans to Italy and other parts of the EU. The development of **hydropower plants** will be limited, but where new ones are built, or old ones maintained, this will be carried out in sustainable ways, following the recommendations of environmental impact assessments. Sustainable development is achieved through **efficient transboundary management**, collaboration and sharing of knowledge and experience with EU countries. Large hydropower plants located in remote/abandoned areas but still near urban agglomerations are preferable but the construction of small ones, on appropriate water flows that are neither in protected areas nor in places of high natural/ecosystem value, is not excluded. Water management allows **multi-purpose use of the hydropower infrastructure**, and new dams do not interfere with water transport. The development and use of new technologies is advanced, with **improved technologies** linked to renewable energy sources – wind, solar and hydro – are based on both domestic and EU knowledge and experience. Strategic planning is key and investments in hydropower, although based on national human and **financial resources, are mainly regional**.

General well-being is based on improved **equality**, **good education**, **security**, close-to-nature lifestyles, good co-operation, sustainable consumption and overall environmental awareness.

The vision for energy and hydropower is closely connected to other socio-economic regimes. Key societal elements linked to energy and hydropower vision were developed.

Box 9: Selected societal elements linked to energy vision

Well-being – due to good, effective, well-coordinated and co-operative development, national GDPs increase, poverty is reduced, and the quality of local food is good. Sustainable construction of new hydropower plants has a positive effect on water availability and tourism as lakes are used for recreation. General well-being is achieved through good education, security, encouragement of close-to-nature lifestyles, good transboundary and regional co-operation, sustainable consumption and overall environmental awareness. People are happy and healthy, due to efficient technology and good knowledge, sustainable project planning and sufficient management.

Policy and finances – national policies have adopted EU legislation. There is a balance between national and international investment. Laws encourage a good investment environment. Policy enforcement and control are appropriate. . Policy and legislation are implementing sustainable development. Water management allows for the multi-purpose use of the hydropower infrastructure through concessions and contracts for all users. An established framework for trans-boundary collaboration allows the proper management or rivers. Investment based on regional and international human and financial resources. Co-operation between institutions is effective. The economy is circular.

Technology – a good and effective education system, long-term planning, high quality standards, accessibility and affordability of BATs are providing good development of new technologies.

Efficiency in irrigation, energy use, the use of water saving bioclimatic buildings for tourism, and all aspects of water use and distribution is high. Smart technologies have been deployed and desalination capacity is increasing and becoming more and more important as a source of drinking water. Development and use of new technologies connected to wind, solar and hydro energy is based on domestic and EU knowledge and experience.

Water use and land use – in designated areas water use is limited or even forbidden. Water is used for irrigation, new dams allow water transport, and some water is also used by industry. Everyone in the Western Balkans have access to safe water and sanitation services – all water is monitored and priced with equity in pricing is based on users. Cropland is expanding due to irrigation with the share of water used for irrigation consequently increasing. Tourism is growing especially in coastal areas and requires more and more water.

6 Identified risks and mitigation

Framed in the three dimensions used by the OSCE, the following security implications emerge:

Economic and environmental dimension (OSCE, 2010):

- **Economic deterioration:** agriculture is a key sector for employment and income in the region. In addition, many countries depend on hydropower for electricity generation. Tourism, a key emerging sector particularly in the coastal areas of Croatia and Montenegro, will be challenged by sea-level rise, increased climate variability such as heat waves, and more unfavourable conditions in some parts of the year. The combination of these impacts may slow poverty eradication and economic development.
- **Energy insecurity:** energy management is a crucial national security issue for all of the countries concerned. The dilemma is that while resources should go toward finding alternative energies and reduce hydrocarbon dependence, the decrease in precipitation will add additional challenges to a number of countries that already rely heavily on it. Increasingly administrations in the region are looking at nuclear power as alternative solution. In some Balkan countries, for example Serbia, the use of nuclear power is likely to rise significantly by 2030 (WNA, 2014). Climate-induced reduction of electricity supply would provide a further incentive for this.
- **Food insecurity:** change in agricultural yields could have grave consequences for food security in a number of countries, including Albania and the Former Yugoslav Republic of Macedonia. Substituting domestic losses, however, will be difficult as global food availability is also likely to decline and thus food prices likely to increase. As agriculture is also a main economic sector, financial capacities to purchase food will also fall. While climate change may create more favourable conditions in mountainous part of the region, the current economic structures prevent making effective use of it.
- **Population movements:** decreasing economic opportunities plus an increased risks of disasters such as flash floods may provide incentives for migration. The EU could be among

the primary destinations, particularly if travel is facilitated by accession. Migration, however, could also take place within the region, further aggravating the economic situation.

Political-military dimension (OSCE, 2010):

- **Ethno-political tensions:** climate change could cause long-term population movements, because of, for example, decreases in precipitation, and short-term ones because of disasters. Such movements, overlapping with previously unresolved conflicts in Kosovo (under UNSCR 1244) and Bosnia and Herzegovina and other political tensions, could create new conditions for violence.

Human Dimension:

- **Social tensions:** the EU 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 (WBGU, 2007). Member states are already upgrading their frontier controls and are likely to increase these further in the future which could lead to the accumulation of potential migrants on the borders of the EU, including in the Western Balkans, generating new social tensions, and potentially violence. As economic opportunities may falter, any new arrivals may be greeted with increasing hostility.
- **Authoritarian governance:** climate-aggravated economic, food and energy crises could challenge democratic processes and institutions. Authoritarian rule may appear as a more effective way of handling issues related to climate change, as they are less concerned with balancing interests than democracies. Dissatisfaction with democratic governments could thus lead to a backlash. Furthermore, the region's democracies have hardly consolidated after the political crises of the past years.

Climate change dimension:

- Areas to the south and south-west could witness precipitation decreases, droughts, and more frequent hot days. This, in turn, could lead to the disruption of agricultural production. Climate change could also lead to floods causing material damage, human losses, and population movements. These combined factors could amplify existing social tensions and overwhelm areas of institutional weaknesses. Major investment is needed to prepare the Western Balkans for climate change adaptation, and diminish major risks and upheavals.
- A further problem in the region is that governments still view threats in military terms, and are only slowly beginning to pay attention to concepts of human security or integrate new notions such as environmental risks (OSCE, 2010).
- However, the Western Balkans are not considered a climate security hot spot by many studies – its close proximity to the EU, or the potential of many countries to join it, provides the region with additional opportunities to cope with challenges of climate change (OSCE, 2010).

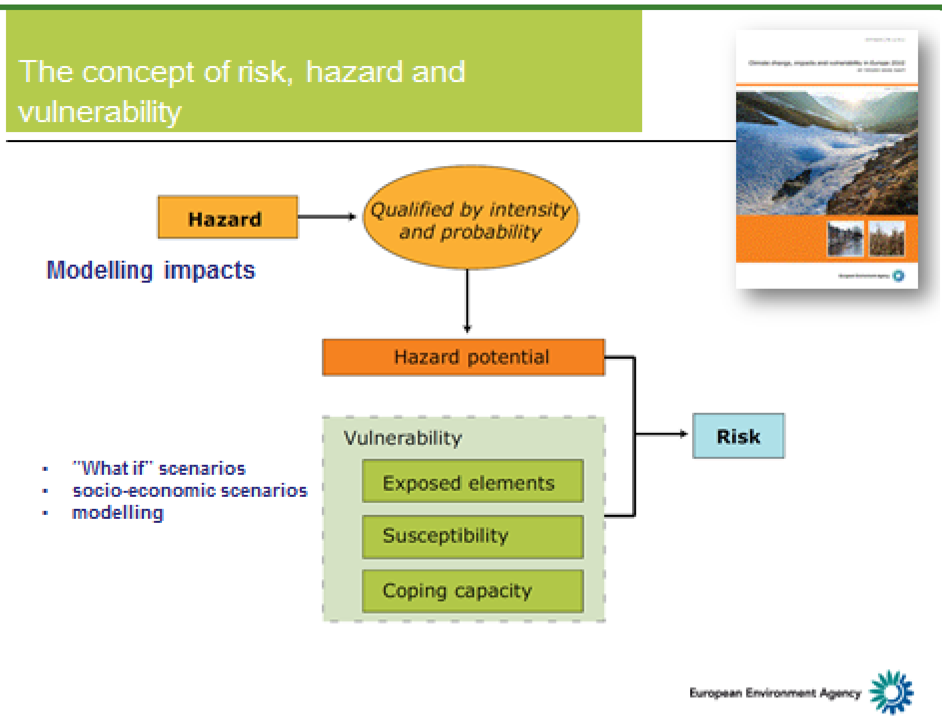


Figure 26: The concept of risk, hazard and vulnerability

The risks identified through scenario descriptions have to be mitigated or avoided – otherwise the vision becomes unattainable. For each scenario, threats, vulnerability and risks were evaluated for agriculture, tourism, energy and urban development sector. The focus was on **water resources** - considering risks and benefits with regard to water availability and hydropower development, management measures are proposed to avoid the unpleasant futures and reach the common vision. Swift implementation of management measures by present policies is recommended. These would reduce impact intensity and probability, as well as vulnerability.

Corruption is a threat to all issues, defined in the vision. International **conflicts** (for example, immigrants from Africa) could cause insufficient transboundary planning and management which might result in pollution, unexploited energy capacities, etc. Bad and unsustainable development could have negative effects on river hydro-morphology. As the vision is largely based on regional agreements, it would be hard to achieve and fulfil if regional conflicts reoccur.

Extreme, even catastrophic, events such as floods and droughts may occur as well. Floods and droughts connected to climate change could also have negative impacts on agriculture. Waterborne diseases such as malaria may occur.

Problems with river-bank stability could occur, due to fluctuations in water levels in the daily **operation of hydropower facilities**. Anthropogenic and natural destruction (earthquakes) of the dams could represent high flood and pollution risks from sediments.

Other risks include a decline in river ecological status and biodiversity; increased tourist development around large reservoirs could cause conflict over water space (landscape) and endanger water availability for energy production, agriculture, industry and the water supply; and increased erosion in catchment areas and rivers downstream of dams.

6.1 Identified risks by scenarios

Good society (Scenario 1):

High energy consumption due to growing economy is causing higher demand for new hydropower plants causing reduction of available water resources. Conflicts between different economic sectors may occur as well. Too high dependency on hydropower can present a risk of electric energy blackouts when there is not enough water in reservoirs. Summer water shortages can affect extension of agricultural growing season and changes in crop productivity, the projected lengthening of the growing season is allowing northward expansion of warm season crops to areas that were not previously suitable. Higher risks of flood and risk events can affect agricultural production. Crop production will decrease.

Techno garden (Scenario 2):

Energy consumption of growing economy is causing demand for construction of new hydropower plants. This can, in addition to longer droughts reduce availability of water for production of electricity. In combination with increasing demand, this can cause an energy deficit and a need for electricity imports. Lower water flows in rivers can cause ecological problems. Water shortage in all seasons can affect agricultural growing season and will change crop productivity. Higher risks of flood and droughts will effect agricultural production. Increasing evapotranspiration is putting pressure on the use of irrigation in drought-prone areas. Food prices are rising. Climate changes can cause substantial consequences where tourism is an important contributor to national GDP (e.g. Croatia). Intense economic development can cause uncontrolled urban sprawl and depopulation of rural areas. Beside heat waves, storms, urban floods and droughts can also threaten urban areas. Growing urban areas can face a higher demand for drinking water, which can result in summer drinking water deficits. Rising temperatures can increase the risk of algal growth in the water supply systems. This can lead to contamination of drinking water. Sea-level rise can cause sea flooding and present a significant risk to coastal cities. Higher mean temperature can increase demand for cooling but lower demand for heating. Climate change will have higher impacts on older, very young and poor people. Tourist infrastructure along the Adriatic coast may be vulnerable to coastal erosion and sea-level rise. Warmer winter temperatures and decreased precipitation can present a significant threat to ski resorts, so winter tourist seasons are becoming shorter.

Run to the hills (Scenario 3):

Unsustainable and insufficiently planned investment in new hydropower projects may prove poor value for money if they end up running at a small fraction of their total capacity. Unsustainable and not strategically planned construction of new hydropower plants can have significant detrimental effects on the water environment (e.g. reduced biodiversity) and can slow down other economic activities in the region. Due to weak management of public water supply and sewer systems, effects on quality of surface and groundwater can be adverse. Energy blackouts may occur due to reduced energy supply from hydropower generation. Higher risks of flood and risk events will effect agricultural production. Inefficient irrigation systems can have negatively effects to water availability and crop production. Extreme weather events and floods can present a moderate threat to traffic infrastructure. Energy transmission networks could suffer and cause additional substantial economic losses in industry. Exacerbation of the urban heat-island effect can lead to increased risk of heat-related mortality and illnesses, especially for chronically sick, very young, socially isolated and elderly people. Heat waves can be especially strong and dangerous in highly urbanised areas without parks and green belts. Beside heat waves, storms, urban floods and droughts can also present a threat to urban areas. Suitability for tourism can decline markedly through the year due to unattractive conditions for tourism and low adaption to climate change. Rising temperatures in the Western Balkan region are likely to cause decreases in summer tourism. However, tourism later and earlier in the season may increase which can extend tourist season and contribute positively to GDP. Warmer winter temperatures, unsustainable infrastructure maintenance, low investments in new tourist facilities and decreased precipitation can present a significant threat to ski resorts and other tourist facilities. Cultural heritage and cultural tourism can be at risk due to unsustainable economic development and high climate impact.

Downward spiral (Scenario 4):

The main threat to hydropower energy production is reduced water availability, which is even more likely due to unsustainable and insufficient water management and poor co-operation on the exploitation of water resources between Western Balkans countries. Droughts can endanger hydropower production as well, causing blackouts when there is not enough water in reservoirs. Unsustainable and insufficiently planned investment in new hydropower projects may prove poor value for money if they end up running at a small fraction of their total capacity. Thermal power plants as major energy source will be under threat due to the increasing scarcity of water for cooling purposes. The declining energy produced by hydropower and thermal power plants, combined with high energy losses can lead to energy imports. This can result in higher electricity prices, which will particularly influence the poorest, rural population. Beside heat waves, storms, urban floods and droughts can present a threat to urban areas. Sea-level rise can cause sea flooding and present a significant risk to coastal cities. Groundwater availability may be at risk due to saline intrusion into aquifers. Public water supply and sewer systems can disrupted due to bad management and frequent extreme weather events. Effects on the quality of surface and groundwater can be consequently adverse. Energy blackouts may occur due to reduced energy supply from hydropower generation. Transport, commerce and economic activities can as well be disrupted. Lack of affordable housing facilities can lead to development of informal settlements on marginal land near cities. Unsustainable economic development may raise social tension, ghettoisation and conflicts, and create unpleasant and unattractive living conditions in urban regions. Water shortages, longer and more frequent droughts and heat waves can have adverse effect on crop yields. Changes in productivity and decreases in yield of wheat, maize, potatoes, and vegetables can be expected. Unsustainable farming practices combined with higher rates of evaporation from topsoil are causing soil degradation. Lower yields will require greater food imports. Rising food prices are likely to hit the poorest people who live in rural areas. The capacity to develop new approaches and mitigate climate change is low among farmers, many of whom have little education. There will be a shortage of water for irrigation; some crops, which are not irrigated, will become more dependent on extra water. Invasive and higher-temperature resilient species are threatening agricultural production. Rising temperatures can cause a decrease in summer tourism. Risk of damage to infrastructure due sea-level rise and coastal erosion along the Adriatic coast is high. Warmer winter temperatures, unsustainable infrastructure maintenance, low investment in new tourist facilities and decreased precipitation can present a significant threat to ski resorts and other tourist facilities. Cultural heritage can be under high risk due to unsustainable economic development, bad and slow renovation and insufficient infrastructure maintenance. Conflicts and social tension are diverting tourists and creating unattractive conditions for further tourist development. Natural hazards can not only discourage tourists but also potentially damage tourist centres and decrease their long-term potential.

6.2 Proposed mitigation measures

Mitigation measures to reduce security implications and reach vision for hydropower development are proposed for all scenarios (Table…). Some measures are relevant for more scenarios and are therefore amongst very important. They are:

- Start cooperation with neighbouring countries to ensure efficiency of energy production and distribution.
- Establish national investment priorities taking into account high vulnerability of existing energy infrastructure to climate change, droughts, heat waves and floods.
- Decentralise and renew existing energy infrastructure.
- Improve maintenance of existing hydropower plants to become environmentally acceptable, otherwise replace them with environmentally friendly energy sources.
- Encourage farmers to adapt to climate change and start growing drought - and high-temperatures resilient crops.
- Establish monitoring and warning systems for floods, fires, diseases, insects and other possible disturbances.
- Build new tourist facilities and infrastructure with minimal environmental footprints (ecologically sound water and waste management, use of solar panels on new buildings).
- Do not concentrate tourist development into coastal areas but rather develop low-impact ecotourism facilities in national parks and mountainous regions.
- Expand tourist season by other tourist activities such as mountaineering, spas, rafting, riding, etc. and develop other sector in most intensive touristic areas.
- Support rural area lifestyle and prevent depopulation of rural areas.
- Monitor water levels and prepare risk maps of drinking water deficits and urban floods.
- Protect coastal urban areas against sea floods with sea-walls and create marshlands as a buffer.
- Avoid informal marginal settlements sprawl and carefully plan new urban facilities and residential neighbourhoods.
- Introduce natural buffers along rivers to mitigate floods, improve water quality and promote reuse and recycle of water in cities.

Table 4: Proposed mitigation measures by scenario and sector

Good society (Scenario 1)	***Techno garden (Scenario 2)***	***Run to the hill (Scenario 3)***	***Downward spiral (Scenario 4)***
Energy			
-Reduce dependency of hydropower -Develop other renewable energy sources (sun, geothermal water, wind).	- Assess if new hydropower development provides long-term benefits and consider reduced water flows when planning new. - Modify existing hydropower plants to improve efficiency considering lower river flows. - Develop, test and implement new environmental friendly technologies. - Keep investigation of climate change and water availability. - Support collaboration of energy, agriculture and water sectors.	- Start cooperation with neighbouring countries to ensure efficiency of energy production and distribution. - Decentralised and renew existing energy infrastructure. - Improve maintenance of existing plants to become environmentally acceptable, otherwise replace them with environmentally friendly energy sources. - Build new infrastructure considering lower water availability and in sustainable way. - Invest in non-hydropower renewable energy sources and ensure energy diversification to avoid blackouts. -Establish national investment priorities taking into account high vulnerability of existing energy infrastructure to climate change, droughts, heat waves and floods.	- Start cooperating with neighbouring countries and develop common strategy for energy sector. - Establish national investment priorities taking into account high vulnerability of existing energy infrastructure to climate change, droughts, heat waves and floods. - Improve maintenance of existing plants to become environmentally acceptable, otherwise replace them with environmentally friendly energy sources. - Initiate projects for energy conservation, improvements of production efficiency and support efficiency of energy use in all sectors. - Decentralise energy sector.
Agriculture			
- Investment into early warning systems	-Improve irrigation efficiency and introduce low-water-demand drip-irrigation techniques. - Switch to less water-intensive crops. -Establish monitoring and warning systems for fires, diseases, insects and other possible disturbances in the agriculture and forestry sectors. -Introduce cooperation between hydro-meteorological and agricultural sectors. -Support research of soil fertility and soil water processes -Integrate remote sensing data and predictions into decision making	- Incorporate measures for adaptation to climate change into agricultural development documents. - Strengthen legislation of food safety and animal health. - Encourage farmers to implement climate change adaptation measures - Give available new technologies of organic and sustainable farming to farmers - improve infrastructure in rural areas - Establish monitoring and warning systems for fires, diseases, insects and other possible disturbances in the agriculture and forestry sectors.	- Incorporate measures for adaptation to climate change into agricultural development documents and immediately start implementing them. - Revise and improve efficiency of existing irrigation systems taking into account low water availability. - In areas where adaption to climate change in agriculture is not economically visible introduce other economic activities. - Remain agricultural production in less impacted areas. - Encourage farmers to adapt to climate change and start growing drought- and high-temperatures-resilient crops. - Avoid depopulation of impacted rural areas, diversify livelihood beyond farming and encourage sustainable rural tourism.
Tourism			
- Develop other sectors in touristic areas. - Mark WB region as a single tourist destination with a unique culture. - Empower collaborate between WB countries in the sector.	- Develop other sectors in touristic areas. - Design buildings with efficient cooling systems. - Build lower-impact ecotourism facilities and infrastructure in national parks and mountainous regions. - Re-assess ski resorts if there is enough snow and re-considering economic efficiency due large climate	- Develop other sectors in touristic areas. - Build new tourist facilities and infrastructure with minimal environmental footprints (ecologically sound water and waste management, use of solar panels on new buildings). - Do not concentrate tourist development to coastal areas but rather build low-impact ecotourism facilities in national parks and mountainous regions.	-Develop other sectors in touristic areas -Build new tourist facilities and infrastructure with minimal environmental footprints (ecologically sound water and waste management, use of solar panels on new buildings.) - Assess coastal tourist destinations at risk of sea-level rise and prepare plan to reduce their vulnerability. - Do not concentrate tourist

	change. - Expand tourist season by other tourist activities such as mountaineering, spas, rafting, riding, etc. - Assess and protect against natural hazards major cultural and other tourist sites.	- Maintain existing ski resorts and construct new if economically efficient and in areas with less climate change impact. - Expand tourist season by other tourist activities such as mountaineering, spas, rafting, riding, etc. - Assess and protect against natural hazards major cultural and other tourist sites.	development to coastal areas but rather build low-impact ecotourism facilities in national parks and mountainous regions. - Assess ski resorts at risk to stay without snow and try to compensate income loss by development of other tourist-friendly activities such as mountaineering, spas, rafting, riding, etc. - Assess and protect against natural hazards major cultural and other tourist sites.
Urban			
-Control urban sprawl. -Support rural area lifestyle and prevent depopulation of rural areas. - Keep controlling risk of damage due to flooding. - Keep controlling risk of drinking water shortages. -Promote and introduce green cities concept, reuse and recycle of water together with urban food production and energy efficiency.	-Control urban sprawl. -Support rural area lifestyle and prevent depopulation of rural areas - Monitor water levels and prepare risk maps of drinking water deficits and urban floods. - Protect coastal urban areas against sea floods with sea-walls and create marshlands as a buffer - Relocate disabled or other vulnerable people from coastal areas if endangered due sea-level rise. - Promote and introduce green cities concept, reuse and recycle of water together with urban food production and energy efficiency.	- Develop heat-health action plans for urban areas affected by heat waves. -Improve climate sensitive disease surveillance, control and sanitation. -Improve efficiency of public transport and make it available to everybody. - Assess and upgrade safety of schools and health facilities. - Avoid informal marginal settlements sprawl and carefully plan new urban facilities and residential neighbourhoods. - Introduce natural buffers along rivers to mitigate floods, improve water quality and promote reuse and recycle of water in cities.	- Support rural area lifestyle and prevent depopulation of rural areas - Monitor water levels and prepare risk maps of drinking water deficits and urban floods. - Protect coastal urban areas against sea floods with sea-walls and create marshlands as a buffer - Develop heat-health action plans for urban areas affected by heat waves -Improve climate sensitive disease surveillance, control and sanitation - Improve efficiency of public transport and make it available to everybody. - Install early warning systems and increase emergency management capacities. - Avoid informal marginal settlements sprawl and carefully plan new urban facilities and residential neighbourhoods. - Assess and upgrade safety of schools and health facilities. - Introduce natural buffers along rivers to mitigate floods, improve water quality and promote reuse and recycle of water in cities.

7 Conclusions

The combined results show that future risks of hydropower development in the Western Balkans depend on socio-economic, environmental and technological factors. Main conclusions are:

1. **Abundant natural resources of the region are at risk of abuse and mismanagement due to the socio-economic instability of the region**. Stability can not be reached instantly but needs a transition process involving political and societal changes, including the strengthening of regional and international co-operation, which would among others provide the sharing of knowledge and experience with EU countries.

2. **In the future, natural resources will change in quality and quantity.** Water resources will still be available, but less abundant. Further management measures will have to be implemented in order to save them from depletion due to climate change. Management of possible future risks associated with hydropower development are to great deal dependent on water management decisions and economic development of the whole region and neighbouring countries.

3. **Future climate change impacts** will most heavily impact agricultural, industrial and transport sectors. Coastal and urban regions will be especially vulnerable and provision of quality drinking water can be at risk.

4. **Hydropower development is big and important natural potential for Western Balkan development.** It is crucial, therefore, to work towards a common vision with hydropower being developed in a sustainable way: strong regional and international co-operation, efficient trans-boundary water management, and collaboration and sharing of knowledge and experience with EU countries. Implementation of the developed vision will be possible but not without trade offs and compromises between different sectors with conflicting interests. The trade offs should be further analysed.
   Hydropower development and the use of new technologies in water use essentially depend on renewable energy – wind, solar and hydro. Existing hydropower plants should be optimised and maintained even when new ones are built. Water management should allow the multi-purpose use of hydropower infrastructure and implement all measures to allow fish passes, water transport and the efficient use of water in all sectors

5. **Environmental and water-use strategies should be developed in close cooperation with other countries in the region and identified common interests.** This can contribute to foreign policies to make the region stronger against international partners who are interested in exploiting 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, preserving biodiversity, ensuring a high level of water quality for society, coping with climate change impacts and poverty.

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Annex 1: Two case studies for modelling of water quantity for two Balkan scenarios: the Former Yugoslav Republic of Macedonia - Vardar river catchment and Montenegro - Morača river catchment

Key messages

Climate and hydrological modelling suggest that in 20 years time there will be 12 % less water in the soil than at present and that up to 79 % of the analysed area will be affected by this decrease. Especially in the already drier Vardar catchment area, which together with the Morača catchment area was used in this case study, this decrease could jeopardise agricultural production, irrigation systems, hydropower production, biodiversity, etc.

It is likely that low water availability in rivers and ground water will extend from the current three months (mid-June to mid-September) to four or even five months. Furthermore, it is estimated that annual water availability in the observed catchment areas will be at least 5 % lower in 2040 in the case of the most positive Scenario 1 (The good society) compared to 1975–1984, and 35 % lower if Scenario 4 (Run to the hills) is realised.

Introduction to modelling analysis

In this report, four plausible explorative scenarios focusing on water availability are described. Transformation of otherwise narrative scenarios into quantitative data can provide valuable parameters that can be used as inputs in climate and hydrological modelling. An assessment of future water availability considering plausible future scenarios and monitored environmental data such as precipitation, temperature, river flow, etc., can be done using case studies. Considering the fact that measured river flows reflect characteristics of river catchments, the scope used for case-study modelling was constrained to catchment levels.

The case study was done on two catchments (Figure 35):

- Vardar catchment in the Former Yugoslav Republic of Macedonia;
- Morača catchment in Montenegro.

Although the catchments are relatively close to each, less than 130 km apart, the Morača catchment is humid with abundant precipitation, approximately 1 600 mm per year, while the Vardar catchment is relatively dry, approximately 500 mm per year. The hydropower potential is unused in both catchments, but there are plans for its exploitation and the construction of hydropower plants on both catchments. The Vardar and Morača are acknowledged as among the most threatened rivers in the Western Balkans (Fluvius, 2012).

There was also an open discussion on hydropower development and security implications on the Vardar and Morača rivers in the workshop *Future water use and the challenge of hydropower development in western Balkan* held in Ljubljana in February 2013.

Figure 27: Case study catchments

Case study 1: The Morača river, Montenegro

The Morača river (

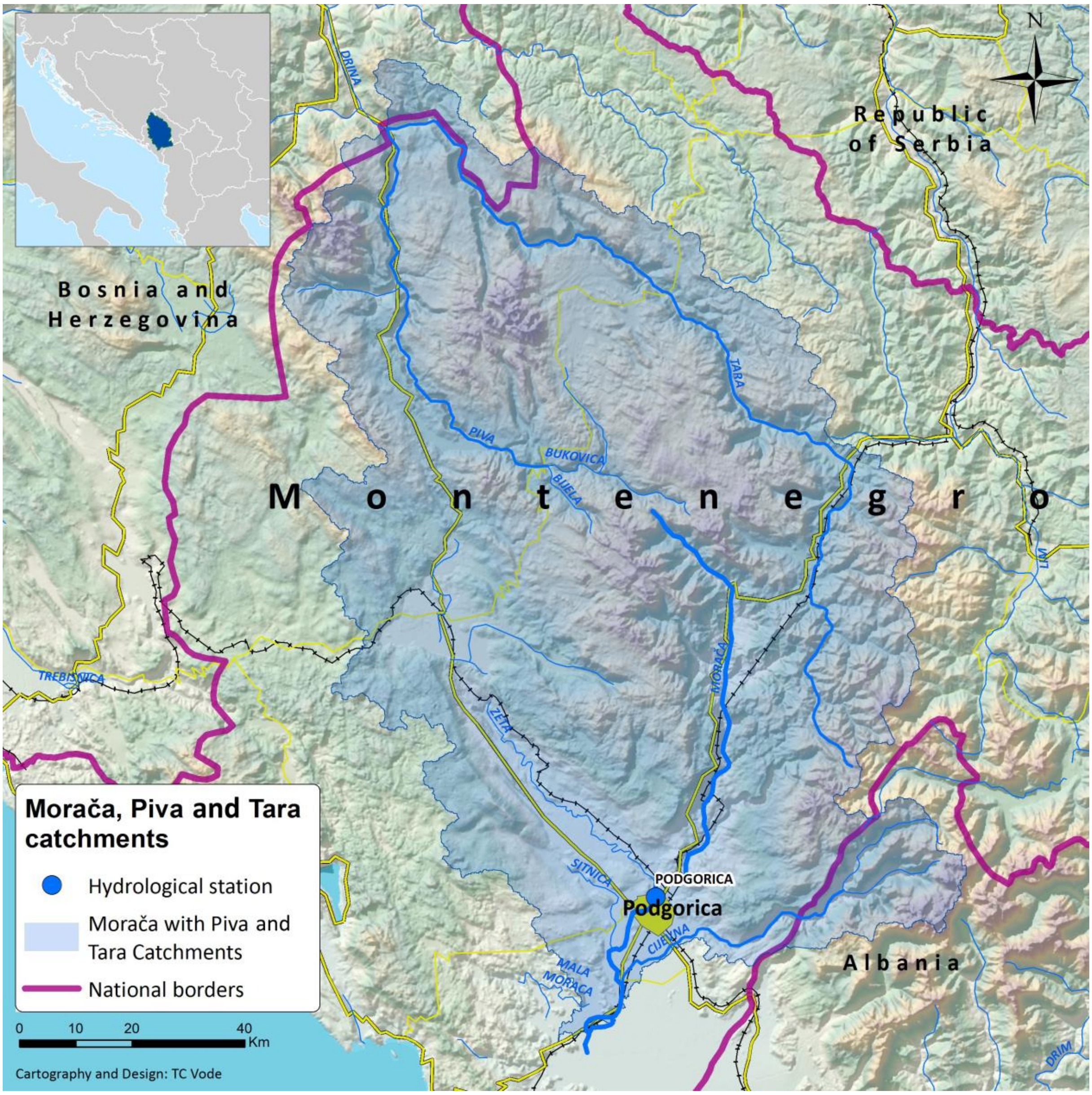


Figure 28) originates from a karstic spring in northern part of Montenegro, under the Rzača mountain (975 m). In its upper stream, Morača has a steep flow that has cut a steep canyon which is still in its natural geomorphological state. The river flows southwards in the direction of Podgorica. In the northern part, the canyon serves as a corridor for the main road and railway leading from Montenegro's coast and Podgorica to northern Montenegro and Serbia. The canyon also attracts sports enthusiasts such as kayakers, climbers, mountaineers, etc. After approximately 70 km, the Morača leaves the canyon and merges with its largest tributary, the Zeta, just north of Podgorica. The Morača is considered one of the symbols of Podgorica, and is the largest river that flows through the

city. It is featured on some flags and country symbols. After merging with the Zeta, the Morača enters the Zeta plain and flows across the Montenegran flatlands until it empties, after 113 km, into Skadar Lake. The Morača is the main source of Skadar Lake, supplying approximately 66 % of its water.

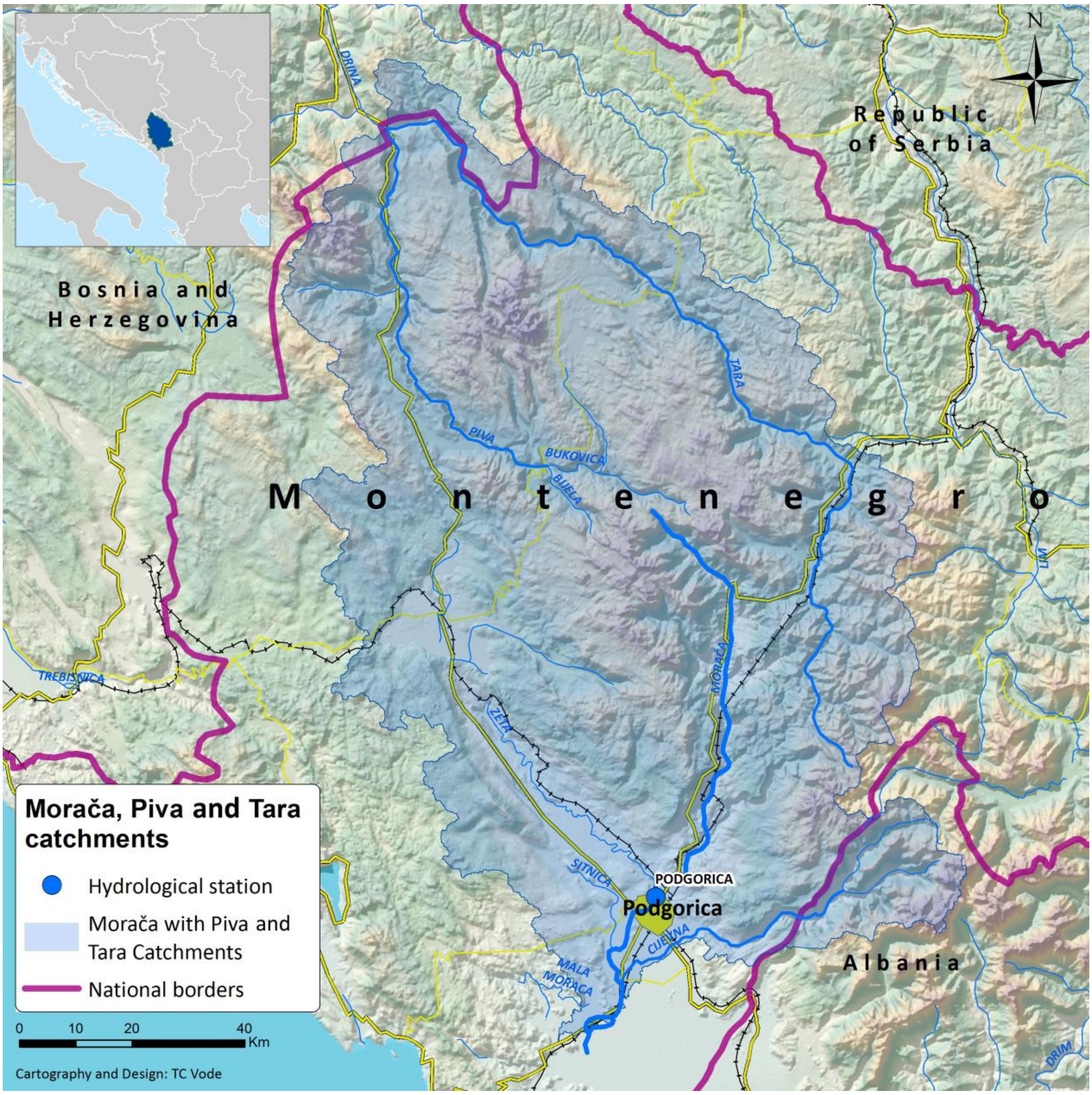


Figure 28: Morača catchment case-study area and the Podgorica hydrological station.

Photo 2: The Morača river.

Source: Wikipedia, 2006.

The Morača is the most important tributary of Lake Skadar. Together with the Bojana, they form an entirely free flowing connection from the high mountains of the Zagradac ridges (2 000 m) to the Adriatic Sea. A hydropower development foresees a cascade of four huge dams, the Andrijevo, Raslovići, Milunović, and Zlatica, with crest heights of 60–150 m and installed power of 37–127 MW. In addition, on the upper Morača the Kostanica hydropower plant is planned with installed power of 550 MW. In sum, together with the upper Tara (with two dams) and tunnels to feed the water into the Morača catchment, this is the largest project in the entire Western Balkans. Lake Skadar, which is protected under the Ramsar Convention, would be heavily impacted as its maximum extent would shrink by about 100 km². The total investment is estimated at almost 700 million Euro (Fluvius, 2012).

Climate

Climate in the observed area has the Adriatic variant of the Mediterranean climate that is highly affected by high surrounding mountains. The effects are seen in temperatures and in the precipitation regime. In the maritime area, the summers are warmer and drier, winters colder, with harder frosts and frequent snow. The mean annual precipitation for 1950–1984 at the Podgorica weather station was 1 664 mm, with a yearly maximum of 2 317 mm recorded in 1979 and the minimum of 869 mm was in 1953. Average monthly precipitation values range from 227 mm in winter to 41 mm in summer. In October 1965 and 1969 and in September 1970 no precipitation was recorded. Although the annual precipitation is high, an analysis of its distribution through the year shows that from October–March the average precipitation is 1 147 mm or 69 % of the annual total. From April till September, when vegetation is densest, the average precipitation is 517 mm, 31 % of annual total. The catchment is therefore characterised by long, humid rainy periods, and a shorter, arid summer periods (Knežević, 2009).

Hydrology

The Morača river is a relatively small, rarely more than 100 m wide and mostly shallow. It is a part of the Skadar Lake's basin which belongs to the Adriatic watershed. The Podgorica hydrological monitoring station (42°27´02´´ latitude and 19°16´02´´ longitude) is at an altitude of 24.6 m above sea level. Its main tributary is the Zeta. The orographic catchment area at Podgorica covers 3 844 km², of which the sub-catchment of Morača occupies 2 627.70 km²; the remaining 1 216 km² is occupied by the Zeta catchment – the water is also recharged from a karstic area on the western side of the Zeta. The length of all flows in the Morača watershed is 545 km, at an average altitude of 1 005 m, while the total flow length in Zeta watershed is 110 km at an average altitude of 937 m. Average annual flows in for 1961–2001 was 156.4 m³/s, with the smallest average monitored in 1983 as 94.9 m³/s and the largest In 1979 as 255.5 m³/s (Knežević, 2009). For 1975–1985, the average annual discharge was 173.5 m³/s, with a minimum average discharge of 33.3 m³/s in August and maximum one of 276.8 m³/s in December. The annual average precipitation for the same period at Podgorica was 1 162 mm. The recharge area of the Morača, with the Zeta, was 3 844 km^2, meaning that the runoff represents 86 % of precipitation.

Case study 2: The Vardar river

The Vardar river (Greek name Axiós; Figure 29) is the longest river in the Former Yugoslav Republic (FYR) of Macedonia, 302.6 km, and one of the most important rivers in Western Balkans. It originates in the Šar mountains, near the village of Vrutok at an altitude of 683 meters and is one of the greatest natural beauties of the Gostivar region. It flows northeast through FYR Macedonia's cities of Gostivar (100,000 inhabitants) and Tetovo (180,000 inhabitants) in the Gostivar-Tetovo depression, then it changes its path and flows southeast through Skopje (570,000 inhabitants), Veles (70,000 inhabitants) and Gevgelija (40,000 inhabitants) on the border with Greece. Its floodplains are mainly used for agriculture and cattle breeding. There are also large chemical industry units in the urbanised areas and the quality of the river water is affected by heavy metal pollution from smelter and fertiliser plants in Veles, the disposal of solid waste near the river bed from a ferro-alloy plant in Jegunovce, and by untreated industrial wastewater discharge from the industries in the watershed. The agricultural runoff from cultivated areas of Tetovo, Veles and Koufalia (in Greece) is a significant source of nutrient pollution. The untreated domestic wastewaters discharged directly into Vardar River, as well as illegal landfills, are contaminating the surface water and groundwater. Agricultural activities are heavily dependent on the river water discharge, which was greatly reduced[12] during recent years due to the construction of retention reservoirs and irrigation works upstream[13]. On the Greek side, the Vardar/ Axiós is 87 km long and very important for irrigation in the fertile plain of Thessaloniki. Before discharging into the Bay of Thermaikos the river forms an ecologically rich delta, which is environmentally protected. The total length of Vardar river is 388 km (Zinke Environment Consulting, 2004).

Vardar valley hydropower project comprises the construction of 12 hydropower plants along the river in the FYR Macedonia. The hydropower plants will be located along the river, near the Greek border (Balkans Business News, 2014).

12 The reduction is most severe in lower river flow in the FYR Macedonia and on the Greek side of the border.

13 Nineteen large and more than 100 small dams and reservoirs have been constructed in this region.

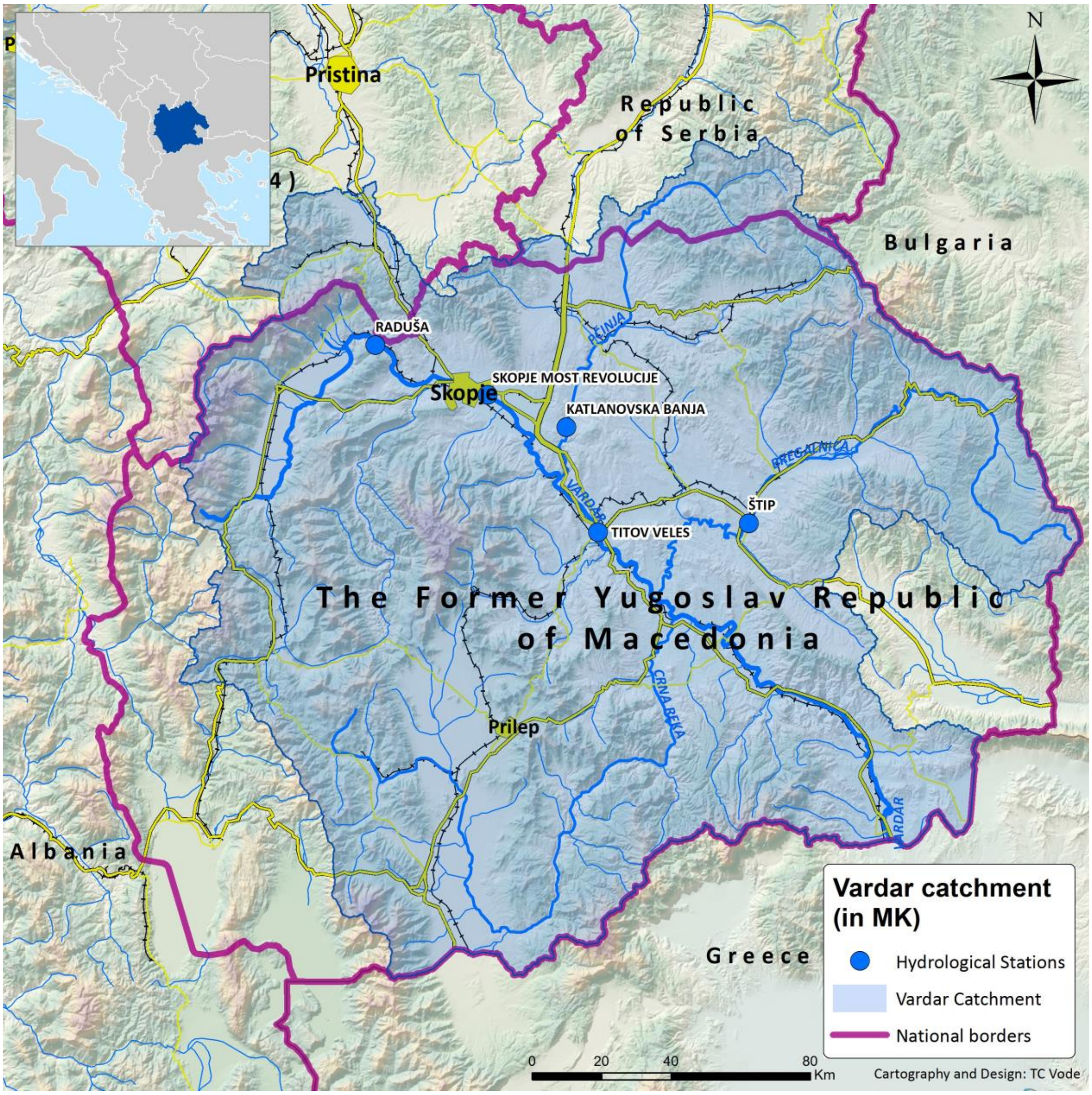


Figure 29: Vardar Catchment case study area in the Western Balkans and the Raduša, Skopje, Titov Veles hydrological stations on the Vardar river and the Katlanovska Banja on Pčinja and Štip hydrological stations on the Bregalnica river)

Climate

The climate of the FYR Macedonia features hot summers and cold winters. There are lots of different types of climate in country that affect average precipitation and temperatures. Climate types consist of continental, changed continental, sub-Mediterranean (changed maritime) and mountainous, as well as their various climate sub-types. In Greece, the climate can be characterized as continental in the northern part of the catchment and Mediterranean towards the coastal zone. The average yearly rainfall in the areas with a changed-maritime climate is fairly low. Average annual precipitation varies from 500 mm in the central part of the country by the Vardar river up to 1 000 mm in other areas of country. On the Greek side, annual rainfall ranges from 400 mm to 1 300 mm. Average temperatures are 9–17 °C.

Hydrology

The Vardar river is 388 kilometres long, with basin area of 26 959 km². The average elevation of the basin is 793 m. Average rainfalls in the basin is 660 mm. Vardar’s main tributaries are the Treska, Pčinja, Bregalnica, Crna Reka, Lepenec, Babuna, Gorgopis and Vardarovasi rivers that form the sub-basin of the Vardar river. Total annual average discharge is estimated to be 4 289 million m³/year. Average discharges of Vardar river basin’s major tributaries are: Treska, 24.2 m³/s; Pčinja, 2.6 m³/s; Bregalnica, 4.1 m³/s; and Crna, 7.4 m³/s.

Photo 3: The Vardar in Veles.

Source: Wikipedia, 2006a.

Method used

The case study was done on two catchments: the Vardar in the FYR Macedonia and the Morača in Montenegro. On both catchments there are plans for the exploitation of the hydropower potential and the construction of hydropower plants while climate change impacts in these two regions are estimated to be relatively high. In these two case studies, the focus was climate change and its consequences regarding water availability which can be further observed through the amount of precipitation, surface runoff, potential and actual evapotranspiration, soil water capacity and other parameters. Those changes were observed through two selected contrasting scenarios: Good society and Downward spiral.

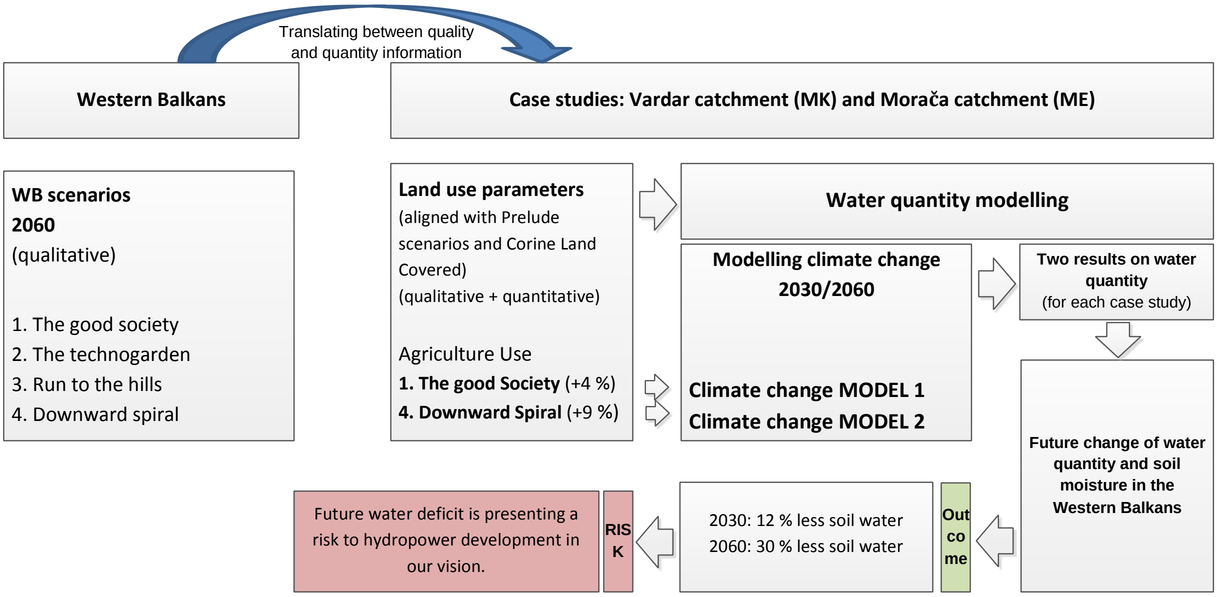


Figure 30: Water and climate modelling for two Western Balkans scenarios

Climate change in the Western Balkans is assessed using results of modelling of global and regional climate change. The most advanced tools for assessing global climate change are the coupled Atmospheric-Ocean General Circulation models (AOGCMs) (Kjellström *et al.*, 2005). General circulation models (GCMs) provide boundary conditions to limited-area models, known also as the regional climate models (RCMs), which simulate climate at local and regional scales in much higher spatial resolution than GCMs, typically 5–50 km. To date, various research projects have produced climate simulations for Europe using different combinations of GCMs and RCMs, forced by emission scenarios. We worked with eight climate simulation runs from the European framework projected ENSEMBLES database (van der Linden and Mitchell, 2009). They correspond to a selected combination of different RCMs and four GCMs using the A1B socio-economic scenario. The RCMs have a horizontal spatial resolution of about 25 km and cover the European domain. The simulations run until end of 21st century. The RCMs use different grids, have different numerical formulations of their physical parameterisation schemes, and also differ in detailed their descriptions of land/sea contrast, coastlines, lakes, albedos, soil types and land covers (Christensen *et al.*, 2008; Maule *et al.*, 2012). They represent the real weather relatively well, given constrains imposed by boundary conditions derived from different GCMs (Maule *et al*., 2012). Therefore, using different combinations of RCMs and GCMs allowed us to address uncertainties among climate simulations, in terms of boundary conditions – by using different GCMs – and physical parameterisation of the climate models – by using different RCMs. Generalised outputs of the model are usually presented as an ensemble mean.

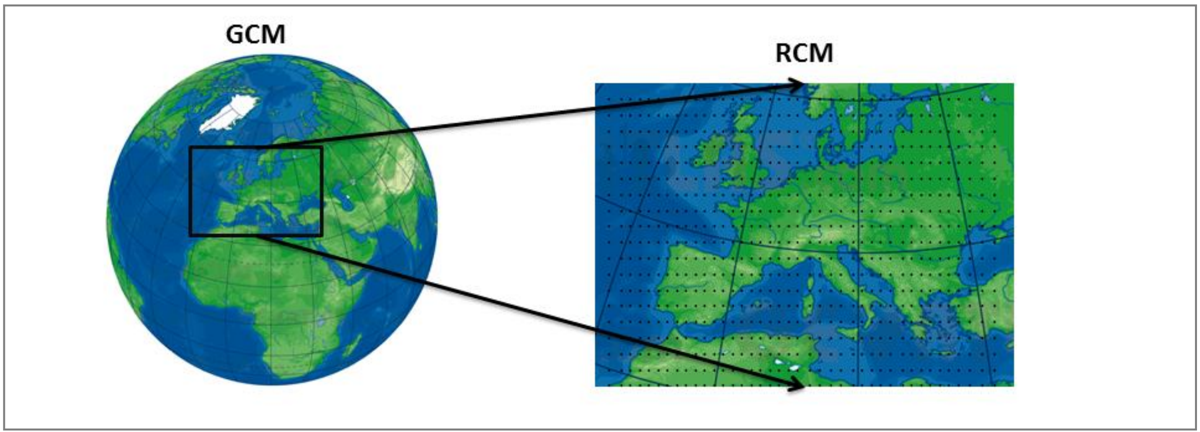


Figure 31: The schematic representation of general circulation models (GCMs) and regional climate models (RCMs).

Source: EEA, 2012.

Analysis of the water cycle in the Western Balkans included two regional climate models with boundary conditions from two different global circulation models, forced by the A1B emission scenario (Nakicenivich and Swart, 2000). The first set of climate simulations (Model 1) were obtained by the regional climate model REMO (Jacob, 2001) driven by the boundary conditions from the global circulation model ECHAM5 (Roeckner *et al.*, 2006). This represents a group of models predicting low to intermediate ranges of changes within the multi-model ensemble. The second model (Model 2) predicts higher changes in temperature than the multi-model ensemble mean. This set of climate simulations has been obtained as a combination of the regional climate model CLM (Jaeger *et al*., 2005) and the global circulation model HadCM3Q0 (Collins *et al.*, 2010).

Water quantity probability in 2030 and 2060 for two scenarios

The groundwater balance was calculated using the swbEWA model **Error! Reference source not ound.**, which takes into account rainfall, evapotranspiration, surface runoff and deep percolation. The data used in the model are based on FAO recommendations on groundwater availability according to different land covers. The soil moisture is calculated by adding and taking input parameters (e.g. rainfall), expressed in millimetres.

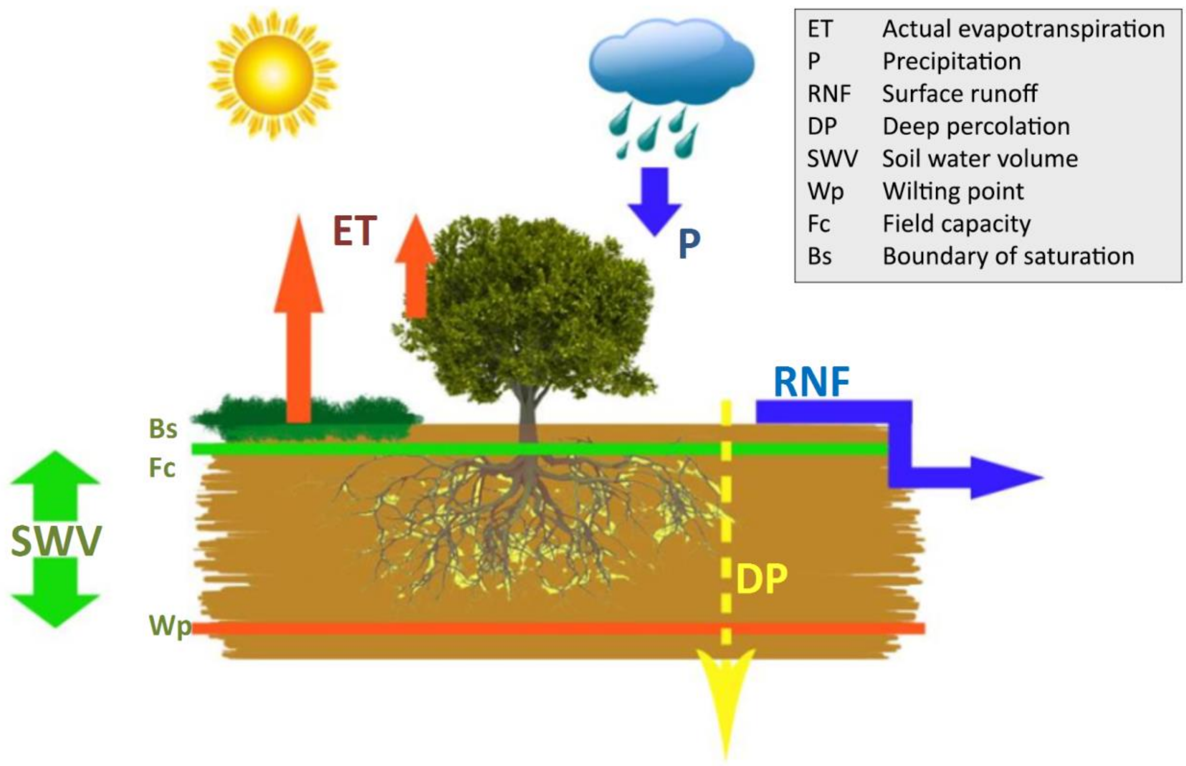


Figure 32: The processes included in the modelling

Table 5: FAO crop coefficients used in the modelling

Soil water balance class	Yearly (Kc)
Artificial surfaces and low transpiring vegetation	0.2
Pastures and grasslands	0.683333
Arable land and permanent crops	0.758889
Broad-leaved forest	0.516667
Coniferous forest	1
Mixed forest	0.758333
Agro forestry	0.758611
Transitional woodland and scrub	0.2275
Wetlands	0.896667
Inland water	1.05
Sea and ocean	0.8525

Note: Climatologic scenarios embedded: S1 = GCM A2, S4 = GCM B1.

Land use on selected catchments

Land use has a significant effect on evapotranspiration and soil-water capacity; different FAO crop coefficients are assigned to different land use categories. Land use is therefore also one of the input parameters in swbEWA model. Land-use categories, originating from Corine Land Cover were aggregated into categories which can be associated with FAO crop coefficients.

In the Vardar catchment, predominating land-use categories are arable land and permanent crops followed by broad-leaved forest. Predominating categories in the Morača, with the Tara and Piva, catchment are broad-leaved forest, transitional woodland and scrub, and pastures and grasslands. The share of arable land in the Morača catchment is lower due to extremely mountainous, rugged terrain that is for unsuitable farming .

Table 6: Present land use in the Vardar catchment (Western Balkans).

Land use category	Area (km^2)	Area (%)
Arable land and permanent crops	6472.66	29.9
Artificial surfaces	356.79	1.6
Broad-leaved forest	6038.80	27.9
Coniferous forest	462.75	2.1
Inland water	105.44	0.5
Mixed forest	407.54	1.9
Pastures and grasslands	3499.48	16.2
Transitional woodland and scrub	4231.97	19.5
Wetlands	88.24	0.4
Total	21663.67	100

Source: EEA (Corine Land Cover), 2006.

Table 7: Present land use in the Morača, Tara and Piva catchments.

Land use category	Area (km^2)	Area (%)
Arable land and permanent crops	751.00	11.55
Artificial surfaces	65.21	1.00
Broad-leaved forest	1628.46	25.04
Coniferous forest	368.58	5.67
Inland water	53.95	0.83
Mixed forest	657.99	10.12
Pastures and grasslands	1467.67	22.57
Transitional woodland and scrub	1496.77	23.02
Wetlands	12.96	0.20
Total	6502.59	100.0

Source: EEA (Corine Land Cover), 2006.

Description of land use change for Scenario 1 (The good society) and Scenario 4 (Downward spiral)

In order to assess future runoff, corresponding FAO crop coefficients were assigned to land-use categories. Due to the fact that land cover shown as FAO crop coefficient categories was used as one of the inputs in the model, categories of present land-use state were expanded or reduced according to descriptions of the explorative scenarios The good society (Scenario 1) and Downward spiral (Scenario 4). For each, the hierarchy of land use expansion or reduction was set up in the first step when in the second step intensity of their expansion or reduction was assessed and quantified. Considering the hierarchy and quantified intensity of land-use changes, two spatial models were designed using global information system (GIS) tools, resulting in four different future land-use maps. Those were used as input parameters in swaEWA model.

Land-use change characteristics of Scenario 1 (The good society):

- artificial surfaces are expanding over all other categories;
- inland-water categories are expanding over all categories except artificial surfaces;
- arable land and permanent crops are expanding over all categories except inland water and artificial surfaces;
- reduction of all the other categories due to expansion of artificial surfaces, inland water and arable land and permanent crops;
- for irrigation potential, areas were identified and used as a spatial irrigation mask.

Land use change characteristics of Scenario 4 (Downward spiral):

- artificial surfaces are expanding over all other categories – not as intense as in Scenario 1;
- inland water categories are expanding over all categories except artificial surfaces – not as intense as in Scenario 1;
- pastures and grasslands are expanding over all categories except inland water and artificial surfaces;
- deforestation – pastures, grasslands and transitional woodland and scrub are replacing deforested areas.

Table 8: Decision rules for expansion/reduction of land-cover categories

	Artificial surfaces	Arable land and permanent crops	Coniferous forest	Broad-leaved f forest	Mixed forest	Transitional woodland and scrub	Pastures and grasslands	Wetlands	Inland water	Vardar HPP
Scenario 1	Buffer 350 m	Buffer 100 m	/	/	/	/	/	/	Buffer 50 m	Buffer 200 m
Expanding hierarchy (Scenario 1)	1	4	5	8	7	9	10	6	3	2
Scenario 4	Buffer 200 m	Buffer 170 m	Reduction 100 m buffer (what is no longer coniferous forest becomes pastures or grasslands)	Reduction 400 m buffer (what is no longer broad-leaved forest becomes scrub)	Reduction 200 m buffer (what is no longer mixed forest becomes scrub)	What remains becomes broad leaved forest	Buffer 300 m	/	/	Buffer 200 m
Expanding hierarchy (Scenario 4)	1	4	7	8	9	10	5	6	3	2

Table 9: Changed Land cover categories (Vardar, Scenario 1)

Vardar Scenario 1	Scenario 1 Area (km^2)	Scenario 1 Area (%)	Present land-cover area (%)	% growth	Yearly KC
Arable land and permanent Crops	7365.16	34.00	29.88	13.78	0.758
Artificial surfaces	1029.97	4.75	1.65	188.50	0.2
Broad-leaved forest	5481.29	25.30	27.88	-9.24	0.516
Coniferous forest	401.91	1.86	2.14	-13.20	1.0
Inland water	212.84	0.98	0.48	102.70	1.05
Mixed forest	374.25	1.73	1.88	-8.27	0.758
Pastures and grasslands	2969.93	13.71	16.15	-15.12	0.683
Transitional woodland and scrub	3746.30	17.29	19.53	-11.48	0.227
Wetlands	82.58	0.38	0.41	-6.17	0.897

Table 10: Changed land-cover categories (Vardar, Scenario 4)

Vardar Scenario 4	Scenario 4 Area (km^2)	Scenario 4 Area (%)	Present land-cover area (%)	% growth	Yearly KC
Arable land and permanent Crops	8483.15	39.16	29.88	31.05	0.758
Artificial surfaces	730.44	3.37	1.65	104.60	0.2
Broad-leaved forest	3157.46	14.57	27.88	-47.72	0.516
Coniferous forest	133.41	0.62	2.14	-71.19	1.0
Inland water	149.71	0.69	0.48	42.57	1.05
Mixed forest	57.53	0.27	1.88	-85.90	0.758
Pastures and grasslands	5814.59	26.84	16.15	66.17	0.683
Transitional woodland and scrub	3106.77	14.34	19.53	-26.59	0.227
Wetlands	31.91	0.15	0.41	-63.73	0.897

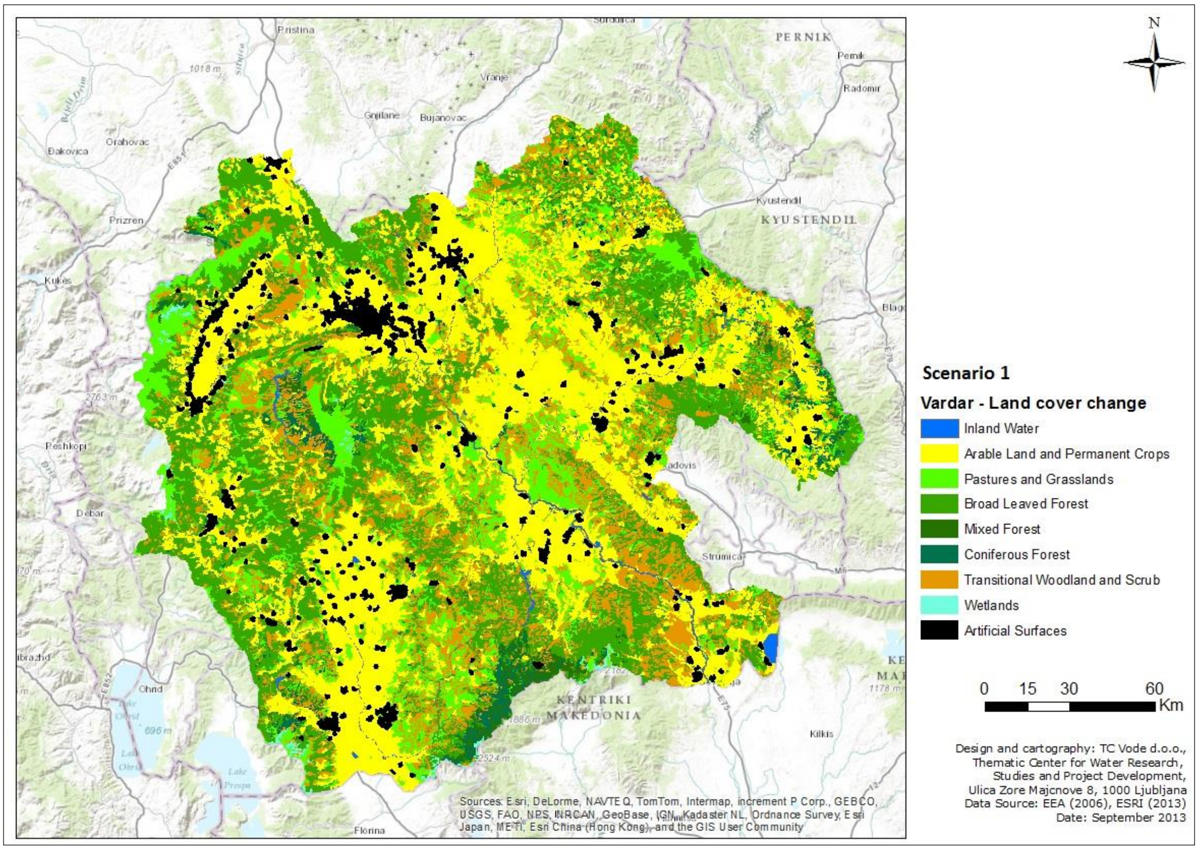


Figure 33: Changed land-cover categories (Vardar, Scenario 1)

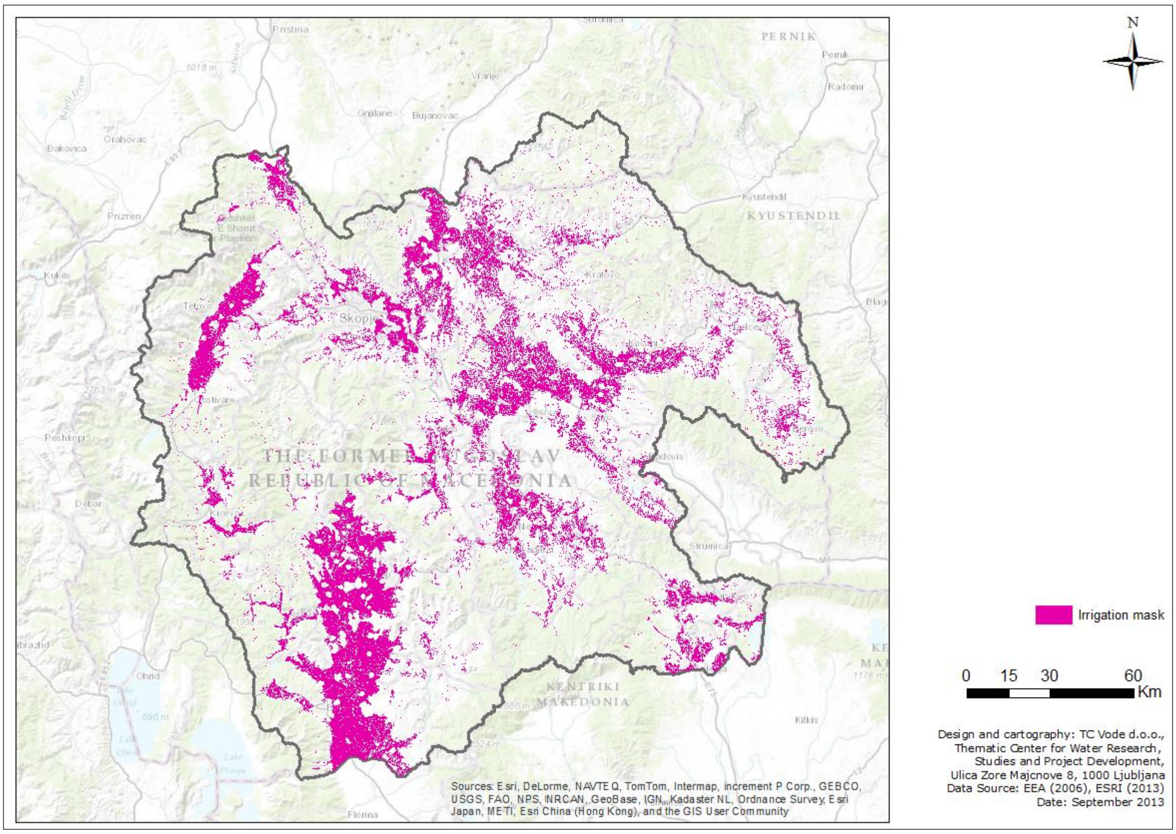


Figure 34: Irrigation potential areas in the Vardar basin.

Table 11: Changed land-cover categories (Morača, Scenario 1).

Morača Scenario 1	Scenario 1 Area (km^2)	Scenario 1 Area (%)	Present land-cover area (%)	% growth	Yearly KC
Arable land and permanent crops	1032.11	15.87	11.55	37.43	0.758889
Artificial surfaces	143.12	2.20	1.00	119.47	0.2
Broad-leaved forest	1469.14	22.59	25.04	-9.78	0.516667
Coniferous forest	332.63	5.12	5.67	-9.75	1
Inland water	131.09	2.02	0.83	142.98	1.05
Mixed forest	630.12	9.69	10.12	-4.24	0.758333
Pastures and grasslands	1380.26	21.23	22.57	-5.96	0.683333
Transitional woodland and scrub	1373.20	21.12	23.02	-8.26	0.2275
Wetlands	10.94	0.17	0.20	-15.57	0.896667

Table 12: Changed land-cover categories (Morača, Scenario 4)

Morača Scenario 4	Scenario 4 Area (km^2)	Scenario 4 Area (%)	Present Land cover area (%)	% growth	Yearly KC
Arable Land and Permanent Crops	1293.37	19.88	11.55	72.22	0.758889
Artificial Surfaces	109.64	1.68	1.00	68.13	0.2
Broad Leaved Forest	1137.78	17.50	25.04	-30.13	0.516667
Coniferous Forest	180.52	2.78	5.67	-51.02	1.0
Inland Water	86.68	1.33	0.83	60.66	1.05
Mixed Forest	268.34	4.13	10.12	-59.22	0.758333
Pastures and Grasslands	2301.65	35.40	22.57	56.82	0.683333
Transitional Woodland and Scrub	1115.72	17.16	23.02	-25.46	0.2275
Wetlands	8.91	0.14	0.20	-31.28	0.896667

Results and discussion

The model predicts that there will be 12 % less water in the soil in 2033 than a present state. The difference between scenarios on the local level is not significant – in 2033, 73 % of area in Morača and 79 % in Vardar will face decreases in water in the soil. Nevertheless, if local climate models were used instead of regional ones, the results could show larger local variations and more significant differences between the two scenarios.

In Scenario 1 the modelled average sum of deep percolation and surface runoff for the period 2030–2040 is 30 % of the Vardar river discharge seen at the Raduša station in the period 1975–1984 and 60 % of Vardar river discharge at Skopje (**Error! Reference source not found.**). For the Morača river, he modelled average sum for 2030–2040 is 20 % of the discharge for 1975–1984. There will be hardly any water available in the river during summer period. The Vardar river discharge at sections with large catchment areas (5 000–10 000 km^2), the yearly water balance stays similar to the present, but with a larger drought in summer and higher peaks in autumn and winter, November to March. At present, the low water availability in rivers and groundwater lasts from mid-June to mid-September but in near future it will last from May to October. In Scenario 4 the modelled average sum for the period 2030–2040 is 20 % of the Vardar river discharge evidenced at the Raduša station for 1975–1984 and 50 % at Skopje (Figure 35).

Annual water availability in the rivers in 2040 will be at least 5 % lower under Scenario 1, The good society, and 35 % lower under Scenario 4, Downward spiral, compared to 1975–1984.

Bothe the quality and quantity of water resources will change in the future and significantly impact social and technological elements of the system.

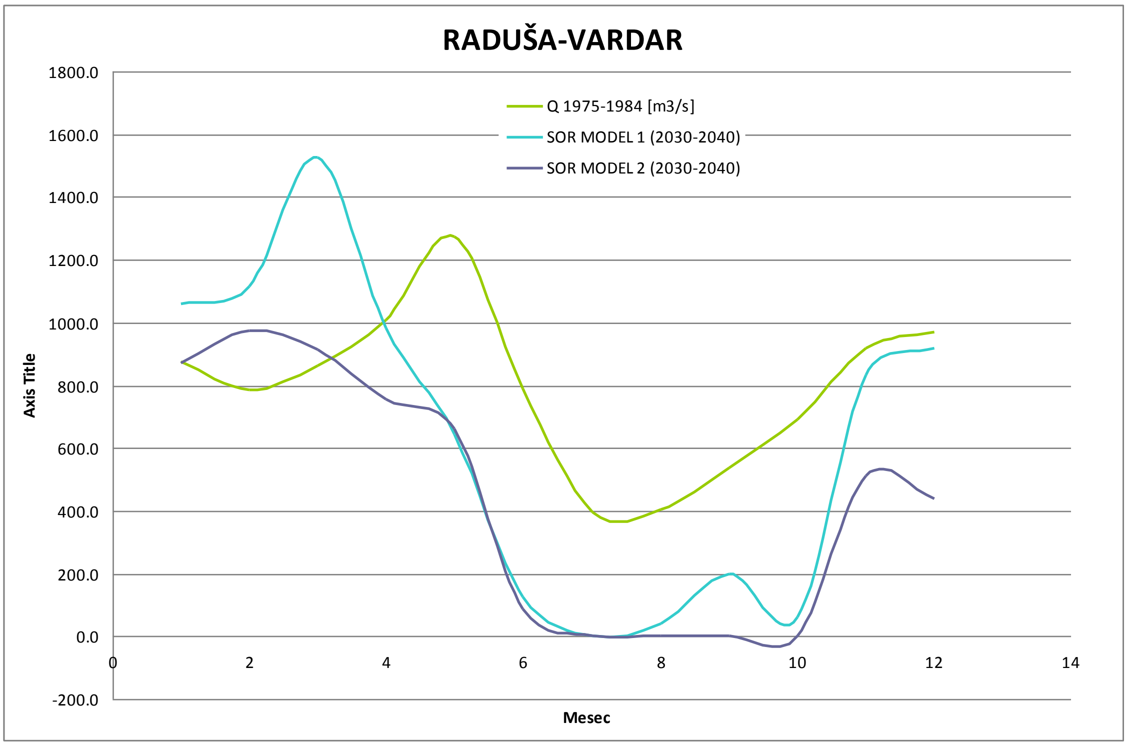


Figure 35: Average monthly river discharges in 1975–1984 and predicted surface runoff and deep percolation averaged over the period 2030–2040 at the Raduša station on the Vardar river in FYR Macedonia.

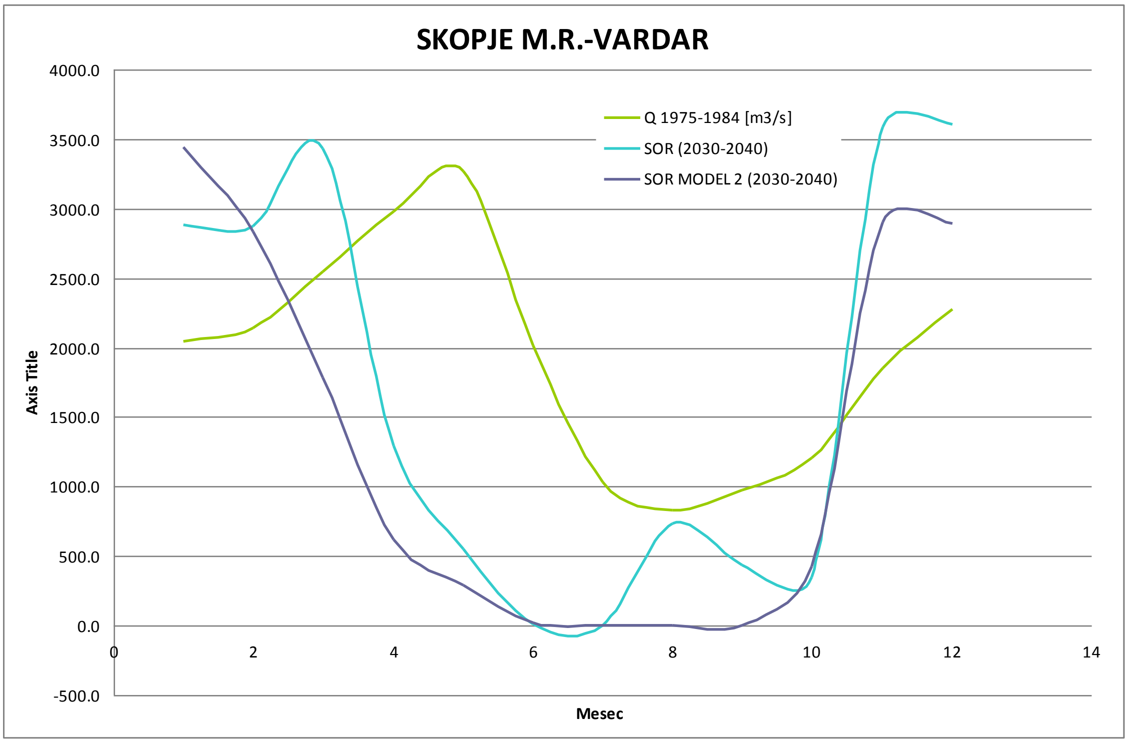
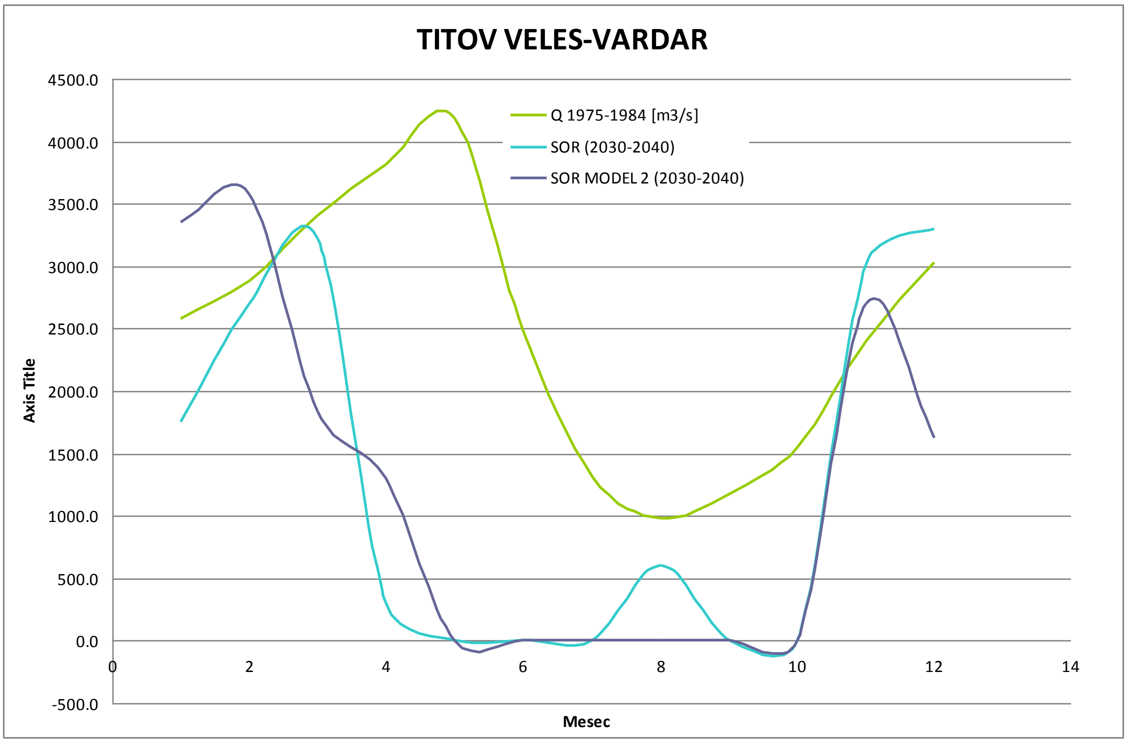


Figure 36: Average monthly river discharges in 1975–1984 and predicted surface runoff and deep percolation averaged over the period 2030–2040 at the Skopje station



on the Vardar river in FYR Macedonia.

Figure 37: Average monthly river discharges in 1975–1984 and predicted surface runoff and deep percolation averaged over the period 2030–2040 at the Titov Veles station on the Vardar river in FYR Macedonia.

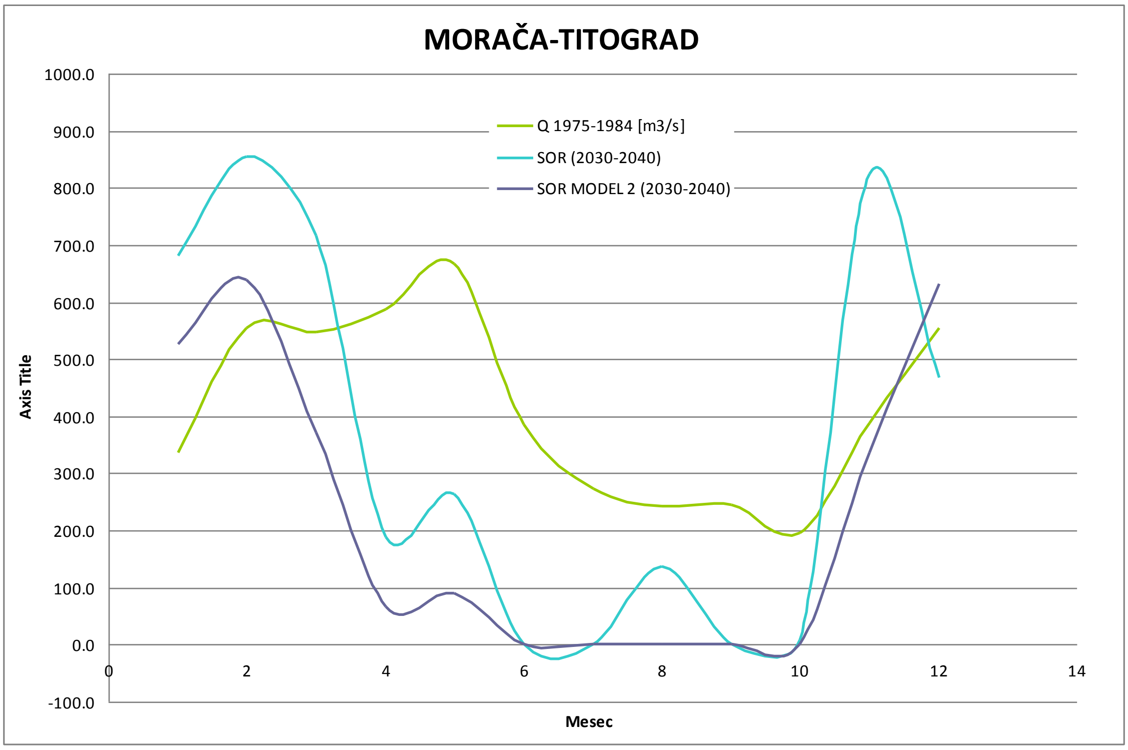


Figure 38: Average monthly river discharges in 1975–1984 and predicted surface runoff and deep percolation averaged over the period 2030–2040 at the Titograd station on the Morača river in Montenegro.