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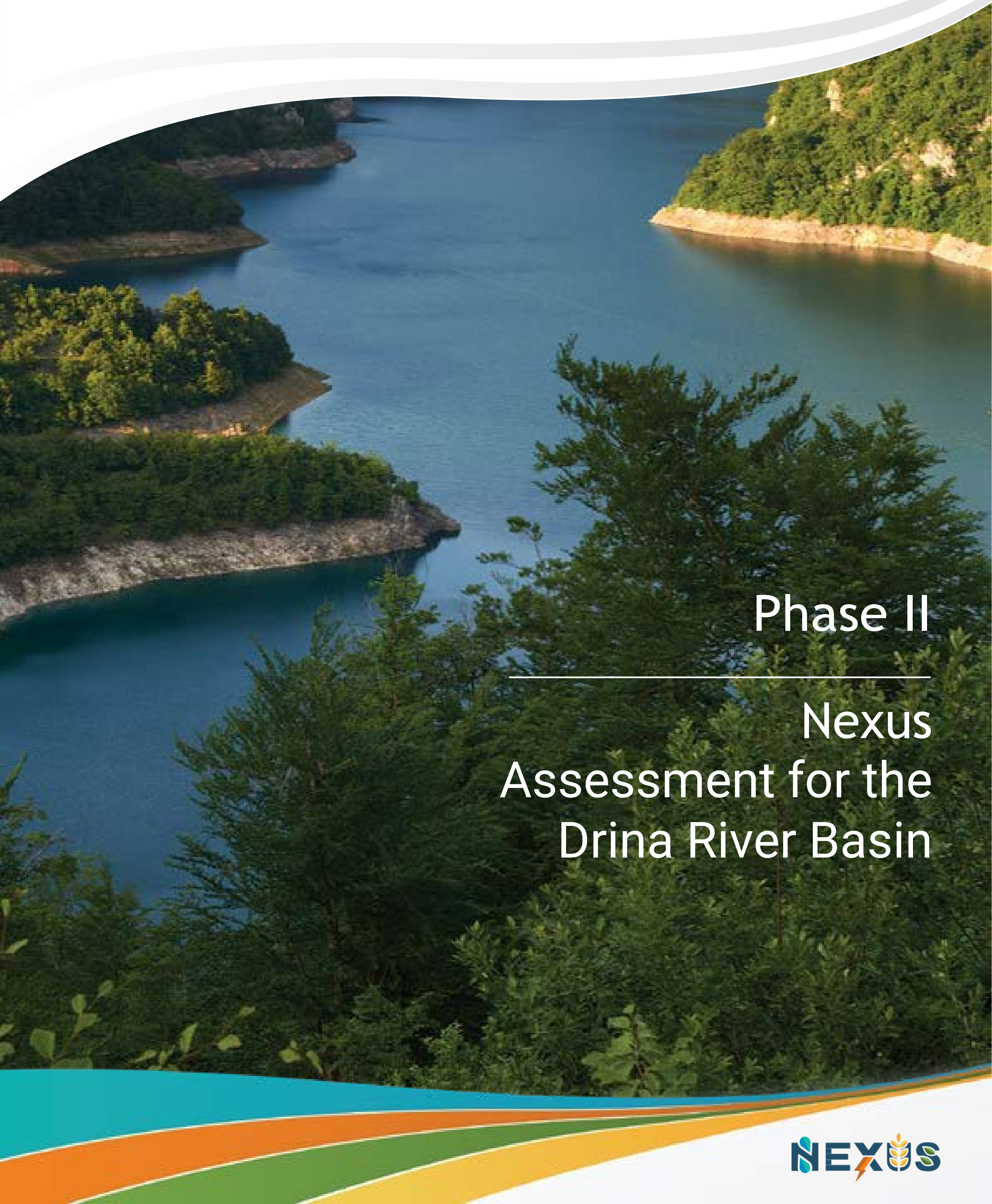

Phase II

Nexus Assessment for the Drina River Basin

NEXUS

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Phase II

Nexus Assessment for the Drina River Basin

NEXUS

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ACRONYMS AND ABBREVIATIONS

ABBREVIATION	MEANING
ADA	Austrian Development Agency
APC	Accident Prevention and Control
BAU	Business As Usual
BA	Bosnia and Herzegovina
CBAM	Carbon Border Adjustment Mechanism
CBD	Convention on Biological Diversity (of the United Nations)
CC	Climate Change
CIF	Climate Investment Funds
DRB	Drina River Basin
EC	European Commission
ECRAN	Environment and Climate Regional Accession Network
EG	Expert Group
EG FREF	Expert Group on Flow Regulation and Environmental Flows
EIA	Environmental Impact Assessment
EMS	Elektromreža Srbije
EPCG	Elektroprivreda Crne Gore
EPS	Elektroprivreda Srbije
ERS	Elektroprivreda Republike Srpske
ESMAP	Energy Sector Management Assistance Program
ETS	Emission Trading Scheme (of the EU)
EU	European Union
EUSDR	*European Union Strategy for the Danube Region*
FASRB	*Framework Agreement on the Sava River Basin*
FFWS	Flood Forecasting and Warning System
FIP	Feed-In Premium
FIT	Feed-In Tariff
FP	Flood Prevention
FRM	Flood Risk Management
GCF	Green Climate Fund
GEF	Global Environment Facility
GIS	Geographic Information System
GWP-Med	Global Water Partnership Mediterranean
HMI	Hydrological and Meteorological Issues
HIS	Hydrological Information System
HPP	Hydropower Plant
HPPDev	Hydropower Plant Development
ICPDR	International Commission for the Protection of the Danube River
INDC	Intended Nationally Determined Contribution
IRENA	International Renewable Energy Agency
ISRBC	International Sava River Basin Commission
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
JPA SRB	Joint Plan of Action for the Sava River Basin
ME	Montenegro
MoP	Meeting of the Parties (to *FASRB*)

ABBREVIATION	MEANING
MoU	Memorandum of Understanding
NDC	Nationally Determined Contribution
NECP	National Energy and Climate Plan
NGO	Non-Governmental Organisation
NTC	Net Transfer Capacities
OSeMOSYS	Open Source energy MOdelling SYStem
PEG	Permanent Expert Group (of ISRBC)
PRTR	Pollutant Release and Transfer Register
RBM	River Basin Management
RBMP	River Basin Management Plan
RBO	River Basin Organisation
RCC	Regional Cooperation Council
RCP	Representative Concentration Pathway
RE	Renewable Energy
RENA	Regional Environmental Network for Accession
REReP	Regional Environmental Reconstruction Program (for South-Eastern Europe)
RES	Renewable Energy Sources (Renewables)
RRD SWG	Regional Rural Development Standing Working Group
RS	Republic of Serbia
SAP	*Strategic Action Program*
SCCF	Special Climate Change Fund
SDG	Sustainable Development Goal
SDIP	*Sava and Drina Rivers Corridors Integrated Development Multiphase Approach Program (of the World Bank)*
SEA	Strategic Environmental Assessment
SED	Sustainable Energy Division (of the UNECE)
SEDRI	Sustainable Energy Development Regional Initiative
SEE	South-Eastern Europe
SMHI	Sveriges Meteorologiska och Hydrologiska Institut
SRB	Sava River Basin
SWICCA	Service for Water Indicators in Climate Change Adaptation
SWMI	Significant Water Management Issue
TEIA	Transboundary Effects of Industrial Accidents
ToR	Terms of Reference
TPP	Thermal Power Plant
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UWWT	Urban Waste Water Treatment
WB	World Bank
WFD	*Water Framework Directive* of the European Union
WRM	Water Resources Management
WWF	World Wildlife Fund

1 INTRODUCTION

This document has been developed within the framework of the project Promoting the Sustainable Management of Natural Resources in Southeastern Europe, through the use of Nexus approach, funded by the Austrian Development Agency (ADA) and implemented by the Global Water Partnership Mediterranean (GWP-Med) in partnership with the United Nations Economic Commission for Europe (UNECE).

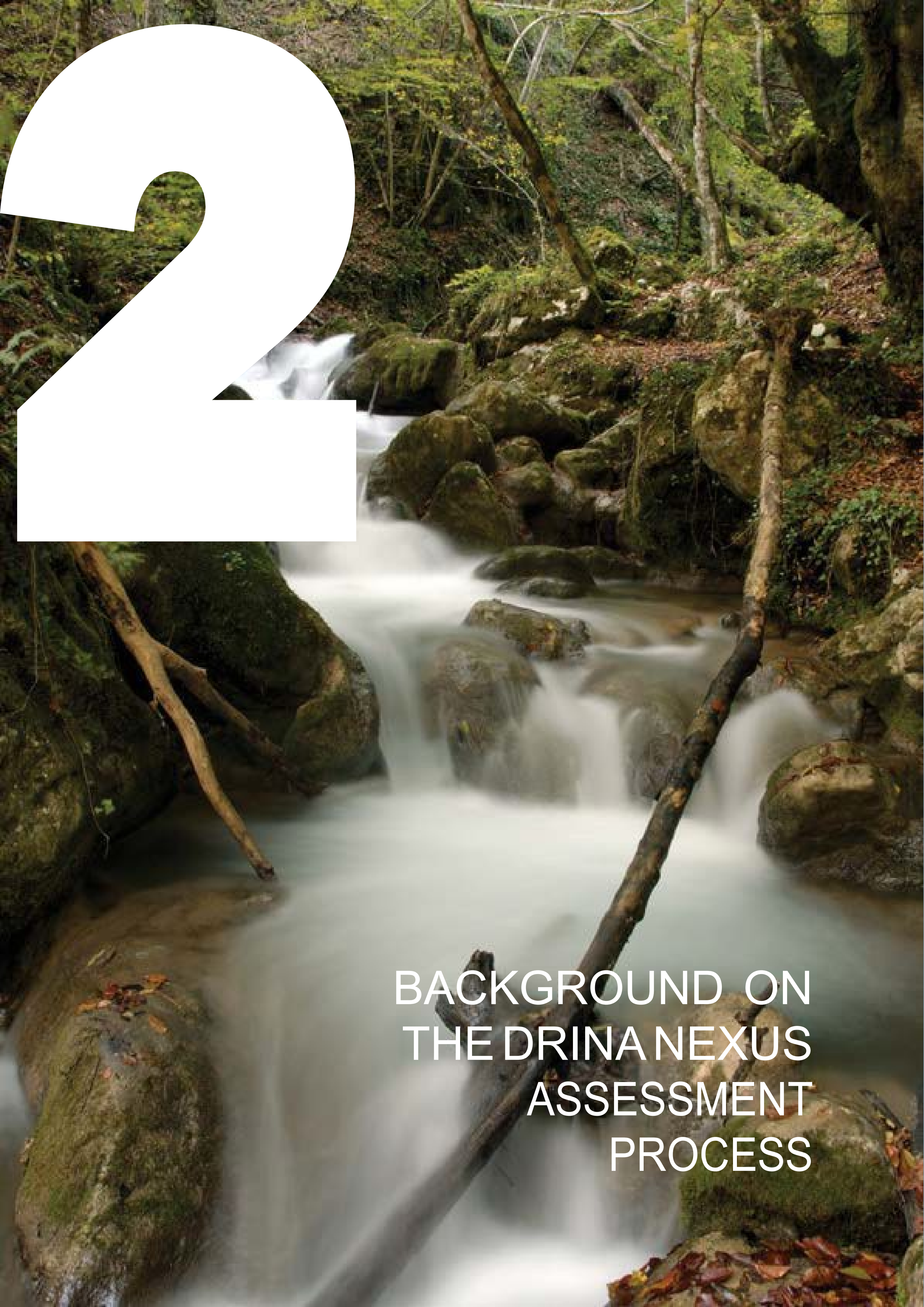
The purpose of the project is to introduce the Water-Energy-Food-Ecosystems Nexus ('Nexus') approach and catalyse action for its adoption and implementation in South-East Europe (SEE), particularly in the transboundary basins of the Drin and Drina rivers, at both national and transboundary basin levels. The project activities, targeting the Drina River Basin, follow up on a sequence of previous Nexus-related activities in the basin, including the Sava Nexus Assessment (2014-2016), the (Phase I) Drina Nexus Assessment (2016-2017), and the Drina Nexus Follow-Up Project (2018-2019) and, therefore, are referred to as the Phase II Drina Nexus Assessment.

The Phase II Drina Nexus Assessment serves two aims:

- To deepen the analysis of two crucial issues for development and transboundary cooperation that emerged in the previous projects, namely:
  - the energy development in the countries, and in the entire Basin, primarily related to the renewable energy and hydropower; and
  - agreeing on key aspects of flow regulation in the Basin, considering all water uses and functions, including the environment, and progress towards formalising some of these aspects.
- To set the basis for the development of a draft of the Drina Nexus Roadmap, as an additional output of the project.

Accordingly, this report integrates key findings of the entire Drina Nexus process and the achievements of the *Phase II Drina Nexus Assessment*. Section 2 of the document summarises the institutional and policy framework, as well as the Drina Nexus process. Section 3 is dedicated to the energy-water modelling for a number of scenarios for sustainable energy development in the Drina Basin. Section 4 deals with governance options for the formalisation of flow regulation in the Basin. Key conclusions and recommendations of the *Phase II Drina Nexus Assessment* are summarised in Section 5. The list of acronyms and abbreviations is provided in Section 6, and the final part of the report, Section 7, includes three annexes containing a detailed overview of conclusions and recommendations drawn by the riparian countries during the Drina Nexus process (Annex 1), and additional information regarding the energy-water modelling analysis (Annex 2), and selected international arrangements on flow regulation (Annex 3), thus complementing Sections 2, 3 and 4, respectively.

As indicated above, this report also provides a basis for a draft Drina Nexus Roadmap that has been developed within the project. The Roadmap aims to facilitate progress towards sustainable and climate-resilient management of natural resources in the Drina River Basin by identifying lines of action and modalities for effective and coherent cross-sectoral coordination at institutional, policy and management levels in the Nexus-related sectors (water resources, energy, land/agriculture, environment). Stemming from the situation analysis summarised in this report and drawing upon the preceding Phase I Assessment, its follow-up project, as well as the studies conducted within the framework of the Phase II Assessment, the Roadmap specifies 10 objectives and suggests main actions in order to achieve them, respective implementing actors and recommendations concerning the implementation of the actions. The first four objectives are of general nature, being common for all types of Nexus issues, whereas the other six pertain to specific Nexus issues identified during the Nexus Assessment process in the Drina Basin. The Roadmap is proposed as a "living" document that can be adjusted by the countries during its implementation, through discussions among the countries and sectors, who can agree upon detailed actions, timeframe, and budget as they consider appropriate.



2

BACKGROUND ON THE DRINA NEXUS ASSESSMENT PROCESS

The Drina River Basin is located in South-East Europe (SEE), in the Western Balkans region. The Basin stretches from the central part of the Dinaric Mountains to the Pannonian Plain. The Drina River originates in Montenegro at an altitude of 2,500 m above sea level (a.s.l.) between the slopes of the Maglić and Pivska Planina mountains. The Drina River is formed as a junction of the Piva and Tara rivers, between the villages of Šćepan Polje (in Montenegro) and Hum (in Bosnia and Herzegovina), draining a substantial karst plateau that receives the highest annual rainfall in Europe (about 3,000 mm/year), resulting in the highest specific runoff in Europe (up to 50 l/s/km²)[1], and flows mainly in a northerly direction to the confluence with the Sava River.

The area of the Drina River Basin is 19,680 km² and is almost equally divided by three riparian countries, with 32% of the Basin in the north of Montenegro, 36% of the Basin in eastern Bosnia and Herzegovina, 31% in western Serbia and less than 1% in Albania. The Drina River is 346 km long, of which 220 km is the border between Bosnia and Herzegovina and Serbia. Around 40 km of the Tara River forms the border between Montenegro and Bosnia and Herzegovina.

The most water-abundant tributaries of the Drina River – the rivers Piva, Tara and Lim – originate in Montenegro and provide two thirds of the Drina River flow[2]. The Drina River reaches its confluence with the Sava River in the Pannonian Plain (Semberija and Mačva), with an average discharge of about 370 m³/s.

The Drina River Basin is rich in water, and is characterised by virtually untouched landscapes and a high level of biodiversity. The Basin also has significant, partially utilised capacity for hydropower production, as well as untapped renewable energy potential, but any development of this potential – especially hydropower – involves trade-offs. Water quality is impaired by the discharge of mostly untreated wastewater and solid waste, and agriculture is being compelled to modernise, which puts additional pressure on water resources. At the same time, the Basin is prone to floods and vulnerable to climate change, which is projected to increase the frequency of extreme hydrological events, such as floods and droughts.

Under these conditions, it is rather challenging and practically impossible to use and manage resources efficiently and effectively without considering the mutual sectoral influences, at both national and transboundary levels.

The water-energy-food-ecosystems Nexus approach has been introduced in the natural resources management agenda to facilitate the enhancement of water, energy, and food security, while preserving ecosystems and their functions[3]. The Nexus approach provides for an integrated and coordinated strategy across sectors, with a view to reconciling potentially conflicting interests as they compete for the same scarce resources, while harnessing existing opportunities and exploring emerging ones. Consequently, implementation of the approach includes a vast number of institutions and policies. The Nexus approach is relevant to SEE, and the Drina River Basin in particular, given the importance of the Basin's water, land and energy resources, as well as its well-preserved ecosystems, for the riparian countries.

This section provides an overview of the institutional and policy framework relevant to the implementation of further Nexus-related activities in the Drina River Basin, and a summary of the Drina Nexus Assessment process and related conclusions and recommendations drawn during that process.

1 UNECE (2017): *Assessment of the water-food-energy-ecosystem nexus and benefits of transboundary cooperation in the Drina River Basin, New York and Geneva.*

2 World Bank (2017): *Support to Water Resources Management in the Drina River Basin, Roof report, Washington, D.C.*

3 Available from: https://gwp.org/seenexus.

10 Available, e.g., from: https://sdgs.un.org/2030agenda.

2.1 INSTITUTIONAL AND POLICY FRAMEWORK

2.1.1 GLOBAL and (PAN-)EUROPEAN LEVELS

The Drina countries have engaged in various mechanisms to foster sustainable development. All three countries are parties to the most important international multilateral agreements covering environmental and water resources management, including the Ramsar Convention[4], the Espoo Convention[5] on Environmental Impact Assessment (EIA) in a transboundary context, the SEA Protocol[6], i.e., The Protocol on Strategic Environmental Assessment (SEA) to the Espoo Convention, the UNECE Water Convention[7], the Aarhus Convention[8], as well as the Paris Climate Agreement (2015). Bosnia and Herzegovina and Serbia are also parties to the Protocol on Water and Health to the Water Convention.[9] Under these instruments, the countries have accepted a set of common standards and governance rules related to international cooperation and River Basin management. In the case of some regional instruments, they are also obliged to submit periodic reports to the relevant convention and protocol bodies on their implementation. In their efforts to achieve these standards and rules, the countries have access to a wide range of supporting mechanisms, including European pre-accession instruments, as well as other bilateral funding and international assistance mechanisms through UN agencies and other international organisations.

The 2030 Agenda for Sustainable Development[10]

4 UNESCO (1971): *Convention on Wetlands of International Importance especially as Waterfowl Habitat, Paris.*

5 UNECE (1991): *Convention on Environmental Impact Assessment in a Transboundary Context (Espoo [EIA] Convention), Geneva.*

6 UNECE (2003): *Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context, Geneva.*

7 UNECE (1992): Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Water Convention or Helsinki Convention), Geneva.

8 UNECE (1998): *Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention), Geneva.*

9 UNECE (1999): *Protocol on Water and Health to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes, Geneva.*

sets clear goals and targets to achieve sustainable development globally. When implementing policies and measures for achieving these goals, it is important to understand the interdependencies between the goals in relation to natural resources. This allows more informed decisions to be taken on strategic matters (e.g., socio-economic development, energy security, climate action) and the management of natural resources (e.g., water, land, forests, etc.) to be improved.

All riparian countries of the Drina Basin have taken steps towards accession to the European Union (EU), thus committing to working towards the adoption of relevant elements of the EU regulations and policies related to water, agriculture, energy and environment, including the *Water Framework Directive (WFD)*[11] and related directives, *the Flood Directive*[12], *Common Agricultural Policy, Rural Development Policy, the Renewable Energy Directive*[13], the 2030 climate and energy framework[14] and various other energy-related directives and strategies, as well as directives related to environment protection, such as those on birds and habitats. For the Drina countries, as non-EU Member States, these commitments are part of closing chapters in the accession process and are subject to progress monitoring without specific sanctions other than a delay in accession. EU policies and processes represent both a driver and an opportunity to improve management via the Nexus approach – the EU initiative to improve resource efficiency beyond sectoral mandates[15] [16], is a good example.

An important window of opportunity for the riparian countries to advance the application of the Nexus approach is associated with the *European Green Deal*[17], providing the foundation of the *Green Agenda for the Western Balkans. The European*

11 EC (2000): *Directive 2000/60/EC of the European Parlia- ment and of the Council of 23 October 2000 establishing a framework for the Community action in the field of wa- ter policy, Official Journal L 327/1, Brussels.*

12 EC (2007): *Directive 2007/60/EC of the European Parlia- ment and of the Council of 23 October 2007 on the as- sessment and management of flood risks, Official Jour- nal L 288/27, Brussels.*

13 EC (2009): *Directive 2009/28/EC of the European Par- liament and of the Council of 23 April 2009 on the pro- motion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, Official Journal L 140/16, Brussels.*

14 EC (2013): *Green Paper – A 2030 framework for climate and energy policies, Communication COM(2013) 169, Brussels.*

15 EC (2011): *Roadmap to a Resource Efficient Europe, Communication COM(2011) 571, Brussels.*

16 EC (2015): *Taking the EU Resource Efficiency Agenda Forward: A policymaker and business perspective, Re- port prepared for the EC, Luxembourg.*

17 EC (2019): *The European Green Deal, Annex to the Com- munication COM(2019) 640, Brussels.*

Green Deal is an ambitious package of measures – ranging from reducing greenhouse gas emissions, to investing into research and innovation, to preserving the environment – developed with the goal of reaching the target of a climate-neutral Europe in 2050. Reaching this target requires action by all sectors of economy, and the *Green Deal* therefore covers a wide range of policy areas, including sustainable agriculture and food systems, sustainable industry and mobility, clean energy, building and renovating, eliminating pollution, and protecting the environment. National Energy and Climate Plans (NECPs) are considered by the European Commission (EC) to be the foundation for delivering the *Green Deal*. Therefore, the ongoing process of drafting the NECPs in the economies of the Western Balkans region, and the revision of their Nationally Determined Contributions, which is progressing in parallel, provide an essential link to the actions foreseen in the *Green Deal*, as well as the opportunities for these countries that may arise from it.

2.1.2 SEE regional level

There is a solid framework for the implementation of development activities in the Drina River Basin, provided by strategies at Danube regional and SEE levels. These include:

a) The *EU Strategy for the Danube Region (EUSDR)*[18], which is a macro-regional strategy seeking to create synergies and coordination between existing policies and initiatives taking place across the Danube region. The *EUSDR* addresses a wide range of issues, divided among 4 pillars and 12 priority areas. Although the strategy is not focused on funding but on closer cooperation, its priority areas 2 ('To ensure more sustainable energy'), 4 ('To restore and maintain the quality of waters'), 5 ('To manage environmental risks'), 6 ('To preserve biodiversity, landscapes and the quality of air and soils'), and 10 ('To step up institutional capacity and cooperation') provide an important framework for the implementation of Nexus-related activities by the Drina riparian countries.

b) The SEE regional growth strategy *SEE 2020 – Jobs and Prosperity in a European Perspective (SEE 2020 Strategy)*[19], as well as the subsequent *SEE 2030 Strategy*[20], both developed under the Regional Cooperation Council. *The Phase II Drina Nexus Project* is directly linked to Dimension J 'Environment', Action 'Identify steps and measures necessary for advancing the water, energy and food Nexus approach at national and transboundary levels', of the *SEE 2020 Strategy*.

c) The Regional Strategy for Sustainable Hydropower in the Western Balkans[21], developed within a process supported by the EC.

The riparian countries' efforts towards full application of the Nexus approach could be facilitated through the existing sub-regional cooperation mechanisms, such as:

1. the **Energy Community,** aiming to extend the EU's single energy market to its neighbourhood region, including the Western Balkans, and providing a platform where the three Drina River Basin countries cooperate on energy matters,
2. the **International Commission for the Protection of the Danube River** (ICPDR), the implementing body of the *Convention on Cooperation for the Protection and Sustainable Use of the Danube River (Danube River Protection Convention)*[22], a platform for cooperation among the Drina countries on water and environment issues, as all these countries are members of ICPDR;
3. the **International Sava River Basin Commission** (ISRBC), the implementing body of the *Framework Agreement on the Sava River Basin*[23] and its protocols as a platform of cooperation among the countries sharing the Sava River Basin on all aspects of water resources management, including water uses, water and environment protection, and protection from harmful effects of water;
4. the **Regional Cooperation Council** (RCC), working to facilitate regional dialogue and cooperation to enable the implementation of programmes aimed at economic and social development of the region, as well as its Biodiversity Task Force of South-East Europe, established under the RCC's Regional Working Group on Environment to contribute to the implementation of MEAs and facilitate the transposition of EU nature conservation acquis; and
5. the **Regional Rural Development Standing Working Group** in SEE (RRD SWG), working to empower and promote sustainable rural development in SEE.

18 EC (2010): *European Union Strategy for the Danube Region, Communication COM(2010) 715, Brussels.*

19 RCC (2013): *SEE 2020 – Jobs and Prosperity in a European Perspective, Sarajevo.*

20 RCC (2021): *SEE 2030 Strategy, Sarajevo.*

21 WBIF (2019): *Regional Strategy for Sustainable Hydropower in the Western Balkans, Executive Summary.*

22 DRPC (1994): *Convention on Cooperation for the Protection and Sustainable Use of the Danube River (Danube River Protection Convention), Sofia.*

23 FASRB (2002): *Framework Agreement on the Sava River Basin, Kranjska Gora.*

The transboundary water cooperation framework in the Sava River Basin has great potential to support the application of the Nexus approach in the Drina Basin. This framework, comprising *FASRB* as its legal arm and ISRBC as its institutional arm, offers excellent opportunities in this context, given that:

- *FASRB* is the broadest legal framework governing the work of River Basin organisations in Europe that enables an integrated approach to water resources management and covers all development issues based on water use (navigation, hydropower use, agriculture, river tourism).
- The possibility of developing additional protocols to *FASRB*, to regulate specific issues, makes the framework flexible and facilitates the tackling of issues of interest as the need arises. At present, four protocols to *FASRB* are in force, of which the *Protocol on Flood Protection to the FASRB*[24] and the *Protocol on Sediment Management to the FASRB*[25] are of special relevance for the Drina countries in the context of implementation of the Nexus approach.
- By nature of *FASRB, ISRBC* offers a broad platform allowing for the involvement of a wide range of stakeholders from various sectors in applying jointly developed policies and guidelines. At the last Meeting of the Parties (MoP) to *FASRB* (Sarajevo, 24 October 2019), high-level representatives of the ISRBC member countries reaffirmed the importance of sustainable development in the Basin and encouraged ISRBC to continue dialogue with relevant stakeholders from the navigation, hydropower, agriculture, nature conservation and other relevant sectors, for further integration of the economic, social and environmental aspects into the River Basin management planning[26].
- A range of tools has been developed and implemented by ISRBC for the involvement of stakeholders at three levels (provision of information to the public, and consultation and active involvement of stakeholders) that could be used across the entire Drina River Basin.
- There are numerous ISRBC achievements that provide an excellent basis for future actions on implementing the Nexus approach in the Drina River Basin, such as:
    - the *Sava River Basin Management Plan*[27];
    - the *Flood Risk Management Plan for the Sava River Basin*[28];
    - the *Water and Climate Adaptation Plan for the Sava River Basin*[29] and the subsequent *Outline of the Climate Adaptation Strategy for the Sava Basin*[30];
    - the *Outline of the Sediment Management Plan for the Sava River Basin*[31];
    - *policies on the exchange and use of GIS data*[32] *and hydrological and meteorological data*[33]*, as well as the information systems developed for the exchange and use of these data (Sava GIS and Sava HIS); and*
    - *the fully operational Sava Flood Forecasting and Warning System, along with the hydrological and hydraulic models integrated into it.*
- Although Montenegro is not a party to *FASRB* and its protocols, but is involved in the activities coordinated by ISRBC based on a Memorandum of Understanding (signed in Belgrade in 2013)[34], all outputs mentioned in the previous point cover the Montenegrin part of the Sava River Basin, i.e., they apply to and can be used across the entire Drina Basin.
- A solid regional network of institutions, officials and experts from various sectors has been created through the work of ISRBC so far, including environment, water management, waterway transport, energy and tourism. This network, expanded by the stakeholders identified through the Drina Nexus process, could serve as a natural environment for discussion on regional cooperation and implementation of further Nexus-related activities in the Drina Basin. The Expert Group on Flow Regulation and Environmental Flows,

24 ISRBC (2010): *Protocol on Flood Protection to the Framework Agreement on the Sava River Basin, Gradiška.*
25 ISRBC (2015): *Protocol on Sediment Management to the Framework Agreement on the Sava River Basin, Brčko.*
26 ISRBC (2019): *Declaration from the 8th Meeting of the Parties to FASRB, Sarajevo, 24 October 2019.*
27 ISRBC (2014): *Sava River Basin Management Plan, Zagreb.*
28 ISRBC (2019): *Flood Risk Management Plan for the Sava River Basin, Zagreb.*
29 World Bank (2015): *Water and Climate Adaptation Plan for the Sava River Basin, Washington, D.C.*
30 ISRBC (2018): *Outline of the Climate Adaptation Strategy and basin-wide priority measures for the Sava River Basin, Zagreb.*
31 ISRBC (2021): *Outline of the Sediment Management Plan for the Sava River Basin, Zagreb.*
32 ISRBC (2019): *Sava GIS Data Policy, Policy on the exchange and use of Sava GIS data and information, Zagreb.*
33 ISRBC (2014): *Policy on the Exchange of Hydrological and Meteorological data and Information in the Sava River Basin, Zagreb.*
34 The Memorandum is available at: http://www.savacommission.org/dms/docs/dokumenti/documents_publications/memo_of_understanding/final_mou.pdf

established within the Drina Nexus process, whose meetings have been supported and hosted by ISRBC, is a good example.

- The *Joint Plan of Actions for the Sava River Basin, supported by high-level representatives of all member countries of ISRBC, and Montenegro in 2017*[35], outlines the path towards sustainable development and growth of the region with the aim of serving as a catalyst for further enhancement of the cooperation.

- ISRBC has played an important role in the implementation of numerous projects in the Sava (and Drina) River Basin in a variety of functions – as a responsible body on behalf of the beneficiary countries, as a coordination body, a communication platform, etc. In a similar fashion, the ISRBC Secretariat will act as the Regional Implementation Unit within the World Bank's *Sava and Drina Rivers Corridors Integrated Development Multiphase Approach Program (SDIP), which is seen as a prime opportunity for the implementation of certain Nexus-related actions.*

- *ISRBC appears to be a convenient platform for engagement of the Drina countries – e.g., if compared to ICPDR, it is due to a finer 'resolution' (i.e., larger scale) in dealing with issues, less member countries, language issues, etc., yet the activities of ISRBC are fully coordinated with those performed by ICPDR, so that duplication of the Drina countries' efforts in the two cooperation mechanisms is minimised.*

In implementing the Nexus approach in the Drina River Basin, the vast experience in facilitating cross-sectoral coordination, gained by cooperation mechanisms such as ICPDR and ISRBC, can be applied. This experience, which is based on efforts of the two river commissions to reconcile the interests of various water users and integrate water policy with other sectoral policies, includes:

- Implementation of J*oint Statement on Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin*[36], coordinated jointly by ICPDR, the Danube Commission and ISRBC, together with the European Commission;

- Implementation of *Guiding Principles on Sustainable Hydropower Development in the Danube Basin*[37], creating a common vision and understanding on the requirements, policy framework, and issues to be addressed to ensure sustainable use of hydropower in the Danube Basin;

- Preparation of River Basin Management Plans for the Danube and the Sava Basins; and

- Implementation of ISRBC activities related to development of navigation, river tourism, etc.

- The *Green Agenda for the Western Balkans* provides opportunities for supporting the implementation of certain Nexus-related activities in the Drina River Basin. The *Green Agenda*[38], envisaged by the *European Green Deal*, and the connected *Economic and Investment Plan for the Western Balkans*[39], setting out a substantial investment package mobilising up to €9 billion in funding for the region, will support the effective decarbonisation of the region to help Europe reach the 2030 climate targets set forth in the *Paris Agreement*. The *Green Agenda*, whose action plan[40] is coordinated by RCC, deals with most Nexus-relevant issues (i.e., climate change, clean energy transition, waste management, water and soil depollution, sustainable food production and rural development, and ecosystem protection and restoration).

2.1.3 BASIN and NATIONAL LEVELS

There is no cooperation mechanism that includes all Nexus-relevant sectors at the level of the Drina River Basin. Furthermore, there are no multilateral and only a few bilateral agreements between the Drina riparian countries regarding water resources management. Agreements on cooperation in protection against natural and other disasters have been signed by Bosnia and Herzegovina with Montenegro (2008) and with Serbia (2011).[41] The agreement on cooperation in protection against natural and civil disasters between Montenegro and Serbia was signed in 2010, but it has not come

35 ISRBC (2017): *Joint Statement of the representatives of the Parties to the FASRB and Montenegro on Plan of Action and Milestones for the Sava River Basin as a Catalyst for Cooperation in the region, Bled.*

36 ICPDR (2008): *Development of Inland Navigation and Environmental Protection in the Danube River Basin, Joint Statement on Guiding Principles, Vienna.*

37 ICPDR (2013): *Guiding Principles on Sustainable Hydropower Development in the Danube Basin, Vienna.*

38 EC (2020): *Guidelines for the Implementation of the Green Agenda for the Western Balkans, Communication COM(2020) 223, Brussels.*

39 EC (2020): *An Economic and Investment Plan for the Western Balkans, Communication COM(2020) 641, Brussels.*

40 RCC (2021): *Action Plan for the Implementation of the Sofia Declaration on the Green Agenda for the Western Balkans 2021-2030, Sarajevo.*

41 World Bank (2017): *Support to Water Resources Management in the Drina River Basin, Roofreport.*

into force yet.[42] In 2009, Bosnia and Herzegovina initiated the development of a bilateral agreement with Serbia on water management relations (based on a similar agreement with Croatia, signed in 1996); however, the procedure has not been completed to date, pending the ratification of the border agreement between the two countries and their common understanding concerning the distribution of the Drina River hydropower potential.[43] There is also a broader agreement, guiding the cooperation in the areas of energy, transport, tourism, and environment protection; however, it has only been signed between Serbia and an entity of Bosnia and Herzegovina – Republika Srpska.[43]

At national level, the institutional and policy framework needs further strengthening to enable the application of the Nexus approach in the Drina Basin. The importance of coherence and integration between sectoral policies, as well as other policies (e.g., climate change mitigation and adaptation) is increasingly recognised in general, but a Nexus approach is not directly reflected in national or sub-national policies of the riparian countries.[44] The countries have adopted national strategies on sustainable development that establish platforms for consideration of environmental and social impacts of development plans, often leading to the adoption of national legislation on EIA and SEA. The fact that the riparian countries share sectoral and cross-cutting agendas (e.g., on water end environment, energy transition, waste management, connectivity, mobility) offers a great opportunity to leverage synergies across sectors at the Basin level.

2.2 OVERVIEW OF THE PROCESS

A series of participatory water-food-energy-ecosystems Nexus Assessments of transboundary water basins have been carried out under the UNECE *Water Convention*[45] since 2013, using a dedicated methodology[46], with the aim of supporting the administrations of riparian countries to address inter-sectoral issues, reconciling the differing objectives of energy, water management and environment protection, and identify concrete mutually beneficial actions to improve the sustainability of natural resource management. As part of this activity, the UNECE has been facilitating a Nexus dialogue involving the Drina River Basin countries since 2014, by mobilising resources and partnerships toward a political commitment to cooperate across sectors **(Figure 1).**[47]

Figure 1. Nexus activities in the Western Balkans (the Sava and Drina River Basins).

42 ISRBC (2019): *Report on the implementation of the FASRB in the period 1 April 2018 – 30 June 2019, Adopted at the 8th Meeting of the Parties to FASRB, Sarajevo, 24 October 2019.*

43 GEF (2020): *West Balkans Drina River Basin Management Project, Strategic Action Program.*

44 UNECE (2016): *Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus in the Sava River Basin,* New York and Geneva.

45 UNECE (1992): *Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Water Convention or Helsinki Convention), Geneva.*

46 UNECE (2018): *Methodology for assessing the water-food-energy-ecosystems nexus in transboundary basins and experiences from its application: synthesis,* Geneva. Available at: https://unece.org/environment-policy/publications/methodology-assessing-water-food-energy-ecosystems-nexus

47 Other transboundary nexus assessments have been completed in the North-West Saharan Aquifer System, shared by Algeria, Libya and Tunisia, the Syr Darya Basin, shared between Kazakhstan, Kyrgyzstan, Uzbekistan and Tajikistan, and the Alazani/Ganykh Basin, shared by Georgia and Azerbaijan.

This dialogue started with the *Sava Nexus Assessment* (2014-2016)[48], and continued with financial support from the Italian Ministry for the Environment, Land and Sea, as the *(Phase I) Drina Nexus Assessment (2016-2017)*[49], *and the Drina Nexus Follow-Up Project*[50], thus leading to the *Phase II Drina Nexus Assessment* (launched in 2020), presented in this report.

2.2.1 SAVA Nexus Assessment

The Nexus Assessment in the Sava River Basin (2014-2016) was the first of its kind carried out in the region, in order to generate information to support the riparian countries and ISRBC in the implementation of *FASRB*, especially regarding further integration of water policies with other sectoral policies. It introduced the Nexus approach and provided for the identification of stakeholders, prioritisation of Nexus issues and an overview of key inter-sectoral linkages, potential solutions, and untapped benefits.[51]

An important goal was to strengthen dialogue with key sectoral actors, especially in the energy and agriculture sectors. The participatory Assessment process brought together sectoral authorities and other key stakeholders from riparian countries to identify major cross-cutting issues and their possible solutions. An analysis, which was carried out within the project jointly by the EC's Joint Research Centre and KTH Royal Institute of Technology, and followed by consultations with competent sectoral authorities of the riparian countries, with ISRBC as the key partner in the process, contributed to the Sava Assessment that provided for the identification of Nexus priority issues and a partially quantitative Assessment of key interlinkages in the Nexus of water, land use, energy, agriculture and climate.

Recognising the results already achieved through the work of ISRBC as a successful multi-sectoral platform for transboundary cooperation, the Assessment indicated that more intensive transboundary cooperation with the participation of relevant Nexus sectors would bring additional benefits to riparian countries. Possible benefits of implementing a transboundary Nexus approach in the Sava Basin to both economic activities and social and environmental wellbeing were considered. Thanks to the increased trust among the countries, the benefits related to regional cooperation, among other positive effects, could increase cross-border investments and improve the regional market for goods, services and labour. The Assessment concluded with the hope that this work informs, guides, and spurs further action by the governments, ISRBC, international organisations and civil society to address the identified inter-sectoral challenges at the Basin level.[52]

Bearing in mind the usefulness of the *Sava Nexus Assessment* for the riparian countries, both at the national and transboundary levels, the countries of the Drina River Basin agreed to proceed with a detailed analysis of the Drina River Basin as the largest tributary of the Sava, focusing on issues more relevant to the Drina River Basin itself.

2.2.4 DRINA Nexus Assessment (PHASE I)

By building on the findings of the *Sava Nexus Assessment, the Phase I Drina Nexus Assessment* (2016-2017) analysed the hydropower, renewable energy, rural/agricultural development, water quality, and benefits of cooperation in greater detail, as key issues specific to the Drina River Basin.

The *Drina Nexus Assessment* had the following objectives: to foster transboundary cooperation by identifying (i) inter-sectoral synergies that could be further explored and exploited, and (ii) policy measures and actions aimed at reconciling water uses; (iii) to improve the countries' understanding of how the use of Basin resources could be optimised through increased efficiency, improved policy coherence and joint management; and (iv) to contribute to capacity building in the three countries to assess and address inter-sectoral impacts of resource use and management, and to the joint identification of benefits of transboundary cooperation in the Basin.[53] The Assessment was funded by the Italian Ministry for the Environment, Land and the Sea as part of the project *Greening economic development in Western Balkans through applying a nexus approach and identification of benefits of transboundary cooperation.*

Sectoral authorities and other key actors from the riparian countries participated in the Assessment, with a more active engagement of the energy sector, as well as representatives of the non-

48 UNECE (2017): Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus in the Sava River Basin, New York and Geneva.

49 UNECE (2017): Assessment of the water-food-energy-ecosystem nexus and benefits of transboundary cooperation in the Drina River Basin, New York and Geneva.

50 Info on these projects is available at: https://www.unece.org/env/water/nexus.html.

51 UNECE (2016): *Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus in the Sava River Basin*, New York and Geneva.

52 UNECE (2016): *Policy Brief: Increasing welfare in the Sava countries through a transboundary nexus approach*, New York and Geneva.

53 UNECE (2017): *Assessment of the water-food-ener- gy-ecosystems nexus and benefits of transboundary cooperation in the Drina River Basin, New York and Geneva.*

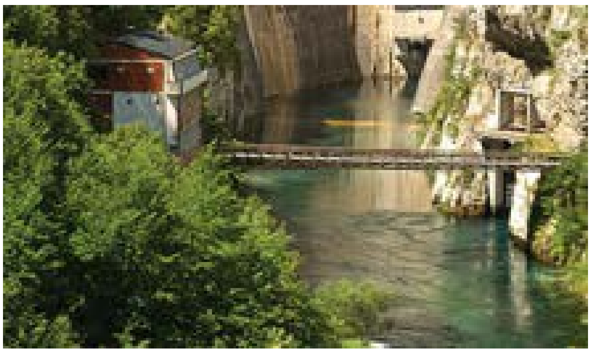
governmental sector. Multi-sectoral workshops[54] were held with the aim of improving the participatory aspect of the Assessment process and to:

- identify inter-sectoral issues and organise multi-sectoral roundtables to discuss potential solutions (21-22 April 2016, Podgorica, Montenegro);
- review preliminary findings and discuss cross-border and cross-sector benefits of cooperation (8-10 November 2016, Belgrade, Serbia); and
- discuss results, solution implementation, and follow-up (19-20 April 2017, Sarajevo, Bosnia and Herzegovina).

Previous analyses of the Sava River Basin have enabled the *Drina Nexus Assessment* to focus on specific topics of interest to stakeholders and to identify areas of action across sectors to advance sustainable development and to achieve multiple benefits through cooperation[55]:

- co-optimisation of flow regulation;
- integrated rural development through eco-tourism, agriculture, and renewable energy sources;
- protection of water quality and improvement of waste management; and
- Basin-level governance to maximise benefits for countries across all sectors.

The Assessment has also yielded a multi-country Drina Water-Energy Model (DWEM) developed by KTH Royal Institute of Technology to analyse scenarios and compare the cooperative operation of hydropower plants (HPPs) with a non-cooperative (uncoordinated) scenario, demonstrating substantive benefits of a coordinated operation of dams, even for electricity generation.



54 The websites of the events can be accessed at: https://unece.org/environment-policy/water/areas-work-convention/water-food-energy-ecosystem-nexus.

55 https://unece.org/environment-policy/water/areas-work-convention/water-food-energy-ecosystem-nexus

2.2.3 DRINA Nexus Assessment Follow-Up

Based on the findings, conclusions and recommendations of the *Phase I Drina Nexus Assessment, the Drina Nexus Follow-Up Project* (2018-2019) further detailed possibilities in four key areas:

1. monitoring of water resources and information exchange in transboundary cooperation;
2. addressing the pressures on water quality, in particular sedimentation;
3. identifying options for formalising a more optimal flow regime (including environmental flows); and
4. supporting investment into sustainable renewable energy with multi-stakeholder dialogue.

Valuable outcomes of the *Drina Nexus Follow-Up Project* included two multi-stakeholder dialogues, one organised in Bosnia and Herzegovina, and one in Serbia, aimed at uncovering barriers and opportunities to renewable energy (Renewable Energy Hard Talks)[56], and conclusions and recommendations on Nexus trade-offs and opportunities, drawn at the two events[57,58], as well as the establishment of an Expert Group on Flow Regulation and Environmental Flows (EG FREF), comprised of members with diverse expertise (water management and environmental protection authorities, hydropower operators and civil society from the three riparian countries), whose first meeting was held on 11-12 June 2019 in Zagreb, hosted by ISRBC.[59]

The project has also provided two outputs:

- *Scoping Study on Erosion and Sedimentation in the Drina River Basin*[60], focused on the

56 More information on the Renewable Energy Hard Talks is available at: https://www.unece.org/energywelcome/areas-of-work/renewable-energy/unece-hard-talks.html.

57 UNECE (2018): *Conclusions and recommendations from the Hard Talk: New Possibilities for Developing Renewable Energy Sustainably in Bosnia and Herzegovina*, Sarajevo, 4-5 Dec. 2018.

58 UNECE (2019): *Recommendations from the Hard Talk: New Possibilities for Developing Renewable Energy Sustainably in Serbia*, Belgrade, 21-22 March 2019.

59 The presentations and documentation related to the meeting are available at: https://unece.org/environmental-policy/events/expert-group-flow-regulation-and-environmental-flows.

60 Technical report by the Jaroslav Černi Water Institut (Belgrade) for UNECE (2019): *Scoping study on erosion and sedimentation in the Drina River Basin.* Available at: https://unece.org/environment-policy/water/areas-work-convention/water-food-energy-ecosystem-nexus

identification of the Basin's areas with a deficit and surplus of sediment, producing an erosion map, as well as proposing zones for surveillance and priority actions, and

- *Desk Study on Environmental Flows and Flow Regulation in the Drina River Basin*[61], providing:
  - a review of international practice with environmental flows and good practices (in particular in the EU and SEE) and an analysis of the environmental flow regulation and its implementation in the three Drina countries;
  - an analysis of relevant international examples of agreeing at the transboundary level upon specific aspects of flow regulation and reconciling different uses; and
  - recommendations and options for formalising the flow regulation in the Drina Basin.

The Drina Nexus Follow-Up Project concluded with a High-Level Workshop (Belgrade, 29 October 2019) that gatthered policymakers, power companies, financial institutions, international organisations and civil society representatives from the Drina Basin countries, to discuss inter-sectoral and transboundary cooperation for the sustainable development and protection of the Basin.

Following the presentation of the project results and a dialogue on two key issues of the water-energy-environment Nexus in the Basin, namely:

- how to better balance development, considering energy generation, land management and water use, and sustainability, including the environment, in the Basin, and
- what is necessary to achieve investments that provide benefits for multiple sectors and that, as such, can be considered "Nexus investments",

a statement from high-level representatives of the riparian countries, focused on reconciling sectoral flow regulation needs, and solutions/investments with multi-sector benefits[62], was endorsed as an overarching outcome of the project.

61 Technical report by Rafael Sanchez Navarro for UNECE (submitted in December 2019, revised in June 2021) Available at: https://unece.org/environment-policy/water/areas-work-convention/water-food-energy-ecosystem-nexus

62 Statement from the high-level workshop *"Action across sectors and borders for sustainable future of the Drina River Basin"*, Belgrade, 29 October 2019.

The statement from the High-Level Workshop is a call to all stakeholders involved in the management of natural resources in the Basin, or concerned with sustainable development of the region, to join forces and develop concerted strategies, aligned policies, and measures coordinated across sectors and countries. This statement is an important first step towards the political commitment to transboundary cooperation on sustainable development of the Drina River Basin.

2.2.4 DRINA Nexus Assessment (PHASE II)

Following up on this sequence of projects and their outcomes, the *Phase II Drina Nexus Assessment*, launched in 2020 under the ADA-funded SEE Nexus Project, aims at deepening the analysis of two crucial issues for development and transboundary cooperation that emerged in the previous projects – sustainable energy development (renewable energy and hydropower, in particular) and flow regulation in the Basin (agreeing on key aspects and making progress towards formalising some of these aspects).

The second, subsequent, aim is to set the basis for development of the *Drina Nexus Roadmap*, translating the recommendations from the Assessments into political commitments.

2.2.5 Relevant SIDE PROJECTS

Besides the series of Nexus Assessments described above, recent projects encompassing the Drina River Basin offer a wealth of data and outcomes that future Nexus-related activities can build upon. The following projects are considered particularly important in this regard:

1. *Water and Climate Adaptation Plan for the Sava River Basin*[63], providing a range of climate change scenarios and a set of adaptation guidance notes for various sectors, including hydropower use, agriculture, and flood protection;
2. Outline of the *Climate Adaptation Strategy and basin-wide priority measures for the Sava River Basin*[64], elaborating further on potential climate change impacts on water resources, economic sectors, nature conservation, and other sectors, as well as the adaptation guiding principles, objectives, and measures;

63 World Bank (2015): *Water and Climate Adaptation Plan for the Sava River Basin*, Washington, D.C.

64 ISRBC (2018): *Outline of the Climate Adaptation Strategy and basin-wide priority measures for the Sava River Basin*, Zagreb.

3. *Support to Water Resources Management in the Drina River Basin*[65], aimed at supporting water management authorities in preparation of investment plans, SEA, and river basin management plans, and proposing an integral development scenario for the Drina Basin; and

4. *West Balkans Drina River Basin Management Project*[66],[67] aiming to improve mechanisms and strengthen capacities in the Drina riparian countries to plan and manage the Basin, through development of a study of the Basin and its water resources, hydraulic and hydrological modelling of the Basin with reservoir operation, and the subsequent, agreed Strategic Action Programme (SAP), mainstreaming the integrated water resources management and climate change adaptation in national planning.

The *Sava and Drina Rivers Corridors Integrated Development Program* (SDIP) provides good opportunities for the implementation of Nexus-related actions in the future. The programme, launched by the World Bank in 2021, has an estimated cost of US$332.4 million and will be implemented in two phases over a 10-year period (2021 - 2030)[68]. The opportunities for the Drina countries originate primarily from the following facts:

- The main goal of *SDIP* is to facilitate integrated water resources management and development along the Sava and Drina River corridors, through integration of improved flood and drought management, (eco-) tourism development, agriculture, hydropower, and climate change adaptation, as well as enhancing transboundary water cooperation in the region. Thus, the programme's scope is sufficiently broad and covers practically all Nexus-relevant areas.

- *SDIP* will be implemented in two phases: Phase I (2021-2026) will be implemented with the three Drina countries (and with Croatia and Slovenia participating in regional activities), while Phase II (2023–2030) is envisaged to implement sub-projects that will be prepared during Phase I, with an emphasis on multipurpose, integrated, and transboundary investments – including into flood protection, hydropower optimisation, environmental improvements, recreation, and tourism – with the aim of further strengthening regional integration and connectivity. The sub-projects will be implemented at national level and will have cumulative regional benefits.

- Phase I of *SDIP* includes a component dedicated entirely to integrated management and development of the Drina River corridor. This component (with a €21 million budget) includes two subcomponents: (i) Flood protection and environmental management, and (ii) Integrated development of the Drina watershed, which will finance infrastructure works (e.g., related to flood protection, drainage, and irrigation measures), detailed design, studies, surveys, and consultations based on findings of the *Drina River Basin Management Project.*[69,70]

- The regional component of *SDIP* has great potential to support the achievement of objectives of further Nexus-related actions in the Drina Basin. This component, to be financed through an €8 million grant in Phase I, is aimed at strengthening strategic regional dialogue and joint planning, as well as sustainable management and development of the shared water resources in the Sava and Drina River Basins. It will allow for the preparation of key regional studies and plans (e.g., preparation of the 2nd Sava RBM Plan, hydrological study, sediment study, climate change adaptation strategy, master plan for sustainable tourism development, and upgrade of flood monitoring, forecasting and management system for the Sava River Basin) that may serve as a good foundation for the implementation of Nexus-related actions in the Drina River Basin.

- The regional component of *SDIP* has great potential to support the achievement of objectives of further Nexus-related actions in the Drina Basin. This component, to be financed through an €8 million grant in Phase I, is aimed at strengthening strategic regional dialogue and joint planning, as well as sustainable management and development of the shared water resources in the Sava

65 World Bank (2017): *Support to Water Resources Management in the Drina River Basin*, Roof report, Washington, D.C.
66 GEF (2020): *West Balkans Drina River Basin Management Project, Strategic Action Program.*
67 GEF (2021): *West Balkans Drina River Basin Management Project, Drina River Basin Water Resources and Basin Study and Hydraulic and Hydrological Modelling for the DRB with Reservoir Operation*, Final Report, Volume 0: General book.
68 World Bank (2020): *Sava and Drina Rivers Corridors Integrated Development Multiphase Approach Program*, Project Appraisal Document, Washington, D.C.
69 GEF (2020): *West Balkans Drina River Basin Management Project, Strategic Action Program.*
70 GEF (2021): *West Balkans Drina River Basin Management Project, Drina River Basin (DRB) Water Resources and Basin Study and Hydraulic and Hydrological Modelling for the DRB with Reservoir Operation*, Final Report, Volume 0: General book.

and Drina River Basins. It will allow for the preparation of key regional studies and plans (e.g., preparation of the *2nd Sava RBM Plan*, hydrological study, sediment study, climate change adaptation strategy, master plan for sustainable tourism development, and upgrade of flood monitoring, forecasting and management system for the Sava River Basin) that may serve as a good foundation for the implementation of Nexus-related actions in the Drina River Basin.

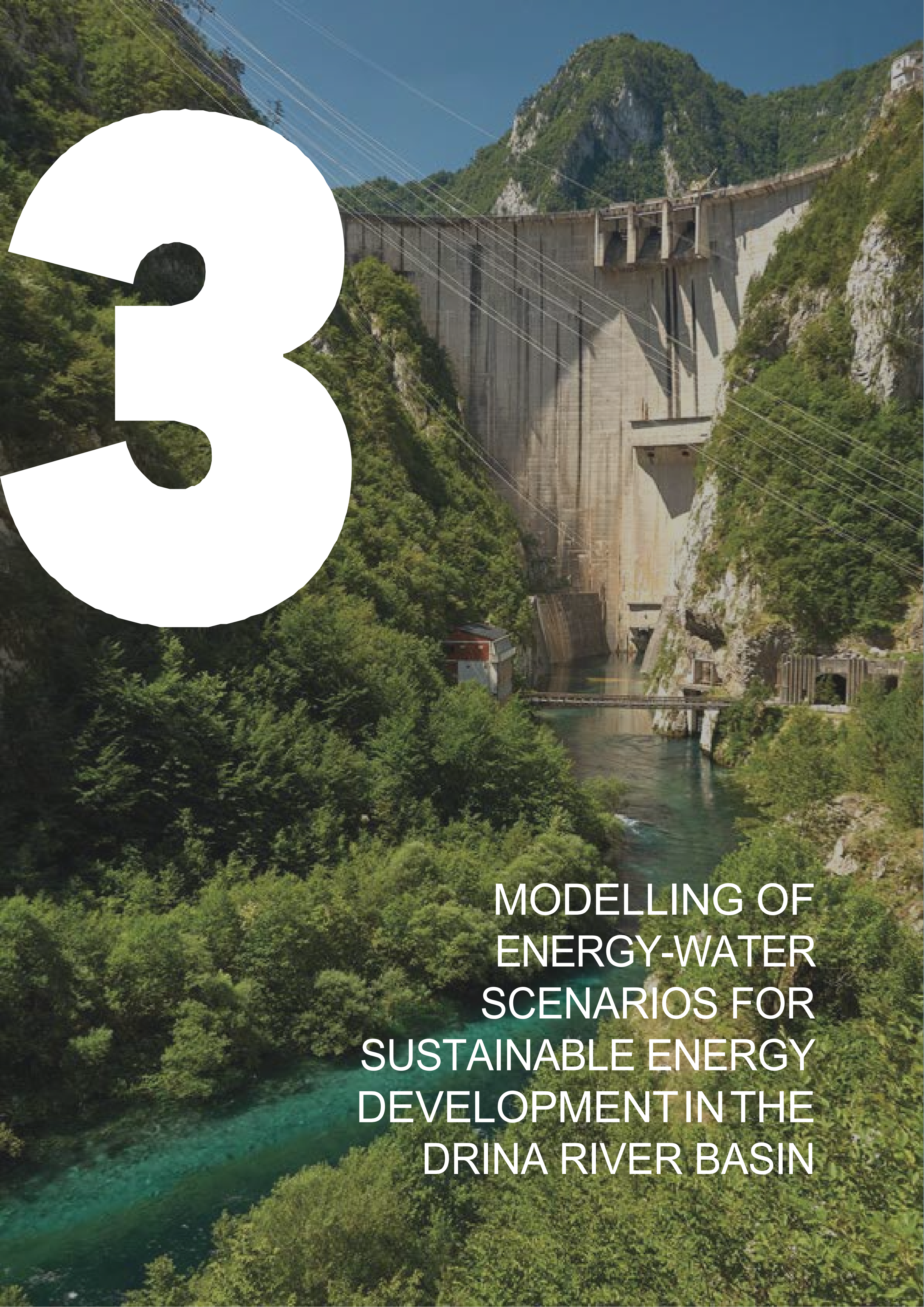
2.3 CONCLUSIONS AND RECOMMENDATIONS

As described in Section 2.2 of the report, a multi-sector dialogue, supported by the participatory water-food-energy-ecosystems Nexus Assessment process involving the Drina River Basin countries since 2014, has helped the national authorities to reach a common understanding on a number of issues of key importance for improved management of the Basin's natural resources, and enhanced water, energy, food and environmental security in the region, as well as its sustainable development.

These issues primarily include:

- further strengthening of transboundary and inter-sectoral cooperation and coordination within the Drina River Basin, and further application of the Nexus approach as a tool to reconcile potentially conflicting sectoral interests, while harnessing existing opportunities and exploring emerging ones;
- focusing on the priority Nexus issues identified during the Drina Nexus process, and building on the partnerships, established during the process among the institutions from the water management, environment and energy sectors, both at the technical and at the decision-making level;
- optimal use of the existing cooperation mechanisms dealing with the Drina Basin, as well as their outcomes and outputs, while seeking synergies with the processes of implementation of the two key regional commitments *(the Green Agenda for the Western Balkans and the SEE 2030 Strategy)* and relevant projects and programmes targeting the Basin;
- exploring possibilities to ensure funding for the implementation of Nexus-related projects in the Basin (e.g., from financial instruments and supporting mechanisms such as the Green Climate Fund).

Key conclusions and recommendations, drawn up during the Drina Nexus process, are summarised in Section 5.1 of the report, and a detailed overview of conclusions and recommendations, related to all Nexus issues identified during the process, is provided in Annex 1 (Section 7.1 of the document).



3

MODELLING OF ENERGY-WATER SCENARIOS FOR SUSTAINABLE ENERGY DEVELOPMENT IN THE DRINA RIVER BASIN

The UNECE *Water Convention*[71] carried out the Assessment of the water-food-energy-ecosystems Nexus in a number of transboundary basins, with the aim of supporting the authorities of riparian countries to address inter-sectoral issues, reconciling the differing objectives of energy, water management and environment protection, and to identify concrete mutually beneficial actions to improve the sustainability of natural resource management.

The single cross-sectoral issue most prone to causing friction in transboundary basins is the operation of dams, both for irrigation and hydropower generation. The dams affect all water-dependent ecosystems. Effectively addressing this Nexus issue early on, by preventing or reducing negative inter-sectoral and environmental impacts across borders, implies empowering water managers and environment authorities to open an informed dialogue with the energy sector, including utilities suppliers. A modelling analysis could be very useful to support this dialogue.

This section of the report presents the analysis carried out by KTH Royal Institute of Technology as a part of the Phase II Drina Nexus Assessment, building on an Assessment of the Sava River Basin carried out in 2014-2016[72], and the first (or Phase I) Assessment of the Drina Basin carried out in 2016-201773. Both the Sava and Drina Phase I Assessments were supported by water-energy integrated modelling.

71 UNECE (1992): *Convention on the Protection and Use of Transboundary Watercourses and International Lakes*, Geneva.

72 UNECE (2016): *Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus in the Sava River Basin*, New York and Geneva.

73 UNECE (2017): *Assessment of the water - food - energy - ecosystems nexus and benefits of transboundary cooperation in the Drina River* Basin, Geneva. Available at:https://unece.org/DAM/env/water/publications/WAT_NONE_9_Drina/Drina-FINAL-EN-WEB_final-correct.pdf

The section introduces water-energy planning questions in the Drina River Basin and the objectives of this analysis, and then describes the methodology, the scenarios, the results of the analysis and the policy-relevant questions that could be posed. The assumptions and data used are reported in Annex 2 (Section 7.2 of the document).

3.1 CONTEXT AND SCOPE

As part of the first Drina Assessment, KTH Royal Institute of Technology carried out a model-based analysis of the benefits of cooperation in the operation of dams in the Drina River Basin in terms of electricity generation. The analysis gave a first-order quantification of the potential benefits. However, it left questions open regarding the role non-hydro renewables could have in the electricity supply in the Basin. It did not touch upon potential effects of climate change on the hydropower supply in and outside of the Basin and the possibility for non-hydro renewables to balance out the effects. As of today, there have been no studies specifically assessing the potential impacts of climate change on hydropower in the Basin.

Several studies indicated the possibility of increasing temperatures and significantly decreasing rainfall in the Drina Basin countries in the coming decades, with potential intensification of precipitations during winter.[74,75,76] This could cause an overall decrease of water discharge and in turn a reduction of energy production from hydropower, which would present two main issues for countries where hydropower is the main electricity source and/or the main renewable one. The first issue is the potential impact of this reduction on the security of supply, and the second one is the need to supply from other (often carbon-intensive) sources, or through imports.

The *Drina Nexus Assessment Follow-Up Project* (2018-2019), funded by the Italian Ministry of Environment, Land and Sea, focused on sedimentation, flow regulation, monitoring and renewable energy. As part of the latter topic, two 'Renewable Energy Hard Talks' events were organised in two of the Drina riparian countries (Bosnia and Herzegovina [2018], and Serbia [2019]), in collaboration with the Sustainable Energy Division (SED) of UNECE. There, the opportunity of further studying hydropower development with a Nexus approach at the level of Drina was discussed with energy stakeholders from the

74 ISRBC (2013): *Sava River Basin Management Plan. Background Paper No. 10.* Available at: http://www.savacommission.org/srbmp/en/draft

75 A. Ceglar and J. Rakovec (2014): *Climate Projections for the Sava River Basin.* Springer.

76 Radmila Milačić, Janez Ščančar, and Momir Paunović (2015): *The Sava River* (The Handbook of Environmental Chemistry). Springer.

public and private sectors. The need to focus on the interdependencies between the management of water resources (related to Sustainable Development Goal [SDG] 6) and the supply of affordable, reliable, sustainable and modern energy (related to SDG 7) emerged. This led to a second (or *Phase II*) *Drina Nexus Assessment*, of which this report is an output.

In the context of the *Drina Nexus Assessment*, the overall prospected developments of the riparians' power sector deserve attention. The Drina Basin countries, as part of the Western Balkans, are actively working on meeting set targets in line with the Energy Community *acquis*. They are also members to ICPDR, which developed the *Guiding Principles on Sustainable Hydropower Development in the Danube River Basin*, adopted in June 2013.[77] The Drina riparians made legally binding commitments by adopting the *Energy Community Treaty* in 2006. They further expressed their commitment to sustainable development within the energy sector by signing the *Energy Community Treaty*[78], the *UN Agenda 2030*[79] and the *Paris Agreement*[80] (in addition to previous agreements such as the *Kyoto Protocol*[81] and the *Energy Charter Treaty*[82]). Specifically, all riparians submitted their Intended Nationally Determined Contribution (INDC) to the *United Nations Framework Convention on Climate Change (UNFCCC)* in 2017, and Bosnia and Herzegovina and Montenegro updated theirs in 2021.[83] The latest of several treaties and declarations signed by the DRB countries is the *Sofia Declaration* signed in November 2020, through which the countries have adopted the *Green Agenda for the Western Balkans*.[84] This is a strategic document for the countries to achieve climate-neutral economies through structural changes.

This declaration binds the parties to align with the *EU Climate Law* once adopted, to achieve climate neutrality by 2050. In addition, the *Sofia Declaration* sets actions to align with the EU Emissions Trading Scheme (ETS) to reduce greenhouse gas emissions[85], prioritise energy efficiency, and strive to decrease and gradually phase out coal subsidies. The phase-out of coal subsidies, as well as active participation in the Coal Region in Transition initiative for the Western Balkans[86], is of high importance for the Drina countries. There are five coal regions in Bosnia and Herzegovina, one in Montenegro, and four in Serbia. The initiative aims to help countries and regions to move away from coal towards a carbon-neutral economy. The European Union, through the *Green Deal*, plans to enforce a Carbon Border Adjustment Mechanism (CBAM). Since it is heavily coal-dependent, the electricity sector of the Western Balkans will be affected, especially electricity exports to the other countries within the CBAM. To avoid being subject to a potential CBAM, Montenegro was the first Energy Community contracting party to implement an emission credits system, i.e., a carbon tax.[87]

Previous relevant studies on the energy, water-energy and climate sectors in the Drina Basin and the broader region (Western Balkans) are summarised in Table 1 (non-comprehensive)

77 Available at: https://www.icpdr.org/main/activities-projects/hydropower.

78 Energy Community (2006): *Treaty establishing the Energy Community*. Available at: https://www.derk.ba/DocumentsPDFs/Energy%20Community%20Treaty.pdf.

79 UN (2015): *Transforming our world: the 2030 Agenda for Sustainable Development.* Available at: https://sdgs.un.org/2030agenda

80 UN (2015): *Paris Agreement.* Available at: https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&clang=_en

81 UN (1997): *Kyoto Protocol to the United Nations Framework Convention on Climate Change.* Available at: https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-a&chapter=27&clang=_en.

82 International Energy Charter (1994): *The Energy Charter Treaty*. Available at: https://www.energycharter.org/process/energy-charter-treaty-1994/energy-charter-treaty/.

83 UNFCCC (2015): *NDC Registry.* Available at: https://www4.unfccc.int/sites/NDCStaging/Pages/All.aspx.

84 RCC (2020): *Sofia Declaration on the Green Agenda for the Western Balkans*. Available at: https://www.rcc.int/download/docs/Leaders%20Declaration%20on%20the%20Green%20Agenda%20for%20the%20WB.pdf/196c92cf0534f629d43c460079809b20.pdf

85 The ETS forms a part of the EU climate policy. It aims at reducing greenhouse gas emissions through the trading of carbon credits. See: https://ec.europa.eu/clima/ eu-action/eu-emissions-trading-system-eu-ets_en.

86 EC (2021): *Initiative for coal regions in transition in the Western Balkans and Ukraine.* Available at: https://ec.europa.eu/energy/topics/oil-gas-and-coal/coal-regions-in-the-western-balkans-and-ukraine/initiative-coal-regions-transition-western-balkans-and-ukraine_en.

87 Montenegro adopts bylaw to introduce emission credits system. (Balkan Green Energy News, 2020). Available at:https://balkangreenenergynews.com/montenegro-adopts-bylaw-to-introduce-emission-credits-system/.

Table 1. Studies related to the energy sector in the Western Balkans

Title	Institution / Authors	Publication year
Drina River Basin (DRB) Water Resources and Basin Study and Hydraulic and Hydrological Modelling for the DRB with Reservoir Operation[88]	Stucky, J. Černi, BETA Studio	2021
A carbon pricing design for the Energy Community[89]	Energy Community	2021
Renewable Energy Market Analysis: Southeast Europe[90]	IRENA	2019
The role of Energy-Water nexus to motivate transboundary cooperation: An indicative analysis of the Drina River Basin[91]	Almulla, Y., Ramos, E., Gardumi, F., Taliotis, C., Lipponen, A., & Howells, M.	2018
Western Balkans: Directions for the Energy Sector[92]	The World Bank ESMAP	2018
Renewable electricity in Western Balkans: Support policies and current state[93]	Rakic, Nikola & Gordic, Dusan & Šušteršič, Vanja & Josijevic, Mladen & Babić, Milun	2018
Support to water resources management in the Drina River Basin[94]	The World Bank, J. Černi, Stucky, COWI	2017
Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems Nexus in the Sava River Basin	UNECE	2017
Assessment of the water-food-energy-ecosystem Nexus and benefits of transboundary cooperation in the Drina River Basin	UNECE	2017
Sharing the gains from EU–Western Balkan renewable electricity cooperation[95]	Frieden, Dorian & Tuerk, Andreas & Dukan, Mak & Ortner, Andre & Lilliestam, Johan	2016
Future Prospects for Renewable Energy sources in the West Balkan countries[96]	CIEMAT	2013

88 Stucky (2021): *Drina River Basin (DRB) Water Resources and Basin Study and Hydraulic and Hydrological Modelling for the DRB with Reservoir Operation.* Available at: https://www.wbdrina2020.com/.

89 Energy Community (2021): *A carbon pricing design for the Energy Community - Final Report.* Available at: https://www.energy-community.org/dam/jcr:82a4fc8b-c0b7-44e8-b699-0fd06ca9c74d/Kantor_carbon_012021.pdf

90 IRENA (2019): *Renewable Energy Market Analysis: Southeast Europe.* Available at: https://www.irena.org/publications/2019/Dec/RE-Market-Analysis-Southeast-Europe.

91 Y. Almulla, et al. (2018): The role of Energy-Water nexus to motivate transboundary cooperation: An indicative analysis of the Drina River Basin. *International Journal of Sustainable Energy Planning and Management,* doi: https://doi.org/10.5278/ijsepm.2018.18.2

92 World Bank, ESMAP (2018): *Western Balkans: Directions for the Energy Sector.* Available at: http://documents1.worldbank.org/curated/en/201391544823541838/pdf/Western-Balkans-Energy-Directions-Paper.pdf

93 N. Rakic, et al. (2018): *Renewable electricity in Western Balkans: Support policies and current state.* Thermal Science, doi: 10.2298/TSCI180512169R.

94 World Bank (2017): *Support to Water Resources Management in The Drina River Basin.* Available at: http://www.wb-drinaproject.com/pdf/Roof%20Report%20-%20English%20-%20Final.pdf.

95 D. Frieden, et al. (2016): *Sharing the gains from EU–Western Balkan renewable electricity cooperation.* Climate Policy, doi: 10.1080/14693062.2016.1155041.

96 A. Tuerk, et al. (2013): *Future Prospects for Renewable Energy sources in the West Balkan countries.*

This modelling analysis addresses the need that emerged in the Hard Talks: to deepen the study of hydro development in the Drina Basin, in relation to the riparians' latest commitments – namely the NDCs and the Sofia Declaration. It furthers the first Drina Assessment, in that it focuses on the operation of hydropower infrastructure when boundary conditions change (e.g., increased share of non-hydro renewables, introduction of the EU Emission Trading Scheme [ETS] and increased ambition in climate change mitigation policies). In this way, it provides a quantitative analysis that delivers more specific insights on the possible future role of hydro and non-hydro renewable energy infrastructure within and beyond the Drina Basin, in the broader context of the multi-country electricity systems of the three riparian countries.

The analysis addresses the following policy-relevant questions, left open by the previous Assessment and identified as key in the Hard Talks:

1. What role can renewables (hydro and non-hydro) in the Drina Basin play in achieving the *UNFCCC* NDCs of the riparian countries?
2. What benefits does an increased share of non-hydro renewable energy bring in terms of greenhouse gas emissions reduction and decreasing reliance on hydropower production?
3. If the proposed plans for HPP development in the Drina Basin are executed, what could be the share of power supply and installed capacity of non-hydro RES, in a least-cost electricity system?
4. What are the effects of climate-induced variability on hydropower generation? How does this affect planning of new hydropower?
5. What effects can the Emission Trading Scheme, as part of the EU integration pathway, have on the hydro and non-hydro renewable energy development in the riparian countries?
6. How are different technologies impacted by the implementation of energy efficiency measures (demand- and supply-side) and by further ambitions in the deployment of renewables?

3.2 METHODOLOGY

The above-mentioned questions were investigated through a scenario analysis, considering several options for the long-term development and operation of the water-energy infrastructure in the Drina River Basin. The analysis identifies infrastructure developments, changes in the electricity supply mix, and costs that the electricity system of the riparian countries (in and beyond the Basin) may bear in the coming decades in each of the situations analysed. It is based on the latest publicly available data, as well as inputs from local institutions, collected through a stakeholder consultation process. Key occasions of exchange and feedback on the progress of the analysis were the meetings of the Steering Committee for Nexus activities in the Drina River Basin and a number of national consultations in Bosnia and Herzegovina, Montenegro, and Serbia.

The assessment of issues related to the water-energy Nexus in the Drina River Basin requires an 'integrated' modelling approach. That is, it implies examining the water and energy systems and the interactions between them. The reason can be explained with one example. New hydropower infrastructure is planned in the Drina River Basin. When starting operation, this infrastructure could increase the electricity supply potential of the Basin and therefore the export potential of the riparian countries. However, this type of infrastructure requires significant capital investments and has an operational life of several decades. Therefore, its operation and profitability must be analysed with a very long-term perspective, if it is not to become a stranded asset. Within the same timeframe, climatic changes in the region may affect the generation of new hydropower plants by making it more variable and potentially decreasing it on average. Hydro generation may need to be backed up by new investments in non-hydro renewables or fossil-fuel generation, for ensuring the security of supply on the one hand, and fulfilling the greenhouse gas mitigation objectives on the other.

The Climate-Land-Energy-Water (CLEWs) framework[97] was created to aid coordinated and coherent policy and investment decision-making across the land, energy and water sectors, and it is employed to inform researchers and policymakers about trade-offs among sectors.[98] The CLEWs

97 Developed by IAEA, UNDESA, UNECE, UNDP, and KTH. Reference: M. Howells et al., "Integrated analysis of climate change, land-use, energy and water strategies," Nature Climate Change, vol. 3, no. 7, pp. 621-626, 2013/07/01 2013, doi: 10.1038/nclimate1789.

98 E. P. Ramos et al., "The Climate, Land, Energy, and Water systems (CLEWs) framework: a retrospective of activities and advances to 2019," Environmental Research Letters, 2020/12/14 2020, doi: 10.1088/1748-9326/abd34f.

framework mostly uses open-source and freely available modelling tools to create easy-to-grasp yet realistic representations of the interlinkages between climate, land, energy and water resources[99], which may be used as a discussion ground for Nexus dialogues or as a scientific basis for planning.

The CLEWs framework has been used in the Nexus Assessment of the Drina River Basin since its first phase (Phase I), with a focus on the interlinkage between climate, energy, and water. Given that the model does not explicitly consider land use aspects, we will refer to it as the Water-Energy model from now on. The model development is part of the UNECE's *Methodology for assessing the water-food-energy-ecosystems nexus in transboundary basins.*[100,101]

In Phase I, the Water-Energy model helped to assess the benefits of transboundary cooperation in the management of water flows along the cascade of hydropower plants in the basin. The results of the analysis indicated how much more electricity could be generated by hydropower plants in the Basin, if the cascade operation (i.e., water releases) were optimised.[102,103] This model was updated and extended in Phase II to address the policy questions of the current assessment, with constant exchange with and validation by the Drina Steering Committee.

Subsection 3.2.1 details the structure and assumptions of the model created for the water-energy Nexus Assessment of the Drina River Basin (Phase II). Subsection 3.2.2 presents the scenarios developed for the analysis and their motivation.

99 These representations can be created with fast learning curves directly by local experts, using the best available data sets and in-country experience. They can then be used as a ground for nexus dialogues and cross-sectoral discussions.

100 Methodology for assessing the water-food-energy-ecosystems nexus in transboundary basins and experiences from its application: synthesis. (UNECE, 2018). Available at: https://unece.org/fileadmin/DAM/env/water/publications/WAT_55_NexusSynthesis/ECE-MP-WAT-55_NexusSynthesis_Final-for-Web.pdf

101 L. De Strasser, et al. (2016): *A Methodology to Assess the Water Energy Food Ecosystems Nexus in Transboundary River Basins,* Water, doi: 10.3390/w8020059.

102 The results are featured in UNECE's: Assessment of the water-food-energy ecosystems nexus and benefits of transboundary cooperation in the Drina River Basin. (UNECE, 2017). Available at: https://unece.org/fileadmin/DAM/env/water/publications/WAT_Nexus/ECE_MP.WAT_NONE_9/Drina-EN-for_Web_final.pdf.

103 A detailed presentation of the model and its core assumptions is given in: Y. Almulla, et al. The role of Energy-Water nexus to motivate transboundary cooperation: An indicative analysis of the Drina River Basin. International Journal of Sustainable Energy Planning and Management, 2018, doi: https://doi.org/10.5278/ijsepm.2018.18.2.

3.2.1 METHODOLOGY used

The tool employed for the water-energy Nexus analysis in the Drina River Basin is OSeMOSYS. OSeMOSYS (the Open Source energy MOdelling SYStem) is an open-source and freely available model generator for the long-term optimisation of the energy and resource (e.g., water) mix of user-defined regions with high technological detail.[104]

The model created for this study represents the electricity system of the riparian countries, namely Bosnia and Herzegovina (BA), Montenegro (ME) and Serbia (RS) and, in an aggregated fashion, the electricity transmission infrastructure among the riparian countries and between them and neighbouring countries. The scope of the model is illustrated in **Figure 2.**

Figure 2. Visual representation of the model scope, including existing hydropower plants (blue dots) and those proposed in the scenario analysis (red dots).

Note

Icons representing wind, solar and thermal power plants indicate the locations (inside vs outside the DRB) in which current types of power plants are located, and the model is allowed to invest in them based on resource availability.

104 M. Howells et al., "OSeMOSYS: The Open Source Energy Modelling System: An introduction to its ethos, structure and development," Energy Policy, vol. 39, no. 10, pp. 5850-5870, 2011/10/01/ 2011, doi: https://doi.org/10.1016/j.enpol.2011.06.033.

The model calculates the year-on-year least-cost electricity supply mix in the riparian countries capable of meeting each country's growing electricity demand and considers criteria including the technical characteristics and operational limits of the electricity supply technologies, the characteristics and volume of hydro dams, the natural water flows along the hydro cascade (including seasonal changes and longer-term climatic changes), planned investments, and policy constraints.

The timeframe of the model spans from 2020 to 2040. A global discount rate of 5% is assumed for all costs incurred in this domain. Each year it is split into 12 months.

3.2.1.1 Structure of the electricity system and cascade

The type of power generation infrastructure, connections and energy vectors considered in the model of the electricity system are summarised in Figure 3.

The supply infrastructure is divided in the model between supply infrastructure inside and beyond the Drina Basin. For the part inside the Basin, each hydropower plant in the cascade is represented individually. The part of the model representing hydropower generation inside the Basin is based on simplified modelling of the hydroelectric power plants and dams on the Drina River and its tributaries. This methodology ensures that water flows and constraints imposed on the electricity generation are properly represented.

The numerical assumptions of the model determine the quality and resolution of its results. They have been compiled by consulting the latest publicly available information (from national reports and literature) and a wide range of stakeholders. The assumptions are reported in Annex 2, including sources and comments on the data review process. Where national sources were not available, international sources have been used. The following subsections describe some of the key assumptions and the scenario setting.

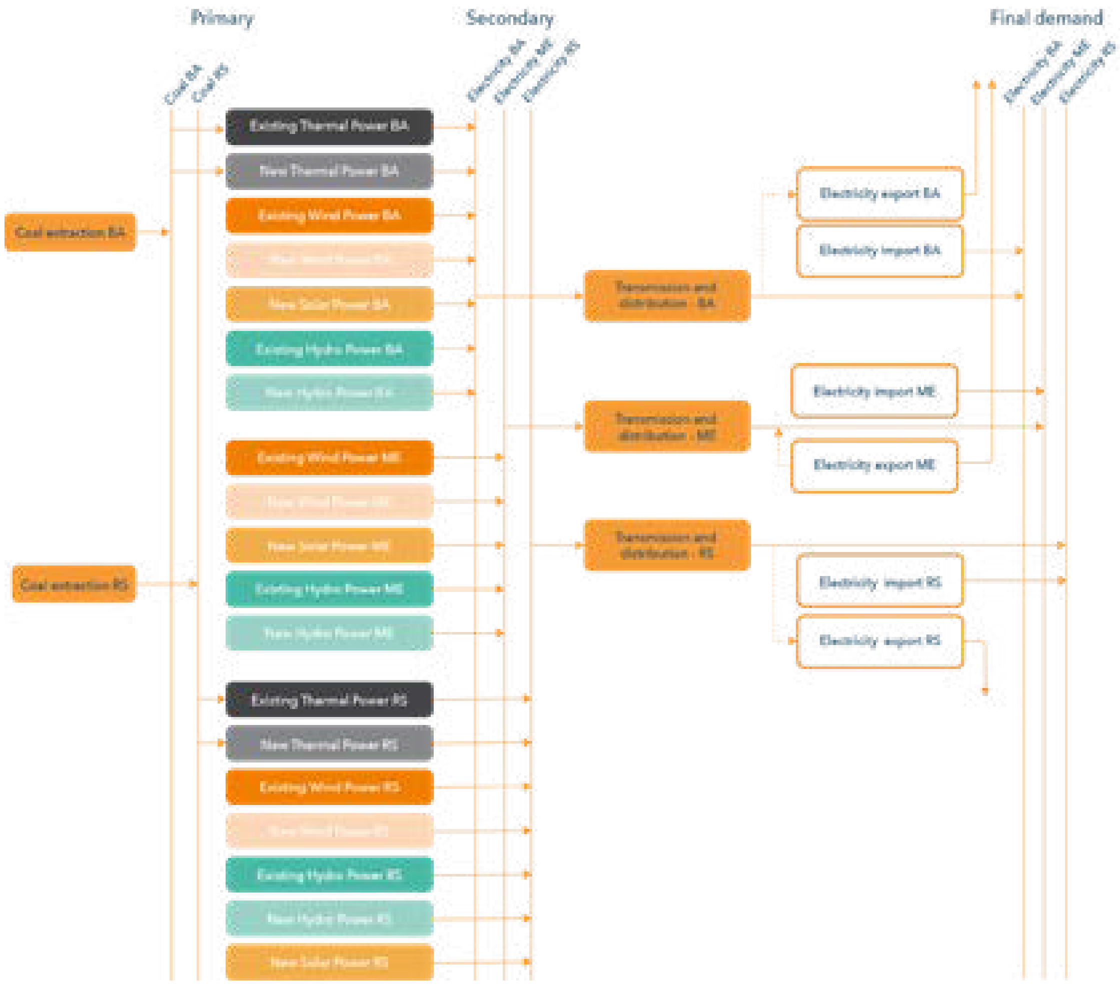


Figure 3. Schematic representation of the structure of the power sector in the model.

3.2.1.2 Demand projections

The model includes three distinct electricity demands, for Bosnia and Herzegovina, Montenegro, and Serbia. Heat demand is not included in this study. Projections from the *Indicative Production Development Plan 2021-2030*[105] are used as a demand for Bosnia and Herzegovina until 2030 and extrapolated to 2040 based on the historical trend. The transmission system development plan of Serbia for the period 2020-2029[106] was used as the reference for the electricity demand projections for Serbia. As in the case of Bosnia and Herzegovina, the Serbian demand from 2030 onward was extrapolated based on the demand in previous years. Using the same approach, the *Montenegro Transmission System Development Plan 2020-2029*[107] was used for the creation of demand projections for Montenegro. The load profiles for each country were obtained and calculated based on the yearly energy balances of the riparian countries.[108,109,110] The load profiles represent the variation in electrical load over time. They differ according to multiple factors, including customer types (residential, commercial, and industrial customers), temperature and holiday season. Multi-year averages of monthly demands were calculated for each country and used as the load profile for the 12 time slices in the model. The load profiles represent the variation in electrical load over time. They differ according to multiple factors, including customer types (residential, commercial, and industrial customers), temperature and holiday season. Multi-year averages of monthly demands were calculated for each country and used as the load profile for the 12 time slices in the model.

3.2.1.3 Electricity trade

Electricity trade is divided into two categories in the energy model. Firstly, trade between the Drina riparian countries is allowed through optimisation. That is, at any point during the modelling period, power is produced within the countries where it is cheapest and can be exported to other riparian countries if it is convenient and needed. The limiting factor for this trade is the net transfer capacities (NTC). Based on existing expansion plans of interconnections between the riparian countries, NTC limits for Bosnia and Herzegovina, Montenegro, and Serbia are increased during the modelling period.

The second aspect of electricity trade in the model is the trade with neighbouring countries that do not share the Basin, such as Albania, Croatia, Hungary, Romania, etc. As Bosnia and Herzegovina and Serbia are power-exporting countries, it is important to consider their exports. Imports and exports of electricity between the riparian countries and their regional neighbours are represented as set values, based on historical, multi-year trade averages.

3.2.1.4 Water discharge data

The water component used for the analysis was obtained from the SMHI HypeWeb model, which includes the Service for Water Indicators in Climate Change Adaptation (SWICCA) data set.[111] The HYPE model for Europe, E-HYPE, generates water variables for past, present and future flows. Historical time series data from the 1981-2010 period were used to calculate average monthly river discharge values. These values were calculated for the Piva, Tara, Ćehotina, Uvac and Lim rivers. The river discharge data from this historical period forms the basis of the cascade water input.

3.2.1.5 Fuel prices

Fossil fuel prices for Bosnia and Herzegovina have been obtained from ERS (Mixed holding power utility of Republika Srpska) and the Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina. Existing and future thermal power plants (TPPs) in the Drina Basin were assumed to have fuel prices equal to the thermal power plant of Ugljevik, while prices for TPPs outside the Drina Basin were calculated based on data from the Tuzla, Kakanj and Gacko plants. Fuel prices for the Pljevlja power plant in Montenegro were provided by EPCG (National Electricity Company of Montenegro). Fuel prices for Serbia were assumed to be in line with the values obtained from Bosnia and Herzegovina.

3.2.1.6 Limitations of the methodology

The model has a coarse time resolution (each year is divided into 12-time steps, with each step representing a month). This time resolution allows for manageable computational effort

105 NOSBiH (2020): *Indikativni plan razvoja proizvodnje 2021-2030.* Available at: https://www.nosbih.ba/files/2020/05/20200528-lat-indikativni-plan-razvoja-proizvodnje-2021-2030.pdf

106 AD EMS (2019): *Plan razvoja prenosnog sistema Republike Srbije.* Available at: https://www.aers.rs/FILES/JavnaKonsultacija/Nacrt%20Plana%20razvoja%20pren.sistema%20R.Srbije%202020-2029_za%20AERS.pdf

107 EPCG (2017): *Plan razvoja prenosnog sistema Crne Gore 2020-2029.* – predlog. Available at: https://www.cges.me/regulativa/razvoj-sistema?download=354:predlog-plana-razvoja-prenosnog-sistema-2020-2029.

108 Independent System Operator in Bosnia and Herzegovina. NOSBiH. Available at: https://www.nosbih.ba/.

109 Electricity production and electro energetic balance. EPCG. Available at: https://www.epcg.com/o-nama/proizvodnja-i-elektroenergetski-bilans.

110 Elektroprivreda Srbije - Godišnji izveštaji. EPS. Available at: http://www.eps.rs/cir/Pages/tehnicki-izvestaji.aspx

111 C. Donnelly, et al. Using flow signatures and catchment similarities to evaluate the E-HYPE multi-basin model across Europe. Hydrological Sciences Journal, 2016, doi: 10.1080/02626667.2015.1027710.

in the optimisation problem while maintaining high technological detail in the representation of hydropower along the cascade. However, it limits the insights that can be drawn on the impact of flooding events (which usually occur over days, not months) and on the day-to-day operation of solar photovoltaics. While the model can be modified to include higher time resolutions, this would be at the expense of a higher computational load and longer solution times for each model run.

Another limitation is that hydropower outside of the Drina River Basin is not represented in as high technological and operational detail as hydropower inside the Basin. Its availability is represented through one average value for all installations, varying each month. The availability is based on historical monthly power generation from all hydropower plants outside of the Basin, with unique values for each riparian country. New installations outside the Basin are allowed up to a certain upper boundary defined by the estimated hydropower potential, with no consideration of where the new installations would be.

Given the open-source nature of the model that is publicly available and accessible through GitHub, further additions and enhancements to it can be made by local stakeholders. Specified electricity demand profiles on a daily level for each country can be incorporated based on data availability, allowing for a higher temporal resolution of the model. Furthermore, techno-economic parameters for specific planned projects can be included into the model to assess the cost-competitiveness against other possible power-generating technologies.

3.2.2 SCENARIOS

The policy-relevant questions, stated in Section 3.1, were addressed by designing five scenarios, with inputs from the Steering Committee. There is no association of one scenario to one question. It is rather the comparison between the scenario results that provides answers to the questions. The scenario tree is shown in Figure 4. The description of the scenarios and their key assumptions follow thereafter.

- **Business as usual (BAU).** *This works as a reference scenario, where limited action occurs, and no noticeable climate change occurs.* It takes into account currently established policies and committed investments in power supply infrastructure. Since the plans for hydropower development in the Drina River Basin are not fully confirmed, no hydropower development is allowed in the Basin. There is room for investments in non-hydro renewables and hydropower outside

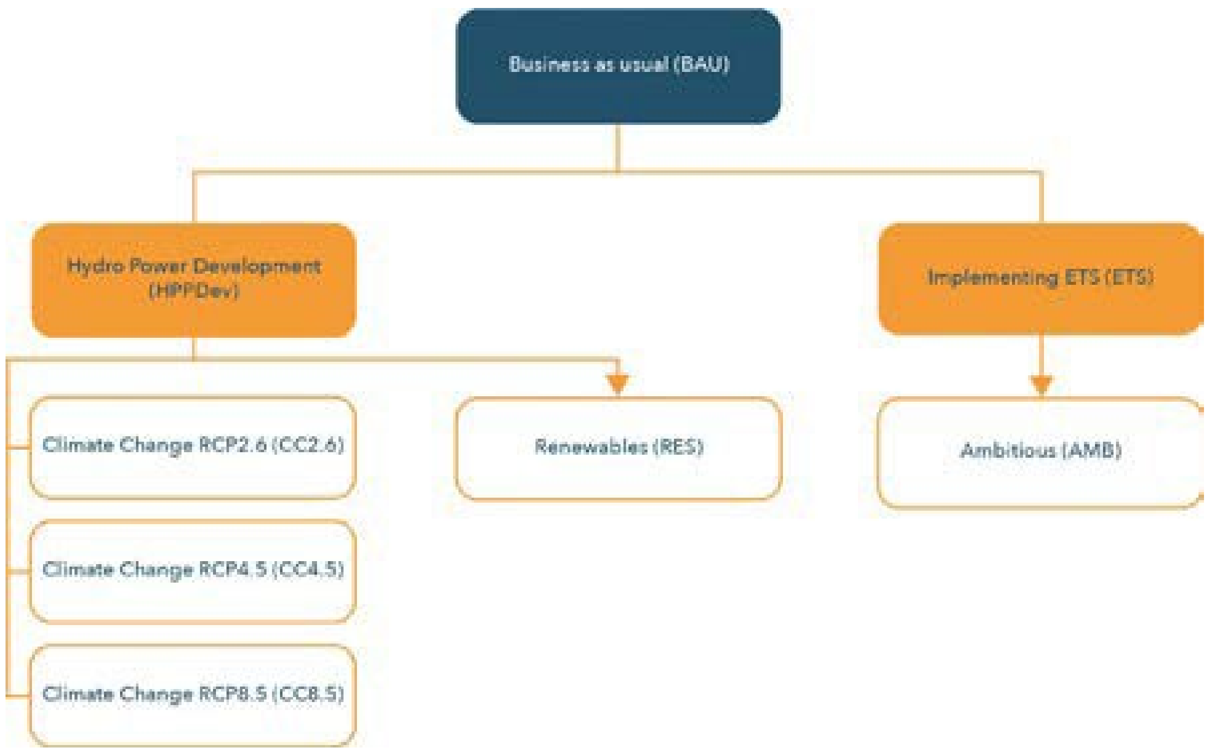


Figure 4. Scenario tree.

of the Basin, if these options are competitive compared to fossil-fuelled generation. The BAU scenario includes currently established policies and committed investments in power supply infrastructure, as well as the countries' Intended Nationally Determined Contributions (INDCs) as submitted in 2017 (noting that new submissions were undergoing review as this model was being finalised).[112,113,114]

- **Hydro Power Plant Development (HPPDev).** *This aims to investigate how hydro and non-hydro renewable generation in the Drina River Basin change if new hydropower infrastructure is built.* It assumes that three new hydropower plants are built, among those for which planning is at the most advanced stage: Buk Bijela, Foča and Paunci. Data on investment plans and techno-economic characteristics of the hydropower plants and dams were retrieved from ERS.[115] The characteristics are presented in Annex 2. There are several other projects currently in the planning phase, including the Komarnica, Ustikolina, Rogačica, Tegare and Kozluk HPPs. A table with planned HPPs within the DRB is shown in Annex 2 (Table A2-6). The reasons for which the Buk Bijela, Foča and Paunci HPPs – and not others – were selected for this study were the following:
    - The commissioning dates of these HPPs were set earlier than the others, and with short construction times, hence their construction was considered more likely.
    - All techno-economic characteristics of these power plants were provided during the project, enabling the integration of these into the cascade part of the created OSeMOSYS model.

  With due modifications, the model would allow inclusion of other hydropower plants, should information become available.

- **Renewables (RES).** *This scenario investigates the effect that decreasing capital investment costs in non-hydro renewables could have on the overall electricity supply mix, as well as the emissions from the power system.* It is developed starting from the HPPDev scenario and compared with it in the results section. It assumes that the capital costs of wind and solar power plants decrease according to projections made by the International Renewable Energy Agency.[116,117] The trends of cost reductions are applied to the current capital cost for wind and solar power for each of the riparian countries. The cost projections are shown in Table A2-9 of Annex 2.

- **Climate Change (CC).** *This scenario is developed starting from the HPPDev scenario and aims to investigate how the cost-optimal power supply and installed capacity of hydro and non-hydro renewables in and beyond the Basin may change considering climate change.* The impact of climate change is represented by the variation in water availability on different segments of the Drina Basin. These variations are expected to influence the functioning of the different reservoirs in cascade and impact hydropower generation. Three sub-scenarios are investigated, looking at three progressively harsher climate change scenarios: **CC-RCP2.6, CC-RCP4.5, and CC-RCP8.5.** These assume different Representative Concentration Pathways (RCPs), RCP 2.6, 4.5, and 8.5 respectively, corresponding to different levels of greenhouse gas emissions and related warming, with consequent different climate change impacts. The impact is modelled by varying the flows in all the river segments represented in the Drina Basin hydropower cascade compared to the HPPDev scenario. The water availability under these different climatic scenarios was obtained from hydrological models within the SWICCA dataset.[118]

  It must be noted that, for each RCP, the intra-annual flow profiles were maintained as constant across the entire time domain of the study and equal to the 2011-2040 average of flows, as obtained through the SWICCA

112 MoFTER (2015): *Intended Nationally Determined Contributions (INDC) - Bosnia and Herzegovina.* Available at: https://www.ctc-n.org/sites/www.ctc-n.org/files/UNFCCC_docs/indc_bosnia_and_herzegovina.pdf.

113 Government of Montenegro (2015): *Intended Nationally Determined Contribution (INDC) of Montenegro following decision 1/CP.19 and decision 1/CP.20.* Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Montenegro%20First/INDCSubmission_%20Montenegro.pdf.

114 MZŽS (2015): *Intended Nationally Determined Contribution of the Republic of Serbia.* Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Serbia%20First/Republic_of_Serbia.pdf.

115 Ž. Ratković (2020): *Request for updating or validating data related to the Electricity System of Bosnia and Herzegovina, for the modelling analysis under the Phase II.*

116 IRENA (2019): Future of Wind: Deployment, investment, technology, grid integration and socio-economic aspects (A Global Energy Transformation paper). Available at: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Oct/IRENA_Future_of_wind_2019.pdf.

117 IRENA (2020): Wind and Solar PV - what we need by 2050. Available at: irena.org.

118 The historical values of the water flows used as a basis for the above results are derived from the SWICCA database and the projections are averaged from the results of several climate models (E-HYPE, Lisflood, VIC). The predictions are derived from the Coupled Model Intercomparison Project (CMIP5). Reference: C. Donnelly, J. C. M. Andersson, and B. Arheimer, "Using flow signatures and catchment similarities to evaluate the E-HYPE multi-basin model across Europe," Hydrological Sciences Journal, vol. 61, no. 2, pp. 255-273, 2016/01/25 2016, doi: 10.1080/02626667.2015.1027710.

dataset. With increasing climate change, flows increasingly vary along the cascade, with intensifying low and high peaks. Since the hydropower infrastructure outside of the Basin is less detailed and offers no representation of water flows, no climate change impact is modelled for the plants outside the Basin. This is a limitation to be considered for future developments.

- **Entering the ETS (ETS).** *This scenario is created by modifying the BAU scenario: a carbon pricing scheme is included to emulate the entrance of the countries in the ETS.* The scenario takes into account the free emissions under the cap-and-trade as well as the yearly decrease of the cap for an initial 5-year period upon entering the ETS. Estimated carbon prices are shown in Table 2.

Table 2. Assumption of carbon prices

EU-ETS in M$/ $MtCO_2$	2025	2030	2035	2040
BA	8.2	36	50	92
RS	9.7	36	50	92
ME	10.5	36	50	92

The basis of this assumption is the Carbon Pricing Design for the Energy Community report[119], in which the 2035 and 2040 values for Montenegro were applied to all the riparians. The reason for this is that Montenegro is the only riparian (and the only member of the Energy Community) that has introduced a carbon tax on CO_2 emissions. Additionally, the values used in the model take into consideration the coal excise duties and reductions based on the eco-tax. The level of reductions and coal excise duties were obtained from EPCG and applied to the power systems of all three riparian countries. In the draft revision of the Serbian NDC120, the country states that implementation of the ETS will occur in 2022. This is taken as the start year for implementation. For Bosnia and Herzegovina, the implementation year was assumed to be 2024.

- **Ambitious (AMB).** *This scenario investigates the impact of energy efficiency measures and further technological advancements in non-hydro renewable energy on generation investments and profiles in and beyond the Drina Basin.* It builds upon the ETS scenario, and the difference lies in the assumed annual demand for electricity and RES potential in the three riparian countries. The amending *Energy Efficiency Directive 2012/27/EU (EED)* requires its Member States to achieve cumulative end-use energy savings for the entire obligation period from 2021 to 2030, equivalent to new annual savings of at least 0.8% of final energy consumption. This demand reduction was applied to the final electricity demand for each of the riparian countries in the form of a cumulative yearly reduction of 0.8%, while at the same time implementing the ETS. Additionally, this scenario allows the model to invest more in RES technologies compared to the other scenarios. The maximum capacity additions in the other scenarios depend on the historical rate of investments, as well as previous studies which explored the potentials of different types of RES technologies.121,122 In this scenario, higher rated capacities for solar and wind power are achievable for a given area due to the improved efficiency of cells and increased diameter of rotors. More details are provided in Annex 2.

119 *Energy Community (2021): A carbon pricing design for the Energy Community – Final Report.* Available at: https://www.energy-community.org/dam/jcr:82a4f-c8b-c0b7-44e8-b699-0fd06ca9c74d/Kantor_carbon_012021.pdf.

120 Republic of Serbia, Ministry of Environmental Protection (2020): *The second/revised Serbia's nationally determined contribution – CCM component.* Available at: https://www.klimatskepromene.rs/wp-content/uploads/2020/10/CCM-revised-NDCs-DRAFT-OCT-2020_.pdf.

121 R. Vujadinovic, et al. (2017): *Valorization of potentials of wind energy in Montenegro.* Thermal Science, doi: 10.2298/TSCI161201016V.

122 Procjena potencijala obnovljivih izvora energije u Republici Crnoj Gori. CETMA. Available at: https://wapi.gov.me/download/3afbf730-ab89-4bb8-838c-36ed98b-1674d?version=1.0.

3.3 RESULTS FROM THE INTEGRATED MODELLING

The key insights from the analysis are shown and discussed through policy-relevant questions.

1. *What role can renewables (hydro and non-hydro) in the Drina Basin play in achieving the UNFCCC NDCs of the riparian countries?*

The results obtained under the assumptions of the BAU scenario suggest that RES technologies are a minor contributor to emissions reductions. Figure 5 illustrates the power supply, imports, and exports under the BAU scenario. Emissions are primarily reduced by decommissioning existing coal-fired power plants in favour of new, more efficient thermal units. These dynamics reflect the fact that thermal power is more cost-competitive than renewables under the assumptions of the BAU scenario.

Figure 5 depicts the increase of renewable energy technologies (including hydro, solar and wind power) in the power supply, indicated in blue, purple and yellow colours, from 34% in 2020 to 39% in 2030. The share of power generation from new thermal capacity additions, shown in light grey in Figure 5, increases from 4% to 21% during the same period.

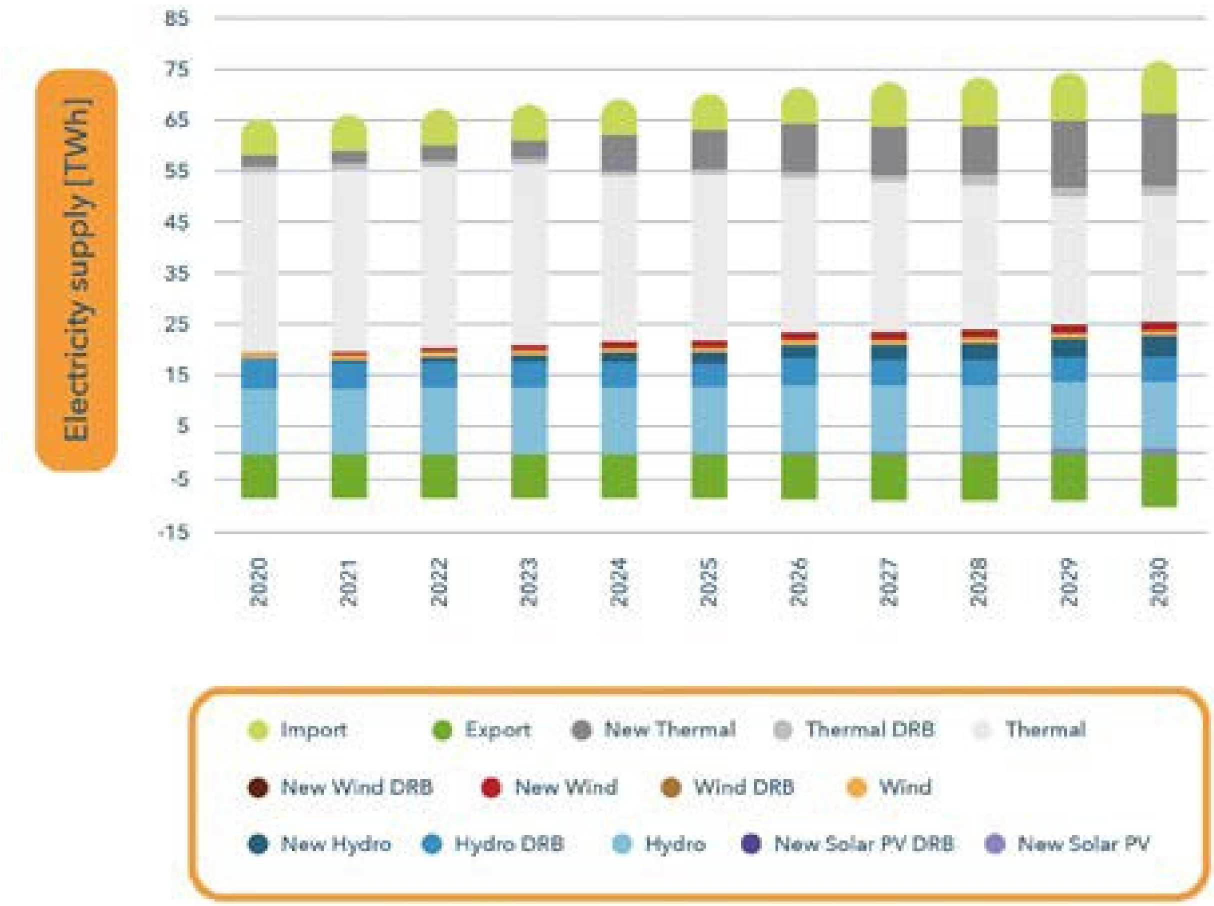


Figure 5. Electricity supply [TWh] for the Drina riparians, including import and export; BAU scenario.

In Figure 6 (top), the electricity supply is shown for each scenario. In contrast to the BAU and HPPDev scenarios, the RES, ETS and AMB scenarios result in renewable energy technologies becoming more competitive than new thermal power. Under the RES scenario, declining prices allow non-hydro renewables to become cost-competitive by 2035, while in ETS, the introduction of the trading scheme further increases their cost-competitiveness, allowing more thermal power to be decommissioned by 2030. When comparing the HPPDev and RES scenarios, it becomes clear that the reduced cost of non-hydro renewables is what allows them to increase their share by 2030 and 2040. The striking increase of non-hydro renewable power generation when moving from the HPPDev to the RES scenario conditions is illustrated in Table 3. Even greater increases in renewable deployment can be observed when more renewable energy resources are accomodated in the system, in the AMB scenario.

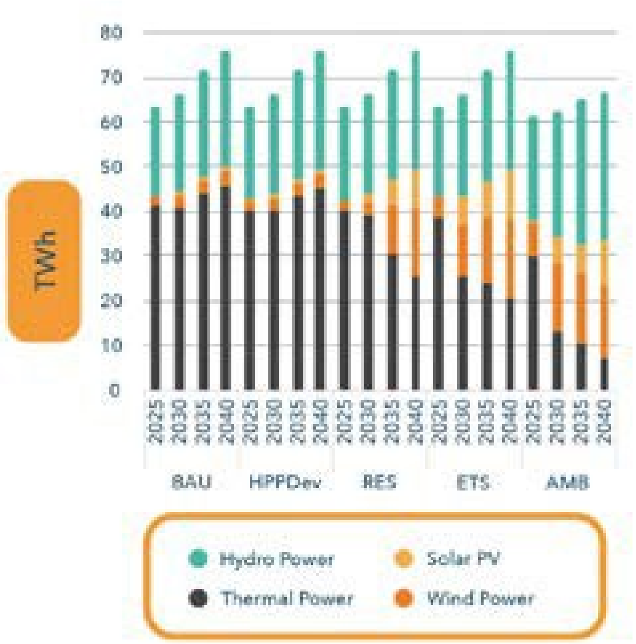
Table 3. Difference in power generation [%] from non-hydro renewables in the RES scenario compared to HPPDev.

Technology type	2030	2040
Wind power	-1.4%	+446%
Solar PV	+71%	+487%

As a result, the total emissions per country show a considerable decrease, in the RES, ETS and especially AMB scenarios, compared to the BAU and the HPPDev scenarios (Figure 6 [right]). Hence it can be concluded that ***the role of hydro and non-hydro renewables is paramount in decreasing emissions,*** where their cost reduces, or policies become more favourable. The role of non-hydro in particular is discussed in the next question.

2. *What benefits does an increased share of non-hydro renewable energy bring in terms of greenhouse gas emissions reductions, and in terms of reduced reliance on hydropower production?*

The first insight for this question follows on from the results shown above. Table 4 summarises the decrease of emissions across the scenarios. The table shows that as the level of ambition increases and more renewables are granted a more important role in the electricity supply mix, they ***determine a sharp decrease of emissions in a cost-competitive way.***



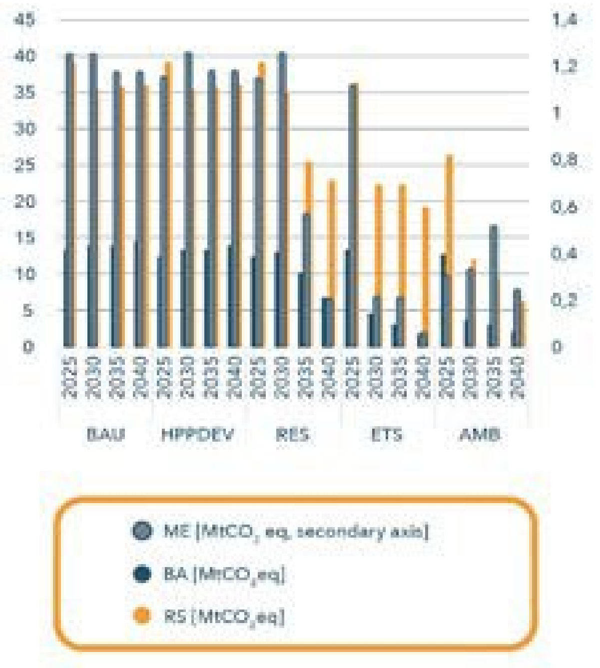


Figure 6. Electricity supply (top) and CO_2 eq emissions (bottom) for multiple scenarios.

Table 4. CO_2 emissions reductions compared to 2020.

Scenario	Reduction in 2030 [%]	Reduction in 2040 [%]
BAU	3.2	0.6
HPPDev	5.1	2.4
RES	6	43
ETS	48	59
AMB	69	83

As Table 4 shows, emissions reductions are achieved to different extents in the explored scenarios. The overall reductions are fairly limited in the scenarios where renewable energy expansion is restricted and old TPPs are mainly replaced by new ones. On the other hand, reductions are far more significant in the RES, ETS and AMB scenarios, where the capacity expansion of renewable energy (both hydro and non-hydro) is greater. In particular, ***in the ETS scenario, the adoption of a carbon tax results in a higher share of non-hydro renewables as compared to the RES scenario, where cost reductions on non-hydro renewable energy technologies are applied.*** Consequently, the reduction in emissions by 2040 for the ETS scenario is approximately 30% greater than for the RES scenario. ***This further underlines the importance of non-hydro renewables in the decarbonisation of the power systems of the Drina River Basin countries.***

It must be mentioned that the reliability of electricity supply with high shares of non-hydro renewables was outside of the scope of this analysis and needs to be carefully evaluated, as a complement to the above results, knowing that hydropower is an important source of stable, dispatchable electricity. The role of hydropower in grid stabilisation needs to be studied in more detail, with appropriate modelling tools that analyse short-term dynamics in the electricity network.

The second interesting insight is that the increased share of non-hydro renewables in the RES, ETS and AMB scenarios does not influence the share of hydropower significantly. It affects coal generation instead, significantly reducing the need for it and making the electricity supply mix overall greener. Therefore, it can be concluded ***that, under the assumptions of the study, non-hydro renewables can be competitive with coal generation but not with hydro generation.*** This means that, from a purely economic perspective, hydropower remains a competitive source of electricity in this context.

The model does not provide insights concerning possible extreme events, such as droughts and floods, and their impact on the power supply. Considering that the time resolution of the model is set to 12 time slices, the positive impact that an increased share of non-hydro renewables could have on flood protection and drought response (i.e., to reduce pressure on reservoirs) is difficult to estimate. Floods tend to occur much more rapidly than monthly increments can show – usually within hours or days. In addition, the model is calibrated with monthly average flows, so extremes of river discharge, such as droughts and floods, are generally averaged out in the model.

3. *If the proposed plans for HPP development in the DRB are executed, what could be the share of power supply and installed capacity of non-hydro RES, in a least-cost electricity system?*

Many hydropower plants have been proposed and considered in order to utilise the remaining potential of the Drina River and its tributaries. However, these proposed projects have been delayed and no new hydropower plants have been built on the Drina River since the breakup of Yugoslavia in the early 1990s. To consider factors such as the uncertainty of hydropower projects, only three projects were included in the HPPDev scenario. These are HPP Buk Bijela, HPP Foča and HPP Paunci, with a combined generation capacity of 180.9 MW. This additional capacity results in an increase of around 1.35% in overall hydroelectric power generation in the HPPDev scenario compared to the BAU scenario. This increase occurs at the expense of non-hydro renewable generation, which overall decreases by the same amount in the HPPDev scenario compared to the BAU scenario. As a result, the supply-demand balance of the riparian countries is relatively unaffected. ***An energy system-wide perspective indicates that the addition of 180.9 MW (HPP Buk Bijela, HPP Foča and HPP Paunci) represents only a small increase in capacity and would imply more significant changes in thermal and non-hydro renewables shares if all of the hydropower projects in the Drina Basin were to be implemented.*** Furthermore, it is important to note that while the system-wide impacts on power supply can be modest, as in this case, planning for expanded hydropower capacity would have important implications in water management.

4. *What are the effects of climate-induced variability on hydropower generation? How does this affect planning of new hydropower?*

Here, the results of the CC scenarios illuminate key insights. The effect of climate-induced variability can be appreciated by comparing the CC scenarios with the HPPDev scenario, in order to investigate the viability of the new hydropower plants constructed. The comparison shows that the average annual power generation from the hydropower plants in the DRB cascade is 0.7% and 2.4% less in the CC2.6 and CC8.5 scenarios respectively, compared to the HPPDev scenario. In contrast, production in the CC4.5 scenario is 3.4% greater compared to the HPPDev scenario. This is depicted in Figure 7.

The reason for this is that the CC4.5 river discharge projections correspond to higher yearly average flows, compared to the other two climate scenarios. In other words, the river discharge projections do not show a progressive decrease of water availability from RCP2.6 to RCP4.5 and RCP8.5 in the short- to medium-term (next three decades). This shows that climatic changes are a complex phenomenon, and in the short-term they may result in different patterns of precipitation and water availability, not necessarily changing in one direction. Clearer trends (whether of decrease or increase in water availability) may emerge in the longer run and when it becomes clearer which RCP trajectory the world is following. Also, it should be noted that the water availability in the three RCPs changes differently in different parts of the Basin, according to the source data. Key outputs of the HPPDev and CC scenarios as compared to the BAU are shown in Table 5.

Table 5. Key outputs of the hydro development and climate change scenarios, as compared to the BAU.

Power generation [TWh]	HP-PDev	RCP 2.6	RCP 4.5	RCP 8.5
Hydro power inside the DRB	113	113	117	111
Thermal power inside and outside the DRB	868	869	865	871
Share of RES [%]	38.3%	38.2%	38.5%	38.1%
Share of non-Hydro RES [%]	4.9%	4.9%	4.9%	4.9%
Total emissions for the modelling period [Mt CO_2eq]	1071	1071	1066	1073

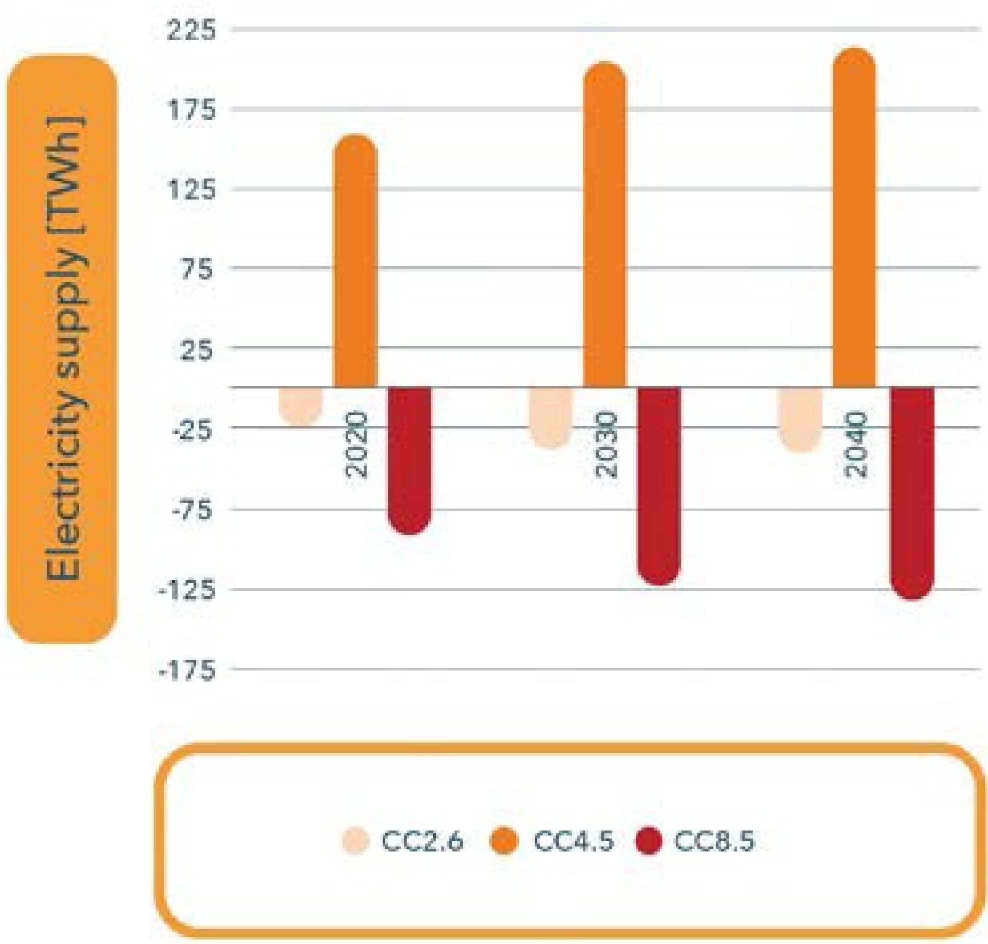


Figure 7. Climate Change impact on power supply from cascade HPPs in the HPPDev scenario,under different RCPs.

From this, an overall key insight can be drawn concerning the planning of electricity infrastructure under climate uncertainty: in the short- to medium-term, there is indication that there could be average reductions in water availability for hydropower generation. However, some climate scenarios indicate that there could be an increase. ***There is no certainty on whether climate changes would cause an average decrease or increase in water availability in the region, and therefore the impact on the productivity of hydropower plants involves a high level of uncertainty.***

Climate models carry uncertainties and an average of their results might not necessarily predict the developments well. To analyse the validity of our assumptions, we ran the CC2.6 and CC8.5 scenarios with another set of historical flows and predictions collected by Princeton University.[123] The CC4.5 scenario was not rerun in this comparison because the new set of historical flows and predictions did not include data for RCP4.5.

The model runs with the SWICCA and with the Princeton dataset could not be compared directly, because the climate models that they are based on use different baselines. Therefore, in order to compare them, we took the following steps. We first calculated, separately for the two runs, the percentage changes in the predicted water flows compared to the historical water flows. That is, the percentage change in predicted flows from the SWICCA dataset compared to the SWICCA historical values, and the percentage change in predicted flows from the Princeton dataset compared to the Princeton historical values. Then, we compared the changes calculated from SWICCA with those calculated from Princeton for RCP2.6 and RCP8.5.

The comparison confirms the trends shown in Figure 7: in both RCPs, both sets of models and data show ***a decreasing trend of water availability in most of the points of the basin we considered.*** The decrease is more significant in RCP8.5. Also, in both cases the water availability in Lim could increase (RCP2.6) or only slightly decrease (RCP8.5). However, the scale of the decreases and increases of water availability is different with the SWICCA and Princeton data. The results using the SWICCA dataset indicate average (across the time domain of the study) decreases in water flows between 0.45% and 0.85% in RCP2.6 and between 0.7% and 3.5% in RCP8.5 (depending on the point in the Basin). Corresponding decreases with the Princeton dataset are between 4.8% and 10.5% and between 1.7% and 15.2%, respectively.

The scenario results and the subsequent comparison of the assumptions regarding water flows highlight that, ***depending on the climate assumptions*** (a certain historical dataset and a more or less pessimistic trend), ***one may observe very different water flows in model results.*** These could in turn affect the production of hydropower plants, ultimately with impacts on their profitability and on the resilience of the system to climatic changes, because the lifespan of dams (several decades) lies on a similar time scale to climatic changes.

Therefore, it can be recommended that the operation of hydropower plants and new hydropower infrastructure investments are planned not on the basis of one or a few individual climate projections, but rather by taking into account the risks of different intensities of change and their probability of occurring. This recommendation is in line with those provided by the Agence Française de Développement and the World Bank in 2015, in a study on the climate resilience of Africa's infrastructure in the water and power sector.[124] There, analysing the infrastructure investment plans and a large range of climate scenarios, the authors estimated that revenue losses from hydropower could range between 5% and 60% in the driest scenarios (due to unfulfilled potential) and between 15% and 130% in the wettest scenarios (due to foregone revenue). They estimate that these potential effects could be significantly mitigated by integrating climate risk analysis in the planning phase.

5. *What effects could the Emission Trading Scheme, as part of the EU integration pathway, have on hydro and non-hydro RES development in the riparian countries?*

Introducing a carbon tax on CO_2 emissions associated with thermal power production in the model contributes to additional costs for the operators of fossil-fuel-fired power plants, summing up to $2.6 billion in the case of Bosnia and Herzegovina, $135 million in Montenegro, and $12.7 billion in Serbia. As a result, ***existing thermal power plants would reduce their power output by 80% by 2028 when compared to 2020***. To meet the demand, the model chooses a cost-optimal mix of new high-efficiency TPPs combined with 8 GW of RES technologies. ***Investments in renewable energy***

123 The historical flows are derived from the VIC land surface model that was coupled to the vector-based Routing Application for Parallel computation of Discharge (RAPID) streamflow routing scheme. The predictions are in this case derived from the five best performing models of the CMIP6 (i.e., more recent than CMIP5) with emphasis on the variability and spatial correlation (CMCC-ESM2, EC-Earth3, GFDL-ESM4, IPSL-CM6A-LR, MPI-ESM1-2-HR).

124 AFD and World Bank (2015): *Enhancing the Climate Resilience of Africa's Infrastructure.* Available at: https://www.worldbank.org/content/dam/Worldbank/Feature%20Story/Africa/Conference%20Edition%20Enhancing%20Africas%20Infrastructure.pdf.

resources are four times greater by 2030 compared with the BAU scenario. Non-hydro renewables account for over 80% of the new renewable capacity additions. By 2040, the total installed non-hydro renewable capacity equals 13 GW, contributing to 38% of total power generation in the Drina riparian countries (Figure 8). These results show that, with an ETS scheme in place, ***the decarbonisation of the power sector would be accelerated, and wind and solar power would play an important role in it.*** The 13 GW of new capacity far exceed the combined capacity of the 13 hydroelectric power plants currently proposed in the Drina River Basin (970 MW), showing the great untapped potential of non-hydro renewables. ***Hydropower could, however, play a critical role in grid stabilisation.*** As previously anticipated, since non-hydro renewable additions may come from variable sources, hydropower plants could provide stable and dispatchable power generation to balance the variability.

6. *How are different technologies impacted by the implementation of energy efficiency measures and by further ambitions in the deployment of renewables?*

The ambitious scenario (AMB) is the most progressive in terms of carbon emissions reductions and penetration of renewable energy sources in the power generation mix. Figure 9 shows the capacity additions for renewable energy technologies in this scenario.

The results of the AMB scenario come from two key assumptions. Firstly, the demand is decreased

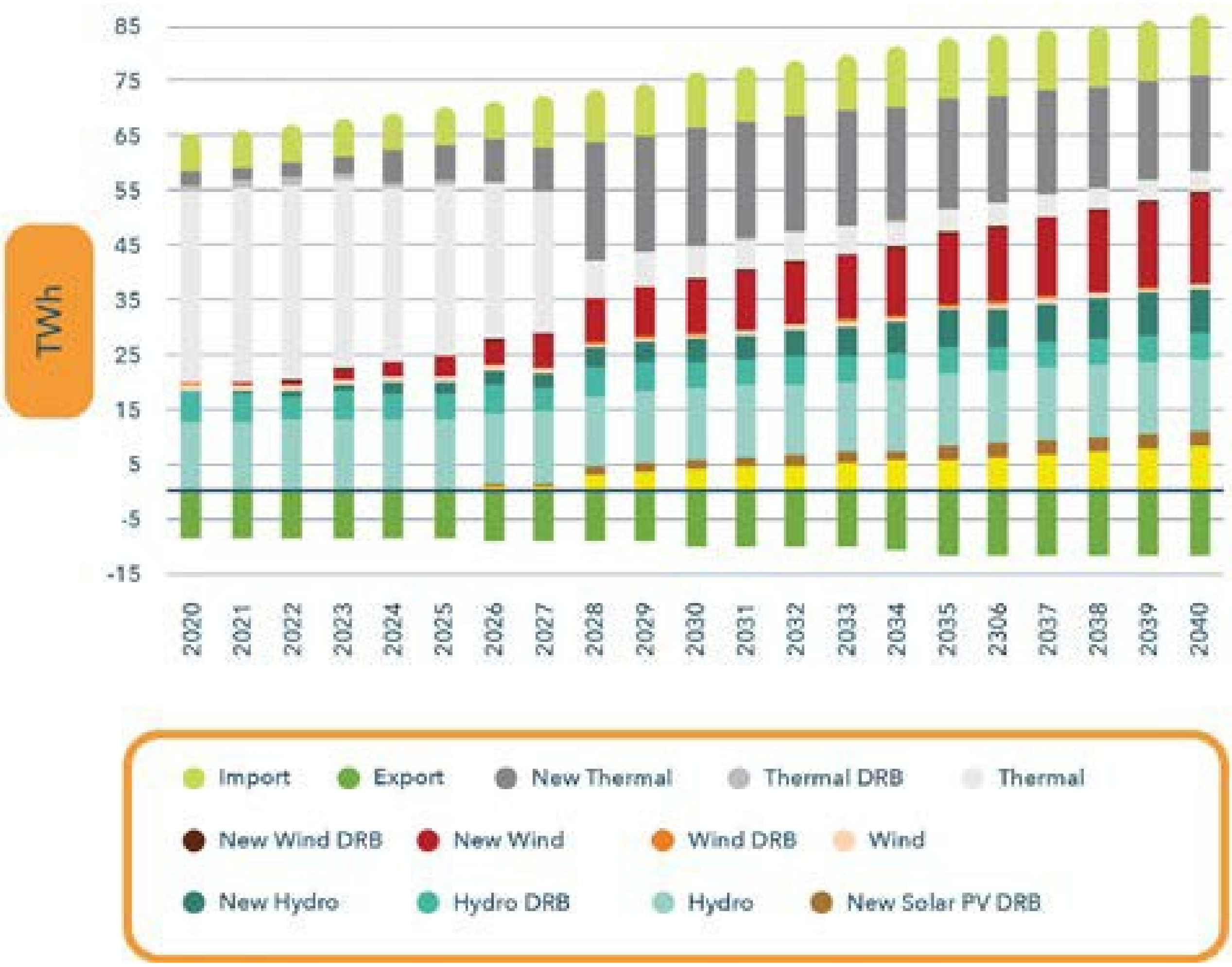


Figure 8. Electricity supply [TWh] for the Drina riparians, including import and export; ETS scenario.

to represent energy efficiency measures on the demand side. No analysis on the implementation and potential of demand side energy efficiency measures was conducted for this study. Instead, the amending *Energy Efficiency Directive 2012/27/EU (EED)* was implemented (as described in the scenario description). Secondly, the possibility to invest in renewable energy technologies is greater compared to the other scenarios, giving the possibility to tap into higher technical potential for solar and wind power.

We conducted a sensitivity analysis, in which we separately assessed the impact of decreased demand on power generation from various technologies. The green bars in Figure 10 represent the differences in power generation between the AMB scenario with energy efficiency (EE) measures, while orange bars represent the AMB scenario without EE measures. All the bars in Figure 10 are compared to the power generation in the ETS scenario.

The most notable change in power generation between the ETS and the AMB scenario is the cumulative thermal power generation reduction of 800 TWh during the modelling period. Wind and hydropower generation also increase, by 160 and 370 TWh respectively.

By allowing the model to invest in higher capacities of renewables, their share in the overall power mix reach 80% by 2030 and 89% by 2040. Adding energy efficiency measures contributes to a cumulative reduction of power produced by renewable technologies corresponding to 270 TWh during the modelling period, while the reduction in thermal power generation is just 55 TWh. ***As a result of electricity efficiency measures, renewables are more affected than thermal power since the model has existing thermal power capacities.*** This capacity is then replaced by new, more efficient TPPs at the beginning of the modelling period. Due to the implementation of the ETS and the lowering of capital costs associated with non-hydro renewables, TPPs eventually become uncompetitive. At this point, all additional demand increases will be covered by renewables. Therefore, if the demand is reduced through EE measures, the power generation from renewables will decrease, as there will be no additional demand to cover.

It is important to keep in mind that this analysis focuses exclusively on reductions in electricity demand because the model is limited to the power system and does not include non-electricity demands such as heating and transport. Besides, the impact on the power supply would likely increase if a broader range of energy efficiency measures were implemented; these findings do not deny the significance of energy efficiency measures in climate mitigation. When water is scarce, a lower electricity demand would alleviate pressure on hydropower generation. Furthermore, a lower power demand could allow for a more rapid phase of the decommissioning of old thermal power plants, accelerating the decarbonisation of the power sector.

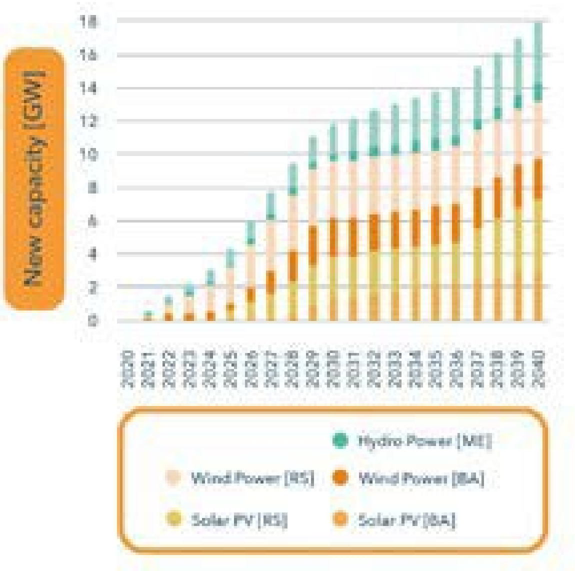


Figure 9. Cumulative new capacity additions in renewable technologies for the AMB scenario.

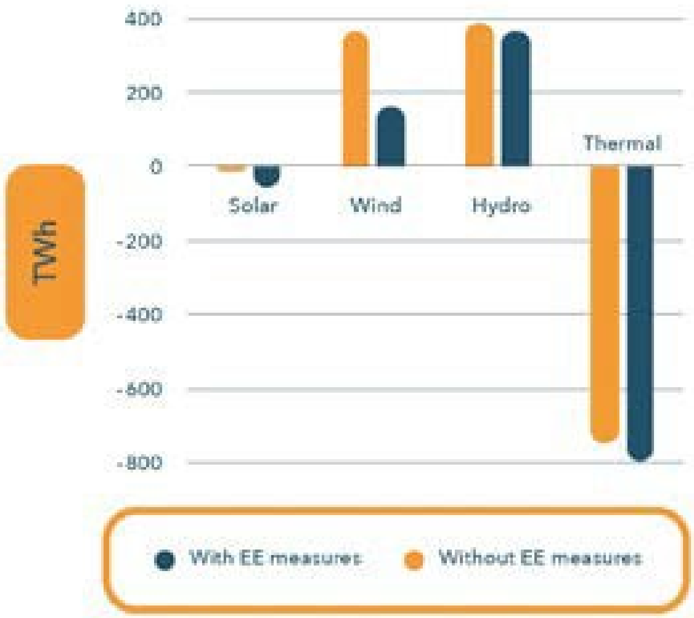


Figure 10. Differences in power generation between the AMB scenario with and without EE measures.

3.4 CONCLUSIONS AND RECOMMENDATIONS

Bosnia and Herzegovina, Montenegro and Serbia currently include 10 coal regions with significant coal-based energy production and coal mining activities. By signing the *Sofia Declaration,* the riparian countries committed to aligning with the *EU Climate Law,* with a vision of achieving climate neutrality by 2050. Additionally, they committed to aligning with the EU Emissions Trading Scheme and to prioritising energy efficiency in all sectors, as well as increasing the share of renewable energy sources.

The results of this analysis indicate that not only hydro but also non-hydro renewable energy expansion could significantly contribute to decarbonisation of the electricity supply of the riparian countries' outcompeting thermal generation and to its phase-down. Renewables allow a 43% decrease of CO_2 emissions in 2040 compared to 2020 in a case where their cost decreases according to trends assumed by IRENA[125,126], the decrease would be 59% in the case of ETS implementation and 83% in the case where, on top of ETS, the technical potential is tapped into more. Enablers for higher penetration of non-hydro renewables are reductions in capital investment costs (currently the main trend and depending on global developments), and the implementation of an Emission Trading Scheme controlled by the riparian countries.

This model helps to explore the potential role of non-hydro RES as a *cost-competitive* low-carbon supply alternative to thermal and hydropower. However, it should be kept in mind that the technical feasibility of a system with high shares of non-hydro RES, and their impact on the reliability of electricity supply, should be studied in greater detail. The reason is that wind and solar power are variable and aleatory, depending on the availability of the sources. With increasing shares of these sources in the electricity supply, there could be increasing oscillations in the power supplied to the network within seconds or minutes. Stable sources like thermal and hydro help to stabilise supply in the case of these events. We therefore advise that the results of our model are analysed with ad hoc modelling tools suited to the analysis of power supply and its reliability.

Recent experience suggests that high shares of non-hydro renewables could be feasible where the electricity transmission infrastructure across the whole of Europe becomes more integrated. This was shown, for instance, in Denmark. In 2020, 62% of the electricity supply in Denmark came from wind and solar power. This was only made possible through integration with the rest of the EU markets and infrastructure.

As far as hydropower is concerned, the analysis shows that hydropower generation is competitive with non-hydro generation. While non-hydro renewables expand at the expense of thermal generation as soon as enabled by the conditions stated above, they do not affect hydropower generation. The findings derived from the scenario analysis indicate that hydropower could generate 26 to 33 TWh of power in the countries considered by 2040, with a capacity expansion of approximately 5 GW in the AMB scenario. The substantial hydropower production (and potential) could present itself as an opportunity for investments in non-hydro renewables, considering that hydropower has a specific load-balancing role to play when it comes to accommodating higher shares of renewable energy in a power grid. However, once again, the balancing role of hydropower needs to be studied with the help of models with higher time resolutions, possibly taking the results from this analysis as an input.

Climate change could affect hydropower generation due to an average decrease of rainfall. The decrease in generation may be up to 40 to 130 GWh annually according to RCP2.6 and RCP8.5, respectively. However, some climate scenarios indicate the possibility of increased rainfall in the Basin, with positive impacts on hydropower generation. Climate scenarios are based on a variety of different model configurations, which need not be the same across various RCP projections. This poses a challenge to the planning of hydropower expansion. It suggests that climate uncertainty needs to be considered as a risk in the planning of hydropower expansion. The planning needs to look at time horizons far beyond 2050, more in line with the time scale of dam infrastructure and climatic changes.

Insights from the analysis indicate that renewable energy technologies can be competitive with coal-fired thermal power. Additionally, rather than investing in more renewable energy capacity to meet a higher demand, energy efficiency measures may allow these funds to be directed to the decommissioning of thermal power. Therefore, we can conclude that the energy efficiency measures

125 IRENA (2019): *Future of Wind: Deployment, investment, technology, grid integration and socio-economic aspects (A Global Energy Transformation paper).* Available at: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Oct/IRENA_Future_of_wind_2019.pdf.

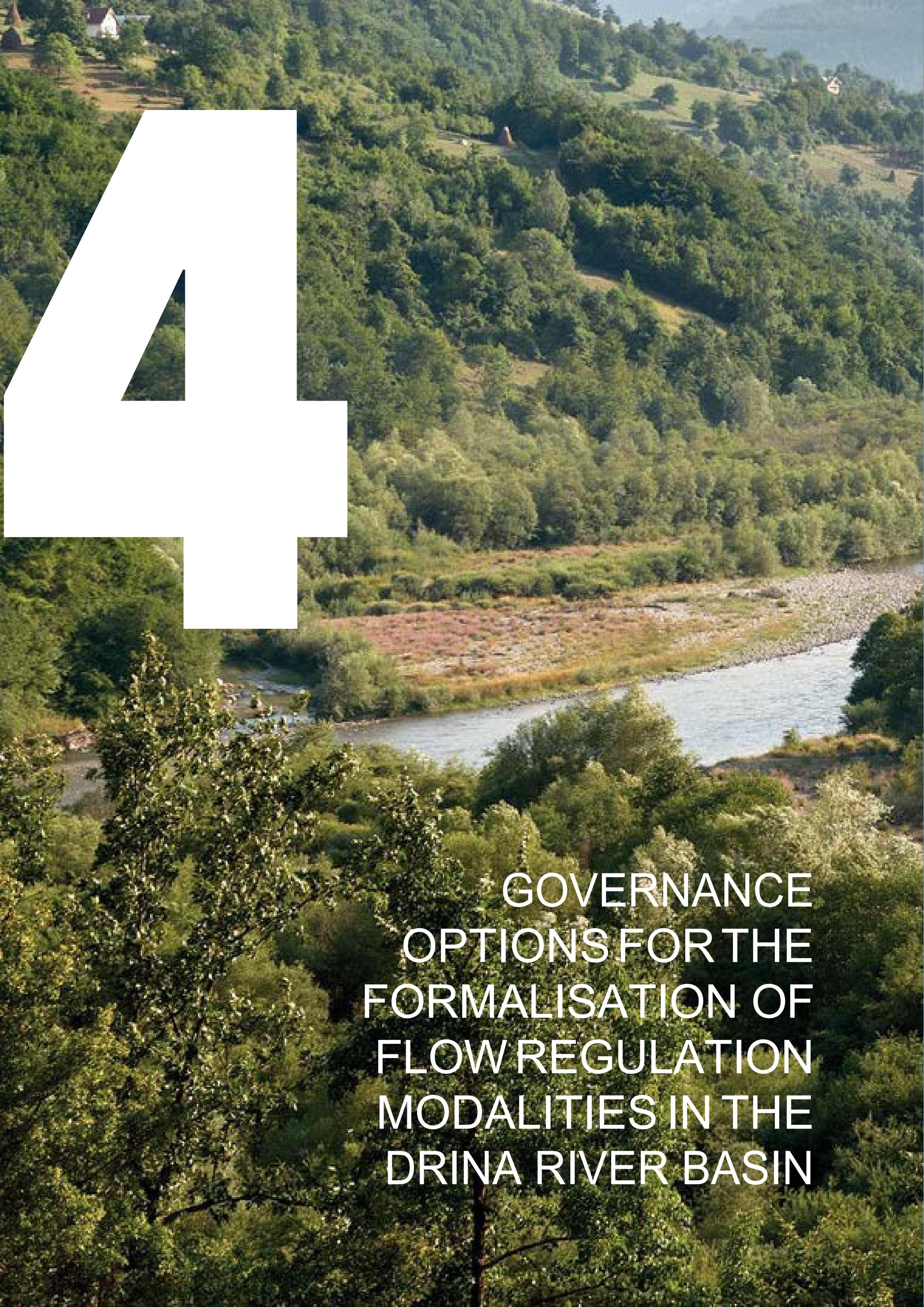
126 IRENA (2020): *Wind and Solar PV - what we need by 2050.* Available at: irena.org.

modelled in this analysis could either reduce stress on hydropower generation or provide an opportunity to decommission thermal power plants at an earlier date.

One last key hypothesis can be made about thermal generation. If power system developments follow the current policies assumed in the BAU scenario, thermal power will keep playing a significant role in the production mix of the riparian countries. This will cause emissions by the electricity sector to stay roughly constant up to 2040, in a way that contrasts with the decarbonisation ambitions of the countries and of the EU. Additionally, the high dependency on thermal generation may cause a technological lock-in, particularly if a carbon border tax adjustment mechanism is implemented with the EU. The expansion of these sources of power generation exposes the countries to the risk of locking into infrastructure that is not the most cost-competitive and could become stranded in the mid-term, before its end of life. The modelling insights show that the introduction of the ETS could cause an 80% reduction in power output from existing thermal power plants by 2028 when compared to 2020, if least-cost planning is pursued.

This analysis was performed with an open-source and freely available modelling tool and using data provided by local stakeholders and extracted from publicly available documents. The tool and the non-confidential part of the dataset are available to future users and developers, and they are documented in detail in Annex 2 and related upcoming publications. The aim is to provide the underlying modelling infrastructure of this study as a public good that may be transferred to and independently used by any interested users from the Drina Basin countries.

The modelling tool and its application are intended as living outputs, to be continuously developed in a collaborative fashion by multiple stakeholders. The data used in this analysis are the best that were available to the developers but are meant to be updated as more information becomes available.



4

GOVERNANCE OPTIONS FOR THE FORMALISATION OF FLOW REGULATION MODALITIES IN THE DRINA RIVER BASIN

4.1 CONTEXT AND SCOPE

The manner of regulation of flow in the Drina River Basin risks becoming uncoordinated and sub-optimal, which may have an impact on both water availability and quality. Especially regarding environmental flows ("e-flows"), the three Drina countries have adopted different approaches. As of writing, e-flows were assessed by some as generally adequate or even exceeded in the case of the three dams on the main stem of the Drina, based on agreements with fishers and the HPPs, while information related to HPP Mratinje at Piva was insufficient. At the same time, ecosystem needs may not be systematically integrated, and, overall, further study is needed. Nevertheless, with additional pressures expected and uncertainties according to climate scenarios, the different water users would benefit from a holistic approach to basin management. To capitalise on the benefits, coordinated policy and technical actions at different levels, across borders are necessary.

Through the Framework Agreement on the Sava River Basin, the Drina countries have access to a well-established institutional platform to discuss flow regulation. The first River Basin Management Plan (RBMP) for the Sava River Basin was adopted in 2014 and the International Sava River Basin Commission (ISRBC) is in an advanced stage of development of the second RBMP. The parties adopted the Flood Risk Management Plan in the Sava River Basin (2019), which represents a truly collective effort in the area of flood risk management (a flood forecasting and information system is functioning) and an important step towards adaptation to climate change. Reflection about how to develop flow regulation in the Drina River Basin towards co-optimisation and better ensuring different uses and functions could benefit from a global review of practice and principles relevant to water allocation. Such a review was carried out as part of preparing a global Handbook on Water Allocation in a Transboundary Context under the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention). The Handbook makes an explicit link to the opportunities of broader approaches, the water-food-energy-ecosystems Nexus, and the benefits of transboundary cooperation.

This section of the report describes different options for the eventual formalisation of key aspects of flow regulation across the riparian countries of the Drina and their Nexus sectors. Regarding flow regulation, the *Phase II Drina Nexus Assessment* seeks to further explore and promote discussion on formal flow regulation mechanisms between countries (agreements, protocols, discharge/operation rules etc.); to highlight good practices in transboundary water allocation, taking into account approaches to environmental and minimum flow as well as clauses for hydrological extremes; and to lay out some possible directions to help the Drina Basin countries in further development of their cooperation. The options available to the Drina countries must explicitly include the needs of different users, as well as the required environmental flows. Achieving an agreement on flow regulation would have implications on sectoral developments in all countries, including energy planning.

The study, presented in this section, builds upon the UNECE *Nexus Assessment in the Drina River Basin (2017)* and the *draft Desk Study on Environmental Flows and Flow Regulation in the Drina River Basin*[127] pursuant to the *Drina Nexus Follow-Up Project* (2018-2019), financed by the Italian Ministry of Environment, Land and Sea (hereinafter, "E-Flow Study").

The current study illustrates formalisation options available from a legal perspective, based on relevant experience from around the world, also considering the key role of actors beyond government authorities from the Nexus sectors, notably hydropower operators and energy utilities. The experiences from other transboundary basins have been considered, taking into account potential similarity to the Drina, both in terms of type/level of transboundary cooperation and in terms of legal and regulatory frameworks for water and environment, but also comparable issues. A key consideration in identified relevant experiences has been whether the cooperation involves actors across sectors or (at least) successfully addresses inter-sectoral aspects at transboundary level. International experience also provides examples of provisions and modalities for shared costs and benefits.

The study has been developed in consultation with the Expert Group on Flow Regulation and Environmental Flows in the Drina which was established with the support of the Drina Nexus Follow-Up Project. The first meeting of the Group was convened in June 2019 by the ISRBC and UNECE; the second meeting was held in March 2021; and the third meeting was convened in October 2021.

To gather the perspectives of all relevant stakeholders in the development of the study, interviews have been conducted with representatives of key institutions, including utilities providers, to compile their inputs, and ascertain up-to-date policy developments and management practices.

4.2 INTERNATIONAL OBLIGATIONS AND THE STATUS OF RELEVANT NATIONAL LAWS AND REGULATIONS

4.2.1 INTERNATIONAL LEGAL STANDARDS related to river flow

The water that precipitates onto land, eventually gathers through surface and groundwater into the course of a river, and flows to a lake or sea is an essential part of the water cycle that supports life on Earth. The flow of water through a particular drainage basin determines the capacities of the basin to support various forms of life and various human activities. The permanence of flow, seasonality of flow, maintenance of flow and extremes in flow are important characteristics of a river basin that are affected by physical, climatological and human factors. While river flow naturally changes over time, humans have developed methods for the integrated management of river basins to maximise benefits and minimise the risk of catastrophe or stress.

It cannot be said that there is an international legal obligation for states to regulate the natural flow of rivers. Given the level of human development in the vicinity of most transboundary rivers, however, it is usually the case that states have allowed

127 *Technical report prepared by Rafael Sanchez Navarro for UNECE (submitted in December 2019, revised in June 2021) for UNECE. Available at:* https://unece.org/environment-policy/water/areas-work-convention/water-food-energy-ecosystem-nexus.

modification of natural flows to a significant extent, which could give rise to liability for transboundary harm. River flow, therefore, is one of the key elements of Integrated Water Resources Management (IWRM) or River Basin Management (RBM). Integrated Water Resources Management (IWRM) has been defined by the Technical Committee of the Global Water Partnership (GWP) as "a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems". Flow is relevant to all three of the IWRM pillars. Social equity requires adequate supplies of municipal and recreational water as well as flood management. Economic efficiency requires adequate flows related to energy and industrial uses. Ecological sustainability requires the maintenance of natural flows at a level that sustains ecological values and functions, including biodiversity.

Flow regulation can enable authorities and the public to manage water resources in a way that fulfils the goals of IWRM. The main concerns of flow regulation include, among others, protection against excess or inadequate flows (flood or drought), seasonal fluctuations, distribution of resources, and disaster risk reduction and response. International standards related to flow regulation are typically contained in IWRM guidelines, such as those issued by UNESCO.[128] However, there are general obligations included in international legal texts as well.

4.2.1.1 Customary international law

The norms relevant to flow regulation are partially based upon the customary international legal norm of equitable and reasonable use of shared transboundary waters. The foundation of the norm of equitable and reasonable use is that the siparian states in a particular river basin have a community of interest in the resource giving rise to reciprocal obligations. The provisions related to equitable and reasonable use that are considered to belong to customary international law were first elaborated by the International Law Association in 1966, followed by draft articles adopted by the International Law Commission in 1994.

The 1997 *Convention on the Law of the Non-Navigational Uses of International Watercourses*[129] (also called the UN *Watercourses Convention*) includes provisions on equitable and reasonable use. Although, among the Drina riparian states, only Montenegro is a party to this convention, many provisions of the UN *Watercourses Convention* would be applicable also to Serbia and Bosnia and Herzegovina to the extent that they represent expressions of customary international law. Nevertheless, the transboundary governance regime would be strengthened if these two states would accede to the convention.

The UN *Watercourses Convention* includes a general obligation at Article 25, para. 1 that states shall "cooperate, where appropriate, to respond to needs or opportunities for regulation of the flow of the waters of an international watercourse". Other provisions of the UN *Watercourses Convention* are potentially useful in establishing a legal framework for cooperation on international watercourses. These provisions establish standards for nature protection (relevant to e-flows), apply the no significant harm rule in the context of IWRM, and address prevention and mitigation of harmful conditions.

Customary international law also includes the obligation of states to prevent harm to other states in accordance with their obligation of due diligence. This principle has been applied in the *Pulp Mills* case in an environmental context to require a state to conduct transboundary EIAs where proposed industrial activities on its territory have the potential to create adverse transboundary environmental impacts. The Permanent Court of Arbitration, in the Indus Waters Kishenganga Arbitration (Pakistan v. India) case[130], examined this and other international legal jurisprudence and found that states which undertake large-scale construction activities affecting shared transboundary waters have an obligation to maintain minimum flows for purposes of environmental protection (e-flows). Other relevant obligations under customary international law involve the obligations to notify and to consult.

The Kishenganga Arbitration decision indicates a tendency for tribunals considering issues of harm prevention to take potential harm to the environment into account in determining whether states have specific obligations in a transboundary context. Future cases may extend beyond the obligation to conduct EIAs or to maintain e-flows, for example into requirements to conduct adequate public participation processes and procedures in accordance with Rio Principle 10 as a mechanism for prevention of transboundary environmental harm.

4.2.1.2 Water management treaties

All three riparian countries are parties to the 1992 UNECE *Convention on the Protection and Use of International Watercourses and Transboundary*

128 See, for example: https://www.hydrology.nl/images/docs/ihp/IWRM_Guidelines/IWRM_Part_2-2_Guidelines_for_Flood_Management.pdf.

129 Available at: https://unece.org/environment-policy/water/un-watercourses-convention.

130 Partial Award, 18 February 2013, at paras. 450-452 and 454, and Final Award, 20 December 2013.

Lakes (hereinafter *Water Convention). Article 2, para. 6 of the convention emphasises the mechanism of bilateral and multilateral agreements as a means for cooperation* on a range of issues related to the protection and use of transboundary watercourses and international lakes. Article 9 further defines the obligations of parties vis-à-vis such agreements "on the basis of equality and reciprocity". Serbia and Bosnia and Herzegovina are also parties to the *Water and Health Protocol.* Flow regulation is relevant to the latter with regards to requirements related to water supply and sanitation for human populations.

The *Water Convention* operates on the basis of the principle that riparian countries should cooperate through bilateral and multilateral agreements at the Basin level and should establish joint bodies for developing strategies, adopting relevant decisions and taking actions. The *Water Convention* contemplates multiple joint bodies which may focus on different geographical scales within catchment areas, as shown by Article 9, para. 5, and numerous practical examples, including the ICPDR and the ISRBC.

The UNECE *Principles for Effective Joint Bodies for Transboundary Water Cooperation* (2018) are informative in determining the parameters of effective cooperation mechanisms. They describe the need for flexibility in agreements establishing joint bodies, including a gradual approach to inclusion of all riparian countries within a particular agreement. The Sustainable Development Goals indicator 6.5.2, the development of which drew upon the experience under the *Water Convention,* considers an agreement or arrangement as a precondition for "operationality", underlining the importance of an agreed formal basis, without distinguishing between different kinds of arrangements.[131]

The GEF-SCCF project undertook certain activities focused on the Drina River Basin that may be built upon in order to establish additional cooperative arrangements. Pursuant to the GEF-SCCF project, the signing of a protocol on data exchange in the Drina Basin was expected to take place at the time of writing, and activities were expected to begin with exchange of data and the use of hydrological and hydraulic models.[132]

All three riparian countries are parties to the ICPDR. The ICPDR can act as a joint body (or River Basin Organisation, RBO) relevant for the Drina Basin for the purposes of the *Water Convention*. It should be contemplated, nevertheless, how effective the ICPDR framework is in terms of governance of the Drina sub-basin, considering that the Sava countries have established their own joint body.

The parties to the *FASRB* are Slovenia, Croatia, Serbia, and Bosnia and Herzegovina. While Serbia and Montenegro were together in one state at the time that the *FASRB* entered into force, a year after the ISRBC was established, Montenegro became independent and is not a party to the *FASRB* but is engaged in it through an MoU, signed in 2013.[133] The scope of the MoU is cooperation in the areas covered by the *Framework Agreement*, for the purpose of better coordination and efficiency of their activities of common interest.

The MoU could be analysed to determine the extent to which it does or does not establish a joint body covering the Drina Basin with sufficient characteristics to reach the level of effectiveness indicated under the *Principles, and what steps could be taken to address any gaps. T*he MoU may be of a different quality in terms of its legally binding nature, in which case the scope of cooperation under the *FASRB* and the MoU may differ. So far, the MoU has been implemented mainly through technical cooperation. E.g., Montenegro can participate in all projects about water management in the Sava River Basin. But the different status of Montenegro can be seen in the context of the adoption of the protocols to the *FASRB*, some of which are relevant to flow regulation, such as the *Protocol on Flood Protection, the Protocol on Sediment Management,* and the contemplated protocol on transboundary impacts specified in the *FASRB*, which some parties contend ought to regulate key issues related to transboundary water allocation, including the water and balance regime and flow.

To the extent that the ISRBC established under the *FASRB* can undertake the functions of an effective joint body under the *Water Convention,* the inclusion of Montenegro as a party within the regime could meet the effectiveness criteria of the *Principles.* Conversely, as long as Montenegro is not a full

131 Step-by-step monitoring methodology for SDG indicator 6.5.2 version "2020" of the Integrated Monitoring Guide for SDG 6 (Final version 2020-01-25) states as follows: Arrangement for water cooperation refers to: a bilateral or multilateral treaty, convention, agreement or other arrangement, such as memorandum of understanding, between riparian states that provides a framework for cooperation on transboundary water management. Agreements or other kind of formal arrangements may be interstate, intergovernmental, interministerial, interagency or between regional authorities. For additional guidance on what constitutes an 'arrangement for water cooperation', the *Guide to reporting under the Water Convention and as a contribution to SDG indicator 6.5.2 (UNECE, 2019)* provides further detail.

132 Interview with D.Dobričić.

133 Available at: https://www.savacommission.org/UserDocsImages/05_documents_publications/basic_documents/memo_of_understanding_between_isrbc_and_montenegro.pdf.

party to the *FASRB,* and cooperation is based upon an MoU, there is a chance that the ISRBC cannot fulfil all the functions of a joint body under Article 9 of the *Convention* with respect to the Drina River Basin. However, it can still be an effective interim cooperative arrangement.

Even without the full participation of Montenegro, the cooperative platform for the Sava goes a long way towards enabling the states to make progress on substance, including flood forecasting and information systems. It also represents a first step towards adaptation measures. The ISRBC practices such as stakeholder engagement, establishing of the Sava Water Council, the Sava Youth Parliament, etc., already serve as mechanisms for application in the Drina River Basin. The *Joint Plan of Action for the Sava River Basin (2017)* is an example of cooperation between the ISRBC and Montenegro at political level. It was supported by the ISRBC and Montenegro through the *Joint Statement of the Parties to the FASRB and Montenegro on a Plan of Action and Milestones for the Sava River Basin as a Catalyst for Cooperation in the Region.* The *Sava Flood Risk Management Plan* is another example of a collective effort covering the Drina Basin.

Yet, during the project, Montenegro brought attention to certain limited capacities in connection with the development of the 2nd *Sava River Basin Management Plan,* which as of the time of writing was in the public consultation phase. Such initiatives should be carefully examined in terms of comparability with respect to the Drina Basin as the level of detail is important. In the same way that planning on the Sava River Basin level could be more precise and effective than planning on the Danube Basin level, the Drina Basin may also benefit from a more focused approach.

Mechanisms through the ISRBC are used especially in the field of integrated water management, in the process of data and information exchange (the establishment of Sava GIS and the Sava Hydrological Information System[134]), in respect of high waters, forecasting, and hydrological and hydraulic modelling. Two subsidiary bodies under the ISRBC have competencies related to flow regulation – these are the permanent Expert Groups for River Basin Management and for Flood Protection.

The *FASRB* has three core goals: "establishment of an international regime of navigation on the Sava River and its navigable tributaries, undertaking of measures to prevent or limit hazards, and establishment of sustainable water management".

134 The *Policy on the Exchange of Hydrological and Meteorological Data and Information in the Sava River Basin* was adopted in 2014, and participation by organisations and the provision of contributing data is evolving.

The ISRBC coordinates the development of various intersectoral plans, among which are the *River Basin Management Plan* according to the European Union *Water Framework Directive (WFD)*, developed between 2009 and 2013, and approved in 2014.[135] It provides a framework for the establishment of joint objectives that can be implemented by countries at different stages of development. The ISRBC also serves as a forum where different interests (such as recreation and tourism, industry, agriculture or navigation) are represented and a platform for discussion on issues of common concern as well as agreement on the coordinated implementation of relevant activities. The ISRBC's *Public Participation Plan*, finalised in 2014, presents a good basis for further activities on strengthening public participation and stakeholder involvement in implementation of the *FASRB*. The general public is informed of progress with *FASRB* implementation through the ISRBC's website[136] as well as through various publications and releases. The Sava Water Council, which increases stakeholder involvement and gives a greater voice to stakeholders, is an advisory platform established in 2015.

As an alternative to Montenegro becoming a party to the *FASRB*, one theoretical possibility would be for the riparian states to establish a specific joint body which covers the Drina River Basin, with potential contributions from the outcomes of the GEF-SCCF project. The riparian states could determine jointly whether a DRB RBMP would represent value added in comparison with other initiatives on the scale of the Danube or Sava Basins. This newly established joint body would then become the platform for various dedicated cooperative mechanisms, including technical working groups, expert bodies and committees.

One priority initiative could be to revise and adopt Basin-wide Flood Protection Plans and water management agreements on controlled operation of HPPs to prevent the reoccurrence of heavy flood disasters on the main course, taking into account the effects of prior flooding and potential effects of climate change.

In the longer term, an appropriate joint body could potentially adopt a *River Basin Management Plan for the Drina River Basin,* drilling down on the planning done under the ICPDR and ISRBC and giving attention to the different planning cycles in the

135 ISRBC (2014): *Sava River Basin Management Plan.* Available from: https://www.savacommission.org/documents-and-publications/water-management-1957/sava-river-basin-management-plan/10359 A second *RBMP* is under preparation. See: https://www.savacommission.org/UserDocsImages/05_documents_publications/water_management/SavaRBMPlan/Draft%202nd%20Sava%20River%20Basin%20Management%20Plan.pdf?vel=14120152.

136 Information available from: www.savacommission.org.

region. Currently, there is no such initiative focused on the Drina Basin on any platform at any scale.

To the extent that navigation is relevant to flow regulation on the Drina, Serbia is a party to the *Belgrade Convention* (implemented under the coordination of the Danube Commission, DC) while Montenegro has observer status.

ISRBC, ICPDR and DC participate alongside the states in the implementation of the *EU Strategy for the Danube Region* (EUSDR). The topics elaborated within the *EUSDR* are very important for the Drina Basin countries, which actively participate in the implementation of this strategy.

4.2.2 Linkage between **WATER MANAGEMENT** and **ENERGY**

Energy matters are largely independent from geographical considerations based on the River Basin approach. Consequently, RBOs typically have mandates that do not extend into energy matters. This disconnect is one of the main obstacles to the development of functioning, comprehensive transboundary flow management schemes. Recognising the importance of engaging HPP operators into their work, the ISRBC has initiated efforts to engage HPP operators into data policy in areas such as flood forecasting in order to contribute data and share data benefits.

4.2.2.1 Energy Community

All three countries cooperate on energy matters through the Energy Community, whose purpose is to extend the European Union's single market in the area of energy to a broader European neighbourhood. Inevitably, the *acquis communautaire* in areas which are relevant to energy security and markets are also promoted through the Energy Community, such as EIA and SEA, and other European policies such as those regarding decarbonisation and renewable strategies.

The *Energy Community Treaty* entered into force in 2006. Parties to the agreement include the European Union and a number of Contracting Parties outside the EU, including the three Drina Basin riparian states. Parties regularly submit reports on national implementation. The Western Balkan countries participate in the South-East Europe Sustainable Energy Policy Programme of the SEE Change Net. The programme is supported by the European Commission's DG Enlargement. All three countries are parties to the *Statute of the International Renewable Energy Agency (IRENA).*

In the context of the Energy Community, the three Drina countries, along with Albania, Kosovo[137] and North Macedonia, participate in a Western Balkans 6 Initiative, promoting infrastructure development and improvement of connectivity within the region as key elements for growth and jobs in the Western Balkans. In 2015, these countries agreed to take steps towards the establishment of a regional electricity market, and in 2016 they agreed upon a Roadmap and a set of priority measures aimed at removing national obstacles to efficient regional capacity allocation.[138]

The Regional Cooperation Council (RCC) supports the countries' commitment to the EEC through instruments such as the *SEE 2020 Strategy, the Energy Strategy by 2020* and the Sustainable Energy Development Regional Initiative (SEDRI). SEDRI is aimed at complementing the Energy Community in relation to strengthening regional energy cooperation by promoting involvement of stakeholders (parliamentarians, civil society, local authorities, etc.), awareness of the need to reduce greenhouse gas emissions generated by energy activities, and sustainable energy development.

The Energy Community's legal regime gradually extends EU legislation (acquis) in the energy field to the non-EU countries covered by the agreement (see Box 1). All three countries are on the same time schedule with respect to implementation of relevant EU Regulations, which have to be harmonised through national legislation. Under the regime, the Drina countries should be moving towards eliminating barriers to trade of energy across borders within the area covered by the treaty.

137 This designation is without prejudice to positions on status, and is in line with UN Security Council Resolution 1244 and the ICJ Opinion on the Kosovo declaration of independence.

138 See WB6 Energy Community – Creating a Regional Electricity Market in the Western Balkans: From Paris to Rome. WB6 Monitoring Report, September 2016. Available at: https://www.energy-community.org/portal/page/portal/ENC_HOME/DOCS/4346408/3E2FD-222C83F0FE8E053C92FA8C032A8.pdf.

Box 1. The EU energy acquis Balkans

The energy acquis as defined in Annex I to the Energy Community Treaty includes the following pieces of legislation, as from time to time amended:

1. Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity, as adopted by Decision No 2011/02/MC-EnC of the Ministerial Council of 06/10/2011.
2. Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas, as adopted by Decision No 2011/02/MC-EnC of the Ministerial Council of 06/10/2011.
3. Regulation (EC) No714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity, as adopted by Decision No 2011/02/MC-EnC of the Ministerial Council of 06/10/2011.
4. Regulation (EC) No 715/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the natural gas transmission networks, as amended by Commission Decision 2010/685/EU of 10 November 2010, as adopted by Decision No 2011/02/MC-EnC of the Ministerial Council of 06/10/2011.
5. Directive 2005/89/EC of the European Parliament and of the Council of 18 January 2006 concerning measures to safeguard security of electricity supply and infrastructure investment, as adopted by Decision No 2007/06/MC-EnC of the Ministerial Council of 18/12/2007.
6. Directive 2004/67/EC of 26 April 2004 concerning measures to safeguard security of natural gas supply, as adopted by Decision No 2007/06/MC-EnC of the Ministerial Council of 18/12/2007.
7. Regulation (EU) No 347/2013 of the European Parliament and of the Council of 17 April 2013 on guidelines for trans-European energy infrastructure, as adopted by Decision D/2015/09/MC-EnC of the Ministerial Council of 16 October 2015.
8. As the EU energy acquis changes, the obligations of members of the Energy Community must keep up through amendments of the annex in the treaty adopted by the Energy Community Ministerial Council.

The Energy Community Treaty[139] **also includes obligations for the Contracting Parties to implement certain Directives within the environmental *acquis*, including:**

1. Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment as amended by Directive 2014/52/EU.
2. Directive (EU) 2016/802 of the European Parliament and of the Council of 11 May 2016 relating to a reduction in the sulphur content of certain liquid fuels and Commission Implementing Decision (EU) 2015/253 of 16 February 2015 laying down the rules concerning the sampling and reporting under Council Directive 1999/32/EC as regards the sulphur content of marine fuels.
3. Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants by 31 December 2017.
4. Article 4(2) of Directive 79/409/EEC of the Council of 2 April 1979 on the conservation of wild birds on the entry into force of this Treaty.
5. Chapter III, Annex V, and Article 72(3)-(4) of Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) **from 1 January 2018** for new plants and by **1 January 2028** at the latest for existing plants.
6. Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage, as amended by Directive 2006/21/EC, Directive 2009/31/EC and Directive 2013/30/EU.
7. Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment.

139 Available at: https://www.energy-community.org/legal/treaty.html

Articles 24 and 25 of the treaty bind parties to adopt core EU energy legislation from the *acquis communautaire,* including that in the area of renewable energy. Some parts of the relevant EU legislation are problematic for countries in the Western Balkans. For example, none of the countries are in compliance with the *Large Combustion Plants Directive, Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants (the LCP Directive).*

One of the missions of the Energy Community is to "improve the environmental situation in relation with energy supply in the region and foster the use of renewable energy …." Hydropower potential is a major component of renewable energy strategies in the Drina Basin. The three countries have submitted periodic reports on promotion and use of energy from renewable sources, the most recent covering the period up to 2019. Due to geographical factors, hydropower plants (HPPs) are among the most significant renewable energy sources within the region. River flow is critical to the operation of HPPs. In the Drina River Basin, HPPs are also powerful economic actors.

Regional arrangements with relevance to Nexus, such as the Energy Community, do not make major distinctions on the level of river basins. Their geographical scope is based on a larger regional market.

4.2.2.2 Potential for integration of energy policies with water management policies

The *Strategy on Implementation of the Framework Agreement on the Sava River Basin envisages* further integration of water policies with other sector policies. Also, the *Joint Plan of Action for the Sava River Basin (JPA SRB)*[140] was developed in spring 2017 and supported by the *Joint Statement of the representatives of the Parties to the FASRB and Montenegro on Plan of Action and Milestones for the Sava River Basin as a Catalyst for Cooperation in the region. JPA SRB* outlines the path towards further development of the region and contributes to the efforts of the Parties and of Montenegro to ensure sustainable economic development and growth of the Basin.

140 Joint Statement and JPA SRB are available here: https://www.savacommission.org/UserDocsImages/05_documents_publications/basic_documents/ISRBC_Joint%20Statement%20on%20JPA%20for%20the%20Sava%20RB.pdf.

4.2.3 MULTILATERAL ENVIRONMENTAL agreements

In addition to the previously mentioned basin-level cooperation, all three countries are parties to various environmentally related conventions, or multilateral environmental agreements. These include the UNECE environmental conventions such as the *Water Convention,* the *Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention),* the *Convention on the Transboundary Effects of Industrial Accidents* (TEIA), and the *Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention).* They are also parties to various global environmental conventions including the *Convention on Wetlands of International Importance (Ramsar Convention),* the *UN Framework Convention on Climate Change (UNFCCC), the Paris Agreement,* and the *UN Convention on Biological Diversity (CBD).*

Montenegro and Serbia are parties to the SEA Protocol and *PRTR Protocol,* while Bosnia and Herzegovina has signed both.

Ratification status with regard to some important conventions and protocols is set forth in Table 6, adapted from the *Drina River Basin Nexus Assessment:*

Table 6. Ratification status with regard to some important conventions and protocols.

Convention / protocol	Bosnia and Herzegovina	Montenegro	Serbia
UNECE Water Convention	X	X	X
Protocol on Water and Health	X		X
Espoo Convention (EIA)	X	X	X
Espoo/SEA Protocol	X	X	X
Aarhus Convention/ PRTR	X	X	X
Industrial Accidents Convention	X	X	X
UNFCCC	X	X	X
Paris Agreement (sig)	X	X	X
Paris Agreement (rat)			

The *Espoo Convention* has been invoked by Montenegro, which on 1 December 2020 submitted a communication to the Implementation Committee expressing concerns about the compliance of Bosnia and Herzegovina with transboundary EIA obligations in connection with the construction of the Buk Bijela HPP on the Drina River and with its ecological permit issuance in 2019. A communication on this matter was originally submitted by a Montenegrin NGO. Representatives from the Ministries of Montenegro and the Republika Srpska responsible for the environment, held a meeting on this topic in July 2021. They have agreed to establish an expert team to examine the possible impact of the Buk Bijela hydropower plant on the Tara River in Montenegro.

SEA examples of integrated policymaking can be found in the region, and Drina countries have participated with neighbouring countries in transboundary SEAs. For example, as stated in the Sava Basin report, "[i]n 2010-2012, Serbia participated in a transboundary SEA for the *Energy Development Strategy of Montenegro, and conducted one for Serbia's new Energy Sector Development Strategy for 2025-2030".* Neighbouring countries participated in a transboundary SEA for the adoption of the *Water Management Strategy* for the Republic of Serbia. Bosnia and Herzegovina, Montenegro and Serbia have participated in cross-border programme SEAs conducted by Croatia. Bosnia and Herzegovina has conducted SEAs of river basin plans in two tributaries of the Neretva River as well as for the Sava River Basin District in Federation of Bosnia and Herzegovina (2016-2021).

A transboundary SEA has been conducted with respect to two planned HPPs at Komarnica in Montenegro. In the Drina River Basin, examples include the SEA of the *Spatial Plan of Sutjeska National Park* (Bosnia and Herzegovina) and the SEA of the *Spatial Plan of Prijepolje.* For these two examples, the transboundary aspects, if any, are unclear. A study has identified shortcomings in EIA and SEA practice in the countries.[141]

All three countries are parties to the Bern Convention on the Conservation of European Wildlife and Natural Habitats.[142] The countries have submitted their inventories of sites for the Emerald Network of Areas of Special Conservation Interest.[143] The three countries are also preparing for implementation of the EU's nature protection pillars related to the *Bern Convention – the Birds and Habitats Directives* – and participation in the Natura 2000 network of protected areas. These two Directives are changed at each enlargement to reflect the status of species in the accession states. Countries are obliged to develop their Natura 2000 network according to the *Birds and Habitats Directives* prior to accession. Nature protection authorities in the three countries have a long history of cooperation, particularly with respect to migratory species. All three countries are parties to the *European Landscape Convention.*[144]

A large number of international initiatives provide frameworks for cooperation on complex issues with environmental and health impacts. These are too numerous to mention here, but one example is the *Transport Environment and Health Pan-European Programme*[145], which has elaborated goals through declarations made in Amsterdam in 2009 and Paris in 2013.

In 2011, IUCN conducted a feasibility study about the establishment of a transboundary protected area – the Tara-Drina – including several existing national parks in Serbia, to be joined with a proposed Drina "Biosphere Reserve" to be designated in Bosnia and Herzegovina. Work on the project began in the context of the project Environment for People in the Dinaric Arc. The status of designation of the Drina Biosphere Reserve is currently unclear.

Another feasibility study was conducted by UNEP in 2010 for a transboundary mountain biosphere area between Montenegro and Albania in the Prokletije area, part of which would be in the high uplands of the Lim River, a tributary of the Drina. WWF has supported the establishment of NGO and protected area networks in several accession and candidate countries, including the three Drina countries.

4.2.4 DISASTER RISK reduction

Flow regulation, particularly in the context of protection against damage from high or low water, should be considered in the context of disaster risk reduction. One of the priorities of the 2015 *Sendai Framework for Disaster Risk Reduction*[146] is strengthening disaster risk management. One of the mechanisms for doing so is to "promote transboundary cooperation to enable policy and planning for the implementation of ecosystem-based approaches with regard to shared resources,

141 WWF Adria and South East Europe Sustainable Energy Policy (SEE SEP), *EIA/SEA of Hydropower Projects in South East Europe. Meeting the EU Standard.* (2015). Available from: *http://www.door.hr/wp-content/uploads/2016/06/hidro_v6_webr.pdf*.

142 Available at: https://www.coe.int/en/web/conventions/full-list?module=treaty-detail&treatynum=104.

143 For more info: https://www.coe.int/en/web/bern-convention/emerald-network.

144 For more info: https://www.coe.int/en/web/landscape.

145 For more info: https://unece.org/transport-health-environment-pep-0.

146 Sendai Framework for Disaster Risk Reduction 2015-2030, available at: https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030.

such as within river basins … to build resilience and reduce disaster risk" (para 28).

A possible follow-up action in future phases of Nexus Assessment of the Drina River Basin could be to conduct an in-depth analysis of the relationship between the *Sendai Framework* and Basin-specific regimes such as flow regulation.

All three riparian countries have bilateral agreements and standard operating procedures with each other in the field of protection and rescue, and provision of support in the case of natural and other disasters. These have been developed in the context of the Sava River Basin, through the *Flood Risk Management Plan,* Flood Forecasting and Warning System, and Geographical and Hydrological Information System.[147]

However, attention has been brought to the lack of a bilateral agreement on the rules of operation of the Mratinje HPP in case of significant flood events to prevent downstream hazards on the upper and middle Drina. Risks are significant in this area, which has recorded the highest precipitation and highest river level in the region.

4.2.5 European Union CONTEXT

The three riparian states are obliged to harmonise their legislation with the energy *acquis* regardless of their candidate status pursuant to the *Energy Community Treaty.*

Montenegro and Serbia are candidate countries, while Bosnia and Herzegovina is a potential candidate country. As reported in the *Drina Nexus Assessment:*

The European Union (EU) has a major influence on developments in the Drina Basin, since all three countries have taken steps towards EU accession. As a consequence, the three countries have made commitments derived from the *acquis communautaire* (EU Law) that affect water, energy, ecosystem and food policies. These laws include the EU *Water Framework Directive* and its substance-specific (or "daughter") directives, various energy directives and strategies, the *Common Agricultural Policy, the Rural Development Policy,* and a number of environment directives such as the *Birds and Habitats Directives*. [...] The Drina countries typically have specific institutions dedicated to EU integration and may adopt specific national strategies for approximation or transposition. The EU integration process also includes possibilities for financing activities aimed at reaching cross-sectoral integration goals. One accession requirement that is particularly important to energy sector development in the Western Balkans is the requirement to meet binding renewable energy targets by 2020 and to prepare and implement *National Renewable Energy Action Plans [NREAPs].* Each country is undergoing gradual structural reform in the agricultural sector to prepare for EU membership. The approximation adoption of the water-related directives has advanced at different stages in the Drina countries.

Since the *Drina Nexus Assessment* was published in 2017, progress has been made in certain areas. In the field of renewables, for example, all three countries have regularly submitted progress reports in relation to their NREAPs. The 2020 overall implementation scores for the countries on renewables were: Montenegro – 73%, Serbia – 58%, and Bosnia and Herzegovina – 49%. Montenegro and Serbia both made progress between 2018 and 2020 by adopting bylaws on biofuels. Serbia also adopted the *Rulebook on the calculation of the share of renewable energy sources in gross final energy consumption.* Moreover, in September 2019, the designated body Elektromreža Srbije (EMS) became a full member of the Association of Issuing Bodies (AIB).[148]

In the most recent progress reports on EU accession (2020), Serbia's progress on water management-related directives was called "moderate", while Montenegro was "limited" and Bosnia and Herzegovina was "very limited". It was noted that an action plan for flood protection and river management in Bosnia and Herzegovina for 2014-2021 was being implemented. Concerning nature protection, in particular the *Birds and Habitats Directives,* Serbia's progress was again "moderate", while Montenegro was "partially aligned" and Bosnia and Herzegovina was "very limited". The Montenegro report made special reference to the need for measures to preserve and improve the ecological value of protected areas and potential Natura 2000 sites, including the Tara River.[149]

River flow is not directly regulated under EU law but is indirectly influenced through legislation aimed at matters such as water management, biodiversity protection, renewable energy and agricultural policy.

Under the EU *WFD,* Significant Water Management Issues (SWMIs) are those pressures acting upon

147 See: *Sava Flood Risk Management Plan* (annex 2, table 17),https://www.savacommission.org/sava-flood-risk-management-plan/1996. E.g, Bosnia and Herzegovina with Serbia ("OG Bosnia and Herzegovina", No. 08/11) and Montenegro ("OG Bosnia and Herzegovina", No. 2/08).

148 Available at: https://www.energy-community.org/implementation/.

149 See:https://ec.europa.eu/neighbourhood-enlargement/system/files/2020-10/serbia_report_2020.pdf, https://ec.europa.eu/neighbourhood-enlargement/system/files/2020-10/montenegro_report_2020.pdf, https://ec.europa.eu/neighbourhood-enlargement/system/files/2020-10/bosnia_and_herzegovina_report_2020.pdf.

the water environment that are considered to put most at risk the ability to achieve the *WFD's* environmental objectives. The SWMIs within the *River Basin Management Plans* (developed in accordance with the EU WFD) are closely linked with energy and agriculture. The ISRBC has worked on identifying SWMIs in the Sava River Basin.[150]

With respect to environmental regulation, the three countries have moved towards adoption of the environmental *acquis*. Regional initiatives have promoted cooperation on developing strategies for harmonisation with the environmental *acquis* and sharing experience and boosting cooperation among environmental inspection authorities. Regional networks and meetings have been organised through projects such as the *Regional Environmental Reconstruction Programme for South-Eastern Europe (REReP),* the *Regional Environmental Network for Accession (RENA)*, and the *Environment and Climate Regional Accession Network (ECRAN).* Environmental enforcement networks such as INECE, IMPEL and ECENA have played an important role in the sharing of experience and the development of guidance materials on European and international standards for inspection, compliance, enforcement and implementation of environmental law.

The EU *acquis communautaire* in the field of water management has profound importance for furthering sustainable water use, and pollution reduction and control. A key element of the *Water Framework Directive* is the requirement of full cost recovery for water services, including environmental costs. Due to the need for expensive investments in infrastructure, new EU Member States typically receive derogations for full implementation of elements of the *acquis* such as the *Urban Waste Water Treatment (UWWT) Directive.* Commitments and deadlines are set down in the respective accession treaties with the EU (e.g., 2023 for Croatia). Meanwhile, the approximation of the water-related directives has advanced at different stages in the Drina countries. For example, in Serbia, based on information from 2021, the *Water Framework Directive* was partially implemented, with *River Basin Management Plans* to be adopted within one year. Based on information obtained from the Republic Directorate for Water, full transposition is planned for 2023.[151] Throughout the region, there is clearly still work to be done to harmonise with existing EU legislation. In addition, these countries may face new and increasing requirements in the future as the EU continues to update and develop its environmental legislation.

In the EU context, a definition of ecological flows and the concept of ecological flows in the context of the *Water Framework Directive* are set out in Guidance Document No. 31, *Ecological flows in the implementation of the Water Framework Directive (2015).*[152]

The EU legislation related to and adopted for the implementation of the *Aarhus Convention* facilitates coordination and cooperation across sectors. The Drina countries have developed extensive practice in the implementation of provisions related to access to environmental information and public participation in environmental decision-making. More needs to be done, however, to aggregate the outcomes of public participation at specific decision-making levels in order to take these into account at more strategic levels. In addition, public participation must be maintained and even strengthened in connection with specific-level decisions that are highly relevant to the Nexus approach, such as in those concerning climate change adaptation.

The EU context is also important from the perspective of the *EU Strategy for the Danube Region (2010).* A "macro-regional strategy" is an integrated framework endorsed by the European Council, which may be supported by the European Structural and Investment Funds, among others, to address common challenges faced by a defined geographical area relating to Member States and third countries located in the same geographical area which thereby benefit from strengthened cooperation contributing to achievement of economic, social and territorial cohesion. While many of the programmes under the *Strategy* are aimed at EU Member States, it also applies to the three Drina countries. The *Strategy* does not provide new funds, but serves as a programmatic tool for the direction of existing funding, including IPA, aimed at enhancing the implementation capacity within the existing legislative and institutional frameworks. The *Strategy* includes an Action Plan. A similar structure has been established in the implementation of the *EU Strategy for the Adriatic and Ionian Region including the Drina Basin countries.*

The EU produces a wide range of guidance documents for approximation with and implementation of the *acquis,* from the Handbook to specific technical guidance on elements of each Directive. Nevertheless, it is often up to each country to determine its own specificities, even where the EU *acquis* sets broad policy goals. There can be large variations in technical approaches, especially in areas where no agreed standards

150 Available at: https://www.savacommission.org/UserDocsImages/05_documents_publications/water_management/SavaRBMPlan//swmi-interim_overview.pdf.

151 Information provided by Republic Directorate for Water.

152 Available at: https://circabc.europa.eu/sd/a/4063d635-957b-4b6f-bfd4-b51b0acb2570/Guidance%20No%2031%20-%20Ecological%20flows%20%28final%20version%29.pdf.

have yet been developed. One example of this area is ecological flows. There is no single agreed methodological approach to ecological flows. Nevertheless, the EU has provided guidance for ecological flows in implementation of the *Water Framework Directive* based upon the current state of knowledge.[153] Ecological flows may also vary over time, and not just seasonally – they may need to be set at restoration levels for a period of time in degraded areas or to respond to particular weather events.

4.2.6 Bilateral **AGREEMENTS**

Bilateral agreements may be stepping-stones towards a comprehensive scheme, but they may also introduce variations and inconsistencies that complicate a Basin-wide approach. While bilateral agreements are contemplated under the *Water Convention,* they should be based upon the basic requirements of IWRM and aim towards application of consistent international standards to the whole catchment area.

Bilateral agreements do not currently play a significant role in water management or flow regulation in the Drina River Basin. Negotiations towards a bilateral water cooperation agreement between Bosnia and Herzegovina and Serbia were suspended on the grounds that issues related to hydropower should also be agreed.

There are no specific agreements among the three countries or between any two of them with direct relevance to the Drina River Basin *per se.* There are also very few direct bilateral agreements between any of the two countries, apart from bilateral agreements for emergency situations. Bilateral agreements on disaster risk reduction may be relevant to management of the Drina River Basin. Bosnia and Herzegovina has signed agreements on cooperation in protection against natural and other disasters with Serbia ("OG Bosnia and Herzegovina", No. 08/11) and Montenegro ("OG Bosnia and Herzegovina", No. 2/08).

The countries report, however, that they plan to negotiate bilateral agreements on water management in the near future. Serbia and Bosnia and Herzegovina have signed a *Memora*ndum of Understanding on the institutional framew*ork for disaster prevention and preparedness in South-East Europe.* An agreement between the Government of Serbia and the Council of Ministers of Bosnia and Herzegovina has been signed on construction of an interstate bridge over the Drina River between Ljubovija and Bratunac. There is an agreement on "Special Parallel Relations" between Serbia and Republika Srpska – an entity within Bosnia and Herzegovina. Under this agreement, four councils have been held, and it covers cooperation on, inter alia, energy, transport, tourism and environmental protection. Subsequently, an agreement on cooperation between the Serbian Government and the Government of Republika Srpska in Energy has been executed, as well as memoranda of understanding between the Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia and the Ministry of Agriculture, Forestry and Water Management of the Republika Srpska, and between the Government of Republika Srpska and Serbian Government on Energy.

The electricity utility of Republika Srpska (EPRS) and the electricity utility of Serbia (EPS) cooperate in planning the construction of HPPs in the upper stretch of the Drina River and its tributaries as well as in the middle stretch of the River with possible involvement of international partners.[154] The special constitutional order of Bosnia and Herzegovina requires coordination at the state level.

Water management authorities have a relatively secure, legally based cooperation across borders. In other sectors, cooperation is based more on MoU-type arrangements.

Arrangements between HPPs to some extent regulate flow, particularly in some stretches of the River. In particular, see the *Rulebook on harmonized and optimal operation of "HPP Višegrad" and "HPP Bajina Bašta"* mentioned below, which are set forth and discussed in detail in the E-Flow Study. Such arrangements are technical and are focused on operational parameters, with limited regard for other aspects of flow regulation. The HPP operators are still required to operate in the context of domestic law and regulation regardless of the guidance in the "rulebook".

Attention has been brought to the lack of a bilateral agreement on the rules of operation of the Mratinje HPP in the case of significant flood events to prevent downstream hazards on the upper and middle Drina. Risks are significant in this area which has recorded the highest precipitation and highest river level in the region. A potential model to be followed in this case is the example of the rules related to the Neretva River in BiH, in particular the Jablanica Dam and Lake, covering energy production, tourism and flood protection, which includes regular discharges during the wet season.

Agreements for the protection of certain objects of world heritage could have an impact on flow regulation. One example is the *Protocol*

153 See: Technical Report 2015-086, "Ecological flows in the implementation of the Water Framework Directive". Guidance Document No. 31 (2015).

154 Information obtained from the electricity utility power company of Serbia (EPS).

on Cooperation between the Government of the Republic of Serbia and the Council of Ministers of Bosnia and Herzegovina on the preservation of the Mehmed-Paša Sokolović bridge in Višegrad, signed on 4 November 2015 in Sarajevo. The agreement requires exchange of information between the two states on activities affecting water levels that could threaten the stability of the bridge and establishes a committee to propose measures for its preservation. The *Protocol,* whose preparation was facilitated by the ISRBC, represents a step forward in the implementation of the *FASRB,* as well as the conclusions of the World Heritage Committee (UNESCO) related to the historical bridge.[155]

There is a *Memorandum on cooperation between Serbia and the Bosnia and Herzegovina entity of Republika Srpska in the field of energy,* as well as the following:

- *Agreement on Cooperation in the Electricity Sector,* which envisages joint investment in the construction of hydroelectric power plants on the rivers Ibar, Sava and Drina, which were signed by EPS and the company SECI Energia S.p.A.;
- *Preliminary Agreement on Strategic Partnership in the implementation of the project "Middle Drina"* from October 23, 2011 (signatories: EPS, Mixed Holding "Electric Power Industry of Republika Srpska-Parent Company JSC Trebinje and Italian company SECI ENERGIA SpA), but its validity expired on 31 December 2014; and
- *Rulebook on harmonized and optimal operation of "HPP Višegrad" and "HPP Bajina Bašta".*[156]

155 Information provided by Ms. Olivera Janković, MAFWM Water Directorate.

156 Information provided by Mr. Radisav Matić, DLHE Bajina Bašta.

4.2.7 NATIONAL FRAMEWORKS, LAWS AND REGULATIONS related to flow regulation

The *Desk Study on Environmental Flows and Flow Regulation in the Drina River Basin*[157] *(hereinafter, E-Flow Report)* presents an accurate and up-to-date summary of the relevant water management institutions, legislation and regulations, including flow regulation, in the riparians. In the context of environmental and ecological flows, Chapter 4 of the report presents the legal and institutional framework for water management in the countries. That report is referred to here for more information on current bylaws related to flow regulation in the riparian countries.

Supplemental to the contents of the *E-Flow Report,* as of early 2021, Serbia was in the process of launching a public procurement in order to determine the methodology that will be proposed for the regulations on minimum sustainable flows, which is yet to be adopted, based upon the *Lawon Waters.* Issues related to individual locations are regulated through Water Acts. These define the permitted water regimes (both in terms of quality and quantity) for a certain subject, at a certain location. They are analogous to integrated permits that take into account the change of natural regime in the project, and the position of the facility, its flood defence, water abstraction, water discharge, etc. with regards to water quality and quantity.

Montenegro adopted the *Rulebook on the detailed manner of determining and ensuring the environmentally acceptable flow of surface waters* ("Official Gazette of Montenegro", No. 69/21 of 25 June 2021), which supersedes the *Rulebook on the method of determining the environmentally acceptable flow of surface waters* ("OG", no. 2/2016, 23/2016).

The Federation of Bosnia and Herzegovina also adopted the *Rulebook on the method of determining the environmentally acceptable flow* ("OG", no. 04/13, 56/16, 62/19).

Based on the IWRM country reports from the project *Support to the Water Resources Management in the Drina River Basin,* the *E-Flow Report* noted differences in methodological approaches to e-flows within the Drina Basin. The methodologies have been compared and recommendations were

157 Technical report prepared by Rafael Sanchez Navarro for UNECE (submitted in December 2019, revised in June 2021) for UNECE. Available at: https://unece.org/environment-policy/water/areas-work-convention/water-food-energy-ecosystem-nexus.

made in the context of the *Drina Nexus Follow-Up Project* and the World Bank projects towards dialogue on harmonisation. The *Rulebook* from the Federation of Bosnia and Herzegovina was noted as a model for the Basin.

An interesting example was recently established of a cross-sectoral body on the national level in Serbia dealing with the problem of pollution of the Drina and Lim River Basins. The agreement establishing this joint body for coordination and cooperation was signed on 26 February 2021, by the Ministry of Environmental Protection, Ministry of Mining and Energy, Ministry of Agriculture, Forestry and Water Management, and Ministry of Public Administration and Local Self-Government. "The joint body deals with pollution whose nature is such that continuous coordination of activities concerning the competences of the signatories of the agreement is necessary"[158].

Besides what is covered in the *E-Flow Report,* flow regulation may be influenced by domestic strategies, policies, laws and regulations related to matters other than water management and environment, such as renewable energy, climate and sustainability, and disaster risk reduction.

In the energy field, since 2014 UNECE's Group of Experts on Renewable Energy (GERE) has been assisting national governments in enhancing their uptake of renewable energy. All three Drina countries participated in the REN 21 UNECE *Renewable Energy Status Report*[159], according to which several countries continue to face strategic energy challenges, such as the need to enhance energy security, the continuing seasonal power outages and insufficient energy. The report considers these challenges as potential drivers for renewable energy deployment. Notably, the Drina countries have a relatively large share of energy from hydropower but have a low rate of investment in renewable energy. More recently, multi-stakeholder UNECE Renewable Energy Hard Talks[160] in Serbia (2019)[161] and in Bosnia and Herzegovina (2018)[162] identified barriers to renewable energy deployment and made related recommendations.

A report of the *South-East Europe Sustainable Energy Policy Programme* has brought attention to the fact that throughout SEE, primary legislation has not been followed through sufficiently in terms of rules, regulations and guidelines. To quote:

> *"Even where regulations are in place there is a widespread lack of application of standard procedures on the part of most competent authorities. These failings arise partly because of inadequate financial and technical capacity within the Ministries and Agencies but they also reflect unwillingness by the authorities to engage fully with local communities and NGOs through the prescribed processes of public participation. The report concludes that this resistance stems from deep-seated traditional practices, political influence, vested commercial interests, and in some cases corruption and illegal activities. In most countries, the most serious failures relate to requirements for public consultation and transparent decision-making."*

4.2.7.1 National plans

In Bosnia and Herzegovina, the two entities' and the Brčko District's *RBMPs* for the period up to 2021 were adopted. In early 2021, in Republika Srpska, the development of the 2nd *RBMP* was ongoing, while in the Federation of Bosnia and Herzegovina, the 2nd *RBMP* was in the public consultation phase.

At the same time in Serbia, the first national *RBMP* was developed with the support of a twinning project with German, Austrian and Dutch experts, and as of writing was in the public consultation phase.

In Montenegro, the first *RBMP* was prepared through the IPA 2017, including completion of the public participation phase. The SEIA still remained to be adopted by the Government in 2021.

The countries have conducted transboundary public participation, with information available on the ministry webpages.

The countries currently have no obligation to develop a RBMP at the Drina Basin level.

Flood risk management planning has proceeded on the national level pursuant to the regional work done on the Sava River Basin level.

158 NEXUS ASSESSMENT OF THE DRINA RIVER BASIN (Phase II), Expert Group Meeting on Flow Regulation and Environmental Flows, second meeting, held virtually on 29 March 2021, 9:30h-14:00h, Recap of the meeting. Statement by Mr. Darko Janjić, Senior Expert at Public Water Management Company "Srbijavode".

159 REN21, *UNECE Renewable Energy Status Report* (Paris, REN21 Secretariat, 2015).

160 Available at: https://unece.org/sustainable-energy/renewable-energy/unece-renewable-energy-hard-talks-unece-countries.

161 The recommendations are available at: https://unece.org/fileadmin/DAM/energy/se/pdfs/gere/Hard_Talks/Priorities_Recommendations_Synergies_-_Belgrade_Hard_Talk_CLEAN_FINAL_10.4.19.pdf.

162 The recommendations are available at: https://unece.org/fileadmin/DAM/energy/se/pdfs/gere/Hard_Talks/HT_Sarajevo_BiH_Dec_2018/Conclusions_HT_EP_BiH.PDF

4.3 GOOD INTERNATIONAL PRACTICES FOR SUSTAINABLE COORDINATION AND OPTIMISATION FOR FLOW REGULATION IN TRANSBOUNDARY WATERS

4.3.1 BACKGROUND

This part of the report identifies best international practices and options for sustainable coordination and co-optimisation for flow regulation in transboundary waters, including their respective legal and institutional basis. It evaluates the relevance for the DRB of selected international experiences about diverse flow regulation aspects that have been formalised as agreements, protocols, permit conditions, contractual or other legal and institutional arrangements.

The goal of flow regulation is to meet economic, social and cultural needs while maintaining the long-term ecological and hydrological foundation of a given river system. Flow regulation regimes encompass the natural and built environment, extremes in weather and climate, and the effects of human activities, including market and other economic and political forces. In turn, establishing an effective flow regulation regime must anticipate the impacts of flow on economic, social and environmental conditions. Flow regulation does not exist in a static environment. It must also be flexible enough to accommodate and react to new developments, market forces, economic growth and changes over time. Flow regulation therefore must go hand-in-hand with other instruments including SEA, EIA, planning and permitting.

In a transboundary context, riparian states need to have equality of capacities, common methodological approaches, and mutual trust and transparency. Each riparian state should coordinate its flow needs across sectors on a national level so as to be an effective partner. To a varying extent, key sectors of water users may also be linked across borders through markets, direct associations and agreements.

Decisions on water allocation are based on a legal and institutional foundation that includes international agreements, joint bodies and other cooperation mechanisms. The UNECE *Global Handbook on Water Allocation in a Transboundary Context*[163] has involved the work of an Expert Group comprising approximately 40 experts in water allocation, and is a practical guide aimed at providing "key elements, frameworks and modalities to consider in the application of transboundary water allocation, while recognising that every allocation context is unique". The *Handbook* is incorporated herein by reference.

The objectives of transboundary water allocation include:

- equitable and reasonable use of shared water resources;
- avoidance of significant harm to other states and parties;
- environmental protection;
- climate change adaptation;
- management of exceptional circumstances, such as droughts and floods;
- vital human needs; and
- benefit-sharing.

Considering that all river basins are unique, proper water allocation must take into account the physical characteristics of the basin; the various water uses; social, economic and ecological balancing; and future scenarios.

Management of exceptional circumstances such as droughts and floods may be treated as an issue collateral to the normal water allocation scheme. In the European context, the *Floods Directive* establishes a common framework for the assessment and management of flood risks in the EU and its neighbourhood, focusing on prevention, protection, preparedness, recovery and review. Exceptional measures may be taken in response to flood and drought events, but these are, by definition, exceptional and outside the parameters of some allocation regimes. Nevertheless, allocation regimes may take into account flood risk, which itself may be a management strategy.

163 Handbook on Water Allocation in a Transboundary Context (UNECE, 2021), available at: https://unece.org/info/publications/pub/363010

The *Global Handbook* catalogues different approaches to water allocation, including those which are rights-based, needs-based or market-based, or which are based on hierarchy, proportionate division, strategic development or future uses. Typically, several of these approaches will be applied at the same time in a particular river basin.

Certain approaches outlined in the *Handbook* would seem to be less relevant to the situation in the Drina River Basin, such as the market-based solutions exemplified by the Queensland, Australia water entitlement auctions. A fixed quantity, historically based approach would also not appear to be appropriate in a locality with rapid demographic change and economic redevelopment.

Needs-based approaches are appropriate, especially where there are pressures due to development projects. E-flow regulation is a well-known example of a needs-based approach, but the approach can also be applied in the context of human populations and municipal water demands to ensure prioritisation of use and fixed minimum flows. With the rise of acceptance of the need to regulate e-flows, the needs-based approach is now almost universally present as a part of flow regulation.

Joint development projects may result in proportionate sharing of costs and benefits, and both historical and new uses may be prioritised through the hierarchical approach to water allocation.

4.3.2 IMPLEMENTATION considerations

4.3.2.1 Information basis

The Drina River Basin riparian states benefit from a World Bank project that is producing state-of-the-art baseline studies on physical, demographic and institutional characteristics of the Basin. The outcomes of the *WB Drina 2020 project* include the *DRB Water Resources and Basin Study* consisting of four background studies and a database:

1. Regional Hydrological Study;
2. localised Minimum Ecological/Environmental/ Maintenance/Duty Flow Study;
3. initial Sediment, Riverbed and River Bank Studies;
4. initial Surface and Groundwater Temperature Study; and
5. database of Torrential Flows (Streams).

The project also aims at establishment and operation of a suitable, jointly endorsed hydrological real-time and hydraulic simulation model for the Drina River Basin combined with a climate change impact module including optimisation of reservoir operation. The set of modelling activities is sub-divided as follows:

1. Hydrological modelling;
2. hydraulic modelling;
3. reservoir operation;
4. sediment-river morphology simulation; and
5. real-time optimisation of reservoir operation.

These models will be integrated into a unique platform for automatic collection of the hydrometeorological data observed in the Basin so that they can be used as offline client support, linked to a GIS database.

4.3.2.2 Common Rulebook

The Expert Group on Flow Regulation and E-Flows in the Drina, which was established with the support of the *Drina Nexus Follow-Up Project,* wishes to undertake a process to adopt a draft proposal for a common Rulebook for the entire Drina River Basin. This is a lengthy process, given that the entire Drina River is under an artificial hydrological regime involving reservoirs and various operational rules, whereas the methodologies for calculating e-flow typically include hydrological calculations, for which it is desirable to have a natural hydrological regime. The first meeting of the Group was convened in June 2019, hosted by the ISRBC and UNECE; the second meeting was held in March 2021; and the third meeting was convened in October 2021. Initial steps include analyses of the state of ecosystems in the Drina Riverbed and biological monitoring. Following adoption of a proposal by the Expert Group, the Rulebook would be transmitted to the governments for adoption through a trilateral agreement.

4.3.2.3 Planning coordination

Broad policy frameworks, for example those related to climate change and sustainable development (NSDs), set the stage for coordination of sectoral planning.

The Sava River Basin context, through instruments such as the *Framework Agreement on the Sava River Basin (FASRB)*[164] and its *Protocol on Sediment Management*[165] and the *Protocol on Flood*

164 Available at: https://www.savacommission.org/about-us/legal-basis/framework-agreement-on-the-sava-river-basin-256/256

165 Available at: https://www.savacommission.org/UserDocsImages/05_documents_publications/basic_documents/protocol_on_sediment_management.pdf

Protection[166], provides a guide for cooperation on the Drina River Basin and coordination with respect to planning. The parties to the *FASRB* agreed (Art. 12) to develop the *Sava River Basin Management Plan* and to cooperate on its preparatory activities. The main strength of the 1st *Sava RBMP* is that it has managed to match the requirements of the EU *WFD* closely and address all significant water management issues which have been, by the agreement of the SRB stakeholders, declared as important for the *Programme of Measures (PoM),* despite socio-economic and political differences between the Sava countries and their different status regarding the EU integration process. The *Protocol on Sediment Management,* moreover, requires the parties to adopt a joint management plan and then to coordinate this plan with other related plans including those on the national level. The *Protocol* also covers institutional arrangements and cooperation, through the designation of focal points facilitated by the joint body (ISRBC) and through regular exchange of information.

The *Protocol on Flood Protection* sets out a programme of joint activities such as risk assessment, mapping, adoption of a flood risk management plan, and a forecasting, warning and alarm system for floods in the Sava River Basin. Along with the progress made on the Sava Hydrological Information System, the Flood Forecasting and Warning System established in 2018 and the future Accident Prevention System will greatly enhance capabilities on the Drina River Basin level.

These agreements are in force for the whole Sava River Basin and its tributaries, including the DRB, according to the terms of the constituent documents.

While urban planning must also be coordinated through these processes, this is a complex subject that could be the focus of future work under the Nexus Assessments.

4.3.2.4 Transboundary SEAs

International practice on transboundary SEAs is highly developed in the European region, through applicable EU legislation and the *Kyiv Protocol on SEA*. *It is regularly applied in the context of the Birds and Habitats Directives* in connection with impacts on Natura 2000 sites, for example. The regional experience with SEAs lags behind other parts of Europe. SEAs should be applied in the region taking into account international legal frameworks and practical experience. Where relevant planning is undertaken on the national level, for example in order to implement regional instruments such as the *Sava Flood and Sediment Protocols,* proper application of SEA will ensure coordinated development of relevant plans, programmes and policies that are fully integrated with the obligations that states have entered into regarding shared natural resources.

SEAs, by incorporating more considerations than only environmental ones, can perform a broader integration function, taking into account social impacts as well. SEAs can also be calibrated with urban planning.

SEAs have been applied in connection with hydropower plans in a transboundary context in the DRB.

4.3.2.5 Permitting systems

A fully integrated permitting system provides a clear framework for decision-making related to environmental governance. Best practices in integrated permitting are promoted through various mechanisms, including the OECD *Guiding Principles of Effective Environmental Permitting Systems*[167] and permitting and enforcement networks such as the International Network for Environmental Compliance and Enforcement (INECE), the EU Network for the Implementation and Enforcement of Environmental Law (IMPEL), and the Environmental Compliance and Enforcement Network for Accession (ECENA) (the three countries are members of the INECE and ECENA networks). Standards for permitting, inspection and enforcement with regards to facilities covered under integrated permitting frameworks include methodologies for coordination with stakeholder agencies. "Depending upon the requirements of national legislation and institutional arrangements, the permitting authority needs to consult other authorities with related responsibilities or interests (the environmental inspectorate, water and health authorities, sectoral ministries, local authorities, etc.)."

Permitting takes place against a background of adopted plans, programmes and policies. Consequently, permitting systems change in response to each SEA that is completed.

The Federation Bosnia and Herzegovina experience on e-flows resulted in the introduction in the permitting system of requirements related to the permanent measurement by automatic hydrological stations of river flows downstream of the water intakes and dams and the continual public monitoring of results. Moreover, the permits allow for inspection measures accordingly.

166 Available at: https://www.savacommission.org/UserDocsImages/05_documents_publications/basic_documents/protocol_on_flood_protection_to_the_fasrb.pdf

167 Available at: https://www.oecd.org/env/outreach/37311624.pdf.

4.3.2.6 Scenario modelling

Effective transboundary cooperation on the Drina River Basin requires something else besides an accurate assessment of present conditions, well-resourced and functioning institutions, and an adequate legal and policy framework, and procedures for engagement and communication. It needs sophisticated forecasting and scenario modelling. Climate change and sustainable development transition scenarios need to be taken into account as well as projections based on the unique conditions pending in a particular river basin. For the DRB, one relevant factor may be depopulation and the impact of changing needs and uses. Projections of future energy needs will vary depending on demographic futures. Course corrections in areas such as energy, involving a shift from fossil fuels to renewables, also have an impact on long-term planning and forecasting.

4.3.2.7 Strategic actions

The *Strategic Action Programme (SAP) of the Drina River Basin* is a negotiating document harmonised within the *West Balkans Drina River Basin Management (WBDRBM) Project.*[168] The *SAP* provides a framework for water management of the entire Basin and the implementation of a priority set of transboundary actions and investments to address jointly agreed priority water and environmental challenges in the Drina River Basin. The *SAP* is based on an Assessment of primary environmental concerns: (1) water quality, (2) water quantity and water regime, (3) biodiversity, and (4) climate change adaptation, and defines technical and management measures to address them. The focus of the *SAP* is on cross-border and/or common environmental problems, i.e., those that can only be solved by the collective action of more than one actor, or even only by the commitment of all Basin countries.

4.3.3 Other TRANSBOUNDARY ARRANGEMENTS and INTERNATIONAL PRACTICES in flow regulation

Annex 3 to this report describes a number of international agreements related to river flow, with particular attention placed on modern integrated agreements related to multiple water uses, including energy. Other examples too numerous to mention include early forms of international agreements mainly aimed at guaranteeing downstream flow levels for the use of populations.

168 GEF (2020): *West Balkans Drina River Basin Management Project, Strategic Action Program.*

Through dialogues between partners, a river contract intends to develop and restore the multiple functions and uses of water in answer to the needs of a community of users. Under this scheme, both government and private sector players commit by means of a contract to implement a consensus action programme to restore the river and its drainage basin's water resources. Information and awareness campaigns are added to concrete actions of waterway development and different sorts of work connected to water.

Rather than a top-down commission established by states, a river contract scheme can make use of a bottom-up river committee, established through democratic means, as a forum for communication between users and operators, citizens and authorities, leading towards consensus on joint management, whereby different stakeholders commit to certain actions and good practices.

River contracts were introduced in France in the 1980s. In its simplest form, the river contract is a model that is applied in domestic contexts.[169] Obviously dependent on effective communications, application in a transboundary context presents difficulties. The scheme has been utilised in limited transboundary applications, e.g., in the Semois-Semoy hydrographical subdrainage basin between France and Belgium, where language and other barriers can be overcome.

Due to its mutually intelligible languages, the Drina River Basin is a good candidate for application of the river contract mechanism.

The following resources are invaluable in relation to international standards related to basin-wide flow regulation:

- OECD (2015). Water Resources Allocation: Sharing Risks and Opportunities170; and
- UNESCO (2013), R. Speed, Li Y., T. Le Quesne, G. Pegram and Z. Zhiwei. *Basin Water Allocation Planning. Principles, procedures and approaches for basin allocation planning.*[171]

In relation to sustainable hydropower planning, the ICPDR adopted *Guiding Principles for Sustainable Hydropower* in June 2013.[172]

169 See, e.g., ML Scaduto (2016). River Contracts and Integrated Water Management in Europe; F. Rosillon and J. Lobet (2008). Transboundary river contract Semois-Semoy between Belgium (Wallonia) and France.

170 OECD Studies on Water, OECD Publishing, Paris. Available at: https://www.oecd.org/fr/publications/water-resources-allocation-9789264229631-en.htm

171 Available at: https://www.adb.org/sites/default/files/publication/30247/basin-water-allocation-planning.pdf

172 See: https://www.icpdr.org/main/activities-projects/hydropower.

The ICPDR has also collected case studies and good practice examples. These examples come from Austria, Germany, Norway, Slovenia, Switzerland, the *Alpine Convention*, WWF and others, and cover restoration measures, protection plans and master plans, strategies and technical solutions. The Slovenian examples are particularly rich and involve, among other topics, criteria and methodology for e-flows, sustainable planning and management of a HPP, and a method for harmonising efficient HPP operation with environmental objectives. The Federation of Bosnia and Herzegovina followed the Slovenian example in developing its e-flow regulation.

International standards are relevant to methodological questions. The ISO has standards for methods of assessment of reservoir sedimentation (ISO 6421:2012). Technical standards related to e-flow have also gotten progressively better. See, e.g., the UK Technical Advisory Group on the WFD: *Updated Recommendations on Environmental Standards, River Basin Management (2015-21), Final Report (Nov. 2013),* which is valuable regarding particular standards such as e-flows but is less relevant to hydropower, which is not a major issue in the UK.[173]

4.4 OPTIONS FOR FORMALISING THE FLOW REGULATION IN THE DRINA BASIN AND SPECIFIC RECOMMENDATIONS

Making progress on establishing an equitable transboundary flow regime in the Drina River Basin must be built upon certain preliminary steps that have been taken in the context of cooperative frameworks including the *Drina Nexus Follow-Up project.* Under this project, a panel discussion involving water, energy and environment policymakers from the Drina riparian countries, cooperation organisations and power companies at the High-Level Workshop "Action across sectors and borders for sustainable future of the Drina River Basin"174 (Belgrade, 29 October 2019) focused on flow regulation and the reconciliation of different water needs coming from different sectors, reflecting on the role of governance and information. The meeting concluded that:

> *"All economic activities as well as other interests related to the water, depend on a timely flow of adequate quantities of water, with fit-for-purpose quality. Currently, in the Drina Basin, the regulation of flow is uncoordinated and sub-optimal, and this has an impact on both water availability and quality. The different users would therefore benefit from a holistic approach to basin management. Such an approach would for instance coordinate erosion control measures and solid waste management in the different sectors. To capitalise on the benefits, coordinated policy and technical actions at different levels, across borders are necessary."*

Along the same lines, the Expert Group on Flow Regulation and E-Flows agreed on certain main conclusions and next steps[175], which included the following:

- Participants supported continuation of the work of the Expert Group on Flow Regulation and Environmental Flows and contribution to the inter-sectoral and transboundary cooperation in the Basin, reiterating the need for further discussion on flow regulation issues and the development of the unified methodology for environmental flow in the Basin.

173 Available at: http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/UKTAG%20Environmental%20Standards%20Phase%203%20Final%20

Report%2004112013.pdf.

174 The presentations and documentation are available at: https://unece.org/environmental-policy/events/high-level-workshop-action-across-sectors-and-borders-sustainable.

175 The 2nd meeting of the Expert Group, 29 March 2021.

- Participants agreed that cooperation between sectors at the national and Basin levels could be improved.
- Participants agreed that there is still lack of data regarding the Basin, particularly related to monitoring (water quantity and quality, sediment quantity and quality, data needed for assessment of e-flow, etc.) as well as relevant information on ongoing projects in the Basin.
- It was expressed that research in Nexus sectors would be central to the improvement of the knowledge in the Basin.
- Participants stressed the necessity of the dialogue between representatives of all hydropower companies and authorities with the aim to harmonise the work of hydropower plants.
- Members of the Expert Group were also invited to comment on a draft of this Study.

4.4.1 Common OBJECTIVES

Placed within the larger context of the long-term cooperation of the Drina Basin riparians and their efforts at cooperation on a range of issues aimed at, inter alia, co-optimising the value for different uses (hydropower generation, etc.), meeting different water-related needs, minimising negative impacts from flooding, and ensuring integrity of the ecosystems, the main interim objectives in the field of flow regulation are:

- developing a Roadmap for taking steps towards establishing a Basin-wide regime for flow regulation,
- thereby addressing fundamental issues related to Basin-wide cooperation generally – for example, the need to establish mechanisms that enhance coordination and cooperation aimed at building consensus and trust – and
- building an enabling environment for action planning in areas relevant to flow regulation, including national planning and mechanisms for coordination at the Basin level. Arrangements need to take into account the situation on the ground and include a set of milestones and objectives for investments and improvement (Action Plan).
- Numerous obstacles to improved cooperation exist, beginning with inconsistencies in methodologies and data management in areas such as e-flows. The ISRBC has worked on harmonisation of methodologies and data through the Sava Hydrological Information System and Sava GIS. Other technical standards and guidance can be adopted throughout the Drina River Basin, bringing the countries closer to joint management of it. One of the most significant guidance documents now available is the above-mentioned UNECE *Handbook on Water Allocation in a Transboundary Context.*

The most important step towards effective cooperation is to agree on the designation of a platform for cooperation dedicated to the Drina River Basin that can serve as a platform for Nexus dialogue. Such a platform would facilitate discussing, addressing and reconciling the different uses and functions of the water resource in the Drina Basin. As discussed in more detail above, the platform should meet the international standards applicable to a joint body under the *Water Convention,* and the existing water cooperation frameworks may provide an adequate basis for cooperation. At the same time, it is clear that some demands and drivers, notably in the energy field, require arrangements that go beyond the river basin level. Progress can be made, step-by-step, in different management domains and involving public and private spheres.

In the meantime, technical expert groups can continue cooperating on priority issues and agree on common objectives that are likely to be met in the short-term. The Expert Group on Flow Regulation and E-Flows in the Drina can build upon its substantial achievements and continue its activities in support of transboundary cooperation. It could also be given specific mandates by the countries.

With the above considerations in mind, this study makes the following key recommendations.

4.4.2 RECOMMENDATIONS

1. **Strengthen the international legal framework:**

   This report looks at the governance of the Drina River Basin including in relation to the obligation under the *Water Convention* for state parties to establish appropriate joint bodies based on principles of “equality and reciprocity” to implement the *Convention.* These Article 9 requirements are based upon fundamental considerations of river basin management. The report analyses and presents, for the consideration of the riparian states, alternative ways in which to cover the DRB through a form of international cooperation that satisfies Article 9 requirements. Options are also discussed regarding the participation of federated states or entities in international agreements.

2. The following steps are recommended at the state level in all three countries:

- Integration with national DRR planning *(Sendai Framework).*
- Better integration in planning generally, with inter-sectoral exchange of information (noting the Serbian example of establishment under the *Water Convention* of a national structure or arrangement for continuous coordination of activities and cooperation with respect to pollution of the Drina and Lim Basins).
- Renewable energy planning with state-of-the-art SEAs (see next item).
- Expanded scope of transboundary SEAs with respect to relevant plans, programmes and policies on a pilot basis – like a Nexus Assessment of a particular proposal for a plan, policy or programme, including: social impact assessment/coordination with urban planning.
- Coordination at national level permitting process as a means of implementing Basin-wide consensus, through integrated permitting in conjunction with periodic SEAs (i.e., upgrading permitting procedures and relevant legal and institutional context in order to ensure optimal realisation of Basin-wide coordinated policy outcomes).

3. High-level Meeting on Flow Regulation in the DRB

In consideration of the number of matters related to the joint management of the River Basin including flow regulation for which progress is required, this report recommends convening a meeting with participation at a high political level that is capable of adopting decisions or initiating steps towards them, acknowledging the Nexus Roadmap as a framework document guiding further implementation of the Nexus approach in the DRB, including flow regulation as one of the substantive specific Nexus solutions identified during the DRB Nexus process. Even without adoption of the Roadmap, the issues presented below would need high-level political consideration in order for progress to be made.

Various projects and initiatives have produced outcomes that are relevant to cooperation and coordination on flow regulation in the Drina River Basin. What is missing is a mechanism to enable progress to be made and to construct optimal outcomes from the various parallel processes, hence the necessity for a political-level forum for decision-making and follow-up. As further discussed below, all existing cooperation frameworks should be taken into account when organising and conducting such a high-level meeting. For example, full consideration should be given to activities supported or implemented under the *FASRB* and its policies and protocols, which should be coordinated and integrated throughout any activities recommended herein. The background documentation for the meeting would include, inter alia, the *E-Flow Report and the Flow Regulation Study.*

It is to be expected that it would be beneficial if the technical expert groups continue to make progress on priority issues pending the organisation of the high-level meeting, thus enabling a more precise formulation of the agenda of the high-level meeting based on those matters that are of primary interest or concern to the countries.

The meeting could take the following decisions:

a. Integrated river flow needs Assessment.[176] The meeting could exchange information on outcomes of projects (including Drina GEF-SCCF), what is in the pipeline, and remaining needs from the various users, and could define the terms of an integrated river flow needs assessment. The terms could include:

   I. Baseline study on the historical flow regime (i.e., pre-channelisation, in relation to environmental flows and biodiversity).

   II. Basin-wide flow requirement studies for different uses, e.g., drinking water, flood protection, fish harvest (wild and farmed), recreational boating, biodiversity, HPP (taking into account WB/GEF studies).

   III. Analysis of downscaled climate change impact studies for a range of climate scenarios.

   IV. Expert-level cooperation on e-flows and other methodologies and assessment tools.

   V. Evaluation of existing infrastructure and development, where appropriate, of remediation plans and strategies (e.g., to address impacts on status of waters, including on species and biodiversity).

176 Such an Assessment could be conducted in conjunction with work on other "specific solutions", for example flood management.

b. DRB Platform[177] on Flow Regulation. The meeting could establish a DRB Platform on Flow Regulation, which would coordinate the needs assessment and also cover the following areas:

   I. Data quality and quantity, verification and comparability, information sharing.

   II. Taking into account all progress made in connection with the establishment of Sava GIS/HIS, this could lead to a protocol on Data Exchange.

   III. A Technical Expert Working Group (recommended to be based on the existing Expert Group on Flow Regulation and E-Flows) could be established to align methodologies that are used in different areas, such as e-flows, and to address identified problems such as shortcomings in taking into account cumulative impacts from multiple HPPs on e-flow requirements, or sediment transport and siltation.

   IV. Monitoring capacities, Disaster Risk Reduction – rapid communication (taking into account *FASRB* work especially on flood management and control).

   V. Coordination in practice (MoUs, Rulebooks, etc.).

   VI. Sharing costs and benefits.

   VII. Transboundary impacts (SRB).

   VIII. Climate regime – enhanced understanding of interactions and drivers of risk due to climate change, including impacts on quantity and quality of water, mitigation and adaptation measures.

   IX. Respect for national priorities and uses.

c. HPP Platform. The meeting could establish a HPP platform to adopt and endorse the DRB hydropower optimisation plan (World Bank and SDIP project) at a high political level. It could cover some or all of the following issues:

   I. To discuss an energy agreement (including all riparians) on HPP in the DRB as a platform for action plans, incorporating cost and benefit sharing. Should there be a transboundary hydropower agreement for the Drina Basin?

   II. Alternatives to HPP also to be discussed, which requires coordination with renewable strategies, climate strategies, DRR strategies, etc.

   III. Participation and liaison with the technical expert working group established under the DRB Platform, particularly with respect to cumulative impacts from multiple HPPs on e-flow requirements (Energy Community interview).

   IV. How to incentivise trading electricity, or balances, to facilitate better cooperation between HPPs.

   V. Review of operational rules leading towards harmonisation.

   VI. Coordination among HPPs on flood protection, sediment management.

   VII. Balancing of HP requirements dependent on other water management goals.

   VIII. Monitoring of SEA processes, coordinated and linked HP plans.

d. Commitment to coordination of permitting processes on all levels as a means of implementing Basin-wide consensus. Improved implementation and enforcement.

e. A process (for example, a committee) to mark progress and assist, where appropriate, the efforts of the riparian countries in bilaterally resolving “legacy” issues (e.g., liability for past flood damage).

f. Taking into account the outcomes of the GEF-SCCF project, and in alignment with the Second *Sava River Basin Management Plan,* making progress towards development of a *Drina RBMP.*

g. May recommend, as appropriate, bilateral agreements or arrangements on specific matters.

177 A DRB Platform could be aligned with the established platform of the Sava Commission for exchange of data and knowledge on issues of importance for the Drina River Basin.

6

5

KEY CONCLUSIONS AND RECOMMENDATIONS

to deepen the analysis of two crucial issues for development and transboundary cooperation that emerged in the previous projects: 1) energy development in the countries, and in the entire Basin, primarily related to renewable energy and hydropower (which was covered in Section 3 of the report); and 2) agreeing on key aspects of flow regulation in the Basin, considering all water uses and functions, including the environment, and progress towards formalising some of these aspects (Section 4). Also, the Assessment aimed at synthesising the findings from the entire Drina Nexus Assessment process (Section 2), thus setting the basis for the development of a draft of the Drina Nexus Roadmap.

This section of the report presents a selection of main conclusions and recommendations concerning the three main topics of the Assessment, as presented in Sections 2, 3 and 4, respectively. For clarity, the key conclusions and recommendations are divided into three parts, each part pertaining to one of the main topics.

5.1 DRINA NEXUS ASSESSMENT PROCESS

1. The Drina River Basin's natural resources, as well as its valuable, well-preserved natural ecosys-tems, are of high importance for the economic and social prosperity of Bosnia and Herze-govina, Montenegro, and Serbia, as well as the entire region. However, the transboundary and inter-sectoral cooperation and coordination are as important for sustainable development of the region within the basin, given the benefits that the riparian countries can gain from, and harms that can be avoided or mitigated through, the cooperation on the management of the basin's natural resources.

2. The water-energy-food-ecosystems Nexus approach can contribute to a more efficient and effective management of the Basin's water, land and energy resources and, in turn, to enhanced water, energy, food and environmental security in the region, by providing for an integrated and coordinated approach across sectors, with a view to reconciling potentially conflicting interests as they compete for the same scarce resources, while capturing existing opportunities and exploring emerging ones.

3. At the global and (pan-)European level, the Drina countries have engaged in various mechanisms fostering sustainable development, thus accepting common standards and governance rules related to international cooperation and river basin management. They have also taken steps towards accession to the EU, thus committing to working towards the adoption of relevant elements of the EU regulations and policies related to water, agriculture, energy and environment. An important window of opportunities for the riparian countries to advance the application of the Nexus approach is associated with the *European Green Deal.*

4. At the level of SEE / Danube region, there are several strategies and cooperation mechanisms providing a solid basis for cooperation of the Drina River Basin countries on Nexus issues, starting with the *Framework Agreement on the Sava River Basin* and its protocols, and the International Sava River Basin Commission as their implementing body, as well as related initiatives and processes, together with the *Memorandum of Understanding on cooperation between the International Sava River Basin Commission and Montenegro.* The fact that, at the Drina River Basin level, there is no cooperation mechanism that includes all Nexus-relevant sectors, and there are no multilateral and only a few bilateral agreements between the riparian countries dealing with water resources management, further increases the importance of using the well-developed water management mechanism at the level of the Sava River Basin, as well as leveraging other cooperation frameworks that encompass the countries of the Drina River Basin.

5. The Drina Nexus Assessment process, implemented through a series of projects targeting the Basin, provided valuable support to the administrations of riparian countries in identifying priority Nexus issues, key inter-sectoral linkages, potential solutions and untapped benefits of transboundary cooperation and inter-sectoral coordination in the Drina River Basin. In addition, recent projects dealing with the Drina River Basin offered a wealth of data and outcomes that future Nexus-related activities can build upon. It is, therefore, important to keep momentum of the cooperation established among the institutions from the water management, environment and energy sectors, both at the technical and at the decision-making level, for further cooperation on Nexus issues at the levels of individual countries and the entire River Basin.

6. In planning and implementing further Nexus-related activities, it is strongly recommended to seek synergies with the processes such as the implementation of the *Green Agenda for the Western Balkans and the SEE 2030 Strategy,* providing strategic guidance for the Drina countries to achieve climate-neutral economies through structural changes, and the activities within the framework of relevant projects and programmes, such as the World Bank's *Sava and Drina Rivers Corridors Integrated Development Multiphase Approach Program,* as well as to explore possibilities of ensuring funding from financial instruments and supporting mechanisms, such as the Green Climate Fund, for the implementation of Nexus-related projects in the Drina River Basin.

5.2 MODELLING OF SCENARIOS FOR SUSTAINABLE ENERGY DEVELOPMENT IN THE DRINA RIVER BASIN

1. By signing the *Sofia Declaration,* the Drina countries committed to aligning with the *EU Climate Law,* with a vision of achieving climate neutrality by 2050. Additionally, they committed to aligning with the EU Emissions Trading Scheme and to prioritising energy efficiency in all sectors, as well as increasing the share of renewable energy sources. Results of this analysis indicate that not only hydro, but also non-hydro renewable energy expansion could significantly contribute to decarbonisation of the electricity supply of the riparian countries' outcompeting thermal generation and to its phase-down. Enablers for higher penetration of non-hydro renewables are reductions in capital investment costs (currently the main trend and depending on global developments, too), and the implementation of an Emission Trading Scheme.

2. The model, used in the Assessment, helps to explore the potential role of non-hydro RES as a cost-competitive low-carbon supply alternative to thermal and hydropower. However, it is worth noting that the technical feasibility of a system with high shares of non-hydro RES, and particularly their impact on the reliability of electricity supply, should be studied in higher detail. Therefore, it is recommended that the model results are analysed with *ad hoc* modelling tools suited to the analysis of power supply and its reliability.

3. Recent experience suggests that high shares of non-hydro renewables could be feasible where the electricity transmission infrastructure across the whole of Europe becomes more integrated. It might be most beneficial for the riparian countries to jointly plan investments to that end. As far as hydropower is concerned, the analysis shows that hydropower generation is competitive with non-hydro generation. While non-hydro renewables expand at the expense of thermal generation as soon as enabled by the conditions stated above, they do not affect hydropower generation.

4. The substantial hydropower production (and

potential) could present an opportunity for investments in non-hydro

renewables considering that hydropower has a specific load-balancing role to play when it comes to accommodating higher shares of renewable energy in a power grid. However, the balancing role of hydropower needs to be studied with the help of models with higher time resolutions, possibly taking the results from this analysis as an input. Moreover, any hydropower development should also take into consideration other flow regulation related aspects, notably flood protection and environmental needs.

5. Climate change could affect hydropower generation due to an average decrease of rainfall. However, some climate scenarios indicate the possibility of increased rainfall in the Basin, with positive impacts on hydropower generation. This poses a challenge to the planning of hydropower expansion and suggests that climate uncertainty needs to be considered as a risk in the planning process. The planning needs to look at time horizons far beyond 2050, more aligned with the time scale of dam infrastructure and climatic changes.

6. Results of the analysis indicate that renewable energy technologies can be competitive with coal-fired thermal power. Additionally, rather than investing in more renewable energy capacity to meet a higher demand, energy efficiency measures may allow these funds to be directed towards the decommissioning of thermal power. Therefore, it can be concluded that the energy efficiency measures modelled in this analysis can either reduce stress on hydropower generation or provide an opportunity to decommission thermal power plants at an earlier date.

7. If power system developments follow the current policies, thermal will keep playing a significant role in the production mix of the Drina countries. This will cause emissions by the electricity sector to stay roughly constant up to 2040, in a way that contrasts with the decarbonisation ambitions of the countries and of the EU. Additionally, the high dependency on thermal generation may cause a technological lock-in, particularly if a carbon border tax adjustment mechanism is implemented with the EU. The expansion of these sources of power generation exposes the countries to the risk of locking into infrastructure that is not the most cost-competitive and could become stranded in the mid-term, before its end of life. The modelling insights show that the introduction of the ETS could cause an 80% reduction in power output from existing thermal power plants by 2028 when compared to 2020, if least-cost planning is pursued.

8. This analysis was performed with an open-source and freely available modelling tool, using data provided by local stakeholders and extracted from publicly available documents. The tool and the non-confidential part of the dataset are available to future users and developers, providing an underlying modelling infrastructure as a public good that may be transferred to and independently used by any interested users from the Drina Basin countries. The modelling tool and its application are intended as living outputs, to be continuously developed in a collaborative fashion by multiple stakeholders.

5.3 OPTIONS FOR THE FORMALISATION OF FLOW REGULATION MODALITIES IN THE DRINA RIVER BASIN

1. This report looks at the governance of the Drina River Basin including in relation to the obligation under the *Water Convention* to establish appropriate joint bodies based on principles of "equality and reciprocity" to implement the Convention. The report analyses, and presents for the consideration of the Drina countries, alternative ways to further develop the institutional and legal arrangements to cover the Drina Basin through a form of international cooperation.

2. Several steps, listed in Section 4.4.2 of the report, are recommended at the state level in all Drina countries to advance their cooperation in the field of flow regulation.

3. It is recommended to convene a high-level meeting to consider issues of key importance for advancing the cooperation and coordination on flow regulation in the Drina River Basin, such as defining the terms of an integrated assessment of river flow needs, establishing a Basin platform on flow regulation that would coordinate the needs assessment, establishing a HPP platform to adopt and endorse the Basin hydropower optimisation plan, committing to coordination of permitting processes on all levels as a means of implementing Basin-wide consensus, and agreeing upon performing other relevant activities at the Basin, bilateral or national levels.

6

ANNEXES

ANNEX 1: CONCLUSIONS AND RECOMMENDATIONS FROM THE DRINA NEXUS PROCESS

The following text provides an overview of main conclusions and recommendations, drawn up during the Drina Nexus process for all general and specific Nexus issues identified during the process.

Improved management of water, energy and land resources in the Drina River Basin is critical for the socio-economic development of the Basin and its riparian countries. An immensely high socio-economic value of the Basin is reflected in its unique environment, biodiversity and ecosystems, as well as in its high potential for development based on the use of these resources.[178,179] However, the resources are subject to various development plans and are exposed to increasing pressures, e.g., due to the growing energy and water demand, the increasing risk of floods and droughts, and the limited water availability due to climate change.[171,172,180] Therefore, there is a need for an integrated approach to resource management to reach the development potential, cope with the challenges, and preserve the natural values simultaneously.

The Nexus approach is perceived by the riparian countries as an opportunity to foster synergies, enable cooperation and inter-sectoral work, facilitate addressing trade-offs in development whilst also identifying opportunities and setting related priorities, and use the climate and green financing opportunities.[181] There is an understanding in the countries that:

i. Coordination across sectors, coherent policies and integrated planning are required both for transposing the EU instruments and delivering the related accession commitments, as well as fulfilling the global *2030 Agenda for Sustainable Development*.[172,182]

ii. A holistic approach to Basin management could yield benefits to multiple users (e.g., benefits of erosion and sedimentation control for agriculture, land management, extractive industries and navigation), facilitate the meeting of requirements (e.g., minimum flow, with future energy development relying on water resources to a great extent) or help reconcile sectoral interests (e.g., needs of thermal plants' cooling systems vs. flood control, alleviating climate change effects on water availability).[171,173]

iii. The Nexus approach is needed to enable the identification of governance reforms, policy measures and investment opportunities to address the challenges and seize the opportunities.[173]

1.1 Transboundary COOPERATION

Transboundary cooperation is among key success factors in the implementation of Nexus solutions. According to a recent analysis by UNECE, transboundary cooperation ranks very high among 26 success factors identified, together with shared data and information; increased awareness of options and benefits for cross-sectoral, transboundary trade-offs, compromise and synergies; and innovative infrastructure operating rules.[183,184] Accordingly, River Basin organisations can play a key role in facilitating a cross-sectoral dialogue that is needed to develop water investments and to develop 'Nexus-proofed' master plans.[176,177]

There is plenty of room for strengthening the transboundary cooperation on integrated management of natural resources in the Drina River Basin, and a clear understanding of the benefits it may bring. The statement from the High-Level Workshop, held within the *Drina*

178 *Statement from the High-Level Workshop "Action across sectors and borders for sustainable future of the Drina River Basin"*, Belgrade, 29 October 2019.
179 UNECE (2017): *Assessment of the water-food-energy-ecosystems nexus and benefits of transboundary co-operation in the Drina River Basin,* New York and Geneva.
180 UNECE (2016): *Reconciling resource uses in trans-boundary basins: assessment of the water-food-ener- gy-ecosystems nexus in the Sava River Basin,* New York and Geneva.
181 GWP-Med (2021): Website, https://gwp.org/seenexus, Report from the national consultation meeting in Bosnia and Herzegovina, held on 22 December 2020 within the framework of the ADA-funded SEE nexus project (Accessed on 23 June 2021).

182 UNECE (2017): *Policy brief: Assessment of the wa- ter-food-energy-ecosystems nexus and benefits of trans-boundary cooperation in the Drina River Basin,* New York and Geneva.
183 UNECE (2021): *Solutions and investments in the wa- ter-food-energy-ecosystems nexus: a synthesis of experiences in transboundary basins,* Geneva.
184 UNECE (2021): *Solutions and investments in the wa- ter-food-energy-ecosystems nexus: preliminary findings from a synthesis of experiences in transboundary basins,* Geneva.

UNECE (2017): *Assessment of the water-food-energy-ecosystems nexus and benefits of transboundary co-operation in the Drina River Basin,* New York and Geneva.

ter-food-energy-ecosystems nexus and benefits of trans-boundary cooperation in the Drina River Basin, New York and Geneva.

Nexus Follow-Up Project, acknowledged that "transboundary and cross-sectoral cooperation make risk prevention, disaster risk management, climate action, environment protection, and – in general – management of natural resources and rural development, significantly more effective and efficient"[185]. On the other hand, further strengthening of regional cooperation in the Basin is a prerequisite to successfully mobilise resources for tackling a variety of Nexus-related issues together. Strengthening and broadening of cooperation around Nexus issues contributes to increased trust and regional economic integration, as well as peace and security[186], by yielding numerous benefits, such as reducing the cost of electricity production; increasing agricultural production by introducing or improving irrigation systems; reducing damages from floods; creating jobs at national and cross-border level and reducing rural-urban migration; protecting water quality and ecosystems; increasing energy trade and integration; and ensuring energy security.

There is a range of possibilities for strengthening the transboundary cooperation in the Drina River Basin. Although there is no specific Basin-level cooperation mechanism for the Drina River Basin, there is a good basis for stronger cooperation between the three countries at the Basin level, e.g., through:

i. using the existing platforms for transboundary cooperation (ISRBC, Energy Community, RRD SWG, RCC) to extend the inter-sectoral dialogue, share experiences and potentially agree on further actions178;

ii. taking full advantage of the EU accession processes (and funding), and activities stemming from multilateral environmental agreements (e.g., the *Espoo Convention* and the *SEA Protocol*), such as transboundary EIAs and SEAs, to improve the management of the Basin's resources; and

iii. considering the possibility of setting up a multi-stakeholder and multi-sectoral platform for the Drina Basin, focused on identifying cross-sectoral impacts and sharing experiences with solutions.

To maximise benefits from transboundary water cooperation, the approach to cooperation should be based on the aggregated benefits provided by a broad range of actions, where not all countries and stakeholders may benefit from every single issue, but wider gains might be made. Basin-wide coordination to prioritise investments, considering the trade-offs between economic sectors and the environment, may have multiple benefits. For illustration purposes, coordinating the operation of the existing dams in the Basin would not only allow for a better flood management, but would also improve national energy security, increase electricity export opportunities and reduce annual greenhouse gas emissions in the long term.[179]

1.2 GOVERNANCE

A need for improvements in governance of the Drina Basin's natural resources has been identified during the Nexus process. Enhancing the management of resources in the Drina Basin requires the following improvements in the governance setting[179]: improved coordination between sectors within each country; more formal cooperation arrangements between countries; broader engagement of stakeholders; and greater focus on compliance. These improvements should be complemented by the application of technical solutions and, in particular, greater and better investments. Both governance and technical improvements must be related to the process of accession to the EU, in which the three countries are currently engaged. Recent high-level political commitments from the riparian countries to creating an enabling environment for good governance through provision of effective public participation in decision-making and implementation of instruments of international law, notably the UNECE multilateral environmental agreements[187], provides a good basis for further action in this regard.

Sustainable management of the Drina Basin's natural resources requires stronger inter-sectoral coordination. Inter-sectoral coordination within each country is a challenge, as each sector has its own geographical scope in planning and operation, multi-level authority framework, planning cycle and stakeholder engagement characteristics.[188] It can be improved through a transboundary cooperation framework in which the country participates. For example, ISRBC member countries report that coordination among the sectors involved in the implementation of *FASRB* is better, thanks to their involvement in the cooperation process on the Sava

185 *Statement from the High-Level Workshop "Action across sectors and borders for sustainable future of the Drina River Basin",* Belgrade, 29 October 2019.

187 *Statement from the High-Level Workshop "Action across sectors and borders for sustainable future of the Drina River Basin",* Belgrade, 29 October 2019.

188 UNECE (2017): *Policy brief: Assessment of the wa-*

River Basin level.[189] Possibilities at the national level include[190]:

- using the arrangements for monitoring and reporting on progress towards the Sustainable Development Goals (SDGs) or on climate change;
- integrating the Nexus approach into strategic documents and local/regional development plans, as the incorporation of sustainable development policies, strategies and action plans can be an effective way of ensuring better coordination and more integrated decision making;
- developing the practice of applying tools such as EIA and SEA, particularly in a transboundary context, to assess the impact of proposed activities or policies on the environment, as well as to ensure proper public participation; and
- using national-level assessments of inter-sectoral coordination to ascertain further opportunities for improvement.

The participation of stakeholders through consultation and their active involvement is a prerequisite for making balanced decisions. At the High-Level Workshop held within the *Drina Nexus Follow-up Project,* the riparian countries' representatives agreed that "all economic and non-economic sectors concerned with water, land use, and environment protection in the Basin should engage in a multi-stakeholder dialogue aimed at reconciling their different needs".[180] A variety of tools for public participation and stakeholder involvement have been developed and implemented by ICPDR and ISRBC. Some of these may be used as good practices in further implementation of Nexus actions in the Drina River Basin.

Data and information sharing is one of the key preconditions for the implementation of Nexus solutions. Development of broad, open, transparent and efficient platforms for reliable, high-quality data serves as the foundation for high-quality decision-making.[191] In the Drina River Basin, the scale of planning and policymaking in energy and agriculture generally does not follow the River Basin approach, and there is room for strengthening the mutual exchange of information about Basin management and the economic sectors' plans.[183] In their statement from October 2019, high-level representatives of the riparian countries committed to improving "availability of and access to relevant information to support well-informed decisions".[180] To that end, outcomes of extraordinary progress in data and information exchange, made by ISRBC through the establishment of the Sava GIS and Sava HIS, can be used. Regular further upgrade of these systems is strongly supported both at a high political and expert level[192], and allows for integration of additional databases and applications as needed. Importantly, the system is fully at the disposal of all countries of the Drina Basin.

1.3 ECONOMIC and POLICY INSTRUMENTS

There are a few policy-related prerequisites for advancing the implementation of the Nexus approach in the Drina River Basin. These include:

- **Stronger and more coherent national policies,** based on reliable information covering different sectors. The development of more coherent national policies can well be supported by EU accession and approximation processes, as well as multi-sectoral assessment processes, such as SEA[193], which is an effective tool to assess the impact of energy, water management and agricultural programmes and policies on ecosystems and to synchronise competing objectives, as well as to ensure adequate public participation. Additional support can be provided by developing recommendations for increasing the integration of Nexus-related factors in policy- and decision-making through specific instruments, including but not limited to SEA, EIA, integrated permitting, public participation requirements, and rules for inter-sectoral coordination and consultation.[194]
- **Stronger multi-sector (and transboundary) planning.** The RBM planning process in accordance with the EU WFD fosters involvement of a broad range of stakeholders and enables addressing conflicting interests of various water users (e.g., dam building vs. environment protection); however, improving

189 ISRBC (2019): *Report on the implementation of the FASRB in the period 1 April 2018 – 30 June 2019,* Adopted at the 8th Meeting of the Parties to FASRB, Sarajevo, 24 October 2019.

190 UNECE (2017): *Assessment of the water-food-energy-ecosystems nexus and benefits of transboundary co-operation in the Drina River Basin,* New York and Geneva.

191 UNECE (2016): *Reconciling resource uses in transboundary basins: assessment of the water-food-ener- gy-ecosystems nexus in the Sava River Basin,* New York and Geneva.

199 UNECE (2017): *Assessment of the water-food-ener- gy-ecosystems nexus and benefits of transboundary co-operation in the Drina River Basin,* New York and Geneva.

192 ISRBC (2019): *Declaration from the 8th Meeting of the Parties to FASRB,* Sarajevo, 24 October 2019.

193 UNECE (2016): *Reconciling resource uses in transboundary basins: assessment of the water-food-ener- gy-ecosystems Nexus in the Sava River Basin,* New York and Geneva.

194 UNECE (2017): *Assessment of the water-food-ener- gy-ecosystems nexus and benefits of transboundary co-operation in the Drina River Basin,* New York and Geneva.

ter-food-energy-ecosystems nexus and benefits of trans- boundary cooperation in the Drina River Basin, New York and Geneva.

the coordination with energy and agriculture sectors would be an important reinforcement to its scope.

- **New bilateral (and multilateral) agreements.** The development of new bilateral and multilateral agreements between the Drina riparian countries, concerning the Nexus-related issues, has been suggested as an important task for the future[195,196], as there are only a few bilateral agreements between the riparian countries, and no multilateral agreements dealing with the management of water resources in the Drina Basin. Recent Drina projects[188,197] suggest that the development of an international agreement, defining competent national bodies and obligations of the parties in terms of the preparation of joint plans and data exchange, is of great importance for reaching the goals of the Nexus approach.

1.4 INFRASTRUCTURE and INNOVATION

Implementation of the Nexus approach may help boost infrastructure investments in the Drina River Basin. Currently, renewable energy, agriculture and rural development in the Basin are characterised by low investment. Planning and implementation of these development activities suffer from several shortcomings, including lack of transboundary cooperation, cross-sectoral coordination at national level and stakeholder involvement, as well as the existence of administrative and regulatory barriers to the implementation of projects, which, in turn, result in a low level of investment.[187] To increase the level of investment, it is necessary to ensure further development of markets, transparency, predictability, accountability and adequate checks and balances in the regulatory system.[187,198] Also, investing better requires coordination and evaluation of alternatives by taking different needs into account, as well as consultation[199], which are the key features of the Nexus approach. Therefore, the application of the Nexus approach is an opportunity to ensure greater investment in Nexus-related development activities.

Nexus investments should be encouraged as alternatives to sectoral projects in the future. 'Nexus investments' are those investments that support the implementation of Nexus solutions, with the aim of providing benefits for multiple sectors.[200] For example, water upstream is of a higher cumulative value than water downstream, from the perspective of both hydropower use and flood control.[201] By rule, Nexus investments are multipurpose, integrated and transboundary (where relevant), thus being important not only for strengthening regional integration but also for attracting funding. The statement of high-level representatives of the Drina countries that, in the future, Nexus investments "should be encouraged and duly considered as alternatives to strictly sectoral projects"[202] clearly indicates the riparian countries' awareness of this fact and orientation towards such an approach.

Development of a Basin investment strategy may well support prioritisation of investments (analysis of trade-offs) and fundraising efforts. The main purpose of the strategy should be to enable coordination of investments across the Basin and sectors, which is instrumental in implementing the Nexus approach. The strategy should include a financing component exploring all possible sources of funding (user charges, local taxes, national budgets, EU funding, donor funding and climate funding).[203] In this context, it would be important to develop a methodology for assessing and ranking specific infrastructure projects and investments in terms of Nexus-related performance, and to compile and maintain a portfolio of priority projects. This activity can build upon the experience of ISRBC in developing action plans and infrastructure and investment portfolios.[192] In addition, screening and evaluation of Nexus-related project proposals being prepared in the Basin may help mainstream Nexus activities in the region and increase the chances of successful fundraising.

195 GEF (2020): *West Balkans Drina River Basin Management Project, Strategic Action Program.*

196 GWP-Med (2021): Website, https://gwp.org/seenexus, Report from the national consultation meeting in Serbia, held on 17 February 2021 within the framework of the ADA-funded SEE nexus project (Accessed on 23 June 2021).

197 World Bank (2017): *Support to Water Resources Management in the Drina River Basin,* Roof report.

198 UNECE (2017): *Policy brief: Assessment of the water-food-energy-ecosystems nexus and benefits of transboundary cooperation in the Drina River Basin,* New York and Geneva.

200 UNECE (2021): *Solutions and investments in the water-food-energy-ecosystems nexus: a synthesis of experiences in transboundary basins,* Geneva.

201 UNECE (2016): *Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus in the Sava River Basin,* New York and Geneva.

202 *Statement from the High-Level Workshop "Action across sectors and borders for sustainable future of the Drina River Basin",* Belgrade, 29 October 2019.

203 UNECE (2017): *Policy brief: Assessment of the wa-*

There is a wide range of financial instruments and supporting mechanisms as potential funding sources for Nexus investments in the Drina River Basin. In general, these include the European pre-accession instruments, as well as bilateral funding and international assistance mechanisms through UN agencies and other international organisations, including those of an overarching character, such as the GEF, the Green Climate Fund (GCF) and the Climate Investment Fund (CIF), and those focused on specific sectors, such as ESMAP initiatives and programmes (e.g., the Hydropower Development Facility), supporting the energy transition. It should be noted, however, that other interesting regionally focused opportunities have emerged recently, including the *Green Agenda for the Western Balkans*[204,205] or the Western Balkans Green Centre (WBGC), established by the Government of Hungary to run a Western Balkans-focused project preparation and capacity-building grant programme, a form of climate action to foster goals of the *Paris Climate Agreement*, while serving as a tool in line with the *European Green Deal,* the *Economic and Investment Plan for the Western Balkans* and the *Green Agenda for the Western Balkans.*

1.5 MONITORING, and DATA and INFORMATION EXCHANGE

As indicated in the *Phase II Drina Nexus Assessment Report,* there is a strong need for the improvement of monitoring and data and information exchange on water quantity and quality in the Drina River Basin, which was emphasised frequently throughout the Drina Nexus process, and the objective was integrated into the *Drina SAP.*[206]

To improve data and information sharing in the Basin in general, the best use of the systems already operating under ISRBC (Sava GIS, Sava HIS, Sava FFWS, together with hydrologic and hydraulic models pertaining to the Drina Basin) and ICPDR (MONERIS, a water quality model) should be made, as noted on many occasions during the Drina Nexus process since 2016. All these systems cover the entire Drina Basin; their use and regular upgrades are supported at both political and expert level; and there is a network of institutions in all Drina countries using the systems. Also, the policies on the exchange of GIS and hydrometeorological data, developed under ISRBC, involve institutions from all Drina countries.

As far as the exchange of water quantity data and information in the Basin is concerned, the room for improvement is linked to the fact that institutions from the energy sector do not participate in data exchange on a continuous basis yet. As important data providers and users from the Drina Basin, these institutions from all countries of the Sava River Basin, including all Drina countries, have been put on the list of preferred signatories to the hydrometeorological data exchange policy of ISRBC. However, although the power companies got involved in some activities within the framework of this policy (e.g., they provided the data necessary for the development of models under the coordination of ISRBC), they have not signed the policy yet. So, effort should be invested in ensuring that these institutions formally sign the data exchange policies and/or get actively and systematically involved in data exchange in the region. In addition, it would be important to assess the needs for, and the feasibility of, extending the existing (meteorological and hydrological) observation network in the Basin and agree upon further steps in this regard, in close coordination with ISRBC.

As for the exchange of water quality data and information, the need has been recognised to achieve an up-to-date, coherent and transparent picture of the water quality of the whole Basin and its effects on biodiversity and the ecosystem, and to get a clear view of the spreading and movement of contaminants through the river network.

1.6 FLOW REGULATION and ENVIRONMENTAL FLOWS

The Drina River Basin is facing an increased water demand and a changing water regime; hence, coordination is needed to optimise water use and reduce water losses. A study of national water management plans of the riparian countries[199] concluded that water needs have not been integrated into long-term planning documents of all countries and have not been agreed among the countries, which may generate risk of disputes, particularly under a significant economic growth. At the national level, water allocation across sectors seems to be vague as well. Given the current situation in terms of water use, and without implementing measures to reduce water losses, ensuring an additional quantity of water in the future may become questionable. The 8th MoP to *FASRB* (Sarajevo, 24 October 2019) recognised "the likely consequences of climate change on the water regime in the Sava River Basin and the need for effective adaptation measures" and "encouraged ISRBC and the Parties to undertake further activities related to the climate change adaptation in the

204 EC (2020): *Guidelines for the Implementation of the Green Agenda for the Western Balkans,* Communication COM (2020) 223, Brussels.
205 RCC (2021): *Action Plan for the Implementation of the Sofia Declaration on the Green Agenda for the Western Balkans 2021-2030,* Sarajevo.
206 GEF (2020): *West Balkans Drina River Basin Management Project, Strategic Action Program.*

basin".[207] So, the framework, provided by *FASRB* and ISRBC, is likely to provide a good context for addressing these issues.

Currently, the regulation of flow (including environmental flows) in the Drina Basin is uncoordinated and sub-optimal, and this has an impact on both water availability and quality. While power generation is a key economic activity in the Drina Basin and is likely to increase, authorities in the Basin are not yet well equipped to deal with impacts of power generation on the river flow.[208,209] Currently, the hydropower plants in the Drina Basin operate on a single unit basis to best meet the needs of each country, rather than working as a coordinated system to optimise hydropower generation for the region. Lack of coordination in managing the water flow may also have environmental consequences, as well as impacts on flood and drought risks. On the other hand, the *Phase I Drina Nexus Assessment Project* concluded that the overall electricity production is not necessarily negatively impacted by pre-emptying a reservoir for flood protection, while it can benefit considerably from basin-level planning and coordination, as opposed to optimising production for each power plant separately.[201]

Co-optimising flow regulation, while considering different objectives, is a top priority. The challenges presented in the previous paragraph, as well as the importance and potential benefits of a coordinated flow regulation and a real-time monitoring of environmental flow, have been addressed within the Drina Nexus project on numerous occasions, including the High-Level Workshop organised within the framework of the *Drina Nexus Follow-Up Project*[210], and national consultations held within the framework of the *Phase II Drina Nexus Assessment Project*.[211,212]

207 ISRBC (2019): *Declaration from the 8th Meeting of the Parties to FASRB,* Sarajevo, 24 October 2019.
208 UNECE (2017): *Assessment of the water-food-energy-ecosystems nexus and benefits of transboundary cooperation in the Drina River Basin,* New York and Geneva.
209 UNECE (2017): *Policy brief: Assessment of the water-food-energy-ecosystems nexus and benefits of transboundary cooperation in the Drina River Basin,* New York and Geneva.
210 *Statement from the High-Level Workshop "Action across sectors and borders for sustainable future of the Drina River Basin",* Belgrade, 29 October 2019.
211 GWP-Med (2021): Website, https://gwp.org/seenexus, Report from the national consultation meeting in Bosnia and Herzegovina, held on 22 December 2020 within the framework of the ADA-funded SEE nexus project (Accessed on 23 June 2021).
212 GWP-Med (2021): Website, https://gwp.org/seenexus, Report from the national consultation meeting in Serbia, held on 17 February 2021 within the framework of the ADA-funded SEE nexus project (Accessed on 23 June 2021).

To co-optimise flow regulation, it is proposed to improve cooperation in the operation of dams and hydropower plants in the Drina River Basin for optimal production and flood control, as well as to improve opportunities for electricity trade in the region (inside and outside the Drina) using energy efficiency measures to release stress on hydro and thermal power. Transparency of operational rules and regimes has been called for as well. The sharing of experience in problem solving and good practices, e.g., on legal aspects, application of environmental flows to different types of watercourses, and monitoring, have been recognised as potentially valuable, too. A variety of concrete recommendations for co-optimising flow regulation, which emerged from the process, are summarised in Section 4 of the report.

1.7 FLOOD management

Responses to floods in the Drina River Basin are inadequate. Flood management has been characterised by poor maintenance of flood protection infrastructure, a lack of fully operational early warning systems, and a limited degree of cooperation between the three countries (often restricted to emergencies), as well as among different agencies and users within each country. While the improvement of flood protection infrastructure, including through Nature-based Solutions, is the subject of projects supported by international financial institutions, notable advances towards better flood management, through transboundary cooperation, have been made within the cooperation process in the Sava River Basin. *The Protocol on Flood Protection to FASRB*[213] provides a legal framework for cooperation of the countries on jointly assessing the flood risk, planning flood risk reduction measures, forecasting and warning, exchanging information, cooperating in emergency situations, and providing mutual assistance in the event of floods. Further accomplishments, building upon the protocol, are summarised in the following points.

The *Sava Flood Risk Management Plan* has the potential to add considerable value to the management of floods in the Drina River Basin. The 8th MoP to *FASRB* approved the first *Sava FRM Plan,* considering it as "a milestone in the cooperation of the Parties leading towards fulfilment of one of the main objectives of FASRB, i.e., to prevent or limit hazards and reduce and eliminate adverse consequences from floods".[214] The Parties also committed to "making their best efforts to implement a *Summary of Measures,*

213 ISRBC (2010): *Protocol on Flood Protection to the Framework Agreement on the Sava River Basin, Gradiška.*
214 ISRBC (2019): *Declaration from the 8th Meeting of the Parties to FASRB,* Sarajevo, 24 October 2019.

which is an integral part of the plan, in order to contribute to meeting the common objectives – avoidance of new flood risks, reduction of existing flood risks during and after the floods, strengthening resilience, raising awareness about flood risks and implementing solidarity principle".[207] Although the implementation of measures is the responsibility of the countries, the MoP requested ISRBC to support the countries in securing funds for the agreed actions at the Basin-wide level. The *Sava FRM Plan*[215] was prepared through active participation and contribution of Montenegro, and it was officially approved by that country. Accordingly, implementation of the jointly agreed measures, foreseen in the plan, is expected to provide valuable assistance in addressing issues of the water quantity management in the Drina River Basin.

The flood forecasting and warning system for the Sava River Basin, operating within the framework of ISRBC, is a great asset that can be used in the Drina River Basin. The system (Sava FFWS), put in operational use in 2018, represents one of the best examples of the outcomes of cross-border cooperation, even far beyond the region. Following a year of its operation, the 8th MoP to *FASRB* acknowledged the Sava FFWS as "a mature and reliable platform for operational hydrological forecasting at both national and international level in the Sava River Basin"[207], as well as the hydrologic model for the Sava River Basin and the hydraulic model for the Sava River, developed under the coordination of ISRBC and delivered to the countries for their use and further upgrades. So, there is a fully operational system and models, readily available for use in the Drina Basin.

1.8 WATER QUALITY management

There is a strong need and large room for the improvement of water quality management in the Drina River Basin. Generally, the water quality in the basin is good but declining. While the surface water quality is 'good' to 'excellent' in the upstream areas, it has been declining in the downstream areas and is only 'moderate' at areas of concern.[216] Degradation of aquatic ecosystems and reduction of biodiversity has been observed as well.[217] The main pressures on water quality in the Basin include organic and nutrient pollution (mostly due to lack of wastewater treatment and to inadequate solid waste disposal), heavy metal contamination (from industrial and mining sites, some of which are abandoned), sedimentation/erosion and hydro-morphological alterations (due to dams). However, these pressures are largely unchecked. Monitoring capacities are uneven, the surface water quality monitoring is neither regular nor systematic, and the monitoring data are not shared sufficiently. The quality of groundwater is mostly unknown.[218] In addition, there is no accidental pollution early warning system.[210] So, improving management practices (concerning the wastewater, solid waste, land use, etc.) and responding to related pressures, on the one hand, and the improvement of monitoring of water resources and information exchange, on the other, should be among the key areas of action in the Drina Basin.

1.9 WASTEWATER and SOLID WASTE as pressures on water quality

Wastewater management in the Drina River Basin is inadequate. Most municipalities do not have wastewater treatment plans and sewage is not separated from storm water, which increases the risk of sewage overflow. Industrial wastewater is rarely treated before disposal and is discharged directly into the streams. It contains, among other things, oil, organic matter and metals.[219]

Solid waste management in the Drina River Basin is also inadequate. The waste generated from municipalities (which includes a large organic fraction) and industries (which is hazardous) is often not separated. Existing municipal landfills are not sanitary and represent one of the main sources of pollution in the Basin. Waste is often dumped illegally in locations close to the riverbanks. This affects water quality in the rivers and aquifers, and it also results in floating waste that affects hydropower production. Mining also causes contamination in the soil with the release of heavy metals, which may lead to acidification and other environmental damage.[212]

215 ISRBC (2019): Flood Risk Management Plan in the Sava River Basin, Zagreb.

216 UNECE (2017): *Policy brief: Assessment of the wa- ter-food-energy-ecosystems nexus and benefits of trans-boundary cooperation in the Drina River Basin,* New York and Geneva.

217 GEF (2020): *West Balkans Drina River Basin Management Project, Strategic Action Program.*

218 UNECE (2017): *Assessment of the water-food-energy-ecosystems nexus and benefits of transboundary co-operation in the Drina River Basin,* New York and Geneva.

219 UNECE (2017): *Assessment of the water-food-energy-ecosystems nexus and benefits of transboundary co-operation in the Drina River Basin,* New York and Geneva.

1.10 SEDIMENTATION / EROSION as a pressure on WATER QUALITY

Planning and implementation of anti-erosion measures are of strategic importance for water management, economy, spatial planning and environment in the Drina River Basin. The Basin is characterised by a high rate of erosion and production of sediment that, when transported to the lower parts of the basin, can cause damage to agriculture (removal of semi-arable land), water management, energy (reduction of the useful volume of reservoirs due to backfilling) and environment (removal of land as a habitat, transport of pollutants).[220] Although present depopulation trends in the Drina Basin (migration of people to urban areas, marginalisation of agriculture, reduction of livestock) lead to land use changes and gradually restrain erosion processes, land loss assessment and planning and implementation of anti-erosion measures are of high importance for further social and economic development of the region.

The scoping study, performed within the framework of the *Drina Nexus Follow-Up Project* based on national data and information, provides comprehensive information about the sediment sources in the Drina Basin, the areas with a deficit / surplus of sediment, the areas prone to erosion (loss of arable land, torrential floods) and the sedimentation of HPP reservoirs, as well as a set of key measures to counter the erosion problem in the Drina Basin.[213] To that end, the need has been identified for the harmonisation of erosion maps; the establishment of a sediment monitoring system; a regular survey of the reservoirs and analysis of the sedimentation process in cooperation with HPP operators; the investigation of the sediment quality (especially the sediment retained in reservoirs); a regular survey of cross sections along the Drina River and its main tributaries; raising the awareness of sectoral actors and the population about the consequences of inadequate land use practices and appropriate anti-erosion measures; and the exchange of good practices among the Drina Basin countries.

220 UNECE (2019): *Scoping study on erosion and sedimentation in the Drina River Basin*, Final Report, Jaroslav Černi Water Institute, Belgrade.

1.11 RENEWABLE ENERGY development

Hydropower development in the Drina River Basin planning suffers from several shortcomings. In the *Sava Nexus Assessment Project*[221], hydropower investments were found to be key to achieving both the climate change mitigation targets in the region (by 2030, 43% CO_2 reduction in the riparian countries is expected to come from hydropower investments), and the national renewable energy targets (between 10-36%, depending on the country). However, several shortcomings of hydropower development were subsequently identified in the Drina Basin[212]:

- Plans are ambitious but hampered by funding constraints and different interests in regional electricity trading.
- Low investment in renewable energy overall is affected by the state of development of the investment environment and related uncertainties; shortcomings in governance, including in the regulatory frameworks; complex procedures for issuing permits; and limited institutional capacity.
- Hydropower development planning in the Basin is not transparent and does not engage international cooperation.
- Many of the planned hydropower plants are located on river stretches of high conservation value that have not been fully utilised.

Institutional and policy shortcomings are affecting opportunities in renewable energy and energy efficiency development. The development of renewable energy is hampered by unrealistic planning processes, while increases in energy efficiency are hindered by limited implementation of energy efficiency policy frameworks and the lack of a business case for investment.[222] A variety of actions to cope with these challenges have been identified, including:

- reviving regional electricity trade;
- accelerating the harmonisation of related legislative, regulatory and institutional frameworks;

221 UNECE (2016): *Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus in the Sava River Basin*, New York and Geneva.

222 UNECE (2017): Assessment of the water-food-energy-ecosystems nexus and benefits of transboundary cooperation in the Drina River Basin, New York and Geneva.

- carrying out transboundary SEAs and EIAs of programmes and projects requiring infrastructure in the Basin, including for energy projects; and
- using the existing cooperation platforms to discuss effects of planned hydropower developments (ISRBC), or implementation and financing of energy efficiency measures, as well as their impact (Energy Community).

1.12 AGRICULTURE, RURAL and ECO-TOURISM DEVELOPMENT

The Drina River Basin resources offer an unexploited potential to promote agriculture, rural and eco-tourism development. There are opportunities to gain higher value of traditional agriculture in the Basin through converting to certified organic agriculture or potentially establishing standards for certified origin of local products, as well as to make a productive use of currently unused land without compromising ecosystems (i.e., grasslands could be used for livestock rearing and the use of abandoned and degraded lands for biofuel production could be explored). Expanded irrigation, using water-efficient technologies, and exploring options for water reuse in agriculture would sustainably increase climate resilience of agricultural production. The mostly untouched landscapes and wildlife offer significant opportunities for further development of eco-tourism, which could bring multiple benefits if properly managed and enhanced by transboundary cooperation.[223] At the 8th MoP to the *FASRB (Sarajevo, 24.10.2019)*, high-level representatives of the ISRBC member countries acknowledged the efforts of ISRBC related to the development of sustainable tourism in the Sava River Basin, by recognising this development as a significant tool in the promotion of economic benefits, and they strongly supported further activities in this area under the umbrella of ISRBC.[224] Therefore, the fact that the ISRBC platform can support the Drina countries in using the potential for the development of tourism should be kept in mind when planning further activities in this area.

Rural development in the Basin is currently hampered by several obstacles. According to RRD SWG, governance-related obstacles are as follows: (i) the broad mass of rural people is ill-connected to development processes; (ii) policies and practices in rural development in the region are still relatively unformed; and (iii) both national and local governments are involved in rural development but the roles of each are unclear, causing confusion for stakeholders. Other obstacles include.[215, 216]

- lack of infrastructure, including for irrigation and drainage, roads, drinking water supply, flood protection, wastewater treatment and solid waste management;
- low level of production, productivity and competitiveness in the agricultural sector;
- employment opportunities in non-agricultural sectors are poor;
- the potential for eco-tourism is not being exploited;
- the pace of reform of agricultural policies is slow; and
- levels of investment in maintaining and building infrastructure are low.

Therefore, promoting integrated rural development in the Basin by exploiting the existing synergies between eco-tourism, sustainable agriculture and renewable energy production, to the advantage of local businesses and communities, is suggested in order to cope with the challenges described above.

223 UNECE (2017): Policy brief: Assessment of the water-food-energy-ecosystems nexus and benefits of transboundary cooperation in the Drina River Basin, New York and Geneva.
224 ISRBC (2019): Declaration from the 8th Meeting of the Parties to FASRB, Sarajevo, 24 October 2019.

ANNEX 2: TECHNICAL SUPPLEMENTARY MATERIAL TO THE ENERGY-WATER MODELLING ANALYSIS

2.1 Model DETAILS

The modelling tool used for the analysis, OSeMOSYS, is a linear optimisation tool. It determines the configuration of the energy system (in terms of total installed capacities, investments in new capacities and intra-annual dispatch) that minimises the total system costs over a period of several years, under a number of user-defined constraints. These include policies, operational constraints of power plants, availability of resources (e.g., water feeding the hydropower plants), fuel prices and others. In this study, OSeMOSYS carries out an optimisation that is:

- Dynamic – this means that the energy system configuration is calculated for every year in the time domain of the study and for several intra-annual time steps;
- Deterministic – this means that no probabilistic distributions are assigned to the inputs;
- With perfect foresight – this means that the technology and fuel costs are considered to be known for all the time domain of the study, as if the model could foresee the future; and
- Assuming competitive market – that is, all the technological options compete only based on their real costs.

Any model in OSeMOSYS is based on two key types of elements: Technologies and Commodities. Technologies can represent any artificial or natural process having a control volume, inputs and outputs. Therefore, they can represent power plants, as well as storages, or segments of a river. Commodities represent any mass or energy flow between different technologies. Therefore, commodities can be coal or electricity, as well as water. This flexibility allows different biophysical systems to be represented jointly in the same model, e.g., electricity supply infrastructure and water courses. This characteristic of OSeMOSYS allowed the authors to create a model that would represent the entire energy system of the riparian countries, but also details of the water-energy system along the Drina hydropower cascade. Here, key details are given.

The modelled hydropower cascade contains different elements. These include river segments, dams/ storages, hydropower plants, spillways and catchments. Each element is illustrated in Figure A2-1.

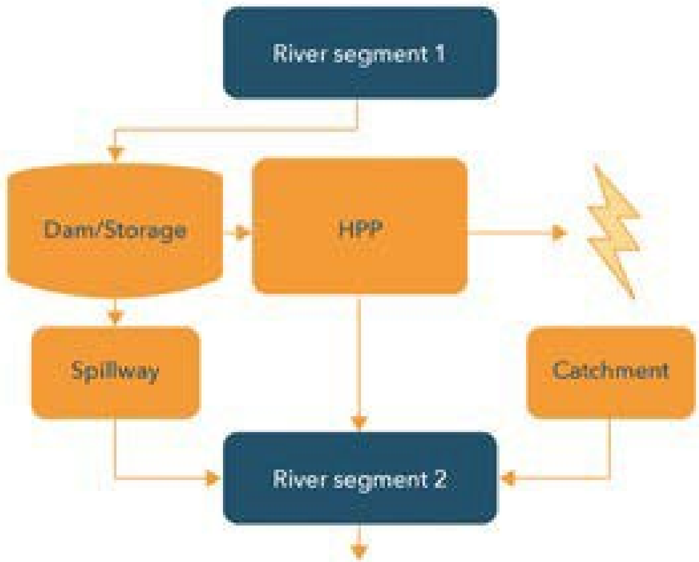


Figure A2-1. Schematic representation of how HPPs, storage, river segments spillways and catchments are modelled.

The upstream river segment allows water to flow into the storage, after which the model has three options. It can (1) save water to generate power during a later stage in the modelling period, or (2) use it directly for power generation. The third option is to use the spillway and send the water to a downstream river segment, where it can be used for power generation by another power plant. The catchments add additional water into the system, which results in higher flows downstream compared to the upstream sections of the cascade. Water used for power generation is sent downstream, where it merges with possible spillway and catchment water before it is discharged into the next downstream dam.

2.2 Data and details on ASSUMPTIONS

2.2.1 Detail: Power potential in Montenegro

In Montenegro, the wind power potential has been estimated at 400 MW.[225,226] Compared to available wind technologies today, the capacity per wind turbine was considerably lower in 2007. In 2018, when the Možura wind power plant went into operation, each turbine contained a capacity of 2 MW. Gvozd, the latest wind power project, has 13 turbines, each with a rated capacity of 4.2 MW. Once the Gvozd wind power plant, which is currently under construction, becomes operational, Montenegro would only have 230 MW of wind power potential available according to the estimated potential. A wind power installation of 230 MW during the modelling period was not deemed ambitious, thus the maximum capacity allowed was increased under the AMB scenario. The same reasoning is behind the increases in solar and hydro, where the rate of investment in the BAU scenario was far less ambitious compared to the available potential.

2.2.2 Detail: ETS in Montenegro

As of 2020, the only DRB riparian that has implemented the ETS is Montenegro. The current value is 24 EUR/tCO_2, and according to the EPCG, that value will be constant for the period 2020-2025. A study published by the Energy Community227 in January 2021 includes projected ETS costs for the DRB countries. The study includes values from 2025, with five-year increments until 2040. Compared to the current ETS price for Montenegro, the projection underestimates the costs, at least for the first decade of the 2020-2040 period. Based on this, only values for 2035 and 2040 were considered for the ETS price projection. These values correspond to 45 EUR/tCO_2 and 80 EUR/tCO_2 respectively.

2.2.3 Data

Table A2-1 shows the characteristics of HPP stations and dams, both existing and planned, within the Drina River Basin. The parameters have been used to create the cascade part of the OSeMOSYS Water-Energy model. The spillway capacity and installed throughflow are dam characteristics, while the installed capacity and average power generation refer to the hydroelectric power stations.

Further technical characteristics of the Drina River Basin dams are provided in Table A2-2. The net head was used to calculate the water needed for power generation per unit of power. In the model, the dams were dimensioned based on the total, useful and dead storage volumes.

The analysis also included hydropower plants outside the Drina Basin. These were aggregated and represented by country. The technical characteristics of these existing power plants are presented in Table A2-3. The parameters of interest for this study are installed capacity, year of commission and average power generation. With these, the model is able to show a representation of HPPs outside the DRB, with their average annual power generation contributing to the overall power systems of the riparian countries.

225 R. Vujadinovic, et al. Valorization of potentials of wind energy in Montenegro. Thermal Science, 2017. doi: 10.2298/TSCI161201016V.

226 Procjena potencijala obnovljivih izvora energije u Republici Crnoj Gori. CETMA. Available at: https://wapi.gov.me/download/3afbf730-ab89-4bb8-838c-36ed98b-1674d?version=1.0.

227 A carbon pricing design for the Energy Community – Final Report. (Energy Community, 2021). Available at: https://www.energy-community.org/dam/jcr:82a4fc8b-c0b7-44e8-b699-0fd06ca9c74d/Kantor_carbon_012021.pdf.

Table A2-1. HPP and dam characteristics.

Country	Power plant	Year of commission	Spillway capacity	Installed through	Installed yearly capacity	Average power generation
	Existing	*Year*	*m3/s*	*m3/s*	*MW*	*GWh*
RS	Zvornik[229]	1955	9000	620	126[230]	456[65]
RS	Bajina Bašta[231]	1966	12 244	644	420[232]	1474[65]
RS	Bistrica [64]	1959	1400	36	102[65]	300[65]
RS	Kokin Brod[64]	1962	1400	37.4	22[65]	68[65]
RS	Uvac[64]	1979	1050	43	36[65]	58[65]
RS	Potpeć[64]	1967	3240	165	51[65]	198[65]
BA	Višegrad[233]	1989	11 190	800	315	956[234]
ME	Piva[235]	1976	2283	240	342	860
	Planned					
BA/RS	Buk Bijela[236]	2025	3790	350	93.52	332.3
BA/RS	Foča[69]	2025	5600	350	44.15	175.9
BA/RS	Paunci[69]	2025	8716	450	43.21	166.9

Table A2-2. Dam characteristics.

Country	Dam name	Dam height	Net head (max)	Rated head (nom)	Net head (min)	Total storage	Useful storage	Dead storage
	Existing	*M*	*M*	*m*	*m*	*MCM*	*MCM*	*MCM*
RS	Zvornik[64]	42	22.7	20.3	17	47.4	21.32	26.11
RS	Bajina Bašta[64]	90.5	69.9	65.1	42.9	340	218	122
RS	Radoinja[64]	42	378	360	345	7.6	4.1	3.5
RS	Kokin Brod[64]	82	73	37.6	25.6	250	209	41
RS	Uvac[64]	110	100	97.5	55	200	160	40
RS	Potpeć[64]	46	38.4	37.6	25.6	27.5	19.8	7.7
BA	Višegrad[66]	79.5	47	43	42.7	161	101	60
ME	Mratinje[68]	220	182.4	162	138	824	746	78
	Planned					MCM	MCM	MCM
BA/RS	Buk Bijela[69]	-	-	-	-	15.7	11	4.7
BA/RS	Foča[69]	-	-	-	-	6.7	4.6	2.1
BA/RS	Paunci[69]	-	-	-	-	5	2.53	2.47

Table A2-3. Existing hydropower plants outside the DRB considered in the analysis.

Country	River	Hydropower Plant	Installed capacity	Average power generation	Storage	Discharge of the turbines	Year of commission	Total storage	Useful storage
		Name	*[MW]*	*[GWh]*	*[GWh]*	*[m3/s]*	*Year*	*[hm3]*	*[hm3]*
BA	Trebišnjica	Trebinje [230]	171	438	1010.7	3x70	1968[20]	-	1082[20]
		Dubrovnik[70]	234	557	8.02	2x48.5	1965[20]	-	9.3[20]
		Čapljina[70]	420	419	3.43	2x112.5	1979[20]	7.1[20]	6.5[20]
	Neretva	Rama[70]	170	663	530.8	2x32	1968[231]	487[239]	466[20]
		Jablanica[70]	180	722	127.7	6x35	1955[19]	-	288[19]
		Grabovica[70]	114	276	2.9	2x190	1982[20]	-	5[20]
		Salakovac[70]	210	403	5.3	3x180	1982[20]	68.1[19]	16[19]
		Mostar[70]	72	233	0.4	3x120	1987[20]	10.9[20]	6.4[20]
	Vrbas	Jajce I[70]	60	244	0.51	2x35	1957	24[20]	4.2[20]
		Jajce II[70]	30	80	0.22	2x27	1954	2.1[20]	1.3[20]
		Bočac[70]	110	256	5.09	2x120	1981		42.9[20]
	Lištica	Mostarsko-Blato[70]	60	89	0.4	2x20	2010	1[20]	0.9[20]
	Tihaljina	Peć-Mlini[70]	30.6	68	0.4	2x15	2004	0.8[20]	0.8[20]
	Prača	Ustiprača[70]	6.9	35	-	2x7	2015	-	-
		Dub[70]	9.4	20	-	2x7.5	2016	-	-
RS	Donau	Đerdap I[22]	1126[65]	5252[65]	-	6x840	1972[240]	2800[241]	-
		Đerdap II	270[65]	1531[65]	-	4200	1985[21]	716.5	-
	Visočica	Pirot[235]	80[65]	104[65]	75	45	1990[21]	170	-
	Vrla, Romanovska, Masurićka, Božica, Lisna	Vrla [236]	50.7	95	211	18.3	1955	172	-
		Vrla 2[24]	23	51	-	18.5	1954	0.1	-
RS		Vrla 3[24]	28.9	73	-	18.4	1957	0.05	-
		Vrla 4[24]	24.9	63	-	18.4	1958	0.1	-
		PAP Lisina[24]	28.6	14	13.9	2x3.75	1978	9.3	-
	West Morava	Međuvršje[237]	10	36	-	-	1957[21]	-	-
	West Morava	Ovčar Banja[25]	8	32	-	-	1954[21]	-	-
ME	Gornja	Perućica[238]	307				1960		[illegible]

Thermal power plants account for the majority of power generated in the Drina Basin countries. Table A2-4 lists all coal-fired TPPs that were considered in the study. These power plants have been aggregated per country, and based on commission year, installed capacity and efficiency, the model is able to represent the current TPP infrastructure, including average annual power generation, coal consumption and emissions related to the burning of coal for power generation. Fuel prices, together with fixed and variable O&M costs, are also represented. These characteristics together with the plant efficiencies are the techno-economic parameters taken into account by the model.

Table A2-4. Existing thermal power plants.

Country	Power plant name	Unit no.	Com-mission year	Decom - mission year	Installed Capacity [MW]	Efficiency [%]	Fuel Price ($/GJ)	Fixed O&M [$/ GW/y]	Variable O&M [€/ MWh]
BA	Tuzla[228]	3	1966	2021 / 2024	100 (90)	30%	3.58[80]	23.04	2.00
		4	1971	2023 / 2024	200 (180)	29%	3.58[80]	41.76	1.67
		5	1974	2030 / 2026	200 (180)	29%	3.58[80]	38.88	1.67
		6	1978	2035 / 2028	223 (200)	34%	3.06[80]	41.76	1.33
	Kakanj[79]	5	1969	2024	110 (100)	31%	3.04[229]	46.08	1.33
		6	1977	2027	110 (100)	32%	3.04[80]	57.6	1.33
		7	1988	2035	230 (208)	32%	3.04[80]	50.4	1.33
	Gacko	1	1983	2031	300 (276)	31%	2.48	185.9	1.67
	Ugljevik	1	1985	2039	300 (279)	31%	2.38	160.4	1.67
	Stanari	1	2015	After 2040	300 (262.5)	37%	2.48	50.1	1.67
ME	Pljevlja	1	1982	After 2040	225	32%	In O&M cost	28.8	11.6
RS	Kolubara[42]	1	1956	-	32	-	-	-	-
		2	1956	-	32	-	-	-	-
		3	1961	-	32	-	-	-	-
		4	1960	-	64	-	-	-	-
		5	1979	-	110	-	-	-	-
RS	Nikola Tesla A[42]	1	1970	2039	210 (225 after 2021)	-	-	-	-
		2	1970	2039	210 (225 after 2022)	-	-	-	-
		3	1979	2039	329	-	-	-	-
		4	1979	2039	308.5	-	-	-	-
		5	1979	2039	340	-	-	-	-
		6	1979	2039	347.5	-	-	-	-

228 Termoelektrane. JP EPBIH. Available at: https://www.epbih.ba/stranica/termoelektrane.
229 Izvještaj o poslovanju JP Elektroprivreda BIH d.d. Sarajevo za 2013. godinu. (JP EPBIH, 2013). Available at: https://www.epbih.ba/upload/documents/obavjestenja/m-tacka2.pdf.

Table A2-4. Existing thermal power plants.

Country	Power plant name	Unit no.	Com-mission year	Decom - mission year	Installed Capacity [MW]	Efficiency [%]	Fuel Price ($/GJ)	Fixed O&M [$/ GW/y]	Variable O&M [€/ MWh]
RS	Nikola Tesla B[42]	1	1983	-	650	-	-	-	-
		2	1985	-	620	-	-	-	-
	Morava[42]	1	1969	2023	125	-	-	-	-
	Kostolac A[42]	1	1967	-	100	-	-	-	-
		2	1980	-	210	-	-	-	-
	Kostolac B[42]	1	1987	-	350	-	-	-	-
		2	1991	-	350	-	-	-	-

While still in the early stages of implementation within the DRB countries, wind power has seen an increasing trend of investment in recent years. Table A2-5 shows the currently constructed wind power plants which are represented in the model, aggregated by country.

Table A2-5. Existing wind power plants.

Power Plant Type	Power plant	Year of commission	Installed Capacity [MW]	Average power production [GWh/year]
BA	Jelovača	2015	36	110
	Mesihovina	2018	50.6	165
	Podveležje	2021	48	120
ME	Možura	2019	46	112
	Krnovo	2017	71.6	200
RS	Košava 1	2019	69	-
	Alibunar	2019	42	-
	Malibunar	2018	8	25
	Čibuk 1	2019	157	-
	Kovačica	2019	104.5	-
	Kula	2016	9.9	27
	La Piccolina	2016	6.6	20

The expansion of the DRB hydropower cascade conducted in this model included the construction of HPP Buk Bijela, Foča, and Paunci. In addition to these, there are many other proposed HPPs.

Table A2-6 lists all the major power plants envisioned for the DRB, including their capacities, planned generation and location by river and country.

Table A2-6. Planned hydropower plants within DRB.

Country	Power plant name	River	Capacity [MW]	Planned generation [GWh]
BA[69]	Sutjeska	Sutjeska	44.1	95.6
BA	Bistrica 1	Bistrica	12	48.8
BA	Bistrica 3	Bistrica	19	71.6
BA/RS	Rogačica	Drina	113.3	413
BA/RS	Tegare	Drina	120.9	448
BA/RS	Dubravica	Drina	87.2	335
BA/RS	Kozluk	Drina	88.5	376
BA[69]	Ustikolina	Drina	60	236
ME/RS[230]	Komarnica	Komarnica	172	213
BA/RS	Drina 1	Drina	87.7	364
BA/RS	Drina 2	Drina	87.8	379
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The model allows for further expansions of TPPs in Bosnia and Herzegovina as well as in Serbia. As of 2020, there are a number of different power plants that are planned or under construction. Table A2-7 summarises the different thermal power projects within the riparian countries.

Table A2-7. Planned and proposed thermal power plants.

Country	Power plant name	Unit no.	Commission year	Capital Cost [m$/GW]	Installed Capacity [MW]	Efficiency [%]	Fuel Price ($/GJ)	Fixed O&M [$/GW/y]	Variable O&M [€/MWh]
BA	Tuzla[231]	7	2025	1941[232]	450	43	3.58	36.6	1.66
	Kakanj[233]	8	2028[234]	2139	300				
	Kostolac B[235]	3	2022	2119	350	40.8[236]	-	-	-
	Kolubara B	6	2024[237]		400				
RS	Pančevo	1	2021[238]	1158[239]	188				
	Vinča	1	2020 (not yet commis-sioned)		30.24				

230 Preliminary design plan for HPP Komarnica to be finished in November. Balkan Green Energy News. Available at: https://balkangreenenergynews.com/preliminary-design-plan-for-hpp-komarnica-to-be-finished-in-november/.
231 Energetska dozvola za izgradnju proizvodnog Objekta Bloka 7- 450 MW u Termoelektrani Tuzla. (Federal Ministry of Energy Mining and Industry BiH, 2017). Available at: https://fmeri.gov.ba/media/1650/nacrt-en-dozv-blok-7-450-mw-te-tuzla.docx.
232 Plan poslovanja za period 2020. - 2022. godina. (Javno preduzeće Elektroprivreda Bosne i Hercegovine d.d. Sarajevo, 2020). Available at: https://www.epbih.ba/upload/documents/62SD_Plan_poslovanja_sastavljeno_NOVO.pdf.
233 Kapitalne investicije - Blok 8 TE „Kakanj. JP EPBIH. Available at: https://www.epbih.ba/stranica/kapitalne-investicije.
234 Indikativni plan razvoja proizvodnje 2022-2031. (NOSBiH, 2021). Available at: https://www.nosbih.ba/files/2021/04/20210402-lat-Indikativni-plan-razvoja-proizvodnje-2022-2031.pdf.
235 I. Todorović. “New thermal power plant feasibility studies understated TPP costs – report.” https://balkangreenenergynews.com/new-thermal-power-plant-feasibility-studies-understated-tpp-costs-report/.
236 Construction of a Super-critical Lignite Power Plant TPP Kostolac B. (Public Enterprise Electric Power Industry of Serbia, 2013). Available at: https://unfccc.int/sites/default/files/07_nama_implementation_kostolac_b3.pdf.
237 I. Todorović. “Serbia issues draft spatial plan for coal-fired thermal power plant Kolubara B.” https://balkangreenenergynews.com/serbia-issues-draft-spatial-plan-for-coal-fired-thermal-power-plant-kolubara-b/.
238 NIS a.d. “TE-TO Pančevo - O Projektu.” https://www.nis.eu/project/te-to-pancevo/.
239 Country Report on Energy Business in Serbia. (Balkan Energy, 2020). Available at: http://balkanenergy.com/files/Country-Report-Serbia-December-2020.pdf.

Table A2-8. Planned and proposed solar power plants.

Country	Power plant	Year of commission	Installed Capacity [MW]	Investment Cost [m$/GW]	Area require d [ha]
ME	Briska Gora	2022	250		
	Velje Brdo	-	50	1800	
RS	Kostolac	-	97.2	1037	270
	Pekta	-	9.95		15
BA	Bileća	2023	60	700	133
	Trebinje 1	2023	73	855	-
	RSV Energy (Bosanski Petrovac)	-	47	914	80
	Podveležje	2023	30	-	-
	Bosanski Petrovac[240]	-	90	670	-
	Divkovići	2024	56	-	-

As part of the techno-economic parameters of non-hydro renewables, the capital cost [M$/GW] for each country is displayed in Table A2-9. While capital costs are an important factor in determining cost-competitiveness, other factors such as availability and capacity factors, fixed and variable operations and maintenance costs, and operational life are also important.

Table A2-9. Capital cost [M$/GW] projections for non-hydro renewables in the DRB countries.[241,242]

Country	Power plant type	2020	2025	2030	2035	2040
BA	Solar PV	863	641	418	371	324
	Wind	1815	1559	1303	1228	1152
ME	Solar PV	1035	769	502	446	389
	Wind	1636	1405	1175	1107	1038
RS	Solar PV	1037	770	503	447	390
	Wind	1922	1651	1380	1300	1220

240 The power plant will be used for export only.
241 IRENA (2019): Future of Wind - Deployment, investment, technology, grid integration and socio-economic aspects (A Global Energy Transformation paper). Available at: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Oct/IRENA_Future_of_wind_2019.pdf.
242 IRENA (2020): Wind and Solar PV - what we need by 2050.

ANNEX 3: SELECTED INTERNATIONAL ARRANGEMENTS ON FLOW REGULATION[243]

3.1 DNIESTER RIVER (Ukraine and Moldova)

The 2017 *Dniester Treaty*[244] between Moldova and Ukraine has been called an example of the strategic development approach. The Dniester River is characterised by historical regularity of flows and is not prone to droughts. Hydrologically, particularly with respect to HPP operation, the River Basin can be divided into zones based on characteristics related to seasonal flood control, water levels for reservoirs, conditions for the operating capacity of HPPs, seasonal flows and natural flows.

With respect to flow, the *Treaty* includes the following:

Article 10. Water flow regulation

The Contracting Parties shall cooperate in regulating water flow in the Dniester River basin and in implementing activities aimed at significant alteration, variation or other management of the water flow of the Dniester River Basin waters which are transboundary in nature.

The Contracting Parties shall participate on a mutually beneficial basis in construction and maintenance of installations required to regulate water flow, which they may agree to build.

Under Article 9, the *Treaty* provides that a flow regime will be established by the RBO (Dniester Commission) and gives priority to ecological flows.

The Dniester Commission has established a working group on River Basin Planning and Management. The ToR of the working group gives it responsibility over regulation of the hydrological regime of the Dniester River Basin and environmental flow releases through the development of e-flow regulations and annual plans for regulation of the hydrological regime of the river, subject to the approval of the Commission.

The Working Group has produced draft regulations to serve as a comprehensive and mandatory normative document for all official bodies involved in regulation of the Dniester. The draft regulations include the rules of operation for reservoirs, power plants and tributary waterways. The issue of seasonal flows is at the core of the draft regulations and also of the comments received from many stakeholders. Water demand is highest during summer and autumn. Natural flows are quite high during summer but decrease in the autumn. During the winter, downstream water demands are reduced, while hydropower energy demand increases. In spring, the main concerns are flood control and releases required for management of protected areas.

With respect to hydropower operation, the draft regulations divide the basin into zones as mentioned above, taking into account seasonal flood control, water levels for reservoirs, condition for operations capacity of HP, seasonal flows and natural flows. These zones include flood control-only zones, increased yield zones, guaranteed yield zones and decreased yield zones, each with its own special rules.

The Dniester Commission example illustrates the historical trends in mechanisms used for water allocation identified by McCracken et al. (forthcoming). By entrusting decisions on water allocation to a joint body, the treaty parties have embraced the indirect mechanism for allocation and avoided the need for frequent, direct international negotiations between states. Furthermore, by using expert working groups that apply certain agreed standards and principles, the Dniester example also represents the trend towards principle-based or technical mechanisms.

3.2 VUOKSI AND SAIMAA (Finland and Russia)

While many earlier agreements on transboundary waters prioritised hydropower, more recent water allocation agreements related to hydropower increasingly integrate competing demands for flows, including e-flows. Such an example is the series of agreements between Finland and Russia related to the Vuoksi River and Lake Saimaa.

243 The Vuoksi, Albufeira, Dniester, Senegal and Columbia River examples in this section are based upon Sanchez Navarro's E-Flow Study. Some of the other examples were identified in "Relevant International Case Studies", compiled and analysed by Dr. Chukwuebuka Edum (available from the UNECE Water Convention Secretariat).

244 Treaty between the Government of the Republic of Moldova and the Cabinet of Ministers of Ukraine on Cooperation in the Field of Protection and Sustainable Development of the Dniester River Basin.

The baseline e-flow concept is a relatively new one. Domestic and municipal water uses including sanitation were prioritised even in the earliest agreements, but agreements such as the 1909 *Boundary Waters Treaty* (Great Britain and the United States), which established the famous International Joint Commission, limited priorities to uses for domestic and sanitary purposes, uses for navigation (including services of canals for purposes of navigation), and uses for power and for irrigation. Diversions for hydropower were limited by quantity, not including diversion for sanitary or domestic purposes or into canals for the purposes of navigation.

The following description is adapted from the *E-Flow Report:*

The Vuoksi regime consists mainly of three legal instruments – the 1964 *Frontier Watercourses Agreement,* 1972 *Hydropower Agreement* and the 1989 *Vuoksi Agreement*. The 1964 *Frontier Watercourses Agreement* sets general rules for the management of transboundary water resources, while the 1989 *Vuoksi Agreement* includes more specific provisions on the flow regulation of the Vuoksi and related water levels in adjacent Lake Saimaa. In addition, the 1972 *Hydropower Agreement* specifies the daily regulation of streamflow at the Svetogorsk hydroelectric station on the Russian side of the border.

The centrepiece of the 1989 *Vuoksi Agreement* is its *Appendix on the Regulations Governing Lake Saimaa and the Vuoksi River (the Vuoksi Discharge Rule).* According to the agreement, the Finnish Government must manage the flow of the river based on these regulations (Art 1). The main principle is that the water level of Lake Saimaa and the corresponding flow in the Vuoksi must remain as much as possible within normal limits corresponding to "natural conditions," as defined in annex 4A and 4B of the 1989 *Vuoksi Agreement.* The annex specifies the average natural water levels and flows seasonally, and is based on the measured values between 1847 and 1984. Annex 4A and 4B also provide upper and lower limits for water levels and flows considered normal, limited to +/− 50 centimetres as measured from the median water level (appendix, para 2.4). If, e.g., due to flooding, more water has to be discharged than agreed, the need for compensation may be assessed.

The 1972 *Hydropower Agreement* is very clear when it comes to the compensation of hydropower losses caused by the Svetogorsk hydropower station in Russia to the Imatra hydropower station on the Finnish side of the river. According to the *Agreement,* the energy losses resulting from the flow regulation on the Russian side are 19,900-megawatt hour (MWh) per year, and the responsible Russian party (i.e., hydropower operator) must compensate the affected Finnish party (i.e., hydropower operator) for this loss on a permanent basis (Art 3). Compensations must be made annually by supplying free electricity from the Russian hydropower station to the Finnish hydropower company (Art 4). The hydropower companies are mandated to agree on the actual supply of the compensatory power in more detail (Art 4).

3.3 ALBUFEIRA CONVENTION (Spain and Portugal)

Another useful example is the transboundary waters regime between Spain and Portugal, which share five main River Basins. The basins are characterised by extreme variations in rainfall from season to season and year to year in a drought-prone arid region. Irrigation is a major source of water demand. Low water pricing exacerbates scarcity. Both countries have a history of large-scale dams and water-transfer projects. In the 1960s, the countries entered into treaties that established equal sharing of the hydropower potential of the five basins. In 1998, the countries adopted the *Albufeira Convention,* which incorporated many concepts from the European project to draft the *WFD* at the same time. The *Convention* establishes an annual flow regime for the five major transboundary rivers, defining mandatory flow volumes in Spanish sections upstream of the border, and for the estuaries or mouths in Portugal of the southern and more arid Tejo and Guadiana River Basins. The agreed flow regime was the subject of an *Additional Protocol to the Convention* that defines the minimum volumes allocated to each River Basin, as well as the conditions, usually associated with drought, required for declaring an emergency regime. Measurements are taken by a set of rain gauge stations for each flow control station to verify whether the accumulated average rainfall is less than 65% of the historical average (taking into account historical seasonal variations). When measurements fall below the threshold, Spain may invoke the special emergency regime and is excused from releasing the minimum flows under the agreement. The emergency regime ends automatically once the threshold values are again exceeded.

3.4 COLUMBIA RIVER (US and Canada)

The 1961 *Treaty between Canada and the United States relating to Cooperative Development of the Water Resources of The Columbia River* governs hydropower operations and management of flood risk and provides substantial benefits to millions of people on both sides of the border. The *Treaty* has also facilitated additional benefits such as supporting irrigation, municipal water use, industrial use, navigation and recreation. Treaty-related agreements also allow for flow augmentation for ecosystem benefits.

Negotiations benefited from the fact that the International Joint Commission (based on the 1909 *Boundary Waters Treaty*) could advise the process and serve as a neutral "third party", building upon its decades of successful experience. The IJC ensured the sharing of information and even undertook engineering studies on behalf of both parties.

The *Treaty* obligates Canada and the United States to coordinate plans, exchange information and establish and maintain a hydrometeorological system under "assured annual flood control" plans. The countries closely cooperate in monitoring and evaluating the system. Weekly flow agreements detail the exact flows to be released during the following seven days. Additional flood control is available "on call", subject to proving need and providing additional compensation, although this facility has not been used so far. Other installations that are not directly covered by the *Treaty* are nevertheless the subject of separate "coordination agreements", such as the *Libby Coordination Agreement.*

The *Treaty* is regarded as one of the most successful agreements on equitable sharing of benefits. The US and Canada share equally benefits associated with the regulation of flow from Canada's upstream projects. Power benefits are calculated based on projected optimal operation, not actual operation. Therefore, regardless of how the US chooses to operate its dams in real-life Canada will receive 50% of the projected agreed amounts of energy and capacity. This is called the Canadian Entitlement. Canada's share of the benefits is given to the province of British Columbia through a domestic agreement between Canada and British Columbia.

The recognition of interests of indigenous groups and the sharing of benefits is another of the special characteristics of the *Treaty.*

The year 2024 is a significant date for the *Treaty,* as the current flood risk management provisions change to a less-defined approach. The *Treaty* is currently under renegotiation to address issues including continued, careful management of flood risk; ensuring a reliable and economical power supply; and better addressing ecosystem concerns. As part of this effort, the U.S. Department of State will hold public town halls to provide updates on the modernisation process.

3.5 MATI AND MAPUTO (Mozambique, South Africa and Swaziland)

The 2002 *Tripartite Interim Agreement between the Republic of Mozambique and the Republic of South Africa and the Kingdom of Swaziland for Cooperation on the Protection and Sustainable Utilisation of the Water Resources of Incomati and Maputo Watercourses* grew out of the 1964 *Agreement between the Government of the Republic of South Africa and the Government of the Republic of Portugal in regard to Rivers of Mutual Interest and the Cunene River Scheme.* Its preamble makes specific mention of the 1997 New York *Watercourses Convention* and it incorporates general principles from that convention. The three countries had set up a Tripartite Permanent Technical Committee (TPTC) in 1983, and the *Incomati-Maputo Agreement* designated the TPTC as the relevant joint body for cooperation.

The *Agreement* establishes priority uses as domestic, livestock and industrial uses, as well as ecological water requirements. The states have the right to develop HP installations, subject to operating rules established by the TPTC, which is responsible to assess the flow regime and minimum flows, and to develop drought and flood mitigation and coordination plans.

3.6 SENEGAL RIVER (Guinea, Mali, Mauritania and Senegal)

The Senegal is the second longest river in Africa. Among the most important traditional livelihoods in the basin has been flood-recession agriculture, carried out on riverbanks and alluvial plains once floodwaters have receded. Grazing on the floodplain has been another important source of livelihood. The construction of the Manantali and Diama dams created significant environmental and social impacts, including the loss of flood-recession agriculture, fuelwood and grazing on the floodplain. There was a 90% drop in the productivity of the fisheries of the Senegal Delta, which relied on inputs of freshwater from upstream. Following the introduction of an e-flow regime, which was relatively small and inundated only around 50,000 ha (20% of the original area), fishermen in the Senegal River at Mauritania saw their annual catch rise from 10 tons to 110 tons once the annual floods were re-established.

3.7 COLORADO RIVER (US and Mexico)

The *Treaty on the Colorado River* makes use of "sunset" clauses that expire after a certain time so that a reassessment can take place and adjustments can be made. This is particularly relevant in River Basins that are subject to periodic droughts and highly sensitive to the impacts of climate change. An alternative to sunset clauses is the periodic review and permanent monitoring facilitated by joint bodies under other treaties.

3.8 URUGUAY RIVER

The 1947 *Agreement Concerning the Utilization of the Rapids of the Uruguay River in the Salto Grande Area* established joint works owned in equal shares by the parties. A commission was established to deal with matters of utilisation and diversion of the waters. The agreement established the following priority uses: domestic and sanitation purposes, navigation, production of domestic power, and irrigation. The agreement also employed cost formulae.

3.9 SAUER HPP AGREEMENT (Luxembourg and Rhineland-Palatinate of Germany)

A *"State" Treaty between the Grand Duchy of Luxembourg and the Land Rhineland-Palatinate in the Federal Republic of Germany* was concluded in 1950 concerning the construction of a hydroelectric power plan on the Sauer River at Rosport/Ralingen. It is particularly noteworthy in that a constituent federal entity was a party to an international agreement on a transboundary watercourse (see discussion in Part 3). The agreement included provisions related to flow regulation, flood control and species protection (fish ladder construction). Among the other provisions, Rhineland-Palatinate transferred land at the border to Luxembourg under private ownership. The energy generated from the HPP belonged to Luxembourg, which also assumed all liability (in the form of a private company) for damages. There was also a subsequent technical agreement between the parties later the same year.

3.10 DANUBE HPP AGREEMENT (Austria, Germany and Bavaria)

The 1952 *Agreement between the government of the Republic of Austria and the government of the Federal Republic of Germany and of the free state of Bavaria concerning the Donau Kraftwerk-Jochenstein-Aktiengesellschaft* (Danube Power-Plant and Jochenstein Joint-Stock Company). This is another example where a constituent federal entity was a party to an international agreement on a transboundary watercourse (see discussion in Part 3). Of course, the State to which Bavaria belonged was also a Party, unlike the 1950 *Sauer HPP Agreement,* which may indicate a clarification of the situation in the latter agreement.

This agreement is essentially an investment agreement related to construction of waterworks in a border region. The governmental parties agreed to establish a joint stock company for their mutual purposes. The main participants in the agreement are two semi-public hydropower companies which joined together to establish a third one. The agreement takes great pains to define the two companies in terms of their relationship to the respective states and Bavaria. There is no flow regulation in the agreement, and it is limited to issues related to the sharing of hydropower benefits, although technical annexes or protocols may have included provisions related to flow.

3.11 RHINE RIVER (France, Germany)

By 1969, a more integrated approach to hydropower as one element in development had taken root. *The Convention between the French Republic and the Federal Republic of Germany concerning development of the Rhine between Strasbourg/Kehl and Lauterbourg/Neuburgweier* includes a benefit-sharing arrangement similar to the 1952 *Danube HPP Agreement* but also establishes institutional arrangements consisting of a joint commission and meetings between the state parties in order to regulate extraction for various uses related to agriculture, fishing and industry. The regime required an establishment of conditionality for granting permits at national level. The *Convention* also covered maintenance of the water table, natural flow, equal allocation of costs to the parties, the legal status of the concessionary company, compensation for loss of generated power, flood mitigation measures and boundary determinations for the purpose of the joint project, among other matters.

3.12 IRON GATES MIXED COMMISSION (Yugoslavia, Romania)

The *Agreement Between the Socialist Federal Republic of Yugoslavia and the Romanian People's Republic Concerning the Construction and Operation of the Iron Gates Water Power and Navigation System on the Danube* was signed at Belgrade, on 30 November 1963. With a view to maintaining permanent co-operation and co-ordination and ensuring the fulfilment and application of the treaty concerning the Systems, the Parties established a Mixed Yugoslav-Romanian Commission for the Iron Gates, as a mixed organ of the two Governments.[245]

3.13 DANUBE DAM TREATY (Hungary, Czechoslovakia)

The 1977 *Treaty Concerning the construction and operation of the Gabcikovo-Nagymaros system of locks* is known for being the subject of a long-running international dispute before the International Court of Justice, but ultimately the case was decided in part thanks to its reliance upon flexible technical annexes that could be periodically reviewed and adjusted based upon changing circumstances in the river regime. The *Treaty* set up a joint commission and a detailed system of coordination, operational procedures and a compliance mechanism. With respect to flow regulation, it established frameworks for coordination of activities and agencies in emergency situations like flood and ice disposal, regulated withdrawals with reference to water balance, and assured protection of water quality, navigation and protection of the natural environment including fishing interests. The *Treaty* also set up a system for compensation for loss of water/energy as a result of increases in water withdrawal.

245 Yearbook of the International Law Commission 1974, Vol II, Part 2. p. 315.

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