DESK STUDY ON ENVIRONMENTAL FLOWS AND FLOW REGULATION IN THE DRINA RIVER BASIN

RAFAEL SANCHEZ NAVARRO[1]

DECEMBER 2019 (revised in OCTOBER 2021)[2]

Developed for the United Nations Economic Commission for Europe,
With the financial support of the Italian Ministry of Environment, Land and Sea

[1] The views expressed in the draft report are those of the author and can therefore in no way be taken to reflect the views of the United Nations Economic Commission for Europe or its Member States.
[2] The initial report was submitted by the author in December 2019. Following a review by the Expert Group on Flow Regulation and Environmental Flows as follow up to the Expert Group's 2nd meeting, convened on-line on 29 March 2021 in cooperation with the International Sava River Basin Commission, the draft report was revised and updated in June and October 2021 taking into account the comments received.

Explanatory note

Flow regulation as one of the main intersectoral issues at the transboundary level in the Drina River Basin, identified in the report *Assessment of the water-food-energy-ecosystem nexus and benefits of transboundary cooperation in the Drina River Basin*[3] (UNECE, 2017).

The Drina Nexus Follow-Up Project (2018-2019), financed by the Italian Ministry of Environment, Land and Sea provided for selected actions to be undertaken or detailing them to advance implementation of the Nexus Assessment's recommendations in the countries.

The range of approaches for e-flow regulation varies depending on level of development, level of environmental stress and based upon the practicality of implementation of existing water management policies. The incorporation of water resource management systems relies upon high-level support from governments, legislation, and institutions for implementation. The EU accession process and the development plans, notably hydro production, makes an assessment of e-flows in the DRB of high priority.

One of the Follow-Up project's components involved preparation of this desk study which considered the following: Environmental flows in the three riparian States are implemented and vary dependent on country context. A comparison of the legal regimes of each riparian State is necessary for an understanding of current e-flow regulation to identify opportunities for the further harmonization. Flow management experiences in transboundary basins provide some international examples of policies, legal arrangements, and regulations that can be considered also in the context of the Drina river basin. The desk study also includes a review of the South-East Europe regional regulation to identify good practices, an analysis of current state of flow regulation.

To oversee the development of this desk study, an Expert Group on Flow Regulation and Environmental Flows was established, consisting of experts and officials from government institutions with different expertise, including on hydrology, ecology and environmental flows and hydropower. The Expert Group was convened by UNECE and the International Sava River Basin Commission in Zagreb from 10 to 11 June 2019 to provide initial guidance for this study.

The Drina Nexus follow-up project concluded with a high-level workshop in Belgrade on 29 October 2019, involving development of recommendations based on the activities of the project and taking into account the process outcomes, and issuing a statement, which provide the basis and direction for further work.

[3] The nexus assessment of the Drina was carried out in the framework of the project "Greening economic development in Western Balkans through applying a nexus approach and Identification of benefits of transboundary cooperation" (2016-2017), financed by the Italian Ministry of Environment, Land and Sea.

INDEX

1. INTRODUCTION

Shared by Bosnia and Herzegovina, Montenegro, and Serbia, the Drina River Basin is a water-rich river basin characterized by untouched landscapes and high levels of biodiversity. The basin also has significant hydropower generation capacity as well as unexploited renewable energy potential, but any development of this potential, notably of hydropower, implies trade-offs. Flood risk management is another key issue in the basin.

Trends of global change, such as demographic change, urbanization and economic development, increase the demand for water, food and energy while putting additional pressure on ecosystems. Recognizing the interlinkages between these sectors, which can cause friction in transboundary basins, Parties to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) have tackled the challenge of the water-food-energy-ecosystem nexus by developing a methodology for intersectoral assessment and related dialogue in transboundary basins to foster cooperation.

The nexus assessment of the Sava River Basin was carried out with the aim of supporting the implementation of the Framework Agreement on the Sava River Basin (FASRB), particularly with regard to the further integration of water policy with other sectoral policies, as well as advancing dialogue with key sectoral stakeholders, notably in the sectors of energy and agriculture. The assessments sought to generate salient information to support decision-making. The nexus assessments of the Sava and the Drina River Basin was part of series of participatory assessments carried out in transboundary basins under the Water Convention with a methodology specifically developed for assessing intersectoral links, trade-offs and benefits.

This paper attempts to highlight important ways in which flow regulation and implementation of environmental flows in shared rivers can be made more effective, based on an understanding of the international legal regime, international practices and the Drina basin situation. The report shall serve as an update document on eflows of the European region and may serve as a reference for the further development of flow regulation and environmental flows in the Drina basin. This document does not offer a particular eflow assessment methodology (each of the Drina riparians have their own) nor is it intended to lead to uniform implementation of eflows in the basin. Instead, Drina countries are encouraged to make best use of the shared understanding of eflows and best practices of flow regulation in the water management process.

The report is structured as follows:

Chapter 2 provides the technical and scientific basis of ecological flows explaining the relevance of the flow regime for the aquatic ecosystems and examples of ecological changes due to flow modification. It explains the emerging concept of eflows and some differences with other related concepts (e.g. environmental versus ecological flows). It introduces briefly the assessment methods, fields of applications and logical frameworks, data quality and availability and implementation.

Chapter 3 provides a review of eflow implementation in EU and the SEE region. This chapter sets the legal context of eflows derived from the EU water and environmental policy. It looks at Member States and how eflows were considered in the first EU River Basin Management Plans. It reviews the guidance document on eflows in the framework of the WFD common implementation strategy (CIS). With respect to the SEE region, this chapter provides a review of eflows in the Danube River Basin Management Plan and gives some insights from the project SEE Hydropower about the definition of policies, methodologies and tools for a better water & hydropower planning and management, including environmental flow assessment tools. This chapter finally distils major findings to be pursued further in the European context. The environmental objectives of the Water Framework Directive (WFD) for natural surface water bodies, including non-deterioration of the existing status, achievement of good ecological status, and well as compliance with standards and objectives for protected areas are also relevant for the Drina countries.

Chapter 4 provides a review of e-flow regulation and implementation in the Drina countries. It compiles the methodology applied in every country, in particular as regards, quantitative criteria, assessments and examples of implementation. Despite the significant policy development, environmental flow provisions use to remain at the stage of policy and debate rather than implementation. It finishes with several related obstacles present challenges to the implementation of environmental flows in the Drina basin.

Chapter 5 presents some important customary and general principles of international law applicable to transboundary water resources management that are accepted globally and incorporated in modern international conventions, agreements and treaties. It summarizes legally binding norms that can be found in numerous international treaties and are reflected also in rules of customary international law. It presents selected case studies that illustrate how five transboundary agreements are effectively developing and applying flow criteria to water policy and planning. It builds a synthesis of the cumulative findings and lessons learnt obtained during the various case studies. It provides a set of few illustrative examples on the current status of flow regulation in transboundary rivers and the main trends associated with the various fields of applications.

Chapter 6 deals with the water management in the Drina basin. It introduces the policy and legal framework for flow regulation in the Drina context and highlights the relevance of the Drina for the riparian countries in terms of water, energy and land resources as well as ecosystems. With respect to the water management issues this chapter reviews the main water uses in the basin and extreme events (floods and droughts). It explores also how socio-economic development, specially hydropower, has a strong influence on future water demand and environmental issues. Finally, it collects how key challenges of flow regulation in the Drina basin are mainly related with hydropower and flood risk reduction.

Chapter 7 draws conclusions delivering an outlook for future development of environmental flows and flow regulation in the Drina basin. It proposes recommendations to overcome the challenges identified during the investigation of this study.

2. E-FLOWS: SCIENTIFIC BASIS AND DEFINITIONS[4]

2.1. RELEVANCE OF THE FLOW REGIME FOR AQUATIC ECOSYSTEMS

A large body of evidence has shown that the flow regime plays a primary role for structure and functioning of aquatic ecosystems. Virtually all rivers, lakes, wetlands and groundwater dependent ecosystems are largely controlled by the hydrological regime. The changing quantity of water flowing in a river provides habitat and significantly influences water quality, temperature, nutrient cycling, oxygen availability, and the geomorphic processes that shape river channels and floodplains. Similarly, zonation of vegetation in lakes and riparian wetlands is controlled by the flooding regime. Freshwater flows from the upper catchment are a major determinant of the environmental conditions in estuaries and coastal waters due to their impact on salinity gradients, estuarine circulation patterns, water quality, flushing, productivity and the distribution and abundance of many plant and animal species.

Natural flow regimes display variability at a range of time scales, including seasonal, and inter-annual, and native aquatic and riparian biota are adapted to this variability. For this reason, the magnitude, frequency, duration, timing and rate of change of the natural flow regime are generally agreed to be the key elements central to sustaining and conserving native species and ecological integrity.

2.2. ECOSYSTEM DETERIORATION DUE TO FLOW ALTERATION

Natural ecosystems have some level of disturbances that characteristically occur within a range of natural variability. Disturbances beyond this range, however, can exert pressure upon the system by altering fundamental environmental processes and ultimately generating stressors.

Human activities, such as the direct removal of water from rivers and aquifers (abstraction), and impoundment (construction and operation of dams for various purposes) have greatly modified the natural flow regimes of many rivers. Assuming that flow regime is of central importance in sustaining the ecological integrity of freshwater systems, the modification of the flow regime should lead to environmental degradation.

2.3. THE CONCEPT AND DEFINITIONS OF ENVIRONMENTAL FLOWS

2.3.1. AN EVOLVING CONCEPT

The concept of environmental flows was historically developed as a response to the degradation of aquatic ecosystems caused by the overuse of water. The recognition of the need for a minimum amount of water to remain in a river for the benefit of important game-fish species gave rise to terms such as minimum flows, in-stream flows and fish flows.

A second conceptual shift resulted in referring the concept to multiple river ecosystem aspects, recognising the vital role of the entire natural flow regime in ecosystem structure and functioning. Environmental flow, ecological reserve, environmental water allocation or requirement, environmental demand and compensation flow are terms used across different regions and by different groups to broadly define the water that is set aside or released in a river to meet the environmental flow needs of water (eco)systems.

[4] This chapter is based in the report ENVIRONMENTAL FLOWS IN THE EU. DISCUSSION PAPER. (Sánchez et al, 2012).

The holistic approach to environmental flow assessment in the 1990s was not just restricted to in-stream processes, but encompassed all aspects of a flowing water system, including floodplains, groundwater aquifers, and downstream receiving waters such as wetlands, terminal lakes and estuaries. This approach also considered all facets of the flow regime (quantity, frequency, duration, timing, and rate of change), the dynamic nature of rivers and water quality aspects.

In 2000s the link between river flows and livelihoods was considered by integrating the human dimension as part of the holistic approach to environmental flow assessment, covering issues such as aesthetics, social dependence on riverine ecosystems, economic costs and benefits, protection of important cultural features and recreation.

The concept continues to evolve and is shifting from the traditional view of minimum water amounts to a more comprehensive and holistic understanding. As this field of research continues to evolve and spread into new areas, it is expected that different interpretations will appear, and new aspects will be integrated.

2.3.2. DEFINITION OF ENVIRONMENTAL FLOWS

Even though the concept of environmental flows has existed for over 60 years there is still no unified definition for it (Box 1). The concept of environmental flows underlying the most relevant definitions is a certain amount of water that is left in an aquatic ecosystem, or released into it, for the specific purpose of managing the condition of that ecosystem.

Definitions of environmental flows

Some of the definitions used internationally are the following.

- Environmental flows describe the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems (Brisbane Declaration).
- Dyson, Bergkamp & Scanlon (2003) in the IUCN guide on environmental flows define the concept as the water regime provided within a river, wetland or coastal zone to maintain ecosystems and their benefits where there are competing water uses and where flows are regulated.
- The 4th International Ecohydraulics Symposium defined environmental flows as the water that is left in a river system, or released into it, to manage the health of the channel, banks, wetland, floodplains or estuary.
- Environmental flows can be described as ‘the quality, quantity, and timing of water flows required to maintain the components, functions, processes, and resilience of aquatic ecosystems which provide goods and services to people (Hirji and Davis, 2009)
- Arthington & Pusey (2003) define the objective of environmental flows as maintaining or partially restoring important characteristics of the natural flow regime (ie. the quantity, frequency, timing and duration of flow events, rates of change and predictability/variability) required to maintain or restore the biophysical components and ecological processes of in-stream and groundwater systems, floodplains and downstream receiving waters.
- Tharme (2003) defines an environmental flow assessment (EFA) as an assessment of how much of the original flow regime of a river should continue to flow down it and onto its floodplains in order to maintain specified, valued features of the ecosystem.
- IWMI (2004) defines environmental flows as the provision of water for freshwater dependent ecosystems to maintain their integrity, productivity, services and benefits in cases when such ecosystems are subject to flow regulation and competition from multiple water users.
- Brown and King (2003) state that environmental flows is a comprehensive term that encompasses all components of the river, is dynamic over time, takes cognizance of the need for natural flow variability, and addresses social and economic issues as well as biophysical ones.

Box 1. Definitions of environmental flows

2.3.3. ECOLOGICAL FLOWS IN THE EU CONTEXT

Today there is a clear tendency to differentiate environmental flows and ecological flows. Environmental flows can be defined as the flows and water levels required in a water body to provide for a given set of values, including ecological, cultural, amenity, recreational, landscape, natural character and other values associated with water. On the other hand, ecological flows can be considered a component of the overall environmental flow and are established to provide for the ecological values attributed to a particular water body. In this sense, ecological flows can be defined as the flows and water levels required in a water body to provide for the ecological function of the flora and fauna present within that water body. In the context of the EU CIS Guidance, ecological flows are considered within the context of the WFD as "a hydrological regime consistent with the achievement of the environmental objectives of the WFD in natural surface water bodies as mentioned in Article 4(1)". These environmental objectives refer to:

- non deterioration of the existing status
- achievement of good ecological status[5] in a natural surface water body,
- compliance with standards and objectives for protected areas, including the ones designated for the protection of habitats and species where the maintenance or improvement of the status of water is an important factor for their protection, including relevant Natura 2000 sites designated under the Birds and Habitats Directives (BHD)5.

Where water bodies can be designated as heavily modified water bodies and/or qualify for an exemption, related requirements in terms of flow regime are to be derived taking into account technical feasibility and socio-economic impacts on the use that would be impacted by the implementation of ecological flows. The flow to be implemented in these water bodies is not covered by the working definition of ecological flows and it will be named distinctively.

2.4. EFLOW METHODS

2.4.1. METHODOLOGIES AND FUNDAMENTALS

Since the 1970s, there has been a progressive evolution of methodologies for assessing the water needs of aquatic ecosystems. Although the techniques for assessing eflows can be categorized in a variety of ways, four basic groups of methodologies are widely recognised; hydrological methods, hydraulic methods, habitat simulation methods and holistic methodologies.

Hydrological methods

These methods are based on the natural flow regime as a key variable in the structure and functioning of aquatic ecosystems. Historical flow data in natural conditions reflect the template of aquatic ecosystems. Eflow recommendations designed from the natural flow regime will result in processes and conditions that will maintain native habitats and species. Depending on the desired level of environmental conservation, eflow recommendations should reflect to a greater or lesser extent the natural flow regime. The basic assumption of hydrological methods

[5] "Ecological status" is an expression of the quality of the structure and functioning of aquatic ecosystems associated with surface waters, classified in accordance with Annex V of the Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Waterbodies are classified in "Good Ecological Status" when the values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions.

is that the full range of natural variability in the hydrological regime is necessary to conserve aquatic ecosystems.

Hydraulic methods

Hydraulic methods relate various parameters, from stream geometry to discharge rate. The hydraulic geometry is based on surveyed cross-sections, from which parameters such as width, depth and wetted perimeter are determined. The hydraulic parameter is used as a surrogate for habitat factors that are limiting for riverine biota, to develop a relationship between habitat and discharge from which to derive environmental flow recommendations. Minimum or optimal flows, usually for fish spawning or maximum production by benthic invertebrates, are generally identified from a discharge near the breakpoint of the wetted perimeter-discharge curve.

Habitat modelling methods

Habitat methods establish flow requirements on the basis of the hydraulic conditions needed to meet specific habitat requirements for biota. Some habitat features such as depth and velocity are directly related to flow; other habitat features such as substrate and cover are indirectly related. Habitat methods are based on hydraulic models that predict how water depths and velocities change with discharge. These models are based on each species' range of preferences regarding the parameters that define the physical habitat (current velocity, depth or substrate type, etc.). Based on the channel characteristics, the amount of habitat for these species can be determined in relation to different flows.

Holistic methodologies

Holistic methodologies aim to assess the flow requirements of the many interacting components of aquatic systems. All major abiotic and biotic components constitute the ecosystem to be managed. The full spectrum of flows, and their temporal and spatial variability, constitutes the flows to be managed. The output is a description of a flow regime needed to achieve and maintain a specified river condition.

2.4.2. KEY FEATURES AND IMPLEMENTATION OF METHODS

Existing methods for the estimation of environmental flows differ in input information requirements, types of ecosystems they are designed for, time which is needed for their application, and in the level of confidence in the final estimates. The four types of "eflow methods" are broadly compared in Table 1 (next page).

This range of techniques, from simple to complex, can be selected to respond progressively to the scale of the analysis, range of risk, intensity of water use, budgets, capacity, and timeframes of a country. Phased, hierarchical implementation can be undertaken in a number of different dimensions, such as:

- i) increasing complexity of scientific assessment, from very simple catchment-scale hydrological analysis to comprehensive site-based investigations;
- ii) increasing complexity of flow regime, from basic protection of low seasonal base flows to more complex flow regimes with intra/inter-annual variability;
- iii) geographical phasing, starting with high priority sites.

Hierarchical approaches mentioned above have been proposed in different countries. Two assessment levels have been extensively applied in Spain to incorporate Eflows in the RBMPs (Order ARM/2656/2008). Three assessment levels of Eflows are proposed for application to UK river water bodies, in which greater investment in the assessment yields lower uncertainty in results.

Table 1. Comparison of environmental flow assessment methodologies

		FEATURES							
		ECOSYSTEM COMPONENTS ADDRESSED	DATA NEEDS	EXPERTISE	COMPLEXITY	RESOURCE INTENSITY	RESOLUTION OF OUTPUT	FLEXIBILITY	COST
METHODS	HYDROLOGICAL	The whole ecosystem, non-specific	L (mainly desktop) Historical flow records (virgin or naturalized) Historical ecological data	L Hydrological Some ecological expertise	L	L	L	L	L
	HYDRAULIC	Instream habitat for target biota.	L-M (desktop limited field) Historical flow records Hydraulic variables of representative cross-sections of the reach	L-M Hydrological Some hydraulic modelling Some ecological expertise	L-M	L-M	L	L	L-M
	HABITAT SIMULATION	Primarily instream habitat for target biota. Some consider channel form, sediment transport, water quality, riparian vegetation, etc.	M-H (desktop and field) Historical flow records Numerous cross-sections data Suitability habitat data for target species	H Hydrological Advanced level in hydraulic and habitat modelling. Specialist ecological expertise on physical habitat-flow needs of target species	M-H	H	M-H	M	H
	HOLISTIC	The whole ecosystem-all/most individual components Some consider the groundwater, wetlands, estuary, floodplain, social dependence on ecosystem, instream and riparian components.	M-H (desktop and field) Historical flow records Many hydraulic variables - multiple cross-sections. Biological data on flow and habitat-related requirements of all biota and ecological components	H Hydrological Advanced hydraulic modelling. Habitat modelling in some cases. Specialist expertise on all ecosystem's components Some require social and economic expertise	M-H	M-H	H	H	H

3. E-FLOWS IN THE EU AND SEE SUB-REGION

3.1. EFLOWS IN THE EU: POLICY AND IMPLEMENTATION

3.1.1. EFLOWS IN THE EU LEGAL FRAMEWORK

The EU Water Framework Directive (WFD) is the cornerstone of EU's water legislation. The WFD purpose is to establish a framework for the protection of all waters which prevents further deterioration and protects and enhances the status of aquatic and dependent terrestrial ecosystems.

The Birds and Habitats Directives form the cornerstone of Europe's nature conservation policy. The Birds Directive places great emphasis on the protection of habitats for endangered and migratory bird species. The objective of the Habitats Directive is to protect, maintain or restore at favourable conservation status selected species and habitats of Community importance and to ensure a coherent network of special areas of conservation. The Special Protection Areas under the Birds Directive and the protected areas under the Habitats Directives together form the Natura 2000 network, which should be an ecologically coherent network. Natura 2000 sites where the maintenance or improvement of the water status is an important factor in their protection are 'protected areas' under WFD (Sánchez and Schmidt, 2012).

The objectives of the water and nature directives are closely related, and special attention and coordination is needed where these directives are implemented in the same areas. The measures serving the BHD and WFD objectives need to be included in the river basin management plans required under Art. 13 WFD and should also be included in the management plans of the Natura 2000 sites.

Building on an assessment of progress in the Water Framework Directive (WFD), the Blueprint to safeguard Europe's water resources stressed the urgent need to better address over-abstraction of water, the second most common pressure on EU ecological status, and to recognize "that water quality and quantity are intimately related within the concept of 'good status '". This would require an EU-wide acknowledgement of the ecological flow, i.e. "the amount of water required for the aquatic ecosystem to continue to thrive and provide the services we rely upon".

In addition to these EU Directives, other international commitments (e.g. World Heritage, Ramsar Convention…) may require EU Member States to appropriately protect, maintain and/or restore certain aquatic ecosystems. These form an additional legal basis for the maintenance and restoration of ecological flows in these areas (Sánchez and Schmidt, 2012).

3.1.2. EFLOWS IN THE FIRST RBMPs

According to the assessment of the River Basin Management Plans in the first planning cycle (2009-2015), up to 88 River Basin Districts (47%) either have already implemented minimum ecological flows (MEF) or have planned it in the framework of the Programme of Measures, while other 69 (34%) show no explicit intention in this regard. Finally, in 29 RBDs (16%), available information is not sufficient to assess (Figure 1).

On the other hand, some kind of hydro-peaking conditioning scheme is considered in 48 RBDs (26%), while this is not so in 101 RBDs (54%) with 37 RBDs (20%) with unclear assessment. It must be pointed out that 45 RBDs (24%) have both measures either implemented or planned, 35 RBDs only MEF (19%) and 3 only HP (3%), while 66 have included neither of the two (35%).

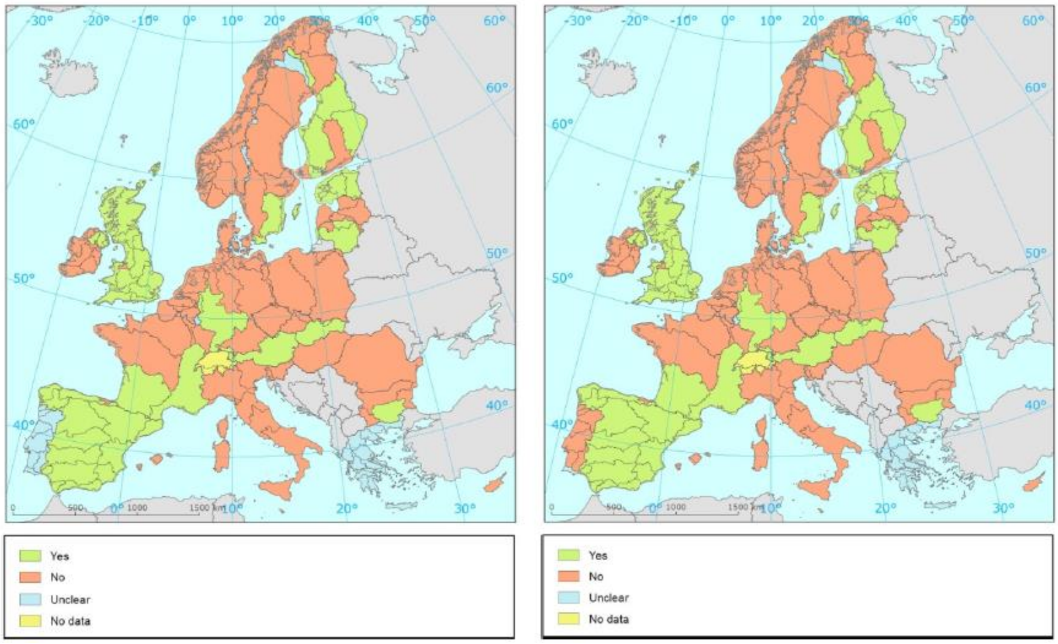

Figure 1. Environmental flows in the first EU RBMPs. Left: Minimum ecological flows; Right: Operational modifications for hydropeaking. Source: European Environment Agency (?)

3.1.3. THE EU CIS GUIDANCE ON ECOLOGICAL FLOWS

As said before, the Blueprint to safeguard Europe's water resources stressed the urgent need to better address over-abstraction of water. To achieve this, the Blueprint proposed the development of a guidance document in the framework of the WFD common implementation strategy (CIS) that would provide an EU definition of ecological flows and a common understanding of how it should be calculated, so that ecological flows could be applied in the next cycle of river basin management plans.

The elaboration of such a guidance document on ecological flows by 2014 was included in the CIS work programme and entrusted to a new dedicated working group [name?]. The document was intended to support a shared understanding of ecological flows (Eflows) and ways to use them in the RBMPs. To that end, it covered a working definition in the context of the WFD. Secondly, it provided an overview of the steps in the WFD cycle where Eflows play a role. Thirdly, the document included lessons learned from practices that Member States already carry out in this field and provided information on methodologies, monitoring, measures and evaluation concerning Eflows.

The document didn´t offer a full protocol for the implementation of Eflows in water bodies, nor was it intended to lead to uniform implementation of Eflows. Member States were encouraged to make best use of the shared understanding of Eflows in all steps of the WFD process. The site-specific Eflows implementation should also take into account other aspects like national or regional legislation, specific environmental values or ecosystem services, while at the same time respecting the obligations under the WFD, Habitats Directive and other EU Directives and international commitments (World Heritage, Ramsar Convention…).

3.2. EFLOWS IN THE SEE SUB-REGION

3.2.1. ENVIRONMENTAL FLOWS IN THE DANUBE BASIN

The Danube River Basin Management Plan guides the way to achieving at least good status for all waters of the Danube River Basin. A pressure assessment on hydrological alterations was for the first time performed for the DRBM Plan 2009. Despite criteria for assessing the significance of alterations through water abstractions vary among EU countries, a water abstraction pressure was considered as significant when the remaining water flow below the water abstraction (e.g. below a hydropower dam) was too small to ensure the existence and development of self-sustaining aquatic populations and therefore hinders the achievement of the environmental objectives. When the river discharge was below 50% of mean annual minimum flow in a specific time period (comparable with Q95[6]) a significant water abstraction pressure was identified.

Water abstractions causing hydrological alterations were reported in 144 cases in the whole basin (including tributaries). The Danube River itself was assessed to be only impacted by alterations through water abstraction at Gabčíkovo hydropower dam (bypass channel) and water abstractions in Germany as well as Hungary and Bulgaria. The key water uses causing significant alterations through water abstractions were mainly hydropower generation (55%), public water supply (3%), cooling purposes for electricity production (3%), agriculture, forestry and irrigation (17%) and others.

The ICPDR's basin-wide vision for hydrological alterations is that they are managed in such a way, that the aquatic ecosystem is not influenced in its natural development and distribution. The management objective towards the vision is a proper discharge of an ecological flow, ensuring that the biological quality elements are in good ecological status, or alternatively – in the case of heavily modified water bodies -- good ecological potential, and the flow requirements for protected species and habitats are met.

Respective definitions on minimum flows should be available in the national RBM Plans. For 13 abstractions, ecological flow requirements for the achievement of GES/GEP have already been achieved in 2015. For 21 water abstractions, restoration measures are planned to be implemented by 2021 and for 25 after 2021 as part of the third RBM cycle.

In addition to already existing hydromorphological alterations, a considerable number of future infrastructure projects are at different stages of planning and preparation throughout the entire DRBD. These projects, if implemented without consideration to effects on ecology, are likely to provoke impacts on water status due to hydromorphological alterations.

The Danube River Basin Management Plan specifically mentions the published EU Guidance Document on ecological flows providing support towards gaining a better shared understanding on ecological flows and ways to use them in river basin management planning.

[6] Q95 is defined as the flow which is equalled or exceeded for 95% of the flow record. The Q95 flow is a significant low flow parameter particularly relevant in the assessment of minimum ecological flows and river water quality conditions.

3.2.2. THE PROJECT "SEE HYDROPOWER"

The project "SEE HYDROPOWER" was targeted to improve water resource management for a growing renewable energy production in the frame of the South-East- Europe Transnational Cooperation Programme. Objectives of SEE HYDROPOWER deal with the promotion of hydro energy production in SEE countries, by the optimization of water resource exploitation, in a compatible way with other water users following environmentally friendly approaches.

Main activities of the project concern the definition of policies, methodologies and tools for a better water & hydropower planning and management, including environmental flow assessment tools. According to the delivered report, there are many different EF assessment methodologies used in the SEE region incorporating different aspects of hydrology, ecology, their interaction and expert knowledge. Methods differ not only from country to country, but sometimes even within a country. Since the variety of methods is so extensive, it is not easy to perform a comparison or ranking of these different methodologies. In the end it is not the most important fact how an EF value was derived, but whether the method is able to fulfil ecological requirements or not.

Methods were evaluated with regard to important criteria for environmental flows. Table 2 gives a short summary of how much of those criteria were fulfilled by the methods of the project countries.

Table 2. Summary of EF assessments

Important EF criteria	**Romania** APELE POLI-B	**Italy** ARPAV	**Slovenia** UL MOP Inst. from Water		**Austria** STYRIA
			Art 7	Art 8	
Hydrological criteria					
Mean flow	+	+	-	#	-
Low flow	+	-	+	#	+
Ecological Parameters					
Species diversity	-	-	-	+	#
Processes in aquatic ecosystems	-	#	-	+	+
Maintenance of habitat conditions	#	#	-	+	+
Components of natural flow					
Flow regime	-	-	-	+	#
Frequency	-	-	-	+	#
Timinig	-	-	-	+	#
Magnitude	-	-	-	+	#
Duration	-	-	-	+	#

(-) Not included (+) Included (#) Indirectly considered

3.3. KEY MESSAGES

Considered a reference document in EU countries and the Danube basin, some key messages can be selected from the CIS Guidance on ecological flows:

- The Water Framework Directive, as well as the Birds and Habitats Directives, set binding objectives on protection and conservation of water-dependent ecosystems. These objectives can only be reached if supporting flow regimes are guaranteed. The establishment and maintenance of ecological flows is therefore an essential element in meeting those objectives. Therefore consideration of ecological flows should be included in national frameworks, including binding ones as appropriate, referring clearly to the different components of the natural flow regime (and not only to minimum flow) and the necessity to link their definition to biological requirements according to the objectives of WFD and BHD; exemptions should be justified in accordance with the ones of the WFD.
- Ecological impacts of hydrological alterations and their significance should be assessed with biological indicators built on monitoring data that are specifically sensitive to hydrological alterations. In case the available biological metrics do not detect hydrological pressures or are not specific enough to isolate their contribution to the overall impact on the status, and because hydrological regime is well acknowledged as a key driver for river ecosystem quality, the evaluation of the significant impact of hydrological pressure can rely to a large extent on an assessment of hydrological alterations of the river flow.
- Monitoring programmes should be adapted to provide an improved picture of hydrological alterations and their impact on habitat/morphology and biology and to effectively support the achievement of ecological flows. The development of operational hydrological monitoring should relate to the surface and groundwater hydrological pressures and be prioritised where action is likely to be needed. The integrated monitoring of hydrological, morphological and biological quality elements will enable the estimation of the effectiveness of flow restoration action as part of the programme of measures.
- Many methods have been developed and may be used to inform the definition of Eflows, mostly differing in terms of integration of biological aspects, scale, complexity and volume of required data. The selection of the most appropriate method depends on resource availability (incl. monitoring data) and on the severity in the pressures. Purely hydrological methods may be a reasonable approach to cover the whole river basin; a more detailed approach will be needed to take specific actions, potentially affecting the socioeconomic uses, to ensure their effectiveness.
- In cases where hydrological alterations are likely to prevent the achievement of environmental objectives, the assessment of the gap between the current flow regime and the ecological flow is a critical step to inform the design of the programme of measures. A careful assessment of costs associated with the implementation should be carried out to inform the selection of the most cost-effective measures or combinations of measures.

- A careful assessment of the hydrological regime to be delivered should be carried out in the definition of good ecological potential together with the mitigation measures to improve the flow conditions; depending on the nature and severity of morphological alteration, the hydrological regime consistent with GEP may be very close to the ecological flows. Similarly, an exemption under Article 4(5) can be justified with a significant hydrological pressure; this justification will require the definition of ecological flow and identification of the necessary measures to deliver it. The flow regime to be implemented in the water body should be the closest possible to ecological flow. When hydrology is not the cause for exemption, the hydrological regime should be as a default the ecological flow identified to support GES unless evidence can be used to set a different hydrological regime which supports the alternative objective.
- Given their importance for the achievement of environmental objectives and the potential impacts of their related measures on users, participation schemes are particularly crucial for the achievement of ecological flows. Success will ultimately depend upon effective interaction with stakeholders, from politicians to local users, and the ability to communicate the need for ecological flows among those whose interests are affected. Public participation on Eflows should be developed in all the phases of the WFD planning process, from its design, implementation plan and effective implementation follow-up, ensuring the participation continues in subsequent planning cycles.

4. E-FLOW IN THE DRINA COUNTRIES[7]

4.1. EF IN MONTENEGRO

4.1.1. INSTITUTIONAL FRAMEWORK

The Law on Water (LW) (“OG” 27/07, 32/11, 47/11, 48/15, 52/16 i 84/18) prescribes the main objectives for sustainable water protection and water management in Montenegro as well as the terms and conditions for implementation of water management activities. The law points to an IWRM approach based on river basins; regulating water ownership, water management planning, water regulation and use, water infrastructure, monitoring and protection from floods and erosion.

The Ministry of Agriculture, Forestry and Water Management (MAFWM) is the principle body responsible for development of water policy in Montenegro. Among other, the Ministry exercises activities related to development water management policy; systemic solutions of provision and use of water, water land and water sources for water supply, water protection against pollution, water and waterway development and protection against harmful effects of water; etc. Administrative responsibility within MAFWM concerning water falls under the Water Management Administration. Water Management Administration exercises activities related to: provisions and implementation of measures and works of water and waterway development, protection against adverse water effects and protection against water pollution; providing use of water, waterway materials, water land and state owned water faculties, through concessions, lease and similar; water facility management for the purpose of protection against adverse water effects; issuing water documents; setting water charges; creating and operating water

[7] This chapter is based in the IWRM country reports from the project "Support to the Water Resources Management in the Drina River Basin"

information system, water cadastre, water registry; setting the boundaries of the water assetsand setting the status of the public water asset; cooperation with relevant international organizations and institutions in line with relevant responsibilities; as well as other activities within its responsibility (Regulation on Organization and Operation of Public Authorities, Article 20, Paragraph 5).

Ministry of Ecology, Spatial Planning and Urbanism (MESPU) has been established on the basis of Article 2, Paragraph 1, Item 11 of the Regulation on Organization and Operation of Public Authorities ("OG" No. 118/20). The Ministry exercises activities, among other, related to the integrated system environmental protection and sustainable use of natural resources; integrated pollution prevention and control; nature protection; air quality; climatic changes , some of which are: sustainable development; implementation of sustainable development programs and projects; provision of technical, organizational and administrative support to the National Sustainable Development Council; spatial and environmental strategic planning; system of integrated environmental protection and sustainable utilization of natural resources; hydro graphic activities; developing environmental protection standards; monitoring environmental conditions; approval and monitoring of projects implemented in order to mitigate the effects of climate change;cooperation with the international financial institutions and EU funds in implementation of environmental protection and utility services projects; cooperation with NGOs; etc. The Agency for Nature and Environmental Protection has been established on the basis of Article 37, Paragraph 1 of the Regulation on Organization and Operation of Public Authorities. Agency goals are as follows: protection and improvement of natural environment in MNE; transparent and accountable implementation of laws, regulations and policies in the sphere of environmental protection; provision of reliable and timely information to public, national and international entities and organizations about environmental conditions in MNE. The Agency exercises technical and associated administrative activities in the sphere of environmental protection, as follows: environmental monitoring; analyses and reports development; permitting; communication with relevant domestic and international entities, organizations and public; exercises other activities set by the Law on Environmental Protection ("OG" No. 12/96, 55/00 and 48/08) and special regulations.

The Institute of Hydro-Meteorology and Seismology of Montenegro (IHMS) has been established according to Article 38, Paragraph 1, Item 2 of the Regulation on Organization and Operation of Public Authorities. IHMS, as the public administration authority, has been established to exercise technical and associated administrative activities by means of applying scientific methods and knowledge, in charge of all physical and chemical processes in the atmosphere and hydrosphere, i.e. hydrological and meteorological activities in the broadest sense (Operational Report, IHMS of Montenegro, 2014, p. 2). Analytical data on environmental conditions is published in the Annual Reports, archived and delivered in suitable form to the line Ministry and other interested users.

4.1.2. POLICY AND REGULATIONS

4.1.2.1. National Regulations Governing Water Management

The Law of Water (LW) regulates the legal status and the method of IWRM, water and coastal land and water facilities, conditions and method of exercising water activity and other issues of significance for water. Furthermore, a separate law regulates financing of water management activities. Water and water land management covers "activities and measures undertaken to maintain and improve water regime within an integral water system in a specific area for the purpose of: providing required water quantities of compulsory quality for specific purposes, water protection against pollution and protection against harmful effects." (Article 18).

Separate provisions of the LW regulate individual forms of water use, including "for electricity generation and other waterpower purposes". The LW also provides for use in catchment, pumping from surface and groundwater for various other purposes (e.g. drinking, sanitation, irrigation, bottling, salt production etc.). In addition for fish, shells and crawfish farming; navigation; sports, tourism, bathing, recreation and balneo-climatological purposes; use of thermal and mineral water (except for groundwater to be used for extracting beneficial mineral raw materials and geothermal energy); and water use for environmental and other purposes, in accordance with the present law (Article 41).

Certain issues of significance for water acts have been regulated by the provisions of Chapter 6 of the LW (Articles 112-132). The Law has recognized four categories of water acts: 1) water requirements; 2) water approval; 3) water permit and 4) water order. For ensuring a unified water regime, IWRM and a fair approach to waters, water acts set the requirements and the method of realization of water rights.

Planning documents for water management are the following: Strategy of water management, water management plan for the river basin, management plan in the international waters of the river basin and special plans (Art. 23-28). Water Management Strategy (the Strategy) is a planning document that sets long-term directions of water management. Strategy has to be adopted by the Government and relates to the period of at least ten years. The strategy is reviewed after six years from the date of its adoption.

The law has set development of the strategic environmental assessment (SEA), cooperation with public and compulsory harmonization with spatial planning documents (Art. 29-33).

4.1.2.2. Environmentally Acceptable Flow

In the LASLW, the "guaranteed minimum" term is replaced with the "ecologically acceptable discharge" and it is planned to adopt a separate regulation related this specific issue. "Ecologically acceptable discharge" is set "on the basis of research, according to the specific features of the ecosystem and seasonal variations of the water discharge in order to ensure a good water status." (Article 22).

According to the provisions of the Rulebook on the method of determining the environmentally acceptable flow of surface waters ("OG", no. 2/2016, 23/2016) EPP is determined in order to maintain or restore the structure and function of aquatic and water-related ecosystems and prevent degradation of water status, in accordance with the law.

Assessment EPP is determined on the basis of the environmental importance of the water body, the characteristics of aquatic ecosystems and ecosystem related to water, their different needs, water protection and water users. EPP is determined on the basis of hydrological data. There is general and special assessment. General assessment of the EPP is made to water bodies in accordance with Art. 7 and 8 of the Rulebook. Special assessment EPP is implemented as an addition to the general assessment of the EPP with the application of a holistic approach, identifying the biological and ecological criteria, and models of habitat, including the development of holistic, hydrological and hydraulic studies.

Table 3 contains a summary of the minimal environmental flow defined from legislation for Montenegro. Definition and consideration of a minimum water flow is provided only in the Water law (2007, 2015).

Table 3. Environmental flow provisions from legislation of Montenegro

Legislation reference	Text of legislation
The Water Law, Podgorica, December 2007, article 5 (Definitions)	"32) Guaranteed minimum flow means the flow downstream from a structure ensuring the survival and development of downstream habitats and species.
	33) Minimum water flow means the flow downstream from a structure or a dam which must not be under the projected value ensuring the survival and development of accordance with the regulations, and meeting the rational needs of the downstream habitats and species, preservation of the water flow quality in downstream users."
The Water Law, Podgorica, December 2007, article 54 (Ensuring of the Guaranteed Minimum Flow)	"In the course of the surface waters abstraction, the guaranteed minimum flow must be ensured downstream from the point of intake in a river. The Ministry shall adopt a more detailed regulation on the procedures for specifying the guaranteed minimum flow, considering needs for providing a good status of water."
The Water Law, Podgorica, December 2007, article 164 (Penalty provisions)	"3) it fails to secure the guaranteed minimum downstream the surface water intake site as laid down by the Article 54 paragraph 2 of this Law (Article 54 paragraph 1);"
Rulebook, OG of the Republic of Montenegro n°2/16	This rulebook describes the conditions of application of the EF and it proposes a methodology for determining the EF (article 8). Calculation is based on natural hydrological flow data, ideally on daily discharges, for a minimal period of measurements of 10 years. A report should justify the determination of the EF (assessment study) with hydrological and biological descriptions, in particular in protected areas and wetland ecosystems.
Addendum of the rulebook, OG n°2/16	This new rulebook changes the formula of determining the environmental flow for surface water (Official gazette MNE No 2/16 article 8) that included an error. The rest of the methodology of the rulebook is unchanged.

The rulebook on the manner of determining environmental flow for surface water (OG No.2/16, 23/16) and the addendum defines the condition of application, the method for the determination of the environmental flow as well as the specific assessment of the EF. Article 1 of the addendum provides the calculation for the minimal environmental flow based on natural hydrological flow data (on mean minimal, mean monthly discharge over a minimal period of 10 years). For protected areas and wetland ecosystems, an ecological study has to be provided in order to improve the minimal EF calculated according to article 6 to take into account the high environmental characteristics of these special areas. The new rulebook (OG No <. 69/21) was adopted at the initiative of the civil sector, I relation to the previous rulebook regulates the issues of continuous monitoring by water users as well as the submission of data on that monitoring to the competent authority.

4.1.3. EF ASSESSMENT

In order to have an order of magnitude of the environmental flow of the Tara and Piva rivers and the main tributaries of the Drina River in the basin, we focus on the definition of the minimal EF in the rulebook of MNE. The MNE rulebook method (article 1 of the addendum) compares, for each month, the mean annual minimal flow mQmin (average of minimal annual discharge over a minimal period of 10 years) with the mean monthly flow mQM(j) (average of the mean monthly discharge over a minimal period of 10 years). When the ratio mQM(j)/ mQmin is lower than 10, the EF for the jth month is equal to mQmin, when EF=mQmin. If the ration is higher or equal to 10, the EF= 20 % of mQM(j).

4.1.4. EXAMPLE ABOUT APPLICATION IN MONTENEGRO

Results of obtained values of environmental flows using the aforementioned method are summary in the Table 4.

Table 4: Estimation of the EF in the Montenegrin part of DRB according to different methods

River	Section	Environmental flows (m³/s)					
		MNE	FBiH	RS-BiH	Serbia	USA	GEP
Piva (WRM I)	Upstream	1.8 to 6.04	1.5a / 2.3b	0.96	1.5	1.5c / 4.6d	1.5e / 2.3f
	Downstream	12.7 to 30.2	7.8 / 11.6	8.70	7.8	7.8 / 23.2	8.7 / 11.3
Tara (WRM II)	Upstream	1.1 to 5.0	1.1 / 1.6	0.90	1.1	1.1 / 3.3	1.1 / 1.6
	Downstream	13.7 to 32.2	8.0 /12.0	9.20	8.0	8.0 / 24.0	9.2 / 12.7
Ćehotina (WRM III)	Upstream	1.3	0.6 / 0.8	0.60	0.6	0.6 / 1.7	0.6 / 1.0
	Downstream	2.1 to 4.3	1.2 / 1.7	2.50	1.2	1.2 / 3.5	2.5 / 3.3
Lim (WRM IV)	Upstream	3.6 to 8.1	1.8 / 2.7	2.80	1.8	1.8 / 5.4	2.8 / 3.4
	Downstream	10.4 to 25.2	5.7 / 8.6	10.1	5.7	5.7 / 17.2	10.1 / 11.8

a: FBiH Method: May to Oct b: FBiH Method: Nov to April April c: USA Method: Autumn-Winter season: d: USA Method: Spring-Summer season e: GEP method – Oct. to March f: GEP method – Apr. to Sept.

Each structure or dams has a duty to release a minimum water flow downstream which is defined case by case in the concession of the dam or in the technical documentation of the planned dams. Table 5 provides for each dams the minimal EF proposed in the HE schemes.

Table 5: Minimum environmental flow for existing and planned dams for Montenegro

Dams	Existing	Planned	WMR	River	EF (m³/s)
Mratinje (Piva)	X		I	Piva	25 (>mQmin)
Komarnica		X	I	Piva	NK
Milovci Reservoir		X	II	Tara	NK
Tepca		X	II	Tara	20 (>mQmin)
Ljutica		X	II	Tara	20) (>mQmin)
Mojkovac		X	II	Tara	NK
Trebaljevo		X	II	Tara	NK
Bakovica Klisura		X	II	Tara	NK
Zuti Krs (low and high)		X	II	Tara	NK
Matesevo HPP		X	II	Tara	NK
Opasanica		X	II	Tara	NK
Otilovici HPP	X		III	Ćehotina	0.80 (< mQmin)
Reservoir Dam Mekote		X	III	Ćehotina	NK
Reservoir dam Gradac		X	III	Ćehotina	NK
Otilovici SHPP		X	III	Ćehotina	0.80 (< mQmin)
Lukin Vir		X	IV	Lim	NK
Andrijevica		X	IV	Lim	NK
Plav		X	IV	Lim	NK

4.2. EF IN BOSNIA & HERZEGOVINA

4.2.1. INSTITUTIONAL FRAMEWORK

4.2.1.1. Water Management and Environmental Protection at BiH level

Ministry of Foreign Trade and Economic Relations of BiH (MoFTER BiH), according to Article 9 of the Law on Ministries and Other Administration Bodies of BiH ("OG of BiH", No. 5/03,42/03, 26/04, 42/04, 45/06, 88/07, 35/09, 59/09, 103/09), is, inter alia, responsible for tasks and duties falling within the jurisdiction of the State of BiH including defining policies and basic principles, coordinating activities and consolidating entity plans with those of international institutions in the following areas: agriculture; energy; tourism; environmental protection, development and use of natural resources.

Sector of Natural Resources, Energy and Environmental Protection is in charge of study-analytical affairs, administrative settlement, normative and legal affairs, professionally-operational affairs, documentation and informational affairs, and administratively-operational affairs in the fields of: natural resources management; concessions; tourism; energy; natural resources and environmental protection. Sector is organized through six divisions, as follows: Tourism Division; Water Resources Division; Primary Energy and Policy Division; Second Energy and Project Division; Environmental Protection Division; Project Implementation Division.

Inter-Entity Environmental Protection Body was established in 2006 to deal with all environmental protection issues requiring harmonized approach by both entities: participates in international processes and cooperates with international organizations; monitors information exchange related to cross-border and interentity environmental issues. Four members of the Inter-Entity Body are appointed by the Government of RS, and four by the Government of FBiH. Members meet at least six times in a year.

4.2.1.2. Water Management and Environmental Protection in RS

Ministry of Agriculture, Forestry and Water Management (MAFWM) exercises administrative and other activities according to the Law on Ministries ("OG RS", No. 70/02, 33/04, 118/05 and 33/06). Scope of work of MAFWM is set by the Law on Republic Administration (Rule Book on Internal Organization and Job Systematization in the Ministry of Agriculture, Forestry and Water Management (OG RS, no. 51/13), Article 2, paragraph 1.). One of MAFWM responsibilities is water management. Parts of MAFWM, inter alia, are: Republic Hydro-Meteorological Office of the Republic of Srpska, Banja Luka (Rule Book on Internal Organization and Job Systematization in the Ministry of Agriculture, Forestry and Water Management, Article 4, Paragraph 1.); Principal organizational units of the Ministry includes Department of Water Management. Department of Water Management exercises, inter alia, activities related to preparation and application of laws and by-laws in the field of agriculture, preparation of strategy and development policy of water management, water management facilities and public water resources in terms of water regime regulation, water use, protection against harmful water effects, monitoring and water quality protection, etc. (Rulebook on Internal Organization and Job Systematization in MAFWM, Article 9, paragraph 1).

Public institution “VodeSrpske” is a public institution in charge of water management (responsible for both basins on the territory of RS, i.e. for Adriatic Sea basin and Black Sea Basin), public water resources and hydraulic engineering structures and systems, rivers, streams, lakes, as prescribed by law, in the Republic of Srpska in accordance with the provisions of the Law on Waters ("OG RS", No. 50/06, 92/09, 121/12 and 74/17) and other relevant regulations; organizes the work and functioning of water management at the regional and river basin, as well as the offices of the basin water management; recommends long-term and medium-term development plans and programs of water management; takes care of providing the necessary funds and determines how to use them; monitor the implementation of plans and programs of water management; controls the use of the funds; recommends the rate of charges, etc.

Ministry of Spatial Planning, Civil Engineering and Environmental Protection (MSPCEEP) performs public administration activities referring to improvement of operation in the areas of spatial planning, construction and environment through preparation and working within the Committees for developing drafts and proposals of laws and other regulations under the Ministry's authority. Within its scope of work the Ministry prepares and proposes questions and materials, and coordinates activities in the areas of spatial planning, construction and environment for consideration by the committees and other Governmental bodies and Council of Ministers responsible for these areas. MSPCEEP manages integrated environment quality protection and improvement by means of research, management and protection measures planning; protection of resources of general interest, natural resources, natural and cultural heritage.

Republic Hydro-Meteorological Office (RHMO RS) is the part of the Ministry of Agriculture, Forestry and Water Management of RS. Activities of the Office have been defined by the Law on Meteorological and Hydrological Activities ("OG RS", No. 20/00), the Law on Seismological Activity ("OG RS", No. 20/97) and the Law on Air Protection ("OG RS", No. 124/11). Activities of the Office have been conducted in three sectors and one department: 1) Meteorology Sector, with two departments: observation department and climatology and agro-meteorology department with two divisions: climatology division and agro-meteorology division; 2) Hydrology Sector, with two departments: hydrology department and ecology department; 3) Seismology Sector, with two departments: observation seismology department and instrumental and engineering seismology department; 4) Financial and Legal Affairs Department.

RHMO and the Federal Hydro-Meteorological Office make the National Reference Center for Surface, Subsurface and Lake Water Quality.

4.2.1.3. Water Management and Environmental Protection in FBiH

Federal Ministry of Agriculture, Water Management and Forestry (FMAWMF) was established according to the Law on Federal Ministries and Other Federal Authorities ("OG FBiH", No. 8/02, 19/03, 38/05, 2/06, 8/06 and 61/06). FMAWMF exercises administrative, technical and other activities under responsibility of the FBiH related, inter alia, to: water sources, plans, master plans and water balances; water intake and use; provision of water for population and industry water supply and other activities as set by law. Water Sector has two divisions: Water Management Division and Development and International Commitments Division.

Federal Ministry of Environment and Tourism (FMET) exercises administrative, technical and other activities under responsibility of the FBiH related, inter alia, to: ecological air, water and soil protection; development of environmental protection strategy and policy; air, water and soil quality standards; ecological air, water and soil monitoring and control and other activities as set by law (Rulebook on Internal Organization of the Federal Ministry of Environment and

Tourism, Article 3, paragraph 1). Environmental Protection Sector includes the following internal organizational units: a) Division of Environmental Protection Strategic and Planning Documents; b) Division of Preservation of Biological and Landscape Diversity; c) Division of Natural resources Protection and Eco-Tourism; d) Division of Air, Water and Soil Protection and Waste Management.

Agency of the Sava River Water Area, Sarajevo (ASRWA). Law on Water ("OG FBiH", No. 70/06) is in application in the Federation of BiH as of January 1, 2008. According to the law Agencies of Water Areas have been created to replace previous public enterprises to exercise water management activities hereby placed under their jurisdiction by virtue of present Law and bylaws adopted on the basis of present Law. For the water management purposes on the territory of the Federation of BiH, the following water areas have been created: 1) Sava River Water Area and 2) Adriatic Sea Water Area. FBiH area being the part of the Black Sea basin is under jurisdiction of the Agency of the Sava River Water Area, based in Sarajevo, and the area being the part of the Adriatic Sea basin is under jurisdiction of the Agency of the Adriatic Sea Water Area, based in Mostar (Article 23, paragraph 2 of the Law on Water). Agency of the Adriatic Sea Water Area, Mostar (AASWA) cover water area of the Adriatic Sea basin, i.e. the basins of the Neretva River, Cetina River and Krka River within the borders of the FBiH.

Federal Hydro-Meteorological Office (Office or FHMO) was established by the Law on Amendments or Addenda of the Law on Federal Ministries and Other Authorities of the Federal Administration, Article 15e ("OG FBiH", No. 9/96). Authorities of the Federal Hydro-Meteorological Office have been regulated in Article 26 of the Law on Federal Ministries and Other Authorities of the Federal Administration ("OG FBiH", No. 58/02, 19/03, 38/05, 2/06, 8/06, 61/06, 57/09 and 50/11), and, thus, the Office is in charge of exercising technical and other activities under jurisdiction of the Federation related to: development and operation of the meteorological, hydrological and seismological activities and environment quality; research in air, water resources, environment quality (air, water and soil) and seismologic processes; etc. (Three Year Plan and Activities of the Federal Hydro-Meteorological Office 2015-2017, FHMO, Sarajevo, October 2014, p. 2).162

4.2.2. POLICY AND REGULATIONS

4.2.2.1. National Regulations Governing Water Management

In accordance with powers stipulated by the BiH Constitution, system of codes defining the legal framework for WRM has been made of regulations adopted on all tiers of government. State level authorities mainly play a coordinative role in the field of international cooperation and harmonization of domestic regulations with EU regulations. Some of the regulations adopted on State level are indirectly relevant to the WRM sector.

The central element of the system of codes in WRM are four laws regulating water management. Two are adopted at entity level: In RS, The Law on Water (LW) ("OG RS", No. 50/06, 92/ 09, 121/12 and 74/17) and in FBiH, the Law on Water (LW) ("OG FBiH", No. 70/06). In accordance with the Constitution of FBiH, 10 cantons have adopted separate laws regulating the water management sector.. Separate Law on Water Protection (LWP) was also adopted within the Brčko District of BiH (BDBiH) ("OG BDBiH", No. 25/04, 1/05 and 19/07), in accordance with the Charter of BDBiH.

I. REGULATIONS IN BIH AT STATE LEVEL

As indicated above, there is no separate law on the BiH tier of government regulating the water management and/or the environmental protection sectors. However, there are several regulations adopted on BiH level that are potentially relevant for some aspects of WRM.

II. REPUBLIKA SRPSKA

According to the provisions of the LW ("OG RS", No. 50/06, 92/ 09, 121/12 and 74/17), regulating "the method of integral water management within the territory of RS", water management includes integrated approach, as follows: "protection of water, water usage, protection against harmful effect of waters, arrangement of water flow and other water bodies and public property" (Article 1). Comprehensive goals of water management in the river basin area have been defined in Article 22 of the Law as "implementation of integrated management principle, protection, improvement and regeneration of surface and ground waters in order to achieve at least a good status of surface and ground waters and prevent aggravation of their status." Inter alia, the Law regulates the following issues: characterization of water, water resources and water facilities; water management; water use; water protection; development of watercourse and other water and protection against harmful water effects; information system; water related legal documents; limitations to the rights of owners and users of land; water management organization; financing water management, supervision, etc. LW stipulated adoption of 24 by-laws, but some have not been adopted and, thus, by-laws adopted earlier are still in force.

Inter alia, the LW regulates the way of use of water rights by issuing the following legal water acts: a) guidelines, b) approvals, and c) permits. Water law acts are administrative enactments issued in the form of decision, i.e. resolution. (3) Procedure for issuing legal water enactments is conducted according to rules of special procedures stipulated by this law and with subsidiary application of the Law on General Administrative Procedure (Article 120). Activities for which water guidelines, approvals and permits are necessary include, inter alia, as follows a) water intake for all economic sectors and activities, especially, but not limited to: 1) industry and energy power, 2) agriculture, 3) water supply, 4) service activities which in technological procedure use water and release technologic wastewaters, 5) tourism activity; b) release of wastewaters into surface waters, c) building facilities for hydropower use, etc.

In addition to the Integrated Water Management Strategy, the Law stipulated adoption of the River Basin Management Plan and programs of measures for each river basin area. The law has regulated the procedure of preparation of such documents (Article 25-47).

Principal strategic document of the RS (Framework Plan of the RS Water Management development) was adopted by the Government of the RS in 2006. Decision on adoption of the Integrated water management Strategy of the Republic of Srpska 2015-2024 is published on 4 March 2016 ("OG", No. 4/16). The Strategy, inter alia, defined the goals and criteria of integrated water management, goals and strategic principles of integrated water protection, water management for various water uses, management aimed at water quality protection, method and sources of financing, etc. As assessed, challenges of the water sector are connected with existing models and the need for reform of financing in water management, institutional changes and the status of RS institutional capacity, i.e. the need for institutional strengthening, improvement of coordination instruments in water management, etc.

III. FEDERATION OF BiH

Principal regulation governing water management in FBiH – LW ("OG FBiH", No. 70/06)80 did not define the concept of IWRM, but similarly to the principal RS regulation, it listed what is covered by "water management" (water protection, water use, protection against detrimental effects of water, and regulation of watercourses and other waters). Similar as in RS, the law was prepared for the purpose of harmonization with EU regulations. The law structure has 16 chapter: general provisions, basic principles and definitions, classification of surface waters, water property and water structures, water management, water use, water use, regulation of watercourses and other waters and protection from harmful effects of water, water information system, water enactments, limitations of rights of land owners and users, organization of water management, water management financing, supervision of the implementation of the law, penal provisions, transitional and final provisions. The law stipulated adoption of by-laws, some of which have not been adopted yet.

Specific feature of the LW of FBiH, as compared to RS, is that it does include (in line with the constitutional organization of FBiH) provisions regulating allocation of responsibilities between the Federation and cantons. According to the provisions of Article 21 of the LW, water management is the responsibility of BiH, Federation, canton, city and municipality.

LW of FBiH distinguished between three types of water acts: preliminary water approval, water approval and water permit (Article 107). Similarly to the LW of RS, activities requiring water enactments include, inter alia, the following activities: 1. abstraction of water in all economic sectors and activities (in particular: industry and energy generation, agriculture, water supply, service activities using water in their technological processes, tourism activities); 2. discharge of wastewater into surface waters; 3. indirect discharge of wastewater into groundwater; 4. artificial replenishment of groundwater; 5. extraction of material from watercourses; 6. construction of facilities for utilization of hydroelectric power; 12. initiation of the procedure to issue concessions for water and water property, (Article 109).

Separate rulebook ("OG FBiH", No. 31/15) has stipulated the contents, forms, requirements, method of issuance of the preliminary water approval, water approval and water permit (water acts), method of keeping and archiving issued water enactments and ensuring public participation preceding the issuance of the water acts, etc. Allocation of responsibilities in regard to water acts (between the Agency of the Water Area and the canton) has been regulated by Article 139 of the LW of FBiH. Cantonal regulation shall stipulate transfer of a portion of cantonal water acts related responsibilities to the city or municipality.

Water management policy shall be defined by the Water Management Strategy. The Federal Ministry shall prepare a water management strategy proposal in agreement with the federal ministry in charge of the environment and it shall be adopted by the Parliamentary Assembly (Article 24). Strategy implementation will be conducted through adoption of the water management plans for the Sava River Water Area and the Adriatic Sea Water Area.

4.3.1.1. Environmentally Acceptable Flow

In accordance with provisions of Article 65 of the LW of RS, (1) Ecologically acceptable discharge is established based on performed research works and according to methods for its determining defined in the by-law from item 3 of this Article, taking into consideration specific issues of local ecosystem and seasonal variations of discharge. (2) Pending the adoption of the regulation referred to in paragraph 4 of this Article, environmentally acceptable flow shall be established on the basis of hydrological properties of the body of water for typical seasons as a minimum mean monthly flow 95% of the probability of occurrence. The article also set that the "Ministry, in cooperation with ministry in charge of ecology, prescribes methodology for determining ecologically acceptable discharge. In addition to methodology, minimum necessary pre-research, competent institutions and decision-making procedures will be defined by special by-law." (Paragraph 3).

On the other hand, provisions of the Article 62 of the LW of FBiH stipulated that the "ecologically acceptable discharge" shall be determined on the basis of the research carried out and in accordance with the methodology for its determination as defined by a separate regulation. As per aforementioned, issue related to “ecologically acceptable discharge” have been regulated by a special decree – Rule Book on Determination of Ecologically Acceptable Flow ("OG FBiH, No. 4/13, 56/16 and 62/19), and a new change is due to introduction of the permanent monitoring of the EF with hidrological stations at downstream of the dams (due to uncontrolled boost and no monitoring of the small diversion HPPs), as well as defining the water users excepted from the EF by the Water Law.

Table 6 contains a summary of the acceptable environmental flow defined from legislation for the Federation of Bosnia and Herzegovina (FBiH) and Republika Srpska.

Table 6. Environmental flow provisions from legislation of BiH

Entity	Legislation reference	Text of legislation
FBiH	The Water Law, OJ of FBiH 70/2006, Article 62 (Ecological acceptable flow definitions)	(1) Environment needs the flow with the minimum flow that ensures the preservation of the natural balance and water-related ecosystems.
		(2) Environmentally acceptable flow is determined on the basis of conducted research works in accordance with the methodology for its determination, the established regulation referred to in paragraph 4 of this Article.
		(3) Until the regulations referred to in paragraph 4 of this Article, the environmental flow is determined on the basis of hydrological characteristics of the water body for characteristic season, as the minimum mean monthly flow of 95% probabilityoccurance.
		(4) The Federal Minister in accordance with the federal minister responsible for the environment shall issue a regulation on the way of determining environmental flow. This regulation specifically includes the methodology and the necessary research, taking into account the specificities of the local ecosystem and seasonal variations in flow and procedures for determining the flow.
		(5) The costs of the investigation shall be borne by the investor or user
	Rulebook OG of FBiH n° 04/13, 56/16 and 62/19	This bylaw describes the conditions of application of the EF and it proposes a methodology for determining the EF (article 11). Calculation is based on natural hydrological flow data, ideally on daily discharges, for a minimal period of measurements of 10 years. A report should justify the determination of the EF (assessment study) with hydrological and biological descriptions, in particular in protected areas and wetland ecosystems. The water user has the obligation to establish the monitoring of the EF.
RS	The Water Law, OG of RS 50/06, 92/09, 121/12 and 74/17, Article 65	(1) Ecologically acceptable flow is established based on performed research works and according to methods for its determining defined in the by-law from item 3 of this Article, taking in consideration specific issues of local ecosystem and seasonal variations of flow.

Entity	Legislation reference	Text of legislation
	(Ecological acceptable flow definitions)	(2) Until passing the by-law, ecologically acceptable flow will be established on the basis of hydrologic features of water body for characteristic seasons, as minimum average monthly flow with ninety-five percent secure.
		(3) Ministry, in cooperation with Ministry in charge of ecology, prescribes methodology for determining ecological acceptable flow. In addition to methodology, minimum necessary pre-research, competent institutions and decision-making procedures will be defined by special by-law.
		(4) Costs of necessary research are covered by investor, i.e. user.
	The Water Law, OG of RS 50/06, 92/09, 121/12 and 74/17 article 230 (Ministerial Regulations and Enactments)	Clause (2) Ministry competent for ecology will pass by - laws and enactments in accordance with provisions of this law, necessary for its implementation: a) … v by- law, in cooperation with Ministry, establishes methodology for establishment of ecologically acceptable flow, from Article 65 of this law, g) …

In FBiH, the rulebook on the determination of environmental acceptable flow ("Official Gazette of FBiH", No. 4/13) defines the condition of application, the method for the determination of the environmental acceptable flow as well as the obligation of the users of water. The article 11 provides the calculation for the minimal environmental flow based on natural hydrological flow data (on mean minimal, mean average and mean decade discharges over a minimal period of 10 years). For protected areas and wetland ecosystems, an ecological study has to be provided in order to improve the minimal EF calculated according to article 11 to take into account the high environmental characteristics of these special areas. The methodology is already applied for all new dams and it is available for all type of extraction intakes. The EF is defined in the article 6 as the minimum flow ensuring the preservation of the natural balance and water-related ecosystems. The rulebook was amended in 2016 and 2019. . Amendments to the Rulebook (56/16) refer to exceptions and harmonization of the Rulebook with WFD terms. The amendment to Rulebook (62/19) stipulates that the Methodology for determining the environmentally acceptable flow will be adopted by the Federal Minister of Agriculture, Water Management and Forestry, with the consent of the Federal Minister of Environment and Tourism, no later than July 21, 2021.

In Republika Srpska, comparable rulebook has not been adopted. The EF is determined according to the Water Law of RS, Article 65: it is defined as the mean monthly flow that happens with a 95% probability: Q95%.

4.3.2. EXAMPLE ABOUT APPLICATION IN BOSNIA & HERZEGOVINA

Obtained values of environmental flows using the aforementioned method are summarized in the Table 7.

Table 7: Estimation of the EF in the BiH part of DRB according to different methods

River	Environmental flows (m^3/s)					
	FBiH	RS-BiH	Serbia	USA	Lanser	GEP
Upper Drina (Bastasi)	14.3a/21.5b	21.7	-	14.3c/43.0c	7.2 -14.3	21.5e/27.6f
Upper Drina (Foča Most)	19.3/28.9	28.2	-	19.3/57.9	9.6 – 19.3	28.2/37.6
Middle Drina (Bajina Bašta)	33.4/50.2	54.5	33.4	33.4/100.3	16.7-33.4	50.2/64.9
Lower Drina (Radalj)	36.5/54.7	57.2	36.5	36.5/109.5	18.3 – 36.5	54.7/68.1

River	Environmental flows (m^3/s)					
	FBiH	RS-BiH	Serbia	USA	Lanser	GEP
Lower Drina (Badovinci)	37.4/56.1	-	37.4	37.4/112.1	18.7 – 37.4	-
Ćehotina Upstream(Vikoč)	1.8/2.6	2.50	-	1.8/5.28	0.88 – 1.75	2.50/3.30
Lim Upstream(Priboj)	9.2/13.8	18.2	9.2	9.2/27.6	4.6 – 9.2	13.4/21.8
Sutjeska Middle (Igoče)	1.4/2.1	1.9	-	1.4/4.14	0.70 – 1.38	1.9/2.4
istrica Middle (Oplazići)	1.2/1.7	1.4	-	1.2/3.57	0.59 – 1.19	1.4/2.1

a: FBiH method – May to Oct. b: FBiH method – Nov. to Apr. c: USA Method: Autumn-Winter season: d: USA Method: Spring-Summer season e: GEP method – Oct. to March f: GEP method – Apr. to Sept.

Each structure or dam has a duty to release a minimum water flow downstream that is defined case by case in the concession of the dam or in the technical documentation of the planned dams. Table 8 provides for each dam the minimal environmental flow defined or proposed for the hydroelectric schemes.

Table 8: Minimum environmental flow for existing and planned dams for BiH

Dams	Existing	Planned	River	EF (m^3/s)
Sutjeska -RS		X	Sutjeska	2.07 (2)
Vikoč*		X	Ćehotina	2.11
Falovići -RS		X	Ćehotina	2.58 (2)
Mrsovo-RS		X	Lim	31.3 (2)
Buk Bijela -RS		X	Drina	24.4 (2)
Foča -RS		X	Drina	27 (2)
Paunci -RS		X	Drina	30.2 (2)
Ustikolina -FBiH		X	Drina	Dry period: EF=38 m^3/s (1) Wet period: EF=57 m^3/s (1)
Goražde -FBiH		X	Drina	No data
Višegrad -RS	X		Drina	45,5
Bajina Bašta **	X		Drina	50
Rogačica**		X	Drina	60.5
Tegare**		X	Drina	61.6
Dubravica**		X	Drina	63.8
Zvornik**	X		Drina	60
Kozluk**		X	Drina	67.5
Drina I**		X	Drina	67.5
Drina II**		X	Drina	67.5
Drina III**		X	Drina	67.5
Buk Bijela PSHPP		X	Vrbnička	0,068

*: Transboundary dam MNE/RS-BiH - **: Transboundary dam Serbia/RS-BiH

There is no official environmental flow regulation required in the statutes covering protected areas. In the FBiH Rulebook, assessment study has to be done including ecological analysis. Some studies give the following ecologically critical parameter related to fish habitat considering a minimum flow speed of 0.3 m/s and minimum mean flow depth of 0.2 m.

In the Municipality of Bajina Bašta, the angler's association of Perućac has estimated, based on their experience of the behaviour of fish that the minimal environmental flow for the aquatic population of the Drina in this section should be 50 m^3/s.

4.3. EF IN SERBIA

4.3.1. INSTITUTIONAL FRAMEWORK

The responsibility, organization and capacities of the public administration institutions are regulated by legal provisions and by the needs associated with economic and social transition to the ultimate goal of joining the EU.

Ministry of Agriculture, Forestry and Water Management (MAFWM). Mandate set in Article 5 of the Law on Ministries ("OG of RS", no. 128/20) clearly distinguished several groups of activities related to agriculture, forestry, water management, etc. Activities related to strategic planning and policy, technical activities and inspection activities in water management sector are practiced in the Ministry. The RWD, as part of the MAFWM is principally responsible for WRM in the MAFWM.

Ministry of Environmental Protection (MEP). Mandate set in Article 6 of the Law on Ministries. The Ministry of Environmental Protection performs state administration tasks related to: basics of environmental protection; environmental protection and improvement system; inspection supervision in the field of environmental protection; nature protection; protection of the ozone layer; climate changes; transboundary air and water pollution; protection of water from pollution in order to prevent deterioration of surface and groundwater quality; determining the conditions of environmental protection in spatial planning and construction of facilities, etc. "Water Protection Division" of the Department of Natural Resources Protection in MEP is responsible for protection of water from pollution in order to prevent deterioration of surface and groundwater quality.

Out of administrative authorities within MAFWM and MAEP, the main role for water and environment is with RWD, EPA, Forest Department and Agricultural Land Department.

Republic Water Directorate (RWD), as the administrative authority within MAFWM, practices public administration activities and technical activities related to: water management policy; multi-purpose water use; water supply, excluding water distribution; water protection; implementation of water protection measures and systematic rationalization of water consumption; development of water regimes; tracking and maintaining water regimes creating and cutting RS borders; inspection oversight in the sphere of water management, as well as other activities set by law.

Environmental Protection Agency (EPA). According to the provision of Article 6 of the Law on Ministries and relevant regulations in the sphere of environmental protection, the scope of work of the EPA is mainly associated with environmental monitoring. To that extent, the Agency has set respective organization with two sectors (Sector for Environmental Control and Sector for Environmental Conditions) and other organizational units.

Republic Hydro-Meteorological Service of the Republic of Serbia (RHMS) has been set up as a separate organization by Article 28 of the Law on Ministries. RHMS is the state administration authority – separate organization, legal entity practicing meteorological and hydrological activities of interest of RS.

Nature Protection Office. Responsibilities of the Serbian Nature Protection Office is relevant for certain water resources management entities in the spheres where the nature protection measures are the requirement of water resources use – provisions of the Law on Nature Protection (“OG RS”, no. 36/09, 88/10 and 91/10-corrected), Decision of Establishment of the Serbian Nature Protection Office (“OG RS”, no. 18/10) and the Statute (“OG RS”, no. 73/10).

4.3.2. POLICY AND REGULATIONS

4.3.2.1. National Regulations Governing Water Management

Water management in the RS is regulated by a wide variety of regulations. The central elements of the system are defined by the Law on Water (LW) (“OG RS”, no 30/10, 93/12 and 95/18) and various regulations that have been passed in accordance with this Law. There is also a substantial list of regulations related to other fields, which are in different ways relevant for water integrated resources management (IWRM). The most important are the regulations in the field of environmental protection (e.g., pollution, waste management), energy sector (particularly renewable sources of energy, i.e. hydro energy) and water transport. The concept of IWRM implies the implementation of a set of instruments that are, in a legal sense, based on regulations governing other sectors (agriculture, spatial planning and construction, mining and geological research, tourism, business and investment, etc.)

As the main regulation in the field of water management, the LW regulates the legal status of water resources, IWRM, water facilities and river basin land management, sources and means of financing water resources management, supervision over the implementation of the Law, as well as other issues which are significant for water management (Article 1). One of the principal aims of the adoption of the new LW (2010) was to harmonize with the EU Water Framework Directive and other EU legislation. The LW comprises 12 chapters including one on integrated water management. Integrated water management (which is also referred to as “water management” in the LW), which is defined as a “set of measures and activities aimed at maintenance and improvement of water regime, ensuring sufficient amount of water with required quality for different purposes, protection of water from the pollution and protection from adverse effects of water”, is the subject of chapter IV of the LW (Articles 24 - 113). Out of total of 228 Articles contained in the LW, 89 regulate IWRM.

In order to provide a unified water regime and achieve water resources management, different water documents have to be issued, such as: 1) water requirements; 2) water approval; 3) water permit; 4) water order, etc. These documents are issued in accordance with the Strategy, Water management plan and appropriate technical documents (Article 113). The LW prescribes several types of planning documents, including: 1) Water Management Strategy for the Territory of the Republic of Serbia (OG RS 3/2017); 2) Water Management Plan; 3) Annual Water Management Program; 4) Plans for protection against adverse effects of water, consisting of: Flood Risk Management Plan, General and Operational Plan for protection against flood, as well as plans regulating water protection (Plan for protection of water against pollution and monitoring program) (Article 29).

The field of fisheries is regulated by separate provisions (Law on Protection and Sustainable Use of Fish Stock, “OG RS”, No 128/2014 and by-laws passed upon previous law regulating this field (Law on Protection and Sustainable Use of Fish Stock, “OG RS”, No 36/09 and 32/13 –

Constitutional Court). The law defines fish stock management in fishing waters, which covers protection and sustainable use of fish stock as public good. Fishery waters at borders of protected areas, as well as protected species and protected movable natural documents, are governed by regulations in the field of nature protection, unless otherwise stated by this law. Decision on determining fishery areas ("OG RS", no 115/07) has identified six fishery areas in the RS: "Serbia – Vojvodina", "Serbia – West", "Serbia – Southwest", "Serbia-South", "Serbia – East", "Serbia – Center".

4.3.2.2. Environmentally Acceptable Flow

The LW (Article 81) prescribes methods and measures to determine minimum sustainable discharge from watercourses including reservoirs". Furthermore, Article 199 of the aforesaid Law prescribes relevant rights and duties for inspection of minimum sustainable discharge. However, it is also necessary to consider the Law on Nature Protection (LNP) ("OG RS", no 36/09, 88/10, 91/10) that prescribes that MAEP shall determine minimum discharge outside of protected areas (Article 18).

The following table contains a summary of the minimal environmental flow defined from legislation for Serbia. Definition and consideration of a minimum water flow is provided only in the Water law (2010). As seen in Table 9, no specific method for calculation of the minimal environmental flow is given in the legislation. However, after discussion with the Water Directorate, it can be considered that in Serbia, the EF value is defined as the 10% of the mean annual discharge up to the establishment of a bylaw on the determination of the EF.

Table 9. Environmental flow provisions from legislation of Serbia

Legislation reference	Text of legislation
The Water Law, 2010, article 3 (Definitions)	41)"Minimum sustainable flow means the flow that must be provided in a watercourse downstream from a water intake, for the survival and development of downstream biocenoses and to meet the needs of downstream users;"
The Water Law, 2010, article 81 (Assurance of Minimum Sustainable Flow)	"During the course of abstraction of water from any watercourse or reservoir, minimum sustainable flow shall be ensured downstream from the water intake, considering, without limitation: the hydrologic regime of the watercourse, the characteristics of the watercourse from the standpoint of water use and water protection, and the status of the aquatic and riparian ecosystems. The Minister and the minister responsible for environmental protection affairs shall stipulate the method and metrics for the determination of the minimum sustainable flow."
The Water Law, 2010, Section X: Oversight - article 199 (Rights and duties of the Water Inspector)	"In performing inspection oversight, the Water Inspector shall have the right and the duty to verify: 6) The implementation of water regime regulations pertaining to the provision of minimum sustainable flow downstream from a water intake."
The Water Law, 2010, Section XI: Penal provisions – Article 211 (Economic offences)	"8) they have, during the course of withdrawal of water from any watercourse or reservoir, failed to ensure minimum sustainable flow downstream from the water intake (Article 81) "

4.3.3. EXAMPLE ABOUT APPLICATION IN SERBIA

Obtained values of environmental flows using different methods are summarized in Table 10.

Table 10: Estimation of the EF in the Serbian part of DRB according to different methods

River	Environmental flows (m^3/s)					
	Serbia	FBiH	RS-BiH	USA	Lanser	GEP
Upper Drina (Region II)	33.4	33.4a/50.2b	54.5	33.4c/100.3d	16.7-33.4	50.2e/64.9f
Middle Drina (Region II)	36.5	36.5/54.7	57.2	36.5/109.5	18.3 – 36.5	54.7/68.1
Lower Drina (Region II)	37.4	37.4/56.1	-	37.4/112.1	18.7 – 37.4	-
Upper Lim (Region III)	6.93	6.93/10.4	10.1	6.9/20.8	3.5 – 6.9	10.1/11.8
Lower Lim (Region III)	9.19	9.2/13.8	18.2	9.2/27.6	4.6 – 9.2	13.4/21.8
Upper Jadar (Region I)	0.31			0.3/0.9	0.15 – 0.3	0.3/0.5
Lower Jadar (Region I)	0.83			0.83/2.50	0.42 – 0.83	0.8/1.25
Middle Uvac (Region III)	0.82			0.82/2.46	0.41 – 0.82	1.0/1.39

a: FBiH method – May to Oct. b: FBiH method – Nov. to April c: USA Method: Autumn-Winter season: d: USA Method: Spring-Summer season e: GEP method – Oct to Mar f: GEP method – Apr. to Sept:

Each structure or dams has a duty to release a minimum water flow downstream which is defined case by case in the concession of the dam or in the technical documentation of the planned dams. Table 11 provides for each dam the minimal environmental flow proposed in the hydroelectric schemes. For the planned dams in the Drina River, they generally correspond to values of RS method.

Table 11: Minimum environmental flow for existing and planned dams for Serbia

Dams	Existing	Planned	River	EF (m^3/s)
Potpec	X		Lim	13.9 (»20% of the MQ» Q80%)
Brodarevo II		X	Lim	10.3 (»13% of the MQ» Q95%)
Brodarevo I		X	Lim	10.3 (»13 % of the MQ)
Prijepolje		X	Lim	NK
Priboj		X	Lim	NK
Uvac (Sjenica)	X		Uvac	No need (reservoir succession)
Kokin Brod	X		Uvac	No need (reservoir succession)
Radoinja-Bistrica	X		Uvac	14 (»10 % of the MQ)
Bajina Basta (PSHPP)	X		BeliRzav	NK
Bajina Basta (HPP)*	X		Drina	50 (»15 % of the MQ» Q95%)
Rogacica*		X	Drina	60.5 (»18 % of the MQ» Q80%)
Tegare*		X	Drina	61.6 (»18 % of the MQ» Q95%)
Dubravica*		X	Drina	63.8 (»18 % of the MQ» Q95%)
Zvornik*	X		Drina	60 (»14% of MQ» Q95%)
Kozluk*		X	Drina	NK
Drina I*		X	Drina	NK
Drina II*		X	Drina	NK
Drina III*		X	Drina	NK

NK = Not known – *transboundary dam Serbia/BiH)

4.4. IMPLEMENTATION CHALLENGES

Several related obstacles present challenges to the implementation of environmental flow policies across the world. These include a lack of political will and stakeholder support, a lack or data insufficient resources and capacity, in water management and allocation institutions generally, and for the delivery of those functions tasked with assessing and enforcing environmental requirements; and, institutional barriers and conflicts of interest.

Four prominent challenges have been identified as significant in the Drina River Basin.

1) Linking methods of assessment with policy implementation

The concept of environmental flows has been widely accepted by resource managers across the world and in many countries has been built into legislation. The slow uptake of environmental flows by policy makers but more so by regulators and resource managers suggests that although there is a perception of an acceptance of the methods, in reality this acceptance is not sufficiently strong to ensure active implementation. A number of obstacles to implementation may be speculated:

- the legal risks associated with the allocation of licenses to use water,
- the threat of objections from stakeholders when water is "reassigned" to the environment,
- the probability that water resource managers and other stakeholders may have a limited ecological understanding and thus acceptance of the need for environmental flows,
- the reliance on specialist input to assess and implement the environmental flows especially when these skills need to be brought in from outside of the regulatory authority,
- doubts about the reliability and authenticity of environmental flow assessments, particularly if supported by errant case studies,
- the complex nature of some models dampens the ability to make decisions,
- the costs of the assessment of environmental flows which poses a threat especially when the need for this expense is not fully accepted by those who manage the purse-strings,
- the perceived loss of water for productive use,
- the challenge of implementing environmental flows in nonregulated rivers,
- the challenge of linking non-flow related issues (e.g. pollution, land degradation) that will be having an impact on the health of the aquatic ecosystem and which may undo any attempts to maintain the condition of a system through flow management,
- the challenge of linking flows with social needs. A technical and non-anthropocentric approach to environmental flows is unlikely to gain acceptance from society.

2) Lack of Understanding of Environmental Flow Benefits

The importance of environmental flows in sustaining ecosystem services, local economies and other river-dependent organisms is still largely unrecognized and under-appreciated, while primary water uses for hydropower, domestic and agricultural purposes still enjoy the highest priority. Very little environmental flow related benefits were recognized during the environmental and social impact assessment phases. Environmental flows are perceived by many as more restrictive and political, serving only for officials who benefit from water resource management, as opposed to seeing them as developmental and conservation tool. The widespread perception is that the impact of large water–resource developments on riparian communities is little understood, with continued misperception that environmental flows are intended to benefit primarily non–human species. Many studies suggest that the existing and potential impacts of aquatic resource loss are high. As long as communications about environmental flows remain centred on non-human benefits and conspicuously absent in the public media, these misperceptions of ecological reserves benefits will persist, and it will be difficult to implement and conserve them.

3) Insufficient resources and capacity

Implementation cannot be achieved without strong institutions with sufficient resources and capacity to carry it out. Virtually every case study undertaken for this review reported that limited capacity of one form or another constrained implementation. Conducting a thorough assessment and developing operational rules for environmental flows at even a single dam or river reach requires significant technical and institutional capacity. Doing so at the scale of an entire state, province, or country requires capacity that few, if any, possess at the onset of environmental flow policy implementation. Compounding the challenge, few begin with adequate financial resources to build and maintain effective environmental flow management programmes, from environmental flow assessment to incentives for flow re-allocation to long-term monitoring and adaptive management.

A comprehensive framework for implementing environmental flows requires that relevant laws, policies, regulations, procedures, and institutions be in place across a wide range of water resource management functions. In each of these contexts, implementing effective environmental flow policies requires two conditions: an effective water management and allocation policy and institutional framework, and recognition of environmental flow requirements within this framework. Neither of these on its own is sufficient to ensure environmental flows.

Basic needs for building these frameworks—all requiring significant managerial, technical and financial capacity—include but are not limited to the ability to:

- Assess resource availability and environmental conditions
- Engage and facilitate stakeholders
- Undertake environmental flow assessments
- Integrate environmental flows into clear water resource allocation and reservoir siting, design, and operation plans and, ultimately, enforceable individual or group water rights
- Enforce water allocations and reservoir release schedules

- Monitor and review the outcomes of environmental flow management
- Engineer win-win solutions to water resource conflicts, including decision support tools, water transactions, and conjunctive management of groundwater and surface water

4) Conflict of Interest

Agencies that plan and manage hydropower, agriculture, land use, urban and industrial development, and natural resources all operate under different legal authorities, yet all play important roles in managing environmental flows. A lack of understanding about the interdependence between various downstream water needs, including estuarine, near-shore, and aquifers, further exacerbates the institutional barriers between the respective government agencies that manage them.

Conflicts of interest may arise not only between, but also within implementing agencies—for example when they are rewarded for economic development rather than for environmental protection, or when they depend on water use fees for their revenue. This intensifies the already significant challenge of reorienting sectoral ministries to the need to include environmental water provisions in their policies and practices. When environmental flow policies are part of comprehensive water policy reform, administrative institutions may change drastically. Enacting an entirely new suite of policies and institutions is a major undertaking. Consequently, significant delays can be expected to plague environmental flow implementation, while the entire reform process slowly becomes operational. The challenges of adjusting to major new policies include, but are not limited to, establishing new regulatory, monitoring, and enforcement institutions.

5. FLOW REGULATION IN TRANSBOUNDARY RIVERS

5.1. GENERAL PRINCIPLES OF SUSTAINABLE MANAGEMENT OF TRANSBOUNDARY WATERS

Key principles of international water law which are also relevant for the flow regulation issue include[8]:

I. Principle of equitable and reasonable utilization. The principle of equitable and reasonable utilisation is the fundamental doctrine guiding water-sharing for international watercourses. It entitles a watercourse State to an equitable and reasonable share of the uses and benefits of the particular watercourse, and also creates the reciprocal obligation not to deprive other States of their respective rights in this regard. Several terms apply: “sustainable use” reflects the need to balance economic, social and environmental values in the use of natural resources and to take into account the carrying capacity of international watercourses. “Optimum utilisation” means the most economically feasible and, if possible, the most efficient use. “Equitable” utilisation does not necessarily mean an equal portion of the resource or equal share of uses and benefits. The application of equitable and reasonable utilisation in a particular watercourse will not prohibit a use that causes damage however States have a due diligence obligation to limit and control significant harm.

[8] Source: Rieu-Clarke, A., Moynihan, R. and Magsig, B., UN Watercourses Convention – User’s Guide. Centre for Water Law, Policy and Science, University of Dundee, 2012.

II. Obligation not to cause significant harm. This obligation, otherwise known as the "no significant harm" rule requires that States in utilizing an international watercourse in their territories, take all appropriate measures to prevent the causing of significant harm to other watercourse States. According to this principle, no states in an international drainage basin are allowed to use the watercourses in their territory in such a way that would cause significant harm to other basin states or to their environment, including harm to human health or safety, to the use of the waters for beneficial purposes or to the living organisms of the watercourse systems. The obligation "not to cause significant harm" derives from the theory of limited territorial sovereignty. The theory of limited territorial sovereignty stipulates that all watercourse States have an equal right to the utilisation of a shared watercourse, but they must also respect the sovereignty of other States to equal rights of use. This principle is widely accepted as the foundation for the law of international watercourses.

III. Notification, consultation and negotiation. Every riparian state in an international watercourse is entitled to prior notice, consultation and negotiation in cases where the proposed use by another riparian of a shared watercourse may cause serious harm to its rights or interest. When a basin State proposes to undertake, or to permit the undertaking of, a project that may substantially affect the interests of any co-basin State, it shall give such State or States notice of the project. The notice shall include information, data and specifications adequate for assessment of the effects of the project.

IV. Protection and preservation of ecosystems. The obligation to protect ecosystems encompasses measures relating to conservation, security and water-related disease, as well as technical and hydrological control mechanisms, such as the regulation of flow, floods, pollution, erosion, drought and saline intrusion. Additionally, the obligation to protect includes the duty to shield ecosystems from a significant threat of harm and therefore by the need to adopt a precautionary approach.

5.2. INTERNATIONAL POLICY AND LEGAL FRAMEWORKS

Adequate environmental flows are crucial for the achievement of the Sustainable Development Goal 6 (Ensure availability and sustainable management of water and sanitation for all), in particular its targets 6.3, 6.4, 6.5 and 6.6. Data on environmental flows are explicitly required for the calculation of SDG indicator 6.4.2, on water stress.[9] Flow regulation in general may contribute to implementation of many other SDGs as it determines the availability of water for various sectors and other uses.

General principles of international law applicable to transboundary water resources management and protection have been incorporated in the two global United Nations water conventions and in numerous multilateral and bilateral agreements.

All Drina riparians are parties of the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes, also known as the Water Convention, and one riparian – Montenegro – is also party to the 1997 Convention on the Law of the Non-Navigational Uses of International Watercourses, also known as 1997 Watercourses Convention.

[9] See https://www.unwater.org/publications/incorporating-environmental-flows-into-water-stress-indicator-6-4-2/

The purpose of the 1992 Water Convention is to improve national measures for protection and management of transboundary surface waters and groundwaters and facilitate transboundary cooperation for sustainable management of shared water resources. The Convention includes provisions on monitoring, exchange of information and data, research and development, consultations, warning and alarm systems and mutual assistance. The Convention requires Parties bordering the same transboundary waters to cooperate by entering into specific agreements and establishing joint bodies. The Convention has three central obligations.

I. Parties are required to take measures to prevent, control and reduce any transboundary impact on the environment, human health and safety and socioeconomic conditions. Such measures include undertaking environmental impact assessments and other means of assessment, preventing and reducing pollution at its source, licensing and monitoring wastewater discharges and developing and applying best environmental practices to reduce inputs of nutrients and hazardous substances from agriculture and other diffuse sources. Parties are obligated to use water resources sustainably, taking into account the ecosystem approach and a basin approach.

II. Parties are required to ensure that transboundary waters are used in a reasonable and equitable way. Whether the use of a watercourse can be considered reasonable and equitable depends on the specific characteristics of the basin, the population dependent on its waters, the existing and potential uses, the impact of such uses, the availability of alternative uses and other factors. In any case the use of water must be sustainable — that is, it should take into account the needs of future generations.

III. In order to translate the two previous obligations into practice, the Convention requires Parties to cooperate on the management and protection of their transboundary waters by concluding transboundary agreements and setting up joint bodies. The Convention encourages such cooperation on the basin level.

Parties to the Water Convention and other countries and stakeholders may benefit from exchange of experience and best practices in the framework of the Convention's institutional platform, including on the issue of environmental flows.

The 1997 Watercourses Convention "applies to uses of international watercourses and of their waters for purposes other than navigation and to measures of protection, preservation and management related to the uses of those watercourses and their waters". The Watercourses Convention has codified some of the most important principles of international customary law relevant to transboundary rivers, namely, "equitable and reasonable utilization and participation" (Article 5), "obligation not to cause significant harm" (Article 7), "general obligation to cooperate" (Article 8) and "regular exchange of data and information" (Article 9). The Convention addresses flow regulation (Article 25) but does not mention environmental flows as such. At the same time, it enumerates factors relevant to equitable and reasonable utilization (Article 6), including "[g]eographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character" and "[c]onservation, protection, development and economy of use of the water resources of the watercourse…" implying consideration of environmental flows as relevant for equitable and reasonable utilization. Where it can be established that there is a conflict of uses between States, and all the conflicting uses are considered reasonable, resolving the conflict will be determined by weighing up all relevant factors and circumstances in all riparians concerned.

More specific legal and technical guidance with regards to environmental flows can be found in soft-law instruments. For example, UNECE's 2003 Guidelines on the Ecosystem Approach in Water Management specifically mention that "[e]cologically sound river flows should be established, as far as possible, and applied in water management through specific methods and technics. […] Such flows should determine the amount of water available for offstream uses, pollution dilution, environmental protection and aquatic ecosystems requirements …" The International Law Association's 2004 Berlin Rules on Water Resources explicitly mention "Ecological Flows" needed to "protect the ecological integrity of the waters of a drainage basin, including estuarine waters" (Article 24).

5.3. REVIEW OF INTERNATIONAL CASE STUDIES[10]

As water quality degrades or the quantity available has to meet rising demands over time, competition among water users intensifies. Experience shows that in many situations the need for water sharing can generate effective cooperation between riparian countries. In various river basins world-wide, transboundary arrangements have been negotiated to ensure navigation, different uses, development, protection and conservation of water resources. Some of these agreements have workable monitoring provisions, enforcement mechanisms, and specific water allocation provisions that address variations in water flow and changing needs. Below are some selected case studies that can be useful for visualizing efforts between countries to manage transboundary waters.

5.3.1. FINLAND-RUSSIA VUOKSI DISCHARGE: FLOOD PROTECTION, LAKE LEVELS AND COMPENSATING ENERGY GENERATION LOSSES

The Vuoksi is a 150 km long transboundary river flowing from Finland to Russia. It originates in Lake Saimaa, flows 13 km through Finland, and empties into Lake Ladoga in Russia. Three quarters of the 70,000 km^2 Vuoksi catchment area lies in Finnish territory. With an average flow of 600 m^3/s, the Vuoksi River comprises more than three-quarters of the total 780 m^3/s water flow from Finland to Russia. The river is used for various activities, such as hydropower production on both sides of the border, and also functions as the sole outlet for Lake Saimaa (4,400 km^2), which is Finland's largest and Europe's fourth largest lake. Due to protected species (a seal), among other reasons, maintaining stable lake levels is critical at certain times of the year.

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 centerpiece of the 1989 Vuoksi Agreement is its Appendix on the Regulations Governing Lake Saimaa and the Vuoksi River (the Vuoksi Discharge Rule, figure below). 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

[10] Only a few case studies were selected to be briefly described by the author. In 2019 work was initiated under the Water Convention to develop by 2021 a Handbook on Water Allocation in a Transboundary Context which as a compendium of experience worldwide about transboundary agreements and arrangements addressing some aspects of flow and allocating water.

defined in annex 4A and 4B of the 1989 Vuoksi Agreement (Figure 2). 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, 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).

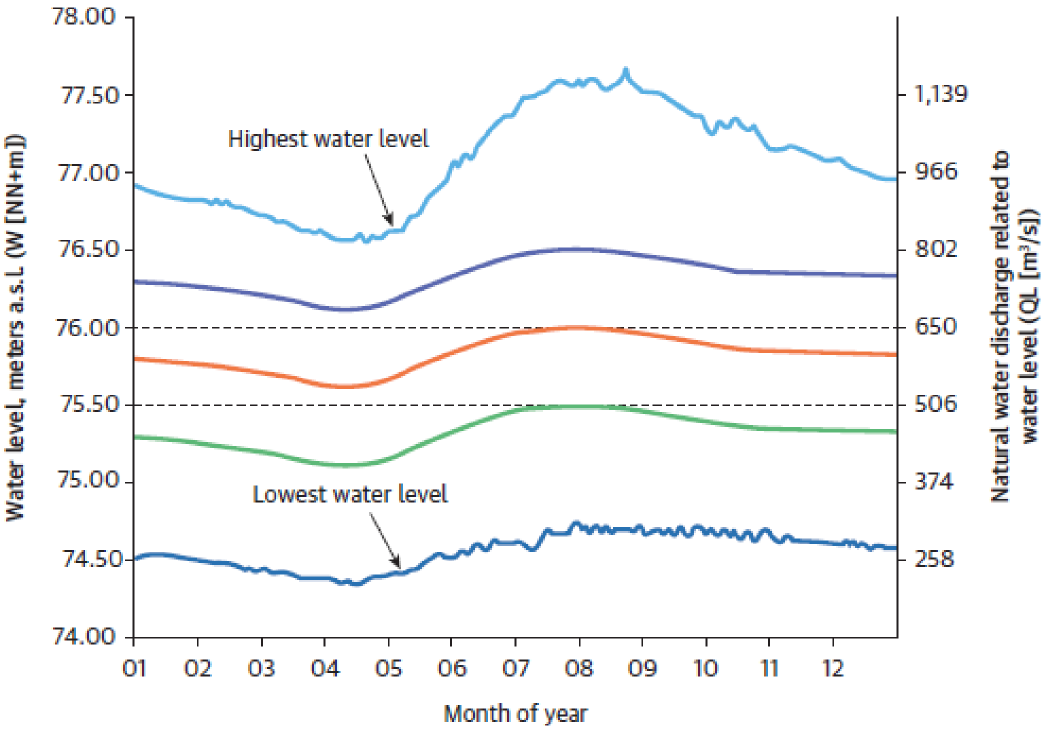

Figure 2. The Principle of Salmaa and Vuoksi Discharge Rule

5.3.2. ALBUFEIRA CONVENTION: FLOW REGULATIONS CONSIDERING DROUGHT CONDITIONS

Spain and Portugal share five main river basins. Three of these (Duero/Douro, Tajo/Tejo, and Guadiana) are also some of the largest basins in the Iberian Peninsula. In general, Spanish territory is upstream and around 70% of the annual water resources of these rivers is generated in Spain. The total area of these five basins represents 45% of the surface area of the Iberian Peninsula, and nearly 64% of Portuguese territory. Extreme variations in rainfall – from season to season and year to year - exacerbate scarcity in water flows, particularly in the drier south. Irrigation, a highly consumptive use, is the main source of demand in both States. Low water pricing also results in overexploitation and lack of progress in conservation and efficiency. These water scarcity and allocation problems are aggravated by the traditional focus of both countries on dam construction and large-scale water transfers from wetter to drier regions (from the Tajo to the Segura, from the Guadiana to the Sado, Odiel and Piedras river basins).

The first water treaty between both States dates from the 19th century. Later, in 1927, a first treaty regulating the use of the border stretch of Douro River for hydropower production was signed and was followed in 1964 and 1968 by two new treaties. With these treaties the hydropower potential of the border stretches of the five basins and their tributaries was shared in equal parts between the two States. The Albufeira Convention (approved in 1998) was drafted in parallel with the early negotiations on a common EU legal framework for water (the WFD, approved in 2000), and its scope and approach reflect some of the key elements and innovative aspects of the latter. The Convention establishes an annual flow regime for all major transboundary rivers (the Minho, Lima, Douro, Tejo, and Guadiana), defining mandatory flow volumes in sections upstream of the border for Spain, and on the respective estuaries or mouths for Portugal (only for the southern and more arid Tejo and Guadiana River Basins). The agreed flow regime was the object of an Additional Protocol to the Convention that defines the minimum volumes allocated to each river basin, as well as the conditions allowing an emergency regime, usually associated with drought periods, to be declared (Art 5). The Convention establishes the minimum flows and conditions presented in Table 12.

Table 12. Minimum flows (in hm^3) and Emergency Regime Set by the Albufeira Convention for the Douro River Basin as approved in 2008.

Control station	Annual flow	Trimestral flow	Trimester	Weekly flow
Miranda	3500	510	Oct-Dec	10
		630	Jan-Mar	
		480	Apr-Jun	
		270	Jul-Sep	
Bemposta	3500	510	Oct-Dec	10
		630	Jan-Mar	
		480	Apr-Jun	
		270	Jul-Sep	
Saucelle + Agueda	3800	580	Oct-Dec	15
		720	Jan-Mar	
		520	Apr-Jun	
		300	Jul-Sep	
Crestuma	5000	770	Oct-Dec	20
		950	Jan-Mar	
		690	Apr-Jun	
		400	Jul-Sep	
Emergency regime	R Oct-Jun < 65%	R in current and previous quarter < 65%		=

The numbers reflect the upstream-downstream relative location between control stations (higher minimum flows downstream), as well as the Mediterranean climate conditions, marked by a dry summer season. To determine the exception period, a set of rain gauge stations (3 or 4) is used for each flow control station to verify whether the accumulated average rainfall is less than 65 percent of the historical average (measured from October 1 to June 1 for annual flows, and from the start of the previous quarter to the end of the current quarter for quarterly and weekly flows). When average rainfall is less that the historical average, Spain may declare an emergency (regime) and consequently not release the minimum flows agreed. The emergency regime ends as soon as the accumulated values (after December, for the annual flows) again exceed the historical average.

5.3.3. THE TREATY OF DNIESTER RIVER: OPERATION RULES PRESERVING WATER USES AND ECOSYSTEMS

The 1,362-kilometre-long Dniester River starts in the Carpathian Mountains in Ukraine, flows through the Republic of Moldova and then re-enters Ukraine where it discharges into the Black Sea. Interannual irregularity of flows is not very pronounced. The average during the period was of 274.6 m^3/s and the minimum was registered in 1961 (131.4 m^3/s), the maximum in 1980 (490.3 m^3/s).

In June 2017, Ukraine ratified the 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 agreement is set to further advance cooperation in response to the complex environmental and economic challenges linked to the management of one of the largest transboundary rivers in Eastern Europe. The draft Regulations are a quite comprehensive normative document, mandatory for implementation by all the organisations and agencies involved in the operation of the Dniester cascade. It consists of the rules of operation that all the involved organisations must abide to when operating the reservoirs, the powerhouses and all the related waterways.

The Water Reservoirs of the HPP and PSPP Dniester Cascade (Figure 1), which consist of, from upstream to downstream, a dam equipped with a hydropower plant (HPP) and a large reservoir, Dniestrovski 1 HPP, a pump storage power plant (PSPP), Dniestrovskaya PSPP, and a second dam, Dniestrovski 2, also equipped with a HPP, the PSPP using the reservoir thus created between the two main dams as downstream reservoir.

The draft Regulations consider and are set upon the Figure below where the operating curves and zones for Dniestrovski 1 HPP are defined.

Zone I – Flood control only zone. This zone is defined by the normal high level (NHL, 121 m) and the total surcharge storage (TSS, 125 m). This volume is of 570 mln m3. Whenever a flood occurs the level of the waters will start raising and when the 121,0 m level is attained the gates will be opened so as to flush it downstream.

Zone II – This is the so-called zone of increased, or excessive, yield. The top level is the NHL (121 m) and the bottom level varies with the month being as low as 114.7 m during January and February, the so-called normal pre-flood level in the reservoir. It is the same as the NHL from April to July, as this is the wet period when high inflow can be reasonably expected, it starts lowering from August to December, when water is required for different uses.

Zone III – This is the so-called guaranteed yield zone. Volumes stored in this zone can be used to ensure irretrievable water consumptions as in Table 6 above. When the level in the reservoir is in this zone or above, the Dniestrovski 1 HPP can operate with the guaranteed capacity.

Zone IV– is a zone of decreased yield. Water in this zone can be used for hydropower production but only with severe limitations so as to prevent probable occurrence of disruption: not having enough water for primary uses downstream, such as the Spring releases required by the park and other downstream uses, in case upstream Spring flows are delayed. HPP-1 capacity should be reduced by 20% in case this happens from December to March and the waters are above the green line (zone V), and 40% if they are below the same line (zone VI), thus reflecting the priority attributed to those irretrievable uses and the environment.

The issue of seasonal flows is at the core of the draft Regulations and also of the comments received from many stakeholders. During Summer and Autumn water needs are the highest (water for consumptive uses). Natural flows are quite high during Summer but decrease with Autumn. During Winter period the power engineering mode dominates, as downstream water needs are reduced. During Spring the main concerns are flood control, on one hand, and Spring releases as required by the park, on the other.

5.3.4. THE SENEGAL BASIN AND MANAGED FLOODS: BEYOND MINIMUM ECOLOGICAL FLOWS

The Senegal River is 1800 kilometres long, making it the second-longest river in Africa. The basin is spread over four countries: Guinea, Mali, Mauritania and Senegal. The river's average annual flow stands at around 24 billion cubic meters, and the mean monthly natural flows used to fluctuate between the maximum values of 3,320 m^3/s in September and 9 m^3/s in May. Among the most important traditional livelihoods has been flood-recession agriculture, carried out on riverbanks and alluvial plains once the floodwaters have receded. Grazing on the floodplain was another important source of livelihood. One estimate suggested that the average annual area of flood-recession agriculture was around 100,000 ha, whereas others put it at 150,000 ha in an average year, going up to as high as 350,000 in high-flow years. Grazing areas were estimated as being much higher.

Serious apprehensions were expressed that the Manantali Dam, with its storage capacity of 11.3 billion cubic meters, would devastate traditional livelihoods like flood-recession farming. One estimate suggested that around 67,000 ha of the flood recession agriculture and 179,000 ha of floodplain grazing would be lost, and access to remaining grazing restricted.

"The construction of the Manantali and Diama dams created significant environmental and social impacts. A primary impact was the loss of flood-recession agriculture, fuelwood, and grazing on the floodplain. There was a 90 percent drop in the productivity of the fisheries of the Senegal Delta, which relied on inputs of freshwater from upstream.… Although the environmental flows included in the plan were small and inundated only around 50,000 hectares (20 percent of the original area), they had impressive benefits. 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."

5.3.5. THE COLUMBIA RIVER TREATY: INFORMATION SHARING IS ONE OF THE KEY ELEMENTS OF SUCCESS

The Columbia River is the fourth largest river in North America, based on estimated average annual flow at its mouth of about 198 million acre-feet (Maf). The average annual unregulated flow of 133 Maf can vary from year to year by up to +/- ~45 percent. The Columbia River is sometimes called the most powerful river in North America, with over 37,000 MW of installed hydropower capacity. The average annual hydropower energy in the U.S. portion of the basin and adjoining four-state region is about three-fourths the regional electrical load.

The 1964 Columbia River Treaty (CRT) between Canada and the United States of America required the construction and operation of three large dams in the upper Columbia River basin in British Columbia, Canada, and allowed the U.S. to construct a fourth dam in Montana. The CRT is known throughout the world as one of the most successful transboundary water treaties based on equitable sharing of downstream benefits. The CRT has proved durable and has evolved through numerous technical issues and changing societal values, which have added to and shaped the implementation processes and procedures.

Information sharing is one of the key elements of its success. During the negotiation of the CRT there was continual information exchange through an International Joint Commission that acted as a neutral third party and 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 hydrometerological system. 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.

The focus of the CRT is on flood control and power generation in the Columbia River basin. Basic numbers are:

- Under the CRT, Canada provided 15.5 million acre-feet (Maf) of reservoir storage at Duncan, Arrow/Keenleyside, and Mica. The combined reservoir storage of all the US and Canadian facilities on the Columbia system is approximately 60 Maf.

- The US paid US$64.4 million to Canada for ½ of the expected avoided flood damages for 60 years (till 2024) under 'assured annual flood control' plans. While the Treaty provides for 15.5 Maf of storage in Canada, Canada is obligated to operate just over half of that storage (8.45 Maf) for assured system flood control.

- The US can request Canada to provide additional 'on call' flood control, subject to proving need and providing additional compensation to Canada. This has never been requested to date (illustrating the effectiveness of the 'assured annual flood control' plans and the difficulty of getting budget approval in the US). For example, 1997 was a year when "on-call" flood control should have been issued. However, no call was issued due to the inability to obtain funding of the $1.875 million payment to Canada.

- The US and Canada share equally in the computed power benefits in the US associated with the regulation of flow from Canada's CRT projects. Increased 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 (BC) will receive 50% of the projected agreed amounts of energy and capacity. This is called the Canadian Entitlement.

- Canada's share of the benefits are given to the province of British Columbia as opposed to the federal government (through a side deal between Canada and BC).
- The US paid US$254.4 million for Canada's share of the increased power for 30 years. This money was used to partially finance the construction of the Canadian dams. This sale fully expired on 31 March 2003 - the Canadian Entitlement has now fully reverted back to Provincial BC government ownership. This is currently about 4000 GWh of power each year, with an estimated annual value of approximately US$300 million.
- The increased power benefits associated with Canadian storage are 'First Added', meaning that the benefit of Canadian storage is recognized in the benefit computations before recognizing storage built in the US after the CRT was signed (including Libby). The 'First Added' status helps to maintain the financial value of Canadian CRT storage. It is questionable if this "First Added" status should remain based on the evolution of power generation in the region, including wind power.
- The CRT permitted the US to build the Libby dam, which it did in 1973, with the Koocanusa reservoir extending 67km into BC. No direct compensation was given to Canada, but Canada benefits from regulated flow from Libby for its power generating facilities on the lower Kootenay River in BC, and for flood control benefits on the Kootenay and Columbia rivers. Although operations of Libby are not detailed under the CRT (as are the other CRT dams), Canada and the US must coordinate (but not necessarily agree on) its operations. Since 2000, Libby has been operated in coordination with BC power and flood interests through the Libby Coordination Agreement.

5.4. SOME LESSONS FROM INTERNATIONAL PRACTICES

This understanding of the international legal regime and international practices suggests the following important ways in which flow regulation and implementation of environmental flows in shared rivers can be made more effective.

- <u>Environmental water needs provide a foundation on which flow regulation should be built</u>. Environmental water is crucial to maintain key system functions on which many services depend and needs to be incorporated at the heart of allocation planning. These requirements should be included even where information is short. Environmental allocations should recognize the need for a variety of different flows, including minimum flow levels and high-water levels at the appropriate time of year. Environmental allocations should be recognized along the length of the river, not just at boundary points. The successful implementation of an environmental flows program can offer significant benefits in terms of the restoration of rivers, preservation of ecology, sustaining traditional livelihoods and creating new ones like tourism, all of which adds up to significant economic and non-economic value.
- <u>Flow regulation and operation rules in transboundary rivers need to have a clear and equitable approach for addressing variability between years.</u> Inadequate provisions for dealing with interannual variability are the root cause of many basin water management disputes around the world. Poorly designed allocation plans can inadvertently penalize certain regions or sectors. Equally, agreements may lack a clear or agreed mechanism

for addressing this problem, leading to conflict. More or less sophisticated approaches are available for doing this, ranging from simple rules for dividing deficits or surplus, through to complex methods based on monthly water resource modelling. Such measures need to link to the way water is allocated at the user level: e.g. farmers and industries require allocations that are both reliable and predictable to allow them to realize the full value of the water. Allocation plans should include approaches for dealing with drought: it can be politically more difficult to develop these responses once drought situations develop.

- <u>From water conflicts to shared benefits.</u> Upstream users – who control sources – can significantly impact the quantity and flows of water to downstream users. Increasing upstream withdrawals may lead to limited water supplies for downstream uses. Often, instead of focusing on the allocation of a certain quantity of water, a distribution of the benefits generated from basin development can offer a better road to reaching agreements. The construction of dams can particularly impact upstream-downstream relations. Dams may provide significant benefits for society, such as renewable energy, regulation of flows, and storage of water for drinking, irrigation and other productive uses. Best practices for dam development have also improved significantly over the years (e.g. natural flow regimes, fish stairways). Dam construction can be a particularly contentious and complex issue, given their potential to affect the timing and flows to downstream reaches, flood upstream reaches, displace populations, and affect surrounding ecosystems and fish migration routes. Therefore, they deserve special consideration when discussing conflict mediation and identifying possibilities for cooperation by sharing the benefits dams provide.

- <u>Flow agreement need to incorporate flexibility in recognition of uncertainty over the medium to long term</u>. Changing economic circumstances are likely to lead to different allocation needs. It is simply not possible now to know what national economic activity will look like in half a century. Decision makers have found that scheduling reviews and updates on a fixed schedule is a useful means of ensuring its long-term flexibility. Technical progress, as well as the implications of emerging data, can lead to reconsideration of goals, progress and policy. This need for flexibility is distinct from the need for allocation plans to deal with hydrological variability. The extent to which flexibility is possible may be determined by national policy frameworks rather than an individual allocation plan. The reallocation of water to adjust to changed circumstances can be achieved either through an administrative review of water entitlements, or by enabling market-based reallocations.

- <u>Information sharing is one of the key elements of transboundary agreement success</u>. Proper communication is important to allow transboundary cooperation, among others, as a critical channel for fostering a common understanding of vulnerability, adaptation policy and action in a transboundary setting. Accurate data and information on water and related natural resources obtained through monitoring and assessment activities are essential for informed decision-making and policy-formulation at the local, national and transboundary levels. Monitoring and assessing water resources requires cooperation between different actors and states, as river basins usually stretch over different administrative and geographical units and state borders. Exchange of information – including on pollution, infrastructure projects, extreme events and hydropower, navigation and irrigation activities – is also vital to building trust and a shared vision among the actors and states involved.

6. FLOW REGULATION IN THE DRINA BASIN[11]

6.1. POLICY AND LEGAL FRAMEWORK FOR FLOW REGULATION IN THE DRINA CONTEXT

6.1.1. INTERNATIONAL MULTILATERAL AGREEMENTS

6.1.1.1. Montenegro

Although not a member of the Framework Agreement on the Sava River Basin (FASRB), the status of Montenegro has been regulated by the Memorandum of Understanding between the ISRBC and Montenegro (December 9, 2014). Parties in the memorandum have agreed to "establish partnership aimed at achieving common strategic goals in water management in the Sava River basin".

Formal membership of Montenegro in the Convention on Co-operation for the Protection and Sustainable Use of the Danube River started on October 28, 2008. Montenegro has observer status in Danube Commission (Convention regarding the regime of navigation on the Danube, 1948)

Montenegro is a member of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes and the amendments to Article 25 and 26 of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes ("OG–International Agreements", no. 1/14). Montenegro is the member of the Convention on the Law of Non-Navigational Uses of International Watercourses ("OG–International Agreements", no. 6/13).

6.1.1.2. Bosnia & Herzegovina

BiH is the member of the majority of crucial international agreements in the field of WRM and environmental protection. This includes the Framework Agreement on the Sava River Basin (FASRB) ("OG BiH", No. 8/03), Protocol on Prevention of Water Pollution Caused by Navigation (""OG BiH"", No. 10/09) and the Protocol on Flood Protection ("OG BiH", No. 7/11). BiH is also the member of the Convention on Cooperation for the Protection and Sustainable Use of the Danube River ("OG BiH", No. 1/05) and the Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes ("OG BiH", No. 8/09) and the Protocol on Water and Health to the Helsinki Convention ("OG BiH"", No. 08/10).

As regards to the FASRB, the most important issues of implementation of relevance for the DRB are the following issues: flood risk management, hydropower plant management, sediment management and water protection (Source: Country Report on Implementation of the Framework Agreement on the Sava River Basin). The most important implementation problems of the FASRB for FHMO are related to the following: - Montenegro is not a signatory of the Agreement; - "insufficient focus on the Drina River in the Sava Commission".

[11] This chapter is based in the IWRM country reports from the project "Support to the Water Resources Management in the Drina River Basin" (http://www.wb-drinaproject.com)

Additionally, it is estimated that "hydropower development ... is of low priority in the Sava Commission", as something of the greatest importance for the Drina River.

The biggest problems in application of international agreement in the field of water management (and/or of relevance for water generally) are related to the fact that bilateral agreements regulating water management relations with Serbia, i.e. Montenegro, have not yet been signed.

6.1.1.3. Serbia

Serbia has regulated its status by most significant international multilateral agreements. Implementation of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (as part of the United Nations Economic Commission for Europe), The Danube River Protection Convention and the Framework Agreement for the Sava River Basin with protocols are of utmost importance. Serbia is also a member state of the Protocol on Water and Health along with the Convention on Protection and Use of Transboundary Watercourses and International Lakes.

Serbia is actively involved in the International Commission for the Protection of the Danube River (ICPDR) and the activities of expert groups. ICPDR adopted in 2009 the Danube Basin Management Plan and in 2015 DRBMP update. Activities related to the implementation of the Floods Directive resulted in the adoption of the 1st Flood Risk Management Plan for the Danube River Basin District (2015).

RS Government Operational Plan set adoption of the Danube River Basin Management Plan with the Program of Measures during 2015. Several projects related to the Danube River basin are currently under implementation.

It is estimated that cooperation within the Framework Agreement on the Sava River Basin, which was signed on 03.12.2002. ("OG S&M – International Agreements", No 12/04) provides solid ground to secure IWRM in the DRB. Serbia is actively involved in all the activities related to implementation of these international agreements. Serbia has ratified the protocols to this Agreement (see list in Annex). The major problem seems to be "lack of capacities in institutions which are in charge of implementation of Framework Agreement." RS actively participated in development of the Sava River Basin Management Plan, adopted in the Fifth Meeting of the Framework Agreement on the Sava River Basin (December 2014) and Flood Risk Management Plan in the Sava River Basin (2019).

Serbia is not a Party to the Convention on the Law of Non-Navigational Uses of International Watercourse.

6.1.2. BILATERAL AGREEMENTS IN DRB

6.1.2.1. Montenegro

Agreements with the Republic of Serbia and Bosnia and Herzegovina do not exist for now.

It is estimated that nonexistence of agreements with all neighbouring countries complicates use of international waters, the consequence of which are difficulties in solving the issues of use and protection of common waters.

Article 12 of the Memorandum of Understanding between the Government of Montenegro and the Government of the Republic of Serbia in the EU accession context (“OG – International Agreements”, no 4/2014) stipulated that “parties in the agreement will also cooperate in other areas of common interest. Parties in the agreement encourage cooperation in regard to struggle against climate change and environmental protection, especially in the light of harmonization with EU acquis.”

6.1.2.2. Bosnia & Herzegovina

BiH has no signed international agreements in the field of water management with the DRB countries, Serbia and Montenegro. According to a report on the work of the Council of Ministers - activities aimed at concluding agreements on water management cooperation between the Council of Ministers and the Government of Montenegro, and the Serbian government were initiated. However, BiH participates in cooperation with the DRB countries and within other international agreements in the water management sector, among which cooperation within the ISRBC and the ICPDR are of special significance. BiH signed a bilateral agreement with Serbia on inland waterways navigation and their technical maintenance (Belgrade, 2012), ("OG BiH", No. 17/12).

BiH signed agreements on cooperation in protection against natural and other disasters with Serbia ("OG BiH", No. 08/11), Montenegro ("OG BiH", No. 2/08), Croatia ("OG BiH", No. 7/01), Macedonia and Slovenia.

6.1.2.3. Serbia

The RS has not signed bilateral agreements with neighbouring countries, which would regulate management of water resources in DRB.

Negotiations on reaching agreement between the RS and Ministerial Council of Bosnia and Herzegovina on cooperation in the field of sustainable transboundary water management were not held in the previous period, but there is still interest expressed by both states to reach such Agreement. Current cooperation with Bosnia and Herzegovina is being achieved on multilateral level and within the work of International Commission for the Protection of the Danube River and International Sava River Basin Commission.

Agreement on Special Parallel Relations between the RS and Republic of Srpska (2006) is a legal foundation of the “Podrinje Development Program”, goal of which is improvement of development and cooperation between municipalities and cities in the wider area of the Drina River.

The RS has not signed agreement with Montenegro which would regulate water management. Current cooperation with Montenegro on multilateral level is achieved within the Water Convention body, International Commission for the Protection of the Danube River and within the International Sava River Basin Commission form the technical aspect.

In the sphere of river traffic, RS has signed the Agreement with Bosnia and Herzegovina on navigation along navigable routes in internal waters and technical maintenance (“OG RS” – International Agreements, no. 6/12).

6.1.3. HARMONIZATION OF NATIONAL AND EU REGULATIONS

6.1.3.1. Montenegro

Montenegro is an EU membership candidate country as of December 2010 and assumed responsibility for harmonizing Montenegrin legislation with the EU acquis by signing the Stabilization and Association Agreement (SAA) (Article 72). On June 21, 2007, the Montenegrin Government prepared the National Program of Montenegro EU Integration (NPI) 2008 - 2012. Further, in February 2015, Montenegro adopted the Program of Montenegro Accession to the European Union for the 2015 – 2018 period envisaging adoption of more than 100 strategic documents and more than 1000 laws and by-laws. In June 2018 Montenegro adopted the 2018-2020 action plan for its national strategy to align with and implement the EU acquis on environmental protection and climate change. However, the lack of administrative capacity and financial resources at national and local level are delaying the strategy's implementation.

According to the Montenegro 2019 Report from the European Commission, alignment on water quality remains limited. The national strategy for water management until 2035 is being implemented and work on river basin management plans is ongoing, but the competent management authorities are yet to be operational. Preparations have started for a water status monitoring system and for improved quality monitoring of surface and ground waters. Wastewater remains a main source of pollution. The development of a floods hazard map and flood risk map is being prepared. The implementation of the Marine Strategy Framework Directive remains at an early stage.

On nature protection, Montenegro is partially aligned with the EU acquis. Work continued on the designation of future Natura 2000 sites. Potential investments in hydropower and touristic developments need to comply with nature protection and water management legal requirements.

6.1.3.2. Bosnia & Herzegovina

Bosnia and Herzegovina was identified as a potential candidate for EU membership during the Thessaloniki European Council summit in June 2003. Since then, a number of agreements between the EU and Bosnia and Herzegovina have entered into force. The Stabilisation and Association Agreement (SAA) was ratified and entered into force on 1 June 2015. Bosnia and Herzegovina presented its application for membership of the European Union on 15 February 2016.

Based on the Decision on Instruments for Harmonization of the BiH Legislation with the EU Acquis ("OG BiH", No. 23/11), the Sector for Harmonization of the BiH Legal System with EU Acquis issues an opinion on regulatory compliance. BiH institutions are obliged (in the procedure of drafting regulations for harmonizing BiH legislation with EU acquis) to develop instruments of harmonization, prepare comparison and a statement of compliance.

According to the assessments from the 2014 Progress Report, "the country still lacks a consistent and harmonized approach to WRM at State level. This includes implementing water laws, monitoring and RBMP. The water policy at State level remains to be adopted, while alignment with and implementation of the acquis has significantly slowed down." Some steps were taken in drawing up a RBMP for the rivers Neretva-Trebisnjica and Sava. The country’s capacities to implement water-related EU Directives remain “insufficient”. Issues of access to drinking water, untreated discharges of wastewater and flood management remain to be sufiiciently addressed and financed There are ongoing activities on adoption of the II. cycle of the RBM Plans, and preparation of the first FM Plans, but long term financing these plans seems not to be likely without joining EU.Bosnia and Herzegovina has a national programme for the adoption of the EU acquis (Programme of EU integrations drafted, to be updated each 4 years). The programme is a legal obligation under the SAA and is essential for planning and streamlining the EU legal approximation process throughout the country. Significant efforts are needed in the areas where Bosnia and Herzegovina has some level of preparation, included environment and climate change.

6.1.3.3. Serbia

In March 2012, the country was granted EU candidate status. In June 2013, the European Council decided to open accession negotiations with Serbia. In September 2013, the EU-Serbia Stabilization and Association Agreement entered into force.

The process of systematic harmonization of the national regulations with the EU regulations in the field of water and environment started in 2009. On the basis of these laws more than 300 subsidiary regulations have been adopted which enabled further harmonization with the EU regulations in the field of water and environment.

The RS adopted the National Program for the adoption of the Acquis - NPAA in 2013, as well as the revision in 2014. The Serbian government adopted in 2018 a third revised version of the National Programme for the Adoption of the Acquis of the European Union (NPAA). According to the NPAA, a full harmonisation of the legislation with the EU acquis is planned by the end of 2021, followed by the period of monitoring the implementation of regulations until membership.

According to the most recent assessments of the European Commission, it is noted that it is necessary “to strengthen capacity of Water Directorate within the MAEP to a degree which will enable them to manage, transfer and apply a large amount of EU legislation on waters". The severe floods that occurred in May 2014 show that it is necessary to rapidly improve the system and infrastructure for prevention of floods and water management.

It is estimated that approximately 76% of the EU WFD is transposed in regulations of the RS. As regards to flood risk management, estimations indicate that around 79% of the Directive on the assessment and management of flood risks (2007/60/EC) has been transposed in RS legal system. The Habitat Directive (92/43/EEC) has been almost completely transposed (98%). Full transposition (segment related to NATURA European Network) should be achieved with accession to EU. Directive on Birds (2009/147/EC) was completely transposed in 2011.

6.1.4. EU POLICY

Hazards, such as floods and droughts, occur naturally and are associated with excess or insufficient rainfall, river overflow and other related phenomena. Their effects and severity depend on a host of other factors and a combination of local and sometimes external influences, many of which are a result of human intervention. Many times, water flow management has an impact on flood and drought risks. The uncoordinated operation of the dams in the Drina basin may itself cause or aggravate high water levels, although the reservoir storage capacity on the Drina is relatively low from the point of view of flood response or containment, especially in periods of prolonged high precipitation. Currently, water use for irrigation is marginal in the Drina basin, while all the riparian countries have plans to increase the irrigated land in order to improve economic performance of the agricultural sector and to adapt to the increasing frequency of droughts due to climate change.

Hazard risk reduction is increasingly recognized as an integral part of water policies and agendas. Beyond the customary and general principles of international law applicable to transboundary water resources management (addressed in Sections 5.1 and 5.2), the European Union (EU) has a major influence in water policy since all three riparian countries have taken steps towards EU accession. Consequently, the three countries have made commitments derived from the acquis Communautaire that affect water, energy, ecosystem and food policies.

Water policy and legal framework related to floods, droughts and ecosystems are well developed in the EU. As analysed before in Section 3.1.1., the legal framework for implementation of environmental flows in EU Member States is set out in the WFD and the Birds and Habitats Directives. The policy and legal framework reducing water-related hazards are set out in the Flood Directive and the Communication on Water Scarcity and Droughts.

Directive 2007/60/EC on the assessment and management of flood risks requires Member States to assess if all water courses and coast lines are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk. With this Directive also reinforces the rights of the public to access this information and to have a say in the planning process. The Directive shall be carried out in coordination with the Water Framework Directive, notably by flood risk management plans and river basin management plans being coordinated, and through coordination of the public participation procedures in the preparation of these plans.

Member States shall furthermore coordinate their flood risk management practices in shared river basins, including with third counties, and shall in solidarity not undertake measures that would increase the flood risk in neighbouring countries. Member States shall in take into consideration long term developments, including climate change, as well as sustainable land use practices in the flood risk management cycle addressed in this Directive.

On the other hand, the concerns about drought events and water scarcity have grown within the EU over the past decade. The main overall objective of EU water policy is to ensure access to good quality water in sufficient quantity for all Europeans, and to ensure the good status of all water bodies across Europe. Therefore, policies and actions are set up in order to prevent and to mitigate water scarcity and drought situations, with the priority to move towards a water-efficient and water-saving economy.

6.2. BASIN DESCRIPTION

6.2.1. GENERAL DESCRPTION

The Drina River is 346 km long and is the largest tributary of the Sava River Basin, which in turn is the largest tributary by volume of water of the Danube River Basin. The Drina River Basin (DRB) has a surface area of 19,680 km^2 and spreads over territory within principally three riparian states: Bosnia and Herzegovina (BiH), which is subdivided into two entities, Republic of Srpska (RS) and Federation of Bosnia-Herzegovina (FBiH), Montenegro and Republic of Serbia. Figure 3 provides a visual overview of the Drina River Basin in terms of water, energy and land resources as well as ecosystems.

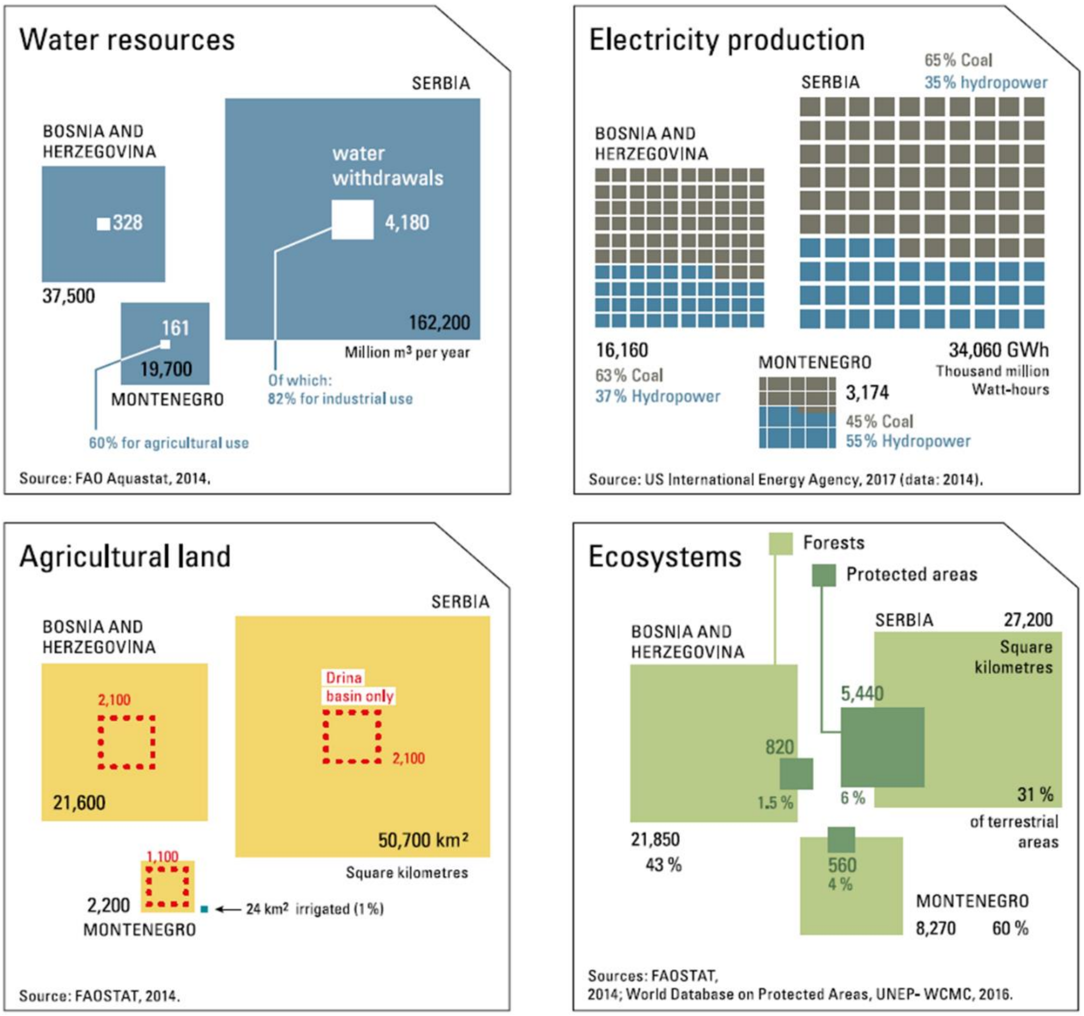

Figure 3. Overview of the Drina River Basin in terms of water, energy, land resources and ecosystems (Source: Policy Brief : Assessment of the water-food-energy-ecosystems nexus and the benefits of transboundary cooperation in the Drina River Basin)

6.2.2. HYDROLOGY

6.2.2.1. Surface water

Principal characteristics of water regimes in a basin area are annual discharges, low discharges and flood discharges. Hydrological stations in the DRB were analyzed with data from the "Drina" HIS database for the years 1946 to 2012.

Average discharges are presented as the mean annual value Q and specific yield q on hydrological station. Low discharges are shown by means of 95% guaranteed minimum monthly discharge and Tennant method for wet and dry period given as 10% of mean annual discharge value on analyzed stations (Table 13).

Table 13. Average annual and low discharges of analysed hydrological stations for the period 1946 to 2012

Country	Hydrological station	River	Average flows		95% min. Qmonth		Tennant Model (Wet/Dry)
			Q	q	Distribution	Q0.95%	Q10%
Montenegro	Bijelo Polje	Lim	61.2	28.1	P3	9.2	6.1
	Plav	Lim	18.4	50.5	LP3	2.8	1.8
	Šćepan Polje	Tara	75.8	37.8	Gumbel	9.2	7.6
	Đurđevića Tara	Tara	55.8	40.4	LN	7.0	5.6
	Šćepan Polje	Piva	71	39.8	Gumbel	8.7	7.1
BiH	Bastasi	Drina	143.5	39.0	LP3	21.7	14.4
	Foča	Drina	195.8	35.9	LP3	28.2	19.6
	Vikoč	Ćehotina	17.6	13.6	Gumbel	2.5	1.8
	Igoče	Sutjeska	13.8	51.3	Gumbel	1.9	1.4
	Oplazići	Bistrica	11.9	28.0	LP3	1.4	1.2
	Goražde*	Drina	218** 196***	-	LP3	Qmin95%god 28.2**	-
Serbia	Bajina Bašta	Drina	334.4	22.6	LP3	54.5	33.4
	Radalj	Drina	364.9	20.9	Gumbel	57.2	36.5
	Priboj	Lim	91.9	25.0	LP3	18.2	9.2
	Prijepolje	Lim	76.4	24.2	LP3	11.8	7.6
	Brodarevo	Lim	69.3	25.1	LP3	10.1	6.9
	Radijevići	Uvac	8.2	6.5	Gumbel	1.0	0.8

Note: - Q-mean multi-annual discharge, q-specific yield of the basin, Q95%-95% guaranteed minimum monthly discharge, Q10%-10% mean annual discharge value

* Data for HS Goražde based on data for period 1946-1975** and 1976-2016*** with discontinuation in observation 1992-2004 (source: Hydrological study of HS Goražde with all contributions, 2019)

Mean annual discharge duration curves are presented by means of numerical values in the following Table 14 for analyzed hydrological stations in the DRB for the period from 1946 to 2012.

Table 14. Mean annual discharge duration curves on analysed hydrological stations in the DRB (1946-2012)

Country	Monthly flow duration curve (%)	0	5	10	20	30	40	50	60	70	80	90	100
Montenegro	"Bijelo Polje" HS	6.1	11.9	14.5	19.6	28.1	38.1	51.2	61.9	76.6	98.2	130	279
	Plav HS	2.4	3.9	4.8	6.9	9.3	11.8	15.6	18.8	23.3	28.6	36.8	70.4
	Šćepan Polje (Tara) HS	8.3	15.4	19.1	29.9	44.3	53.5	68.2	80.3	95.4	115.6	146	295
	Đurđevića Tara HS	5.5	11.8	14.8	21.7	30.5	38.2	48.2	58.4	70.0	85.3	110	218

Country	Monthly flow duration curve (%)	0	5	10	20	30	40	50	60	70	80	90	100
	Šćepan Polje HS (Piva)	6.5	13.6	17.4	25.1	32.9	46.2	60.1	72.1	90.0	113	146	358
BiH	Bastasi HS	19.0	33.0	39.0	54.0	77.7	100	125	151	180	219	280	587
	Foča Most HS	21.0	44.7	55.0	74.0	104	143	177	210	249	301	377	699
	Vikoč HS	2.3	3.8	4.4	6.1	8.8	11.6	13.9	17.8	22.6	28.1	34.5	70.0
	Igoče HS	1.7	2.7	3.0	4.2	5.9	8.2	11.0	13.1	17.1	21.3	28.7	103
	Oplazići HS	0.4	1.4	1.7	2.8	4.8	7.2	9.6	12.0	15.2	19.4	25.3	68.7
Serbia	"Bajina Bašta" HS	48.0	75.0	91.9	127	180	237	297	354	425	525	646	1220
	Radalj HS	64.0	89.0	108	147	207	269	332	386	460	561	680	1270
	Priboj HS	17.1	25.1	28.4	37.1	49.5	64.8	77.8	94.2	113	139	178	327
	Prijepolje HS	10.6	15.3	18.5	25.5	37.5	49.9	64.6	78.9	97.5	122	154	304
	Brodarevo HS	6.8	13.5	16.0	22.2	32.2	44.7	58.6	72.0	89.8	111	141	282
	Radijevići HS	0.2	1.2	1.7	2.4	3.2	4.5	6.3	7.8	10.4	13.4	17.9	40.0

Flood discharges in the DRB were determined independently of average discharges and low discharges. Analysis was conducted for hydrological stations in the Drina River, Ćehotina River and Lim River (Table 15). Data on maximum daily and absolute annual maximum discharges on hydrological stations were used in calculations.

Table 15. Flood discharges of different return periods T on analysed hydrological stations in the DRB (m^3/s)

Country	Hydrological station	River	T - return period (years)								
			1000	500	200	100	50	10	20	5	2
Montenegro	"Dužki most"	Piva	1048	914	752	640	544	430	354	283	193
	Mratinje	Piva	1275	1200	1091	1002	919	809	722	629	485
	"Šćepan Polje"	Piva	1398	1288	1133	1015	907	768	663	557	402
	Crna Poljana	Tara	724	618	489	403	334	256	206	163	110
	Trebaljevo	Tara	1214	1076	905	786	680	553	465	382	272
	Đurđevića Tara	Tara	1652	1491	1311	1183	1054	889	767	645	469
	Šćepan Polje	Tara	2050	1892	1696	1526	1372	1168	1011	847	601
	Pljevlja	Ćehotina	222	199	171	150	132	110	94	79	59
	Gradac	Ćehotina	300	281	256	236	216	189	167	144	107
	Vikoč	Ćehotina	494	462	418	386	353	309	275	239	186
	Brodarevo	Lim	1,362	1,268	1,135	1,026	927	797	696	591	432
	Bijelo Polje	Lim	1,323	1,208	1,073	978	882	757	663	567	427
	Andrijevica	Lim	705	640	554	497	441	371	319	268	197
	Plav	Lim	401	375	344	317	290	253	223	190	137
Bosnia & Herzegovina	"Badovinci"	Drina	5529	5134	4601	4192	3806	3298	2909	2505	1896
	Radalj	Drina	6429	597	535	4875	4425	3835	3383	2913	2205
	Bajina Bašta	Drina	7763	6971	598	5248	4617	3854	332	2809	2124
	Višegrad Most	Drina	7512	6743	5787	5097	4484	3735	3205	2696	2004
	Foča Most	Drina	6114	5362	4454	3806	3258	2614	2178	1775	1257

Country	Hydrological station	River	T - return period (years)								
			1000	500	200	100	50	10	20	5	2
	Bastasi	Drina	3835	3473	3056	2763	2468	209	181	1528	1121
	Vikoč	Ćehotina	494	462	418	386	353	309	275	239	186
	Foča Aladža	Ćehotina	447	417	378	348	318	278	247	215	166
	Strmica	Lim	2525	2179	1758	1515	1288	1029	859	706	519
	Priboj	Lim	1655	1509	1325	1186	1064	912	802	695	547
Serbia	"Badovinci"	Drina	5529	5134	4601	4192	3806	3298	2909	2505	1896
	Radalj	Drina	6429	597	535	4875	4425	3835	3383	2913	2205
	Bajina Bašta	Drina	7763	6971	598	5248	4617	3854	332	2809	2124
	Višegrad Most	Drina	7512	6743	5787	5097	4484	3735	3205	2696	2004
	Strmica	Lim	2525	2179	1758	1515	1288	1029	859	706	519
	Priboj	Lim	1655	1509	1325	1186	1064	912	802	695	547
	Prijepolje	Lim	1503	1387	123	111	999	854	744	632	465
	Brodarevo	Lim	1362	1268	1135	1026	927	797	696	591	432
	Bijelo Polje	Lim	1323	1208	1073	978	882	757	663	567	427

6.2.2.2. Groundwater

The basin's surface and groundwater resources represent an important economic potential and have considerable environmental value. The Drina Basin drains a vast karst plateau that receives the highest rainfalls in Europe (around 3,000 mm) and produces the highest specific runoff in Europe (up to 50 $l/s/km^2$). Two thirds of the water of the Drina River is provided by the Lim, Piva and Tara rivers, which originate in Montenegro. The Dinaric Karst Aquifer System is the main source of groundwater in the region and within the Drina River Basin the main aquifers in the region are the Lim, Tara-massif and Macva – Semberija. Groundwater makes up the main water supply to rural communities. Some areas face severe water shortages in the dry seasons when the demand is high and supply is low. The basin is vulnerable to floods and droughts due to the high variability of river discharge rates.

6.2.3. BIODIVERSITY

The DRB has a very complex and high diversity of ecosystems, adapted or developed in accordance with its notoriously extreme high and low flows. Even though, integrity of these ecosystems is already partially damaged as DRB hosts eight medium to large hydropower generation dams in addition with a history of lack of sustainable water and waste managements, which are already affecting sections of rivers. However, some sections of the flows in DRB are still rather untouched ecosystems and, despite possible pollution problems, constitute a unique heritage to be preserved. In addition, the DRB still hosts many species and habitats of outstanding ecological value and unique importance for biodiversity on national, regional and European level.

Wetlands and alluvial forests are amongst of the most important habitats in DRB. Even though they are not covering large surfaces along the Drina River and its tributaries above the level of 140 m a.s.l, they are still an important factor in habitat diversity and they are providing conditions and shelter for a large variety of species and habitats that would be otherwise absent from the region.

DRB is a region rich in biodiversity and is a home to many endemic species, as well as many species that have become rare or endangered locally and on continental level. The Drina River Basin holds a high number of endemic species, many of them of European importance. The number of endemic and relict plants is exceptionally high in the southern part of the basin, in the karst massifs surrounding rivers Piva and Tara (in the whole Basin, the number of endemic plant species exceeds 130).

Drina River offers a variety of different habitats and ecosystems and is inhabited by more than 50 fish species. The upper parts of the basin are primarily inhabited by Salmonid fish, mostly Danube Salmon (Hucho hucho) and Brown trout (Salmo labrax) and Grelling (Thymallus Thymallus). Bullhead (Cottus gobio) and Brook barbel (Barbus caninus) are also common in these regions. Preserving the rich fish populations of the Drina River would enable also the protection of a high proportion of the Balkan and European fish species and their genetic diversity.

The future management of the DRB needs to ensure that the focus of measures is not only on the restoration of pollution that affects rivers but also it must preserve the few important areas that are still ecologically intact. Nature protection in the basin is a challenging task as it is could oppose the planned investments and efficiency of its measures depends strongly on cross-border dialogues and regional cooperation.

6.2.4. PROTECTED AREAS

A number of natural parks and protected areas covered the DRB and the landscape is dotted with unique glacial lakes and canyons. The DRB even host the Tara Canyon, a UNESCO World Heritage site. However, only 5.44% of the DRB is protected (under 3% in Bosnia and Herzegovina, 10% in Republic of Serbia and 7.9% in Montenegro), which is far under the European average. The DRB is then not sufficiently protected regarding the fact that it holds above average biodiversity and diversity of habitats. There are many of the planed protected areas (Pas), that could bring a better protection regarding terrestrial habitats but the benefit for the preservation of aquatic biodiversity is rarely considered in the future plans for protection. The existing and planned Pas are summarized in figure 4.

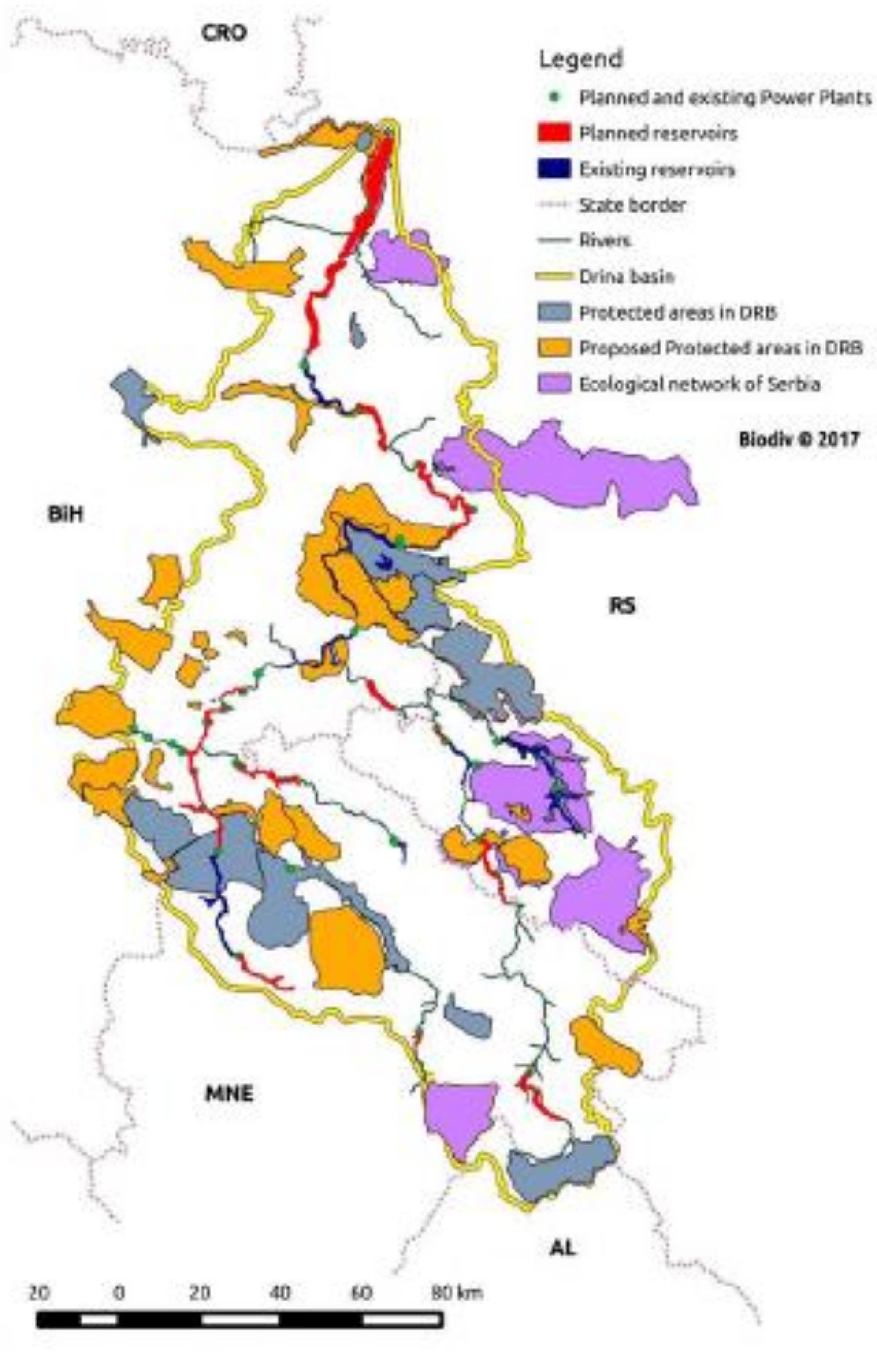

Figure 4. Existing and planned protected areas in the DRB

6.3. WATER RESOURCES MANAGEMENT IN THE DRINA BASIN

6.3.1. WATER MANAGEMENT REGIONS

6.3.1.1. Montenegro

The northern region of Montenegro essentially covers the four main river systems making up the DRB. These are the Piva, the Tara, the Ćehotina and the Lim (Figure 5).

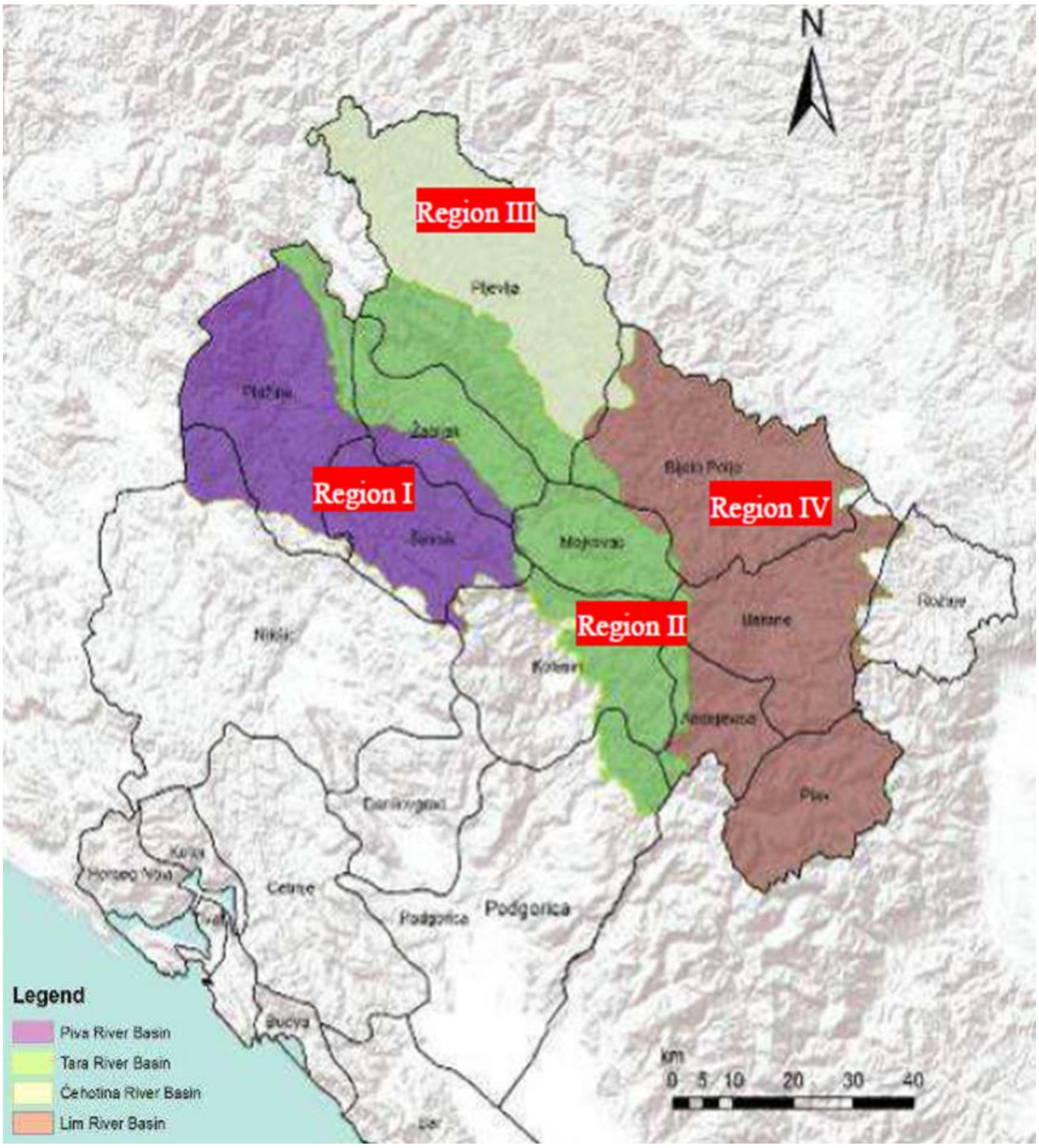

Figure 5. Water Management Regions for the DRB in Montenegro

The DRB takes the shape of a rectangle aligned Northwest-Southeast. The only other river basin in the north region that is part of the Black Sea Basin, but not the DRB is the Ibar, which mostly comprises Rožaje municipality.

All four of these water management regions have individual exit points from Montenegro flowing north and northwest to BiH in the case of Piva, Tara and Ćehotina and into Serbia for the River Lim.

6.3.1.2. Bosnia and Herzegovina

The DRB in BiH borders the eastern edge of the country and receives rivers flowing northwards extending out of Montenegro and Serbia, but also from within BiH, which is subdivided into three regions as shown in Figure 6.

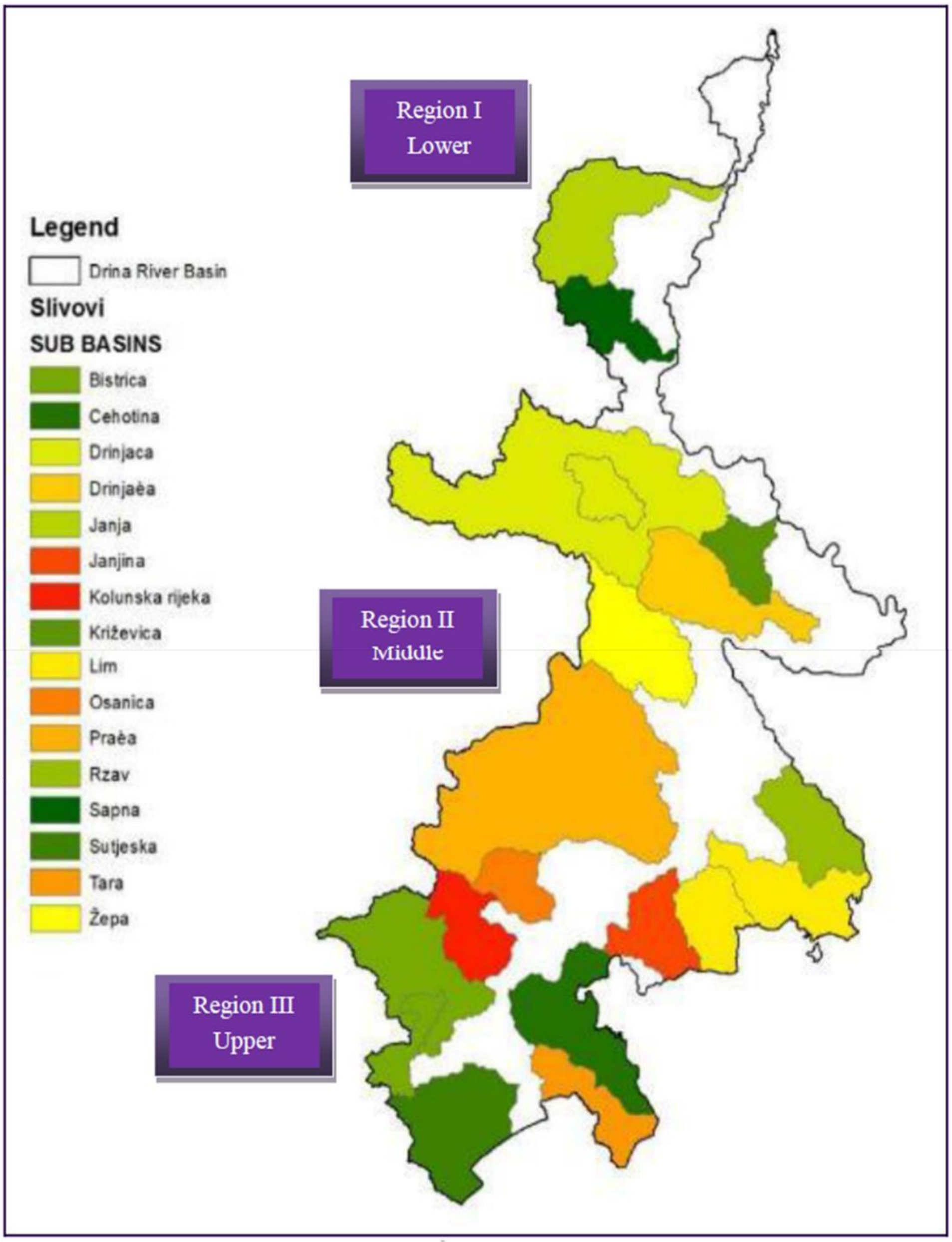

Figure 6. Water Management Regions for the DRB in BiH

Four main Montenegrin rivers flow north; the Piva River becomes the Drina River in BiH; the Tara and Ćehotina rivers rise in Montenegro and then pass into BiH before meeting the Drina near Foča; and the Lim river rises in Montenegro and passes through Serbia before flowing into the Drina in BiH. Other BiH rivers in the upper part of the DRB also drain into the Drina, most notably the Bistrica and the Sutjeska rivers. The Drina then becomes BiH's eastern border with Serbia until the confluence with the Sava River. In the middle part of the DRB smaller left bank tributaries such as the Prača, Osanica, Žepa and Drinjača drain into the Drina and on the right bank the Janjina and Rzav. Further downstream in the lower part of the DRB the left bank tributaries of the Sapna and the Janja flow into the Drina.

6.3.1.3. Serbia

The DRB in Serbia borders the western edge of the country and essentially covers the three main river systems. These are the Lim in the south extending out of Montenegro; the Jadar in the north, which flows out in a northwest direction to the Drina; and the Drina proper, which receives waters upstream from BiH and from Montenegro (Piva, Tara and Ćehotina) (Figure 7).

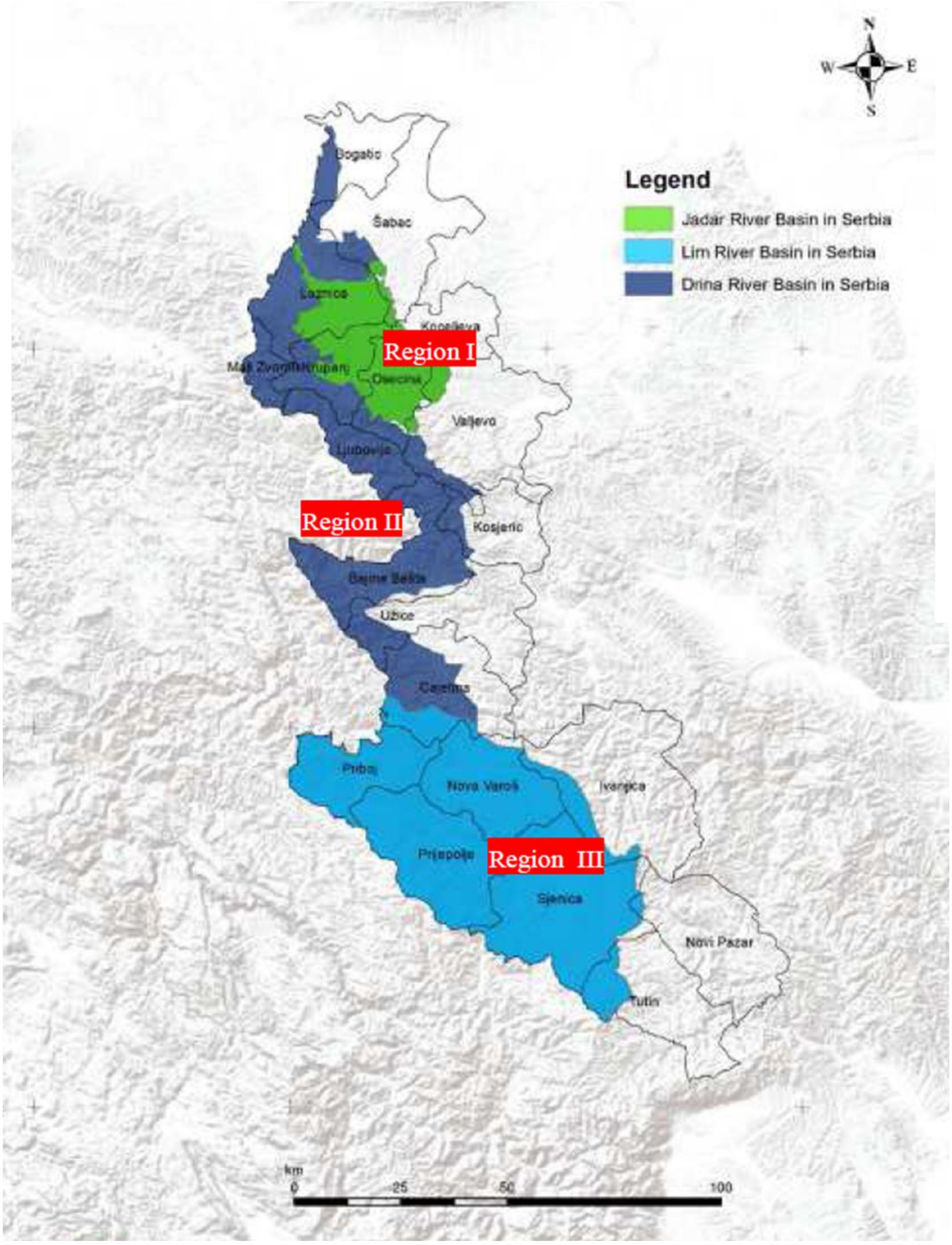

Figure 7. Water Management Regions for the DRB in Serbia

The DRB in Serbia, has a noticeable "zigzag" shape trending in a south to north direction toward the confluence with the Sava River.

6.3.2. WATER USE

6.3.2.1. Montenegro

A summary of the water use from the different sectors in the municipalities making up the DRB is presented in Table below. This estimates that about 19 Mm³/yr of water is necessary to cover consumption for the domestic, industrial and irrigation sectors making up the municipalities in the DRB. This amount does not consider NRW and with that added then the water use will be nearer 27 Mm³/year. It is clear that WMR IV for Lim has substantially more demand. WMR IV requires 12.2 Mm³/year of water compared to only 3 Mm³/year for WRM II - Tara and 3.1 Mm³/year for WRMIII - Ćehotina 0.6 Mm³/year for WRM I for Piva. This information is in the summary Table 16.

Table 16. Allocation of Water Demand in the Water Management Regions of Montenegro DRB

WMR	River System	Surface area Sub Basin (km²)	Sub Basin (% of DRB)	Total Population	Water use (Mm³/yr)			
					Domestic	Industrial	Irrigation	Total Use
I	Piva	1,456.16	22.63%	6,685	0.56	0.05	0.00	0.61
II	Tara	1,721.40	26.75%	28,954	2.42	0.46	0.16	3.04
III	Cehotina	1,024.44	15.92%	24,713	2.07	0.93	0.13	3.13
IV	Lim	2,232.06	34.69%	92,766	7.75	0.43	4.03	12.21
	Total	6,434.06	100.00%	153,119	12.80	1.87	4.32	18.99

6.3.2.2. Bosnia and Herzegovina

A summary of the water use from the different sectors within the three WMR for the BiH part of the DRB is presented in Table 17. This estimates that about 32.7 Mm³/year of water is necessary to cover consumption for the domestic, industrial and irrigation sectors in the DRB. This amount does not consider NRW and with that added then the water use will be nearer 50 Mm³/year. WMR II for Drina has the most demand (15.7 Mm³/year) followed closely by the WMR I (14.7 Mm³/year). The Upper WMR III has the lowest demand at around 2.3 Mm³/year.

Table 17. Allocation of Water Demand in the Water Management Regions of BiH DRB

WMR	River System	Surface area Sub Basin (km²)	Sub Basin (% of DRB)	Total Population	Water use (Mm³/yr)			
					Domestic	Industrial	Irrigation	Total Use
I	LOWER	943.09	14.82%	133,455	10.4	3.4	0.8	14.7
II	MIDDLE	4,225.57	66.41%	145,237	11.1	3.7	0.9	15.7
III	UPPER	1,194.00	18.77%	20,09	1.6	0.5	0.1	2.3
	Total	6,362.66	100.00%	298,782	23.2	7.6	1.9	32.7

6.3.2.3. Serbia

A summary of the water use from the different sectors within the three WMR for the Serbian part of the DRB is presented in Table 18. This estimates that about 22.5 Mm³/year of water is necessary to cover consumption for the domestic, industrial and irrigation sectors in the DRB. This amount does not consider NRW and with that added then the water use will be nearer 30

Mm³/year. WMR II for Drina has the most demand (9.8 Mm³/year) followed closely by the Lim WMR III (8.6 Mm³/year). The Jadar WMR I has the lowest demand at around 4.1 Mm³/year.

Table 18. Allocation of Water Demand in the Water Management Regions of Serbia DRB

WMR	River System	Surface area Sub Basin (km²)	Sub Basin (% of DRB)	Total Population	Water use (Mm³/yr)			
					Domestic	Industrial	Irrigation	Total Use
I	JADAR	759.04	12.60%	52,047	2.72	0.61	0.74	4.07
II	DRINA	2,172.44	36.06%	124,982	6.52	1.46	1.79	9.77
III	LIM	3,092.56	51.34%	110,414	5.76	1.29	1.58	8.63
	Total	6,024.04	100.00%	287,443	15.00	3.36	4.11	22.48

6.3.3. HYDROPOWER

The Figure 8 illustrates the location of all existing power schemes of the Drina River Basin. The following HPPs were built on the territory of Montenegro: "Perućica" HPP, "Piva" HPP and few SHPPs such are "Glava Zete" SHPP and "Slap Zete" SHPP. Only "Piva" HPP is located in the DRB. This HPP and its dam and reservoir present the largest structures that were built on the Piva River. With its generous useful volume, the "Piva" reservoir provides favourable conditions for important discharge regulation. The "Piva" HPP operates in the “peak-load” mode within the regional hydropower system.

In the part of the Drina basin located on the territory of Republic of Srpska there are three dams with HPPs constructed. Two of them are located along to boundary line between Serbia and Republic of Srpska (BiH) ("Zvornik" HPP and "Bajina Bašta" HPP) and are managed by EPS. Only one HPP is completely located on territory of Republic of Srpska (BiH) and managed by ERS – "Višegrad" HPP. The power system in FBiH disposes over three storage-type hydropower plants with installed power of 400 MW and design mean annual production of approximately 1,770 GWh. In addition, it disposes over five runof-river hydropower plants having storages with daily flow regulation, with installed power of 459 MW and design mean annual production of approximately 1,494 GWh. It also disposes over an exceptional generation plant – pumped-storage hydropower plant, "Čapljina" PSHPP, with installed power of 440 MW and design annual production in turbine operation of 400 GWh, with capacity for work in all four quadrants.

Within the territory of Serbia the following HPPs were built: " Đerdap I" and "Derdap II", "Pirot", "Vrla I", "Vrla II", "Vrla III" and "Vrla IV", , "Ovčar Banja", "Medjuvršje", "Zvornik", "Bajina Bašta" (HPP and PSHPP), "Bistrica", "Kokin Brod", "Uvac" and "Potpeć". Only the last seven are located within the Drina River Basin.

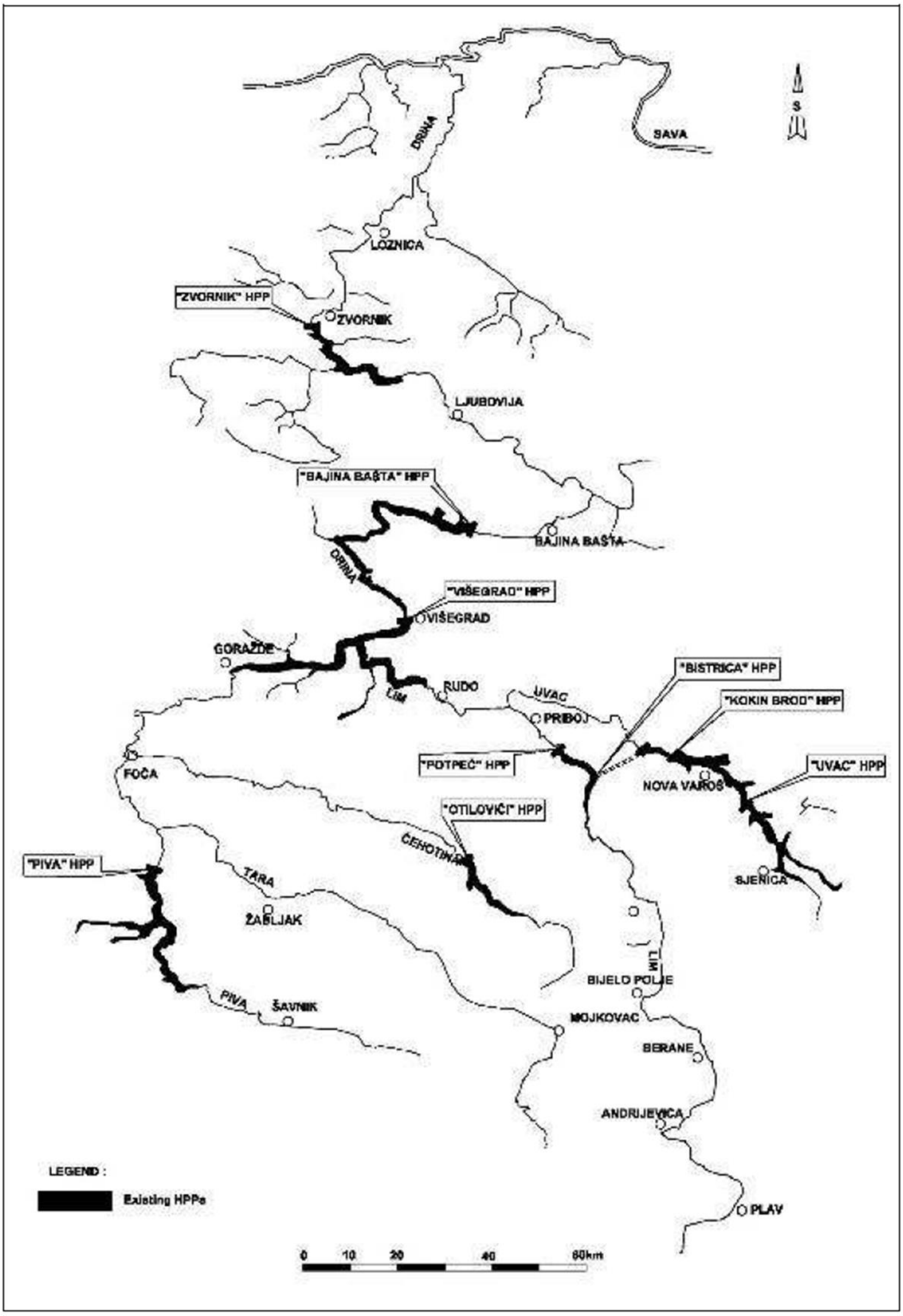

Figure 8. Existing HPPs on the Drina River Basin

6.3.4. FLOOD HAZARDS

In close cooperation with the relevant national institutions, ISRBC prepared the joint Flood Risk Management Plan for the Sava River Basin (Sava FRMP), which was officially approved by the FASRB Parties at their 8th Meeting held in Sarajevo on October 24, 2019. In addition to the FASRB Parties (Bosnia and Herzegovina, Croatia, Slovenia and Serbia), Montenegro was also actively involved in the development of the plan, thus ensuring the integrity of planning for the entire basin including actions in the Drina River Basin as well.

Sava FRMP represents a milestone in the cooperation of the Parties leading towards fulfilment of one of the main objectives of the Framework Agreement on the Sava River Basin – to prevent or limit hazards and reduce and eliminate adverse consequences, including those from floods.

Based on national Areas with Potential Significant Flood Risk, Sava FRMP identified 21 Areas of Mutual Interest for flood protection at the Sava River Basin level (AMIs), as basic units for analyzing the flood risks, with a total surface of 5,659 km2, representing 5.8% of the Sava River Basin area and home to 1.4 million people. In AMIs 38 structural measures were identified with a total value of over € 250 million while at 42 non-structural measures were also identified, that mostly relate to the entire AMIs or the Sava River Basin. The implementation of the measures will strongly contribute to meeting the commonly agreed 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. Coordination mechanisms at the Sava River Basin level and cooperation in case of extraordinary flood defense were also analyzed, with recommendations for improvements.

The Sava FRMP in all official languages of the FASRB Parties, as well as in English and Montenegrin, is available at: www.savacommission.org/sfrmp/.

As implementation of the one of very important non-structural measures, ISRBC has established Flood forecasting and Warning System for the Sava River Basin (Sava FFWS), and put it into operational use in October 2018. This effort was also done in close cooperation with the relevant national institutions of the Sava countries. Sava FFWS is a unique forecasting system at the international level, implemented as an open and flexible platform for managing the data handling and forecasting processes, allowing a wide range of external data and models to be integrated. This concept is particularly important for the five Sava countries, each with its own specifics in terms of organization of the water sector, stage of development of monitoring and forecasting systems, and legal and regulatory framework for flood risk management. Sava FFWS is installed at the hosting sites in the four countries and consists of one primary and three back-up installations in the national institutions, while the archive and web servers are located in ISRBC. The system is currently used by 10 organizations – hydrometeorological services and water agencies. In order to ensure the smooth operation of the system and its regular maintenance and performance control of the system, as well as training of engaged personnel, in July 2020 the Sava countries (and ISRBC) signed a MoU on cooperation concerning regular functioning and maintenance of Sava FFWS. This agreement will ensure the long-term sustainability of Sava FFWS as well as its further developments.

6.3.4.1. Montenegro

The International Disaster Database (www.emdat.be) reports that among four natural disasters within the last 10 years in Montenegro, there were three floods occurring in 2007, 2009 and

2010. Damage and losses caused by the 2010 flood alone amounted to around Euro 44 million. The May 2014 flood did not substantially affect the Montenegrin part of the DRB.

In Montenegro, floods occur primarily due to the hydrological regime of torrential type, triggered by the fact that about 94 % of the territory has a slope above 5 per cent. Therefore, floods potentially threaten 250 km^2 of farmland and urban zones and this is particularly pronounced in some areas surrounding Lake Skadar and Bojana River, Zeta and Bjelopavlici plains, Plav ravine and the Lim, Tara, Ćehotina, Morača and Ibar river valleys. The need for flood protection measures is particularly evident in the large flat karst plain areas (e.g. Barsko, Cetinjsko and the groves of the Matica valley) which are not within the Montenegirn part of the DRB. Most of the constructed drainage systems are not in operation, in general due to insufficient maintenance.

6.3.4.2. Bosnia and Herzegovina

According to data published in Water Management Strategy in FBiH the estimated catchment area exposed to erosion is as high as 95% and eroded material from only 5% of the catchment area is trapped by soil and water conservation measures. The remaining amount causes either channel aggradation that reduces channel conveyance, or reservoir sedimentation. The reduction of channel conveyance increases the risk of flooding, while reservoir sedimentation affects not only hydropower production but also storage capacity and reservoir management during flood evets.

The flood damage is nowadays significantly increased when compared to the situation before the war in the Balkans due to the constant encroachment of flood plains caused by a rapid expansion of settlements, plants and infrastructure toward lower laying zones. This is particularly intensified, in lowlands of Semberija bounded with the Sava River on the North side and the Drina River on the East side, where intensive migrations during the 1990s, caused by the war, made migrants to settle in the flood prone zones where the land was cheaper. Nowadays, even the discharge of the Drina River of approximately 3500 m^3/s (flood event from May 2014), measured at "Radalj" measurement station, which corresponds to a 40-year return period, can cause substantial damages.

6.3.4.3. Serbia

The channel of the Drina River is in its lower course rather shallow, braiding and meandering due to great discharge variability, geological composition of river bed and banks, geo-mechanical characteristics of bed load, geo-mechanical characteristics of bed and river bank materials, regimes of bed and suspended load and unscheduled dredging of sand and gravel from the main channel and/or banks. Therefore, the conveyance capacity of the main channel is rather low – around 1100 m^3/s.

Consequently, the water spills in cut-offs, oxbow lakes and low-laying planes, erodes and undercuts river banks, moves the channel laterally (towards the east) and causes migration of existing and development of new bars. Furthermore, the groundwater table is rather high which makes arable lands of Mačva prone to both river and internal flooding. Mačva region is divided into a number of polders whose north and west boundaries are embankments along the Sava and Drina Rivers, respectively. During the two latest catastrophic flood events from December 2nd, 2010 and May 15th, 2014, when the entire area spanning from the origin of the Drina River at the junction of Piva and Tara Rivers to its confluence with the Sava River was severely endangered by high flows, Mačva region experienced both problems with internal flooding, and a serious threat of dike breaching on the Sava River side due to dike's poor condition along certain reaches.

In the middle course, river valleys of the two largest right tributaries – Rivers Ljubovińa and Jadar and those brooks that directly flow in the Drina River, are exposed to frequent flooding, i.e. they are flooded almost every year. There are no right tributaries in the upper course of the Drina River on the territory of the Republic of Serbia.

6.3.5. DROUGHTS

The Drina River Basin is generally abundant with water, but the droughts can occur. The increased climate variability has been observed since 1981 in all seasons. For example, a trend of rapid changes from extremely hot or cold periods, usually lasting between 5 and 20 days, and periods of intense rainfall, has been observed. Drought has also been more frequent and more intense over the past ten years: since 2000, there were five very dry years (2000, 2003, 2007, 2011 and 2012). Due to the limited irrigation infrastructure in lower Drina River Basin (e.g. only 0.65% of arable land in Republic of Srpska is irrigated), the year 2012 was the fourth successive year in which agriculture suffered significant losses due to droughts. The damages caused by drought and high temperatures during the summer of 2012 in BiH/RS were estimated at about USD 1 billion in lost agricultural production with almost 70% of vegetables and maize fields destroyed.

The high environmental value of the DRB could be endangered during drought periods. Primarily the small tributaries of the Drina River can be most affected during these drought events. Indeed, during extreme droughts, the main effects on environment could be:

- Endangered fish population (reduction of the population) by drying complete section of small tributaries, putting pressure on the food resources, increasing the water temperature, increasing the concentration of pollutants and degrading the water quality.
- Endangered terrestrial fauna habitats by destruction due to increase of forest fires.

This situation happened during extreme droughts in 2012 and 2013 when many kilometres of salmonid streams were left without water.

6.3.6. PERSPECTIVES ON FUTURE WATER MANAGEMENT

Three future demand scenarios for water use were analysed in the Integrated Water Resources Management Country Reports for the three riparian states. These were:

a. High Growth Scenario, taking the population growth experienced historically in the DRB. The growth rate was projected forward for 30 years (2044) and for 50 years (2064). Industrial and irrigation growth used the pro rata amount per inhabitant.

b. Flat Growth Scenario, taking the population constant for 30 years (2044) and for 50 years (2064). Industrial growth and irrigation growth also remain constant.

c. Real Growth Scenario, taking the population growth experienced in the DRB over the past 20 years. This growth rate is projected forward from last census for 30 years (2044) and for 50 years (2064). For industrial and irrigation growth pro rata amount per inhabitant are used.

Future water demand is summarised in Table 19.

Table 19. Allocation of Water Demand in the Water Management Regions of Serbia DRB

ountry	Scenario	Domestic			Industrial			Irrigation			Total net		
		2015	2044	2064	2015	2044	2064	2015	2044	2064	2015	2044	2064
Montenegro	HIGH GROWTH (+1.07%)	2.67	3.64	4.50	1.50	1.50	1.50	3.45	3.45	3.45	7.62	8.59	9.45
	FLAT GROWTH (0%)	2.56	2.56	2.56	1.50	1.50	1.50	3.45	3.45	3.45	7.51	7.51	7.51
	REAL GROWTH (-1.16%)	2.44	1.74	1.38	1.50	1.50	1.50	3.45	3.45	3.45	7.39	6.69	6.33
BiH	HIGH GROWTH (+0.9%)	4.65	4.90	5.08	6.13	6.46	6.70	1.49	1.57	1.63	12.27	12.93	13.41
	FLAT GROWTH (0.0%)	4.64	4.64	4.64	6.11	6.11	6.11	1.48	1.48	1.48	12.23	12.23	12.23
	REAL GROWTH (-0.7%)	4.54	3.40	2.78	5.99	4.48	3.67	1.45	1.09	1.09	11.98	8.97	7.54
Serbia	HIGH GROWTH (+0.9%)	3.11	4.03	4.82	2.79	3.62	4.33	3.41	4.42	5.29	9.31	12.07	14.44
	FLAT GROWTH (0.0%)	3.00	3.00	3.00	2.69	2.69	2.69	3.29	3.29	3.29	8.98	8.98	8.98
	REAL GROWTH (-0.7%)	2.92	2.38	2.07	2.62	2.13	1.85	3.20	2.61	2.27	8.73	7.12	6.19

The declining population in the DRB is a tangible issue, evidenced by the increasing number of abandoned dwellings in more remote villages. There is no evidence to suggest that this decline will change. Industrial demand also appears to be flat and there is no sign of any upturn in industrial activity in the basin. Demand from irrigation could increase, but there is no data to suggest this and the amount of agricultural land suitable for irrigation is also extremely limited. Climate change could have an impact on the future demand with longer periods of drought and this scenario will be further considered later in the project (through modelling). There could be small increases in demand from tourism, but this is not expected to be significant. Hydropower could also influence water use, but the water is likely to be retained within the river system.

Socio-economic development has a strong influence on future water availability and sectoral water demand. In general, therefore, the key drivers of change are:

- Water supply for the population. The water supply for the population should have the highest priority. From a quantity viewpoint, this can be satisfied for all users in all WMRs and can come from groundwater and surface water resources. However, from a quality perspective this is another issue, (see section on Water quality). The only solution would be the construction of wastewater treatment plants and the implementation of adapted landfills far from the riverbanks and the flood plains. Sanitary protection around licenced spring sources should also be considered to protect aquifers and groundwater supplies. The main problem in the region is usually inadequate sustainability of the water services/ public enterprises, low water tariffs and high water losses, which can only be resolved through long term reform and regulation of the water/sanitation sector, as well as capital investing secured.

- Flood security for the population. Recent floods that occurred in 2010 and then in 2014 caused significant damage to property in the DRB. This again highlights the ideals regarding the options for flood protection mitigation through the construction of multipurpose reservoirs and design of flood reserve volumes (to prevent flood surges), the creation of flood retention basins and the expansion and strengthening of the flood levees system. Furthermore, a restrictive policy of housing construction permitting procedures needs enforcement to prevent construction of housing on floodplains not protected from floods.

- Water supply for agriculture (irrigation) inc. fish farming. Water supply for irrigation is generally flat as there are no new irrigation areas considered in the DRB. The major part of the water supply for irrigation is from water courses with a very low percentage from groundwater resources. Furthermore, the water volumes to be withdrawn in the DRB are not significant and do not affect the water management balance. Predicted climate change in the future however may necessitate the need for more irrigation and different crops and cropping patterns, as well as the exempting the irrigation of the EF as the states' priority The agriculture needs shall be the II. priority due to the climate change and sustainable development. More water saving irrigation techniques (e.g. drip irrigation) therefore need further consideration for most optimal results.

- Water supply for industry. The water supply for industry is not a significant issue in the DRB although it was more important in the 1990's. Industrial production has significantly declined, and demand is not substantial. The same issue prevails on the quality aspects and there is need of corresponding wastewater treatment plants.

- Hydropower production. Water is at most diverted from the river on a limited, stretch, between the water intake and the power plant. Depending on the type of hydropower scheme (run-of-river or accumulation), the discharge regime of the river may marginally (run-of-river) to strongly modified (seasonal water transfer).

- Environmental conservation. The minimum environmental flow is the biggest water demand compared to other water uses and its volume is a very significant component in the water management balance especially during the dry season each year. The environmental flow can directly be in conflict with the irrigation water needs.

- Recreation, tourism and fishing. Recreation, tourism and fishing are in obvious conflict with other water uses, e.g. hydropower construction and operations, the diversion of waters resulting in dry riverbeds, pollution etc. However, enforcing the minimum environmental flow in all the WMR will mitigate this issue.

6.3.7. HYDROPOWER DEVELOPMENT

Until now, nine hydropower plants have been built in the DRB: "Uvac", "Kokin Brod", "Bistrica", "Potpeć", "Piva", "Višegrad", "Bajina Bašta", "Bajina Bašta" and "Zvornik". "Bajina Bašta" is a pumped storage HPP; all others are "regular" power plants. The total installed power is 1,932 MW and the average annual production 6,350 GWh. On the existing "Otilovići" storage, no HPP has been built yet.

A total of 41 HPPs are planned in the DRB. Figure 9 illustrate respectively the geographical location of all the planned HPPs (> 2 MW).

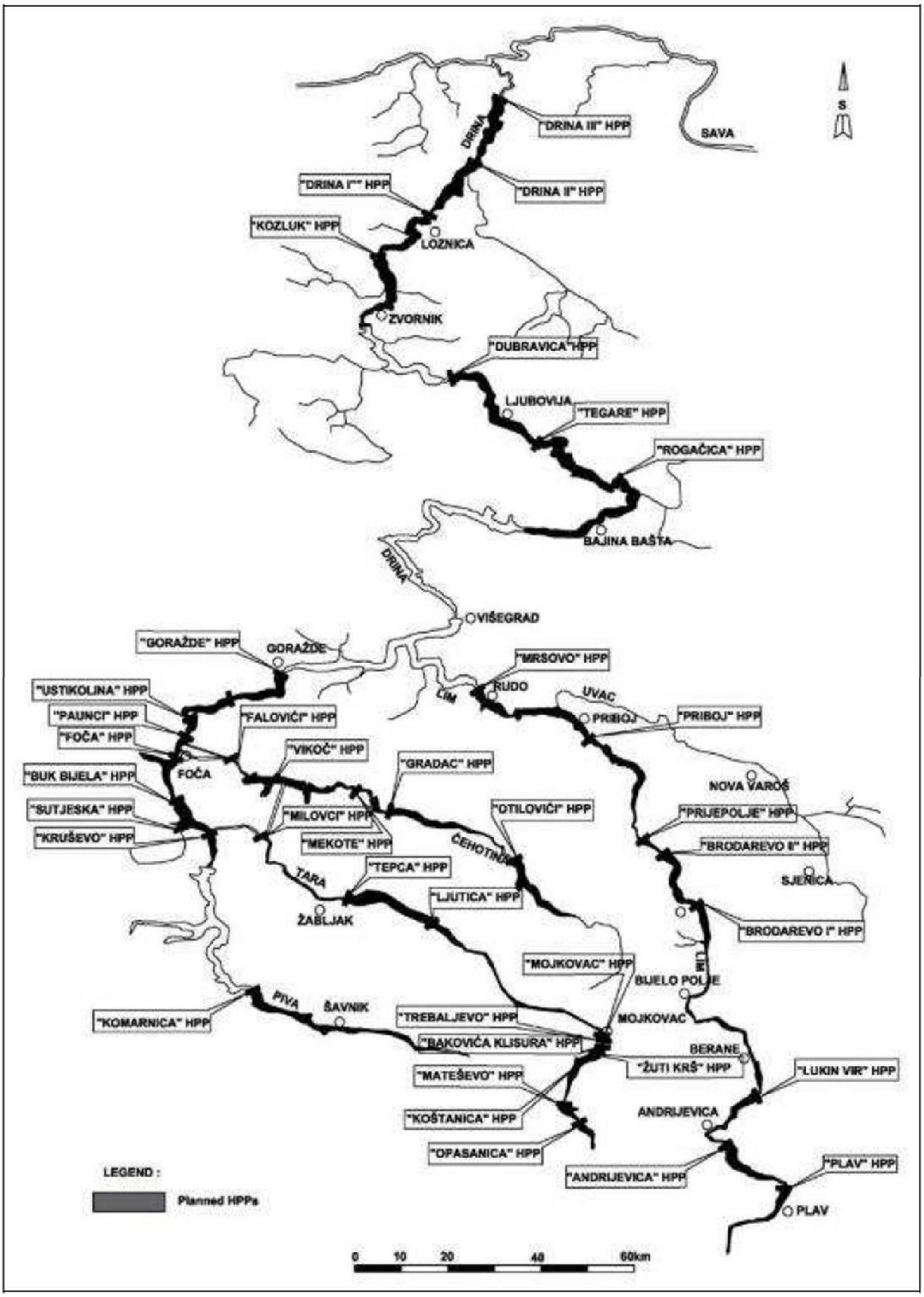

Figure 9. Planned HPPs on the Drina River Basin

6.4. KEY CHALLENGES OF FLOW REGULATION IN THE DRINA BASIN

Water management and environmental protection have been addressed in chapters 3 and 4 on environmental flows. Key challenges of flow regulation in the Drina basin are mainly related with hydropower and flood risk reduction.

Sustainable hydropower

Hydropower belongs to the main hydromorphological driving forces identified in the Drina basin. It is therefore essential to organize in close cooperation with the hydropower sector and all relevant stakeholders a broad discussion process with the aim of agreeing on guiding principles on integrating environmental aspects in the use of existing hydropower plants, including a possible increase of their efficiency, as well as in the planning and construction of new hydropower plants. The nexus assessment project identified some water management issues in the Drina River Basin related to hydropower:

- Cooperation in the operation of dams is limited. The Drina Basin's hydropower plants were originally designed and operated as a single system, when the countries were part of the former Socialist Federal Republic of Yugoslavia. The flow regime was controlled to minimise the impact of lower and higher flows, provide for flood protection and safeguard the maximum possible output from hydropower plants.66 Currently, however, flow regulation is sub-optimal because hydropower plants operate on a single unit base. This has increased the vulnerability of the power plants in the lower part of the basin to lower and higher flows. The uncoordinated operation of the dams with significant associated reservoir capacity may itself cause or aggravate high water levels, although the reservoir storage capacity on the Drina is relatively low from the point of view of flood response or containment, especially in periods of prolonged high precipitation. Developments in the energy sector, notably liberalization, integration into the single European Union energy market, building new infrastructure, integration of non-hydro renewable energies, makes coordination on dam operations more urgent.

- Hydropower development planning suffers from several shortcomings. The Drina countries want to develop the as yet unutilised hydropower potential in the Drina Basin. Ambitious plans have been put forward but are hampered by funding constraints and different interests in regional electricity trading. Low investment in renewable energies overall is affected by the state of development of the investment environment and related uncertainties, shortcomings in the governance including in the regulatory frameworks, complex procedures for issuing permits and limited institutional capacity. Hydropower development should be carefully planned, not least due to its potential negative effects on the basin's water resources and biodiversity, and with adequate consideration of, and consultation about, the related trade-offs. 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.

Flood protection

Floods have a high economic and human cost in the Drina countries – those of the May 2014 floods have been estimated at 15% of GDP for Bosnia and Herzegovina and about 4.7% of GDP for Serbia. The Drina Basin is characterized by the absence or poor maintenance of flood protection infrastructure, a paucity of 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 all water users have prepared their own individual development plans, considerable effort is now needed to integrate these sectoral plans and address the trade-offs between different water uses. Efforts are being made to improve the situation, though, including actions at the level of the Sava River Basin, with the support of the ISRBC (based on the Protocol on Flood Protection), and the Western Balkans Investment Framework (WBIF) programme, that already resulted with Sava FFWS as the flood forecasting and warning system covering the Drina Basin, as well as with Sava FRMP, the flood risk management plan that involves the planning activities and measures in the Drina Basin too.

All flood risk management activities should be planned and carried out in line with the article 9 of the Directive 2007/60/EC, which requires taking appropriate steps to coordinate the application of the EFD with the WFD, focusing on opportunities for improving efficiency, information exchange and for achieving common synergies and benefits having regard to the environmental objectives of the WFD.

7. RECOMMENDATIONS

The following recommendations are based on the study findings:

1. DEVELOP AN E-FLOW PROGRAM FOR THE DRINA BASIN

There is now a proliferation of debates around environmental flows, and significant current dynamism around the development of laws and policies to recognise environmental flows across the European Union and the world. The development of scientifically credible eflows national frameworks, taking into account their regional and local specificities, will be a major contribution to the resolution of conflicts on over water uses and to ensure of achieving EU ecological objectives. Such a common understanding of ecological flows and its effective implementation is particularly critical to embed in the management of transboundary river basins. On the other hand, support for implementation is bolstered where a clear, high-level working programme is achieved at the national and transboundary level. This can provide the political commitment required to ensure that implementation occurs. The eflow programme for establishing environmental flow requirements in the Drina basin should involve technical and non-technical components (i.e. technical evaluations, legal, regulatory, and public participation issues, etc.). Three aspects, among others, can be very relevant to carry out an e-flow program for the Drina basin:

1.1. HARMONIZATION OF EFLOW METHODS IN THE BASIN

Existing methods in the Drina countries are promising and well founded. Nevertheless, a sound, inclusive, transparent, and well-communicated process for harmonizing eflow methods in the basin should be carried out. According to another international experiences, tentative steps for this process could be:

a) Create an Expert Group on e-flows

A new Environmental Flow Advisory Group could conduct independent technical, legal, and policy analysis and develop a process to ascertain the suitability and structure of an environmental flow program for the Drina basin. The Expert Group's aim would be to provide technical advice to the Drina countries on issues relating to environmental flow assessments, its implementation and policy development. The Expert Group would also exchange information, experience and good practice on eflows covered by EU legislation. The Advisory Group would meet on multiple occasions to discuss how the environmental flow program might be implemented in the Drina basin, including the possible design, development and performance of pilot studies in designated sites. Measurable goals and objectives should keep eflow programme on track and set the stage for adaptive management.

b) Assessment of current e-flow methods in the Drina countries

The Environmental Flow Advisory Group could conduct a process for selection of methods and implementation of eflows. Selection includes relevant aspects related to the scientific knowledge, legal requirements and best practices in application of methods (Figure 10). In this sense, the Advisory Group task should include at least a comprehensive review of the legal and scientific fundamentals of methods, the field of application of ecological flows in the Drina countries, criteria for selection of methods and the requirements for an adequate application of them. The logic of the selection process is as follows:

(i) <u>Fundamentals of methods of calculation of environmental flows.</u>

A review of the legal aspects (1) helps to better contextualize the field of application and scope of environmental flows in the Drina basin. Usually the normative framework places eflows in the field of water management and environmental conservation (3). Review of legal aspects also identifies guiding principles of management of natural resources (ecosystem-based approach, IWRM, caution principle approach, etc.) that can be used for excluding inappropriate calculation methods (4). On the other hand, eflow science has evolved rapidly in the last two decades. A wide review of scientific foundations helps to better understand the dynamics of natural systems and key actions for preserving them (2). Thus, for example, the paradigm of the natural river, the natural range of variability, or the natural disturbance regime constitute clear elements that can be used for the selection of reference methods for the Drina basin (6).

(ii) <u>Scope of eflows</u>

Eflow scope determines those situations for which the ecological flows are necessary for management of natural resources. The field of application has big implications in the selection of the reference methods (6). For example, from the legal point of view it is obvious there are different levels of protection of natural areas what is related at the same time to eflows. According to the biological condition gradient, environmental flows would be closer to the natural hydrological regime if the protection level is higher and vice versa. Consequently, methods should have some interim adjustment required in each case (protected natural areas, heavily modified ecosystems, etc.).

(iii) Selection of reference methods

The objective in selecting eflow methods is to identify a set of suitable methods according to the different situations you can find in Drina basin (3). A preliminary step is to assess those appropriate eflow methods, i.e., acceptability criteria of methods (4) based on rigor and scientific validity (2) and legal conditions of the country (1). The starting point for the selection of methods are those ones established in the Drina countries. A good selection of methods could involve develop a good survey outside the Drina countries (i.e. broad and updated survey) to identify the most appropriate methods for the basin.

(iv) Application of methods

A case to case method should be selected according to the complexity and diversity of situations. A toolbox allows selecting methods depending of the degree of conflict, urgency of time and economic costs, and availability of information (7). In this context, a "toolbox approach" is more useful than a rigid recipe. On the other hand, good methods can lead to bad results if not applied correctly. In this sense, it is necessary to develop detailed protocols (8) to ensure they include pertinent information for correct application of methods.

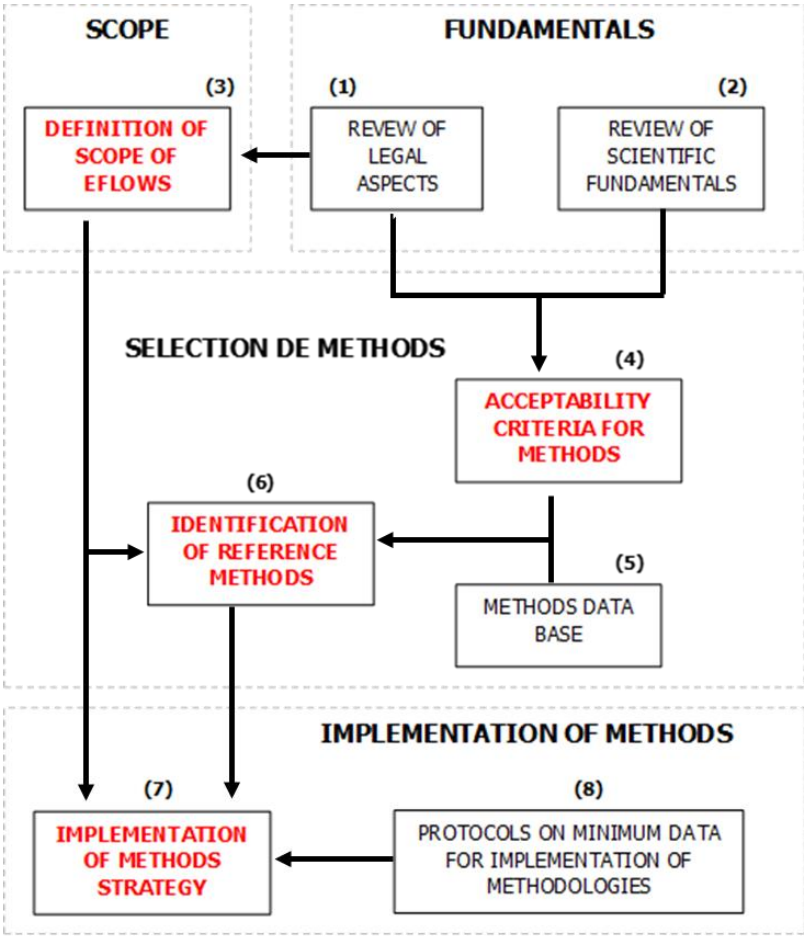

Figure 10. Systematic procedure search, selection and application of methods of calculation of Environmental flows

c) Final adoption of recommendations concerning eflow methods for the Drina basin: validating eflow methods through selected pilot studies

Successful local pilot projects are vital for building technical capacity and political support and showing that implementation is possible at much larger scales. Pilot sites should be undertaken to complete the verification of existing methods and application to characterize eflow requirements for a number of sites across the basin. The engagement of stakeholders in pilot projects ensures buy-in and builds trust that catalyses broader policy reform. Monitoring and interpretation of pilot-project outcomes assure stakeholders that human and ecosystem benefits are being delivered, and guide improvements in subsequent applications.

Pilot sites would ideally be selected in order to comprehensively represent a number of diverse issues related to physiography, land use, water taking, environment, watershed type and size and anticipated ecological thresholds. The studies in each pilot area would be organized focused on testing instream flow methods and focused on developing a framework or process to apply environmental flows methods in different sub-basins.

Results from pilot studies would be used as a basis for testing alternative flow methods and for assigning instream flow requirements for a number of streams and rivers across the Drina basin. A discussion of how suitable the alternative flow assessment tools is for each of the selected watersheds should be provided. The transferability of alternative methods to other locations and sub-basins would be discussed and recommendations should be made concerning what tools are best for different watershed conditions. The study results should focus on the following items:

- The effectiveness/value of each site, including the approach used as well as methods used and findings;
- The data requirements, level of detail, types of information to be collected/summarized in the field component and in the review and synthesis of available information including historical data;
- The applicability of the approach and findings to other watersheds;
- Discussing the various methods evaluated in terms of cost, suitability, accuracy and transferability; and
- Presenting major conclusions and recommendations, including identifying additional steps.

1.2. EFLOWS INTEGRATION IN THE WATER PLANNING

River basin planning is the process of collecting and analyzing river basin data and promoting and evaluating management measures in order to achieve the environmental objectives. The provision of environmental flows fundamentally depends on water being reserved as part of the allocation process to meet environmental objectives. Despite EU WFD does not use the term environmental flows explicitly, eflows play a significant role to ensure a better achievement of the main components of the planning process: Environmental flows contribute to defining environmental objectives, establishment of pressure thresholds regarding the risk of not achieving environmental objectives, design and implementation of the program of measures, etc. Effective integration of eflows in the river basin management plan could be developed as follows:

a) Identify steps and phases in the water planning process where eflows are relevant

Water quantity issues are imbedded in the water planning process. This is the case of the WFD. For example, all categories of water bodies (rivers, lakes, transitional waters or coastal waters) include the hydrological regime as a relevant variable that affects the ecological status. Another example are those water bodies affected by hydrological alterations, where eflows should be considered in many implementation steps: i) identification of significant pressures; ii) assessment of the risk of failing environmental objectives; iii) design of the monitoring program; iv) construction of a cost-effective program of measures to achieve environmental objectives. Additional explanations can be found in Appendix A.

b) Conduct eflow assessments in the Drina basin in a strategic way

Eflow assessments provide the data necessary to help support decision-making processes. A robust assessment should be used to determine environmental water requirements. Eflow studies will (usually) need to be considered in the context of the broader water allocation planning process, as well as other relevant basin planning activities. The assessment process should involve determining:

- The key environmental objectives for the river basin, such as important environmental assets or processes to be sustained; and
- The flow regime required to meet those objectives (e.g. to sustain important assets in the desired condition).

It should be noted that assessments can take several years and high cost of resources. Generally speaking, high-confidence, very explanatory, easily defensible assessments contrast with quick and easy, inexpensive, lower-confidence estimates, that may need to be monitored and revised. As a rule, the efforts and time required increases as the spatial scale of assessments decreases, and more focused and quantitative assessments are necessary. Strategic planning process in eflow assessment requires a well-structured plan for how to optimally allocate time, human capital and financial resources to carry out eflow assessments in the basin. A phased hierarchical approach is probably the most efficient way to address the application of methods in a basin. As another international experiences, it could be developed a consistent 3-level assessment and implementation framework that builds seamlessly from simple desktop estimates of flow needs through to a highly sophisticated programme of research and modelling to refine environmental flow targets with each level building information, capacity, and support for subsequent levels of sophistication as deemed necessary. Geographical phasing is another option, starting with high priority sites.

c) Eflow negotiations with riparian countries and stakeholders

The water allocation process is, fundamentally, a socio-economic process, albeit one informed by the best available science and involving multiple objective optimisation. It is the mechanism for deciding how water should be allocated between competing uses and users. Thus, while an environmental flow assessment may identify a preferred flow regime, the water allocation process should reconcile these requirements with the needs of other water users. This may involve adjusting or trading-off environmental objectives against other uses.

The purpose of this process is to make informed allocation decisions: to ensure that where water is allocated to the environment, this water will be made available in the most effective way. Similarly, where decisions are made not to provide water for certain environmental purposes, this is done with an understanding of the risk of environmental damage and the likelihood of loss of environmental goods and services.

The result of this process should be the allocation scheme in the River basin Management Plan which:

- Identifies key environmental assets, and the flows required to sustain them
- Determines the consumptive/non-consumptive split within the basin (i.e. how water will be shared between the environment and other water users)
- The mechanism for achieving the required flows

1.3. EFFECTIVE IMPLEMENTATION OF E-FLOWS IN THE DRINA BASIN

Despite advances in improving environmental flows science and establishing national environmental flows policies, internationally progress in implementation remains poor. In most cases, environmental flows implementation has remained stalled at the policy level, with relatively few instances of environmental flows being incorporated into allocation rules and operating arrangements. In those instances where water has been allocated for the environment, it has often been done in a simplistic manner, with little understanding of the underlying environmental needs, and at levels below what is required to achieve a healthy ecosystem.

There is a range of regulatory tools and approaches used for implementing environmental flows. These options are not mutually exclusive, and in many instances a combination of these approaches may be appropriate. The type of approach adopted may vary with the level of development, the level of environmental stress, and based on what is practically possible given the existing water resources management systems. The following tools are generally given effect through one or a combination of annual water allocation rules, water abstraction licences and reservoir operation licences.

1) Develop reservoir operation rules and special flow releases

The River Basin Management Plan may define minimum volumes of water that must be flowing in the river at certain locations and at certain times. It is commonly used to regulate the actions of infrastructure operators, including for hydropower production. The water infrastructure licence may specify environmental flow requirements with which the reservoir operator must comply, including: i) minimum daily releases (for instance to maintain base flows); ii) requirements to pass-through certain events (such as environmentally important pulses); iii) maximum rates of rise and fall (to minimize ecological harm caused by rapid changes in flow rate or depth); iv) requirements not to release water at certain times (for instance, in rivers that are periodically dry under natural conditions). This type of approach can be particularly relevant where total water abstraction is low (that is, mean annual flows remain high relative to natural levels), but significant hydropower development means there is a potential for major changes to the seasonality and variability of the flow pattern.

2) Assess if limits to abstraction are needed

The River Basin Management Plan may reserve a volume or percentage of the available water for environmental purposes. Water entitlements are granted to other water users with consideration of this reserve. As a result, provided estimates of the available water supplies are correct, and provided water users do not exceed their entitlements, the reserved water should remain in the river system for environmental purposes. These limits are typically given effect through licensing systems, with water managers not allowed to grant water licences that will take total consumption beyond the defined limit. Placing a cap on abstractions can be a critical first step in protecting flows for the environment. Experience shows that it can be extremely difficult to recover water for the environment. As such, there can be merit in establishing a cap on further growth in abstractions, even where there is not a detailed understanding of the environmental flow requirements for the basin.

3) Preconditions to abstraction and event-based management rules

The RBMP or an abstraction licence may prescribe flow conditions that must be met prior to water being abstracted or limit the amount of water that can be abstracted. Such an approach can allow for environmental water requirements to be given priority, by limiting water abstraction by other users until environmental needs have been met.

2. DEVELOP OPERATIONAL RULES IN THE DRINA BASIN

A reservoir operation policy specifies the amount of water to be released from the storage at any time depending upon the state of the reservoir, level of demands and any information about the likely inflow in the reservoir. Reservoir operating rule curves are the most common way for guiding and managing the reservoir operation and ensuring high water supply reliability. The rule curves are developed at the planning stage through intensive regulation of typical inflow series based on long-term inflow data, water demands, experiential judgment, and engineering standard. With the recognition of environmental benefits for reservoir releases and the emergence of society’s awareness of hydrological hazards, significant opportunities exist to update reservoir operations in the Drina basin.

1) Developing harmonized or coordinated operational rules in the basin

The coordinated operation of multiple-reservoirs systems is typically a complex decision-making process involving many variables, many objectives, and considerable risk and uncertainty. System operators are challenged to meet often conflicting objectives while complying with all legal contracts agreements and traditions affecting water allocations and use. The Drina Basin’s hydropower plants were originally designed and operated as a single system, when the countries were part of the former Socialist Federal Republic of Yugoslavia. The flow regime was controlled to minimise the impact of lower and higher flows, provide for flood protection and safeguard the maximum possible output from hydropower plants. Currently, however, flow regulation is sub-optimal because hydropower plants operate on a single unit base. This has increased the vulnerability of the power plants in the lower part of the basin to lower and higher flows. It´s highly recommended to start discussing about developing harmonized or coordinated operational rules for all the major HPPs to reflect relevant issues, including flooding, sediment management in a coordinated fashion, water shortage (including in relation to other/future uses), environmental flows, solid waste etc.

2) Integrate flow variability and extremes in reservoir rule curves

Hydrological variability exists both seasonally and interannually. Seasonal variability results from the normal changes in water availability over the course of the year. Unlike seasonal variability, interannual variability is inherently unpredictable. Inadequate provisions for dealing with interannual variability are the root cause of many basin water management disputes around the world. Poorly designed allocation plans can inadvertently penalize certain regions or sectors. Equally, agreements may lack a clear or agreed mechanism for addressing this problem, leading to conflict.

Additionally, floods and droughts have caused, and continue to cause, serious economic and environmental losses in the basin. Further development in floodplains and areas with limited water supplies also increase losses. Due to climate change and landscape change there is an increasing need to emphasize prevention, preparedness, mitigation, and risk management to respond to these events in order to protect human safety, quality of life, economy and environment. Particularly, operational curves should consider extreme flows. With flow rates below a minimum threshold, production of hydropower should be at minimum, transportation and water abstraction would be difficult, and negative impacts can be visible on fisheries and aquaculture, as well as on recreational uses of the river. By contrast, high flow rates of more than a specified value would cause harm to hydropower production and can also damage properties and industries. In addition to mechanisms for addressing normal variability, reservoir rule curves may also consider acute periods of water shortage or excess. Generally, drought and flood plans are triggered based on storage levels, each of which elicits a particular response.

3) Integrate uncertainty in operational rules

Current and future changes associated with socio-economic development and climate are characterized by high levels of uncertainty. Uncertainty can relate to changes in average water availability, greater climatic variability, and limited information on the nature and impact of possible changes. Greater levels of uncertainty are likely to increase the need for adaptive management and thus increase the importance of having the flexibility to amend operational rules. Decision makers have found that scheduling reviews and updates on a fixed schedule is a useful means of ensuring its long-term flexibility. Technical progress, as well as the implications of emerging data, can lead to reconsideration of goals, progress and policy. Consequently, operational rules and the water release program should be discussed and approved by the parties periodically.

3. DEVELOPING EXCHANGE OF INFORMATION

The exchange of data and information in the Drina basin can provide a first step toward broader transboundary cooperation and agreeing and formalizing, taking into account existing frameworks. A solid information base is necessary to delineate areas of agreement and disagreement and to structure and inform debate. On an agreed basis and in an agreed framework, exchange of data and information can form a basis for coordinated management. Coordinated management at a basin level can improve water use efficiency and minimize impacts of droughts, floods, and other extreme events. At the operational level, exchange of data and information can be fundamental to implementation of what is agreed, for example, by providing the information necessary to control dam operations for power production and flood control. Long after an agreement or other appropriate arrangement/modality (or arrangements/modalities) is concluded, maintaining cooperation and adherence to its provisions requires trust. Information and data exchange can be a catalyst for confidence building. Data and information exchange can form a basis of transparency and trust, providing mutual assurance of joint compliance.

Procedures for Data Sharing and Exchange should specify the type of data and information to be shared, as well as source, frequency, format, standards, quality assurance, and the method of transfer; roles and responsibilities of involved institutions; timeframes for supplying the agreed data and information; and ownership and access rights to shared data and information.

In particular, data in the Drina basin should:

- Promote transparency about the operational rules and regimes of dam operators in the basin.
- Improve monitoring and data collection and exchange on the status of waters. Monitoring programmes should be adapted to provide an improved picture of hydrological alterations and their impact on habitat/morphology and biology. The development of operational hydrological monitoring should relate to the surface and groundwater hydrological pressures and be prioritised where action is likely to be needed.
- Increase the exchange of information and data. As energy production only currently covered by data exchange between the power companies, and there is a need for information on water availability and variability, extend exchange of information and data. Explore options for officialising access to data. Enable hydropower companies to benefit from available hydrometeorological data in the Sava GIS Geoportal. Encourage new institutions, seeing benefits in joining, to access to /participation in ISRBC data exchange policy.

APPENDIX A. ENVIRONMENTAL FLOWS IN THE WFD PLANNING PROCESS

River basin planning is the process of collecting and analyzing river basin data and promoting and evaluating management measures in order to achieve the environmental objectives. The provision of environmental flows fundamentally depends on water being reserved as part of the allocation process to meet environmental objectives. Despite EU WFD does not use the term environmental flows explicitly, eflows play a significant role to ensure a better achievement of the main components of the planning process: Environmental flows contribute to defining environmental objectives, establishment of pressure thresholds regarding the risk of not achieving environmental objectives, design and implementation of the program of measures, etc. Figure A-1 shows how ecological flows are embedded in the WFD water planning process.

Pressure and impact analysis (1)

Article 5 establishes that each Member State shall ensure that for each river basin district a review of the impact of human activity on the status of surface waters and on groundwater according to the technical specifications set out in Annexes II and III.

Annex III specifies that Member States shall collect and maintain information on the type and magnitude of the significant anthropogenic pressures to which the surface water bodies in each river basin district are liable to be subject, inter alia:

- Estimation and identification of significant water abstraction for urban, industrial, agricultural and other uses, including seasonal variations and total annual demand, and of loss of water in distribution systems.

- Estimation and identification of the impact of significant water flow regulation, including water transfer and diversion, on overall flow characteristics and water balances.

Article 5 analysis should carefully assess the significant pressures altering the flow regime, which result in an impact on biology likely to contribute to the failing of environmental objectives. For those bodies identified as being at risk of failing the environmental quality objectives, further characterization shall, where relevant, be carried out to optimize the design of both the monitoring programs required under Article 8, and the program of measures required under Article 11.

With respect to groundwaters, Member States shall carry out the characterization of all groundwater bodies to assess their uses and the degree to which they are at risk of failing to meet the objectives for each groundwater body under Article 4. This analysis shall identify, inter alia, abstraction and those groundwater bodies for which there are directly dependent surface water ecosystems or terrestrial ecosystems.

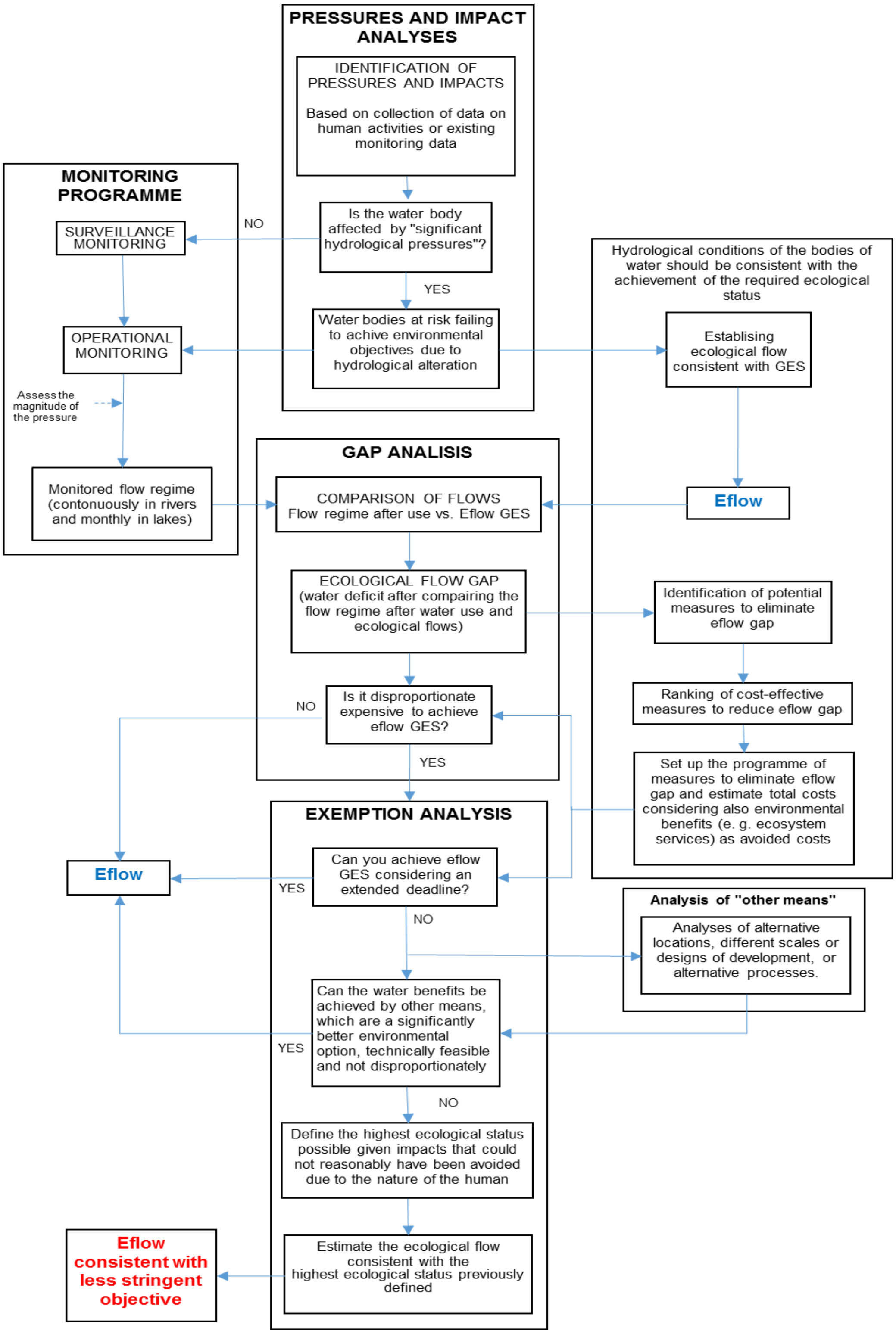

Figure A-1. Eflows in the WFD water planning process

Monitoring (2)

Member States shall ensure the establishment of programs for the monitoring of water status in order to establish a coherent and comprehensive overview of water status within each river basin district. For surface waters such programs shall cover the volume and level or rate of flow to the extent relevant for ecological and chemical status and ecological potential. For groundwaters such programs shall cover quantitative status. In protected areas the above programs shall be supplemented by those specifications contained in Community legislation under which the individual protected areas have been established.

Operational monitoring shall be undertaken in order to establish the status of those bodies identified as being at risk of failing to meet their environmental objectives. In order to assess the magnitude of the pressure to which bodies of surface water are subject Member States shall monitor for those quality elements which are indicative of the pressures to which the body or bodies are subject (e.g. hydrological regime). For bodies at risk from significant hydromorphological pressure, sufficient monitoring points within a selection of the bodies in order to assess the magnitude and impact of the hydromorphological pressures.

Establishing environmental objectives (3)

The core objective for surface waters is to improve waters where necessary in order to achieve at least good status. Surface waters and groundwaters already meeting good or better standards must continue to be managed to protect them from deterioration. Some waters require greater protection (including drinking, bathing and shellfish waters, nutrient-sensitive areas, protected habitats and species). Protected areas must achieve standards relevant to their designation which may be stricter than good status.

Some surface waters have been substantially changed in character to allow uses such as navigation, water storage, public supply, flood defense and land drainage. Heavily modified and artificial waters are expected to achieve good ecological potential, which recognizes their important uses while making sure that ecology is protected or improved as far as possible.

Gap analysis (4)

In the general context of the WFD, “gap analysis” consists in the identification for each water body of any deviation between its existing status and the one required to achieve the environmental objective. In cases where hydrological alterations are likely to prevent the achievement of environmental objectives, an assessment of the gap between the current flow regime and the ecological flows should be carried out: the “Eflow gap analysis”. This analysis requires the previous definition and calculation of ecological flows.

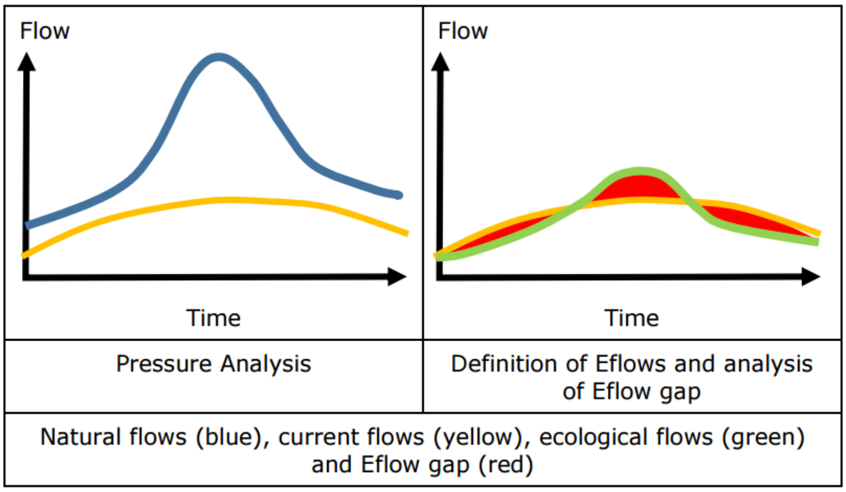

Figure A-2. Graphical definition of eflow gap.

While the pressure analysis assessment of hydrological alteration considers the deviation of current flows from natural flows, Eflow gap analysis consists in assessing the distance between current flows and ecological flows (figure A-2).

The concept of "eflow gap" or Eco-deficit (originally developed for regulating flows through dams in an ecologically sustainable way) can be computed over any time period of interest (month, season, or year) and reflect the overall loss in streamflow during that period that results from flow modification.

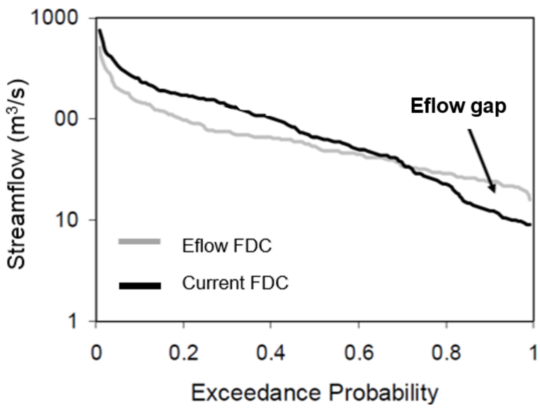

Figure A-3. Definition of the ecodeficit region (eflow gap) corresponding to the area between current and eflow flow duration curves.

Eflow gap represents the net volume of water that is now unavailable for ecological flow needs due to the water withdrawals or regulation (figure A-3). This is an important piece in developing the program of measures. For surface water bodies that currently meet the ecological flow regime corresponding to its environmental objective (no eflow gap), focus will be to maintain the current measures (or any additional) to meet those ecological flows in the future. Conversely, where the current hydrological regime prevents eflow compliance attention should be focused on the PoM to eliminate the gap in meeting such ecological flows.

Programme of measures (5)

Each Member State shall ensure the establishment for each river basin district of a programme of measures, taking account of the results of the analyses required under Article 5, in order to achieve the objectives established under Article

The programme of measures builds on the gap analysis and includes, inter alia:

(c) measures to promote an efficient and sustainable water use in order to avoid compromising the achievement of the objectives specified in Article 4;

(e) controls over the abstraction of fresh surface water and groundwater, and impoundment of fresh surface water, including a register or registers of water abstractions and a requirement of prior authorisation for abstraction and impoundment. These controls shall be periodically reviewed and, where necessary, updated. Member States can exempt from these controls, abstractions or impoundments which have no significant impact on water status;

(i) for any other significant adverse impacts on the status of water identified under Article 5 and Annex II, in particular measures to ensure that the hydromorphological conditions of the bodies of water are consistent with the achievement of the required ecological status or good ecological potential for bodies of water designated as artificial or heavily modified. Controls for this purpose may take the form of a requirement for prior authorization or registration based on general binding rules where such a requirement is not otherwise provided for under Community legislation. Such controls shall be periodically reviewed and, where necessary, updated;

Exemptions (6)

The Directive includes a number of provisions that allow Member States to set lower environmental standards for specific water bodies where there are legitimate technical, economic, environmental or recovery constraints, default objectives are redefined by setting alternative objectives for the waters in question.

Instances where the costs of measures to bring a water body into compliance with Directive requirements are disproportionate to the benefits gained, or where there is no feasible alternative solution, may form the basis upon which to seek a permanent derogation. Note that in all cases where alternative objectives apply, all actions that are technically feasible and not disproportionately expensive should still be taken to reach the best status possible.