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Consulting Services for

SUPPORT TO WATER RESOURCES MANAGEMENT IN THE DRINA RIVER BASIN

PROJECT ID NO. 1099991

BOSNIA AND HERZEGOVINA – IWRM STUDY AND PLAN – BACKGROUND PAPER – VOLUME 1 – MAIN REPORT

June 2016

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ACRONYMS AND ABBREVIATIONS

AAC	Average annual concentration
AASWA	Agency of the Adriatic Sea Water Area
ADR	Age Dependency Ratio
AGN	Agreement on Main Inland Waterways of International Importance
AIDS	Acquired Immune Deficiency Syndrome
ASRWA	Agency of the Sava River Water Area, Sarajevo
Art.	Artificial
ASCI	Areas of Special Conservation Interest
BD	Brčko District
BiH	Bosnia and Herzegovina
BMW	Biological Municipal Waste
BOD	Biological Oxygen Demand
BPKG	Bosansko-podrinjski Kanton Goražde – Sarajevo
^oC	Degrees Celsius
$Ca\ CO_3$	Calcium Carbonate
ca	Approximately
CARDS	Community Assistance for Reconstruction and Development
Ca/Mg	Calcium – Magnesium Mole Ratio
CBMT	Central Bosnian terrane
CEPRES	Centre for Ecology and Natural Resources
CG	Crna Gora (Montenegro)
CH	Matthey Method of environmental flow
CH_4	Methane
CIS	Common Implementation Strategy
CLIDATA	Climate Data Software System
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CORINE	Coordinated Information on the European Environment
CW	Civil Works
DC	Direct Current
DHCT	Dalmatian-Herzegovinian composite terrane
DIKTAS	Dinaric Karst Aquifer System
DIV	Diversion (Hydropower Type)
DJF	Winter season (December, January, February)
DNA	Designated National Authority
DOP	Dinaridic Ophiolite Belt
DRB	Drina River Basin
E	Endangered
EBDT-IBDB	East Bosnian-Durmitor terrane
EBRD	European Bank for Reconstruction and Development
EBU-POM	Eta Belgrade University – Princeton Ocean Model
EE	Electrical Equipment
EEA	European Environmental Agency
EEC	European Economic Community
EF	Environmental Flow
Eh	Oxidation reduction potential (redox)
EIA	Environmental Impact Assessment
El	Elevation

ACRONYMS AND ABBREVIATIONS

EN	Endemic
EP	Elektroprivreda
EPA	Environmental Protection Agency
EPCG	Elektroprivreda Crna Gore (Montenegro)
EPR	Environmental Performance Review
EPS	Elektroprivreda Serbia
ER	Endemic Relict species
ERS	Elektroprivreda Republike Srpske
EU	European Union
EUR	Euro
FAO	Food and Agriculture Organisation
FASRB	Framework Agreement on Sava River Basin
FBiH	Federation of Bosnia and Herzegovina
FCDA	Federal Civil Defence Authority
FGO	Federal Geological Office
FHMO	Federal Hydro-meteorological Office
FHMS	Federal Hydro-meteorological Service
FIA	Federal Inspection Authority
FMAWMF	Federal Ministry of Agriculture, Water Management and Forestry
FMEMI	Federal Ministry of Energy Mining and Industry
FMET	Federal Ministry of Environment and Tourism
FMIA	Federal Ministry of Internal Affairs
FMTC	Federal Ministry of Transport and Communications
FOFDP	Federal Operational Flood Defence Plan
FRY	Federal Republic of Yugoslavia
FSO	Federal Statistical Office
GCI	Global Competitive Index
GCOS	Global Climate Observing System
GDP	Gross Domestic Product
GEP	Guaranteed Environmental Flow method
GHG	Green House Gas
GIS	Geographical Information System
GSS	Geological Survey Service Montenegro
GW	Groundwater
GWB	Groundwater Body
GWh	Gigawatt hours
H	Height (water level)
Ha	Hectare
HBV	Hydrologiska Byråns Vattenbalansavdelning – Swedish HBV Model
HDI	Human Development Index
HDWG	Hydrology Domain Working Group
HEC-HMS	Hydrologic Engineering Centre – Hydrologic Modelling System
HEC-RAS	Hydrologic Engineering Centre – River Analysis System
HIS	Hydrological Information System
HME	Hydro-Mechanical Equipment
HMSS	Hydro-Meteorological Service of Serbia
HMWB	Heavily Modified Water Body
HMZ	Hydro meteorological Institute
HPP	Hydropower Plant

ACRONYMS AND ABBREVIATIONS

HS	Hydrological Station
IAWD	International Association of Waterworks in the Danube Catchment Area
IBA	Important Bird Areas
IBRD	International Bank for Reconstruction and Development
ICPDR	International Commission for the Protection of the Danube River
IE	Inter (entity) water body
IMO	International Meteorological Organization
INC	Initial National Communication
INDC	Intended Nationally Determined Contribution
Inst	Installed
IPAs	Important Plant Areas
IPCC	Intergovernmental Panel for Climate Change
IPF	Investment Prioritisation Framework
IPPC	Integrated Pollution Prevention and Control
ISRBC	International Sava River Basin Commission
IT	Information Technology
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
JCI	Jaroslav Černi Institute
JJA	Summer season (June, July, August)
JV	Joint Venture
KM	Convertible Marks
km	kilometres
Km^2	Square kilometres
kV	Kilovolt
kW	Kilowatt
KWh	Kilowatt hour
LBAP	Local Biodiversity Action Plan
LC	Least Concern
l/c/d	Litres per capita per day
LEP	Law on Environmental Protection
LFFEP	Law on Fund and the financing of environmental protection RS
LN	Log Normal
LP	Log Pearson
L/s	Litres per second
$l/s/km^2$	Litres per second per square kilometre
LW	Law on Waters
LWM	Law on Waste Management
LWP	Law on Water Protection
m	Metres
m^3/s	Cubic metres per second
m^3/year	Cubic metres per year
MAEP	Ministry of Agriculture and Environmental Protection - Serbia
MAFWM	Ministry of Agriculture, Forestry and Water Management (RS BiH)
MAM	Spring season (March, April, May)
MARD	Ministry of Agriculture and Rural Development - Montenegro
MAWRMF	Ministry of Agriculture, Water Resources Management and Forestry – RS BiH
m a.s.l.	Metres above sea level
MCH	Meteorological, Climatological and Hydrological database

ACRONYMS AND ABBREVIATIONS

MCS	Mercalli-Cancani-Sieberg scale (Seismic Intensity)
MCT	Ministry of Communications and Transport
ME	Mechanical Equipment
MET	Ministry of Environment and Tourism
Mg/l	Milligrams per litre
MH	Ministry of Health
MIA	Ministry of Internal Affairs
MIEM	Ministry of Industry Energy and Mining (RS)
mm	Millimetres
Mm^3	Millions of cubic metres
Mm^3/yr	Million cubic metres per year
mm/a	Millimetres per year
MME	Ministry of Mining and Energy
MNE	Montenegro
MNM	Memorial Nature Monument
MOFTER	Ministry of Free Trade and Economic Relations (BiH)
MoN	Monument of Nature
MoU	Memorandum of Understanding
MPC	Maximum Permissible Concentration
MQ	Mean Monthly Flow
MS	Meteorological Station
MSPCEEP	Ministry of Spatial Planning, Civil Engineering and Environmental Protection (RS)
Mt	Mountain
mV	Millivolts
MVA	Mega Volt Ampere (apparent power)
MW	Megawatt
NAMA	Nationally Appropriate Mitigation Actions
Nat.	Natural
NE	Not Endangered
NE	North East
NGO	Non-Government Organisation
NH^3	Ammonia
NMVOC	Non-Methane Volatile Organic Compounds
NO_2	Nitrous Oxide
NO_x	Mono-nitrogen oxides
NP	Nature Park
NRW	Non-Revenue Water
NT	Near Threatened
NW	North west
O_3	Ozone
O&M	Operation and Maintenance
OECD	Organisation for Economic Cooperation and Development
OEL	Operation Elevation Level
OG	Official Gazette
OGC	Open Geospatial Consortium
p	Probability
PA	Protected Areas
PCW	Preparatory Construction Works
PE	Public Enterprise

ACRONYMS AND ABBREVIATIONS

pH	a numeric scale used to specify the acidity or alkalinity of an aqueous solution
PHI	Public Health Institute
PHO	Public Health Office
PSHPP	Pumped Storage Hydropower Plant (reversible HPP)
PM	Particulate Matter (PM_{10} $PM_{2.5}$)
POP	Persistent Organic Pollutants
PRTR	Pollutant Release and Transfer Register
PUC	Public Utility Company
Q	Discharge
RANSMO	Development of a National Environmental Monitoring System
RBMP	River Basin Management Plan
RCM	Regional Climate Model
RCP	Representative Concentration Pathways
REC	Regional Environmental Centre
RES	Renewable Energy Sources
RGSO	Republic Geologic Survey Office (RS)
RHMO	Republic Hydro Meteorological Office (RS)
RHMS	Hydro meteorological Service of Serbia (RS)
RIA	Republic Inspection Authority
RNP	Regional Nature Park
RP	Regional Park
RS	Republic Srpska
SAA	Stabilisation and Association Agreement
SE	South East
SEA	Strategic Environmental Assessment
SEEBAP	South East Europe Biodiversity Action Plan
SEI	Stockholm Environment Institute
SEPA	Serbian Environmental Protection Agency
SFRY	Socialist Federative Republic of Yugoslavia
SHPP	Small (mini) Hydropower Plant
SMCT	Serbian-Macedonian composite terrane
SNC	Second National Communication
SNR	Special Nature Reserve
SO_2	Sulphur Dioxide
SO_x	Sulphur Oxides
SON	Autumn season (September, October, November)
SRB	Sava River Basin
SR BiH	Socialist Republic of BiH
SRES	Special Report Emissions Scenarios
SRO	Science Research Organisation
SW	Surface Water
SW	South West
SWB	Surface Water Body
T	Threatened
TBA	Trans Boundary Aquifer
TDA	Drina Rapid Transboundary Diagnostic Scan and Analysis
TNC	Third National Communication
TPP	Thermal Power Plant
TOR	Terms of Reference

ACRONYMS AND ABBREVIATIONS

UN	United Nations
UNDP	United Nations Development Program
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Program
UNESCO	United Nations Educational Scientific and Cultural Organisation
UNESCO-IHE	UNESCO – Institute for Water Education
UNFCCC	United Nations Framework Convention for Climate Change
USA	United States of America
USD	United States Dollar
UTC	Coordinated Universal Time
VZCT	Vardar Zone composite terrane
VF	Vascular Flora
VNC	Multiple Non-Linear Regression Model
VU	Vulnerable
WAAC	Water Area Advisory Council
WAC	Water Area Council
WATCAP	Water and Climate Adaptation Plan
WB	World Bank
WBIF	Western Balkans Investment Framework
WD	Water Directorate
WEA	Water Endangering Activities
WEAP	Water Evaluation and Planning System by SEI
WED	Water Endangering Deposition
WFD	Water Framework Directive
WHO	World Health Organisation
WHYCOS	World Hydrological Cycle Observing System
WISKI	Water Information Systems KISTERS
WMO	World Meteorological Organisation
WMR	Water Management Region
WQI	Water Quality Index
WRMP	Water Resources Master Plan
WWII	World War Two
WWF	World Wildlife Fund
WWTP	Wastewater Treatment Plan
%	Percentage
µg/l	Milligrams per litre
µS/cm	Micro Siemens per centimetre
µm	Micro metres

EXECUTIVE SUMMARY

The Joint Venture (JV) Consultant comprising COWI AS of Norway as lead together with JV partners Stucky Limited from Switzerland and Jaroslav Černi Institute (JCI) from Serbia have entered into a contract (Contract No 8005176) with the World Bank to provide support to the Water Resources Management of the Drina River Basin (DRB). COWI are also supported by the Sub Consultants, CeS COWI of Belgrade and the Faculty of Civil Engineering of the University of Belgrade.

The Contract for the assignment was signed 2nd October 2014 and the Inception period ended with the approval of the Inception Report by World Bank and the Steering Committee in March 2015. This report in hand represents the Integrated Water Resources Management Country Report for the Bosnia and Herzegovina (BiH) part of the DRB.

Physical Characteristics of the Basin

The Drina River appears at the joining of the Tara River and Piva River near Šćepan Polje. The biggest and the most water-abundant tributary is the Lim River. Its tributaries are also Sutjeska River, Bistrica River, Ćehotina River, Prača River, Rzav River, Drinjača River and others. The DRB in BiH covers 7,300 km^2 (about 6,400 km^2 in the Republic of Srpska (RS) and 900 km^2 in the Federation of BiH) and represents just over one third of the entire basin.

The landscape is dominated by past glaciation and karstification in the higher mountain ranges and by karst and alluvial relief in the lower regions. In the lower catchment, the Drina flows into the Sava River and in that part of the basin belongs to the Jadar Geotectonic Block terrane (JBT). The DRB is mostly covered by sediments of Neogene and Quaternary age. Also, the DRB partly passes through the Western Belt of Vardar Zone (VZWB), known as "Zvornik Suture". That marks the tectonic boundary between the Drina-Ivanjica and Jadar-Kopaonik thrust sheets. Then the Drina River passes through the geotectonic units of Drina-Ivanjica element (DIE), the Dinaridic Ophiolite Belt (DOB) and the East Bosnian-Durmitor terrane (EBDT) and in a small part through the Dalmatian-Herzegovinian composite terrane (DHCT).

The main rock type is karst that has been weathered providing favourable conditions for groundwater storage. Alluvial sequences are common in the north of the basin. Geology has a major influence on sol formation. In the north of the DRB in BiH, the most common types of soil are Stagnic Podzoluvisols, Fluvisols, Umbric Gleysols and Eutric Gleysols. In the central part of the DRB in BiH in the hilly areas, the most common types of soil are Chromic Luvisols, Eutric Cambisols, Leptosols – Rendzic Leptosols and Vertisols. Soil erosion can be a problem in these areas especially on slopes of 13% or more. In the mountain zones in the south of the DRB in BiH, Dystric Cambisols and Dystric Regosols are predominantly present, followed by Leptosols – Rendzic Leptosols and Regosols. In these areas, soil erosion is still a concern, but the land is more likely to be covered with forests and pasture.

The highest levels of seismic activity within BiH, representing intensity IX (9) on the MCS are along the southern edge of the country, on the border with Montenegro and Croatia and in a small pocket centred on the city of Banja Luka in the north, all outside of the DRB area. The DRB is predominantly within zones VI (6) in the north of the basin and zone VII (7) in the centre and south of the basin. There is a small pocket of zone VIII (8) just south of Sarajevo at Kalinovik municipality in the DRB.

The BiH part of the DRB experiences a "continental" type climate, with relatively cool and humid summers and long and harsh winters. Precipitation is variable and averages about 1,030 mm/year in the Basin.

Twenty-three surface water bodies (SWB) were delineated in the Sava River Basin Management Plan (RBMP), but according to ongoing process of BiH by laws for both entities (RS and FBiH) this number of SWB is 32. However, more recent work on the EU IPA project (Eptisa 2015) using data from SHP files indicate that there are 234 SWB in RS and 46 SWB in FBiH. From this total 26 SWB are delineated as heavily modified (HMWB) all in the RS.

Varieties of stakeholders monitor air quality in RS and FBiH. Some monitoring is undertaken in the basin within the municipalities of Ugljevik and Gacko to oversee emissions from the thermal power plants (TPP) nearby. Generally, results indicate the DRB is outside of the influence of the high air pollution except in the north of the DRB where industry and TPP can at times cause elevated emissions SO_2, CO, particulate matter NO_x. Notwithstanding, the air quality of the major proportion of the DRB is good.

The DRB has 61% of land area covered by forests in the DRB and 37% by agriculture; the remaining areas comprise inland waters /wetland (about 1%) and other land and settlements (about 1%). However, there is substantial variation in land use throughout the basin; the areas of Prača and Semberija have the greatest percentage of agriculture land, the latter is a fertile plain between the Sava and Drina rivers. The most forested municipalities are in the south of the DRB. For agriculture, the general trend in the BiH part of the DRB is for a high proportion of meadows and pastures mostly due to the mountainous terrain that characterises these areas. However, up to 40% of the land remains uncultivated at times due to an ageing population and migration of younger people away from the area. For land available under arable farming, maize, wheat and then fodder crops are dominant.

The Balkan Peninsula, of which BiH is a part, is one of the most important centres of Biodiversity in Europe. Consequently, within the BiH territory of the DRB there is a diverse variation of natural habitats and broad range of altitudes implying a large selection of fauna and flora species, many of them relict and endemic. The most endemic forms are recognized within the flora of the higher plants (e.g. endemic Serbian Spruce *(Picea omorika)* and relict Persian Walnut (*Juglans regia*)), which at the current state of knowledge is estimated to have 450 endemic taxa. Riparian vegetation and alluvial forest are important for aquatic ecosystems that enable riverbank protection from erosion and provide shelter for aquatic fauna. The area is under threat from a number of invasive species especially in the lower parts of the DRB in the north basin.

There is also a rich variety of fauna, especially icthiofauna (fish) with the Danube Salmon being the most important and one of the most endangered species, on the IUCN Red list and endemic to Danube drainage. The Lim River is also an important habitat for Grayling and Brown Trout. Only the upstream section of the Prača and Drinjača Rivers, which is not affected by dam construction or other social pressure, presents “high ecological status” of water based on fish fauna (as defined in Annex V of the WFD). The section of the Drina River in BiH is also "high status" due to the Tara River flowing unaffected into it. The other tributaries and the Drina downstream have “good to moderate ecological status”. Invasive species such as Rainbow Trout have been widely introduced through fish farming practices.

There is no less than 55 taxons of macro-invertebrates that have been recorded in the Drina River. The most diverse group is *Ephemeroptera.* More than 35 species of amphibians and reptiles are present within the basin, whilst there are more than 230 species of bird, with 114 registered in the Sutjeska National Park alone. No distinctive migratory corridors exist for birds in the basin, but there are occasional sightings of raptors of the genera *Circus* (Harrier) which have been observed with up to 100 individuals on a daily passage.

There are some species of bird directly related to water resources of the DRB. Some of them, like the Cormorants, come into conflict with local anglers gathering on open stretches of water (Zvornik etc.) who see them as pests feeding on fish stocks. Further downstream, the Drina River is characterized by numerous gravel islands, some of them hosting small colonies of Little Tern (*Sterna albifrons*) and of Common Tern (*Sterna hirundo*) that are unique in the DRB.

In the forests of the upper catchments of BiH part of DRB, live mammals such as the brown bear, wolf, chamois, wildcat and otter, but they are rare and endangered. In particular, Drina River canyon and basins of its tributaries are permanent habitats of the Eurasian Brown bear. Bats are well represented in the DRB part of BiH; with more than 30 species present and some of them very rare, with the Drina River providing a migratory corridor. Biodiversity of Lepidoptera is high; for other insects, there are high numbers of endemic subspecies present in the DRB. Invasive insect species occur in the DRB but they are not well recorded.

Population trends for flora and fauna are difficult to assess due to lack of past and present data, however it can be assumed from IUCN that many species are declining in recent years. For endangered endemic species such as the Danube Salmon (fish), the Serbian Spruce (tree) or bird species like the Rock partridge and rare Woodpeckers such as the Three-toed and the White-backed Woodpecker, there is sufficient data to say that populations are declining.

The main threats for habitats and species within the BiH part of the DRB are both environmental and human. The most prominent environmental factor is drought, whose occurrence is likely to increase in the future due to climate change. The most affected watercourses by drought are the smaller tributaries, which can be left without water. Floods are also a threat but mainly to riverbanks that can destroy riparian habitats. Human pressure from land conversion, building dams, fish farms, solid waste, industrial and municipal pollution, gravel extraction, introduction of non-native fish species through fish farming are also a threat to biodiversity.

There are five protected areas in the BiH part of the DRB (4 in RS and 1 in FBiH) covering about 2.6% of the land area of the basin. By far the largest area is Sutjeska NP, whose major ecosystem types comprise of mixed mountain forests and highland ecological systems. A much larger Drina – Cross Border Biosphere Reserve has been proposed, but is not yet protected.

Socio-economic pressures from forest ownership and management, invasive species, hunting and fishing, land ownership disputes in protected areas, change of land use, water use and water management, wastewater, tourism and recreation, and illegal collection of medicinal herbs and fungi, are all contributing to the detriment of the protected areas.

The Council of Europe adopted the Emerald network in 1979 under the Bern Convention in order to conserve wild flora and fauna and their natural habitats. A pilot project was launched in 2005 to start the implementation of the Emerald network in BiH. A total of 29 sites were identified for protection as well as three Ramsar sites. Among these sites, four are located within the BiH part of the DRB. The decrees on protection of these sites have not been adopted yet. In addition to Emerald, BiH aims to become part of the EU and hence it needs to implement the Natura 2000 network according to the EU Habitat Directive and EU Bird Directive. The Emerald Network is set to the ecological principles of Natura 2000 sites.

Socio Economic Characteristics of the Basin

In terms of natural resources, forestry and agriculture are important but are very susceptible to drought. The drought year of 2012 especially affecting maize production and there being a significant increase in forest fires. Industry has a significant share of GDP and there have been small rises in output since the economic downturn in 2009, but this is finely balanced. Hunting is an important source of income with almost 30,000 hunting licenses issued in 2013-14 season for FBiH and almost 22,000 for the equivalent period in RS.

There is commercial fishing and sports fishing carried out in the DRB as well as some fish farming. In DRB, there are 24 angling associations (4 in FBiH and 20 in RS) and 2,443 licenced members (435 in FBiH and 2,008 in RS). Fish farming principally involves farming Cyprinid and Salmonid species (mostly rainbow trout and carp). In all of BiH, there are about 90 fish farms, but in the BiH part of the DRB there are six fish farms (1 in FBiH and 5 in RS) about 50% of the farms are not licenced facilities. Most of the fish production occurs in reservoirs, lakes and rivers; but a smaller part is practised in cages. The six fish farm areas cover about 2 hectares of the DRB. The fish farms can have very important negative impacts on the aquatic ecosystem due to the introduction of invasive species (e.g. the Rainbow trout, which is in conflict with the Brown trout). In addition, the application of fertilisers and fish food leads to downstream pollution with high amounts of nutrients released into the watercourse.

Mining and quarrying are also important activities and coal and oil derivatives provide substantial energy outputs for the electricity and transport sectors. Tourism is another important sector with a steady growth in tourism of about 13% (2012-13), principally due to an influx of foreign tourists.

There are 82 cultural monuments in the municipalities of the BiH part of the DRB, with Foča and Čajniče in the RS have the substantial majority. The war in the early 1990's badly damaged or destroyed a number of these monuments, however UNESCO have been active to try and redress this loss.

The BiH part of the DRB is home to around 298,782 people (2013 census) with an average population density of 41/km². However, FBiH part of the basin has a density of 62/km² while RS has 40/km². For all the municipalities within or partly within the basin the total population based upon 2013 census is 450,397 with an average density of 45/km². The population has declined significantly in recent years and is likely to decline even further in the next 30 to 50 years. With the exception of Bijeljina, Pale, Zvornik and Sapna, there appears to be a general population decline in all municipalities and is due to net migrations out of the area to urban centres or even abroad. The population is getting older and increasingly more social services to assist the elderly population will be necessary in future. The gender balance is essentially equal, with a slight advantage of females over males (50.9% vs. 49.1%)

Around 20.6% of the population of the BiH part of the DRB are children of pre-school to secondary school age (0-18 years). Illiteracy rates in the DRB are not available but nationally they have improved from 10% in 1991 to 2% in 2011. Illiteracy is more pronounced in women especially over 65 years old.

In terms of health, overall medical facilities and medical services have improved. Heart disease remains the leading cause of death in the adult population followed by various cancers.

In terms of employment, around 38% of the population of the DRB are in employment whilst 46% are unemployed, the remaining population are infants or retired persons. The average gross and net wages in the basin municipalities vary between Euro 580/month (gross) and Euro 380/month (net). Ugljevik municipality in RS has the highest gross average wages, whilst Kladanj municipality (in FBiH) has the lowest wages in the basin. The inference from the data provided by the statistical office is that taxation between gross and net wages is greater in RS than in FBiH.

The average age dependency ratio (the number of persons who are not economically active (people younger than 15 or older than 64) for every 100 economically active persons (aged 15-64) in that population) in the BiH part of the DRB was 40. Crime rates in the basin are not available but nationally rates are in decline in RS, but rising slightly in FBiH.

From a point of view of transportation, the DRB is an important platform for road and rail routes to the north and south and to the west with international networks to other Balkan countries. There are no airports in the basin and the Drina River is not navigable within BiH.

Surface Water Hydrology

Data from a total of 36 meteorological stations and 24 hydrological stations were used in the assessment. A substantial amount of gap filling was required for all data series to enable the hydrological modelling to be prepared. The model needed to review the complete basin and therefore needed all three countries data included. The model calibration was conducted between October 1971 and September 1977, which equates to the start of the hydrological year when soils are dry and rains generally start. The hydrological model provided a good match between the observed and modelled series. The work enabled a spatial distribution of the water resources of the basin to be mapped by isolines of specific water yield. The most water abundant segments of the basin are the Tara River, Piva River and Sutjeska River, followed by the southern basin segments of the Lim River. This generally follows the trend in spatial distribution of precipitation (including snow) with largest flows during the spring due to snowmelt.

Principal characteristics of water regimes in a basin area are annual discharges, low discharges and flood discharges. Hydrological stations in the DRB were analysed with data from the “Drina” HIS database for the years 1946 to 2012. The gaps of mean monthly discharges on analysed hydrological stations were filled in accordance with the presented methodology. This is how monthly discharge time series were formed for the synchronous period from 1946 to 2012.

Annual discharge trends suggest that long-term changes are taking place on all hydrological stations in the DRB, and that they exert significant influence on the estimation of average discharges. Average annual discharges registered in the period from 1946 to 2012 are lower than the ones recorded from analyses covering earlier processing periods, suggesting a downward trend.

Groundwater
Six hydrogeological regions with significantly different geological structure, hydrogeological and hydro-chemical characteristics were distinguished, namely i) Allochthonous Palaeozoic and Triassic, ii) Dinaric carbonate platform, iii) Dinara ophiolitic zone, iv) Bosnian flysch, v) Sava-Vardar zone, and vi) Post-orogenic Oligocene, Neogene and Quaternary formations. Three main types of aquifer occur:

- Karst aquifer
- Intergranular aquifer
- Fissured aquifer

Porosity is the limiting factor in determining aquifers in the BiH part of the DRB. The karstic aquifers with good permeability dominate the DRB and have fissure-cavernous porosity with substantial groundwater accumulations in them, and are the most significant water-bearing rocks in BiH. Inter-granular aquifers comprising sands and gravels (river alluvium) follow the main river channels and are primarily in the north of the part of the DRB, near to the confluence with Sava River, but also in isolated pockets on the main Drina channel in areas where the river flow has slowed. Despite this, knowledge of the flow regime in the DRB is inadequate, due in part to very limited long term monitoring. Springs with highest yields occur on the point of contact of permeable and impermeable rocks and in the areas of intergranular porosity (river alluvium). Spring flow in the DRB vary due to the climatic conditions (through precipitation) and the largest flows are measured in the late autumn and early winter, with the minimum flows observed in the summer months (primarily August and September).

Based on data from the EU IPA Project, a total of 1,365 l/s of minimal capacity is currently used, but more than 5,170 l/s of water supply is available as a reserve in the BiH part of the DRB (RS only) and is currently unused.

Within the whole area of Western Serbia including the part of the DRB, especially along the border areas, abundant groundwater provides high amounts of mineralization, which are ideal as spa waters. Aquifers in Mačva district have better yield that those in Zlatibor district. Aquifer types are phreatic (compact) in alluvial deposits in the river valleys, fractured primarily in sandstones and karst, which are within massive reef limestones.

Groundwater makes up the main water supply to rural communities from boreholes, dug wells and from springs. Spring flow varies considerably due to climatic conditions with the largest flows generally observed in the late autumn and early winter and the minimum flows between Aug-Sept. The ratio between the maximum and minimum flows is difficult to quantify due to lack of data.

The general trend of groundwater flow direction is along the Drina valley from southwest to northeast. Although there is adequate groundwater protection legislation in place in BiH; and the fundamental principles, objectives and measures from the EU Groundwater Directive have been included in the national legislation; often monitoring, enforcement and correct implementation is often lacking due to lack of staff and training. This issue can seriously undermine and threaten groundwater quality at source, which is important, as groundwater is the main source of domestic consumption in BiH. Aquifers are particularly at risk near the main settlements.

The Sava RBMP undertaken by the ISRBC only delineated seven GWB in the whole of BiH, with only two within the DRB. With the current EU IPA Project (preparing a Draft RBMP for the Sava in BiH), six GWB have been delineated in the BiH part of the DRB and three more adjoin the DRB on the western boundary.

Water Quality

The Law on Waters of both entities FBiH and RS obliges public institutes and private companies using water and having wastewater discharge to measure and control the water quality. Water quality monitoring was interrupted during the war, but resumed in 2000. In the FBiH part of the DRB, there are 4 monitoring profiles in the Drina River and 1 monitoring profile in the Prača River. In the RS-BiH there are 4 monitoring profiles in the Drina River, and there are 12 monitoring profiles in the tributaries

Generally, the water quality in the DRB in BiH has been improving after the war from class II/III to class I/II. This is mainly due to the reduction/closure of industrial facilities in the basin and the slow uptake of new industry and agriculture.

Notwithstanding, there are still hotspots of potential pollution created by municipalities, industry, landfills, agriculture and contaminated soil. The main municipal hotspots in the FBIH are present in the municipalities of Goražde, Pale-Prača, Ustikolina and Kladanj. In the municipalities of Teočak and Sapna, there are no activities that are considered a significant and/or potential threat to water quality. In RS all the municipal hotspots are located downstream of wastewater outfalls from main settlements on the tributaries and on the main Drina River. This includes those settlements such as, Bijeljina, Zvornik and Višegrad etc.).
The most polluting centres of industrial activity are located at nine sites in the BiH part of the DRB, with the four biggest potential industrial pollution sources being coal mining in Ugljevik, bauxite mining in Zvornik and lead and zinc mining in Srebrenica.

Solid waste disposal into landfills and general "fly tipping" in the catchment are persistent problems. There is no waste incineration or mechanical and biological waste treatment in BiH. Landfill disposal is the only current option for solid waste management; hence, work to reclaim, remediate and sanitise them is urgently required, remediated, and sanitised. In the BiH part of the DRB and near to the basin borders, there are three registered sanitary landfills located at Tuzla at the border, as well as at Bijeljina.

Agricultural hotspots are a major source of pollution of surface and groundwater originating from uncontrolled and excessive use of agrochemicals, improper use of pesticides and fertilizers, and others discharges such as farm slurry etc. The main agriculture hotspots are located in large pockets of farmland, particularly surrounding the cities of Goražde, Bratunac and Bijeljina encompassing the Semberija area in the far north of the DRB

The final range of hotspots are contaminated soil sites associated with mining, past industrial activity, agriculture etc. Mining has lowered groundwater levels affecting agricultural productivity and making the soil more prone to erosion. Indiscriminate disposal on soil layers damages the soil substrate making it less productive, allowing downward percolation and increasing the danger of groundwater contamination.

Water Use

In terms of assessing water use in the BiH part of the DRB, the basin has been divided into three water management regions (WMR). These are the Upper Basin in the south (WMR III) extending out of Montenegro; the Piva River becomes the Drina River in BiH; the Tara River flows from Montenegro and forms the border with BiH before meeting the Drina River at Granični Prijelaz Šćepan Polje, the Ćehotina River rises in Montenegro and flows 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 WMR III draining into the Drina are most notably the Bistrica and the Sutjeska rivers. In the middle part of the DRB, WMR II includes the 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 WMR I includes the left bank tributaries of the Sapna and the Janja flow into the Drina.

Water demands comprise domestic consumption, industrial consumption, irrigation, fish farming and hydropower. The latter two in general do not consume water, they just to use it before it passes back into the system through gravity, although a certain amount is lost from gravity.

Data on water consumption is not reliable and unavailable at DRB level in BiH, hence to obtain a figure on water use it is necessary calculate from different sources including UNECE, World Bank IAWD and EU IPA Project. For consumption norms covering domestic supply, an average per capita consumption estimate for the two entities, was 222 litres/capita /day (l/c/d) for RS, and 168 l/c/d for FBiH which are similar to other European countries but do not include water losses. Average water losses (non-revenue water - NRW) in BiH range from 48-55% (IAWD 2015), which is below the average for the region.

Population estimates for the people living in the DRB were from the 2013 census, which is available at municipal level and has been broken down to DRB level by the EU IPA Project. The estimated domestic water consumption in the DRB is 23.2 Mm³/year. At sub basin level the Lower Basin (WMR I) accounts for 10.4 Mm³/year, the middle basin (WMR II) with 11.1 Mm³/year and finally the upper basin (WMR III) with 1.6 Mm³/year. Taking into consideration NRW then this could amount to 36 Mm³/year.

No data is available at DRB level for connectivity; however, BiH overall has traditionally enjoyed a good level of service for water and sanitation, with 88% of overall population having access to piped water and 91% for flush toilets. Access to publicly provided services is lower, at 58% for public water supply and 31% for sewerage. Only 3% of the population are connected to WWTP. Groundwater is predominantly used for water supply in FBiH and RS with around 84%-87% of all water abstracted from aquifers, springs, and the remaining 16% from rivers, artificial reservoirs and natural lakes respectively.

Industrial consumption has fallen away considerably in recent years but the DRB in BiH once used to consume large quantities. The EU IPA Project has assumed a per capita figure of 70 l/c/d which if applied across the basin indicates a water use of 7.6 Mm³/year of water.

There is little data on irrigation use in the DRB, but assuming it being used for 5 months of the year (May to September and using a *pro-rata* amount for the population within the DRB an estimated 1.9 Mm³/year

There is inadequate monitoring of industrial and irrigation use at municipal level. It therefore follows that pollution prevention is not adequate in BiH and remains a significant issue. Furthermore, groundwater pollution is a cause for concern due to the vulnerability of the aquifers.

There is an estimate of 12-14 l/s of water is necessary for fish farming primarily rearing rainbow trout and carp. Substantial amounts of free-flowing water are required that are diverted from rivers and streams, but then returned to the system. The Consultant has assumed there are no water losses in the DRB from fish farming. However, there are concerns from excessive nutrients entering the system from fish farms.

All water used in hydropower production is assumed to be returned to the rivers; hence, there are no losses, with the exception of evaporation.

Overall water demand within the basin is estimated to be about 32.7 Mm³/year, with WMR I accounting for 45% of this amount (14.7 Mm³/year). The demand from WMR II accounts for 48% (15.7 Mm³/year) whilst WMR III accounts for 7% (2.3 Mm³/year). Certain assumptions regarding returns to the system have been made for domestic (80%), Industry and irrigation (20% each), fish farming and hydropower (100% each). Net water use therefore is 12.2 Mm³/year for the DRB in BiH with WMR II accounting for 48%; hence, this is the most stressed region.

An environmental flow (EF), i.e., a minimal quantity of water, must be required in the basin to maintain the healthy natural ecosystems (habitats, fauna and flora) and the water quality.

In the FBiH legislation (Rulebook OG, No 04/13), the minimal value of EF is calculated based on the average mean discharge, the average minimum discharge and the average decade discharges over a minimal period of 10 years. The minimum EF is defined for two periods, from May to October (warm/dry seasons) and November to April (cold/wet seasons including spawning period). In RS, the Water Law (article 65) defines the EF as the mean monthly flow occurring with a 95% probability ($Q_{95\%}$). The Consultant reviewed The FBiH, RS, Serbian methods and three other different hydrological methods of EF (from Europe and USA) to obtain a range of values and then applied these to the three WMR of BiH. Holistic methods cannot be applied at this scale of the basin characterisation. Minimum EF was also taken from concession and technical documentation of existing and planned dams in BiH part of the DRB.

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

Finally, the proposed EF for the Drina River, which crosses FBiH, RS and Serbia, is the FBiH method. Indeed, this method is a good compromise between the guarantee of maintaining ecological river function (quality and quantity of the water) and the socio-economic use of the water resources (domestic use, irrigation, hydropower etc.). In addition, the EF values cover the range of magnitude of the value calculated with the RS and Serbian methods. For the tributaries, the method of the concerned entity is applied.
On this base, the Consultant has proposed, for the Drina River, a range of minimum EF values that should be maintained in each of the three WMR for two periods of the year (May to October and November to April). For Drina River, in the WMR I, these vary between 36.5–37.5 m^3/s and 54.5-56.5 m^3/s, for WMR II between 19.5-36.5 m^3/s and 29.0-54.5 m^3/s and for WMR III between 14.5-19.5 m^3/s and 21.5-29.0 m^3/s. Subsequent modelling to be undertaken later in the Project will be able to fine-tune these estimates.

Future demand requirements for 30 years (2044) and 50 years (2064) have been estimated based upon three scenarios after consultation with stakeholders, namely high growth (+0.1812%) based on population growth from 1971 - 1991, flat growth (0) and "real" declining growth (-0.9945%). The evidence suggests that the demands for domestic consumption in the basin will decline compared with today due to the continual migration of people away from the basin. Overall the Consultant is of the opinion that the actual water use within the DRB will be somewhere between the Flat Growth and Real Growth Scenarios, with overall water use varying between 32.02 and 32.66 Mm^3/year at present day, to 23.96 to 32.66 Mm^3/year in 2044 and 19.87 to 32.66 Mm^3/year in 2064. Taking into consideration the returns in the system then the net future water use for the BiH part of the basin over the 30 and 50 year timeframes varies 8.97 Mm^3/year to 12.23 Mm^3/Year in 2044, to between 7.54 Mm^3/year and 12.23 Mm^3/year in 2064, for the respective real growth and high growth scenario.

Key drivers that have been identified are:

- Water supply for the population,
- Flood security for the population,
- Water supply for agriculture(irrigation),
- Water supply for industry,
- Hydropower production,
- Environmental conservation,
- Recreation and tourism, and
- Fisheries.

Prioritisation of these drivers will occur in the next stage of the project (Investment Prioritisation Framework).

Hydropower

In BiH, three hydropower plants (HPPs) are in operation in the DRB for RS. There are no HPP in the FBiH part of the basin. Two of them are located along to boundary line between Serbia and RS ("Zvornik" HPP and "Bajina Bašta" HPP) and are managed by EPS. Only one is completely located on territory of RS and managed by ERS – "Višegrad" HPP.

BiH disposes over significant primary energy resources; for example, estimated hydropower potential amounts to approximately 6,800 MW, out of which has been used only approximately 35% in terms of capacity, i.e. approximately 38% in terms of the maximum possible electricity generation.

Out of the many imagined new HPPs in DRB part of BiH, 16 have reasonable chances of being implemented. The total installed capacity of all planned hydropower schemes in RS BiH reaches 1,143 MW. The total cost of all investments amounts to some Euros 2,700 million. This implies that the average cost of each installed megawatt is Euro 2.36 million. This ratio is in the usual range for this kind of projects.

Flood Hazards and Risks

The need for flood protection measures in the BiH part of the DRB is important. Most of the already constructed drainage systems are not in operation, principally due to insufficient maintenance. The most recent flood in May 2014 and those earlier in 2010 caused widespread disruption and loss of life and many millions of Euros in damages.

The European Commission recognised the need for flood damage recovery including projects located in the DRB. Twenty-nine flood related projects are planned in the DRB (covering all three riparian states) with a budget amounting to 99.3 M€. Nearly 50% are located in the BiH part of the DRB comprising 14 projects with the estimated budget of 43.7 M€.

It is very important that the regulation and protection measures planned along the middle and lower reaches of the Drina River are harmonized with the designs of the planned hydropower (cascade) systems along the corresponding river reaches.

Climate Change

BiH is a member of the UNFCCC and Kyoto Protocol and submitted the Initial National Communication in 2010, whilst the Second National Communication was submitted in 2013. As a non-Annex I member country, BiH is not required to decrease its greenhouse gas (GHG) emissions. However, it is obliged to report on its national GHG emissions, to systematically observe and research the climate and the climate change impact and vulnerability of its natural resources and economy, as well as to identify measures of adaptation to climate change.

Between periods 2010-1981 and 1961-1991 increases in mean annual temperature are observed in the range of 0.4 and 0.8 °C. There has not been a significant change in total precipitation amount, but there has been in distribution, which have increased climate variability and the occurrence of extreme events in BiH.

Short-term and long-term future climate change scenarios are indicating temperature increases of 0.4 to 1°C for the period 2001-2030 (under the A1B scenario) and 3.4 to 4°C for the period 2071-2100 (under the A2 scenario) respectively. Precipitation change is highly varied depending on scenario and varies between -20% to +10 % in the short-term future to a decrease 0 to 30% in the long-term future. Some projections also indicate seasonal variation with increases in winter and spring and less rainfall in summer. This is likely to have significant impact in the forestry and agriculture sector with greater risk of forest fires and more reliance upon irrigation.

Monitoring Networks

Various stakeholders are responsible for monitoring, including ministries and related institution, power companies, state- and federal hydro-meteorological service etc. Presently in BiH there are two active hydrological stations (one in RS and one in FBiH) and in 19 active meteorological stations (18 in RS and 1 in FBiH).

There is room for improvement regarding monitoring and data exchange through joint investments and harmonization of development programs. One of the possible development directions is establishment of contemporary hydrological and meteorological monitoring (information) forecast system. Furthermore, analyses performed within the preparation of this report have also clearly indicated a need for updating and improving the DRB monitoring network and data exchange practice. This is likely to involve a considerable cost. The main deficiencies identified in organization of monitoring and data exchange in WRM in BiH are lack of organization, the condition of equipment and infrastructure, lack of finances and human resources, as well as the lack of standard platforms and procedures of data management.

Legislative Framework

The basic elements of the legal system in the field of water resources management in BiH constitute regulations adopted within the competence of entities (Republic of Srpska and the Federation of Bosnia and Herzegovina). In the broader context, several parts of legislation adopted at the level of Bosnia and Herzegovina (as a state) are relevant. The law on water protection has relevance in Brčko District of BiH, also.

BiH at the state and entity level has significantly changed its legal and policy framework in preparation for EU Acquis. A new package of laws and corresponding secondary legislation have been adopted or are in the process of adoption, but it is considered that there is still a long way to go before all legislation is fully transposed and harmonised.

BiH participates in international cooperation in the field of water resources management and it is a member of key international agreements in this field. However, there are no signed agreements in WRM between BiH, Serbia and Montenegro, which is considered an obstacle to IWRM at the DRB level.

The basic strategic goals are defined by the Strategy of integrated water management of the Republic of Srpska 2015-2024 and the Water Management Strategy of the Federation of BiH 2010-2022.
Although many strategic documents are adopted to define the strategic vision in many specific sectors there are some areas, e.g. water and climate change, that are still not covered by overarching strategic documents, and more strategic planning is considered required.

Institutional Assessment

A questionnaire was sent to 12 institutions in BiH and responses were obtained from eight.

The basic responsibility for carrying out activities in the field of water resources management is at the entity level, although certain jurisdictions have the authority at state level.

MOFTER is the principal ministry responsible for WRM at country level. At entity level the Federal Ministry of Agriculture, Water Management and Forestry (FMAWMF) in FBiH, and the Ministry of Agriculture, Forestry and Water Management (MAFWM) in RS are responsible. Public Institution “Vode Srpske” based in Bijeljina, is in charge of the basins of the Adriatic Sea and Black Sea in RS. In FBiH, the Agency of the Sava River Water Area based in Sarajevo is in charge of the Black Sea basin and the Agency of the Adriatic Sea Water Area based in Mostar is in charge of the Adriatic Sea basin. The respective ministries of health in both entities are in charge of drinking water quality issues.

BiH institutional structure for WRM has relatively clearly defined responsibilities, but complexities in the system especially between state and entity and between entity and cantonal/municipal level are a constraint. Furthermore, the competence in handling administrative matters, such as issuing permits, approvals, opinions etc. are suffering due to institutional capacity issues.

In addition, there is lack of capacity, equipment and financial resources for the implementation of the institutional obligations and this is a major problem in both the short and long term. There is great need to strengthen the mechanisms of horizontal and vertical cooperation between competent authorities.

There is limited progress in reforms directed to EU integration. A limited number of EU regulations are transposed in the internal legal system of BiH (RS and FBiH). This is in part a result of weaknesses in institutions and lack of capacity and financial resources.

Challenges regarding regional cooperation in DRB are lack of finances; lack of water related data; inability to rely on historic data; unsuitability of existing data, lack of the international agreements between the countries in the basin and lack of alignment of regulations.

Management of water resources, floods, urban issues, energy, foreign investment, environmental protection and climate change are considered as priority areas of cooperation between the countries in the DRB.

Recommendations

BiH stakeholders during a workshop held on 25-26 January 2016 prioritised the recommendations for this report. The high priority recommendations covering the principal sectors (e.g. environment, hydropower, institutional etc.) for the four main outcomes of the project are:

For Outcome 1 – "More effective data collection and analysis:

Environment

Recommendation

- Data exchange with other institutions
- Show the ecological status of all the rivers in the DRB on a map using fish species as indicators (according to Annex V of the WFD) in order to have a reference for surveying the trend of aquatic ecosystems. This will enable a decision-making tool related to the development of social and economic activities (implantation of dams, of gravel exploitation, of recreational activities, etc.).

HPP

Recommendation

- Carefully perform the monitoring of the dams' flow regime and improve data exchange between stakeholders. As important structures bearing a high potential risk, the dams are key elements of hydropower schemes.

Institutional

Recommendation

- Acquisition of Technical equipment for line authorities and additional equipment, especially for institutions dealing with regular monitoring

Prioritised recommendations for Outcome 2 – "Enhanced dialogue and coordination in the DRB" are:

Environment

Recommendation

- Harmonise national regulations and foster cooperation between the three countries in the DRB in order to successfully implement biodiversity protection programs
- Taking into account the Spatial Plan RS BiH by 2025 (MSPCEEP), the following are important:
  - Spatial plan of special purpose integrates the land basin of Upper Drina, in order to comprehend and define the interests and needs of energy and protection of natural values;
  - Adequate waste management because of the strong problem of floating waste in the Drina River is due to the tributaries of rivers Lim and Rzav from neighboring countries Montenegro and Serbia;
  - Work towards the establishment of sewerage system for wastewater

- In built-up areas and isolated dwellings to stimulate the construction of septic tanks
- In economic zones introduce clean technologies with pre-treatment of waste water; - drafting the law on the national park " Drina ". Drina National Park.

Institutional

Recommendation

- Institutional strengthening and developing strategic and normative base in flood prevention and defence;
- Harmonisation of the strategic objectives of spatial development in the DRB countries;
- Reform of the existing system and improvements of financing in the field of water management and environmental protection (collection of funds, level of charges; charge payer databases; mechanisms of receivables collection from legal entities in long lasting court procedures; financial management, etc.
- Strengthening institutional capacity, provision of finances and developing prerequisites of joint monitoring implementations within the DRB;
- Strengthening capacities of the public water management enterprises and efficiency improvements within public utility enterprises
- Further analysis of the most optimal ways for multi-lateral cooperation within the DRB;
- Improving coordination of financing in the field of water management with financing instruments from other fields (environment, agriculture, forestry, etc.); providing conditions for other funds and private capital to join to water sector development funds; creating conditions required to use EU funds and co-financing within fields where subject support is provided;

Legal

Recommendation

- Intensifying efforts to establish bilateral agreements with neighbouring states in the field of WRM and energy with Serbia and Montenegro.

Prioritised recommendations for Outcome 3 – "Better decision-making and management in the DRB as a multi-purpose water resource", are:

Environment

Recommendation

- Control environmental flow
- Avoid and/or better regulate gravel exploitation within riverbeds
- Build new sanitary landfill away from groundwater protection zones and from riverbeds
- Close existing landfills and move them away from riverbanks and flood plains
- The concept of flood protection to be coordinated
- WWTP are needed at the main centres of population and for industry in order to reduce the pollution loads in the rivers
- Introduce larger part of clean energy
- Real consideration is necessary for the provision of multi-purpose reservoirs and flood retention basins to protect downstream settlements from flooding
- Control the technical compliance of vehicles
- Coordination of land use in particular agriculture
- Protect and/or restore riparian vegetation along rivers especially along smaller tributaries in order to prevent soil erosion, filter pollution and prevent floods

HPP

Recommendation

- To devote great care to the maintenance of the existing schemes. The reliable functioning of all structures and machines is a must for an efficient use of the natural resource.

- Strive to harmonize legal-administrative frameworks for developing cross-border HPPs. The largest potential for HPP development of the DRB in BiH resides in these types of HPPs. Take into account the spawning areas of the target fish and the high value wetland ecosystems in new HPP projects.

Socio Economic

Recommendation

- Increase stricter control on sand and gravel extraction and improve policing of unlicenced operators

Prioritised recommendations for Outcome 4 – "More effective application of EU WFD regulations and preparation of RBMP", are:

Institutional

Recommendation

- Strengthening cooperation between the competent institutions, especially in view of the distribution of competencies between different levels of government, in terms of water management
- Improve employment opportunities and implement policy to attract and retain younger staff.
- Strengthen capacities of stakeholder bodies in charge of water management.

Legal

Recommendation

- Consistent implementation of obligations under international agreements
- Undertaking further measures aimed at harmonization of internal regulations with EU regulations
- Preparation and adoption of required by-laws as per applicable laws on water;
- Harmonization of regulations governing utility services with the regulations governing WRM; Adoption of the law to regulate utility services in FBiH; Adoption of the law on chemicals (in FBiH);
- Intensifying activities of adoption of the water management plans;
- Invest efforts in transfusion of the strategy in sector policies and strategies;
- Improve strategic planning and implementation of acquis in the field of environment and climate;
- Adopting a Strategy of environmental protection and Waste management strategy in RS;
- Strengthen regulatory enforcement capacity in the field of industrial and hazardous waste;
- Strengthening instruments of adjustment, coordination and involvement of various tiers of government in preparation and adoption of regulations and their harmonization with EU regulations;
- The following regulations are to be charged or adopted to strengthen FHMO capacities: Law on Hydro-Meteorological Activities (FBiH); LW of FBiH (either certain amendments to the existing law or adopt a new law); Adequate enactment should regulate the status and responsibilities of FHMO as regard to public reporting, EEA WMO and other; Regulations related to the quality management system-QMS;
- Regulatory reform to create more efficient financing system in the water sector, or of relevance for water sector;

Socio Economic

Recommendation

- Stronger coherence between strategic and planned documents and environmental objectives.

1 Introduction

The Joint Venture (JV) Consultant comprising COWI AS of Norway as lead together with JV partners Stucky Limited from Switzerland and Jaroslav Černi Institute (JCI) from Serbia have entered into a contract (Contract No 8005176) with the World Bank to provide support to the Water Resources Management of the Drina River Basin (DRB).

World Bank and JV Consultant signed the Contract for the assignment on 6th October 2014. Mobilisation began immediately thereafter and a draft Inception Report was prepared and presented at an Inception Workshop on 1st December 2014 that was held in Zagreb. After small amendments, the World Bank and the Steering Committee subsequently approved the Inception Report in March 2015 and a local language version was prepared and distributed in May 2015.

This report in hand represents the Integrated Water Resources Management (IWRM) Country Report for the Bosnia and Herzegovina (BiH) part of the DRB that comprises of the entities of Federation of Bosnia and Herzegovina (FBiH) and the Republic Srpska (RS). The draft IWRM Country Report for BiH was submitted in November 2015 (local language version in December 2015). The Country Report was thoroughly discussed at a workshop held in Belgrade 25/26 January 2016. Comments were received from the BiH stakeholders and these have been addressed in this new version of the report (see Annex 1-1).

The total extent of the DRB covering BiH, Montenegro and Serbia, is around 19,700 km^2 and about 37% of the land area belongs to BiH (about 7,300 km^2), the majority covered by the entity of RS and around 840 km^2 from FBiH.

In terms of the macro economy, Gross Domestic Product (GDP) has shown signs of modest growth from 2009 until 2013. GDP in FBiH in 2013 amounted to Euro Billion 8.648 whereas in RS it was Euro Billion 4.480. In per capita terms, however the GDP is similar Euro 3,018 for FBiH and Euro 3,142 for RS. In both entities, there has been a modest increase in GDP from 2012. The following Table 1-1 provides macro-economic indicators in both entities from 2001 to 2013 and Box 1 and Box 2 provide data on transition and human development with further details being provided in Annex 1-2.

Table 1-1: Macro Economic Indicators for BiH (FBiH and RS) 2001 to 2013.

Development Indicator	Unit	2001		2009		2010		2011		2012		2013	
		FBiH	RS	FBiH	RS	FBiH	RS	FBiH	RS	FBiH	RS	FBiH	RS
GDP	Bill. €	-	1.875	7.933	4.211	8.177	4.253	8.431	4.439	8.464	4.390	8.648	4.480
GDP/capita	€	-	1.295	2.781	2.934	2.854	2.968	2.942	3.105	2.953	3.071	3.018	3.142
GDP growth	%	-		-2.5	-2.5	0.9	0.9	0.9	0.9	-1.2	-1.2	2.7	2.7
GDP /capita (PPS)-BiH	EУ-28 =100	-		29		28		29		29		29	
Sector	**Unit**	**Gross Value Added (GVA) by Main Sectors**											
Agriculture, forestry and fishing	%	-	-	7.1	13.0	7.0	12.4	7.1	12.1	7.5	11.6	7.1	12.3
Industry	%	-	-	20.8	19.0	21.4	19.0	21.4	19.3	21.2	18.1	21.7	19.6
Construction	%	-	-	6.0	7.1	5.2	5.8	5.0	5.3	4.8	5.1	4.6	5.2
Services	%	-	-	66.1	60.9	66.4	62.8	66.5	63.3	66.5	65.1	66.6	62.9

In terms of Gross Value Added (GVA) the services sector is by far the dominant activity, which increased its participation in FBiH from 66.1% in 2009 to 66.6% in 2013 and in RS from 60.9% in 2009 to 62.9% in 2013, (the greatest expansion was made by traffic and telecommunication and trade sectors and sector of financial services). Contrary to this, industry marked a modest growth of participation in GVA from 20.8%

in 2009 to 21.7% in 2013 for FBiH and from 19% in 2009 to 19.6% from RS as the consequence of restructuring and privatization of companies, and inadequate structure of investments and their volume. In contrast, the construction sector has fallen in both entities from 6.0% to 4.6% in FBiH and from 7.1% to 5.2% between 2009 and 2013. The agriculture sector in FBiH has remained flat, at around 7.1%, whilst a slight fall in RS has been recorded from 13% in 2009 to 12.3%.

Box 1: Bosnia and Herzegovina's Transition and Development

In terms of the EBRD transition index, BiH scored 2.8* in 2009, which is a mid-value indicator and is 24-25th place out of 29 analysed countries in transition. The country's consistently low scores on many indicators compared to other countries suggests there is a lack of consensus on deep economic reforms and there is substantial scope of improvement in areas such as licensing and permits and enforcement of contracts. Key priorities include political reforms, boosting competitiveness, reforming social benefits and improving the country's infrastructure.

In terms of the Global Competitiveness Index (GCI) the most recent report from 2015-2016 shows that BiH occupies 111th place out of 140 countries. As seen by Figure 1-1 BiH in general follows a similar pattern to other countries in emerging and developing Europe, but having significant advantages in health and primary education, but particularly lagging behind in the area of institutions, infrastructure, labour market efficiency and financial market development.

Index of global competitiveness	Rank	Score
	111	*3,7*
Basic requirements (40%)	***95***	***4.2***
1. Institutions	*127*	*3.2*
2. Infrastructure	*103*	*3.1*
3.Macroeconomic stability	*98*	*4.3*
4.Health and primary education	*48*	*6.0*
Efficiency enhancers (50%)	***112***	***3.5***
5.High education and training	*97*	*3.8*
6.Efficency of market goods	*129*	*3.7*
7.Efficency of labour market	*131*	*3.4*
8.Complexity of financial market	*113*	*3.3*
9.Technological readiness	*79*	*3.6*
10.Market size	*97*	*3.1*
Innovation and sophistication factors (10%)	***120***	***3.0***
11. Business sophistication	*125*	*3.3*
12.Innovations	*115*	*2.8*

Table 1-2: GCI for BiH in 2014.

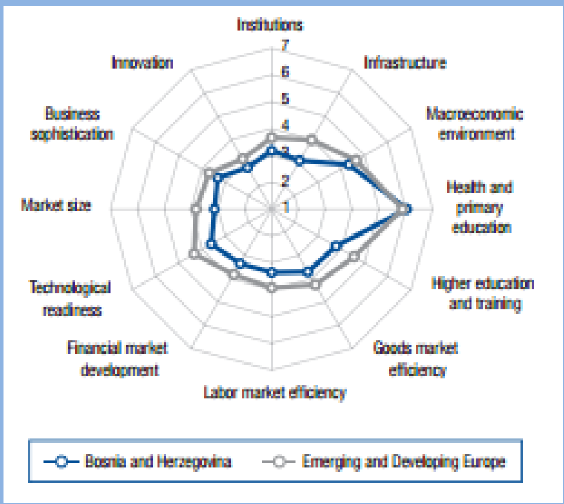


Figure 1-1 BiH position in the GCI

* Based on exchange rate 1.12 USD = Euro 1

The transition indicators range from 1 to 4+, with 1 representing little or no change relative to a rigid centrally planned economy and 4+ representing the standards of an industrialised market economy.

Box 2: Bosnia and Herzegovina's Human Development
The Human Development Index (HDI) is a composite index measuring indicators such as quality of life, life expectancy, literacy, education etc.; BiH is ranked 86th out of 187 countries and can be classified as a "high human development" category. The HDI has been gradually increasing from 2005 with an HDI of 0.731 in 2013, an increase of 2.1% or an annual average increase of 0.45%. The HDI score for 2013 places BiH slightly below the average of 0.738 for countries in Europe and Central Asia. BiH scores relatively well in terms of life expectancy and education, but it lags behind significantly when it comes to economic performance. Consequently, for HDI to improve in the future there is urgent need for acceleration of economic growth. Table 1-3 below shows details.

Table 1-3: HDI trends in BiH – 2005 - 2013

Year	HDI	Life expectancy at birth (years),		Mean years of schooling (years),	Expected years of schooling (years),	GNI per capita (2011 PPP $)	Average annual HDI growth (%), 2000-2013
2013	**0.731**	76.4		8.3	13.6	9.431	0.45
	Human Development Index (HDI) Value						
2005	0.716						
2010	0.726						
2011	0.729						
2012	0.729						
2013	0.731						

In order to obtain a picture of advancement in BiH it is important to ascertain an appreciation of the procedures for spatial planning and development.

1.1 Spatial Planning

Unlike Montenegro and Serbia, the spatial planning system in BiH is regulated at the entity level so that RS and FBiH have their own laws that regulate spatial planning. In FBiH, there is the Law on spatial organization and land use ("Official Gazette FBiH", No. 2/06, 72/07, 32/08, 4/10, 13/10 and 45/10) for the entire entity, and all cantons have their own laws on spatial organization for their territories. The Law on Spatial Organization and Construction ("Official Gazette of RS", No. 40/13) regulates spatial planning in RS and it covers all the planning levels (entity and municipal level). According to the Law, all municipalities adopt the decisions on construction (or on spatial organization) for their territories to regulate the construction conditions based on the specific situation and with more details.

Spatial and urban planning documents in FBiH are:

1) Spatial Plan:
   - Spatial Plan of FBiH,
   - Spatial plan of Canton,
   - Spatial Plan of the Area with Special Characteristics (such as area of the construction of large hydropower plants (over 30 MW), especially vulnerable areas (flood areas, bare land, landslides, etc.), corridors, etc.)
   - Spatial Plan of the Municipality (except for the municipalities which belong to cities of Sarajevo and Mostar);

2) Urban plan;

3) Detailed Planning Documents:
   - Regulation Plan,
   - Urban Project.

Spatial and urban planning documents in the RS are:

1) Spatial Plans:

- Spatial Plan of the Republic,
- Spatial Plan of the Area (such as areas of large exploitation of mineral resources, tourism and recreational, sports and spa area of special importance, the national parks, areas of exceptional cultural and historical significance and other protected areas or specific)
- Spatial Plan of the Municipality,

2) Urban Plans,
3) Regulation Plans,
4) Urban Projects.

Spatial and Urban Plans are long term strategic planning documents that establish the basic objectives, directions and instruments of development in the area and the settlement, and they are adopted for a period of at least 10 years. Regulatory plans and urban projects are technical regulatory planning documents that define the requirements for the design and construction of facilities.

The land use, the formation of construction parcels, construction of settlements and facilities, communal and other infrastructure, and generally any intervention in the area and providing a construction permit shall be allowed only in accordance with the relevant plans.

Table 1-4 below provides an indication of the most important planning documentation.

Table 1-4: Most important spatial planning documentation in BiH

FBiH	
Spatial Plan of Federation of Bosnia and Herzegovina for the Period 2008-2028	draft
Spatial Plan for the Area of Tuzlanski Canton 2005-2025	2006
Spatial Plan for Special Purpose Area of Protected Landscape "Konjuh" for the Period 2010-2030	2013
Spatial Plan for the Area of Bosansko-Podrinjski Canton Goražde for the Period 2008-2028	draft
RS	
Spatial Plan of Republic of Srpska to 2015	2008
Amendments to Spatial Plan of Republic of Srpska to 2025	2013
Spatial Plan of National Park "Sutjeska"	1986
Spatial Plan for Special Purpose Area of National Park Sutjeska 2011-2031	in progress

Further details on spatial plans are provided in Chapter 12 and in Annex 1-3.

1.2 Scope of Work and TOR

Following on from the inception period, the Consultant has followed the terms of reference (ToR) and focused on IWRM Country Report for the BiH part of the Drina Basin. The report essentially consists of Main Tasks 2, 3, 4 and part of 5 from the TOR. This report is one of four principal deliverables (there are others planned e.g. Stakeholder Consultation Report) as depicted in Figure 1-2 below. The Inception Report is completed (shaded grey) and work now focusing on the IWRM Country Report (shaded red). As agreed at the workshop in Belgrade on 25/26 January 2016, the IWRM Basin Report was no longer required, hence the principal deliverables were reduced from five to four.

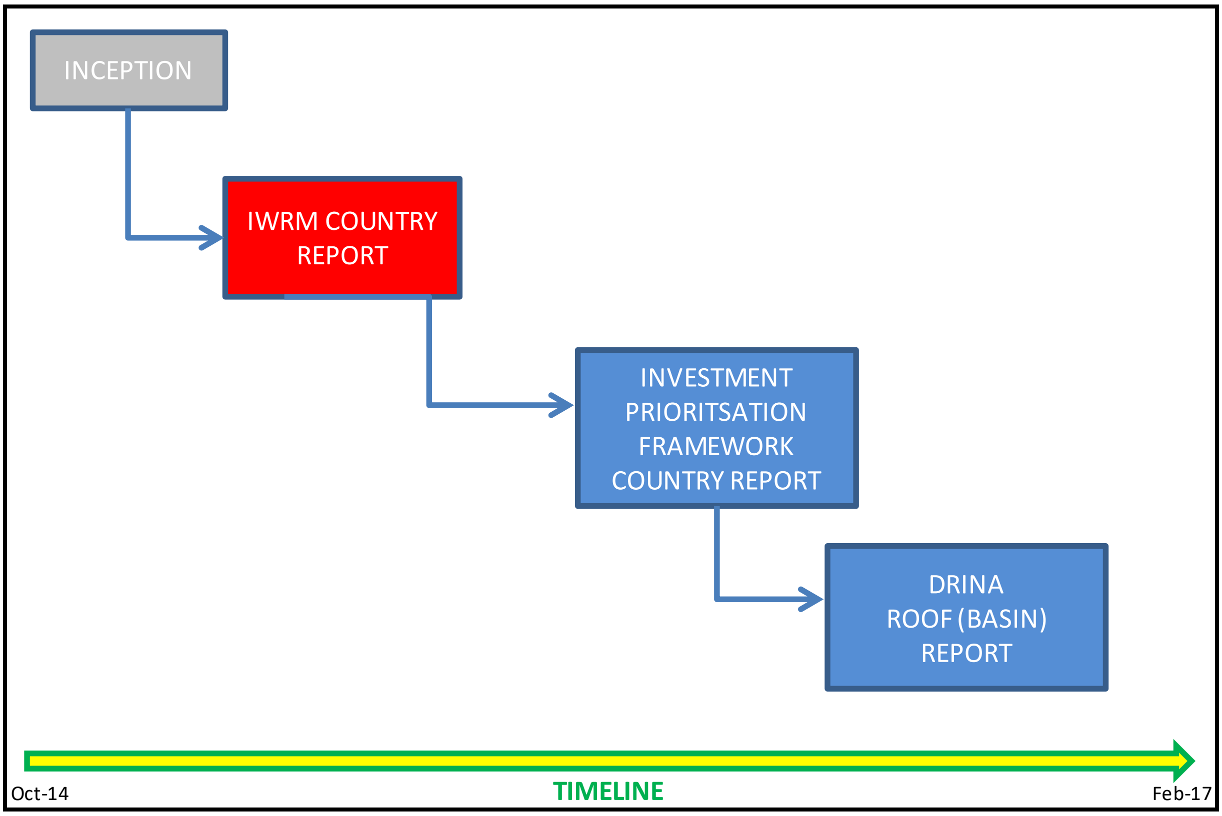


Figure 1-2: Main Deliverables and Project Timeline

1.3 Layout of the Report

In order to respond to the TOR objectives, this IWRM Study and Background Paper for BiH has been prepared with 15 chapters. Consequently, after this introductory chapter, Chapter 2 begins with a presentation of the physical characteristics of the BiH part of the DRB focusing on the environmental aspects, followed in Chapter 3 by the socio-economic characteristics of the basin in order to establish a baseline condition.

In Chapter 4, the JV Consultant provides a description of the surface water hydrology providing a review and assessment of meteorological and hydrological data with a view to processing into the hydrological model. The chapter then proceeds to provide a hydrological analysis of the modelling results.

In Chapter 5, we provide a description of the geological characteristics of the DRB, the basin's tectonic composition and hydrogeological characteristics. The chapter then provides an indication of the main aquifers and their availability, groundwater flow and assessment and provides an indication of the current groundwater synopsis of the principal strategic studies that have taken place on the DRB in the past up to the present day.

Chapter 6 contains a description of the water quality in the past and since 1995 and comments on the current hot spots and provides a general classification. Chapter 7 is devoted to water use and indicates water resources management; the present water demands in the Basin; and provides key drivers.

Chapter 8 focuses on the existing hydropower in the basin and makes comments on the present management of hydropower plants, the unused hydropower potential and the computation methodology. Chapter 9 focuses on flood hazards and risks, providing an insight into the flood prone areas in the DRB, the current flood protection infrastructure and measures. The Chapter continues with a review of the hydraulic modelling results of the flood prone areas and an assessment of the current flood hazards and risks.

Chapter 10 introduces Climate change scenarios to the DRB and assesses their impact on the hydrological regime.

Chapter 11 provides a description of the monitoring networks that are in operation in the DRB and those that are planned for the future.

Chapter 12 provides the legislative set up in BiH in the entities of FBiH and RS, and the legislation of direct relevance to the DRB from national, regional and international perspectives. Chapter 13 follows with a review of the Institutional Assessment providing a description of the roles and responsibilities of the institutions that are concerned with the DRB.

Chapter 14 provides an overview of the main conclusions and recommendations for IWRM in the BiH Part of the DRB and finally Chapter 15 provides a list of the references used in the preparation of the study.

Attached to the main report there are also numerous annexes that support the various chapters

WARNING

All data related to the hydropower projects presented in the three IWMR reports were compiled in a uniform way by the authors of the reports. These computations were based on the respective available information, and this for the entire Drina River basin. Through this approach, the – possible – losses of accuracy in the determination of structural characteristics, investment cost and energy generation were compensated by a higher overall consistency allowing a sound comparison of all projects. This approach makes full sense for the relative ranking of the projects, to be made in the next step of the study (multi-criteria analysis).

The HPP projects of the Republika Srpska (RS) have however been treated differently: on behalf of Elektroprivreda of Republika Srpska (EPRS), the characteristics of the RS HPPs presented hereafter reflect exactly the data provided by EPRS. They have not been checked by the authors. This may lead to some discrepancies with the characteristics of the HPP projects of the neighbouring countries (which have been calculated according to the abovementioned homogenous procedure). The HPPs of FBiH remain unaffected by ERS' request.

Apart from a few exceptions, the differences between EPRS' and recalculated HPPs characteristics are in general not sensible. The ranking to be developed in the next report (IPF) is not likely to be more than marginally affected.

2 Physical Characteristics of the Drina Basin

2.1 Main properties of the Drina River Basin

The Drina River rises at the joining of the Tara River and Piva River near the town of Šćepan Polje. The biggest and the most water-abundant tributary in BiH is the Lim River. Its tributaries are also Sutjeska River, Bistrica River, Ćehotina River, Prača River, Rzav River, Drinjača River and others. The DRB makes one fifth of the Sava River basin, and even one third of the Sava River water arrives through the Drina River. The most water abundant tributaries of the Drina River originate in Montenegro and the Piva River, Tara River and Lim River provide two thirds of the Drina River water. Average altitude of the DRB is 961.6 m a.s.l. and it ranges between 75.4 m a.s.l., at the confluence, and more than 2,500 m a.s.l. on the highest mountains in Montenegro (Prokletije Mountain 2,694 m a.s.l., Komovi 2,487 m a.s.l. and Durmitor Mountain 2,522 m a.s.l.) (Figure 2-1).

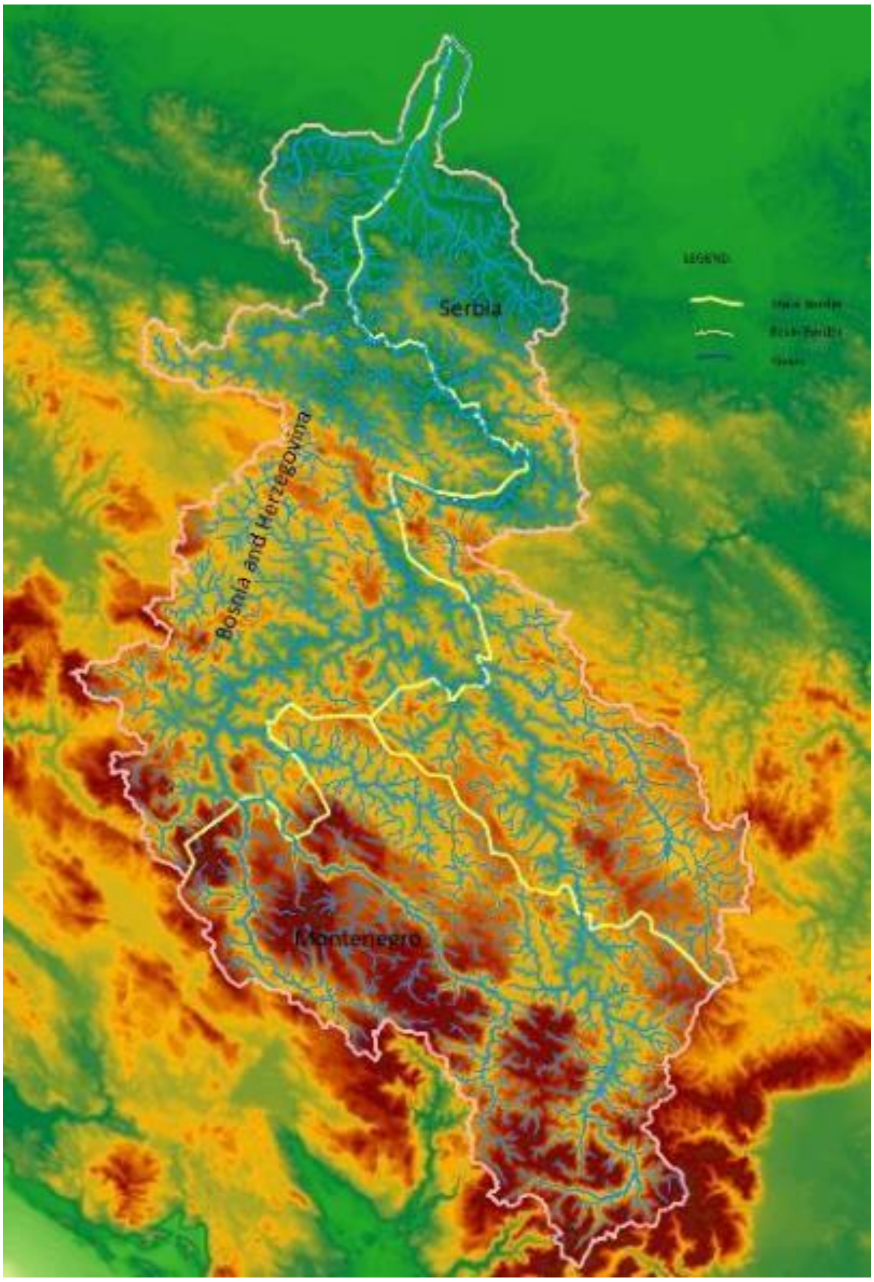


Figure 2-1: The overall extent of the Drina River Basin

The average discharge of the Drina River at the confluence with the Sava River is 395 m^3/s. With its specific run-off of 19.8 $l/s/km^2$, the Drina River is the water most abundant river on the Balkans.

2.2 Morphology and Topography

2.2.1 Morphology

The morphology and topography of the DRB are dominated by past glaciation and karstification in the high mountain ranges whilst karst and alluvial relief are formed on the lower mountain areas (see Figure 2-2).

Glacial Relief

During the Pleistocene, glaciation centres were on Maglić Mountain and on several mountains in Montenegro.

Mountain group of Maglić Mountain (2,386 m) on the border between BiH and Montenegro, Bioč Mountain (2,397 m) in Montenegro and Volujak Mountain (2,336 m) on the border between BiH and Montenegro hosted three glacial fans, joining under the cirques making a uniform glacial field.

Karst Relief

Due to large spreading of calcareous rocks on all mountains with expressed glaciation, karst formations are also present and they are frequently interchangeable.

Karst is particularly present in Sutjeska River Basin, Bistrica River Basin, Prača River Basin, Žepa River Basin and upper part of the Drinjača River Basin.

In the belt of medium height mountains, karst is most widely spread on the Tara Mountain and Zvijezda Mountain with limestones above the Drina River reaching thickness of more than 1000 metres. Mildly curled erosive plateau includes all karst formations: sinkholes, depressions, caves and cavities. Even though limestones are very thick, no major speleological structures have been identified. The biggest cave is in Topli do (dale) between Tara Mountain and Zvijezda Mountain, hidden mouth of which is located 200 m above Perućačko Lake. It has only one spacious room with rich sinter decorations and short side canal. Total length is 80 m.

Alluvial-Denudation Relief

Apart from glacial and karts erosion, the biggest impact on relief of the DRB was exerted by the river and torrential erosion and denudation in broad sense (rock decomposition and soil erosion).

Larger wide areas are found near the town of Foča at the confluence of the Bistrica River and Ćehotina River, near the town of Goražde, near the town of Ustiprača at the confluence with the Prača River, near the town of Višegrad at the confluence with the Rzav River and near the town of Bajina Bašta at the confluence of Rača River and Solotuša River. The longest gorges are Međeđanska gorge, between the town of Goražde and the town of Višegrad, 26 km long and more than 700 m deep, and Klotijevačka gorge between the town of Višegrad and the village of Klotijevac, 38 km long and up to 1,000 m deep, appearing under Zvijezda Mountain as the narrow canyon bottom of which now is 80 m deep lake. Downstream of the town of Bajina Bašta, the valley cuts through parallel with the mountain ranges stretching direction. It turns wider with milder slopes, to completely disappear downstream of the town of Loznica in Mačva and Semberija plains.

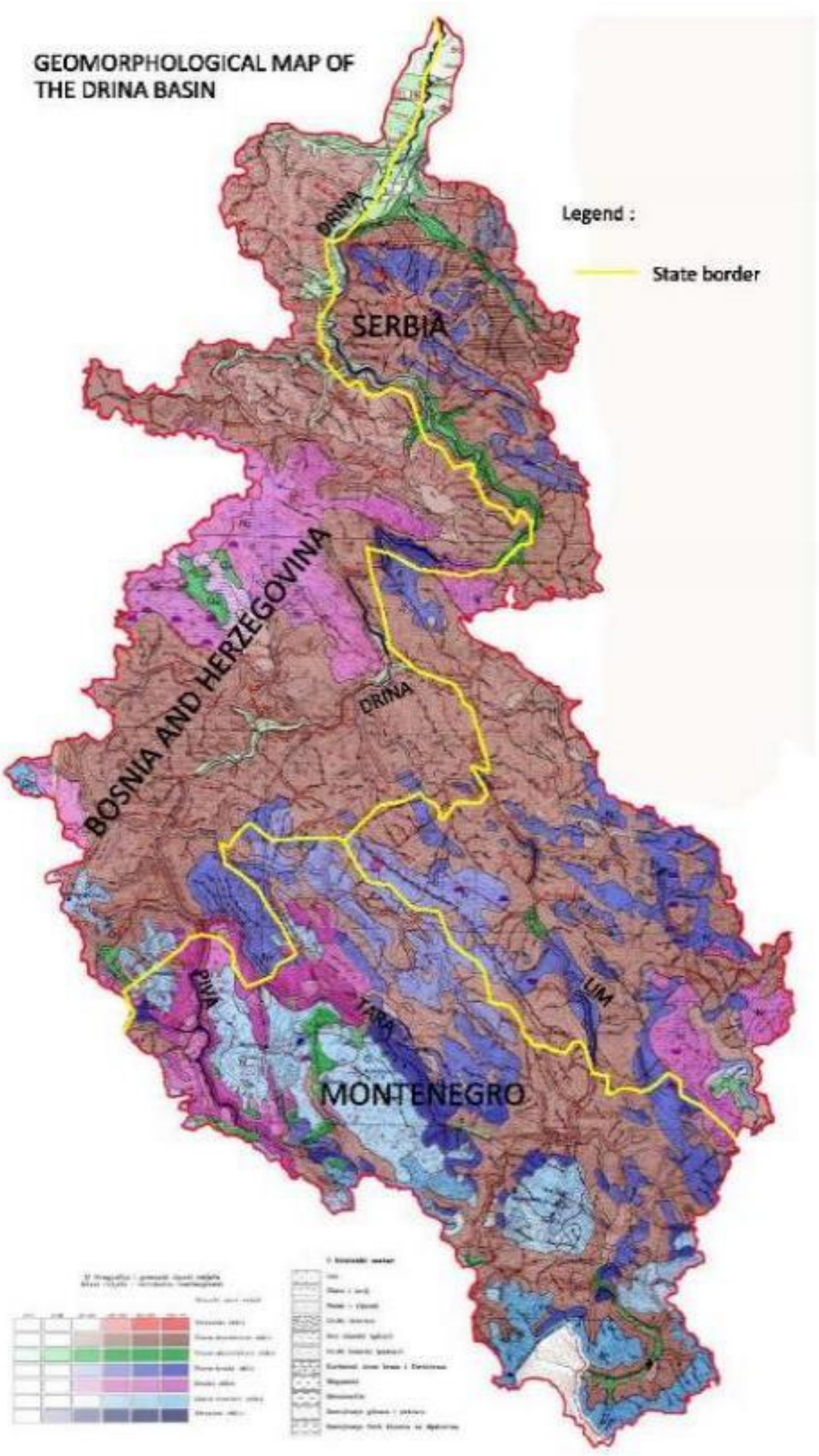


Figure 2-2: Geomorphological map of Drina River Basin

It has been determined that in the DRB many river courses changed their direction and moved from one river basin to another. Such phenomenon is called "river capture" and it was found on several locations. However, the youngest example is diversion of the Jagodnja River near Rogačica. Under the influence of young tectonic movements, the river cut short its path to the Drina River significantly by abandoning about 2 km long old river valley near the village of Donji Žlijebac, now mouthing approximately 10 km downstream of that location. At the diversion spot, valley bottom is 16 m lower than the bottom of the abandoned valley. This diversion happened during the Holocene.

There is a series of larger terraces along the bottom of larger valleys indicating cutting in distributed in stages, where the higher ones are of rocky in character, while the lower are pebbly.

Execution of any kind of height related correlation is also difficult, as the number and height of terraces is under major impact of the river valley morphology (ravines and narrow spots) and tributaries. Considering the fact that the Drina River valleys, and of its tributaries, mainly appear as gorges and canyons, rocky terraces are difficult to identify, particularly on higher altitudes as they were subsequently altered substantially under the impact of sub-aerial processes. Apart from alluvial-glacial terraces in the valleys of the Tara River and Piva River, pebbly terraces in the Drina River valley are better preserved downstream of the town of Bajina Bašta with three pebbly terraces 20, 50 and 100 m above the riverbed. Fragments of pebbly terrace are preserved around the confluence with the Jagodnja River at 150 m, as well as a pebbly terrace at 12 m following the Drina River course on both sides. The lowest terrace near the town of Bajina Bašta and the town of Rogačica is recent, while the higher ones are of virmic age. Therefore, all pebbly terraces are very young created by sedimentation of river deposits in late Pleistocene and Holocene. Downstream of the town of Loznica is the start of huge inundated fan at the confluence with the Drina River, covering the Mačva and Semberija, where a major part of eroded materials from the basin are deposited. This inundation of the Drina River has significantly moved the course of the Sava River towards the north in this section.

2.2.2 Meandering and Erosion of the River Bed

Division of the DRB into the characteristic sectors and impact of geo-morphologic characteristics of the basin on river processes

The DRB is very large with total area of almost 20,000 km². It is heterogeneous in geo-morphological sense and three characteristics sectors can be identified. Common river course division is on the Upper, Middle and Lower Drina River. Upper Drina River covers the sector upstream of the "Bajina Bašta" HPP, Middle Drina River sector is between "Bajina Bašta" HPP and "Zvornik" HPP, and the Lower Drina River sector is between the "Zvornik" HPP and the confluence with the Sava River.

From geo-morphological perspective, the Upper Drina River is characterized by hills and mountain type of relief and very narrow river valley. The Middle Drina River is characterized by a wider river valley with torrential tributaries running through arriving from the hilly margin of the valley. Finally, river valley in the Lower DRB is very wide which can be characterized as the plain watercourse. Described characteristics of the three sectors affect the width of the floodplain along the watercourse. Figure 2-3 is the map of the DRB with clearly indicated floodplains along the watercourse. Floodplain does not exist on the Upper Drina River at all since the riverbed is of gorge type and, thus, no flood discharges occur. Floodplain on the Middle Drina River is of minimum width with the most significant location in the section of the town of Bratunac (the town of Ljubovija on the opposite side of the Drina in Serbia). Situation on the Lower Drina River is completely different. Floodplain on the right bank is very wide and connected to the floodplain of the Sava River in the most downstream sector. Floodplain on the left-hand bank is much narrower, but it still covers several smaller dwellings.

River valleys on the Upper and Middle Drina River are shown in Figure 2-4 and Figure 2-5. Much steeper sided slopes can be seen on the Upper Drina River course, and rich forestation is evident in both sectors.

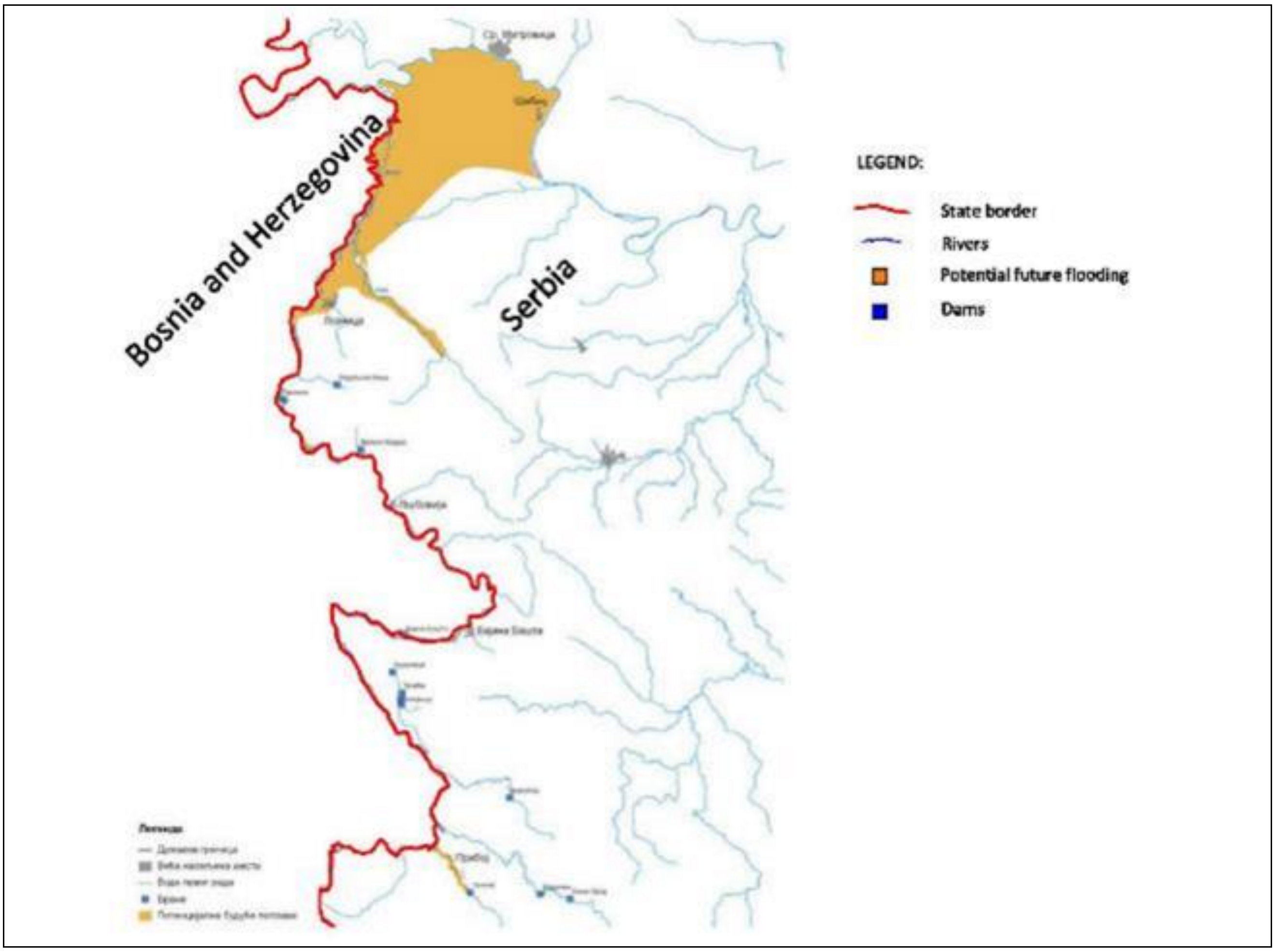


Figure 2-3: Floodplains along the Drina River course

Figure 2-4: River valley along the Middle Drina River

Figure 2-5: River valley on the Upper Drina River ("Buk Bijela" profile)

River processes in the Middle Drina River sector are manifested in the form of sporadic accumulations of deposits along the watercourse (Figure 2-6 and Figure 2-8), because of insufficient sediment transportation capability of the watercourse. On the other side, alluvial erosions and disintegration of riverbanks are present in certain segments (Figure 2-7).

Figure 2-6: Deposits in the Sutjeska River bed

Figure 2-7: Ruinous bank on the Middle Drina River

Figure 2-8: Deposit accumulation and the reef in the riverbed in the Middle Drina Sector

General Characteristics of Erosion Processes in the Basin and Watercourse

The DRB has numerous forms of erosion work of which is reflected in the shape of surface run-off (surface erosion) of soil transportation in thin layers of various thickness (laminar erosion), transportation of bulkier fractions of rock soil (screes – detritus erosion), occurrences of gullies and ravines (mixed and depth erosion) and occurrences of chemical dissolution of limestone. Described forms of erosion on smaller areas occur in the basic form in initial stages, while on larger areas and later development stages they appear in combinations.

Erosion processes in the area are a result of degradation of the vegetation cover (unplanned use of forests and pastures on inclined terrains) on geologic and pedologic layer, which are subject to significant erosion in the existing climate and meteorological conditions. Development of erosion processes is also the subject of the population’s pressure on agricultural and forested land.

Alluvial erosions manifested by landfalls, bank decomposition, eroding and activation of powerful alluviums created by long-term depositing of sediment should be pointed out to. This form of erosion was identified both in the main course and in the higher order tributaries. During the arrival of flood discharges in the conditions of sharp riverbed slopes, strong towing forces activate and transport significant quantities of deposit. Depending on the intensity of torrential arrivals, materials arriving from tributaries to the main watercourse are settled within the zones of natural depositing.

Erosion processes character is different on different sectors of the Upper, Middle and Lower Drina River in view of the differences between the geo-morphologic and vegetation characteristics of correspondent basins. Steeper relief in the Upper DRB is suitable for erosion development, but this is also partially compensated by good vegetation cover (Figure 2-5). On the other side, canyon type of the riverbed of the Drina River conditions direct entry of eroded sediment into the waterway. Erosion processes in the Middle DRB are of weaker intensity. Wider river valleys include more tributaries, in a part of the sediment (transported from the basin) is deposited on the way to the main watercourse and, thus, reduces deposit entry to the Drina River. Finally, particularly wide river valley of the Lower DRB reduces the contact between the basin and the waterway. This is the reason why erosion processes are reduced almost exclusively to alluvial erosion.

The lower course of the Drina River, from the "Zvornik" HPP dam up to the confluence with the Sava River, is approximately 80 km long. The Drina River is of distinctively plain character in this sector (total elevation difference is approximately 60 m), and the course is distributed with the large number of meanders, estuaries and abandoned watercourses. Morphologic processes occur by two different phenomena – on one side, accumulation of the river deposits within certain segments and, on the other side, erosion of the riverbed and riverbank disintegration. Figure 2-9 shows a large reef of accumulated deposits close to the Drina River mouth into the Sava River, while Figure 2-10 shows a collapsed riverbank.

Figure 2-9: Sedimentation close to Sava River confluence

Figure 2-10: Collapsed banks on Lower Drina River

Meandering of the Drina River Course

As already pointed out, the geomorphologic nature of the DRB has major impact on river processes, particularly on meandering. Meandering is almost non-existent on the Upper and Middle Drina River, but this phenomenon is very much present on the Lower Drina River.

Meandering of the river course covers a broad strip of the river valley, around 1 to 3 kilometres in width. Secondary riverbeds (river arms) are located on the edges of the meandering strip that are activated under the conditions of flood discharges. Under such hydrologic conditions, the entire meandering strip is under water. Wide floodplain includes several rural dwellings, as well as the large complex of Stanišići "ethnic" village, near the town of Bijeljina.

Figure 2-11 and Figure 2-12 show meandering of the river terrace within the Drina River reach downstream of the town of Bijeljina, which is representative in terms of meandering.

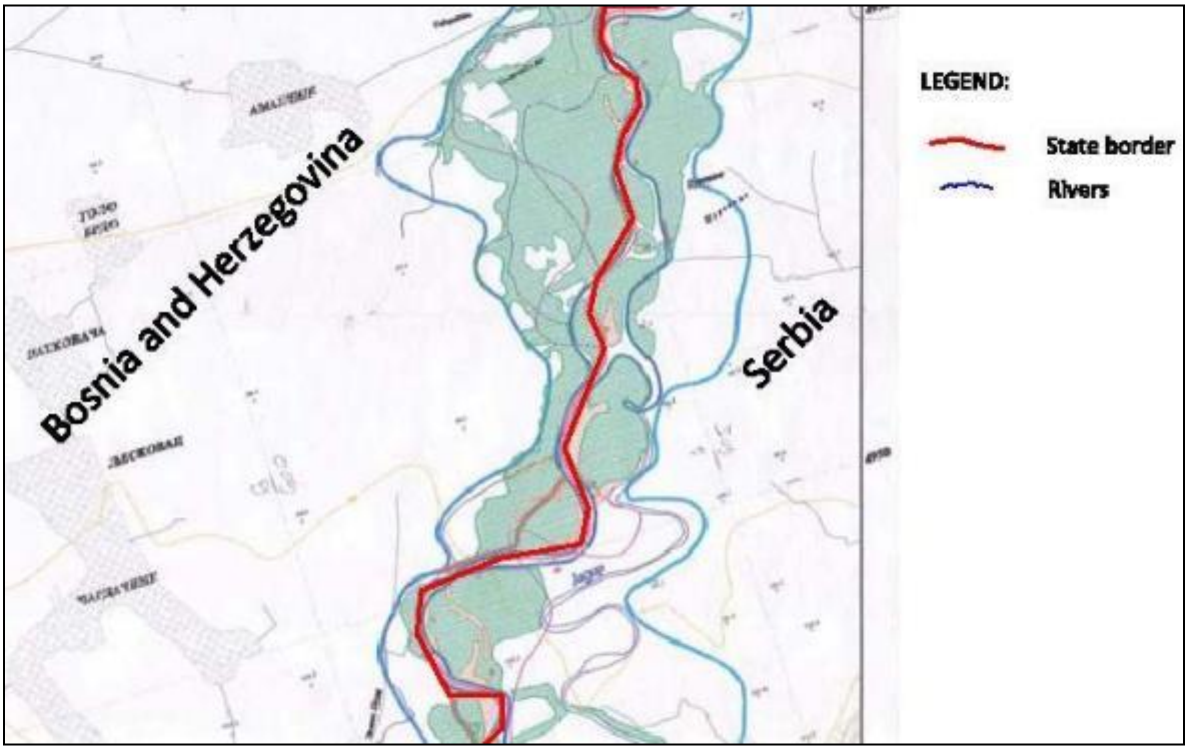


Figure 2-11: Meandering in the Lower Drina River reach

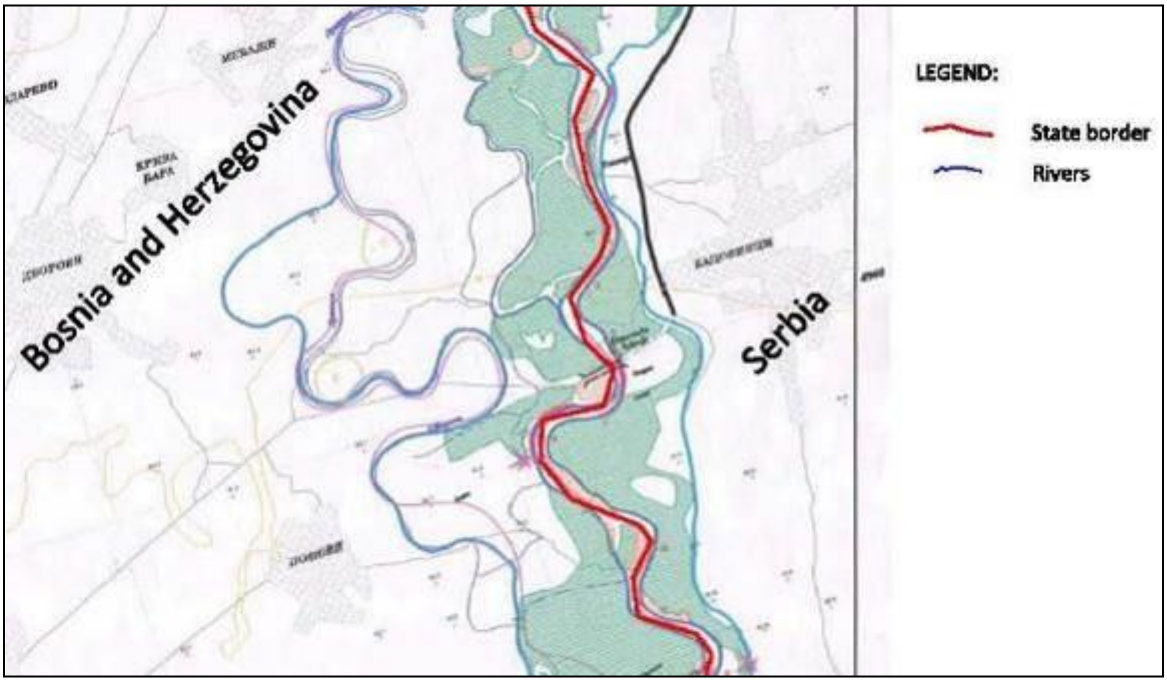


Figure 2-12: Meandering of the river terrace along the lower Drina River course

Effects of existing water management facilities (built-up storages) on deposits balance in the basin

So far, seven large dams and storages have been built in the DRB, all of them with primary hydropower purpose. The basic data on reservoir storages are shown in Table 2-1. It can be concluded that along the Drina River course there are three dams with storages, while four facilities have been built on its tributaries. The period of construction of the subject facilities has been relatively long, lasting more than half a century.

The oldest is the storage of the "Zvornik" HPP, finished in 1955, while the most recent is the dam and storage of the "Višegrad" HPP, finished in 1989.

Table 2-1: Basic data on existing storages in the DRB

Dam and Storage	Watercourse	Basin area (km^2)	Year of construction	Initial storage volume (million m^3)
"Zvornik"	Drina	17,400	1955	95
"Bajina Bašta"	Drina	15,195	1967	342
"Višegrad"	Drina	13,360	1989	118

All storages in the DRB are vulnerable to sedimentation to a certain extent, depending on the natural characteristics of the sub-basins. The dynamics of the storage deposit filling processes is best described by the example of the oldest one – the storage of the "Zvornik" HPP. "Zvornik" reservoir was formed by construction of the dam in 1955. During the last 60 years, the storage was subjected to constant sedimentation as an unavoidable consequence of the damming of the river. Considering the importance of the "Zvornik" HPP for the power industry, systematic tracking of storage conditions was initiated at the very start of operations. During the exploitation period, 10 surveys of the storage basin were conducted: between 1955, and 2005. Surveys have been performed every three years, but then their frequency was reduced after 1967 (see Figure 2-13). One can conclude that a very large water storage volume reduction has occurred during 50 years (from 1955 to 2005).

Following the above elaboration, the general balance of the DRB sediment under the natural regime can be calculated prior to the construction of the dam and storage as follows:

- Average annual sediment entry from the Tara River: 1,2 million m^3,
- Average annual sediment entry from the Piva River: 1.2 million m^3,
- Average annual sediment entry from the Lim River: 1.1 million m^3,
- Average annual sediment entry from other tributaries: 0.5 million m^3,
- Average annual sediment transport on the Middle Drina River: 4.0 million m^3,

After the dam and storage system construction in the DRB, sediment transport along the Middle Drina River reduced gradually. Construction of storages on the Uvac River, Lim River and Piva River led to significant reduction of the average annual sediment entry into the storage of the "Bajina Bašta" HPP by approximately 2 million m^3 (including the "Potpeć" storage filling), and sediment entry to the "Zvornik" HPP storage by approximately 3 million m^3 (including the "Bajina Bašta" HPP storage filling). Subject balance is in line with the data on filling of subject storages,

After the construction of the "Višegrad" HPP dam and storage, balance of sediment along the Middle Drina River has not been significantly altered due to low intensity of storage filling.

The impact of the Drina River and its tributaries storage system had the biggest effect on the Lower Drina sector. Stopping the sediment transport on the upstream sectors significantly reduced sediment transfer along the Lower Drina River. Measurement of sediment during the recent period resulted in an annual transfer of approximately 1 million m^3.

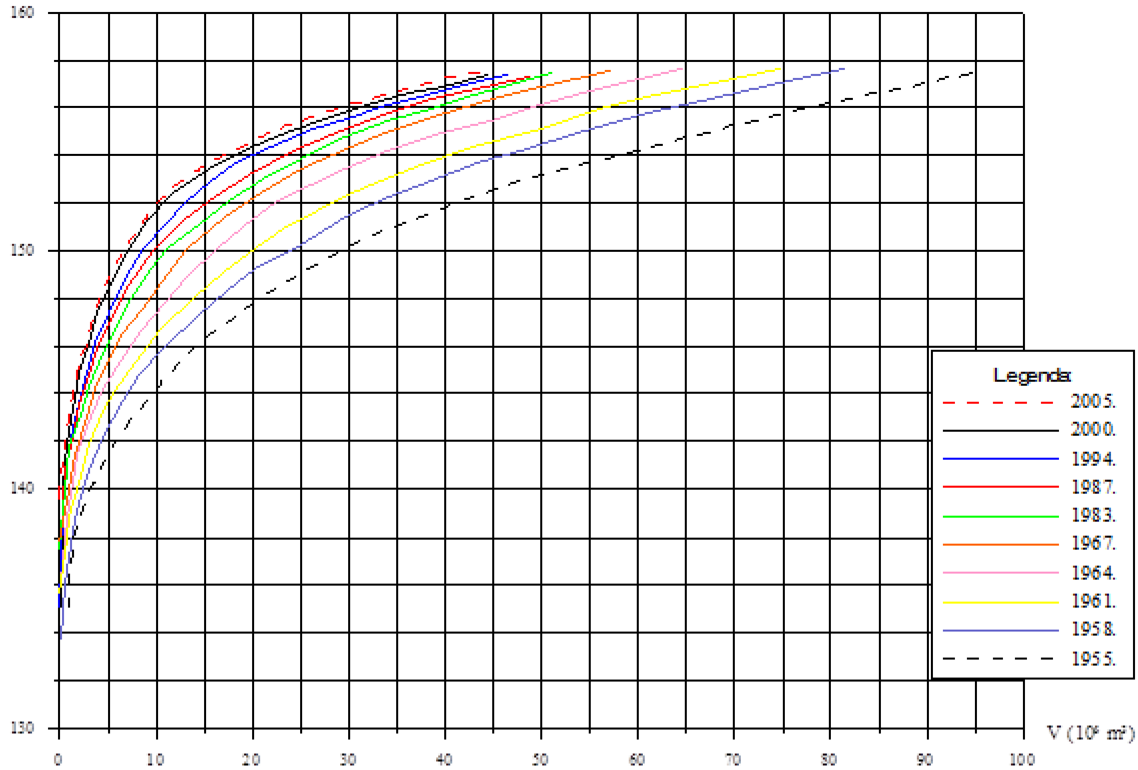


Figure 2-13: Comparative storage volume curves of the "Zvornik" HPP

Effects of materials exploitation from the riverbed on the riverbed stability

Commercial materials exploitation is very much present, as the lower course of the Drina River is an important gravel resource (favourable alluvium structure and high quality materials). Exploitation is performed from the borrow pits in the riverbank area or reefs along the bank area. However, inadequate and unplanned exploitation is present in old abandoned estuaries, something that can lead to their reactivation and waterway route alteration. Figure 2-14 shows one site for exploitation from the Drina River course.

Figure 2-14: Sand and gravel exploitation from the Drina River course

Dredging of materials from the riverbed may potentially have extremely negative consequences on the river and riverbed route stability. Inadequate dredging sites can strengthen the trend of the river route meandering. On the other hand, disintegration of riverbanks is often the consequence of unplanned exploitation of the river deposits from the waterway. Therefore, subject issue should be given due attention in the forthcoming period.

Floods along the Drina River Course

Flood defence structures have been built on a relatively short length of the Drina River course. The longest flood defence section is located on the right-hand bank of the Drina River, downstream of the village of Badovinci. Additionally, there are also shorter segments of built up protection embankments in upstream sectors. To that extent, one should bear in mind that the concept of protection against the flood discharges of the Drina River is largely based on proactive approach – flood discharge wave control with the system of existing storages. However, it should be noted that all storages were built up with the primary hydropower purpose and, thus, there will be always a possibility of conflict between the power and flood defence interests.

Considering the geo-morphologic characteristics of the Drina River course and bank, potential floodplains are located only in the Middle and Lower Drina River sectors. Major recent floods have taken place in the areas of the town of Goražde, town of Ljubovija and town of Bijeljina. Figure 2-15 shows the flooded urban areas in the town of Goražde.

Figure 2-15: Flood in town of Goražde

Guidelines for the Drina River Waterway and Bank Development

Substantial natural hydropower potential of the Drina River has been utilized so far only partially. Therefore, construction of new dams, storages and hydropower plants has been planned on the upper and middle course of the Drina River in future. Project documents are being developed for the Upper Drina River dams of "Buk Bijela" HPP, "Foča" HPP and "Paunci" HPP, while locations of future facilities on the Middle Drina River have not been definitely determined yet. Construction of these facilities would greatly impact development of the waterway and the bank of the Drina River.

Other major water management related issue on the Drina River is related to floods and arrival of flood discharges. Subject problem is particularly distinguishable in the lower course of the Drina River due to plain like character of the waterway and wide river valley. Major floods of 2010 resulting in significant damages on the right bank and bank area are the last warning of urgent need for flood protection problem. Within the hydro-technical development of the Lower Drina River course, it will be required to plan technological measures of psalmologic and morphologic processes control along the waterway, protection of riverbanks against alluvial erosion and ensuring stability of the regulated Drina River bed.

One special problem is exploitation of materials from the riverbed and riverbanks. As already mentioned, commercial exploitation of materials from the riverbed is very much present since the Lower Drina River course is an important gravel resource (favourable alluvium structure and high-quality materials). Future period will require change of approach to subject issues and introduction of planned exploitation of alluvium deposits from the riverbed by means of application of adequate floating machinery. This would create double effects: provision of significant material quantities for commercial exploitation and, on the other hand, psalmologic and morphologic processes control along the waterway. Namely, dredging of numerous reefs in the riverbed would provide for controlled alteration of the waterway current and distancing mainstream from concave banks would mostly resolve the issue of alluvial erosion and reduce the disintegration of riverbanks.

2.2.3 Topography

The lowest point in the DRB is at 82.3 m a.s.l. at the confluence of Drina River and Sava River near the village of Crna Bara. The average altitude of the DRB is 961.6 m a.s.l. and altitude is in the range from 75.4 m a.s.l. at the mouth to more than 2,500 m a.s.l. on the highest mountains (Prokletije Mountain 2,694 m a.s.l., Komovi Mountain 2,487 m a.s.l. and Durmitor Mountain 2,522 m a.s.l.).

2.3 Hydrography

The Drina River is the biggest tributary of the Sava River in terms of the total area of the basin, the length of the watercourse and water quantity. The major tributaries of the Drina River in BiH are the Sutjeska River, Bistrica River, Ćehotina River, Prača River, Lim River, Rzav River, Žepa River, Rogačica River, Ljuboviđa River, Drinjača River and Janja River. There are numerous natural and artificial lakes in the DRB. The hydrographic map of the DRB is presented in Figure 2-16.

The Sutjeska River
The Sutjeska River is the first major tributary to the Drina River. It rises on the slopes of Volujak Mountain at 1,500 m a.s.l. and mouths into the Drina River at approximately 430 m a.s.l. It is 35 km long, with a very high slope (30‰). The Sutjeska River runs between Volujak Mountain and Maglić Mountain on the eastern side and Zelengora Mountain and Treskavica Mountain on the western side. The Sutjeska River course includes a 6 km-long Prosječenica canyon, with the narrowest segment called Vratar gorge wide approximately only 20 m and the canyon valley is 1,200 m deep.

The Bistrica River
The Bistrica River is 41.4 km long. It springs at 1,227 m a.s.l. and mouths at 395 m a.s.l. The average slope is 20‰. Its major tributaries are Miljevina River, Draženica River, Govza River, Krupica River and Oteša River.

The Ćehotina River
The Ćehotina River basin is 125 km long. It rises under the Stožer Mountain at 1,380 m a.s.l. and, like the other right tributaries of the Drina River, runs in the direction south-east – north-west. It is the second biggest tributary to the Drina River, after the Lim River. Downstream of the village of Kamenica up to the mouth into the Drina River near the town of Foča the Ćehotina River runs along the canyon valley.

The Prača River
The Prača River springs under the northern slopes of the Jahorina Mountain at 1,460 m a.s.l. The river course is 57 km long. It mouths into the Drina River near the town of Ustiprača at 329 m a.s.l. The basin of the Prača River up to the Renovica site belongs to hydrologically unstudied basin areas since no systematic hydrologic measurements of the discharge have been done before. Specific run-off is on average approximately equal to 22 l/s/km^2. The most significant Prača river tributary is the Rakitnica River.

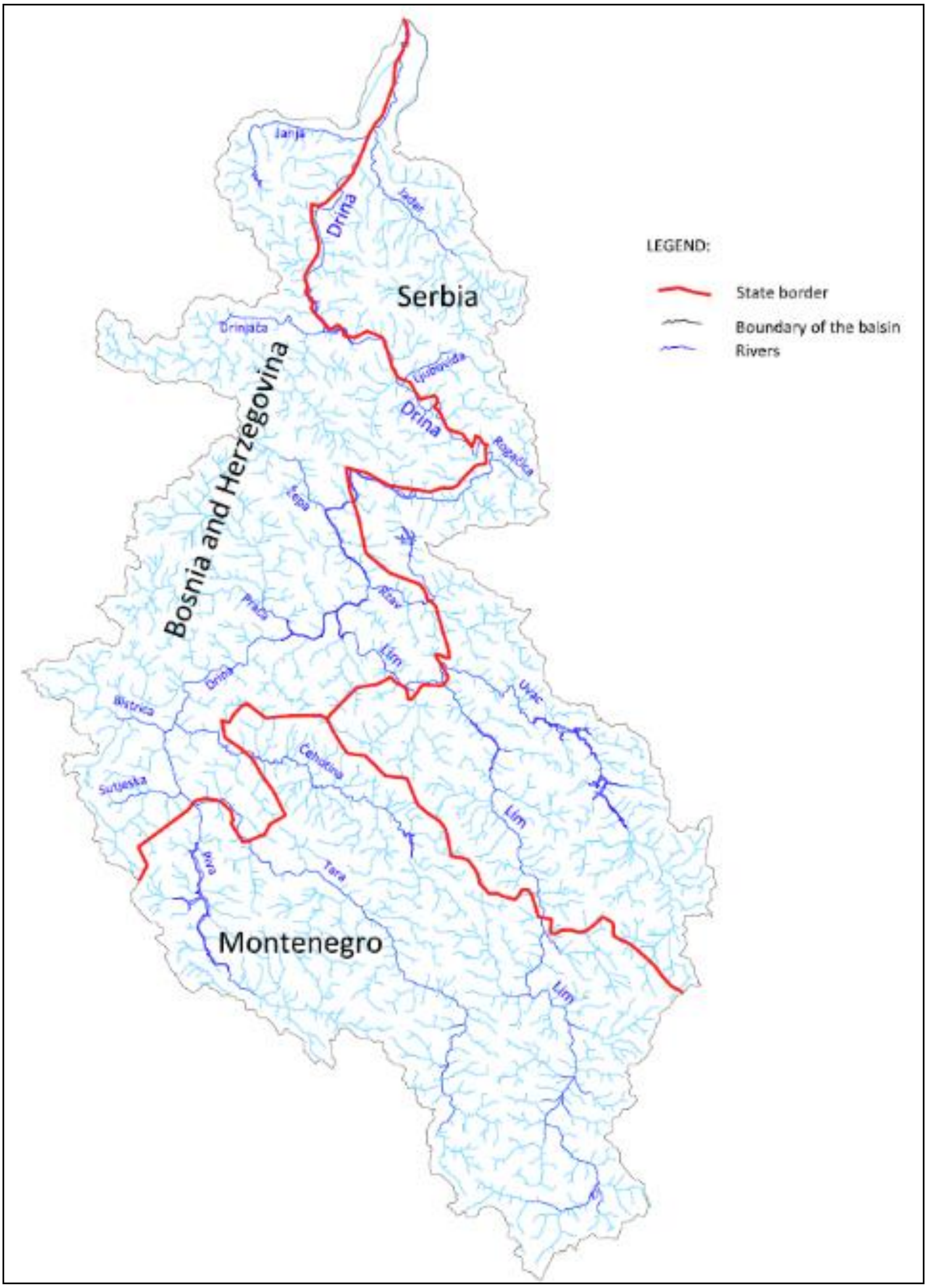


Figure 2-16: Hydrographic map of the DRB

The Lim River

The Lim River is the biggest tributary to the Drina River. The Lim River is 201.6 km long, running from Lake Plav up to the mouth into the Drina River. Further downstream, the Lim River descents with major curves up to the valley of the Drina River to mouth to the Drina River near Međeđa.

The Žepa River
Although relatively small, this river is very water-abundant (run-off of approximately 22 l/s/km^2). The Žepa River is the left-hand tributary to the Drina River. It is 30 km long. The Žepa River used to mouth into the Drina River near the village of Slapa. The downstream segment of the Žepa River included a very beautiful canyon, but it is now flooded due to the construction of "Bajina Bašta" HPP dam.

The Rzav River
The Rzav River is created by the Beli Rzav River and Crni Rzav River near the village of Donje Vardište on the border between Serbia and BiH (Republic of Srpska). The Crni Rzav River rises on Čigota Mountain at 1,300 m a.s.l. The length of its course is 48 km. The Beli Rzav River rises on Tara Mountain under the Koziji Vid Top at 1,520 m a.s.l. Its length is 28 km. Storages "Zaovine" storage, "Kruščica" storage and "Stajići" storage were built up on the Rzav River course. The Rzav River runs first through the limestone gorge with several valley meanders. Near the village of Dobrun river valley broadens and the river mouths into the Drina River near the town of Višegrad.

The Drinjača River
The Drinjača River is the longest left-hand tributary to the Drina River with the length of 77 km. The Drinjača River springs under Konjuh Mountain at 1,100 m a.s.l. and runs along the narrow valley. The river is water abundant, i.e. with run-off of approximately 19 l/s/km^2. The biggest tributary is the Jadar River that drains out of the northern slopes of the Javor Mountain.

The Janja River
The Janja River is the left-hand tributary to the Drina River. The length of the river is 57 km. It rises under Stolice, the highest top of the Majevica Mountain. Its biggest tributary is the Modrana River. The Janja River mouths into the Drina near the eponymous settlement.

The Drina River
The Drina River course is 322 km long. Its course is not constant since the Drina River meanders (in the lower segment of the river course), by means of expanding or even cutting through new riverbeds and, thus, the river length alters. The Drina River valley starts at the town of Šćepan Polje and stretches mainly towards north-east. Up to the mouth of the Sutjeska River, left-hand bank is very steep with the milder right-hand bank. Immediately upstream of the town of Foča, the Bistrica River mouths into the Drina River on the left-hand side and the Ćehotina River on the right-hand side. This segment of the watercourse is characterized by numerous tributaries and sources that create small valleys and provide for denudation of the Drina River bed. Between the town of Foča and the town of Ustikolina, riverbanks are milder and also distributed, with several stone terraces and numerous gravel terraces. Riverbed characteristics downstream of the town of Ustikolina towards the town of Goražde do not change significantly.

Several tributaries mouth downstream of the town of Goražde towards the town of Višegrad, the left-hand tributary Prača River and the right-hand tributaries Janjina River, Lim River and Rzav River. This segment of the watercourse is the location of Međeđanska gorge and all the way to its merge with the Lim River the Drina River is characterized by the canyon-type valley. The storage of the "Višegrad" HPP is located in the zone of Međeđanska gorge.

From the village of Štitarevo downstream, the Drina River creates large bend running towards east, around the Zvijezda Mountain. The valley here is a pronounced canyon with the sides approximately 850 m high, with as much as 1,100 m in the Klotjevačka gorge. Suitable shape of this watercourse segment provided for dam construction and large storage, the "Perućac" storage belonging to the "Bajina Bašta" HPP. Total storage volume is approximately 340 million m^3 with the non-diversion type power plant built in 1966. Pumped-storage power plant was built in the later stage next to the existing power plant with the storage of 170 million m^3 located within the area of the Beli Rzav River source.

Near the town of Rogačica, the eponymous river mouths into the Drina River on its right-hand side and the Gračanička River mouths into it in the town of Ljubovija.

A "cut-in" within the limestone with 250 m high cuts-offs is located immediately upstream of the town of Zvornik. This is the location where the confluence of the Drinjača left-hand tributary joins the Drina River. A gravity dam was built in 1955 within the area of the aforementioned cut-in and storage was formed with an initial volume of 89 Mm^3 to serve the needs of the "Zvornik" HPP. The storage is today mainly filled with sediment.

From the town of Zvornik to the town of Loznica and all the way to the village of Lešnica, the Drina River bed cuts through varied rock materials, slowly expanding towards a spacious alluvial plain. The Drina River creates a large meander in the Loznica field branching around the river island. The Drina River meanders between the town of Loznica and the village of Lešnica. The Drina River tributaries along this segment of the watercourse are the Štira River, Jadar River, Janja River and Lešnica River, with flat, placid watercourses, due to large quantities of gravel deposited by the Drina River around its riverbed. The Drina River meanders downstream of the village of Lešnica, creating river arms and abandoned riverbeds. Immediately downstream of the village of Crna Bara the Drina River mouths into the Sava River. The main characteristics of the rivers in the DRB are shown in Table 2-2.

Table 2-2: Characteristics of runoff of the Drina River and its main tributaries in BiH

River	Area (km^2)	Length (km)	Discharge Q (m^3/s)	Runoff q ($l/s/km^2$)
Drina	19,982	322	395	19.77
Sutjeska	270	35	13	48.15
Bistrica	423	41.4	12	28.37
Ćehotina	1,501	125	22	14.66
Prača	1,109	57	22	19.84
Lim	5,934	201.5	110	18.54
Rzav	605	72	8	13.22
Žepa	223	30	5	22.42
Drinjača	1,104	77	21	19.02
Janja	292	53	2.9	10

Natural lakes
The most important natural lakes in the DRB are located in Montenegro and will not be mentioned here. The following Subection 2.3.2 provides details of artificial lakes.

2.3.2 Water Bodies of the Drina River in BiH

Drainage area of Drina River covers 14% of the territory of BiH (Figure 2-17). The Drina River flows through BiH northward for 346 km; over 200 km out of that length is along the border of BiH and Serbia. Significant shares of middle and lower parts of the DRB are located in BiH.

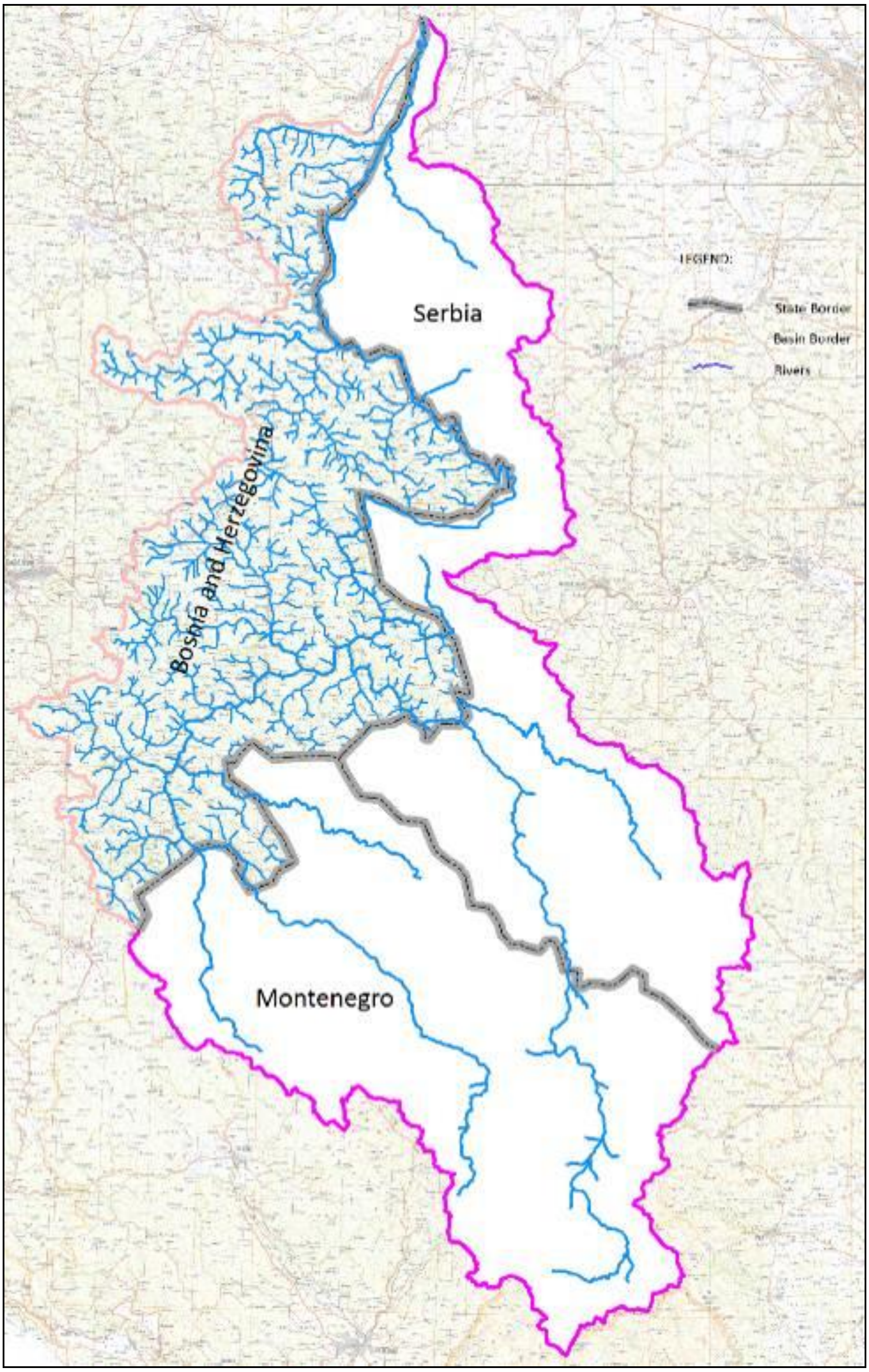


Figure 2-17: Drina River Basin in BiH

All left-hand tributaries to the Drina River have a source in BiH. Since the right-hand Drina River tributaries flow through more than one country, only the tributaries that originate in BiH are included in Table 2-3. Consequently, the main features for rivers are included in reports at country level with respect to source location. As exhibited in Table 2-3 the Lim River and Ćehotina River are excluded from country report since their source is in Montenegro. The characteristics presented in the previous Table 2-2 refer to the whole basins regardless of its share in riparian countries.

Table 2-3: Characteristics of rivers in the DRB that originate in Bosnia and Herzegovina

River	Drainage area (km^2)	Length (km)	Q (m^3/s)	Contribution to total Q (%)
Sutjeska	270	35.0	13.0	3.3
Bistrica	423	41.4	12.0	3.0
Prača	1,109	57.0	16.0	4.1
Žepa	223	30.0	5.0	1.3
Drinjača	1,104	77.0	21.0	5.3
Janja	292	53.0	2.9	0.7
Drina	19,982	322.0	395.0	100


Figure 2-18: Sutjeska River


Figure 2-19: Drinjača River

A great number of natural lakes is located in the upper and middle parts of river basin located in BiH. In addition to natural lakes, artificial lakes and dams are developed. Table 2-4 presents characteristics of selected natural and artificial lakes in DRB in BiH.

Table 2-4: Selected natural and artificial lakes in DRB in BiH

Lake	Length (km)	Width (km)	Area (km^2)	Depth (m)	Nat./Art.*	Elevation (m a.s.l)
Štirinsko	0.600	0.350	0.3	4.5	Nat	1,672
Crno	0.170	0.080	0.014	3 to 4	Nat	1,450
Perućac**	50	0.150 to 1.000	12.4	60	Art	290
Višegradsko	40		10.7	49	Art	125
Zvorničko**	25	0.3-3 km		39	Art	140

* Nat. and Art. refer to Natural and Artificial Lake, respectively
** Shared with Serbia

Figure 2-20: Štirinsko Lake

Figure 2-21: Drina River canyon and Perućac Lake

2.3.3 Delineation of Surface Water Bodies

The activities related to the transposition of the Water Framework Directive (WFD) requirements into the riparian countries are ongoing. Discrepancies exist at the national level with respect to that and development of by-laws that would contribute to implementation vary from country to country. Based on available data and information, the by-law that would characterize surface and groundwater bodies in BiH is still pending. Consequently, Table 2-5 below summarizes excerpts from the Sava River Basin Management Plan relevant for surface water bodies (SWB) within the DRB in BiH. Depicted SWB are delineated for tributaries with catchment areas larger than 1,000 km^2. Different delineation of SWB by riparian countries has been recorded for certain sections of the Drina River shared by BiH, Montenegro and Serbia, based on the Sava River Basin Management Plan - Background paper No.1 ("Surface water bodies in the Sava River Basin"). Data and information included are provided by countries, for Serbia and BiH, while for Montenegro SWBs are proposed.

Table 2-5: Surface water bodies in Bosnia and Herzegovina

No	River	Water body code	Length (km)	Natural water body	HMWB (Candidate)
1	Drina	BA_DR_7	21.08	x	
2	Drina	BA_DR_6	27.5		c
3	Drina	BA_DR_5	42.5		x
4	Drina	BA_DR_4	56.8		x
5	Drina	BA_DR_3	79.5		x
6	Drina	BA_DR_2	29		x
7	Drina	BA_DR_1	91		x
8	Tara	BA_DR_TAR_1	24.44	x	
9	Ćehotina	BA_DR_CECH_1	25.66	x	
10	Prača	BA_DR_PRA_5	13.76	x	
11	Prača	BA_DR_PRA_4	18.35	x	
12	Prača	BA_DR_PRA_3	12.55	x	
13	Prača	BA_DR_PRA_2	3.33	x	
14	Prača	BA_DR_PRA_1	14.68	x	
15	Lim	BA_LIM_1	44.77	x	
16	Uvac	BA_DR_LIM_UVA_1	8.17	x	
17	Drinjača	BA_DRNJ_7	3.4	x	
18	Drinjača	BA_DRNJ_6	17.2	x	
19	Drinjača	BA_DRNJ_5	10.8	x	
20	Drinjača	BA_DRNJ_4	13.31	x	
21	Drinjača	BA_DRNJ_3	33.5	x	
22	Drinjača	BA_DRNJ_2	7.5	x	

No	River	Water body code	Length (km)	Natural water body	HMWB (Candidate)
23	Drinjača	BA_DRNJ_1	4.29	x	

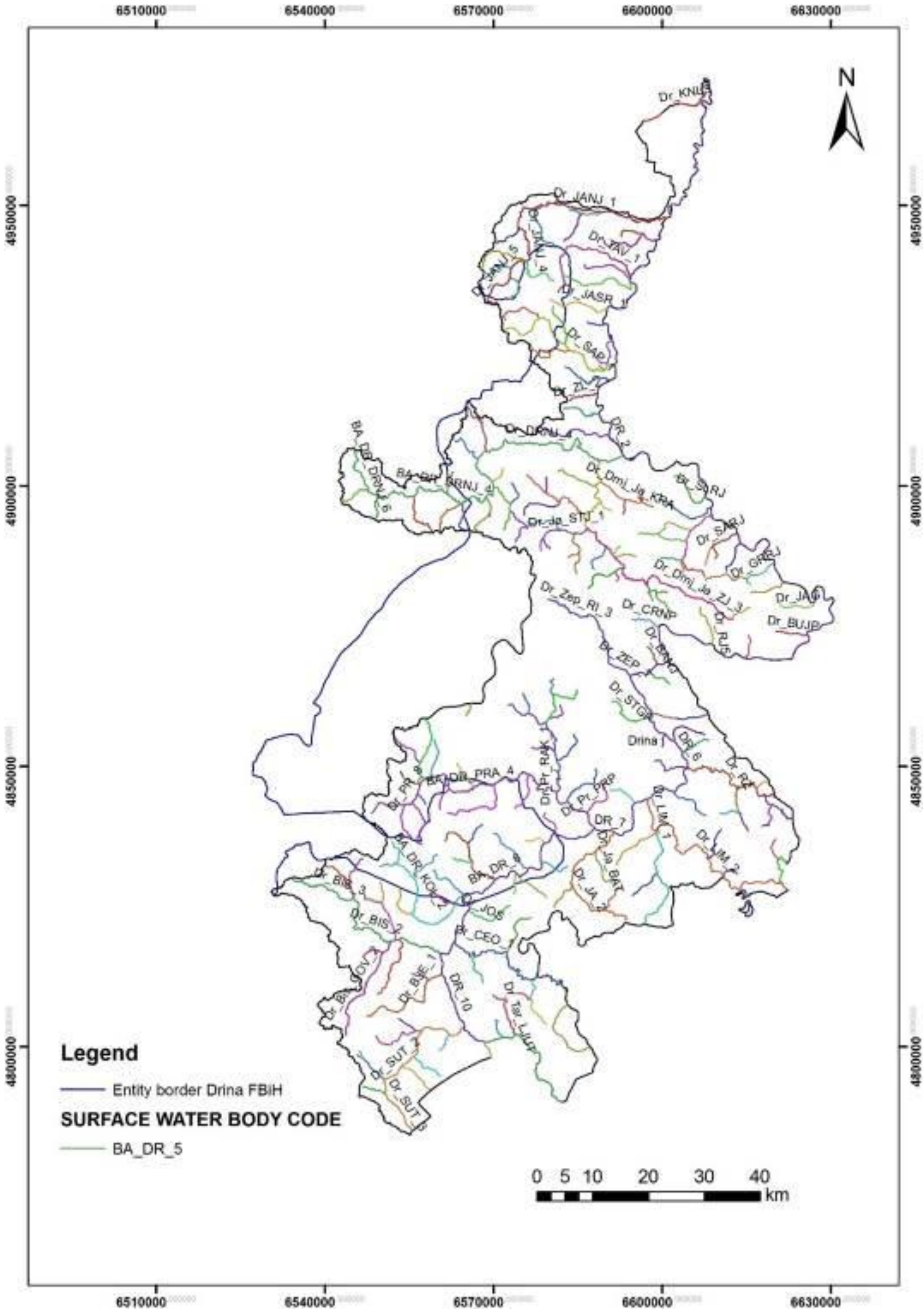
Table 2-6 exhibits summary outcomes from an ongoing process of development of a by-law on surface water bodies characterization in BiH for both entities. Based on available information there is a significant number of surface water bodies with lack of relevant data for suitable characterization. Thus, surface water bodies with available data are evaluated with respect to heavy modification based on their corresponding typology.

Table 2-6: Drina River surface water bodies in BiH – ongoing process of bylaw development

No.	Water Body	Watercourse	HMWB	Length(km)	Water Body Code	Water Sub-Basin
1	Drina from town of Goražde to town of Foča, type change location	Drina	NO	21.83	BA_DR_6	Drina
2	Drina from "Višegrad HPP" to town of Goražde	Drina	Candidate	5.36	BA_DR_5	Drina
3	Prača from "Mesići" SHPP water intake up to Čemernica confluence, type change location	Prača	NO	5.45	BA_DR_PRA_3	Drina
4	Sapna from type change point to Rožajska river confluence, type change location	Sapna	Candidate	2.21	BA_DR_SAP_2	Drina
5		Grabovica	No data	1.04	DR_DRNJ_GRABOVICA_1	Drina
6	Prača from Čemernica confluence to Grabovica confluence, type change location	Prača	NO	12.13	BA_DR_PRA_4	Drina
7	Odska river from confluence with Drina to left tributary Topola confluence, type change location	Odska rijeka	No data	10.53	BA_DR_ODS.RIJ_1	Drina
8	Podhranjenski creek from confluence with Drina to Hranjenski creek confluence, type change location	Podhranjenski potok	No data	10.76	BA_DR_PODHR.POTOK_1	Drina
9	Kolunska river from type change location to Mazlinska river confluence, type change location	Kolunska rijeka	NO	12.71	BA_DR_KOL_2	Drina
10	Kolunska river from Mazlinska river confluence to head water	Kolunska rijeka-Korjen	NO	4.43	BA_DR_KOL_3	Drina
11	Kolunska river from Drina confluence to type change location	Kolunska rijeka	NO	12.84	BA_DR_KOL_1	Drina
12	Sapna-Munjača from Rožajska river confluence to head water	Sapna-Munjaca	NO	9.31	BA_DR_SAP_MU_1	Drina
13	Drinjača from Tišća confluence to river Strovnica confluence, type change location	Drinjača	NO	16.52	BA_DR_DRNJ_4	Drina
14	Drinjača from Vojnik river confluence to rivers Miljevica and Haluga junction	Drinjača	NO	20.78	BA_DR_DRNJ_6	Drina
15	Osanica from confluence with Drina to left tributary Konjevski creek, type change location	Osanica	Candidate	16.53	BA_DR_OSA_1	Drina
16		Bebroštica	No data	4.68	DR_DRNJ_BEBROSTICA_1	Drina
17		Ujiča	No data	9.44	DR_DRNJ_UJICA_1	Drina
18		Ljaljički potok	No data	6.79	DR_KOLUNSKA_LJALJICKIPOTOK_1	Drina
19		Bahovski potok	No data	3.91	DR_OSA_BAHOVSKIPOTOK_1	Drina
20		Mazlinska rijeka	No data	3.66	DR_KOLUNSKA_MAZLINSKARIJEKA_1	Drina
21		Dragošin	No data	1.82	DR_PRACA_DRAGOSIN_1	Drina
22		Srebrnica	No data	7.61	DR_DRNJ_SREBRNICA_1	Drina
23		Trudanj	No data	6.53	DR_OSA_TRUDANJ_1	Drina
24		Čemernica	No data	15.38	DR_PRACA_CEMERNICA_1	Drina
25		Rašković potok	No data	2.39	DR_OSANICA_RASKOVICPOTOK_1	Drina
26		Kamenička rijeka	No data	4.95	DR_PRACA_KAMENICKARIJEKA_1	Drina
27		Rožanjska rijeka	No data	8.36	DR_SAPNA_ROZANJSKARIJEKA_1	Drina
28		Gučina	No data	7.69	DR_DRNJ_GUCINA_1	Drina
29		Jezernica	No data	5.53	DR_DRNJ_JEZERNICA_1	Drina
30		Brzava	No data	4.56	DR_JANJA_BRZAVA_1	Drina
31		Rastošica	No data	4.44	DR_JANJA_BRZAVA_RASTOSNICA_1	Drina
32		Osica	No data	7.44	DR_DRNJ_OSICA_1	Drina

Source: Stakeholders from BiH

Provisional data (SHP files) obtained from the EU IPA Project undertaking the characterisation report for the SRB in BiH indicate that the DRB has been subdivided into 234 SWB in RS and 46 SWB in FBiH part of the basin. Out of these SWB, 26 are HMWB all in RS and none are in FBiH. Figure 2-22 shows these details.



Source: Eptisa SHP files

Figure 2-22: Provisional map of SWBs in DRB in BiH delineated under the EU IPA Project

2.4 Climate

The highest segments of the DRB (source area) are under the influence of the Mediterranean climate. Subject influence, even though much weaker, is still felt in the upper segments of the DRB, up to the town of Foča, wherefrom temperate continental climate is predominant, while the lower basin of the Drina River, downstream of the town of Zvornik is the area with predominantly continental climate. Influence of orientation and altitude on other high mountains in the DRB also determines climate features. River valleys are commonly characterized by temperate continental climate, up to 1,200 m a.s.l., the climate is sub-mountainous, and above 1,200 m a.s.l., it is mountainous. On high mountains and medium-height mountains, summers are fresh and winters are long and cold. Temperatures are below zero for 3 to 4 months during the year. If high mountains in the source area of the DRB are to be compared, medium-height mountains in the upper and middle segment of the river basin receive significantly less rainfall than the others. More rainfall is present in May, June and July, and the least rainfall is present in January and February, with precipitation mainly occurring in the form of snow. Ravines surrounded by mountains on all sides are characterized by specific climate. In summer, the temperature in them is higher than the one on the surrounding mountains, spring starts earlier, autumn is warmer, and annual rainfall is lower.

2.4.1 Precipitation

The DRB stretches south-north from the area of high mountains under the influence of Mediterranean pluviographic regime and progresses into the zone of temperate continental rainfall regime ending in the area of the continental prairie rain. The snow regime on the high mountains (Volujak Mountain, Maglić Mountain and Zelengora Mountain) is very important. Large quantities of show are accumulated during winter to melt down and drain during the spring. Average annual rainfall in the DRB is approximately 1,030 mm. Average multi-annual rainfall ranges between 700 mm in the eastern segment of the basin (Badovinci-Sjenica) and 2,500 to 3,000 mm in the source area of the Lim River on the Prokletije Mountain (in Montenegro). South-western part of the basin is more abundant in rainfall than the north-western part. Since the Drina River cuts through two mountain ranges of the Dinara System (Javor Mountain-Tara Mountain and Majevica Mountain-Cer Mountain), rainfall depressions are located in between them. Depression of rainfall in the broad area between two mountain ranges from the town of Sjenica to the town of Višegrad is particularly pronounced. Most rainfall occurs during November and the least during July. Figure 2-23 below indicates the areas with the highest amount of precipitation and those with the lowest in the BiH part of the DRB. There is a general decreasing trend in average annual precipitation amounting to about 300 mm/year from south to north across the DRB.

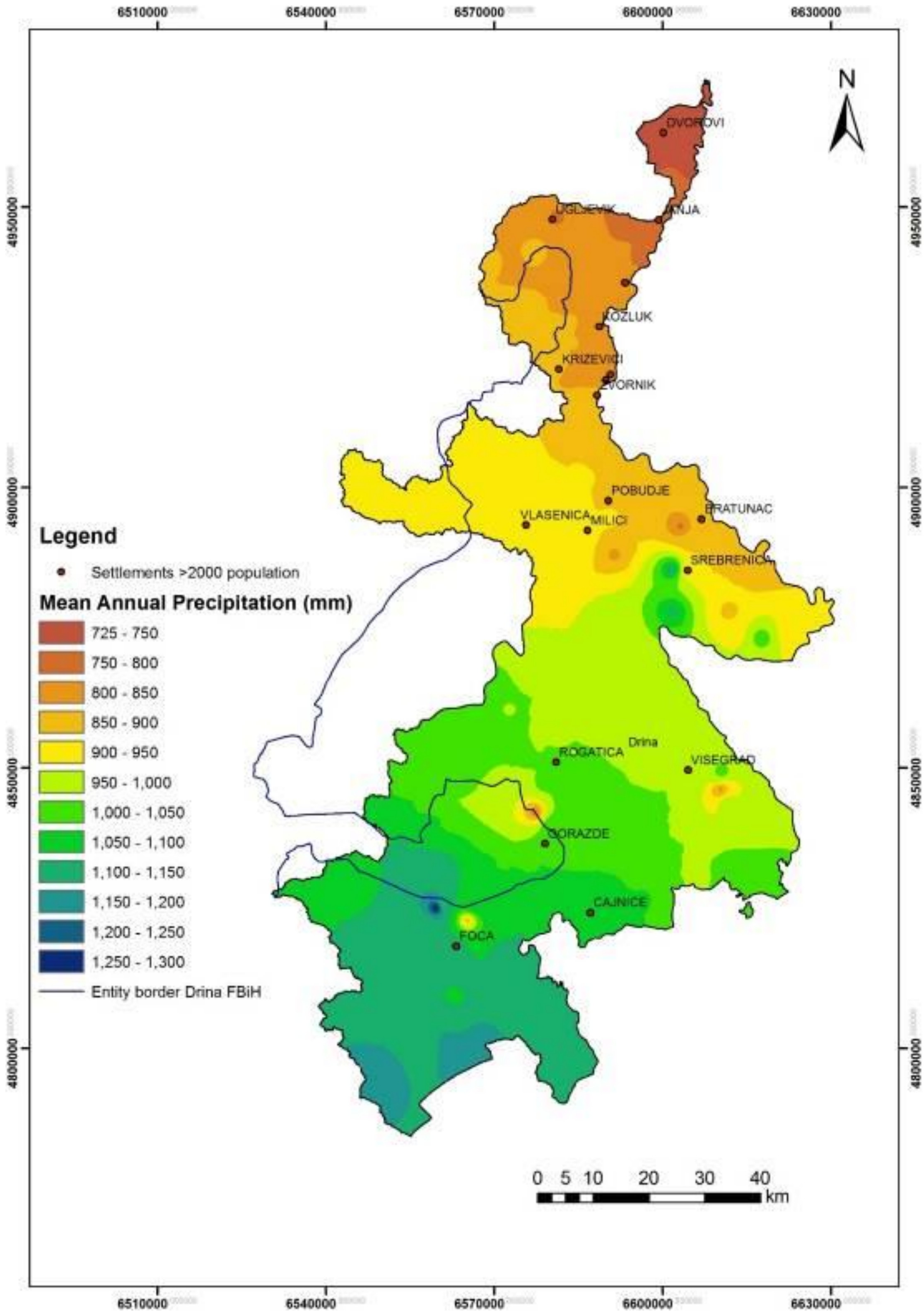


Figure 2-23: Mean Annual Precipitation in the DRB in BiH

2.4.2 Air Temperature

Generally, mean annual air temperatures in the DRB are far more balanced than the mean annual temperatures during individual months as seen in Figure 2-24 below.

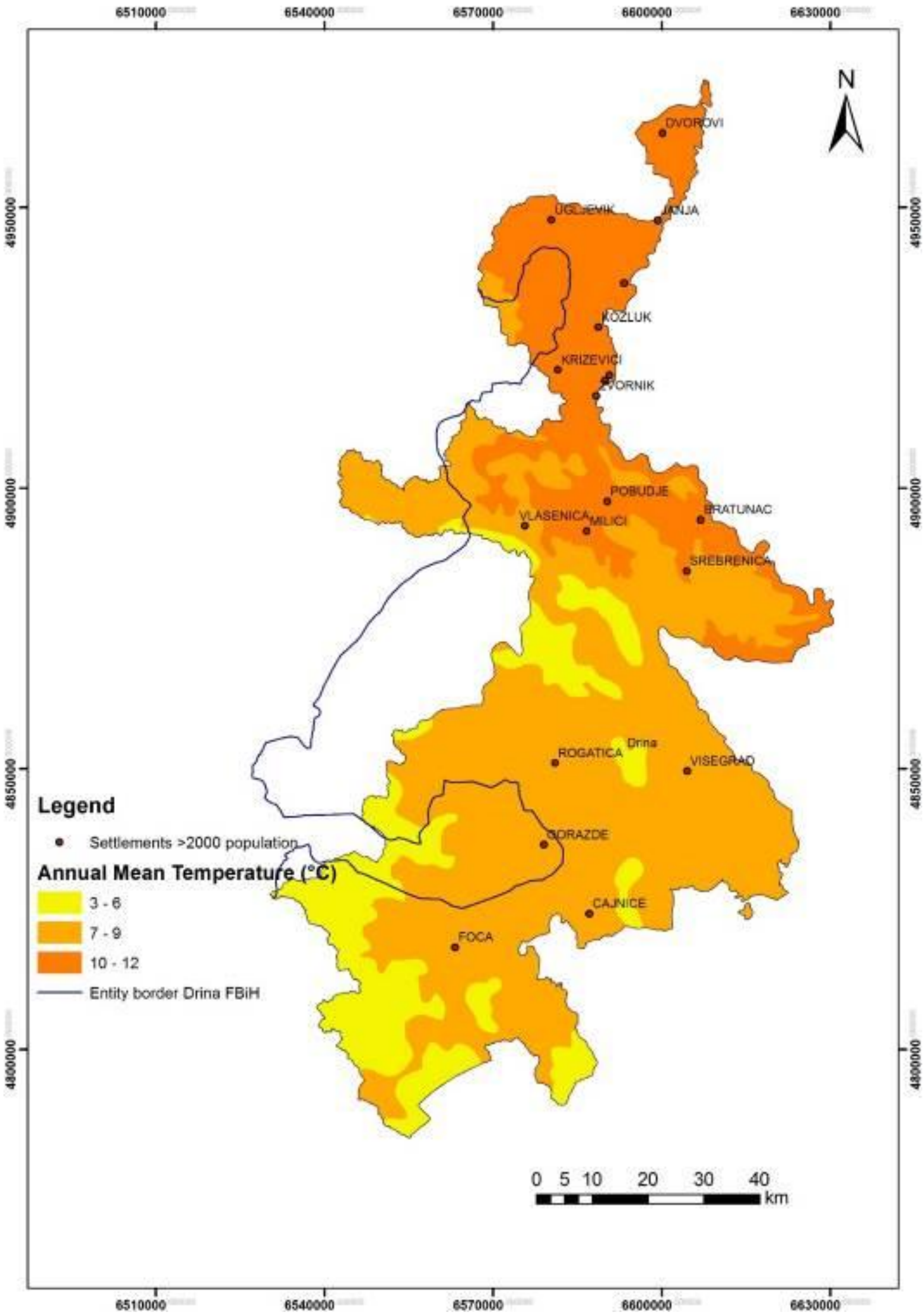


Figure 2-24: Mean Annual Temperature in the DRB in BiH

In the northern segment of the basin, mean annual air temperatures range between 10.5 and 11.1 °C corresponding to the lower course of the Drina River. The "Mitrovac" station on the Tara Mountain has lower air temperatures than "Zlatibor" on Zlatibor Mountain during all months, even though they are located at almost the same altitude. Reasons for that is the geographic position, i.e. topographic characteristics. "Mitrovac" is located in a dry valley under the influence of cold north-eastern wind, while "Zlatibor" is a highland open towards north-west and closed towards south-east, and the climate if transiting from temperate continental to sub-mountain.

2.4.3 Evaporation and Evapotranspiration

Values of evapotranspiration in Serbia and BiH in the DRB increase as one gets closer to the confluence with the Sava River as a direct consequence of smaller slopes in the basin, i.e. lower runoff coefficients in watercourses, as well as more abundant vegetation cover, pedologic characteristics of soil and other characteristics. Evapotranspiration values rise up to 620 mm annually in the lower segment of the DRB.

2.4.4 Air Quality

As already mentioned in the inception phase, air quality is important for IWRM because the secondary effects caused by gaseous emissions that can lead to acid rain that in turn can damage vegetation and lead to erosion. In addition, local air pollution can also directly affect the water resource (acidification of lakes). Poor air quality can also affect tourism, especially in heavily air polluted areas, and it affects human health in many ways.

Monitoring

The early data collections on air quality are from 1990. However, it was not until 2010/2011 that major improvement to monitoring equipment in BiH came into effect due to the adoption of the Law on air protection. The Hydro-meteorological institutes of FBiH in Sarajevo and of RS in Banja Luka, as well as a few other public institutions carry out the air quality monitoring.

In the FBiH entity, the public institutes monitor 13 automatic air quality stations in total. They measure SO_2, CO, NO_x, O_3, particles and NMVOC (non-methane volatile organic compounds). The Institutes also monitor seven manual stations that measure SO_2, black smoke and particles. The frequency of measurements is daily.

In the RS entity, the public institutes are in charge of measuring air quality and radioactivity in the air and in rainfall. There is one automatic monitoring station in Banja Luka that measures SO_2, CO, NO, NO_2, and NO_x and 14 manual stations in Banja Luka, Gradiška and other municipalities. These stations measure particles and SO_2 with a low frequency of three times per week. In addition, a few companies and industries have voluntarily equipped their plants with measuring devices.

Though there are about 40 monitoring stations in total BiH, they are almost all concentrated in the main cities of Sarajevo, Tuzla and Banja Luka and very few are in or near the DRB. There is a lack of monitoring outside cities, in the countryside of BiH. The measurements mainly concentrate on particulate matter and SO_2. Other toxic air pollutants (e.g. volatile organic components), acidifying gases and metals are not measured. In addition, the different institutes do not use the same monitoring methods.

The following Table 2-7 shows the state of air-quality monitoring in BiH in 2011. The pink shaded box indicates stations within the DRB, whilst yellow shading indicates stations near the border of the DRB.

Table 2-7: Network of air quality monitoring stations in BiH in 2011

Institutions	Number	Station types	Location	Parameters measured
Public bodies				
FBiH Meteorological Institute of Sarajevo	2	automatic	Sarajevo Ivan Sedlo	SO_2, CO, NO_x, O_3, PM_{10}
(FBiH) Directorate for Environmental Protection of Tuzla canton	6	automatic	Tuzla	SO_2, CO, NOx, particles, O_3, NMVOC and $PM_{2.5}$
(FBiH) Metallurgical Institute of Zenica	1	manual	Zenica	SO_2, particles, NO_x
(FBiH) Cantonal Institute for Public Health of Zenica	2	automatic	Zenica	SO_2, CO, NO_x, particles
(FBiH) Cantonal Institute for Public Health of Sarajevo	8	5 manual 3 automatic	Sarajevo	SO_2, black smoke SO_2, CO, NO_x, particle

Institutions	Number	Station types	Location	Parameters measured
		(3 fixed & 1 mobile)		
(FBiH) Cantonal Institute for Public Health of Mostar	1	manual	Mostar	SO_2, black smoke
RS Hydro-meteorological Institute	1	automatic	Banja Luka	SO_2, CO, NO_x, O_3, PM_{10}
(RS) Institute for Protection, Ecology and Information	14	manual	Banja Luka, Gradiska and some other municipalities	SO_2, black smoke
Brčko District Government	3	automatic	Brčko District	SO_2, CO, NO_x, particles, black smoke
Companies				
Cement Factory of Kakanj	1	automatic	Kakanj	SO_2, CO, particles, NO_x
Power Utility of BiH	2	automatic	Kakanj, Tuzla	SO_2, CO, particles, NO_x
Power Utility of RS	2	automatic	Ugljevik, Gacko	SO_2, CO, particles, NO_x
Pharmaceutical Company "Bosnalijek" (through a sub-contract with a Dvokat company)	1	automatic	Sarajevo	SO_2, CO, particles, NO_x

Original Source: FBiH Ministry for Physical Planning and Environment and RS Ministry for Physical Planning, Civil Engineering and Ecology – taken from UNECE Environmental Performance Review 2011

(yellow)	On the border with DRB
(orange)	In the DRB

As can be seen, there are two stations in the DRB (Ugljevik and Gacko), but the data gathering does not allow to have a clear picture of the state of air quality in the DRB.

Sources of Pollution

Industry

The main sources of air pollution in BiH are coming from coal power plants and from the mining industry. Even if though nowadays these facilities are equipped with gas filters, they still emit high quantities of fly ash, of SO_2 and NO_x, and soot.

A small number of industries are concentrated in the lower part of the DRB: lead and zinc mining and aluminium facilities. There are three main thermal power plants near and in the DRB. They could affect the air quality in the lower part of the DRB:

- The Tuzla thermal power plant (near the border of the lower DRB), which emitted SO_2 values exceeding the European limit during the period 2000-2003. Monitoring results show that the concentration of SO_2 is slightly lower in the period of 2002-2011 compared to 1990-1991 and it is decreasing since 2008. Since last decade, there is no exceeding of the acceptable limit of 125 $\mu g/m^3$ (24 hours average).
  In 2014, the concentration of emission of SO_2 was from 2,289 mg/m^3 (for T3) to 5,373 mg/m^3 (for T6), of NO_x was 325 mg/m^3 (for T5) to 553 mg/m^3 (for T4) and of particles was 29 mg/m^3 (for T6) to 128 mg/m^3 (for T4) (source: national Emission Reduction Plan - NERP, 2015)
- The Ugljevik thermal power plant[1] (in the lower DRB), which burns bad quality coal with high sulphur contents. In 2014, the concentration of emission of SO_2 was 16,661 mg/m^3, of NO_x was 424 mg/m^3 and of particle matters was 377 mg/m^3 (source: NERP, 2015)
- The Gacko thermal power plant[1], also near the boundary of the upper part of the DRB, which produces high quantities of fly ash. In 2014, the concentration of emission of SO_2 was 1,500 mg/m^3, of NO_x was 450 mg/m^3 and of particle matters was 250 mg/m^3 (source: NERP, 2015).

However, due to the economic recession in BiH, the coal-power plant activity is decreasing, which results in decreasing emissions.

In addition, on 30.12.2015, the Ministers of BiH adopted the National emission reduction plan (NERP) and gave their approval to the Ministry of Foreign Trade and Economic relations to deliver the plan to the

[1] The Consultant could not find public data of air monitoring of these industries

Energy Community Secretariat. This National plan provides the reduction obligation of emissions of sulphur dioxide, nitrogen oxides and particle matters of combustion plants in BiH (boilers, thermal plants) from 2018 to 2027. Near the border of the DRB and in the DRB, that concerns the Tuzla Thermal Power Plant in FBiH, the Gacko and the Ugljevik Thermal Power plants in RS-BiH. This plan will contribute to significantly improve the quality of air of BiH.

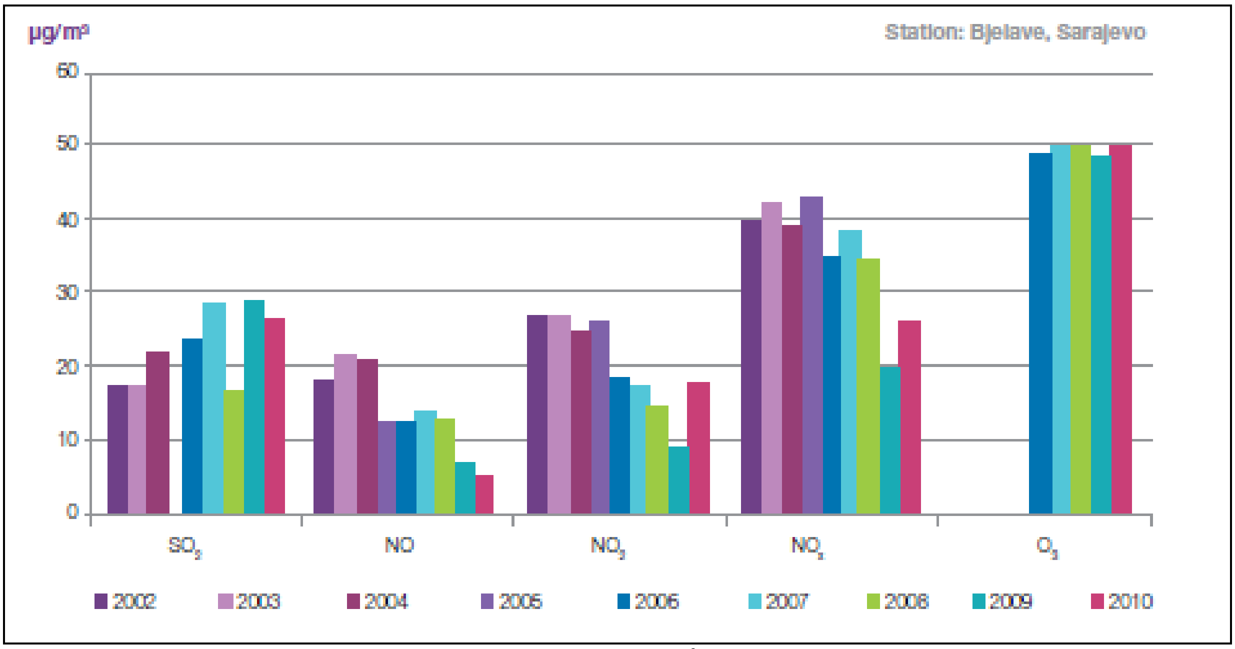
Traffic

In the last ten years, local traffic has increased rapidly. That has caused a degradation of air quality. Indeed, fuel combustion from vehicles is of low quality with high sulphur content, and with emission of ozone precursors and particles. These harmful emissions are all the greater in big cities such as Bijeljina, Zvornik and Višegrad in the DRB and in Sarajevo, near the boundary of the middle part of the DRB.

Trend

Air quality in BiH is better than it was pre-war. Pollution due to industrial process emissions have decreased since 2000 due to the destruction of many industrial facilities during the war and due to the economic recession. However, in same time, pollution due to rising traffic emissions, mostly in urban areas, have experienced a constant increase. This traffic pollution is intensified in valleys where the specific climate conditions facilitate the trapping of emissions. In addition, due to the climate conditions in BiH and the temperature inversions, the air pollution is significantly higher in winter months.

As mentioned above, air pollution in city areas is mainly caused by emissions from stationary sources (industrial activities), caused by fuel combustion, followed by traffic emissions. As an example, average annual concentrations of SO_2, NO, NO_2, NO_x and O_3 in Sarajevo since 2002 are given in Figure 2-25. Despite the increase of traffic, all the concentrations remain lower than limiting values defined in the Guidelines for Limit values of Air Quality Parameters in the FBiH (Official Gazette of FBiH, 12/05).



Source: FHMI BiH, 2010 in State of Env. Report 2012

Figure 2-25: Average annual concentrations of SO2, NO, NO2, NOx, O3 in Sarajevo (1-hour values) from 2002 to 2010

Ozone precursors (NO_x, CO_2, methane and non-methane volatile organic compounds-NMVOC)

From 1990 to 2004, monitoring of ozone precursors shows a significant decrease of about 63 % in all BiH. Before the war, about 62% of the ozone precursors was emitted by the energy industry and only 24% by traffic while, after war, the energy production emission is decreasing (54% in 2004) and the traffic emission is significantly increasing (40% in 2004).

Ozone depleting substances (greenhouse gases)
Regarding ozone depleting substances (many of which are also greenhouse gases), thanks to the implementation of the Montreal protocol (1987) and the Kyoto Protocol on Climate change (1997), Ozone depleting potential has decreased significantly, by over 90% since 2002. After the war, there has been no production of ozone depleting substances in BiH.

Acid rain is analysed by the Federal Hydro-meteorological Institute of BiH in Sarajevo and in Banja Luka but there is no monitoring in the DRB.

Due to the small number of monitoring stations in the BiH part of the DRB, it is not possible to have a good air quality status in the DRB. In addition, there is no reporting on the impacts of air pollution on the water bodies and the environment in general.

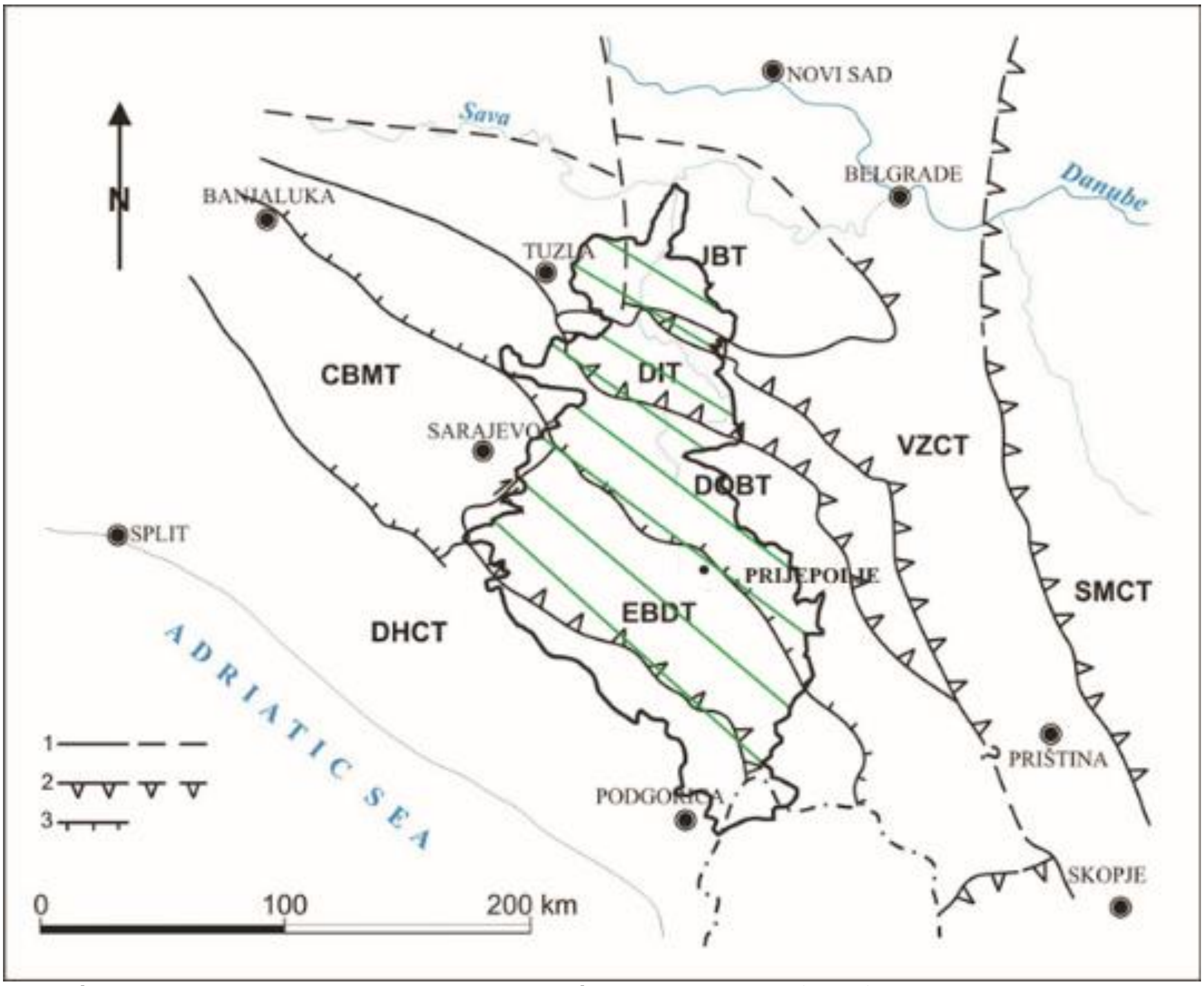
However, regarding the small quantity of industry and big cities in the DRB, and the fact that there is no observation of acidification of water bodies in the basin, we assume that the air quality in the major portion of the DRB in BiH is good, except in its lower part, where it is affected by the thermal power plant emissions. However, due to the NERP, it is expected that this pollution will be reduced in medium term. The air quality is unlikely to be a key component for IWRM and environment management within the DRB in BiH.

2.5 Geology and Soil

2.5.1 Geology

The Drina River and its tributaries lying within the territory of BiH belongs to a few geotectonic units (blocks, terranes; as shown on Figure 2-26). In the lower catchment, the Drina flows into the Sava River and in that part of the basin belongs to the Jadar Geotectonic Block terrane (JBT). The DRB is mostly covered by sediments of Neogene and Quaternary age. Also, the DRB partly passes through the Western Belt of Vardar Zone (VZWB), known as "Zvornik Suture" (Dimitrijević, 1995, 2001). The "Zvornik Suture", according to the opinion of Schmid et al. (2008), marks the tectonic boundary between the Drina-Ivanjica and Jadar-Kopaonik thrust sheets. Then the Drina River passes through the geotectonic units of Drina-Ivanjica element (DIE), the Dinaridic Ophiolite Belt (DOB) and the East Bosnian-Durmitor terrane (EBDT) and in a small part through the Dalmatian-Hercegovinian composite terrane (DHCT).

In recent years, a more detailed geotectonic scheme for BiH has been given by Hrvatović (2006).



DHCT - Dalmatian-Hercegovinian composite terrane; CBMT - Central Bosnian terrane; EBDT (=IBDB) - East Bosnian-Durmitor terrane; DOBT (=DOP) - Dinaridic Ophiolite Belt terrane; DIT (=DIE) - Drina-Ivanjica terrane; JBT(=JB) - Jadar Block terrane; VZCT - Vardar Zone composite terrane; SMCT - Serbian-Macedonian composite terrane. 1. Fault, observed and covered; 2. Thrust; 3. Tectonized boundary (simplified; Karamata et al., 2000)

Figure 2-26: The geotectonic position of central part of Balkan Peninsula, between Moesia plate and Adriatic Sea.

The geological characteristics of the DRB within BiH are observed on the Basic Geological Map sheets of 1:100,000 scale, from north to south as follows: Bijeljina, Zvornik, Ljubovija and Višegrad (Figure 2-27).

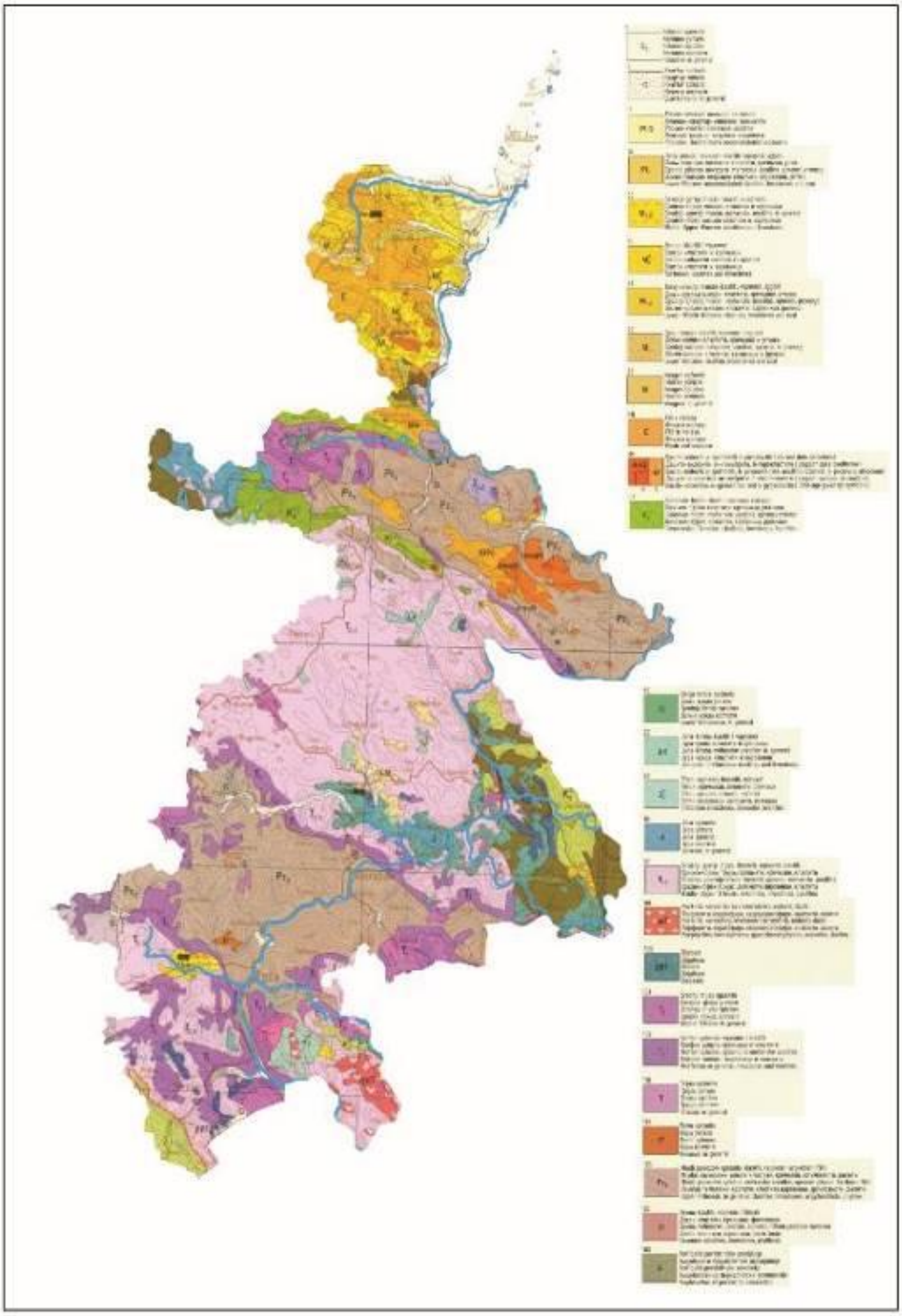


Figure 2-27: Geologic Map of Drina River Basin in BiH (Geologic Map of SFRY - 1:500,000 1970.).

The Drina River on the *Bijeljina sheet*, *1:100,000* (Vrhovčić et al., 1986), flows north into the Sava river and displays intensive meandering. From the Bosnian side the Drina River tributaries are: Janja, Tavna, Sipulja, Kozlučka rijeka, Sapna etc. Upstream from the confluence with the Sava River the Drina passes through flood plain, within the arable rich Semberija region which represents an accumulative-alluvial plain with a gently slope from S to N and W to E, with approximate elevation from 75 to 106 m a.s.l. Geologically, the Semberija region, is mostly covered by polygenetic Quaternary sediments, which are the youngest in this part. The Semberian part of the first Drina terrace, between Drina and Sava rivers, is 4-5 m below the normal level of Drina and Sava rivers, at an elevation from 80 to 100 m a.s.l. The sediments of the first terrace have an accumulative nature, and they are represented by heterogenous gravels of channel facies, alluvial-flooded silts and sands, and silts with loessoidal characteristics that form a terrace plain.

The oldest deposits of Neogene age are fresh-water, terrestrial-limnic deposits of the Lower Miocene Ugljevik Coal Basin. Over them lying concordantly are the Tortonian marine deposits with two different developments. First are sandstones, claystones and marls, sporadically with limestones, and second are reefal and peri-reefal massive "Leitha limestones", more often toward southern margin of Pannonian Basin. Sediments of Tortonian age pass into Sarmatian continually and, because of shallowing, different lithological heterogenous sediments are formed (limestones, marly clays, clayey and calcareous marls etc.). Sediments of Pannonian age (clays, clayey marls and sandstones) and Upper Pliocene (fresh-water "Paludina" beds) are not observed on surfaces, only they are found in boreholes.

The whole area of Bijeljina sheet belongs to the Jadar Block.

The Drina River, meandering, continues through middle part of the *Zvornik Sheet, 1:100,000* (Mojsilović et al., 1977). Its trubutaries in that part are: Sapna, Lokanjska rijeka, Pilička reka, Tavna and Janja. The Drina River passes through two geotectonic units: Western Belt of Vardar Zone (VZWB), i.e. "Zvornik Suture" and through the Jadar Block-Terrane (JBT). Part of DRB which belongs to the Jadar Block is mostly covered by the same Tertiary-Quaternary sediments that are developed on the north. The rocks of Upper Cretaceous age are also present.

The oldest rocks are Upper Permian in age. They are represented by bedded, organogenic limestones in the wider area of Teočak. Nearby are the sediments of Lower Triassic age, represented by varicolored sandstones and thin bedded limestones are also developed.

The older, Upper Cretaceous Senonian rocks, are widely distributed around Kozluk and in the Tavna valley. The younger, Upper Cretaceous-Paleocene rocks, also occur frequently and are thicker. They are located in the Sapna valley, near to Glumina, Kozluk, Jasenovačka reka and Snagovo village. They are built of massive and thickly bedded, rarely bedded limestones, together with intercalations of sandy limestones, marly, quartzitic and micaceous sandstones.

Overlying deposits of Eocene age are distributed around Skočići on Drina, over Kiseljak and Tavna to Ugljevik. The Lower Eocene rocks, are made of thinly-bedded claystones, marlstones and intercalations of finegrained sandstones, and are less widely distributed (from Sečanik creek on the west to the Tavna monastery on the east). The Middle Eocene limestone-sandstone succession is around 200 m thick (located on the road Ugljevik-Teočak, near to Prisjeka), appears in a E-W direction, from Mezgraje over the Graben to Počivalo. The Upper Eocene sandstones and conglomerates are distributed between Sapna and Kozluk in the south and Majdan and Lokanjska rijeka in the north. The dacites and andesites of Tertiary age appear as flows followed with pyroclastites (Snagovo, surroundings of Ugljevik). The pyroclastites are also found together with effusive rocks around Zvornik, Sapna, Ugljevik, south of Snagovo (Velja Glava). Intercalations of tuffs near to Sapna appear below Tortonian limestones.

Sediments of Miocene age are widely distributed in Eastern Bosnia. Fresh-water deposits of Lower Miocene are often in the area of Ugljevik-Glinje, north of Jablangrad and in the area of Mezgraje. The Tortonian is developed in a clayey facies and is found in a wider area of Zvornik town near to the village of Kitovnica and around the hill Mramorje. The Tortonian clays are often north of Sapna River. In addition, the Tortonian, is developed in Leitha and the Lithothamnium facies can be followed from Crveno brdo, over Pilići and Šepak to Jasenovačka rijeka. The best sections are seen in Pilići and Lokanjska rijeka and in the creeks Dobra voda and Vrela. In the area surrounding Zvornik, they are found on two belts, firstly between the villages Mrakodol and Čolopek, and secondly between Kitovnica and Grbavac, over Ćirilovo brdo to the Sapna valley. The brackish sediments of Sarmatian are developed in a clayey-sandstone facies (from the village Atmačići to Crveno brdo and in the area Sapna-Ramići-Mamutovići) or in limestone facies (from

Šepak and Pilice to Crveni breg). The Meothian (Pannonian) sediments appear in a belt oriented NW-SE in the Atmačići-Počivalo-Branjevo area. They comprise clayey and sandy marls, clayey sands and clays with gravels. In the area of Trnovo and Bjelasica Pliocene (Pontian) deposits are developed.

The sediments of Quaternary age are represented by alluvial deposits (the greatest thickness of alluvium is 43 m, near to Janja), river terraces (are around 25 m in thickness on the left side of Drina River) and deluvial sediments.

In the southern part of the Zvornik sheet, the Drina River passes through "Zvornik Suture", i.e.through the unit of Western Belt of Vardar Zone (VZWB). In that, tectonically reduced Vardar Zone, are identified rocks of Triassic and Jurassic age, also sediments of Upper Cretaceous age, which appear in small, intensively folded blocks and fragments tectonically involved in Ophiolite melange.

The rocks of Triassic age occur in the surrounding area of Zvornik town, that are most probably Lower and Middle Triassic in age. The Lower Triassic sediments, comprising conglomerates, breccias, quartzites and sandstones, then pinkish and greenish clastites intercalated by crystalline limestones lie transgressively over very folded Paleozoic sediments.

The rocks belonging to the Ophiolite melange of Jurassic age appear in a long, narrow, discontinuous zone, oriented NW-SE in the area north of Zvornik. The most common rocks are serpentinites, gabbros, diabases, amphibolites, rodingites, and also claystones, sandstones, melaphyres and tuffs. The serpentinites (primary harzburgites) are visible west and east of Zvornik, and they are in tectonic contacts with Paleozoic, Triassic and Upper Cretaceous rocks. At a very few places serpentinites are penetrated by gabbros and rodingites (Zvornik, Snagovo).

After Zvornik town, and Zvornik Lake, the Drina continues onto the *Ljubovija sheet, 1:100,000* (Kubat, 1977). From Bosnian side the tributaries are: Voljevica, Križevica, Drinjača and Kamenica. The Drina River passes through the Paleozoic rocks that belong to the Drina-Ivanjica Element (DIE), which is made of clastites, i.e. change of unequally metamorphosed sandstones and siltstones and intercalated with conglomerates. Besides the Paleozoic clastites, the tributaries of the Drina River subordinately pass through clastic and carbonatic rocks of Lower Triassic age and carbonatic and volcanogenic-sedimentary rocks of the Middle Triassic age (connected with Anisian rift volcanism).

The Paleozoic rocks are probably Lower-Middle Paleozoic in age, and for their development a model for DIE is used according to Đoković (1985). At the base of lithologically different rocks three series are distinguished. The rocks of the lower series are found around Milići, Kolovska and Pribojevička rijeka, south of Udrč Mt. and the village Kravica, in Šutorinska rijeka near to Milići and Mlječvanska rijeka near to Bratunac. They are built dominantly of phyllites, silty and clayey schists, quartzites and scarce sandstones. In higher levels are found characteristic black bedded limestones. The rocks of the middle series are distributed from Drinjača, on the north-west, to Tegar, on the south-east. In the series lithologically dominant are metasandstones, less dominant are phyllites, sericitic and clayey schists, and very rarely are seen sericitic quartzites and actinolite-epidote schists. The rocks of the upper series (metasandstones and sandstones, eruptive rocks and tuffs, carbonate rocks and conglomerates) are less well distributed, located at Šubin brdo, Osmače, Ljeskovik, Karn, Tokoljak, Lupoglav and Nemić Kamen.

The Lower Triassic sediments are represented by quartz-clastic series in which are included varicoloured sandstones, less conglomerates, claystones and limestones. The thickness of this series in Šutorinska rijeka is around 230 m. Then, it is followed by limestones (thickness is around 80 m) of Campilian age, then Middle Triassic rocks distributed in Ravna Romanija, and in Kravica-Drinjača zone, made of different limestones, dolomites and more rarely volcanogenic-sedimentary rocks. In the area of Gerovo and Vrsinje these limestones are the base of bauxite deposits. In the area of Udrč-Barski potok huge masses of limestones are present forming the tectonic southern boundary. The thickness of Middle Triassic rocks generally is around 800 m. The rocks of Anisian age are organogenic-tetritic limestones. In rocks of Ladinian age are separated into the volcanogenic-sedimentary formation made of sandstones, cherts, less limestones, diabases and tuffites (north of Kravica near Bratunac) and carbonate rocks (organogeno-detritic and dolomitic limestones). The rocks of Upper Triassic age are characteristic only on Ravna Romanija (Žep, Brložnik and Podžepje). They are represented by bedded, rare massive and partly dolomitic limestones.

After the Ljubovija sheet, the Drina River passes through the sheets Valjevo and Užice, 1:100,000, then passes through the territory of the sheet Višegrad, 1:100,000, in a direction mostly SW-NE (from Višegrad to Bajina Bašta). Its tributaries from western side are Prača and Žepa, from the south is the Lim River, while the Rzav River drains the larger part of the eastern area.

In the area of *sheet Višegrad, 1:100,000* (Olujić & Karović, 1986), the Drina River flows through three tectono-stratigraphic units: East Bosnian-Durmitor Block Terrane (EBDT) on the southwest (made of schists of Paleozoic age and limestones of Mesozoic age) which was treated as structural-formational zone Prača-Drina-Lim, then through the Dinaridic Ophiolite Belt (DOB) or structural-formational zone of Višegrad, and a small part on the north-east through the Drina-Ivanjica Element (DIE, here structural-formational zone of Tara-Sjemeć).

For the oldest Paleozoic rocks, distributed on the ultimate northeastern part of the sheet, is used the model for DIE according to Đoković (1985). Lithofacially they are similar to rocks in the north, but here they appear in elongated lenses of m-thick limestones and basic rocks (spilites). Schists, sandstones, siltstones and phyllites are also present. The Paleozoic units of East Bosnian-Durmitor Block have similar lithology, they are represented by pelitic-psammitic-psephitic sediments, rarely semi-metamorphosed pelitic rocks.
In this area, the most distributed and wholly developed are rocks of Triassic age, but facial differences exist between the Triassic zone along the DIE and the EBDT. In the Lower Triassic two units are separated: clastic and carbonate, but carbonate is limited with the DIE. The clastic facies of Lower Triassic age (Verfenian clastites) lies on the north-east over DIE, on the south-west over EBDT, but also west of Rogatica, south-west of Međeđa, on the left side of Drina River between Višegrad and Međeđa, and in the south in Lim River area. The thickness of these clastic units is around 250 to 300 m. On the northern slopes of Tara Mt. over the clastic unit lie micrite limestones around 50 to 75 m in thickness. During the Anisian shallow-water dolomitic limestones were deposited (around 400 m thick), and, because of volcanic activity, andesites and similar rocks. During the Ladinian and the whole Upper Triassic were deposited massive and thick-bedded reefal and perireefal (on north-east they built Tara Mt., Zvijezda Mt., thick to 500 m), but also partly deep-water limestones with cherts in southwest part of sheet (Ladinian in age, thick around 150 m, in EBDT). The rocks of Jurassic age here are represented by different type of rocks of Ophiolite mélange (diabases, spilites, gabbros, sandstones, cherts etc.), and also rocks of oceanic crust – ultrabasites.

After the Cenomanian-Turonian transgression, over rocks of Ophiolite melange, and widely over Triassic and Paleozoic units, Upper Cretaceous sediments were deposited. Firstly, terrigenous facies were deposited, around 250 m thick, then carbonate facies of Turonian age around 700 m thick. The Upper Cretaceous succsession is completed with Senonian rocks around 200 m thick. The sediments of Neogene age are deposited in depressions formed during the Miocene. The fresh-water Neogene sediments contain rare appearances of coal. Quaternary sediments are represented by deluvial and proluvial aprons, floods, terrace, pond and alluvial sediments.

The Drina River come the from territory of sheet Višegrad in territory of *sheet Prača, 1:100,000* (Vujnović, 1981) folowing direction W-E. DRB is distributed only around Goražde town. Its tributaries from the left side are Gračanica, Rakitnica, Prača and Pothranjenski potok. It passes through geotectonic units of East Bosnian-Durmitor terrane (EBDT). The southern part of DRB is covered by the sheets Foča and Gacko, 1:100,000. The Drina River, with its tributaries dominates Foča sheet, 1:100,000 (Buzaljko & Pamić, 1982), where it is formed by the Piva and the Tara rivers. Geotectonically, the DRB here is mostly in the East Bosnian-Durmitor terrane (EBDT). Only, in the *sheet Gacko, 1:100,000* (Mirković, 1980) does the DRB partly belong to Dalmatian-Hercegovinian composite terrane (DHCT).

The DRB in the geotectonic unit of the East Bosnian-Durmitor terrane (EBDT) is mostly made of rocks of Paleozoic and partly of Permo-Triassic age. In the Drina River valley, predominant rocks are from the Lower

Carboniferous in age and they are present in tectonic units of Goražde, Jabuka and Ustikolina (in Ustikolina unit, they are located in the valleys of Drina, Ćehotina and Bistrica). The rocks of Lower Paleozoic age, often found in the area surrounding Prača, are made predominantly of clastic rocks (subgreywackes, metasandstones, greywackes, microconglomerates and breccias, siltstones, claystones etc.) and contain lenses of bedded and massive limestones (in the valley of Odski creek, also in valleys of Drina and Osanica). Its thickness varies from 100 to 1000 m. The marginal parts of the Lower Carboniferous sediments are built of the Permian-Lower Triassic red quartzitic sandstones and conglomerates (structural-facial unit of Prača-Foča, in the area from Brod on Drina to Šćepan Polje, also near to Ifsar and Slatina). They are followed by widely distributed pinkish and greenish micaceous schists and sandstones of Lower Triassic age, 100 to 400 m thick. Limestones and dolomites of Anisian age, with thickness from 100 to 400 m over lie these rocks. They are distributed in the area of Papratna, also around the villages Zubovići, Dragočava and Slatina. Tectonic contacts are with limestones of Ladinian age, which are massive and thickly bedded, and usually organogenic-detritic. In the tectonic unit of Bunova they are located to the east of Tvrdak, on the plateau over the Ćehotina. In the area between Šupljice creek and Kržavska rijeka the limestones are marly and bedded. Facially different, thinly-bedded limestones with cherts are found in the tectonic unit of Bunova, in the Ćehotina canyon, near to Vikoč where they are up to 400 m thick. Also found at this location, but relatively rare are massive limestones of Upper Triassic age. The reefal massive limestones of Carnian age, are 50 to 100 m thick, and are located in the tectonic unit of Bunova, in the area of Rajetići and Korča. Limestones of Norian age overlie this. The limestones around the locality Zlatni bor (tectonic window of Klinci) are probably Rhaetian in age. The products of Middle Triasssic volcanic activity in this area are andesites followed by quartz-keratophyres and keratophyres. They are found from both sides of the Tara River and are represented by bigger andesite masses of the areas Šuplja stijena and Ljubišnja. The quartz-keratophyres and keratophyres appear as km-size body in the lowest flows of Tara River, and in small masses near to Viševina, around Čelebići and as part of the volcanic area of Ljubišnja.

2.5.2 Soil

The landscape relief and the rock composition has a major influence on the genesis and evolution of soil in the DRB. In the north of the DRB in BiH the most common types of soil are: Stagnic Podzoluvisols, Fluvisols, Umbric Gleysols and Eutric Gleysols. In the central part of the DRB in BiH in the hilly areas, the most common types of soil are: Chromic Luvisols, Eutric Cambisols, Leptosols – Rendzic Leptosols and Vertisols. Soil erosion can be a problem in these areas especially on slopes of 13% or more. In the mountain zones in the south of the DRB in BiH, Dystric Cambisols and Dystric Regosols are predominantly present, followed by Leptosols – Rendzic Leptosols and Regosols. In these areas, soil erosion is still a concern, but the land is more likely to be covered with forests and pasture.

Hence, the common soil formations, on the same or similar lithological bases, in the DRB are as follows:

- Soil sequence on the alluvium and river terraces, are represented by alluvial soil with loamy composition, while some smaller areas are covered by semi-gley and eugley (waterlogged land). Since this area is rich with groundwater and many settlements are developed here, these soils are of great importance, not only for intensive agricultural production, but also for water management, alluvial ecosystem, and the communal economy;
- Soil sequence on lake sediments (Neogene) occupies wider areas of river valleys, which is usually on gently undulated to hilly terrain in the zone up to 500 m altitude. It includes soils of various ecological values - from highly productive Cambisol and Vertisol, to medium fertile loess like soil and low productive pseudo-gley and eroded land;
- Soil sequence on the sandstones and flysch deposited on a larger area in the hilly and mountainous regions of the south and central parts of the DRB in BiH. Most dominant soils in this series are acidic Cambisols, which are generally shallow and erodible, and by its ecological values classified as natural grass and forest ecosystems;
- Soil sequence on the limestones and dolomites is one of the most widespread in the hilly and mountainous areas. On the flat parts of the terrain, in the depressions and sinkholes, deeper,

ecologically more valuable brown soils have developed. They are usually used as arable land and meadows. On the slopes, only skeletal and rocky soils can be found, suitable just for the forest habitats and pastures;

- Soil sequence on the igneous rocks, that regularly forms humus siliceous soil, of small depth, and are unsuitable for cultivation;
- Soil sequence on the metamorphic rocks, are also characteristic for the hills and mountains and generally is destined for the forest and grass ecosystems. Somewhat deeper soil is located on the rocks with lower degree of crystallinity, and shallow soil developed on the rocks of medium and high degree of crystallinity;
- Soil sequence on the serpentine group is a specific formation, rarely turned into a bare land, as the ultimate level of land degradation. These areas are predestined for the grasslands and woods.

The structure and basic soil characteristics in the BiH part of the DRB are shown in Table 2-8 below.

Table 2-8: Soil types and characteristics in BiH part of DRB

No.	Soil type	Description of characteristics
1	Chernozem (Phaeozem)	Without limitation - highly productive land.
2	Vertisol	Moderate limitations - highly productive land.
3	Cambisol (Eutric Cambisol)	Moderate limitations - productive land.
4	Stagnosol or pseudo-gley (Planosol)	Moderate to significant limitations - conditionally productive land.
5	Alluvial soil (Fluvisol)	Without limitation to serious limitations - conditionally could be highly productive land (land amelioration).
8	Soils on the limestones (Calcomelanosol and calco-cambisol)	Significant to medium limitations - low to medium productive land.
9	Soils on the serpentine group of rocks (Ranker and Eutric Cambisol on serpentine)	Significant to medium limitations - low to medium productive land.
10	Distric Cambisol (Acidic brown soil)	Significant to serious limitations - slightly to moderately productive land.
11	Rankers	Moderate to significant limitations - mainly productive land for meadow-pastures production in mountainous regions up to 800-1,200 m altitude.
12	Lithosol	Serious limitations - unproductive land.

Source: Adapted from Popvic, V, May 1995.

2.6 Seismic Conditions

Seismic activity in the BiH part of the DRB is due to tectonic plate movements. Earlier seismic maps for BiH (prepared during the times of Yugoslavia) clearly indicate that the region is prone to earthquake activity.

At the macro level, BiH is near to the boundary of the Eurasian Plate and the African Plate with the Adriatic and Aegean micro plates sandwiched in between. Complex movements along these plates create seismic activity, the Adriatic-Ionic micro plate being subducted by the actively overriding Aegean micro plate. Such tectonic movements have resulted in the formation of the mountain ranges, tectonic graben, trenches, normal and reverse faulting. The orientation of the faulting is usually parallel to the Dinarides.

Two institutions are involved in seismic monitoring in BiH – Federal Hydro-meteorological institute in Sarajevo is responsible for the territory of FBiH and Hydro-meteorological institute in Banja Luka is responsible for the territory of RS.

According to seismological monitoring data, there are more than 1,100 earthquakes of intensity less than III on the Mercalli-Cancani-Sieberg scale (MCS) occurring in BiH and the wider region on an annual basis.Furthermore, over the last 110 years there have been 1,084 earthquakes greater than III recorded on the MCS. Table 2-9 below provides a list of the most intense earthquakes to have occurred within BiH and the region in the past 110 years. Those grey-shaded are the three most destructive and those shaded in yellow are within or very near to the DRB.

Table 2-9: Most destructive earthquakes in BiH and the region over the last 110 years

Date	Place	Magnitude by Richter's Scale (depth to epicentre)	Intensity at epicentre MCS
07.04.1905.	Pertovac	5.0	VII
01.08.1907.	Počitelj	5.7	VII-VIII
25.12.1908.	Vlasenica	5.3	VI-VII
12.03.1916.	Bihać	5.0	VII
06.02.1923	Jajce	5.0	VII
1923	Tihanjina	6.5	No data
14.02.1927	Ljubinje	6.0	VIII
17.12.1940.	Derventa	5.1	VII
31.12.1950	Drugovići (Prnjavor)	5.7	VIII
11.06.1962	Treskavica	6.0	VIII
26.07.1963	**Skopje -Vitina (Macedonia)**	**6.1 (depth 5km)**	**IX**
07.03.1967	Srebrenica	5.1	VII
27.10.1969	**Banja Luka**	**6.6**	**IX**
25.08.1970	Gacko	5.0	VII
29.10.1974	Lukavac	5.0	VII
15.04.1979	**Kotor-Bar-Petrovac (Montenegro)**	**6.9 (depth 11km)**	**IX/X**
23.05.2004	Grude	5.5	VI-VII
31.03.2009.	Region Sarajevo	4.2 (depth 2 km)	VI
21.06.2009.	Posušje, Western Herzegovina	4.6 (depth 10km)	VI
18.03.2010	55 km from Sarajevo	3.9 (depth 2 km)	V
28.04.2011	Banja Luka	4.5 (depth 10.1 km)	VI
20.08.2011	20 kms from Mostar	4.2 (depth 10 km)	VI
27.07.2012	5 kms from Zenica	4.5 (depth 5 km)	VI

The highest levels of seismic activity within BiH, representing intensity IX (9) on the MCS are along the southern edge of the country, on the border with Montenegro and Croatia and in a small pocket centered on the city of Banja Luka in the north. Figure 2-28 below shows the seismological map for BiH. The DRB is predominantly in zones VI (6) in the north of the basin and zone VII (7) in the centre and south of the basin. There is a small pocket of zone VIII (8) just south of Sarajevo at Kalinovik municipality in the DRB.

Regional seismological centres are located near the DRB at Sarajevo and at Tuzla. In the area of the DRB, there are two seismic stations with the same seismic equipment (Bijeljina and Han Pijesak) and another is out of use. In addition, there are other stations in nearby proximity (see Table 2-10) some in use and some out of use.

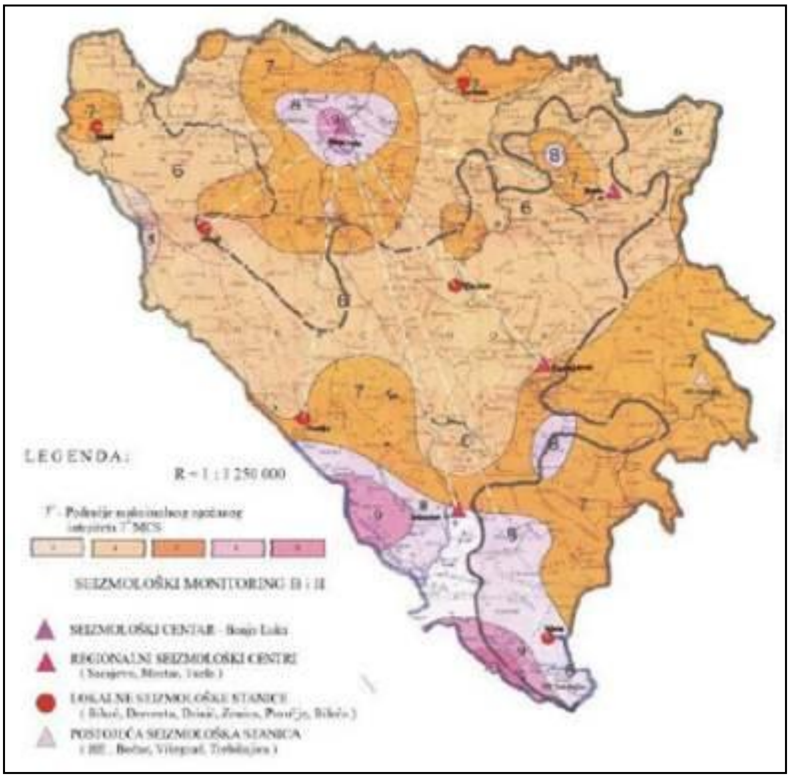


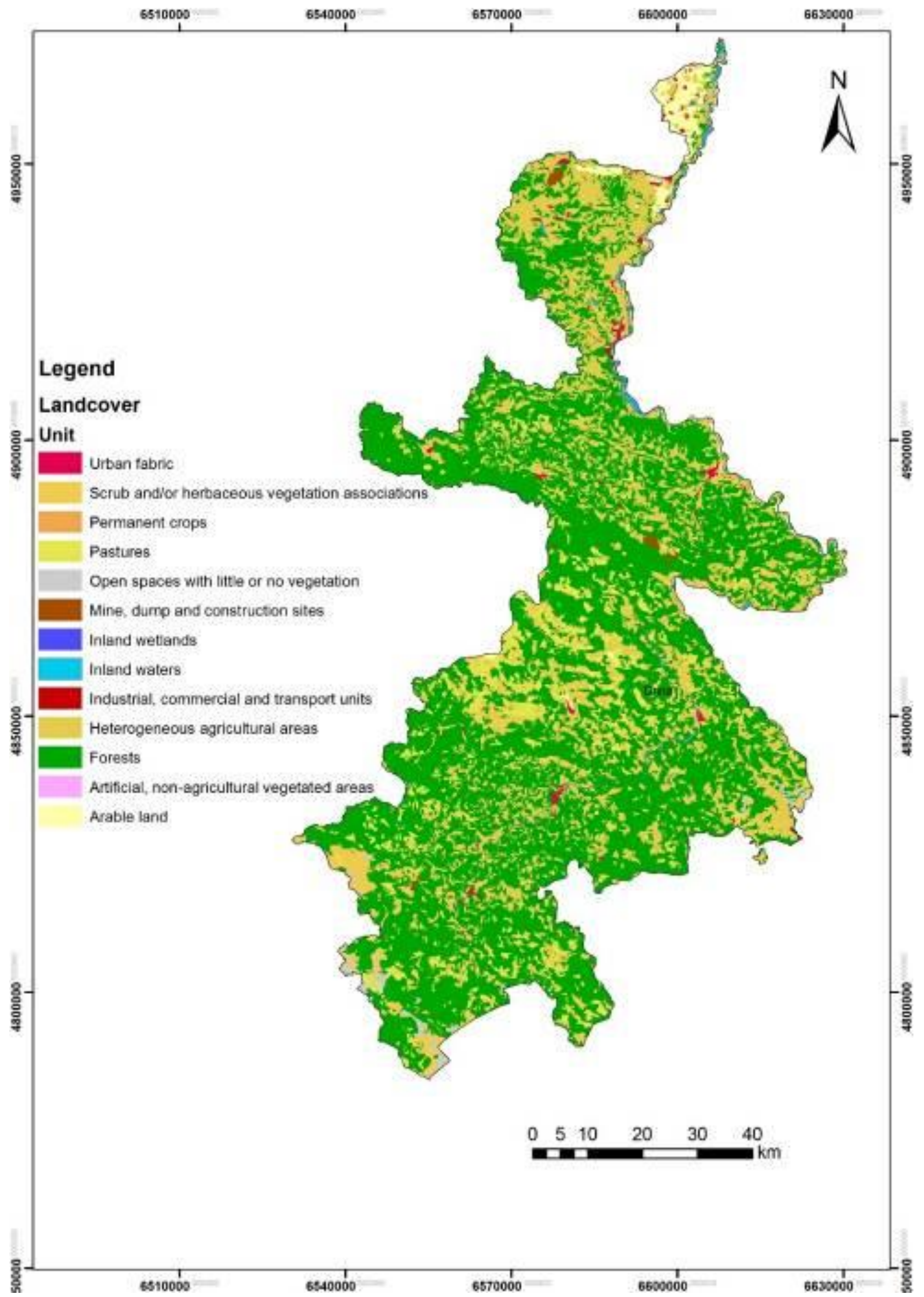
Figure 2-28: Seismological map of BiH

Table 2-10: Seismic stations in BiH part of DRB and nearby

Code	Name of station	Lat(N)	Long (E)	Elev (m)	Entity	Seismometer Type	Data acquisition	Data transfer technique
INSIDE DRINA BASIN								
BLJ	Bijeljina	44.7830	19.2670	94	RS	SS-1 1Hz – short period	Kinemetrics Quanterra Q330 – 24 bit	Internet via leased line
HAPS	Han Pijesak	44.0861	18.9515	1200	RS	SS-1 1Hz – short period	Kinemetrics Quanterra Q330 – 24 bit	By fixed telephone
RUDO	Rudo	43.6180	19.3700	413	RS	Out of use	ND	ND
OUTSIDE DRINA BASIN								
SAR	Sarajevo	43.8733	18.4283	725	FBiH	Smart 24	ND	In real time by Internet
MST	Mostar	43.3500	17.8767	70	FBiH	Smart 24	ND	In real time by Internet
TUZ	Tuzla	ND	ND	ND	FBiH	Smart 24	ND	In real time by Internet
DOB	Doboj	44.7330	18.1000	165	FBiH	Out of use	ND	ND
TRA	Travnik	44.2167	17.6833	ND	FBiH	Out of use	ND	ND
PRIJ	Prijedor	44.9720	16.7130	141	RS	Out of use	ND	ND
BLY	Banja Luka	44.7488	17.1839	256	RS	SS-1 1Hz – short period	Kinemetrics K2	Real time data BLY is the main centre
MRAK	Kozara (Mrakovica)	45.0128	16.9001	850	RS	SS-1 1Hz – short period	Kinemetrics Quanterra Q330 – 24 bit	By mobile telephone
MGRS	Mrkonjić Grad	44.41700	17.08400	560.0	RS	Out of use	ND	ND
TREB	Trebinje	42.7170	18.3500	300	RS	SS-1 1Hz – short period	Lennartz M-24 Compact LP	In real time by Internet via leased line

2.7 Land Use

The Consultant has reviewed the CORINE land cover available for BiH and reviewed the spatial plans and other documents covering the DRB in the two entities of FBiH and RS. The CORINE land cover provides 13 types of land use, as shown in the map on the next page (Figure 2-29) and listed in Table 2-11 below.



Source: CORINE

Figure 2-29: CORINE Land Cover in the BiH part of the DRB

Forest cover predominates with around 61% recorded. Agricultural land including pastures, scrub and arable land cover around 37% and inland waters and wetlands around 1% and urban areas and industrial areas around 1%.

Table 2-11: CORINE Land Cover in BiH part of the DRB

No	Corine Land Cover Type	Area km²	Proportion of land in the DRB
1	Arable land	105.13	1.50%
2	Artificial, non-agricultural vegetated areas	0.01	0.00%
3	Forests	4285.10	60.95%
4	Heterogeneous agricultural areas	1581.64	22.50%
5	Industrial, commercial and transport units	4.66	0.07%
6	Inland waters	65.45	0.93%
7	Inland wetlands	2.00	0.03%
8	Mine, dump and construction sites	16.51	0.23%
9	Open spaces with little or no vegetation	48.45	0.69%
10	Pastures	432.06	6.15%
11	Permanent crops	2.88	0.04%
12	Scrub and/or herbaceous vegetation associations	447.08	6.36%
13	Urban fabric	38.99	0.55%
	Total	**7029.96**	**100.00%**

A review of the national picture concerning land use shows that the DRB is significantly more forested, the DRB having 61% forest cover, whilst forest for the entire country only covers 43% of the land area. Nationally agricultural areas amount to 42%, significantly more than in the DRB.

2.7.1 Agriculture

The share of agricultural land has remained flat in the past years, with an equal share of between RS and FBiH of about 1.2 million hectares, which is high when compared with developed and highly developed countries. However up to 40% of this land remains uncultivated at times and this percentage is increasing and can be explained by, the ageing population in the rural areas (farming areas), the migration of younger people away from the area, and the downturn of the global economy.

2.7.2 Forestry

Forest account for about 63% of all land areas in BiH that relates well by proportion with the land area designated as forest in DRB (61%) from CORINE above (Figure 2-29). The state owns about 80% of forested land and the remaining 20% is in private ownership. BiH has about 0.84 ha/capita of forested land placing it among the highest in Europe and similar to Montenegro and some Scandinavian countries. Forested land can be divided into; i) High economic forest, ii) Coppice forest, iii) Shrubs, and iv) Barren land and other forest areas. Over the past 15 years, the amount of forested land has increased, to the detriment of agricultural land.

2.8 Biodiversity

The Drina River forms at the BiH/MNE border, at the confluence of the Tara and Piva rivers that rise in Montenegro. The Drina flows partially within the BiH territory and then further downstream it forms a natural border between Serbia and BiH, with the Drina canyon being its most distinctive feature. In the latter stages, downstream at Lake Perućac at the "Bajina Bašta" HPP, the Drina River acquires some of the characteristics of more mature slower rivers with meandering, arriving at the very broad Pannonian plain, where the Drina meets the Sava (UNEP, 2010). As mentioned in Section 2.1, the main BiH tributary of the Drina is the Lim River.

In the following sections, data sources are from scientific local and international papers and websites as well as well as reports from various Bosnia ministries (FBiH and RS) and international organisations. All references are listed in Chapter 15.

2.8.1 Flora

As previously mentioned, the flora of the DRB is characterised by a high diversity with numerous relict[2] and endemic[3] species (Gajić, 1990). Most endemic forms are recognised within the flora of higher plants, which at current state of knowledge is estimated to have 450 endemic taxa (BiH 4th report to UNC on Biological Diversity, 2010).

However, available data is scarce and first steps for completing it will be taken during the incoming meetings with the key stakeholders. It would be of highest importance for the project to get more data about amphibian vegetation species that are often rare and protected and riparian habitats described in Annex 1 of the Habitat Directive of the European Union (92/43/EEC):

- Riparian mixed forests of English oak (*Quercus robur),* European White Elm *(Ulmus laevis)* and Field Elm *(Ulmus minor)*, European ash *(Fraxinus excelsior)* or Narrow-leafed ash *(Fraxinus angustifolia)*, along the great rivers (*Ulmenion minoris*) (Habitat 91F0[4]) ;
- *White willow (Salix alba)* and Silver poplar (*Populus alba)* galleries (Habitat 92A0*[5]);
- Alluvial forests with European alder (*Alnus glutinosa)* and European ash(*Fraxinus excelsior,Alno-Padion, Alnion incanae, Salicion albae*) (Habitat 91E0 *)

The flora in the Bosnian part of the DRB is characterized by the following:

Forest, shrubs and herbaceous

The most famous endemic tree species in the DRB is the Serbian spruce *(Picea omorika*) that can be found on Zvijezda Mountains along the Serbian and BiH borders, as well as in a few other localities such as Radomišlja. There are also other relict species of particular importance: for example, the Persian walnut (*Juglans regia)* that forms many relict communities in this area (Mišić and Kojadinović, 1985).

Other examples of important endemic plant species are: *Daphne malyana, Saxifraga rocheliana, Centaurea incompta, Dianthus kitaibelii, Cerastium lanatum, Centaurea derventana, Aquilegia grata, Amphoricarpus autariatus, Valeriana braun-blanquetii, Campanula balcanica, Adenophora liliifolia, Cirsium wettsteinii, Cicerbita pancicii, Melampyrum hoermanianum, Teucrium arduini, Iris bosniaca* (Redžić et al, 2008).

The largest part of the DRB belongs to the area of European, mainly deciduous forest, but unlike typical forest in this category, has the character of European mixed forests. Due to the specific climatic and other environmental conditions, there are a large number of Mediterranean and sub-Mediterranean species in some parts.

Drina River

In the lower parts of the Drina river basin, there are mostly deciduous forests, including tree species like the Turkey oak (*Quercus cerris*), the Hop Hornbeam (*Ostrya carpinifolia*), the Oriental Hornbeam (*Carpinus orientalis*) and the Manna ash (*Fraxinus ornus*). These forests spread on the sides of the canyons and gorges to a certain extent as well. In addition, as mentioned below, alluvial forests are located in this lower part of the valley.

In the middle course of the Drina River, at lower altitude, thermophilous[6] deciduous forests are present. Dominant species in this forest are thermophilous oaks (*Quercus cerris* and *Q. petraea or Q. frainetto).* Some of the characteristic species of these forests are: *Acer tatricum, Ligustrum vulgare, Euonymus*

[2] Relict plants are species that were much more diverse and widespread in the past and that inhabit a much smaller area than in the past due to environmental changes. Therefore, relict plants also require conservation efforts.
[3] Endemic plants are unique and only found in a specific region and habitat type. Therefore, endemic plants are more vulnerable and require conservation efforts.
[4] Natura 2000 code in the Annex 1 of the Habitat Directive of the EU.
[5] *indicates priority habitat types.
[6] Thermophilous forests are a forest family that thrives under warm conditions

europaeus, Festuca heterophylla, Carex montana, Poa nemoralis, Potentilla micrantha, Digitalis grandiflora, Lychnis coronaria, Silene nutans, Lathyrus niger etc. (Drešković et al., 2011).

In the upper watercourse of Drina River refugio-relict habitats[7] are observed. The most common relict forests are pine forests: forests of Dalmatian black pine (*Pinus nigra* subsp. *dalmatica*), forests of White-bark pine (*P. albicaulis*) and forest of Illyrian black pine (*Pinus nigra* var. *illyrica*), presented in series on peridote and serpentinite, on dolomites and on limestone.
Refugio-relict communities, as *Asplenietea rupestris* and *Thlaspeetea rotundifolii* are also recorded in the canyon of Drina River, (BiH 4th report to UNC on Biol. diversity, 2010).

In the middle and upper watercourse of Drina River, at lower altitude, dominant forests are acidophilous community *Luzulo-Fagetum* with the dominant species (European beech) *Fagus sylvatica)* and White wood-rush (*Luzula luzuloides).* Other characteristic species are: *Polytrichum formosum, Vaccinium myrtillus, Pteridium aquillinum, Luzula pilosa, Dicranum scoparium, Leucobryum glaucum*, etc. (Drešković et al., 2011).

At higher altitude, the forests are characterised by fragments communities of European beech (*Fagus sylvatica*), Silver fir (*Abies alba*) and Spruce (*Picea abies*) species. Characteristic species of these communities are: *Aremonia agrimonioides, Cardamine trifolia, C. waldsteinii, Euphorbia carniolica, Knautia drimeya, Lonicera nigra, Acer obtusatum, Sesleria autumnalis, Vicia oroboides, Daphne mezereum, Ruscus hypoglossum, Ostrza carpinifolia, Fraxinus ornus,* etc. (Drešković et al., 2011).

Finally, on the slopes of the canyon of the Drina River, black pines (*Pinus nigra*) form endemo-relict communities in the cracks of rocks (Redžić et al., 2008). These craks are refugial habitats for relict communities. The main species of these communities are: *Asplenium trichomanis, Edraianthus jugoslavicus, Achillea serbica, Dianthus kitaibelii, Cerastium lanati, Moltkia petrea, Campanula balcanica, Genista dalmatica, Daphne malayana, Centaurea derventata,* etc. (Redžić et al., 2008).

According to Milanović (NATURA 2000, 2011), the species *Adenophora lilifolia* is rare, recorded in Drina valley near Bastas. This plant is sensitive to changes in water regime which cause dissapearing populations of this species *Adenophora lilifolia*. This species is in Annex II of the Habitat Directive of the European Union (92/43/EEC). However, in BiH their protection status is not defined.

Sutjeska River

Sutjeska River flows through high mountainous areas and flora in the Sutjeska Gorge is characterized by high diversity of plant species. Among them, endemic and relict species are of particular importance, such as: *Daphne malayana, Gentiana laevicalyx, Plantago durmitorea, Edraianthus jugoslavicus, Edraianthus sutjeske, Edraianthus serpyllifolius, Trifolium durmitoreum, Verbascum durmitoreum, Lilium bosniacum, Silene sendtneri, Knautia dinarica, Viola elegantula* (Fukarek, 1969).

In this gorge, important vegetation diversity is observed. Communities from the class *Asplenietea rupestris* are developed on bared areas and in the cracks in the limestone rocks. These areas are refugial habitats for endemic taxa and other species such as *Micromeria croatica, Micromeria thymifolia, Onosma stellulata, Achillea abrotanoides* and others (Grupa autora, 2013). Vegetation that belongs to class *Thlaspetea rutindifolii* species is present in relict-refugial habitats.

Along the Sutjeska River, the flora is distributed as follows, depending on the altitude (Fukarek, 1969, Grupa autora, 2013, http://www.npsutjeska.net /):

[7] Refugio-relict habitats are habitats that were the least altered during the period between the pre- and post-glaciation and that have been preserved in their natural ecological values.

- At 630 m.a.s.l, mesophyllous[8] meadows are developed. In these communities, many species are endemic. Among them, considering number and abundance, the most important are: *Pimpinella serbica, Lilium bosniacum, Silene sendtneri, Knautia dinarica, Viola elegantula.* The other important species are: *Alchemilla vulgaris, Ranunculus montanus, Plantago media, Colchicum autumnale, Taraxacum officinale, Leucanthemum vulgare, Astrantia major, Phleum alpinum, Pedicularis verticillata, Trifolium montanum*.
- From 720 to 750 m.a.s.l, the prevailing species of forest are the Sessile oak (*Quercus petraea)*. The other dominants species that are observed are *Carpinus betulus, Fagus moesiaca, Carpinus betulus, Seslaria autumnalis, Galium verum, Fraxinus ornus, Cotinus cogyggria, Helleborus odorus, Anemone nemorosa.*
- From 1000 to 1600 m.a.s.l., the prevailing species are the Balkan beech (*Fagus moesiaca)* forms different associations:

  - *Fagetum moesiacae montanum* (1040 m.a.s.l.), with dominant species: *Fagus moesiaca, Acer platanoides, Ulmus montana, Sorbus aurcuparia, Asperula odorata, Viola silvatica.*
  - *Seslerio autumnalis-Fagetum moesiacae* (1160 m.a.s.l.), with dominant species: *Fagus moesiaca, Acer platanoides, Populus tremula, Rubus idaeus, Asperula taurina, Poa nemoralis.*
  - *Abieti-Fagetum moesiacae* (1200 m.a.s.l.), with dominant species: *Abies alba, Fagus moesiaca, Acer platanoides, Festuca drymeia, Asperula nemoralis.*
  - *Luzulo-Fagetum moesiacae subalpinum* (1600 m.a.s.l.), with dominant species: *Fagus moesiaca, Picea abies, Luzula pilosa, Veronica officinalis*.

- From 1700 to 2200 m.a.s.l., the Mountain pins (*Pinus mughi*) species form the endemic community Pinetum mughi dinaricum. Dominant species in this community are: *Pinus muhgo, Juniperus intermedia, Vaccinium myrtillus, Veratrum album, Linum capitatum*.
- At higher altitude, communities with numerous endemic and relict species are developed: *Edraiantho-Veronicetum satureioidis, Poeto-Caricetum caryophylleae, Potentillo-Caricetum sempervirentis*. Some of species that form these communities are: *Edraianthus jugoslavicus, Carex caryophyllea, Leucanthemum montanum, Crepis dinarica, Lilium bosniacum, Hieracium pavichii, Orchis sambucina, Lotus ciliatus, Crocus neapolitanus, Crepis dinarica*.

This characterization shows that the BiH part of the DRB is endowed with rare relict and endemic terrestrial species of flora. The following Table 2-12 proposes a summary of the main species to be protected.

Table 2-12: Main rare and endemic and relict species in the BiH part of the DRB

Relict species	Endemic species
Halacsya sendtneri	*Acinos orontius*
Potentilla visianii	*Alyssum moellendorfianum*
Fumana bonapartei	*Asperula hercegovina*
Haplophyllum boissierianum	*Barbarea bosniaca*
Gypsophila spergulaefolia f. *serbica*	*Campanula hercegovina*
Alyssum moelendorfianum	*Centaurea bosniaca*
Thymus aureopunctatus	*Dianthus freynii*
Acinos orontius	*Edraianthus niveus*
	Minuartia handelli
	Oxytropis prenja
	Symphyandra hofmanni

Aquatic flora

In residual ponds, backwaters and stagnant pools left behind from flooding of Drina River, freely floating vegetation of eutrophic waters with dominance of different species of the genus *Lemna* is developed. Communities of this type are being developed in the shallow ponds and channels (10-50 cm) with water still

[8] Mesophillous meadows are meadows with moist habitats.

or slow moving. The bottom is muddy, oozing with a lot of detritus. The characteristic species of these communities are: *Lemna minor, Lemna trisulca, Azolla filiculoides, Ceratophyllum sp., Myriophyllum spicatum, Salvinia natans, Utricularia vulgaris,* etc. (Redžić et al., 2008).

Regarding the benthos flora, the habitats where this flora developed in the DRB is still unexplored, there is no existing data.

Gravel pits in rivers
Gravel pits concern mainly large river beds, therefore the Drina River. In the lower course of the Drina River, there are communities developed on different types of alluvial deposits, mainly with a limestone substrate in which the gravel and coarse sand predominate. Soils have a higher content of clay, sometimes with layers of gravel that interrupt capillary action of the water. This is vegetation of shrubs dominated by different species of willow (*Salix species*). The stands of these communities are usually small and scattered, and appear in the form of narrow strips along the river beds. Given that the human impact on these habitats expressed, one can notice the existence of a number of ruderal species (*Rubus caesius, R. hirtus, Urtica dioica, Bidens tripartita,* etc.).

Wetland flora
In the lower course of the Drina River, downstream from the dam at Zvornik Reservoir (Hydropower "Zvornik"), wetland vegetation has a fragmentary occurrence. These communities are dominated by the following species: *Phragmites communis, Schoenoplectus lacustris, Typha latifolia, T. angustifolia, Calamagrostis pseudophragmites, Acorus calamus*.

These plant communities normally develop on the muddy banks of rivers in mountainous and sub-mountainous regions, in places where water is retained longer and where ponds are created (Lakušić, 2005). The Zvornik reservoir that is more and more full of sediments is becoming a wetland ecosystem: wetland vegetation is developing.

The woody flora in wetland habitat consists in hygrophylous[9] woods and shrubs of willow, alder, purple and marsh willow (Grupa autora, 2010).

Alluvial forests
In the valley of the Drina River there are small stands of alluvial forest, in particular in Semberi region.
Black alder *(Alnus glutinosa)* is dominant species in these forests. They need to be briefly but regularly flooded.

The species White willow (*Salix alba)* is also dominant species in alluvial forests situated along the Drina River. This type of vegetation is recorded sporadically. These communities occur on alluvial sediment (Redžić et al., 2008).

The characteristic species of these alluvial habitats are: *Alnus incana, Salix alba, S. fragilis, S. purpurea, Populus nigra, P. alba, Euonymus europaea, Festuca gigantea, Crex remota, Aegopodium podagraria, Sambucus nigra, Impatiens noli-tangere, Circea lutetiana, Lamium maculatum, Ranunculus lanuginosa, Oxalis acetosella, Ajuga reptans, Cardamine amara,* etc. (Redžić et al., 2008; Drešković et al., 2011).

In particular, at the confluence of Sava and Drina, alluvial forests can be observed. Different willows species occur, such as the Olive willow *(Salix eleagnos)*, the Bay willow *(Salix pentandra), the* Purple willow *(Salix purpurea)*, the White willow *(Salix alba),* the Old World willow *(Salix amydalina)*, and the Almond willow *(Salix triandra*), all of which are dominant species. These willows are followed by hygrophilous shrubs and small trees such as the Black poplar (*Populus nigra),* or the Common alder *(Alnus glutinosa)*. Communities of this type occur in alluvial deposits, hydromorphic gley, pseudo-gley or alluvial semi-gley soils. Soils are frequently flooded, and the groundwater level is usually very high, saturating the soil with water. Therefore,

[9] Hygrophilous species are growing and thriving in moist areas.

alluvial forests develop on land that is permanently saturated. Such habitats occur at altitudes up to 700 m.a.s.l. (Mišić and Kojadinović, 1985; Lakušić et al., 2005).

Invasive flora species
The most noticeable invasive plant species in the DRB are Common ragweed (*Ambrosia artemisiifolia)* and Japanese Knotweed (*Reynoutria japonica)*. Common ragweed is already well established in the complete lower part of the DRB, while Japanese Knotweed is a great threat for the riparian vegetation and is spreading in the lower part of the region (Anđelković et al., 2013). On gravel pits in the lower course of the Drina River, invasive species such as Indigo bush (*Amorpha fruticosa), Box elder (Acer negundo),* Tree of heaven *(Aillanthus altissima), Japanese Knotweed d,* etc. occur.

A great threat for the natural habitats located on steep slopes of canyons and gorges is an invasive tree species called Tree of heaven (*Ailanthus altissima)*. Its current distribution is not wide, but the species is present on both sides of the Drina River, especially in the Municipalities Višegrad (Municipality of Višegrad, 2013).

Common milkweed *(Asclepias syriaca*is) is probably the most common invasive plant species after the Common ragweed in the lower parts of the DRB.

2.8.2 Fauna

Because of its high variety of habitats, the DRB in BiH covers a large variety of fauna, including fish (about 50 species), amphibians (about 35 species), mammals (about 80 species), birds (more than 230 species) and insects.

Fish
The most important fish species in the region is the Danube Salmon (*Hucho hucho),* whose migration routes are interrupted by dams, and whose populations are showing a disrupted structure, whilst the overall population size has decreased significantly. It is to note that this Danube Salmon is one of the most endangered European fish species (IUCN Red List), endemic for Danube drainage. The Drina River is a very important habitat for this species.

Other important salmonid species present in the basin are the Grayling (*Thymalus thymalus)* and the Brown trout (*Salmo labrax)* and, only at the locality of Gromiželj (Special Nature Reserve Gromizelj in the Municipality of Bijeljina, RS), the European mudminnow (*Umbra krameri)*. Also observed are Cyprinid species such as the Chub (*Leuciscus cephalus*), the Nase (*Chondrostoma nasus)*, the Barbell *(Barbus barbus),* the Danube Roach (Rutilus pigus virgo) and Carp (Cyprinus carpio).

Fish are among the most endangered vertebrates and preserving the rich fish ecosystems of the Drina River would enable the protection of a high proportion of the Balkan and European fish species and their genetic diversity.

The protection status of fish species in the DRB in BiH is given in Annex 2-1.

<u>Drina River</u>
With approximately 350 kilometres of water flow, Drina River offers a variety of different habitats and ecosystems. Thanks to this variety of ecosystems, the Drina River is inhabited by more than 50 fish species and because of that represents one of the key fish diversity locations in the Balkans.

- In the <u>upper part,</u> there are mountain streams and small water flows with clean and cold water inhabited by Salmonid fishes primarily. There are also Drina tributaries that are an important part of its water flow. At these locations, the following can be observed: Brown Trout, Bullhead (*Cottus gobio*) and Brook Barbel (*Barbus caninus*). These species are mostly affected by small dams, overfishing (especially Brown Trout), and moderate amounts of nutrients coming from nearby fish farms.

- The middle part of the Drina River offers water which is a bit warmer with moderate water flow and smaller gravel size. These waters are mainly inhabited by a combination of Cyprinid and Salmonid fishes. At these locations, Danube Salmon is also observed, as well as Grayling and even Brown Trout as representatives of Salmonids. There is also Rainbow Trout (*Oncorhynchus mykiss*) (introduced species) that have escaped from nearby fish farms and directly affects mainly Brown Trout by competing for their food. All these species have been affected by pollution and overfishing pressure for the last 50 years. In addition, in this zone, Barbel, Nase, Danube Roach, Chub, Bullhead, Zingel and many more species can be observed.
- In the lower part of the Drina River, near the confluence with the Sava River, the landscape has lowland/wetland characteristics with flooded areas which are inhabited by typical limnophylic species. Typical lowland species such as Carp, Pike (*Esox*), Common Bream (*Abramis brama*) and Catfish can be found, but we can also occasionally find Danube Salmon. In flooded areas there are also Prussian Carp, Tench (*Tinca tinca*)and even the endangered and endemic Mudminnow (*Umbra krameri*), reported from Gromiželj wetland and from Drina rRiver, locality Janje .

Fish populations distributed over five sections of the Drina River in BiH are presented in Annex 2-2.

As the Drina River is endowed with particularly rich fish ecosystems that include the most endangered species from the Balkans and from Europe, if follows that particular attention must be given to the trend of this ecosystem to ensure that it is adequately protected.

In annex 5, the Water Framework Directive (2000/60/EC) provides with normative definitions of ecological status classifications. Table 1.2.1 is called "*Definitions for high, good and moderate ecological status in rivers*" and gives definitions for different biological quality elements. In this table, fish fauna is one of the water biological quality indicators that provide information about water status in rivers as shown in Table 2-13:

Table 2-13: Water quality in rivers based on fish fauna

High status
Species composition and abundance correspond totally or nearly totally to undisturbed conditions. All the type-specific disturbance-sensitive species are present. The age structures of the fish communities show little sign of anthropogenic disturbance and are not indicative of a failure in the reproduction or development of any particular species.

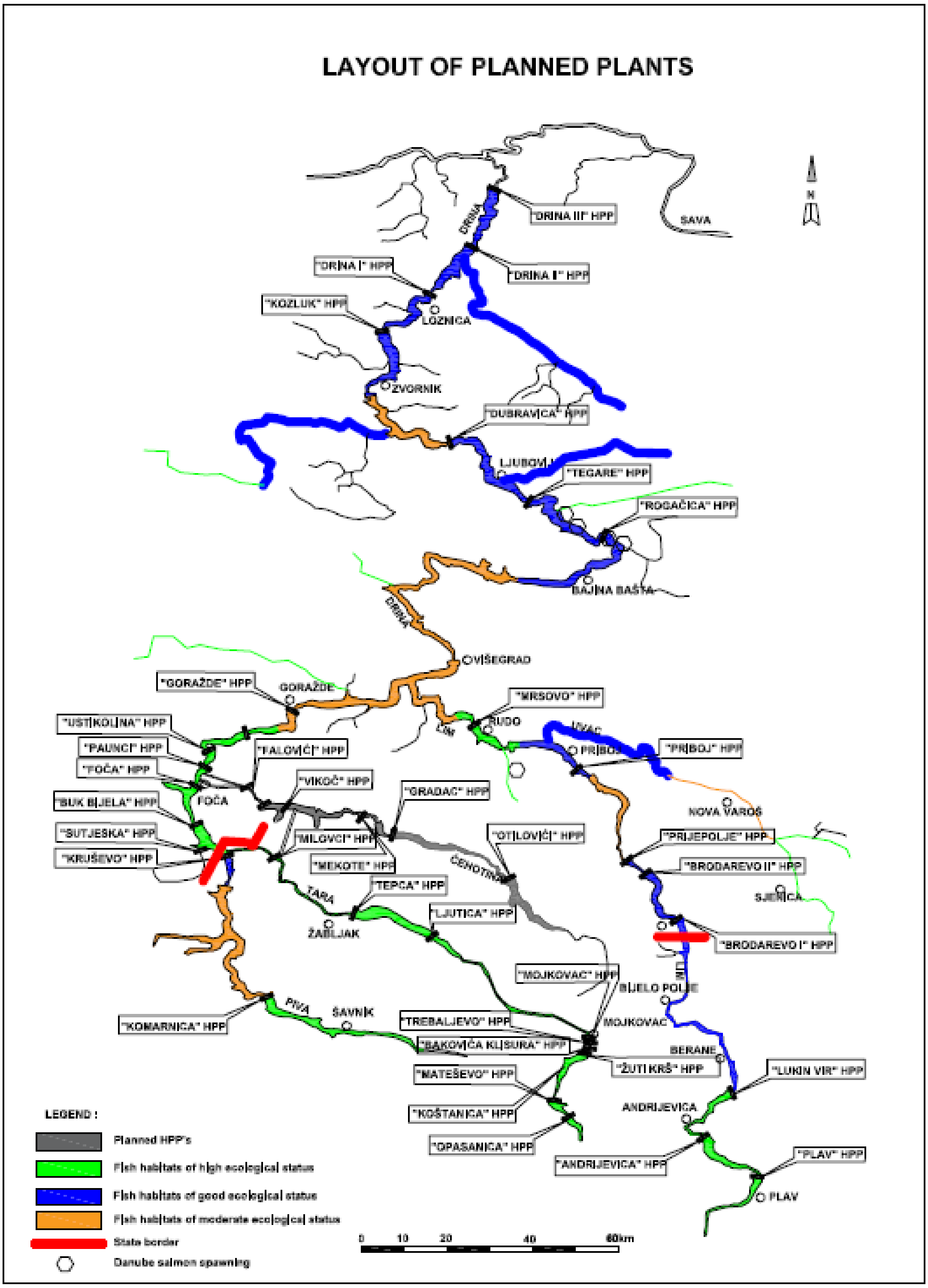
Good status
There are slight changes in species composition and abundance from the type- specific communities attributable to anthropogenic impacts on physio-chemical and hydro-morphological quality elements. The age structures of the fish communities show signs of disturbance attributable to anthropogenic impacts on physio-chemical or hydro-morphological quality elements, and, in a few instances, are indicative of a failure in the reproduction or development of a particular species, to the extent that some age classes may be missing.

Moderate status
The composition and abundance of fish species differ moderately from the type- specific communities attributable to anthropogenic impacts on physio-chemical or hydro-morphological quality elements. The age structure of the fish communities shows major signs of anthropogenic disturbance, to the extent that a moderate proportion of the type specific species are absent or of very low abundance.

Source: WFD, Annex V

For this report, we decided to use data on fish fauna as an indicator for water quality in rivers because more data is available on fish fauna that on other indicators as Phytoplankton, Macrophytes and phytobenthos or Benthic invertebrate fauna.

The fish experts (ichthyologists) employed by the JV consultant have made an indicative map about water quality in rivers using fish fauna as a biological indicator. Their analysis is based on the WFD classification, data on fish from existing academic papers and on their own knowledge based on field experience. This map is presented hereafter in Figure 2-30 and shows water quality of high ecological status (green), good ecological status (blue) and moderate ecological status (orange) in the DRB rivers using Fish fauna as a biological indicator. The map also shows spots for Danube salmon spawning (in white), hydropower plants (grey) and the limits of the river sections within the BiH territory in red. The analysis has not been made for Ćehotina River.



Note: Legend explanations are within figure

Figure 2-30: Water quality in the rivers in of the DRB using on fish species as an indicator

Following this approach, the results for the Drina River that borders Serbia and BiH can be described as follows:

→High ecological status of water based on fish fauna
In this section, the water ecological status has been assessed as high even if there are pressures on fish fauna (poaching and pollution).

Drina River from confluence of Piva and Tara to Foča:
This section withheld the primeval characteristics of the Drina River before dam construction and other alterations. The Drina River here is fast flowing with stone and gravel bottom, cold and rich in oxygen. It is dominated mostly by Salmonids (Danube Salmon, Grayling and Brown Trout), but autochthonous cyprinid reophilic species are also present here in great numbers (Chub, Nase, Danube Roach, Barbel, Minnow). In these upper parts of the Drina, Bullhead and Loaches (Balkan Loach, Golden Loach and Stone Loach) are also found.

The *Prača tributary* and the *upstream part of the Drinjača tributary* presents also high ecological status with fast flowing water, cold and rich in oxygen. These tributaries are habitat for Danube Salmon population.

Only the *upstream section of the Uvac River*, which is not affected by dam construction or other social pressure, presents high ecological status with fast flowing waters. It is dominated by salmonid and cyprinid species.

→Good ecological status of water based on fish fauna

Drina River from Perućac reservoir (Bajina Basta HPP) until the beginning of Zvornik reservoir:
This part of Drina is characterized by a moderate water flow, rocky bed and high oxygen concentration. Water conditions are adequate for both salmonid and reophilic cyprinid species. Good populations of Danube Salmon and Grayling are found here. Brown Trout is here in strong competition with alochtonous Rainbow Trout and is not found very often. Many cyprinid species are found here but most dominant are Nase, Danube Roach, Schneider and Minnow. Different species of Loach are also found here but Bullhead is quite rare since the great pollution incident in 2010 that occurred during the servicing of the turbines.

This middle part of the Drina River (from Bajina Bašta dam to Zvornik Reservoir) is a high value section to be protected as the spawning areas for the Danube salmon.

Drina downstream of Zvornik dam
Before the constructions of the dams, Drina had cyprinid character downstream from Zvornik, and that characteristic remains today. In that part we can see typical lowland species such as Carp, Pike, Wels Catfish, Bream, Barbel, but there are also occasionally Danube Salmon and Grayling records. Also, Nase and Danube Roach are common in this part of Drina.

→Moderate ecological status of water based on fish fauna

Lake Perućac and Lake Zvornik on the Drina River
- Lake Perućac is a deep, narrow canyon type lake with stone and gravel at the bottom. In Perućac Lake, Bleak, Carp and Tench are most common representatives of cyprinid fishes, but Nase and Danube Roach are also found in great numbers. Catfish is a common predator, together with Perch and Chub that are smaller predators.
- Lake Zvornik is shallower and wider with a smaller granulation of the bed. Reed patches and other immersed vegetation are present in Lake Zvornik. In Lake Zvornik, Pike Perch, Pike, Wels Catfish and Asp are dominant predators.

With time, a great amount of sediment has deposited on the bottom of both lakes. In both lakes one can find a great diversity of species but many of them allochthonous to the DRB.

In these lakes one can also find Danube Salmon, Grayling, and some rheophilic cyprinid species, but these findings are quite rare.
The main fish species occurring in nine sections of tributaries of the Drina River, whether in BiH, Serbia or Montenegro are presented in Annex 2-2.

Invasive fish species
In the DRB, the following invasive fish species have been identified: *Oncorhynchus mykiss, Salvelinus fontinalis, Ctenopharyngodon idella, Ameiurus nebulosus* (Federal Ministry of Environment and Tourism of BiH, 2009).

A widely introduced species is the Rainbow Trout (*Oncorhynchus mykiss)* from California and Arctic Char (*Salvelinus alpinus).* Both species have been introduced to the mountain glacial lakes of NP Sutjeska. According to Sutjeska National Park's web site, they are both present in the Orlovačko Lake. The arctic char is the only species introduced in the Štirinsko Lake.

Benthos fauna
Aquatic macro-invertebrates are a functionally important component of aquatic ecosystems. They can be used as quality indicators for the riverbed and the water.

According to a paper published in 2011 about bio-indicators of Drina River water quality (Tomović et al. 2011), in total, no less than 55 taxons of macro-invertebrates have been recorded in the Drina River. The most diverse group is *Ephemeroptera* with 23 recorded species. *Oligochaeta* and *Diptera* have been recorded with 10 and 9 species, respectively.

The group with the smallest diversity was *Hirudinea*, with only one recorded species. The number of taxons found was similar at all sampling points but higher at the locality of Bačevci, with 14 species. The highest community density has been recorded at the locality of Crnča, while the smallest was recorded on the locality downstream from Zvornik. Highest values of the Shannon-Weiner (biodiversity) index were recorded on the localities Bačevci and downstream from Zvornik, 2.30 and 2.28, respectively. On other four localities diversity indexes are significantly lower, the lowest being on locality Crna Bara at 1.39.

The dominant class of aquatic macro-invertebrates are insects, with Ephemeroptera dominating four samples with an average of 35.7% of individuals. They are followed by Diptera with 32.1% and Oligochaeta with 10.7%. Representatives of Coleoptera have been recorded only at Bačevci.

The saprobity index has been determined by the Zelinka-Marvan method (Zelinka et Marvan 1961) and ranges from 1.76 at Crnča to 2.81 at Culine.

Amphibians and reptiles
Amphibians and reptiles are present in the DRB with at least 35 species recorded, the most remarkable amphibians being the Alpine Salamander (*Salamandra atra).*

Reptiles inhabit fresh water ecosystems, swamps, wetlands along the Drina and its tributaries and almost all land ecosystems. There are about 40 species observed. The most remarkable reptiles are the Meadow Viper (*Vipera ursinii)* and the endemic Mosor Rock Lizard (*Dinarolacerta mosorensis).*

Birds
Birds are present in the DRB with at least 230 species. Knowledge of birds in DRB is not equal throughout the basin, and can be improved drastically in some parts of the area, especially in protected areas along country borders.

Many charismatic birds can be observed, such as the Golden eagle (*Aquila chrysaetos*), the short-toed snake eagle (*Circaetus gallicus*), the peregrine falcon *(Falco peregrinus*), the Black grouse (*Tetrao urogallus*), the Griffon vulture (*Gyps fulvus*), the Eurasian woodcock (*Scolopax rusticola*). It is also important to mention the Rock partridge (*Alectoris greaca*), that is the only Balkan endemic bird species and which is declining throughout the region.

There are no distinctive migratory corridors for birds in the whole DRB. At times, raptors from the genera *Circus* can be observed in numbers of up to 100 individuals on a daily passage (observed in Lim canyon during the last decade), but such sightings are not regular and do not occur as a rule.

High elevation mountain birds in the DRB

The main bird families in the DRB that can be indirectly affected by the water resources management, on very high elevations above 2000m, are the Shore lark (*Eremophilla alpestris)*, the White-winged Snow Finch (*Montifringilla nivalis)*, and the Alpine Accentor (*Prunella collaris)*.

Species that are characteristic for the steep cliffs along the rivers of the DRB are the Golden Eagle and the Peregrine Falcon, as well as the Eagle Owl. All of them are found throughout the DRB.
Out of the bird species that inhabit cliffs, the most important is the Griffon Vulture (*Gyps fulvus)* which does not breed in BiH but in three different colonies in Serbia (Trešnjica, Uvac and Mileševka regions). Currently, this species is dependent on conservation measures, most of all supplementary feeding.

Forest birds

The most interesting bird species of the forests of DRB are:

- Owls: the Ural Owl (*Strix uralensis)*, the Pygmy Owl *(Glaucidium passerinum)*, the Tengmalm's Owl (*Aegolius funereus);*
- *W*oodpeckers: the Three-toed Woodpecker (*Picoides tridactylus*), the White-backed Woodpecker (*Dendrocopos leucotos*), and
- Flycatchers: the White Collared Flycatcher (*Ficedula albicollis)* and the Red-breasted flycatcher (*Ficedula parva*).

All of them are indicators of forest quality.

Another species, the Black grouse (*Tetrao urogallus)* can be found in forest habitats but it is threatened due to disturbance and hunting.

Water birds

There are some species of birds directly related to the water resources of the Basin, like the Cormorants (*Phalacrocorax carbo)*, which during winter months are gathering on the lakes of the Drina River, being in conflict with local fishermen, who see them as a pest feeding on fish stocks.

Symbol of the flowing waters of the DRB is the Dipper *Cinclus cinclus,* which is found only on the parts of the flow where the water level is not regulated, and is especially common on smaller tributaries.

Further downstream, the Drina River is characterized by numerous gravel islands, some of them hosting small colonies of Little Tern (*Sterna albifrons*) and of Common Tern (*Sterna hirundo*) that are unique in the DRB.

The downstream part of the Drina River and its wetlands are the refuge for migratory birds.

Birds in the Sutjeska National Park (RS)

Bird monitoring and observation are well developed in this protected area. A total of 114 bird species have been registered in the Sutjeska National Park, which makes 36% of the overall number of known species in BiH. The real species diversity is certainly higher.

Out of 114 registered bird species 61 species reside and breed in the Park, 32 species visit the Park only in summer, but alsobreed there. 16 species are migratory birds which traverse the Park in spring and autumn going north where they breed, while they spend the winter in southern regions. Five species usually appear only in winter.

More details on bird species in this protected area are given in Annex 2.4.

Mammals
In the forests of the upper catchment of the DRB in BiH live species, such as the Brown bear (*Ursus arctos*), the Eurasian wolf (*Canis lupus*), the chamois (*Rupicapra rupicapra*), the wild cat (*Felis silvestris*), and along the rivers of the region, the European otter (*Lutra lutra*). These species are all rare and endangered.

In particular, Drina River canyon and its tributaries are permanent habitats of the Eurasian Brown bear, hibernating in the canyon caves. Canyon crags are the permanent habitats of the Chamois.

There are also more common species of mammals such as the fox, the marten, the badger, the wild boar, the deer, and the rabbit.

Bat species are also well represented in the DRB in BiH. The probable number of species in DRB is at about 30 and Drina River represents a corridor for bat migration. This has been confirmed in August 2012, above Perućac Lake.

The main data for bats in the region are provided by monitoring in Tara NP in Serbia and in Durmitor NP in Montenegro.
According to bat monitoring in Tara National Park (NP) (Biotope 2012, Biodiv 2014), the following 25 bat species have been recorded: *Barbastella barbastellus, Eptesicus serotinus, Eptesicus nilssonii, Hypsugo savii, Miniopterus schreibersii, Myotis alcathoe, Myotis bechsteinii, Myotis capaccini, Myotis daubentonii, Myotis emarginatus, Myotis myotis, Myotis mystacinus, Myotis nattereri, Nyctalus leisleri, Nyctalus noctula, Pipistrellus kuhlii, Pipistrellus nathusii, Pipistrellus pipistrellus, Pipistrellus pygmaeus, Plecotus auritus, Rhinolophus euryale, Rhinolophus ferrumequinum, Rhinolophus hipposideros, Tadarida teniotis, Vespertillo murinus.*

According to Durmitor NP's management plan, 13 bat species have been recorded: *Rhinolophus ferrumequinum, Rhinolophus hipposideros, Plecotus austriacus, Plecotus auritus, Myotis mystacinus, Myotis emarginatus, Myotis nattereri, Myotis myotis, Myotis blythii, Pipistrellus pipistrellus, Hypsugo savii, Eptesicus serotinus and Vespertilio murinus.*

Myotis capaccini, Pipistrellus nathusii, Pipistrellus pipistrellus are species depending on water ecosystems (lakes, reservoirs, ponds).

A similar number of species and species composition is probably present throughout the DRB, including in the BiH part of the Basin.

Eptesicus nilssonii and *Tadarida teniotis* are rare species in the region. *Tadarida teniotis* is also known from Prokletije NP and Lelija Mt in BiH (Ciechanowski, 2005). *Myotis brandtii* is known from Prokletije NP, and *Myotis aurascens* from the Stabna, near Piva River (Benda, 2004).

Insects
The diversity of moth butterflies is exceptionally high. Other groups of insects are also remarkable because of the high number of endemic subspecies present in the DRB. For example, there are at least 45 endemic species of *Carabidae* (*Coleopterea*) and most of them are confined to the Dinarides and present in the DRB.

Invasive insect species
Even though the number of invasive species among Arthropoda is the highest, it is not very well recorded. One notable infestation happened in the mid-nineties when a corn pest, *Diabratica virgifera* appeared on the agricultural fields of the lower Drina flow (Federal Ministry of Environment and Tourism of BiH, 2009).

2.8.3 Trends of flora and fauna and main pressures

Trend
Population trends for flora and fauna species in the DRB are difficult to assess due to lack of past and present data. According to the state of environment report of BiH 2012, BiH has still not established a central or coordinating body for monitoring the biodiversity status, data are very scarce and the Red Data Book has still not be adopted in BiH.

However, based on the IUCN status and trend of population of important species in the DRB (see Annex 2-3) and because of the human pressure and of the observed invasive species, we can suppose that many flora and fauna species have been decreasing over the past few years.

For the Danube Salmon, the Serbian Spruce or bird species like the Rock partridge and rare Woodpeckers (such as the Three-toed and the White-backed Woodpecker), data are sufficient to say that populations are declining because detailed studies have been written about them over the last few years, giving population estimates.

Furthermore, some bird species that were breeding in the past in the DRB are not breeding anymore.

The populations of Griffon vulture, of Black vulture and of Bearded Vulture that are scavengers have been declining in the past because they have been eating carcasses of poisoned wolfs. Wolf poisoning is now forbidden and the population of Griffon vulture is increasing again. However, it is extremely rare to see a Black or a Bearded Vulture on passage in the DRB even though they were breeding there in the past.

Birds and bats living in cliffs would be threatened by the creation of new dams and subsequent canyon flooding and their population could decline.

Pressures
The main threats for the habitats and species in the DRB come from both environmental and human factors. The most prominent environmental factor is drought, which claimed a significant toll on forests that were exposed and growing on shallow soil during the summers of 2012 and 2013.

Human pressure
Human pressure caused by agricultural and urbanization developments, hunting, forestry and tourism is a threat for biodiversity.

In the mountain regions, the biggest problems are tourism related activities and forestry, both of which are not planned according to the biodiversity values of the area.

In the lower regions and in the river valley, the habitat conversions, the overexploitation of natural resources (specifically in the lower flow of the Drina River, exploitation of the river sand and gravel material) and the agricultural and urbanization development remain the biggest threats. Human and environmental pressures are described below in more detail.

Agricultural and urbanization development
There is a general expansion of agricultural areas which results in the conversion, therefore destruction, of high value habitat into mostly monoculture areas. This decrease in the variety of habitats through replacement by agricultural land has a direct consequence on the impoverishment of the flora and fauna species.

Urbanization and construction of the connected infrastructures lead to habitat degradation and to habitat fragmentation and ecological corridor interruptions.

Dams
In the Drina River, fish live in very specific ecological conditions, with a strong influence of anthropogenic factors.

Three dams have been constructed, the Višegrad dam, located downstream Visegrad, the Bajina Bašta dam, located near the town of the same name in the middle section of the Drina River, and the Zvornik dam located on the lower section of the Drina River, near to Zvornik town.

Zvornik dam is the only location in the DRB that is equipped with a fish ladder. The environmental flows provided by the dam is about 50 to 60 m^3/s from upstream to downstream, which represents of about 15% of the mean average Drina River flow discharge.

These three dams have turned a river ecosystem into a lake ecosystem (fast flowing waters become stagnant waters), changed the hydrological regime, destructing habitats and significantly changing living conditions for fish. In addition, HPP activity leads to excessive daily oscillations of the water level along the downstream section of the Drina River and changes the thermal regime of the water.

Furthermore, the dams (with the mentioned exception the fish ladder-equipped Zvornik dam) have now created separate river sections, disturbing fish migration, implying the fish are no longer able to migrate naturally in order to reproduce. No data is available to estimate the efficiency of the fish ladder at the Zvornik dam.

All these factors have caused the populations of Salmonids, in particular the Danube Salmon, to decrease significantly within the Drina River, but they also heavily affected other fish species (Mikavica, 1987).

It has also been observed that the Bajina Basta dam has caused massive mortality among fish population in the last 20 years, especially in 1993 and in 2010, due to oil pollution during servicing of the turbines and electric transformers.

The Višegrad dam and a part of its reservoir on the Lim River contribute to disturb the aquatic ecosystem and interrupt the fish migration in this tributary.

The exploitation of the dams can also lead to fast fluctuations of the level of the water in the river downstream (hydro peaking) and to significant variations of the water level of the reservoir. These water fluctuations create significant damages during breeding period, between March and May.

Birds and bats living in cliffs as well as riparian vegetation are threatened by the creation of new dams and subsequent canyon flooding.

Fish farming
Fish farms have negative impacts on the water quality of the rivers due to great amounts of nutrients that they generate and also on the water quantity in some places (the drying of the small tributaries) due to water derivation without guarantee of a sufficient environmental flow.

In addition, uncontrolled fish release for sport fishing purposes can cause more harm than good if the wrong species is released or introduced; the Rainbow Trout is a prime example.

Gravel mining and cast quarries
Gravel mining has a negative impact on the waters of the DRB. It leads to destruction of breeding areas of fishes in the rivers, pollution of the water resources, and destruction of natural sediment regimes and can exacerbate flooding.

Opening of cast quarries for construction resources leads to a fragmentation of forest and land ecosystems and to a decrease in the variability and size of the habitats.

Tourism activities
People are disturbing traditional habitats and corridors for fauna. They do not respect the main paths, they make noise and they pollute the land by discarding solid waste.

Indeed, the quantity of waste increases significantly during the peak tourism periods: Tourism leads to infrastructure development and the construction of accommodations, which lead to decreasing sizes of areas of high environmental value.

Forestry activities
Forest exploitation is occurring without proper sustainable management. This has the consequence of disturbing bird nest and breeding areas and can lead to a significant loss of habitats. In addition, and for economic reasons, forest regeneration does not use high quality species.

Hunting
BiH is endowed with a large number of hunting sites. Status is given according to the hunting species. However, there is either a lack of management or inadequate management of populations of hunting fauna, with illegal hunting practice taking place. As a consequence, the population of certain species declined and must be protected.

Solid wastes and industrial pollution
There is still a use of obsolete industrial technologies and mostly non-renewable energy and mineral resources which lead to high industrial pollution levels.

BiH suffers from uncontrolled waste disposal with many illegal dumpsites in the river bed or on the riversides. Solid waste management is one of the largest environmental problems in the BiH part of the DRB. The floating pollution due to floating waste affects the aquatic ecosystems by suffocating micro-fauna and flora. In general, official or non-official waste disposal sites are very near the rivers. Wastes are transported by the rivers in every flood.

The rivers can be contaminated with industrial and agricultural pollutants. Water pollution can either regionally disturb the aquatic ecosystem for a short period or decrease the water quality in the long term.

Air pollution, in particular ozone and acid rain, can damage vegetation and harm plants and tree growth or lead to acidification of water.

Environmental pressure
Drought
The watercourses most affected by drought in the DRB are small tributaries of the Drina River.

During extreme droughts, as happened in 2012 and 2013, many kilometres of salmonid streams were left without water, which led to mass migration of fish from secondary flows toward the main watercourses and reservoirs. Many tributaries ran dry and the fish started gathering in the whirlpools as early as in July.

Therefore, in addition to vertical migration from tributaries toward main watercourses, within each larger watercourse there was a horizontal migration - from shallower to deeper waters and from the rapids to the whirlpools. Such migrations that can occur naturally during winter also appear during summer months due to drought.

Movements of fish in conditions of extreme drought result in a dramatically increased concentration of fish in a small space, putting pressure on the food resource. It leads to overfishing at the sites of high fish density.

Considering this phenomenon, the most sensitive fish species are Common Nase, Common Barbel and Cactus Roach (*Rutilus virgo)*, mostly because other species interesting for fishing, Brown Trout and Grayling, do not tend to concentrate in and around whirlpools.

During the period 1997-2003, thanks to the mild winters and low water levels in the winter, overfishing occurred at the places where fish had gathered, significantly reducing the population of Common Nase, Common Barbel and Cactus Roach.

The fish population has since recovered due to high precipitation experienced in winters from 2004-2010, which lead to difficult conditions for fishing. One of the potential reasons may also have been the positive impact of a fish ladder located by at HPP Zvornik, which is being used every year around mid-April since 2003 (RTS, 2011), but there is no research to prove this.

In addition, droughts can increase the negative effects of water pollution by increasing the concentration of pollutants in the water.

<u>Floods</u>
Floods affect the riverbed by rearranging gravel distribution, creating erosion or deposition that can damage habitats. This can be the cause for local decline in a fish population in an affected area. However, contrarily to human pressure, flood pressure is a specific event followed by a natural recovery.

In addition, floods have an effect on riverbanks that can destroy the water vegetation.

The effects of extreme floods on biodiversity that dominated the spring of 2014 are yet to be assessed (Travar, 2014). However, floods damaged the barriers between Korenita River (tributary of Jadar River) and a deposition site from an Antimony mine "Stolice", which led to the massive pollution of the Jadar and the Drina rivers with heavy metals (B92, 2014).

2.8.4 Main proposed objectives of protection

The overall objective of this study is to promote more effective water resource management in the DRB with a special focus on flood and drought mitigation. The key issues regarding biodiversity protection must focus on ecosystems and species that are directly or indirectly impacted by WRM changes.

Changes in water intakes and water abstractions management, in dam construction and dam operation as well as climate changes could modify hydraulic regimes (discharge, water level and stream velocity).

The first ecosystems to be impacted by these changes are aquatic ecosystems in streams, rivers and lakes as well as adjacent terrestrial ecosystems that directly affect or are affected by the aquatic environment: floodplains, swamps, riparian forests and reed beds.

For this reason, the objectives of protection of biodiversity that are proposed by the Consultant are summarized in Table 2-14.

Table 2-14: Proposition of main biodiversity protection objectives

Key objectives	Main recommendations for management
Fish ecosystem (habitat for fishes): • The Danube salmon (*Hucho hucho*); • The Grayling (*Thymallus thymallus)*; • The Bullhead (*Cottus gobio*); • The Brown trout (*Salmo labrax*).	- Impose fish ladders for new dams - Control environmental flows - Reduce hydro-peaking during breeding period - Regulate gravel exploitation - Prohibit fishing during drought periods - Improve fish farming processes - Build adequate landfills - Shield rivers from existing riparian pollution sources

Key objectives	Main recommendations for management
	(landfills, deposits)
Riparian ecosystem (alluvial forests and other types of riparian vegetation, reed beds…)	- Concept of flood protection to be coordinated - Mitigation of drought with HPP reservoirs - Coordination of land use in particular agriculture - Management of protective forest

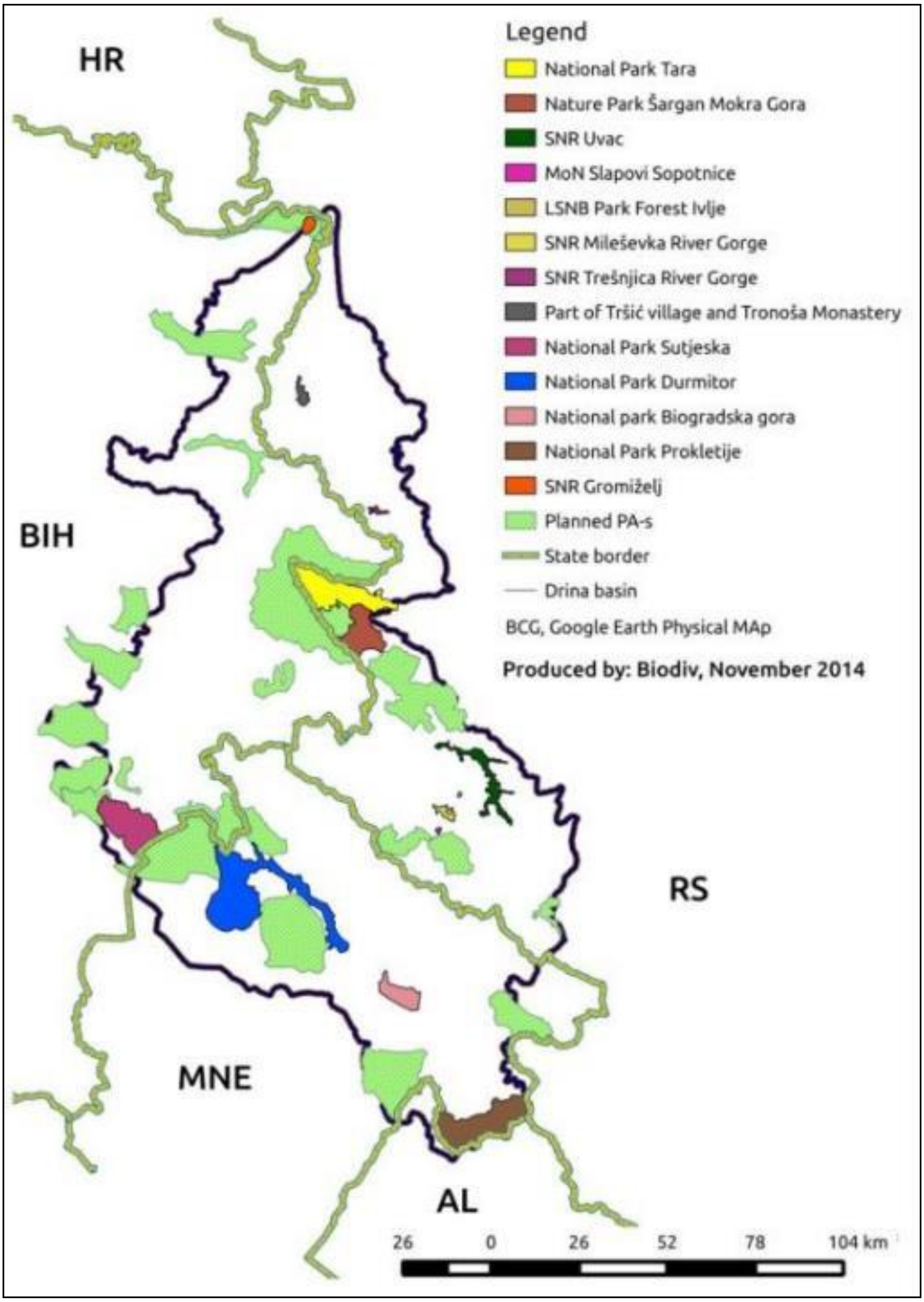
Taking into account the protection of the four fish species while managing water resources in the DRB is very important. It will also help preserve other species living in aquatic ecosystems. As these species are present in all 3 countries that share the DRB, their protection will require transboundary cooperation.

Protection of riparian ecosystems is also very important for biodiversity and for human settlements. Indeed, riparian vegetation mitigates the run-off (mitigation of the flood peak rise) and protects against soil erosion. It also acts as a filter for pollutants and of course provides habitats for many fauna species.

Unfortunately, there is very little data available about riparian ecosystems and no European classification of quality of the riparian ecosystems, therefore, at this stage it is not possible to locate the riparian ecosystems of high, good and moderate quality.

2.9 Protected Areas

This chapter considers protected areas according to biodiversity and landscape protections. Natural protected areas have been created on sites of particularly important ecological value and of scenic beauty. Protected areas located within the whole DRB are shown in Figure 2-31. The areas are quite dispersed between the different countries. According to the State of Envoronment report 2012, the total area of protected areas in BiH in 2011 represented 2% of the territory.

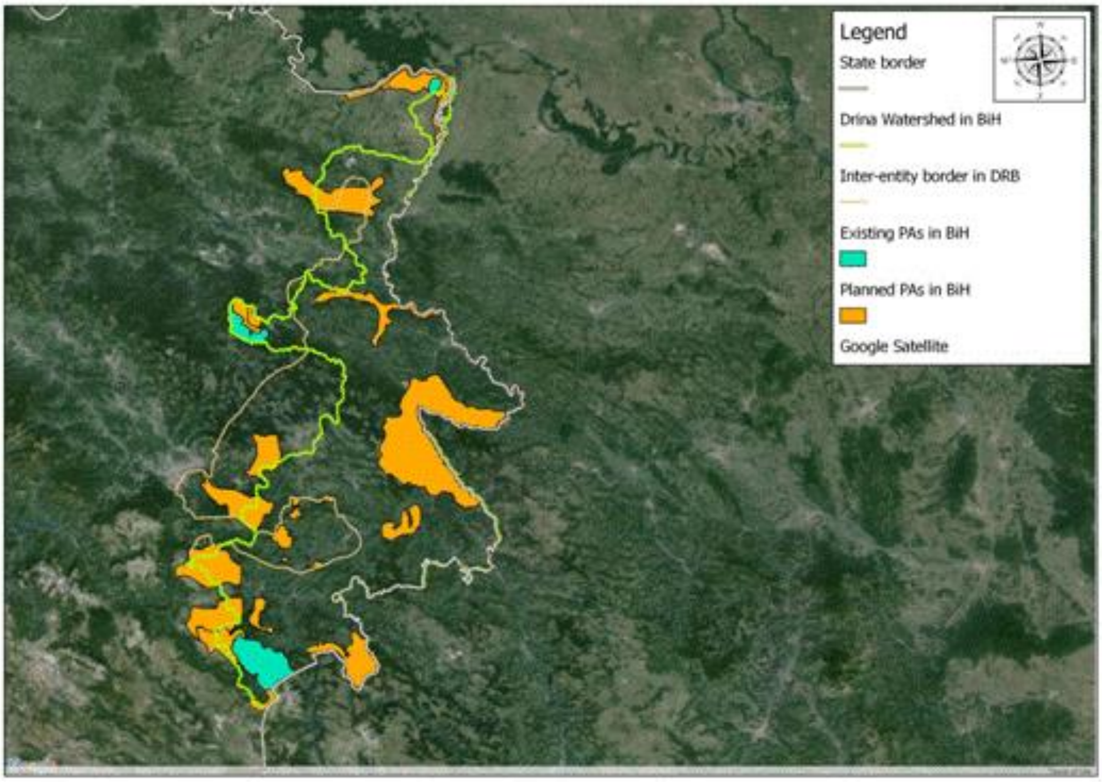


Source: Biodiv, 2014

Figure 2-31 Map of Both Existing and Planned PAs in DRB

2.9.1 Overview of protected areas

Focusing on the DRB in BiH, there are four protected areas in RS and 1 in FBiH. The first was designated in 1954, during the time of the Federal Republic of Yugoslavia. These are shown in Table 2-15. A map of the existing and planned protected areas in the BiH part of the DRB is given in Figure 2-32. These protected areas cover more than 2.6 % of the DRB in BiH.



Source: Biodiv, 2015 and EU IPA Report (Eptisa 2015)

Figure 2-32: Map of Both Existing and Planned PAs in the BiH part of the DRB

Table 2-15: Protected Areas of BiH in the DRB

Name and type of Protected Area	Size (km^2)	Date Formed
Federation of BiH		
Protected Landscape Konjuh (partially in the DRB)	80.16	2009
Republika Srpska		
Perućica (part of NP Sutjeska): SNR, IUCN:Ia	14.34	1954
Sutjeska: NP, IUCN: II	160.52	1962 2012: Planned extension
Gromiželj : SNR, IUCN :Ib	8.33	2011
Drina: NP, IUCN:II	63	In process of legal protection, not yet protected. Declaration of National Park “Drina” planned for the current year.
Drina: Cross border Biosphere reserve1	626	Not yet protected
Drinjača: NP, IUCN:V	-	Final border proposal not yet established, not yet protected
Many other NP, IUCN:V (Sava-Drina, Lelija, Majevica, Romanija, Viogor-Lim,...) Area of habitat management, IUCN V (Rača – Bijeljina) Protected Natural landscape, IUCN V (Javorina) MoN, IUCN III (Pećina Ledenjača)	-	Final border proposal not yet established, not yet protected

Note 1: Crossborder Biosphere reserve, together with NP Tara, Zaovine protected landscape, portion of the Zlatibor Nature Park and Nature park “Mokra gora” in Serbia.

Legend: MNM: Memorial Nature Monument; MoN: Monument of Nature; NP: Nature Park; RNP: Regional Nature Park; RP: Regional Park; SNR: Special Nature Reserve.

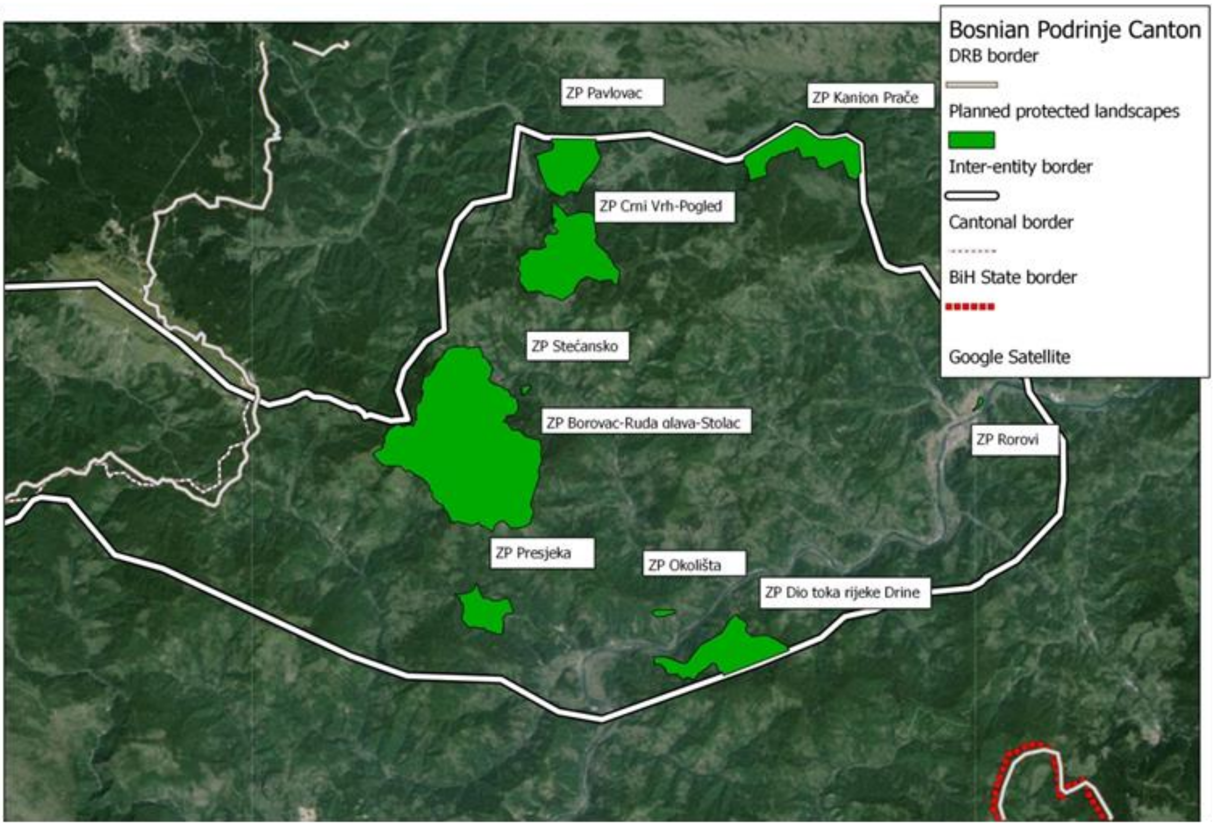
In the DRB, two areas of extraordinary environmental characteristics, Mokra Gora and Zovine, situated on Serbian territory, are on the preliminary list of the **Drina Cross-border Biosphere Reserve** (MAB-UNESCO) together with parts on the territory of the Republic of Srpska (BiH). This future Drina Cross-border Biosphere Reserve would comprise the existing Tara National Park (municipalities of Banja Bašta, Užice and Čajetina), two areas of extraordinary environmental characteristics listed above and the potential Drina National Park in BiH (municipalities of Rogatica, Višegrad and Srebrenica).

Initiatives for declaring the Drina Cross-border Biosphere Reserve were launched within UNESCO ROSTE’s MAB program in mid-2004, when the Tara National Park was re-nominated for a future Biosphere Reserve and trans-border park for peace between Serbia and BiH. Bilateral cooperation programmes of the Republic of Serbia and BiH have included plans for forming the Drina Cross-border Biosphere Reserve. What is more, a memorandum of Understanding related to this project was signed between the National Park Tara from Serbia and the Republic Institute for Protection of Cultural, Historical and Natural Heritage Banja Luka from BiH on 16 November 2011 (IUCN 2011). This partnership took place in the framework of the project "*Environment for people in the Dinaric Arc*" that has been implemented from 2009 to 2012 by the IUCN, WWF MedPO (World Wide Fund for Nature Mediterranean Program) and SNV (Netherlands Development Organization), and funded by the Ministry of Foreign Affairs of Finland. Declaration of the Drina National Park is planned for the year 2016.

The biodiversity in the existing protected areas of **SNR Gromiželj, NP Sutjeska and in the planned NP Drina** in RS which are part of the DRB are described in detail in Annex 2-4.

The spatial plan of the FBiH for the period 2008-2028 presents 15 new protected areas but none of them are in the DRB (Federal Ministry of Physical Planning of the Federation of BiH, 2013). However, the website of the Bosnian-Podrinje Canton Goražde (BPK) is suggesting the creation of protected areas. These documents are draft versions of the spatial plan of the BPK Goražde for the period 2008-2028. The first draft from 2010 suggested the creation of two nature parks (BPK Goražde, 2010) in the FBiH part of the DRB.

The second draft from 2013 (BPK Goražde, 2013) suggested the creation of eight small protected areas under the status “*Protected Landscape*”: “*Kanjon Prače, Pavlovac, Crni Vrh-Pogled, Borovac-Rada Glava-Stolac, Stećansko Polje (Goršić Polje), Presjeka, Okolišta, Dio toka rijeke Drine (Zubovići-Modrani*” (see Figure 2-33), all including in the FBiH part of the DRB.



Source: BPK Goražde, 2013, Map "Protected objects and natural heritage areas and areas for remediation" (draft)[10] and Biodiv 2015

Figure 2-33: Map of Proposed PAs in FBiH part of the DRB

It should be noted that the planned protected areas are not represented on the map in Figure 2-31.

2.9.2 Main pressure on protected areas

The general and special measures that regulate the protected areas are found in the Law on Nature Protection. Although the situation of protection has been improving these last years, the protection regime in these areas is still not strict enough and it is not always coherent with the requirements for nature protection.

Indeed, in spite of these improvements in protected areas' management, some shortcomings are noticeable, which have to be addressed in order to ensure a better sustainable development of protected areas. This concerns in particular the lack of financial and human resources and the lack of cooperation of local communities in the protected areas' management, with in addition a need of harmonization of national and municipal regulations.

The Environmental performance reviews for BiH (2004) and the State of environment report 2012 highlight the following main pressures which threat and harm the natural goods of the protected areas:

- Inadequate forest management

The forest management has been improved these last years but there is still a problem of non-sustainable harvesting and exploitation, clear-cutting along the roads and illegal logging.
⇒ This results in degradation of forest habitats, disconnection of habitats and therefore in disturbing the biodiversity of protected areas.

- Invasive species

Problems of invasive species mostly concern wet habitats. The presence of common ragweed (*Ambrosia artemisiifolia*), acacia overgrowth in riverbanks and invasive fishes are noted.

[10] Web site: http://mu.bpkg.gov.ba/prostorni-plan/727/nacrt-prostornog-plana-za-podrucje-bpk-gorazde-za-period-2008-2028-godine

- Hunting and fishery

Activities of hunting and fishing are harmonised with protection regimes through regulations (seasonal limitations, species protection). Though the hunting and fishing is more and more controlled, there are still problems with poaching and illegal fishing. They do not respect the legal period and non-authorized species.
⇒ That disturbs the natural reproduction and the preservation of the populations.

- Conversion of land use

It is related to demographic changes and to the intensification of the exploitation of the resources. Natural habitats are converted into agricultural land or urban land and consequently also in construction of road networks.
⇒ That leads to an increase of water pollution and to the decrease of habitats and discontinuity of ecosystems.

- Wastewater

Pollution of water is mostly due to the lack of facilities for wastewater treatment and to run-off from the surface layer of soil which is treated with chemicals and fertilizers from agricultural production. This affects fauna to the greatest extent and in particular fish populations.

- Tourism and recreation

There is a lack of record-keeping of the amount of tourist activity in protected areas. However, growth of tourism leads to the development of legal and illegal constructions, to the development of infrastructure, to an increase of waste left behind, and to increased water consumption.
⇒ This development of tourism threatens the ecosystem balance, damages vulnerable zones and needs sustainable management with a limitation of the number of tourists and of the access to natural areas to protect the vulnerable habitats and species.

- Overexploitation of medical herbs and fungi

There is a general disregard of the law and incompetence of those who collect plants for economic gain, without being concerned by the conservation of habitat structure, flora population, etc.
⇒ Plants are damaged; the most endangered species are marshmallow, chamomile, salvia, great yellow gentian, red geranium and blackberry.

2.9.3 Ecological network

Within the whole territory, those areas include: 29 "Emerald" areas (see below for DRB) and 3 Ramsar sites (according to the Ramsar Convention[11]).

Emerald Network in the DRB

The Emerald Network is the first ecological network that has been implemented in Europe. This initiative was adopted in 1979 by the Council of Europe in order to conserve wild flora and fauna and their natural habitats in the countries that are party to the Bern Convention, including Serbia, Montenegro and BiH.
The objective of the Emerald Network is to ensure the long-term survival of the species and habitats of the Bern Convention requiring specific protection measures. These habitats and species are listed respectively in Resolution 4 (1996) and Resolution 6 (1998) of the Standing Committee to the Bern Convention.

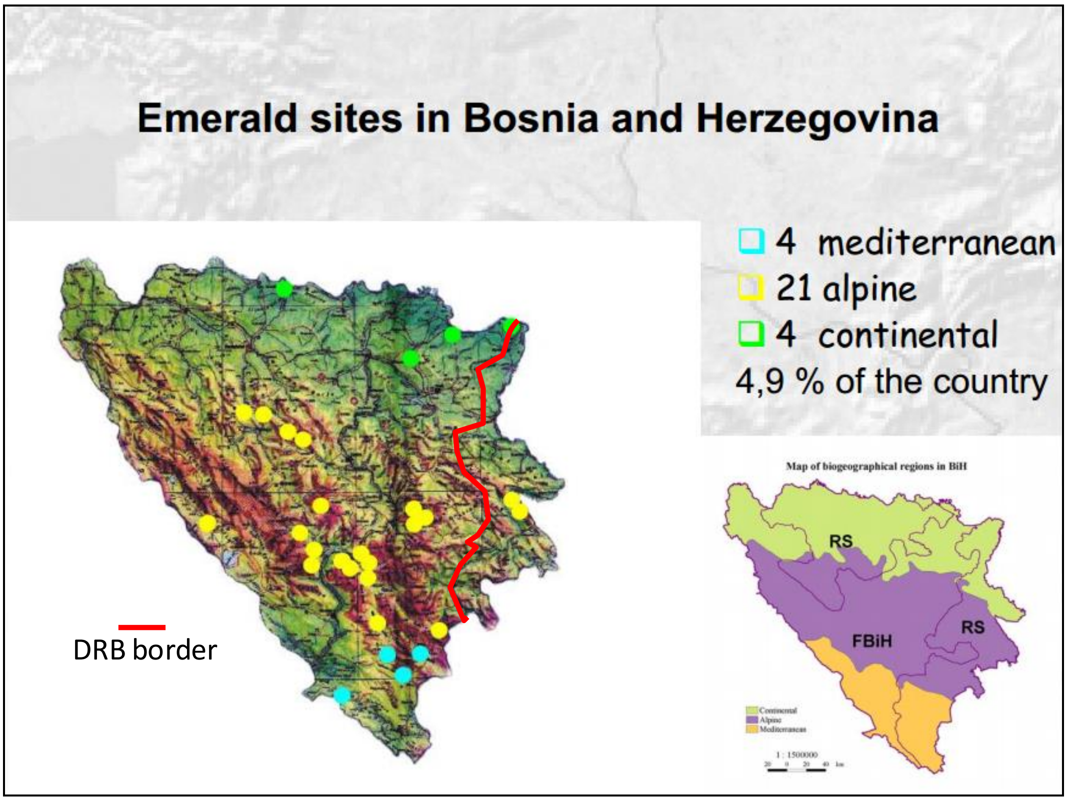
A pilot Project was launched in 2005 to start the implementation of the Emerald Network in BiH. After identification of Emerald species listed in Resolution No. 6 (1998) and Emerald habitat listed in Resolution No. 4 (1996) present in BiH, potential Areas of Special Conservation Interest (ASCI) were selected based on the criteria listed in the Recommendation No. 16 (1989).

[11] Ramsar Convention is a "Convention on the Conservation of Wetlands of International Importance, especially as Waterfowl Habitat", designated as internationally important wetlands.

According to the last update of the Council of Europe, in December 2014, the Emerald sites in BiH had been officially nominated (candidate site) but have not been adopted yet. Therefore, they still are not considered as Emerald sites.

The implementation of the Emerald Network in the DRB might push governments to protect more effectively the species requiring specific protection measures according to the Bern Convention. In addition, the Emerald Network is set to the ecological principles of Natura 2000 sites.

In the context of the protected areas system reform and increase of area under protection, BiH is implementing the project that identified 29 sites to be part of the Emerald Network of BiH, shown in Figure 2-34, with four sites that are in the DRB (see Table 2-16).



Source: CEPRES, 2011

Figure 2-34: Map of the Emerald network in BiH

Table 2-16: Emerald sites in DRB in BiH

Emerald site Ref No	Type of site
BA0000018	Rača – Bijeljina Continental
BA0000027	Veliki Stolac Alpine
BA0000028	Kanjon Drine Alpine
BA0000009	Maglić – Volujak – Zelengora Alpine

In addition to the Emerald network, since BiH is aiming to become part of the European Union, the country would have to implement the Natura 2000 network according to the Habitat Directive (92/43/EEC) and to the Bird Directive (79/409/EEC).

Natura 2000 Network in the DRB

In 2007, WWF MedPO started the ambitious project for the support to the implementation of the European Ecological Network Natura 2000 in BiH. With the support of the Ministry of Foreign Affairs of Norway, the objective of the WWF MedPO project "Europe's Living Heart" is to improve the system of nature protection in Bosnia and Herzegovina using EU nature protection standards, namely Natura 2000 network.

Data on all species and habitats existing in BiH from Annex I and II of the EU Habitat Directive are published in 2011 (Natura 2000 in BiH, 2011), on the basis of the literature data, and partially verified within the field research.

The evaluation of the biodiversity of the habitats researched (Habitats of Annex I) and species (Species of Annex II) in BiH was based on a large body of literature and field data on spatial distribution of the flora and fauna species.

Besides the analysis of the available literature data, the large number of the information has also been achieved by the original field research which the members of the expert team carried out in the period 2007 – 2011.

The mapping of all types of habitats and species from the Reference list of BiH have been carried out on the basis of the mentioned desktop studies collected data. These data were the basis for the preparation of the digital database - Biodiversity Information System (BIS), which is based on ArcGIS platform.

Even though distribution maps for all the species of interest have been produced, the borders of future Natura 2000 sites haven't been proposed.

3 Socio Economic Characteristics of the Drina Basin

3.1 Natural resources

3.1.1 Wood and timber

Forests and forestland in BiH encompass an area of 3.231 million ha, which is around 63% of the total land area, one of the highest values in Europe. In terms of forest ownership, around 80% are public forests, and 20% are under private ownership. Based on recent data from FAO Sector Review in 2015 and the National Forest Inventory in 2012 this is sub-divided as shown in Table 3-1.

Table 3-1: Subdivision of Forest and Forest Land in BiH

Vegetation form	Available surface				Protective forest	Total
	Economic forests	Non-economic forests	Protected forests	Special purpose forests		
	ha	ha	ha	ha	ha	Ha
1. High forest	1 329 500	46 300	5 200	8 800	262 600	1 652 400
2. Coppice forest	843 200	158 700	1 600	2 400	246 300	1 252 200
3. Shrubbery	52 700	41 100	0	100	36 700	130 600
4. Barren land	55 700	88 400	800	3 400	38 900	187 200
5. Other forest areas	3 300	3 100		100	2 600	9 100
Total of all forest and forest land	**2 284 400**	**337 600**	**7 600**	**14 800**	**587 100**	**3 231 500**

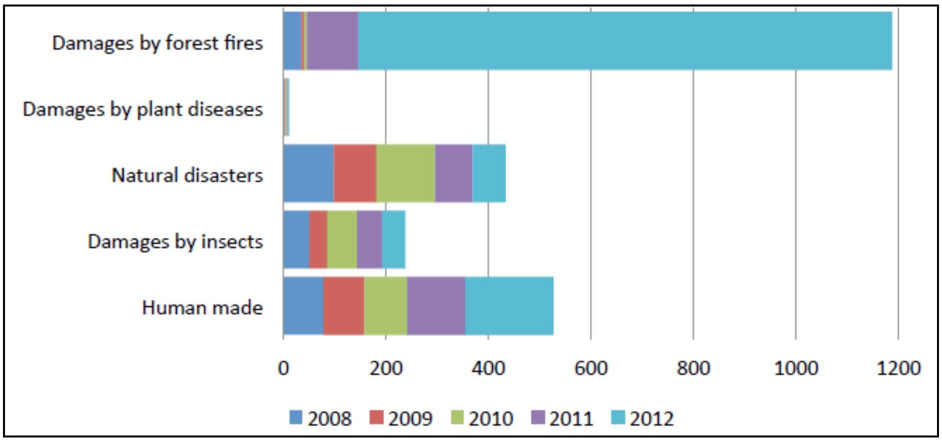
Source: National Forest Inventory 2012

The number of forest fires increased considerably in 2012 (coinciding with a drought year) as can be seen in Table 3-2 below and in Figure 3-1.

Table 3-2: Forest damages in BiH 2008–2012 (in thousands of m³ of wood)

Type of Damage	2008			2009			2010			2011			2012			Total for period 2008-2012		
	RS	FBiH	BiH	RS	FBiH	BiH	RS	FBiH	BiH	RS	FBiH	BiH	RS	FBiH	BiH	RS	FBiH	BiH
Human made	17	61	78	18	62	80	17	67	84	25	88	113	89	83	172	166	361	527
Damages by insects	29	21	50	29	7	36	57	1	58	48	0	48	45	1	46	208	30	238
Natural disasters	88	10	98	76	8	84	106	8	114	71	2	73	59	5	64	400	33	433
Damages by plant disease	3	0	3	2	0	2	2	0	2	1	0	1	3	0	3	11	0	11
Damages by forest fires	22	13	35	5	1	6	3	2	5	73	27	100	69	973	1042	172	1016	1188

Source: Institute for Statistics of RS, 2013; Institute for Statistics of FBiH, 2013)

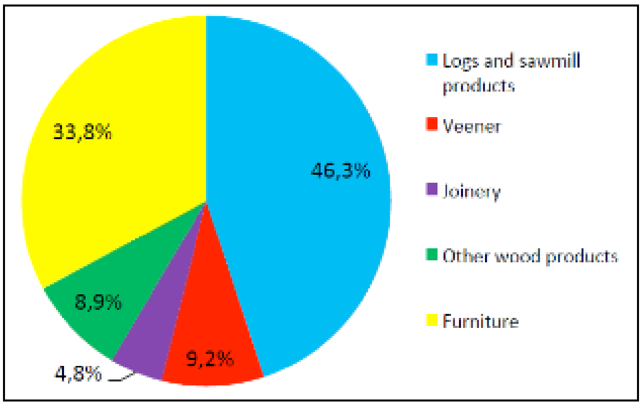


Source data: Institute for Statistics of RS, 2013; Institute for Statistics of FBiH, 2013

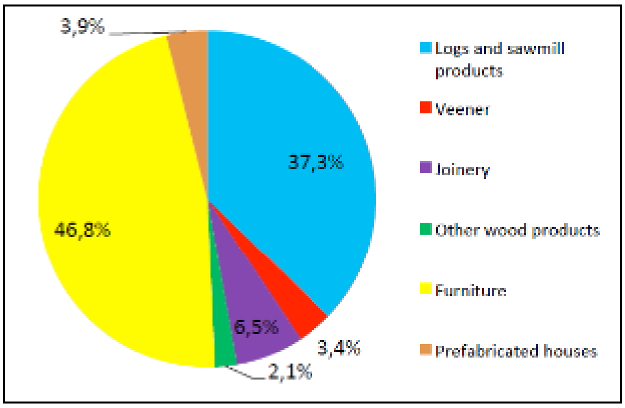
Figure 3-1: Forest damages in BiH 2008–2012 (in thousands of m³ of wood).

Around 1 million m³ of forest were damaged in 2012 representing more than 90% of all damage combined in the period 2008-2012. The FBiH was particularly badly affected by forest fires in 2012 with 93% of all forest fire damage occurring in this entity. Human made damage represents the second most damaging factor.

Revenues and exports from the wood processing industry are indicated in Figure 3-2 below. Logs and sawmill products have the largest share of revenue, followed by furniture. However, furniture has the largest share of exports followed by the logs and sawmills products. The total value of the forestry sector in BiH is around Euro 113 million/year representing about 0.86% GVA. The share of GDP has dropped about 20% since the global economic crisis of 2008.



Revenues



Exports

Source: Chamber of Commerce of BiH
Figure 3-2: Structure of Revenues and Exports of Wood Processing Industry in 2011

3.1.2 Land based agriculture

There is no data on agriculture in the area of DRB, or from the municipalities that are in or partially within the DRB.

In BiH in 2013 the structure of the total sown areas for cereals account for 58%, industrial crops 2%, vegetables 15% and feed crops 25%. Comparing to the same period in 2012, the total production of wheat increased by 17.8%, rye by 12.2%, maize (grain) by 48.0%, buckwheat by 46.0%, soya-beans by 18.7%, tobacco by 21.3%, potatoes by 23.7% and cucumbers by 20.2%.

According to fruit and grapes production data in 2013 the total yield increased as follows: apples by 70.2%, pears by 81.5%, plums by 104.4%, cherries by 37.4%, sour cherries by 44.0%, peaches by 8.1%, apricots by 1.7%, quinces by 57.5%, walnuts by 61.8%, almonds by 15.9%, raspberries by 29.4% and grapes by 22.6%.

Prices of agricultural products in FBiH were 25.4% higher in 2013 than in the year 2009 with the increase in prices of agricultural products caused by increases in the price of crops. Data on the production of maize, wheat and potatoes and data on number of livestock are presented in Figure 3-3 and Figure 3-4. There is a fall in the production of maize in 2011 which corresponds to a drought year,

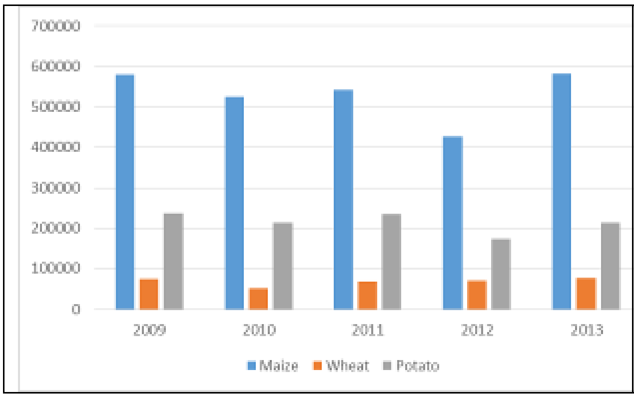


Figure 3-3: FBiH Production Maize, wheat and potato 2009-2013

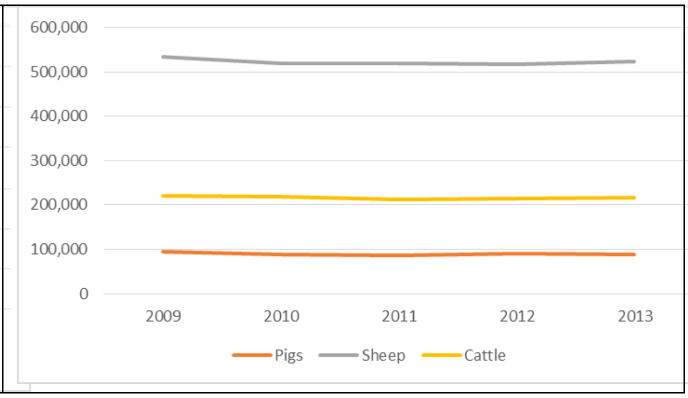


Figure 3-4: FBiH Number head livestock 2009-2013

The share of agriculture in the structure of GDP of RS has been decreasing constantly in the past years, but it remains high when compared with developed and highly developed countries. In 2012, the share of agricultural GVA in the GDP formation was 8.4%, which was 0.5% lower than the share realised in the previous year and 1.7% lower than that from 2008. Observed separately by individual crop, the structure of sown arable land was dominated by areas under maize, which covered 143,024 ha, or 45.1% of the total sown arable land in 2012. Area under maize increased slightly compared to the previous year (by 0.3%) and to the ten-year average (by 0.8%).

Prices of agricultural products in RS were 33.9% higher in 2012 than in the base year 2005, and 7.3% higher than in 2011. This increase in prices of agricultural products was mainly caused by the increase in prices of crops by 55.7% compared to 2005 and by 5.3% compared to the previous year. Prices for livestock and livestock products were 16.8% higher than in 2005 and 9.6% higher than in 2011. Cereals, as a group of products, realised the highest increase in prices. This increase was 89.9% compared to 2005 and 10.7% compared to the previous year.

Data on the production of maize, wheat and potatoes and data on number of livestock are presented in Figure 3-5 and Figure 3-6. There is a considerable fall in the production of maize in 2003, 2007 and 2012 and it is unlikely to be a coincidence that these years coincide with drought periods in BiH.

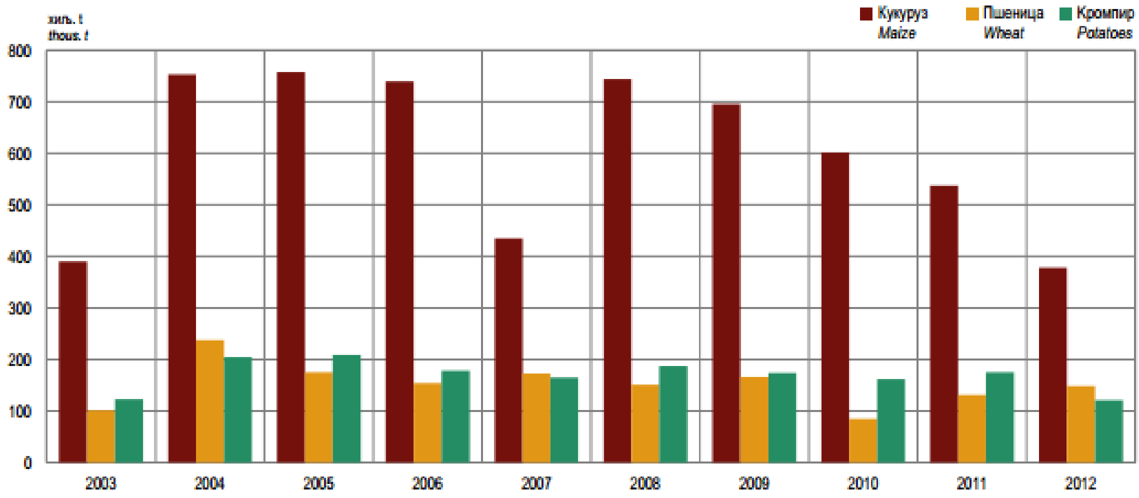


Figure 3-5: Republic of Srpska - Production of maize, wheat and potatoes, 2003-2012.

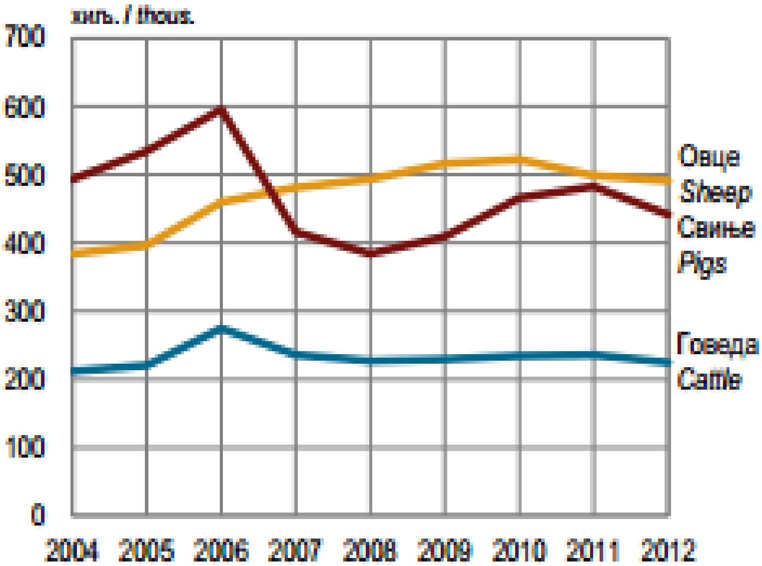


Figure 3-6: Republic of Srpska - Number of livestock, 2004-2012

3.1.3 Industry

In the area of DRB, or municipalities that are in the scope of DRB, there is no data, there is only the data for whole BiH, FBiH and RS.

Comparing calendar adjusted data from September 2013 with September 2014, industrial production in BiH increased by 1.7%. Broken down by divisions of activities (rates are calculated from calendar-adjusted indices) the highest growth is recorded in the following divisions: division 32 - Other manufacturing (50.0%) and division 18 -Printing and reproduction of recorded media (40.7%). The largest decline in industrial production in September 2014 compared to September 2013 was recorded in the following divisions: division 26 -Manufacture of computer, electronic and optical products (-68.5%) and division 11 - Manufacture of beverages (-16.4%).

Industrial production in FBiH decreased by 4.0% in 2012 compared to 2011, but picked up again in 2013 increasing by 5% (see Table 3-3). Manufacturing has been the strongest sector in FBiH and mining and quarrying has been the weakest.

Table 3-3: FBiH - Indices of industrial production by section 2009-2013.

Previous year =100

Section	2009	2010	2011	2012	2013
INDUSTRY TOTAL	88.2	103.8	100.9	96.3	105.3
Mining and Quarrying	96.4	95.7	112.3	95.9	90.9
Manufacturing	83.6	106.2	100.0	97.7	105.9
Electricity, gas, steam and air conditioning (except 35.3)	95.7	102.4	95.1	92.5	114.9

Industrial production in RS decreased by 4.0% in 2012 compared to 2011. After quite a long period of the growth of industrial production, between 2008 and 2011, a decrease by 4.0% was recorded in 2012, compared to 2011 (see Table 3-4). Industry had a significant share in the GDP (14.1%) while the biggest share within industry was that of manufacturing (7.8%). The total seasonally adjusted industrial production in RS in September 2014, compared to September 2013, total working day adjusted industrial production in RS increased by 9.1%.

Table 3-4: Republic of Srpska - Indices of industrial production by section 2008-2012.

Previous year =100

Section	2008	2009	2010	2011	2012
INDUSTRY TOTAL	117.7	110.7	105.4	104.8	96.0
Mining and Quarrying	114.1	92.9	109.1	118.2	96.1
Manufacturing	120.8	121.4	105.5	104.3	95.6
Electricity, gas, steam and air conditioning (except 35.3)	110.5	103.6	103.0	100.0	96.3

In September 2014, compared to August 2014, seasonally adjusted production of Energy was 26.8% higher, of Intermediate goods 7.2% higher, of Non-durable consumer goods 6.0% higher and of Durable consumer goods 2.3% higher, while production of Capital goods was 7.4% lower.

In September 2014, compared to September 2013, working-day adjusted production of durable consumer goods was 26.2% higher, of energy 21.5% higher, of capital goods 12.3% higher, of non-durable consumer goods 4.4% higher and of intermediate goods 0.8% higher. By section of the KD 2010, working-day adjusted industrial production in September 2014, compared to September 2013, increased in electricity, gas, water, steam and air-conditioning supply by 31.0%, in manufacturing by 5.4%, while in the section for mining and quarrying it decreased by 0.2%.

3.1.4 Fishing and Fish Farming

According to the review of the fisheries and aquaculture sector in BiH (FAO 2015) there are 213 species of fish fauna in BiH. Around 52% of these species are freshwater, 36 % are marine and 12% are diadromous (i.e. they move between freshwater and marine environments for breeding, spawning etc.) (Hamzic, A. 2003).

Fishing

In all of BiH, there are 154 angling associations (95 in FBiH, 58 in RS and 1 in Brcko District) with about 17,000 licensed members (FAO 2014) and there are 123 operational aquaculture enterprises of which 27 trade only in fish.

In the DRB, there are 24 angling associations (4 in FBiH and 20 in RS) and 2,443 licenced members (435 in FBiH and 2,008 in RS). This represents about 16% of all members. It is estimated that the yearly quantity of fish caught by registered anglers is about 10 kg per person. Using 10 kg as the statistical mean, this implies that 24.5 MT of fish are caught in the DRB each year (the yearly total of legally captured fish for all of BiH amount to between 160 to 170 MT, while the quantity of unreported, illegally captured fish in the inland waters might be almost 150 MT a year).

Species, fishing seasons, minimal size and quantity allowed to be caught by sport fishers is regulated in BiH legislation. However, there are deficiencies in the working conditions, equipment, financing and the number of fish inspectors. Consequently, this prevents proper supervision of the fishing activities and intervention when illegal practises are performed.

Fish Farming

Fish farming in BiH is recognized as an opportunity for industrial production, tourism and placing high quality healthy food on the market (domestic and European markets) as well as for rural development and the creation of new jobs.

Hydrographical conditions for freshwater fish farming in BiH are very favourable and two types of aquaculture can be observed: aquaculture of the mountain regions, where the trout production is prevailing, such as in case of the Drina and its tributaries, and plain aquaculture along the Sava River where the principal production species is carp (Savić, N. 2008).

The main species used for aquaculture in BiH are Salmonids, mainly rainbow trout produced in tanks and cages that benefit from the plentiful water resources in mountain areas. The annual production of land based trout farms depends on the available quantity of water. As a rule of thumb, fish farmers calculate fish production of 100 kg per year on a 1 litre per second water supply, hence supplying 1 MT of trout on around 12-14 litres per second water is necessary. The majority of Salmonids' farms have hatcheries, but only a few farms are specialized solely in the production and sale of stocking material (fish fry).

The freshwater fish species that are farmed in BiH are:

- Cold water species: the Brown trout (*Salmo labrax*), the Rainbow trout (*Oncorhynchus mykiss)* and the Brook Trout (*Salvelinus fontinalis*)
- Warm water species: the Common Carp (*Cyprinus carpio*), the Silver Carp (*Hypophthalmicthys molitrix*), the Bighead Carp (*Hypophthalmichthys nobilis)* and the Grass Carp (*Ctenopharyngodon idella*) (Local Development Initiative Banja Luka, Savić, N. 2007).

As mentioned above, the main types of aquaculture production facilities are ponds, tanks and cages.

In the whole territory, there are 41 registered freshwater and saltwater fish farms and it is estimated that there are about 20 unregulated fish farms (Nurković, R., 2014) and additionally about 28 carp and predatory fish farms on the plains. In 2008, 75% of the potential for aquaculture had been developed. For 2013, the Institute for statistics of the FBiH and of RS provided a total fish production in BiH of 2,853.3 MT/year (FAO Regional Office for Europe and Central Asia 2015).

Although incomplete and dating from 2003 (Hamzić, A. 2003), in terms of fish production, DRB is the least developed basin in BiH, with a small number of active fish farms (see Figure 3-7). The list of fish farms in BiH in 2010 shows that there was only one fish farm in the DRB, the Ribogojilište Milići, which was only producing 20 MT[12] in 2010, less than 1% of the total production of the leading fish farms in BiH, which was 2,087 MT in 2010 (Nurković, 2014). However, more recent FAO study (FAO Regional Office for Europe and central Asia 2015) shows an increase in fish farming activity with six fish farms now present within the DRB, as summarised in Table 3-5.

Table 3-5: Survey of fish farms in the BiH part of the DRB in 2014

Type of Fish Farm	Number of farms	Total ponds (ha)	Total volume of water tanks and cages (m^3)	Fish production (MT)
RS				
Pond	1	2	0	5
Tank	2	0	7,272	86
Cage	2	0	46,360	780
FBiH				
Pond	0			
Tank	1	0	470	1
Cage	0			
TOTAL	**6**	**2**	**54,102**	**872**

Source: Farm surveys of Review team, (FAO Regional Office for Europe and central Asia 2015)

The FAO Regional Office for Europe and Central Asia 2015 study also shows that in the whole BiH, 74% of all the fish farms consume surface water, the rest using underground water. That represents an annual volume of about 632,200,000 m^3 of surface water, 134,400,000 m^3 of underground water and a mix of 30,700,000 m^3 of river and undefined surface or spring water in 2014.

[12] MT : Metric tons

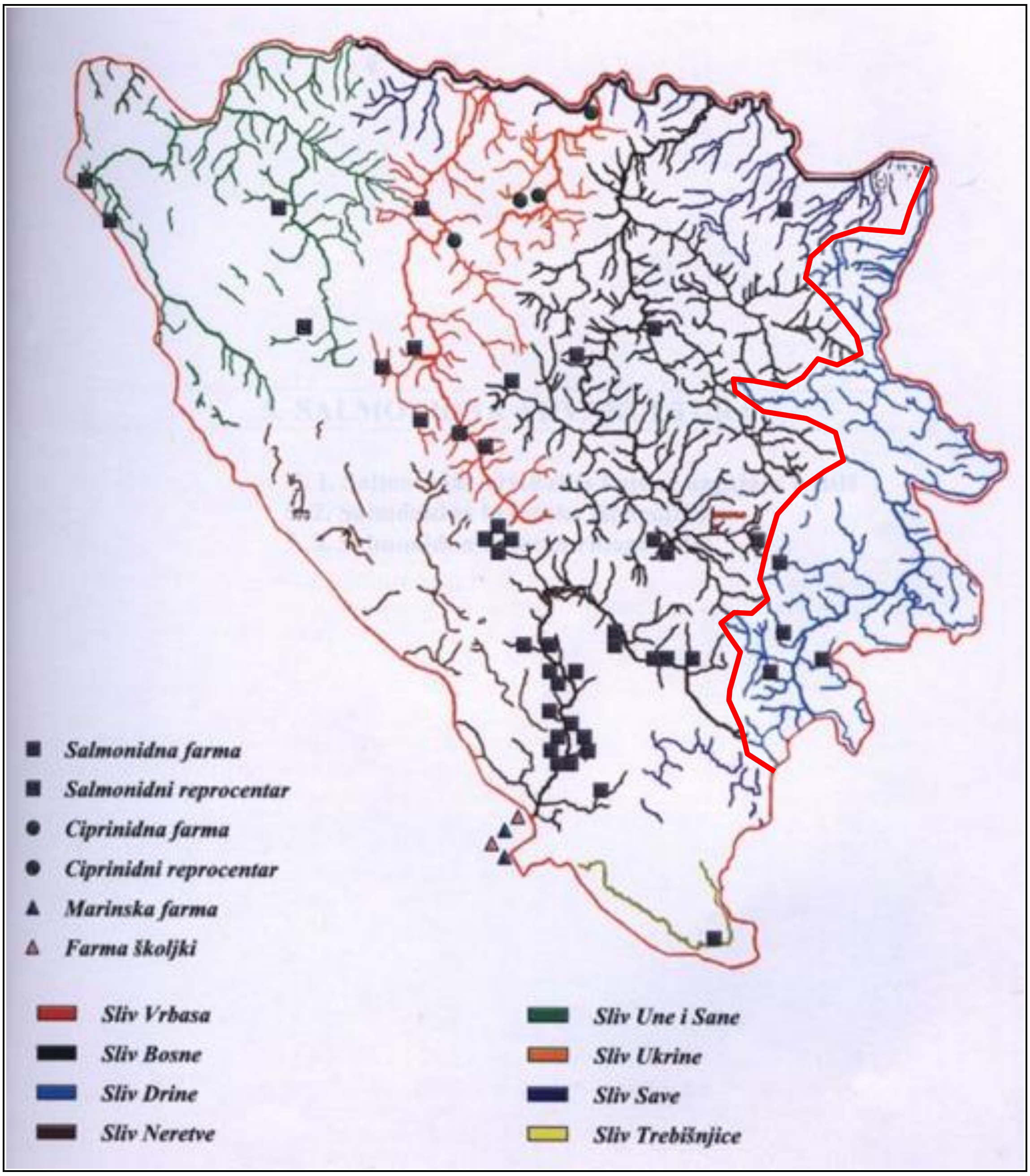
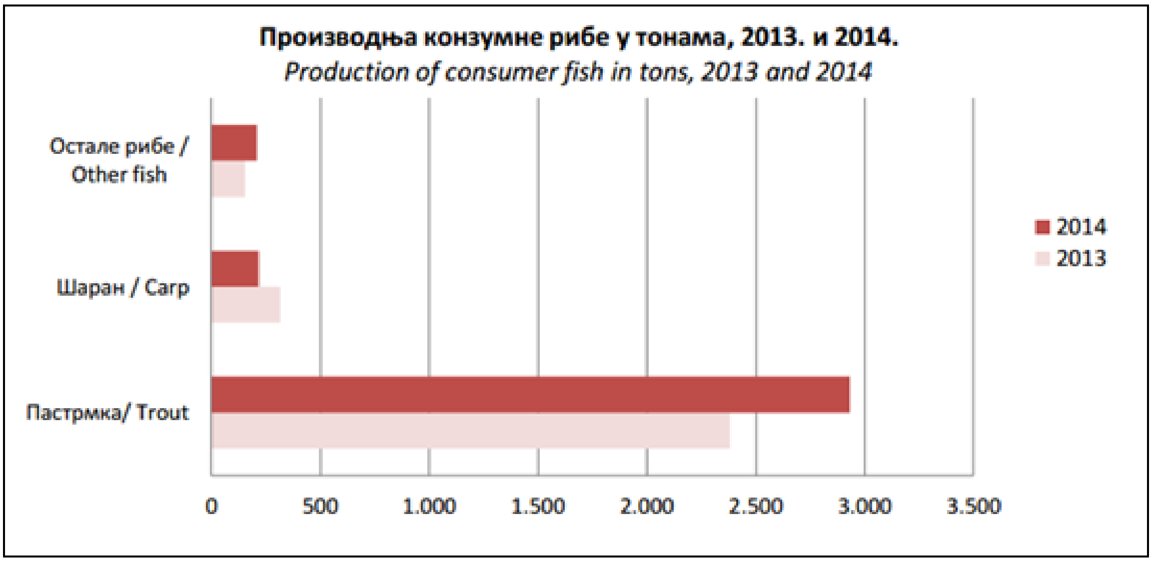


Figure 3-7: Fish farms by type and basin in BiH (Hamzić, 2003) – In red the border of the DRB

As already mentioned, the fish farming in BiH is an increasing activity. The data shown in Figure 3-8 seem to support this assertion. The surface of fish ponds (for salmonid species) and production in tonnes has been increasing. As an example, the surface area of salmonid fishponds rose from 85,367 m^2 in 2013 to 141,250 in 2014 (+39.6 %). At the same time, production of salmonid fish rose from 2,382 to 2,930 MT (+18.7 %) (Agency for Statistics of BiH, 2015). Nevertheless, the data for the two years (2013-2014) must be taken with caution, because the series is very short and the year 2013 was an exception due to the long summer period of drought. Consequently, a decline of the fish farm production was observed in that year due to this environmental stress.



Source: Annual Report on Aquaculture in BiH, Agency for Statistics of BiH, 2015

Figure 3-8: Production of consumer fish in BiH in 2013 and 2014

In RS, fish farming is considered as a profitable means of exploitation of water resources, wherever it is spatially and legally possible. Therefore, although both salmonid and cyprinid fish farms are developed throughout the country, new ones are still being planned (Spatial plan of RS until 2025).

Fish farms are poorly equipped for environmental surveying. In order to mitigate the impacts of aquaculture on the environment, one principle is that the water quality of the inflow and outflow of the fish farm has to be of the same category. That implies that the water quality of the fish farms should be regularly controlled. Since there is a large proportion of illegal fish farming without any water quality control, this activity is a certain source of pollution of the underground and surface water.

The following tables from (FAO Regional Office for Europe and Central Asia 2015) show the environmental loading caused by a tank and a cage fish farm.

Table 3-6: Calculated average environmental loading in 1 m^3 of discharged water of a tank fish farm

Parameters	Unit	Values
Water used	m^3/year	606,838,120
Faeces = Total Suspended solids	g/m^3	1.81
BOD_5	g O_2/m^3	1.09
COD	gO_2 /m^3	2.71
TAN	g/m^3	0.18
P issued	g/m^3	0.03

Source: Ebeling J.M 2006, Eding et al, 2006, Piedrahita, R.H. 2003, Piper et al, 1982, Skjoolstrup et al 1998 and Susuki et al 2003.
BOD: Biochemical oxygen demand (BOD5: Bochemical oxygen demand during 5 days sampling)
COD: Chemical oxygen demand
TAN: Total N loading

Table 3-7: Calculated average environmental loading after production of 1 MT of fish in a cage farm

Water quality parameter	Unit	Values	Visualisation of the value
Suspended solids	Kg	319	By C content equivalent to 1.3 m^3 we pig manure
BOD_5	Kg O_2	191	
COD	Kg O_2	478	
TAN	Kg	32	Equivalent to N content of 100 kg ammonium nitrate
P issued	Kg	5.3	Equivalent to P content of 66 kg superphosphate

Source: Ebeling J.M 2006, Eding et al, 2006, Piedrahita, R.H. 2003, Piper et al, 1982, Skjoolstrup et al 1998 and Susuki et al 2003.

Due to the potential environmental impact, salmonid fish ponds in RS can be developed only on rivers without any threat to the source River, and cage fish farming is forbidden in reservoirs used as drinking water supply. In all other types of reservoirs, fish farming will be allowed if the local municipality's urbanism plans are up-to-date and the ministry in charge gives its permission (Spatial plan of Republic of Srpska until 2025). One of the goals of this spatial plan of RS until 2025 is to adopt an ordinance on the implementation of new salmonid and cyprinid fish farms.

That concerns the DRB, where new fish farms are planned to be built. Among them, there is the new fish farm at the source of Žepa River which is planned to be built in the close proximity of Zepa source, which is in conflict with the regulation proposed in the spatial plan until 2025.

Recommendations
The fish farms can have very important negative impacts on the aquatic ecosystem due to the introduction of invasive species (as an example the Rainbow trout that is in conflict with the Brown trout). In addition, the application of fertilisers and food leads to downstream pollution with high amounts of nutrients as shown in tables above. To mitigate these impacts, enforcement of aquaculture directives and control is necessary. The enforced measures should comprise modernization of fish farms with mechanical filters, keeping away pond locations from natural spawning areas and building nutriment precipitators.

There is also a need to harmonize the strategic development and management of fisheries and aquaculture within the entity of BiH and between the three countries of the DRB.

Finally, concerning sport fishing, there is a lack of national strategy and a need of reinforcement of legislation, with more authority and more capability to be given to fish guards

3.1.5 Hunting

The number of hunters in FBiH has increased by about 6% between 2009 and 2013 and is now close to 29,000 (see Table 3-8). Common pheasant, Fox, hare, wild boar, waterfowl and roe deer are the most commonly hunted species. Hunting takes place in 315 hunting lodges in FBiH. There are 73 hunting associations in 2011 up from 55 in 2008. There are 23,691 members of which 23,639 are male and 52 female.

Table 3-8: FBiH – Hunting lodges and hunters, 2009-2013

Year	No of Hunters	No Hunting Lodges	Hunting lodges area
2009	27190	266	24,967
2010	27,976	290	26,481
2011	28,387	300	26,400
2012	28,253	302	25,706
2013	28,847	315	29,742

The hunting industry in the RS occurs within 87 hunting areas, covering an area of 2.433 million ha (2,433km^2), of which 2.207 million ha is hunting area, the non-hunting area 227,000 ha and under forests is 1,098,000 ha. The hunting industry permanently employs 321 workers, broken down as follows: forestry engineers and technicians 52, gamekeeper and forester 179, workers to breeding game 24 and administrative and other workers 67. Further data on hunting grounds and hunters are presented in Table 3-9.

Table 3-9: Republic of Srpska - Hunting grounds and hunters, 2009-2013

Year	Hunting grounds						Hunters
	Number	Area (thousand ha)					
		Total	Hunting	Non-hunting	Under forests		
2009	88	2,454	2,211	244	1,107		21,621
2010	91	2,462	2,228	233	1,099		21,576
2011	90	2,465	2,236	229	1,112		21,439

Year	Number	Hunting grounds				Hunters
		Area (thousand ha)				
		Total	Hunting	Non-hunting	Under forests	
2012	90	2,468	2,230	238	1,099	21,674
2013	91	2,468	2,229	239	1,099	21,670

3.1.6 Mining and Quarrying

In FBiH, there were 215 mining and quarrying enterprises in 2013, 194 under private ownership, 15 under state ownership and 6 mixed. The industry in FBiH employs around 14,012 people in 2013, by far the majority were men, with 1,008 women. Those in work in this sector have dropped by 1,000 in 3 years, indicating the continued economic slowdown that is occurring in the Balkan countries. The mining and quarrying sector account for 2.2% GDP in 2013, a fall from 2.4% of GDP the previous year. In real terms this represents a contraction of 5.6%. Around 3.86 million tonnes of coal were mined in 2013, a fall of 200,000 tons from the previous year. Some 2.4 million tonnes of lignite were also mined in 2013, a fall of 550,000 tonnes from the previous year.

In RS, mining and quarrying production was 22% lower in 2012 compared with 2011. Over 95% of the total available amount of coal was consumed for production of energy in RS. Brown coal and lignite represent significant natural resources in RS. Out of the total available amount of coal, 95% was consumed for production of energy, while the rest was used in mass consumption. Given the fact that RS does not have its own production of natural gas, all the necessary amounts are imported. The largest final consumer of natural gas was industry, which accounted for 86.9% of the consumption, while the remaining 13.1% of natural gas was consumed by households and other consumers.

3.1.7 Energy

FBiH is an exporter of electricity and produces a gross 10,000 GWh peach year with aroud 60% from thermal power plants and the remainder from hydroelectric plants. 2011 and 2012 were particularly bad years for the hydropower industry due to a prolonged drought, but in 2013 production returned to pre-2011 levels. Distirbution losses have halved in 2013 from 2009. Table 3-10 below provides details of the electricity balance in FBiH.

Table 3-10: FBiH – Balance of Electricity (GWh)

Type of Energy	2009	2010	2011	2012	2013
Gross production	9,771	10,694	9,708	8,686	10,758
Hydroelectric power plants	3,590	4,696	2,531	2,329	4,222
Thermal power plants	5,870	5,605	6,851	6,014	6,189
Autoproducers	311	393	325	343	347
Own consumption	710	719	779	716	721
Net production	9,061	9,975	8,929	7,970	10,037
Hydroelectric power plants	3,559	4,657	2,509	2,311	4,196
Thermal power plants	5,234	5,013	6,138	5,368	5,550
Autoproducers	268	305	282	291	291
Losses in the distribution	1,223	640	827	607	597
Energy sector	219	228	251	227	226
Final consumption	6,313	7,190	7,421	7,684	7,610

RS is also an important exporter of electricity but in recent years, unfavourable hydrologic conditions have caused a decrease in production of electricity in hydroelectric power plants. Realised net production of electricity in 2012 amounted to 5,130 GWh, out of which 1,878 GWh or 36.6% was produced in hydroelectric power plants, and 3,252 GWh or 63.4% in thermal power stations. In the period between 2006 and 2012, a slight increasing trend was recorded in final consumption of electricity.

Gross electricity production in 2013 was 6,693 GWh, out of which 3,657 GWh or 54.7% was produced in thermal power plants, 3,014 GWh or 45,0% in hydro power plants, and 22 GWh or 0.3% was produced in autoproducer plants. The biggest final consumers of electricity were households, with a share of 55.1% in the final consumption. Other consumers had a share of 23.5%, industry had a share of 18.8%, while total consumption in the sections construction, transport and agriculture was 2.6%.

Table 3-11: Republic of Srpska - Production and final consumption of fuels and energy

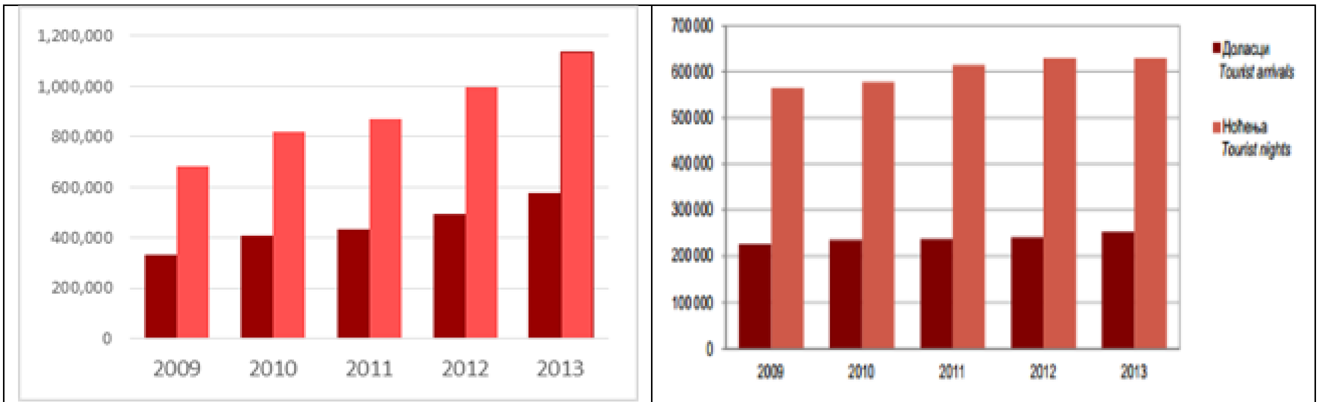
Production of fuels and energy	2009	2010	2011	2012
Brown coal (1,000 t)	1,930	1,550	2,147	2,201
Lignite (1,000 t)	2,834	3,042	3,379	3,024
Electricity[1)] (GWh)	5,640	6,183	5,298	5,130
Hydroelectric power plants[1)] (GWh)	2,638	3,318	1,848	1,878
Thermal power stations[1)] (GWh)	2,993	2,856	3,450	3,252
Other production[1)] (GWh)	9	9	-	-
Heat (TJ)	1,547	1,680	1,737	1,806
Final consumption of fuels and energy	**2009**	**2010**	**2011**	**2012**
Brown coal (1,000 t)	63	74	81	71
Lignite (1,000 t)	98	104	134	133
Electricity (GWh)	2,847	2,922	2,970	3,000
Heat (TJ)	1,378	1,483	1,613	1,506
Natural gas (thous. Sm^3)	32,097	36,026	67,037	27,883

1) Production and threshold

3.1.8 Tourism

No data on tourism exists at DRB level or at municipal level. There is data available for the whole of BiH and for RS and FBiH.

Tourism in both FBiH and RS continues its increasing trend, which has been characterised by a constant increase in number of tourist nights in the past five years (see Figure 3-9).



FBiH	RS

Figure 3-9: Tourist arrivals and tourist nights in FBiH and RS 2009-2013

In 2011, tourists made 686,148 visits, which is higher by 4.5% and 1,504,205 overnight stays, which is higher by 6.2% compared to the same period in 2010. The structure of foreign tourists in the same period were realized by tourists from Croatia (15.6%), Serbia (13.7%), Slovenia (8.4%), Poland (7.9%), Italy (6, 5%) and Turkey (6.0%), making a total of 58.1%. Tourists from other countries realized 41.9% of tourist nights

In 2012 tourists made 747,827 visits, which is more by 9.0% to 1,645,521 overnight, which is more by 9.4% compared to the same period of 2011. The structure of foreign tourists in the same period were realized by tourists from Croatia (16.2%), Serbia (13.1%), Poland (8.1%) and Slovenia (7.4%), making a total of 44.8 %. Tourists from other countries realized 55.2% of tourist nights. As for the length of stay of foreign tourists in our country during the same period, in the first place were tourists from the Russian Federation with an average stay of 4.1 days, Ireland with 3.6 days, Iran with 3.2 days and Egypt with 3.0 days.

In 2013, tourists made 844,189 visits, which is more by 12.9% to 1,822,927 overnight stays, which is more than 10.8% compared to the same period of 2012. According to the type of the object highest number of overnight stays was realized through the kind of hotels and similar accommodation with a share of 92.0%. The structure of foreign tourists in the same period were realized by tourists from Croatia (15.3%), Serbia (11.9%), Turkey (9.5%), Poland (7.3%) and Slovenia (6, 8%), making a total of 50.8%. Tourists from other countries realized 49.2% of tourist nights. As for the length of stay of foreign tourists in the same period, the first place is: Malta with an average stay of 6.9 nights from 4.2 nights Kuwait, and Egypt and Estonia with 3.6 per night (Table 3-12).

In 2014, tourists made 846,581 visits, which is higher by 0.3% and 1,711,480 overnight stays, which is less by 6.1% compared to the same period in 2013. According to the type of accommodation the highest number of overnight stays was realized through hotels and similar accommodation with a share of 93.4%. In the structure of overnight stays of foreign tourists in BiH for the same period were realized by tourists from Croatia (15.1%), Serbia (10.8%), Italy (8.1%), Turkey (7.6%), Slovenia (6.2%) and Germany (4.4%), making a total of 52.2%. Tourists from other countries realized 47.8% of tourist nights. As for the length of stay of foreign tourists in the same period, the first place is: Malta with an average stay of 6.3 nights from 3.6 nights Kuwait, Russia with 3.2 nights, Ireland and India with 3.0 per night (Table 3-13).

Table 3-12: Overview of arrivals and overnight stays in Bosnia and Herzegovina for 2011, 2012, 2013 and 2014.

Year	2011	2012	2013	2014
Overall arrivals	**686.148**	**747.827**	**844.189**	**846.581**
Domestic	294.203	309.242	315.610	310.227
Foreign	391.945	438.585	528.579	536.354
Total overnights stays	**1.504.205**	**1.645.521**	**1.822.927**	**1.711.480**
Domestic	668.200	714.440	714.022	623.008
Foreign	836.005	931.081	1.108.905	1.088.472

Source: Agency for statistics BiH

Table 3-13: Detailed overview of arrivals and overnight stays in Bosnia and Herzegovina (FBiH, RS and BD) for 2014

2014	Tourist arrivals				Tourist overnights			
BiH	Total	%	Domestic	Foreign	Total	%ª	Domestic	Foreign
Federation BiH	575.566	67,99	162.959	412.607	1.094.986	63,98	292.388	802.598
Republika Srpska	260 160	30,73	141 898	118 262	598 668	34,98	323 002	275 666
Brčko District	10.855	1,28	5.370	5.485	17.826	1,04	7.618	10.208
Total BiH	**846.581**	**100**	**310.227**	**536.354**	**1.711.480**	**100**	**623.008**	**1.088.472**

Source: Agency for Statistics, Federal Office of Statistics of FBiH and the Republic Institute for Statistics of RS

In RS BiH in 2014 year 260,160 tourist arrivals were recorded, 2.6% more than in 2013. However, in the reporting period there were fewer overnight stays, which in 2014 in the RS were 598,668. In 2014 in RS there was a reduced number of tourist nights by 4.9% compared to 2013. As in previous years, the highest visit, in addition to domestic tourists, were from the region e.g. Serbia, Croatia, Slovenia and Montenegro, and from other European countries including Turkey, Germany, Italy, Austria and Russia. In RS, the most attractive National Tourist destinations are Banja Luka, Teslić (spa tourism) and Trebinje, and of course Jahorina during the three winter months.

In FBiH in 2014 there were 575,566 tourists' visits, which is 0.3% less than in 2013. The ratio of domestic tourists to foreign was 28.3% to 71.7%. The total number of overnight stays in 2014 was 1,094,986, which is 3.6% less than in 2013. Participation of domestic tourists in the total number of overnight stays was 26.7% and foreign tourists 73.3%.

The breakdown of foreign tourist nightswere Croatia (12.5%), Italy (9.7%), Turkey (9.3%), Slovenia (5.9), Poland (5.4%), Germany (4.8%), Other Asian countries (4.4%), Serbia (4.0%), which combined makes a total of 56.0%. Tourists from other countries realized 44% of tourist nights. The Canton Sarajevo is the most visited in the FBiH, followed by Mostar and Medjugorje, and dominated by day tourist visits without overnight stays.

3.2 Cultural Heritage and national monuments

The cultural heritage of BiH is heterogeneous, including a wide range of cultural goods from prehistoric and ancient times, to medieval, to the Ottoman period and modern times. The varied heritage is mainly due to the geographical position of BiH, and through its participation in four major civilizations of Europe: namely Mediterranean, Central European, Byzantine and Oriental-Islamic.

The Bosnian War destroyed or badly damaged a large number of architectural, sacral and secular monuments. Following this, some of the stakeholder institutions lost their status, budgets, documents and experts.

To redress this loss in part, UNESCO has paid special attention to the protection of cultural and historical heritage in BiH. The first monument from BiH, which was put on the world list of protected monuments, was the Old Bridge in Mostar (outside of the DRB). Furthermore, the bridge of Mehmed Pasha Sokolovic in Visegrad over the Drina River (within the DRB and connecting Serbia with BiH) is listed on the World Heritage List of UNESCO.

The oldest cultural heritage in BiH is from the Paleolithic and from that period, there are two sites, namely: Kadr in Svilaj near Bosanski Brod and near the mouth of Usore near Doboj (both outside the DRB).
Sites from the Neolithic culture in BiH are common and there are 12 locations, of which the Neolithic settlement of Butmir "Butmir Culture" is the most famous.

In addition to the above, there are a number of sites from prehistoric archaeological finds (94), sites from ancient Greece (13); object-locations from the Roman period (78); sites from the Bronze Age (1); and over 60,000 "stacks"-medieval memorial monuments, representing exceptional and original appearance of the art of the Middle Ages in this region.[13]

The following Table 3-14 provides an indication of the number of cultural monuments within the municipalities falling completely or partially within the DRB. Further details are provided in Annex 3-1.

Table 3-14: Number of Cultural Monuments in the municipalities within or partially within the DRB

FBiH Municipalities	No of Monuments	RS Municipalities	No of Monuments	RS Municipalities	No of Monuments
Foča	4	Bijeljina	3	Pale (RS)	5
Goražde	3	Bratunac		Rogatica	3
Kladanj	2	Čajniče	13	Rudo	1
Pale	1	Foča	16	Šekovići	4
Sapna	0	Gacko	4	Sokolac	3

[13] Study of long-term development of tourism in Bosnia and Herzegovina

FBiH Municipalities	No of Monuments	RS Municipalities	No of Monuments	RS Municipalities	No of Monuments
Teočak	0	Han Pijesak	1	Srebrenica	9
		Kalinovik	2	Ugljevik	0
		Lopare		Višegrad	2
		Milići	1	Vlasenica	
		Novo Goražde	3	Zvornik	2

3.3 Demographics

3.3.1 General information

Following the Dayton Agreement there were radical changes in the political and territorial landscape of BiH. The Dayton line of demarcation between the two created entities (the RS and FBiH) disected many of the previous municipal units and even smaller settlements. The Bosnian War (1992-1995) caused forced migration and displacement of the population that has continued to the present day.

BiH is administratively subdivided into the following:

- The entity of FBiH with 51% of BiH territory and
- The entity of Republic Srpska (RS) with 49% of BiH territory.
- Brčko District, that represents a neutral, self-governing administrative unit, under the sovereignty of BiH.

Presently, FBiH is divided by cantons (total of 10) and municipalities (total of 79); with six municipalities that are included in the DRB belonging to the Bosnian Podrinje Canton Goražde and Tuzla Canton. The RS is divided by municipalities (total of 62) and twenty of them are completely or partly included in the DRB.

3.3.2 Area and Population Density

The total area of the municipalities included or partially included in the DRB in BiH is 10,007.6 km², which is 27% more than actual catchment area of Drina River (about 7,301 km²). Some municipalities are completely and some partly belonging to Drina River catchment area. Table 3-15 below provides estimates of the population density within the municipalities making up the DRB. The last three column of the table provide an indication of the population within the DRB based upon the work by Consultants undertaking an EU IPA project (Eptisa 2015).

Table 3-15: Summary of BiH Municipalities and population densities within or partly in the DRB

Entity/Municipality	Municipal Area (km²)	Municipal Population	Pop Density of Municipality (inh/km²)	DRB Area (km²)	Actual Population in the DRB*	Density in DRB (inh/km²)**
RS	**9,025.0**	**392,277**	**43.5**	**6,246**	**246,336**	**39.5**
Bijeljina	733.9	114,663	156.2		32,113	
Bratunac	293.5	21,619	73.7		21,592	
Čajniče	274.6	5,449	19.8		5,439	
Foča	1,134.6	19,811	17.5		19,800	
Gacko	735.9	9,734	13.2		126	
Han Pijesak	322.9	3,844	11.9		1,188	
Kalinovik	681.2	2,240	3.3		164	
Lopare	292.6	16,568	56.6		4,379	
Milići	279.3	12,272	43.9		12,251	
Novo Goražde	119.0	3,391	28.5		3,389	
Pale	492.8	22,282	45.2		1,615	
Rogatica	645.0	11,603	18.0		11,599	
Rudo	347.6	8,834	25.4		8,830	
Šekovići	237.2	7,771	32.8		6,366	

Entity/Municipality	Municipal Area (km²)	Municipal Population	Pop Density of Municipality (inh/km²)	DRB Area (km²)	Actual Population in the DRB*	Density in DRB (inh/km²)**
Sokolac	693.5	12,607	18.2		826	
Srebrenica	526.8	15,242	28.9		15,228	
Ugljevik	165.2	16,538	100.1		13,726	
Višegrad	448.1	11,774	26.3		11,740	
Vlasenica	225.3	12,349	54.8		12,313	
Zvornik	376.1	63,686	169.3		63,652	
FBiH	**982.6**	**58,120**	**59.1**	**840**	**52,446**	**62.4**
Foča- Ustikolina	169.4	2,213	13.1		2,103	
Goražde	248.8	22,080	88.7		22,052	
Kladanj	331.0	13,041	39.4		7,680	
Pale-Prača	86.4	1,043	12.1		1,026	
Sapna	118.0	12,136	102.8		11,985	
Teočak	29.0	7,607	262.3		7,600	
Total	**10,007.6**	**450,397**	**45.0**	**7,301**	**298,782**	**40.9**

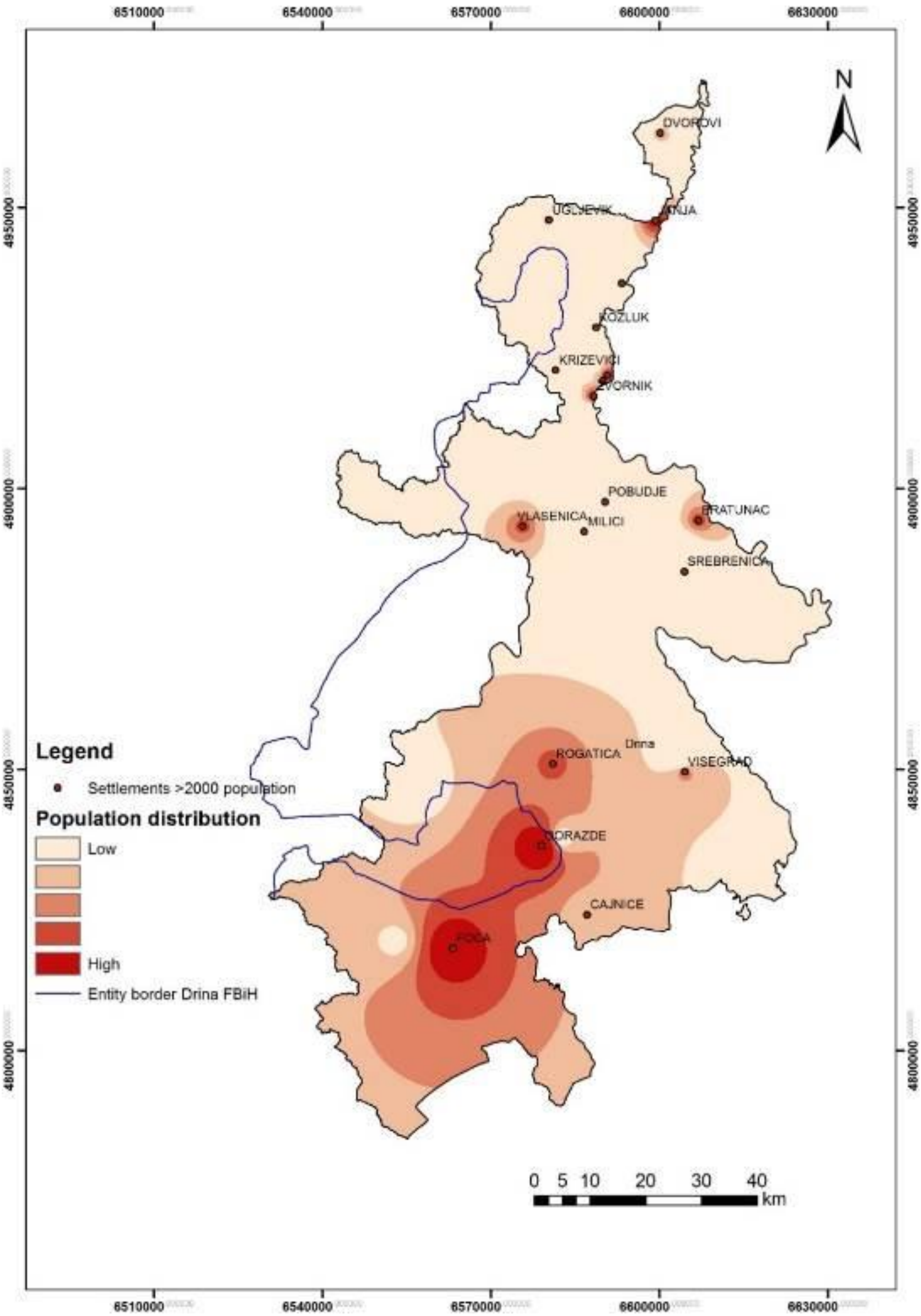
Source: www.statistika.ba (Census 2013)
* Results taken from EU IPA Project (Eptisa Report): ** Actual municipal areas in DRB not known

Regarding territory, the part in RS makes up approximately 90% and the FBiH only 10% of the area. The largest administrative unit is the Municipality Foča (RS) with 1,134.6 km^2, followed by the municipalities Gacko and Bijeljina with more than 700 km^2. The smallest municipal area is Teočak (FBiH), with just 29 km^2.

The largest administrative unit, regarding the number of inhabitants, is Bijeljina with a population of 114,663, although only 32,113 are actually living within the DRB. Zvornik municipality (RS) has the highest population living completely within the DRB with more than 63,500 people.

The average population density of municipalities falling partly or totally within the DRB in RS is 43.5 inhabitants/km²; while in the FBiH it is 59 inhabitants/km^2. The average population density of the actual population living within the DRB is 40.9 inhabitants/km². The highest population density in FBiH and in the whole DRB, is the municipality of Teočak with 262 inhabitants/km^2. High densities of population are also occurring at municipalities of Bijeljina (156 inhabitants/km^2), Zvornik (169 inhabitants/km^2) and at Sapna (103 inhabitants/km^2).

Low population densities occur at the municipalities of Han Pijesak, Foča (FBiH and RS), Pale (FBiH), Rogatica, Sokolac, Kalinovik, Gacko and Čajniče, which have densities of less than 20 inhabitants /km^2. The following map (Figure 3-10) provides an indication of the growth centres within the BiH part of the DRB.



Source: Using EU IPA Project data

Figure 3-10: Map showing geographical distribution of population

3.3.3 Population

The recent EU IPA Project has indicated that the actual population living within the DRB is 298,782. However, in order to undertake further analysis of the population it is important to use official data that is only available at municipal level and not at DRB level. According to the 2013 census, 450,397 people live within the municipalities, either fully within or partially within the DRB. Review of natural population growth rates for the entire BiH (no data available at municipal level) indicates a decline from 2010 to 2014 (continuing the population decline from the time of the Bosnian war). This decline was the largest in 2014 at -3.5% and there is no sign this decline is levelling off. This information is shown in the Table 3-16 and Figure 3-11 below.

Table 3-16: Natural population growth rate in BiH

Year	Natural population growth rate
2010	-2.4
2011	-2.9
2012	-2.7
2013	-3.1
2014	-3.5

Source: http://www.bhas.ba/

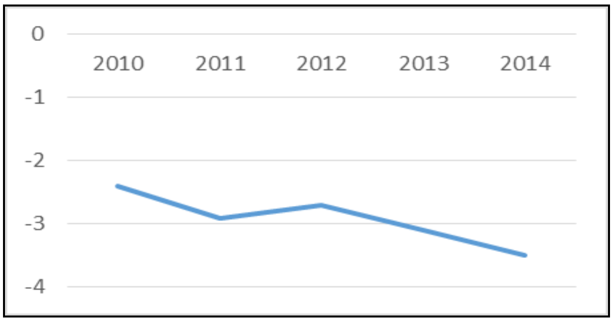


Figure 3-11: Natural population growth rate in BiH

For municipalities, the absolute data for births and deaths are available, i.e. for natural growth, as a midyear assumption but without assumptions for their total population. In 2014, the municipal areas that belong entirely or partly to the DRB had a population decline of -1,696 inhabitants. In RS, all the municipalities show negative natural growth, whilst the municipalities Teočak and Sapna in FBiH show positive values (Table 3-17).

Table 3-17: Vital statistic for BiH in 2014

Municipality	Births	Deaths	Natural growth
RS	2,404	4,059	-1,655
Bijeljina	910	1,339	-429
Bratunac	124	161	-37
Čajniče	26	59	-33
Foča	124	225	-101
Gacko	72	104	-32
Han Pijesak	27	62	-35
Kalinovik	8	42	-34
Lopare	52	231	-179
Milići	42	97	-55
Novo Goražde	2	25	-23
Pale	179	240	-61
Rogatica	69	158	-89
Rudo	25	86	-61
Šekovići	37	88	-51
Sokolac	88	151	-63
Srebrenica	53	91	-38
Ugljevik	103	204	-101
Višegrad	51	152	-101
Vlasenica	68	84	-16
Zvornik	344	460	-116
FBiH	484	525	-41
Foča- Ustikolina	12	26	-14
Goražde	251	281	-30
Kladanj	91	102	-11
Pale-Prača	5	15	-10
Sapna	70	54	16
Teočak	55	47	8
Total	**2,888**	**4,584**	**-1,696**

Source: http://www.bhas.ba/

In the period from 1971 to 2013, only the Bijeljina municipality has experienced a continuous population increase, while the whole area covered by the municipalities has the most inhabitants in 1991 (Table 3-18). Former municipality Foča faced a significant population decrease, considering that the sum of population for both new units in 2013 was more than 50% lower than the population in 1971. A similar situation is also observed in the municipalities of Han Pijesak, Kalinovik, Lopare, Rogatica, Rudo, Srebrenica and Višegrad.

Table 3-18: Population statistics for the period from 1971 to 2013

Municipality[14]	Population by Census year			
	1971	1981	1991	2013
Bijeljina	86,826	92,808	96,988	114,663
Bratunac	26,513	30,333	33,619	21,619
Čajniče	11,602	10,280	8,956	5,449
Foča (RS+FBiH)	48,741	44,661	40,513	22,024
Gacko	12,033	10,279	10,788	9,734
Han Pijesak	7,804	6,879	6,348	3,844
Kalinovik	9,458	6,597	4,667	2,240
Lopare	33,847	33,769	32,537	16,568
Pale (RS+FBiH)	16,119	15,482	16,355	23,325
Rogatica	25,501	23,771	21,978	11,603
Rudo	15,982	13,601	11,571	8,834
Šekovići	10,570	10,356	9,629	7,771
Sokolac	17,053	15,281	14,883	12,607
Srebrenica	33,357	36,292	36,666	15,242
Ugljevik+Teočak	24,178	24,540	25,587	24,145
Višegrad	25,389	23,201	21,199	11,774
Vlasenica+Milići	26,623	30,498	33,942	24,621
Zvornik+Sapna	60,910	73,845	81,295	75,822
Goražde (RS+FBiH)	34,685	36,924	37,573	25,471
Kladanj	14,015	15,641	16,070	13,041
Total	541,206	555,038	561,164	450,397

Lowest Highest

Source: Federal Statistical Office Newsletter from 1998 and Census 2013

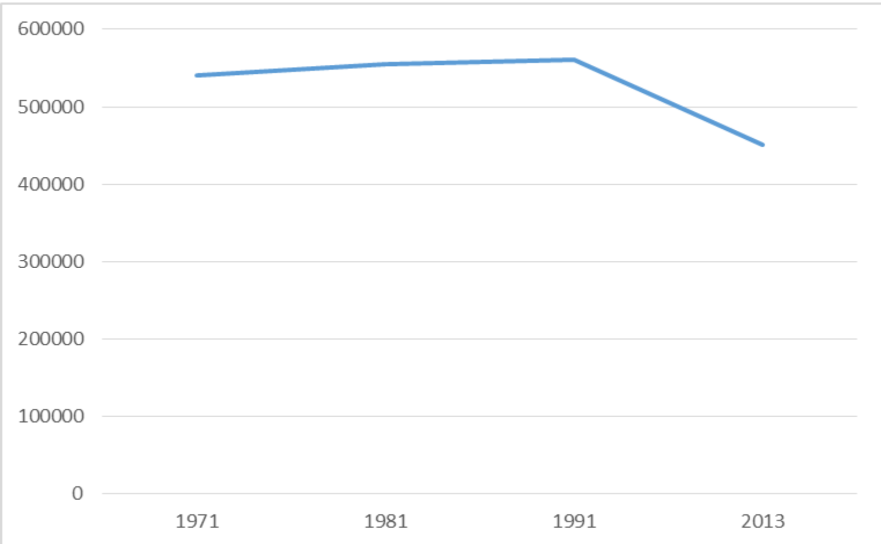


Figure 3-12: Population in the Municipalities within or partly within the DRB 1971-2013

[14] Municipalities subdivided by the Dayton Agreementare shown in their previous form whilst the 2013 population shows newly created separate municipalities calculated together (e.g. Foča, Pale and Goražde).

3.3.4 Distinction between rural and urban population

The average level of urbanization in the municipalities fully and partially making up the DRB in both RS and FBiH is approximately the same at 37%, while the differences at the municipal level are very variable (see Table 3-19 and Figure 3-13).

Greater urban populations are seen in the municipalities of Foča (62%), Pale (62%), Han Pijesak (53%) in the RS and in the municipality of Goražde (57%) in the Federation. The municipalities of Novo Gorazde in the RS and Foča and Pale in FBiH do not have an urban center or any urban population due to the new administrative division. These newly created municipalities were parts of the former larger municipalities, whose municipal centers and urban settlements are now located on the territory of RS (for Foča and Pale), and in the Federation (for Novo Goražde).

Table 3-19: Distinction between urban and rural population in the municipalities within or partly within the DRB

Entity/Municipality	Population	Distinction between urban and rural population			
		Urban		Rural	
		No	%	No	%
RS	**392,277**	**145,015**	**37.0**	**242,262**	**61.8**
Bijeljina	114,663	45,291	39.5	64,372	56.1
Bratunac	21,619	8,359	38.7	13,260	61.3
Čajniče	5,449	2,401	44.1	3,048	55.9
Foča	19,811	12,334	62.3	7,477	37.7
Gacko	9,734	5,784	59.4	3,950	40.6
Han Pijesak	3,844	2,018	52.5	1,826	47.5
Kalinovik	2,240	1,093	48.8	1,147	51.2
Lopare	16,568	2,709	16.4	13,859	83.6
Milići	12,272	2,368	19.3	9,904	80.7
Novo Goražde	3,391	0	0.0	3,391	100.0
Pale	22,282	13,883	62.3	8,399	37.7
Rogatica	11,603	6,855	59.1	4,748	40.9
Rudo	8,834	1,949	22.1	6,885	77.9
Šekovići	7,771	1,519	19.5	6,252	80.5
Sokolac	12,607	5,919	47.0	6,688	53.0
Srebrenica	15,242	2,607	17.1	12,635	82.9
Ugljevik	16,538	4,155	25.1	12,383	74.9
Višegrad	11,774	5,869	49.8	5,905	50.2
Vlasenica	12,349	7,228	58.5	5,121	41.5
Zvornik	63,686	12,674	19.9	51,012	80.1
FBiH	**58,120**	**21,643**	**37.2**	**36,477**	**62.8**
Foča- Ustikolina	2,213	0	0.0	2,213	100.0
Goražde	22,080	12,512	56.7	9,568	43.3
Kladanj	13,041	4,241	32.5	8,800	67.5
Pale-Prača	1,043	0	0.0	1,043	100.0
Sapna	12,136	2,073	17.1	10,063	82.9
Teočak	7,607	2,817	37.0	4,790	63.0
Total	**450,397**	**166,658**	**37.0**	**278,739**	**61.9**

Source: www.statistika.ba (Census 2013)

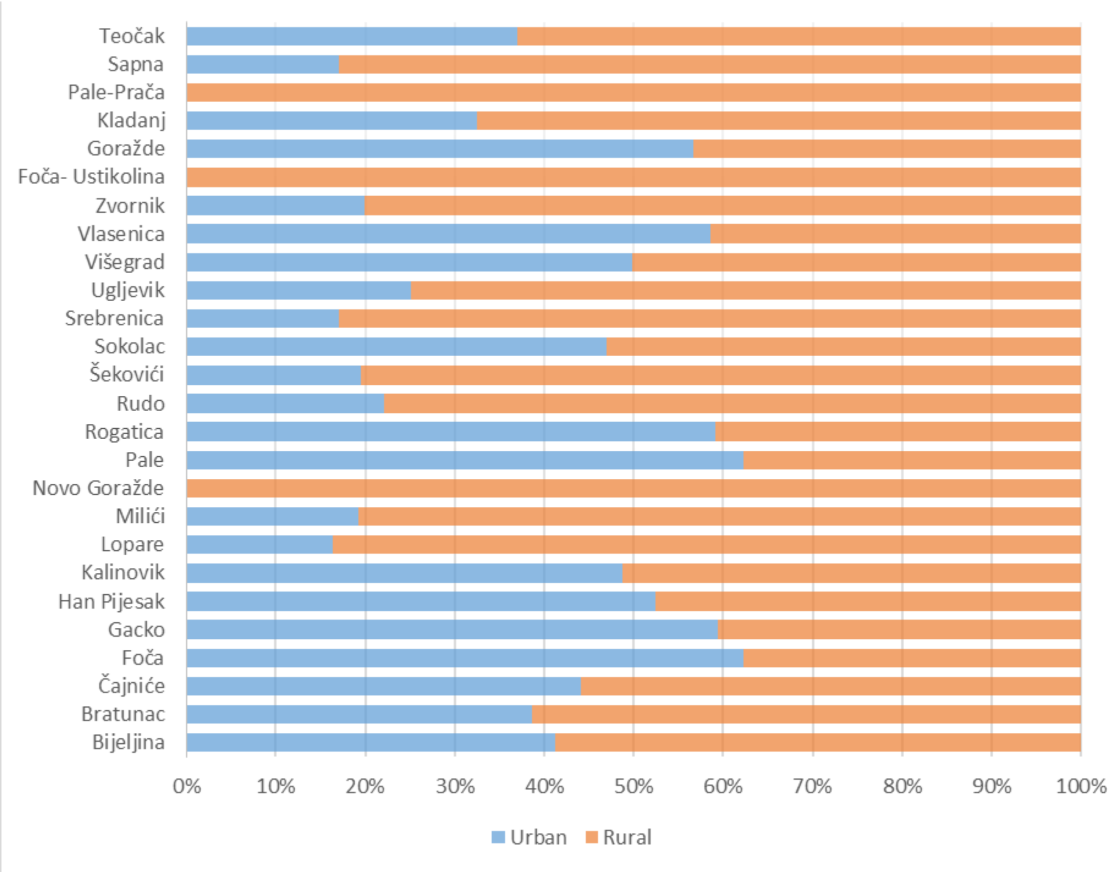


Figure 3-13: Distinction between urban and rural population

3.4 Gender and age structure

Table 3-20: Share of Male and Female population

Area	Male (%)	Female (%)
BiH	49.0	51.0
FBiH	48.9	51.1
RS	49.1	50.9

Source: Household Budget Survey in BiH 2011

Data regarding age and gender structures of the population are only available for BiH at the entity level. In BiH there are more females then males (96 males per 100 females).

In RS, there are 96.3 males per 100 females, while in FBiH there are 95.6 males per 100 females. The percentage share is shown in Table 3-20.

Most inhabitants of BiH belong to the 35-64 years age group (41.3%). The population is younger in FBiH (average age 38.5 years) compared to RS (42 years). The younger population (<18 years old) makes up 20.6% of the total population in BiH, whilst children younger than 6 years make up 5.6%. FBiH has a larger percentage share of young population (21.7%) compared to RS (18.6%). The older population (65 and over) makes up 15.8% of the total population, while 57 of 100 older persons are females. There is an older population in RS (19.1%) compared to FBiH (14.1%).

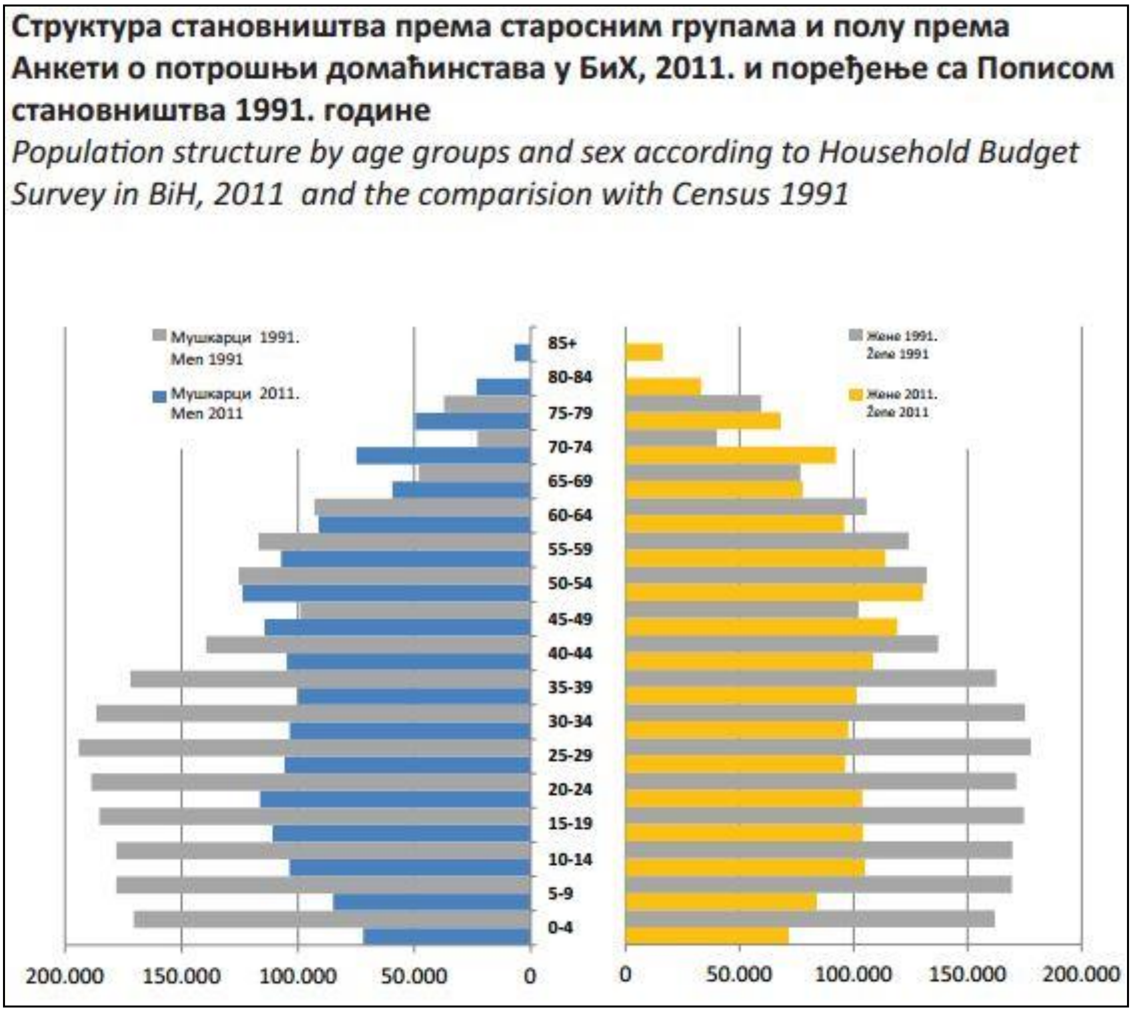


Figure 3-14: Age and Gender Population Pyramid comparing 1991 with 2011

Table 3-21: Average age in BiH by gender for period 1981-2011

Average age in BiH		
year	male	female
1981	28.7	30.5
1991	33.0	35.0
2011	38.6	40.8

Source: Household Budget Survey in BiH 2011

There is a significant decrease of the younger population in 2011 compared to 1991 as shown in Figure 3-14. The favourable shape of the pyramid in 1991 with a large base changes dramatically in 2011 showing less children and older people in 2011.

Consequently, the average age of the population in BiH shows a significant increase between 1981 and 2011 (Table 3-21).

In general, the male population is younger on average compared to females. The male population in 1981 belonged to category of “demographic maturity” while the females belong to the “demographic threshold”. According the data from 2011, the male population can be described as “demographic ageing” and the female population as “deep demographic ageing”.

The average age of the male and female population in the BiH in recent years is shown in Figure 3-15 below.

Figure 3-15: Average age in BiH between males and females in recent years

Table 3-22: Average age in BiH and Entities by gender

Average age in 2011			
Area	male	female	total
BiH	38.6	40.8	39.7
FBiH	37.6	39.4	38.5
RS	40.5	43.6	42.0

Source: Household Budget Survey in BiH 2011

In 2011 both entities have an older average female population than males. Furthermore, the female population in RS belongs to the last category of "deepest demographic ageing" with the average age of over 43 years. The total population of BiH is still in the category of "demographic ageing" because of FBiH which has a more favourable situation then RS (Table 3-22).

3.5 Human Health

In 2013, the most deaths were caused by diseases of the circulatory system (51%), followed by Neoplasms (cancers) (21%) and complications in pregnancy, childbirth and puerperium (delivery of placenta) (14.3%).

Table 3-23: Total Morbidity by Group of Diseases in BiH

Group of diseases	No.	%
Infectious and parasitic diseas	268	0.8
Neoplasms	7,506	21.0
Diseas of blood and blood forming organs, disorders involving the immune mechanism	50	0.1
Endocrine and metabolic disorders	1,970	5.5
Mental disorders	192	0.5
Diseases of nervous system	382	1.1
Diseases of the circulatory system	18,186	51.0
Diseases of the respiratory system	1,428	4.0
Diseases of the digestive system	955	2.7
Diseases of skin and subcutaneous tissue	31	0.1
Diseases of the musculo-skeletal system and connective tissue	57	0.2
Diseases of the genito-urinary system	581	1.6
Complications in pregnancy, childbirth and puerperium	5,110	14.3
Certain conditions originating in peri-natal period	101	0.3

Group of diseases	No.	%
Congenital malformations	38	0.1
Symptoms, signs and inadequately defined conditions	2,107	5.9
Injuries and poisoning	1,024	2.9
External causes of mortality	4	0.0
Total	35,662	100.0

Source: http://www.bhas.ba/

The first registered case of HIV/AIDS in BiH was in 1986 and from then until November 2012, a total of 222 persons were registered with HIV infection, of which 120 persons developed AIDS. In the period 2005 to 2012, two women and eight men died of AIDS.

3.5.1 Health Care Institutions and Staff in the DRB

Primary health care includes: general practice, health care of preschool and school children, hygienic and epidemiological care, dental care, emergency health services, occupational health, primary health care of women, community nursing and pharmacies. It is provided by health institutions irrespective of ownership: health centres, institutions for emergency medical care, institutions for home health care, pharmacies and private offices.

Secondary health care includes specialist – consultative health care, hospital health care in general and specialized hospitals and health resorts.

Tertiary health care includes most complex forms of health care in the field of specialist activities in clinics and state health institutes.

In RS, there were 53 Health Centres for primary health care, while in FBiH there were 916 ambulances of family practice. In 25 hospitals of FBiH there are 8,245 beds, or 3.5 beds/1,000 inhabitants. RS has 2,941 beds in General Hospitals, 420 beds in Matrnity Hospitals, 505 beds in Mental Illness hospitals and 730 beds in the Institute of Physical Medicine and Rehabilitiation.

In 2012, in BiH, there were 28,199 public health workers. Their structure is shown in Table 3-24 below.

Table 3-24: Public Health Workers in 2012

Public health workers 2012	
Doctors	6,874
Dentists	820
Pharmacists	421
Nurses-medical technicians	17,085
Other	2,496
Total	28,199

Source: http://www.bhas.ba/

In 2013, there were 118 social welfare institutions in BiH (FBiH 72, RS 45, and Brčko 1) with 1,318 employees.

Most of employees were social workers and administrative personnel, but there were also health care staff, special education therapists, pedagogues, psychologists and others (see Figure 3-16).

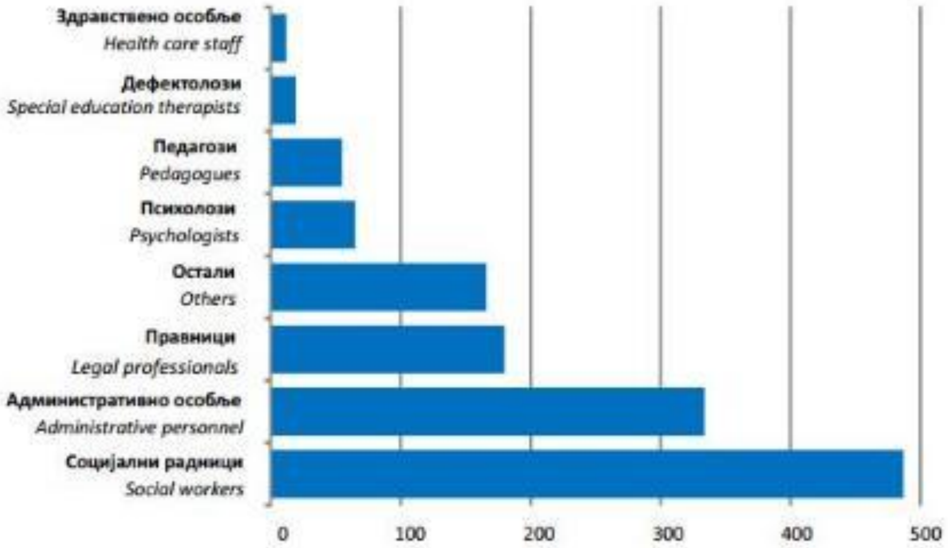


Figure 3-16: Employees in Social Welfare centres in BiH in 2013

The main forms and services of social welfare in BiH include:

- Guardianship and adoption
- Placement in institutions
- Educational and protective measures to minors
- Assistance in vocational training
- Allowances
- Other (health care expenses, assistance in solving housing problems, assistance in conflicts, etc.)

In 2013, the total number of handled cases in centres were 462,823, while the number of treatments rendered in centres were 686,455. Most of minor beneficiaries of social welfare were the ones with disadvantaged family situations and persons with social and protective needs.

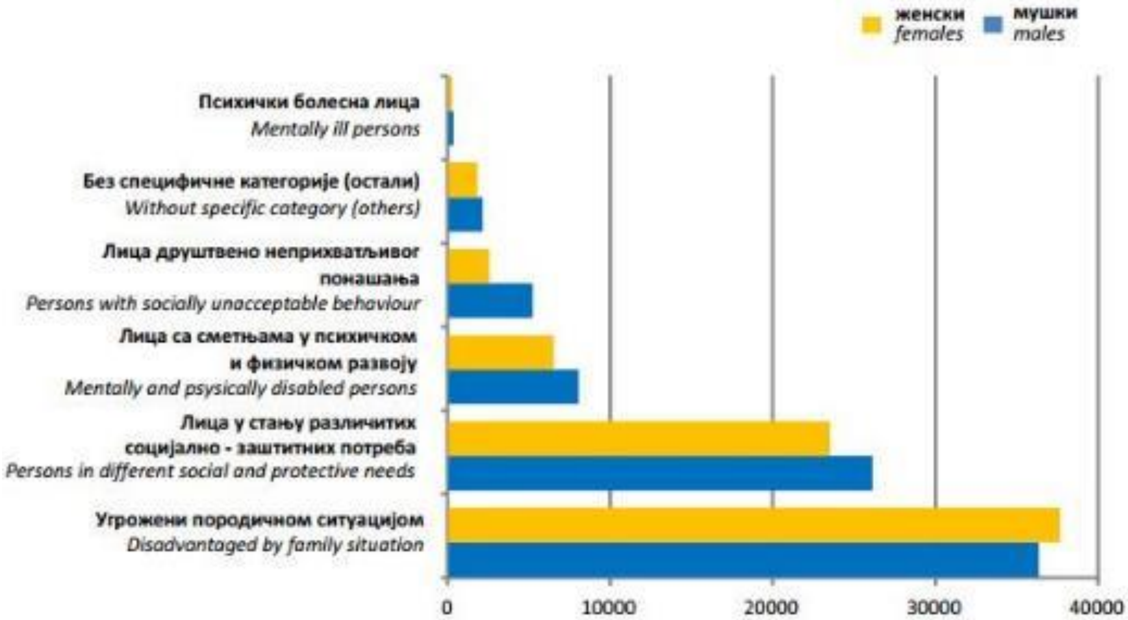


Figure 3-17: Minor – beneficiaries of social welfare by type of category and gender - 2013

Most of the adult beneficiaries of social welfare were persons without sufficient income or persons with different social and protective needs.

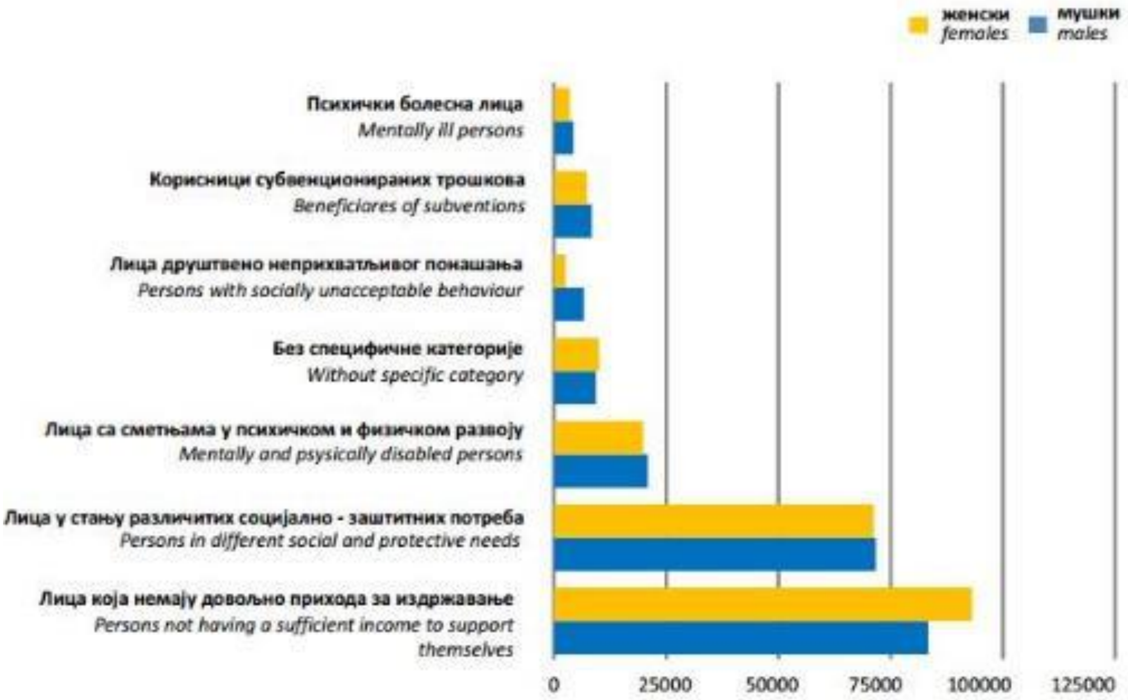
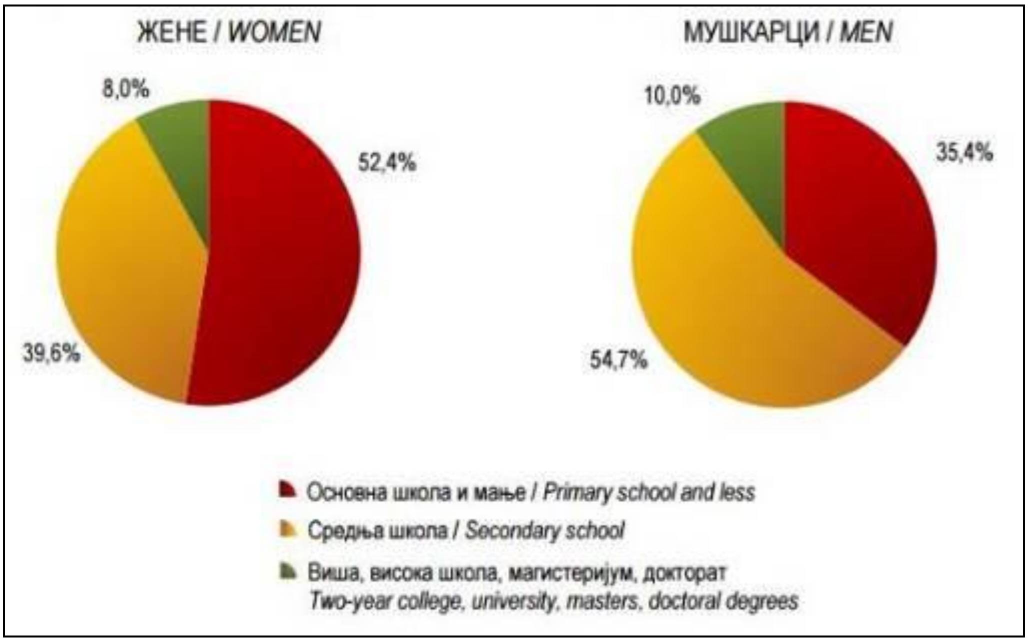


Figure 3-18: Adult beneficiary of social welfare by type and gender - 2013

3.6 Education and illiteracy

According to the Census 1991, 9.9% (16.4% of female, 3.4% of male) of the BiH population were illiterate. The data from the Living Standards Measurement Survey, (UNDP, 2001) show that approximately 5% of the BiH population are illiterate. Therefore, presently there are no official data on the BiH population literacy rate, but CIA World Factbook states that literacy of total BiH population in 2015 is 98% (male literacy 99.5%, female literacy 96.7%). Even if there are not enough comparable data, it can be assumed that there were important improvement in literacy rates since 1991.

Furthermore, there are no reliable data on the structure of BiH population according to education levels. According to the data provided by the BiH Household Budget Survey, 52.4% females and 35.4% of males aged 15 and over have primary education or less, 39.6% of females and 54.7% of males finished secondary, while 8% of women and 10% of men have completed higher education (see Figure 3-19).



Source: RSIS Labour Force Survey

Figure 3-19: Percentage distribution of population aged 15 and over in 2012 by highest level of education attained

Conditions of school facilities in BiH are not favorable. A large number of school buildings were constructed more than thirty years ago. War-torn buildings were mainly reconstructed using international community loans and donations, but without taking into account the need to equip schools with modern teaching aids. Specific problems relate to the maintenance of school facilities, and especially to capital construction of the educational institutions, that are not being adequately resolved due to the lack of financial resources.[15]

3.6.1 Education in BiH

No data exist for education at municipal level. For pre-school education in BiH for the school year - 2013/2014 in BiH a total of 19,880 children were engaged while 1,366 children were rejected because of overcapacity. The total number of pre-school institutions was 258 with 3,019 employees.

In primary education, there were 15,421 classes (190 for the children with special needs) with 302,133 pupils in the school year 2013/2014. The first grade had 32,038 children registered. In regular primary schools, there were 24,179 teachers, while in schools for children with special need there were 297 teachers employed.

In secondary education, there were 6,338 classes with 156,350 students and 13,037 teachers that provides a ratio of 1 teacher for every 12 students. Most students (53%) attended technical schools, while half of that number (26%) attended grammar schools. This information is shown in Table 3-25 below.

Table 3-25: Total number of classes and students at Secondary School in BiH

Type of secondary school	No of classes	No of students
Grammar school	1,620	40,065
Technical school	3,182	82,743
Art school	112	1,445
Religious schools	80	2,258
Specialized schools	1,270	2,9414
Schools for children with special needs	74	425
Total	**6,338**	**156,350**

[15] EU-ICBE Project: TA to the Education Reform in Bosnia and Herzegovina, 2008 (Funded by EU)

For higher education in BiH in the school year 2013/2014 99,760 students attended classes: 93,252 at the Universities, 5,429 at higher schools and 1,079 at religious faculties.

3.7 Employment, unemployment and living standards

A summary of the employment and unemployment and living standard are provided below and further details are provided in Annex 3-2.

According to data in FBiH in 2013, the labour force numbered 678,000 persons and there were 964,000 inactive persons. The labour force included 501,000 persons in employment and 191,000 unemployed persons. The unemployment rate in 2013 was 27.6% (27.1% for men and 28.4% for women), while in 2012 year it was 29.4% (27.9% for men and 32.2% for women), so a slight reduction. The unemployment rate was the highest among young persons aged 15 to 24 years. It was 58.9% overall (58.8% for men and 59.1% for women). The activity and employment rates in 2013 were 41.8% and 30.3%, while in the same period 2012 year that were 42.4% and 30.0%. Both rates were higher for men than for women. The activity and the employment rates were by far the highest in the age group 25 to 49 years (68.4% and 50.8% respectively). The structure of persons in employment by sectors of activity in 2013 shows that 54.5% of them worked in services, 32.9% in industry and 12.7% in agriculture.

In RS the labour market is still negatively affected by the global economic crisis. After the unemployment rate dropped from 25.2% in 2007 to 20.5% in 2008, in 2009 it started to increase again. The unemployment rate in 2009 increased by 0.9%, in 2010 by 2.2%, in 2011 by 0.9%, and in 2012 it increased by 1.1%. By sex, female unemployment rate in 2012 was 1.7% higher than in the previous year, while male unemployment rate increased by 0.8 % during the same period.

The structure of employed persons by group of sections of activities in 2012 was as follows: agricultural 31.7%, industrial (non-agricultural) 24.7% and services 43.6%, while by employment the structure was: employed persons (employees) 62.7%, self-employed persons 29.2%, and unpaid supporting family members 8.1%. Male employment rate in 2012 was 44.1%, and it was 16.9% higher than female employment rate, which is a common divergence in this region. Half of all employed persons in RS work in Manufacturing, Trade and Public Administration. Every second employee has completed secondary education, and every fourth has completed a higher education school or has a university degree. Every sixth employed person is under 30 years of age, while one in four employed persons is older than 50.

3.7.1 Employment and Unemployment in DRB

In the area of DRB that belongs to FBiH, the employment rate was the highest in the municipality of Goražde (57.0%) and the lowest in the municipality of Teočak (15.1%), the regional average being 37.7%. Beside the municipality of Goražde, the employment rate was above the regional average in the municipalities of Kladanj (39.8%) and Pale (38%) (See Table 3-26).

Table 3-26: Employment and Unemployment in FBiH municipalities associated with the DRB

FEDERATION OF BOSNIA AND HERZEGOVINA		
Municipalities	Employment rate (%) 2010	Unemployment rate (total %)
Foča	34.5	61.6
Goražde	57.0	35.4
Pale	38.0	62.2
Kladanj	39.8	60.4
Sapna	21.8	82.2
Teočak	15.1	80.7

The unemployment rate in the FBiH was the highest in the municipality of Sapna (82.2%) and the lowest in the municipality of Goražde (35.4%), the regional average being 46.2%.

Only the municipality of Goražde had an unemployment rate below the average for the DRB.

For RS municipalities within or partially within the DRB the employment rate was the highest in the municipality of Ugljevik (65.5%) and the lowest in the municipality of Rudo (29%), the regional average being 37.7%. Beside the municipality of Ugljevik, the employment rate was above the DRB average in the municipalities of Han Pijesak (62.3%), Zvornik (61%), Bijeljina (60.6%) and others. This information is contained in Table 3-27.

The Unemployment rate in the RS was the highest in the municipality of Bratunac (64.7%) and the lowest in the municipality of Ugljevik (35.6%), the average being 46.2%. The municipalities of Han Pijesak (38.6%), Zvornik (39.2%), Pale (41%) and others had unemployment rates below the average for the DRB municipalities.

Table 3-27: Employment and Unemployment in RS municipalities associated with the DRB

REPUBLIC OF SRPSKA		
Municipalities	**Employment rate (%) 2010**	**Unemployment rate (total %)**
Bijeljina	60.6	41.8
Bratunac	38.3	64.7
Višegrad	53.2	49.9
Vlasenica	55.1	47.0
Zvornik	61.0	39.2
Kalinovik	44.5	55.9
Lopare	48.9	52.5
Milići	58.0	44.2
Novo Goražde	50.2	45.7
Pale	58.3	41.0
Rogatica	56.9	46.3
Rudo	29.0	73.0
Sokolac	58.3	45.1
Srebrenica	51.9	43.2
Ugljevik	65.5	35.6
Foča	53.8	47.7
Han Pijesak	62.3	38.6
Čajniće	46.6	56.4
Šekovići	41.4	60.1

3.7.2 Living standards of population

In FBiH, the highest average gross and average net monthly wage, was in the municipality of Goražde (587.5 € and 384 €), which in comparison is above the average for the DRB (581 € and 379.8 €). The lowest average gross and average net monthly wage, was in the municipality of Kladanj (504.6 € and 336.9 €), which is below the average for the DRB. This information is shown in Table 3-28 and Figure 3-20 below.

Table 3-28: Average gross and net salaries in the DRB

AVERAGE SALARIES (EUR) 2013.		
Municipalities	**Average gross salaries**	**Average net salaries**
Foča	578.3	381.4
Goražde	587.5	384.0
Pale	553.7	367.1
Kladanj	504.6	336.9
Sapna	593.6	394.7
Teočak	594.6	394.7
DRB Average	**581.0**	**379.8**

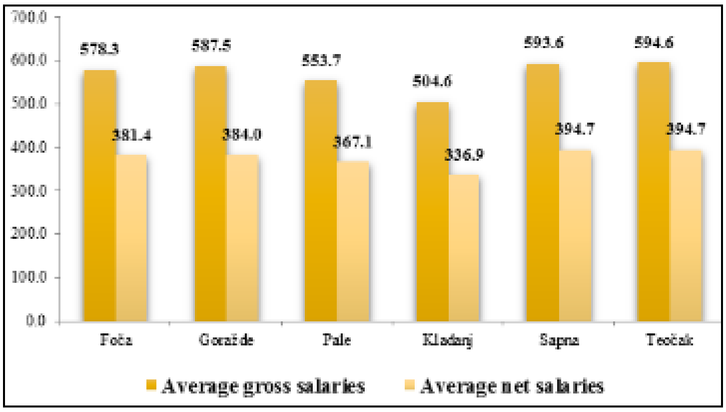


Figure 3-20: Average gross and net salaries in the DRB municipalities in FBiH

Table 3-29: Average gross and net salaries in the DRB municipalities in RS

AVERAGE SALARIES (EUR) 2013.		
Municipalities	Average gross salaries	Average net salaries
Bijeljina	668.2	403.4
Bratunac	597.2	362.5
Višegrad	707.1	424.9
Vlasenica	641.6	385.5
Zvornik	618.6	389.6
Kalinovik	616.6	369.7
Lopare	591.0	357.4
Milići	618.6	374.3
Novo Goražde	631.4	377.3
Pale	688.2	414.6
Rogatica	570.6	345.1
Rudo	722.4	434.6
Sokolac	653.4	394.7
Srebrenica	663.1	399.3
Ugljevik	913.1	556.8
Foča	756.2	451.5
Han Pijesak	617.6	374.3
Čajniće	673.9	404.9
Šekovići	534.3	328.2
DRB Average	**581.0**	**379.8**

In RS, the highest average gross and average net monthly wage, was in the municipality of Ugljevik (913.1 € and 556.8 €), which is above the average in comparison for the DRB (581 € and 379.8 €).

The lowest average gross and average net monthly wage, was in the municipality of Šekovići (534.3 € and 328.2 €), which is below the average for the DRB municipalities in RS (See Table 3-29).

It is interesting to note that the average gross salaries for RS are significantly higher in the majority of municipalities when comparing to FBiH, however the net salaries are closer to FBiH levels, suggesting that the RS salaries are subject to greater taxation.

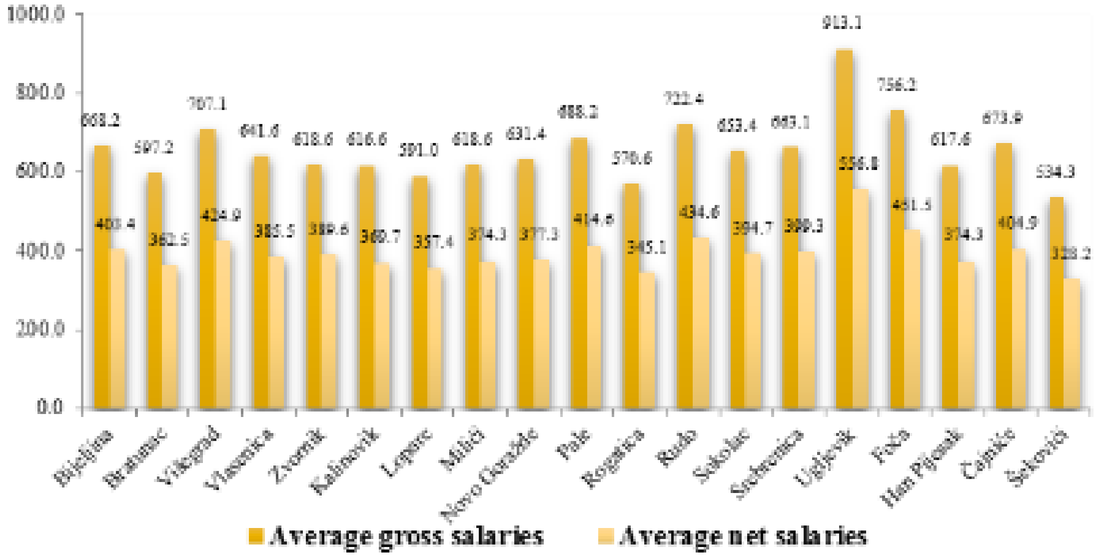


Figure 3-21: Average gross and net salaries in the DRB municipalities in RS

3.7.3 Age Dependency Ratio

The Age Dependence Ratio (ADR) quantifies the number of persons in a population who are not economically active (i.e. People younger than 15 or older than 64) for every 100 economically active persons (aged 15-64) in that population. The ratio highlights the potential dependency burden on workers and indicates the shifts in dependency from a situation in which children are dominant to one in which older persons outnumber children as the demographic transition advances (that is, the transition from high mortality and high fertility, to low mortality and low fertility).

The average value of ADR for all municipalities in BiH in the period 2011-2014 was 40/100 inhabitants of working age. In other words, there were 40 people who are not economically active for every 100 economicaly active persons. The average value of the ADR indicator is high and indicates that the economically active population and the overall economy face a greater burden to support and provide the social services needed by children and by older persons who are often economically dependent. According to World Bank data the ADR has been around 40 for the past 4 years.

3.8 Crime

Nationally, In RS, the total number of reported adult perpetrators of criminal acts in 2013 decreased by 5.5% in 2012 when compared with 2011. In contrast in FBiH the number of criminal acts increased by 7.4% in 2012 compared with 2011.

The most common crimes are criminal offences against property: 47.4% of all cases in RS and 40% in FBiH.

By far the majority of perpertrators are male at 94.5%.

There is no data available to provide indications of crime rates at the DRB level. Further details on crime statistics are provided in Annex 3-3.

3.9 Transportation

A summary of the transportation networks is described in the sections below and more details are provided in Annex 3-4.

3.9.1 Airports

There are no airports located within the DRB in BiH and the nearest ones are located in Tuzla and then in Sarajevo.

3.9.2 Roads

The road network in RS and FBiH is among the most poorly developed in Europe. This is evident both from data on the density of the national road network (0,468 km/km^2 which is 2.5 to 4 times less than in other Western European countries) and from a point of technical parameters, elements of the road route, longitudinal and transverse road profiles etc.

The planned reconstruction of two road routes passing through the DRB are of international importance, namely

a) E-761 Bihać - Mrkonjić Grad - Jajce - Sarajevo - Višegrad - Vardište (border with Republic of Serbia);
b) E-762 Sarajevo - Brod na Drini - Šćepan Polje (border with Montenegro).

3.9.3 Railway

The main railway routes in BiH that pass through the DRB are:

- Novi Grad-Banjaluka-Doboj-Živinice-Zvornik, Šamac-Doboj-Sarajevo-Ploče, which is the best equipped railway in BiH with modern signaling interlocking devices and tele-remote traffic management;
- Branches of railroads Bijeljina-Rača and Jablanica-Štrpci on the main Beograd-Zagreb railway.

There are two important European railway lines that pass through, or skirt DRB:

1) E–70 Paris-Trieste-Zagreb-Sunja-Beograd, i.e. Banja Luka-Doboj-Zvornik;

2) E–771 Budapest-Subotica-Samac-Doboj-Sarajevo-Ploce.

3.9.4 Waterways

No part of the Drina River is navigable within BiH, although at the confluence with the Sava River there is much river traffic. According to AGN [16] belong to class IV from its confluence to Brcko, located at rkm 225 and to class III from Brčko to Sisak. Notwithstanding the Sava River is an important international inland waterway and the area of DRB is directly connected with it and hence it is important for the development of a wider area.

[16] European Agreement on Main Inland Waterways of International Importance (AGN), United Nations Economic Commission for Europe

4 Surface Water Hydrology

4.1 Meteorological Data

In terms of available hydro-meteorological knowledge, the Drina River Basin falls into the category of well-studied basins, studied over a relatively long period. Among meteorological parameters, the present ones are related to rainfall, with 36 official rainfall stations in BiH analyzed within the present study, followed by air temperature, with 16 meteorological stations analysed here, while other meteorological parameters are monitored on a significantly smaller number of stations.

Measuring of meteorological phenomena in the DRB is officially conducted by authorized institutions (Republic Hydro-Meteorological Service of Republic of Srpska and Federal Hydro-Meteorological Service). In former SFRY, observation, measuring and archiving of hydro-meteorological data was executed by republic hydro-meteorological services (Serbia, Montenegro, and BiH). Federal Hydro-Meteorological Service (FHMS) has collected data from the republic hydro-meteorological services using data only from selected hydrological stations to publish the data in the form of the "Yearbook of the Hydro-Meteorological Service of Yugoslavia" ("Meteorological Yearbook I", "Meteorological Yearbook II" and other.). FHMS has worked on development of the "Hydrological and Meteorological Database". Partial hydro-meteorological databases were also developed within the republic hydro-meteorological services. Contents of the subject database, as well as their status and availability for potential users, are not made known to the professional audience.

After the disintegration of the former SFRY, republic hydro-meteorological services took over all competencies in the field of publishing and distribution of hydro-meteorological data from their territories. As of 1991, Serbian RHMS started regular data publishing in the form of meteorological and hydrological yearbooks and the hydro-meteorological database is under development. Until 2014, data from the territories of BiH were available only in the archives of the subject institutions. Situation on the territory of BiH was far more complex, as since 1991 data is in the Republic Hydro-Meteorological Service of Republic Srpska (in Banja Luka) and Federal Hydro-Meteorological Service (in Sarajevo). For reasons of well-known war-related events on the territory of BiH, a broader professional audience does not know the scope and type of available hydro-meteorological data. It is assumed that the majority of data after 1991 does not exist at all, and data that exists can be only procured on the market; market conditions in different riparian states are substantially different. Some data records on certain measurement stations can be obtained only in a somewhat limited form.

Being involved in development of numerous hydrologic studies, projects and water master plan analyses, such as the "Water Resources Master Plan" of SFRY, Serbia and Montenegro, "Hydrological Study of the Sava River", "Hydro-Meteorological Balance" and "Hydrological Monograph of the Danube River Basin" and the study "Formation of Weekly Hydrological Series of Unregulated Discharges between 1926 and 2012 for Predefined Profiles", the "Jaroslav Černi" Institute for the Development of Water Resources collected relevant hydro-meteorological data from the majority of official stations in the DRB for the period of the stations' inceptions until the end of 2012. All subject data records are either in the original form or processed, and are archived in the "Drina" Hydro-Information System ("Drina" HIS), which is constantly being populated with newly arriving data.

4.1.1 Review and Assessment of the Existing Meteorological Data

Meteorological data from 36 meteorological stations in the DRB in BiH were analyzed. These stations represented those, that were previously active or that were active during a certain period and then abandoned. The source of data is the "Drina" Hydro-Information System ("Drina" HIS), developed in the "Jaroslav Černi" Institute for the Development of Water Resources – Belgrade, Serbia.

Analysis of available data on rainfall and air temperatures from the metrological stations in the DRB was conducted, for the period from 1946 to 2012. It was then divided into the two periods, from 1946 to 1990 and from 1991 to 2012; the complete period from 1946 to 2012 was also analyzed. The following Table 4-1 is a summary of analyzed metrological stations in the DRB with their basic data.

Table 4-1: Meteorological station in the DRB in BiH

No.	Station	Location (entity)	H (m.a.s.l.)	Established	Status
1	"Višegrad"	RS	344	1934	Active
2	"Bijeljina"	RS	94	1924	Active
3	"Borike"	RS	1,180	1901	Active
4	"Čemerno"	FBiH	1,305		Active
5	"Foča"	RS	390	1892	Active
6	"Han Pijesak"	RS	1,089	1932	Active
7	"Kalesija"	FBiH		1954	
8	"Kladanj"	FBiH	560	1892	Active
9	"Metaljka"	RS	1,388	1934	Active
10	"Prača Vrelo"	RS	1,461	1934	
11	"Vlasenica"	RS	668	1932	
12	"Dobro Polje"	RS			
13	"Drinjača"	RS			
14	"Grabovica (BiH)"	RS	800	1958	
15	"Kalinovik"	RS	1,090	1889	
16	"Kalimanići"	RS			
17	"Kovačevići"	RS	940		
18	"Kramer Selo"	RS	942		
19	"Nadromanija"	RS	1,368		
20	"Osječani"	FBiH	1,060		
21	"Prača"	RS	692	1897	
22	"Šekovići"	RS			
23	"Sokolac"	RS	872	1932	
24	"Tjentište"	RS			
25	"Vranići"	RS			
26	"Vrbnica"	RS			
27	"Goražde"	FBiH	345	1931	Active
28	"Strmica"	RS			
29	"Vikoč"	RS	496	1932	
30	"Zvornik"	RS	170	1931	
31	"Rogatica "Pe" "	RS			
32	"Bukovica"	RS			
33	"Stambulčić"	RS	692	1923	Active
34	"Derventa"	RS	109	1936	
35	"Jeleč"	RS			
36	"Zelengora"	RS			

Rainfall Data
For the purpose of monitoring and analysis of the metrological regime in the DRB, network of meteorological stations was set up and was used in the previous period for constant or occasional observation and gauging of meteorological phenomena.

Some of the stations are not operational any more, or they were replaced by other located in the immediate vicinity of former stations.

Rainfall data from the metrological stations in the "Drina" HIS are available for a long period (since 1923 until present). Rainfall data for the 1923 to 1940 period were taken from the yearbook of the Kingdom of Yugoslavia and is available for 15 stations in BiH in the DRB. This period is characterized by data discontinuity. None of the subject stations has the complete data series (that contains all data) for 18 years of observation. There are is no data available for any of the meteorological stations for the period from 1941 to 1945 (WWII).

In the "Drina" HIS database for the period from 1946 to 1969 there are no rainfall data for the basin segments in BiH.

Data in the "Drina" HIS database are the most complete, if one considers the entire DRB, for the period from 1970 to 1984 period. There is no rainfall data for the period from 1984 to 2012 for the basin segment in the BiH.

It has already been mentioned that data analysis for the needs of present design was prepared using the data from the meteorological stations in the DRB for the period from 1946 to 2012.

Data related to the start of operations of the subject stations and their elevations were taken from the existing meteorological yearbooks. It should be noted that subject yearbooks exhibit certain differences in data taken from the same station. The following Figure 4-1 shows the percentage of rainfall data completeness for the DRB in BiH, for the periods from 1946 to 1990, from 1991 to 2012 and from 1946 to 2012.

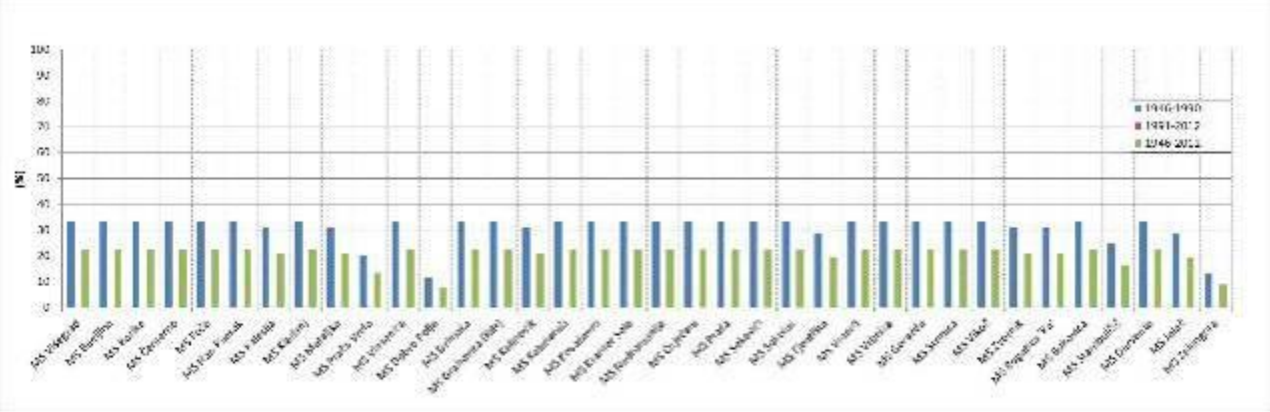


Figure 4-1: Percentage of daily rainfall sum data completeness along the segment of theDRB in BiH

Based on the above chart one may notice that for the period from 1946 to 1990 data (but no complete series) exist for all stations and percentage of completeness of data is low. One may also notice that in the basin segments in BiH there are no stations with available data for the subject period.

Note: by the end of 2015 (after the completion of the CR) for the purpose of this project the authorized hydro-meteorological services in Banja Luka and Sarajevo have delivered the data on daily values of precipitation for: "Kladanj" HS (from 1961 to 1969 and from 1985 to July 1991), "Bijeljina" HS (from 1961 to November 1991 (with a gap in 1989) and from 1997 to 2014) and "Čemerno" HS (from 1961 to 1991 and from 2001 to 2014, with a gap in August 2012).

Air Temperature Data

Total number of measurement stations in the "Drina" HIS database with air temperature data available analyzed within this study is 16.

In the "Drina" HIS database there are no data for the period before 1946 (ending with 1945) available for any stations analyzed within the basin.

In the "Drina" HIS database for the period from 1946 to 1969 there are no air temperature data available for the basin segments in BiH.

The best data completeness, as regards to the entire basin is for the period from 1970 to 1984 period (same as for the rainfall data). Air temperature data in the "Drina" HIS database for the period from 1985 to 2012 are available to a lesser degree for the entire DRB territory that belongs to BiH.

Figure 4-2 below shows the percentage of air temperature data completeness for the DRB in BiH, for the periods from 1946 to 1990; from 1991 to 2012 and from 1946 to 2012.

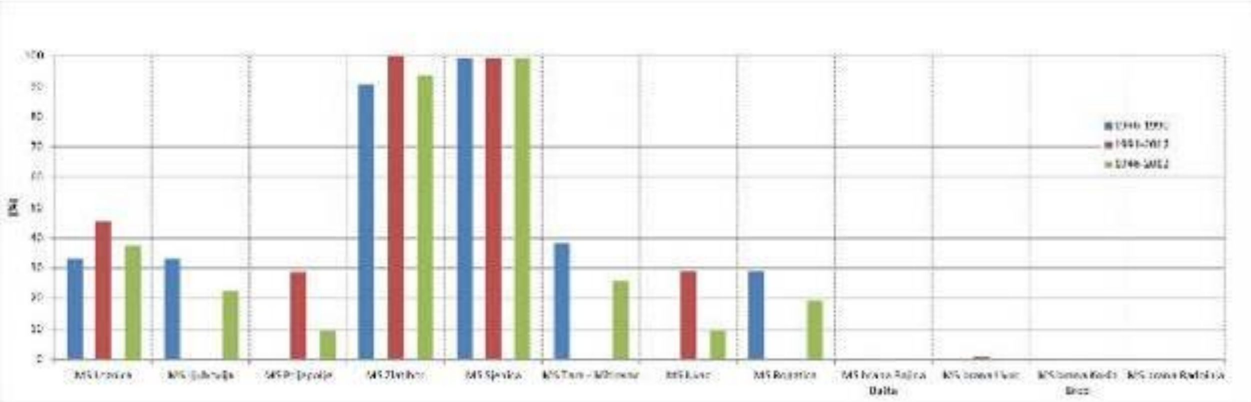


Figure 4-2: Percentage of completeness of mean daily air temperature data along the DRB in BiH

Based on the above graph, one may notice that for the period from 1946 to 1990, in the basin segment in BiH, data series for the subject period exist on 15 out of 16 existing stations, but they are not "complete" and percentage of completeness of data is low. One may notice that in the basin segments in BiH, data are available from five (out of 16 existing) stations, but the percentage of data completeness is low.

Note: by the end of 2015 (after the completion of the CR) for the purpose of this project the authorized hydro-meteorological services in Banja Luka and Sarajevo have delivered the data on daily values of mean daily temperatures for: "Kladanj" HS (from 1961 to 1969 and from 1985 to July 1991), "Bijeljina" HS (from 1961 to November 1991 (with gaps in 1987 and 1989) and from 2001 to 2014) and "Čemerno" HS (from 1961 to 1991 and from 2006 to 2014).

4.1.2 Processing and Gap-Filling of Meteorological Data

In order to work with the hydrological model (described in Chapter 4.3) it was necessary to perform the task of completing daily rainfall and air temperature data from the representative meteorological stations in the DRB. Firstly, it was necessary to perform control of existing data series that may be subject to various data errors (typing errors, as well as errors in data gauging possibly identified by visual observation of data series and their plots). Evident errors identified were corrected for the model to be in position to generate correct results. Processing and control of existing data was conducted by means of standard mathematical and statistical procedures, i.e. procedures implemented in the "Drina" HIS.

Model development required complete data series. Existing data series frequently are not complete, and they miss data to a greater or lesser extent. Thus, it was necessary to define the method of gap-filling the missing data into time series and performing their control. Commonly, missing data are gap-filled into time series by means of standard gap-filling methods and, thus, data are prepared for model utilization.

Gap-filling of data was conducted by means of VNC (Multiple Non-Linear Regression) model (integrated into the "Drina" Hydro-Information System) developed in the "Jaroslav Černi" Institute. For a specific station with no data it was performed on the basis of existence of data for another one and the existence of a synchronous period (period when data are available on both stations). This process required relevant calculations and correction with respect to elevation and position of the respective meteorological stations.

Processing and generation, i.e. gap-filling of missing data was conducted for total of 29 rainfall station and for 14 meteorological stations on the territory of BiH. Rainfall and air temperature data analysis and processing period was from 1970 to 1984.

4.1.3 Analysis of Precipitation Regime in the Basin

Climate conditions in the DRB are subject to constant reduction of the altitude, ranging between high-mountain altitudes to the Pannonia plain ones. Therefore, the basin is under the influence of different climate regimes. The highest source area of the Drina River in Montenegro is under the influence of the Mediterranean climate, which, although weaker, is still felt in the upper segment of the basin up to the town of Foča, wherefrom dominant climate is temperate continental climate, while in the lower segments, downstream of the town of Zvornik, continental climate is dominant. Subject changes are best observed in the annual rainfall quantities.

High mountain areas (above 2,000 m a.s.l.) receive 2,000 to 3,000 mm, medium height mountains approximately 1,500 mm and low mountains from 800 to 1,000 mm of atmospheric precipitation. Quantity of atmospheric precipitation around the Drina River confluence with the Sava River is 700 mm. Rainfall quantities, however, drop along the river course, although not regularly, as regularity is dis-torted by local conditions. Rainfall distribution is the same throughout the year. Annual quantities grow in balanced manner up to the town of Šćepan Polje, with the driest month receiving 4.2% of the total annual rainfall quantity, up to the town of Loznica, with the higher average of 7.1%.

Drina River, Tara River and Piva River and tributaries along the Drina River upper course belong to the so-called snow-rain regime of Dinaric-Macedonian variant. This means that the highest discharges occur in May and April, except for the Piva River, with the highest discharges in December. Although the period of flood discharge in the Drina River is long-lasting, due to gradual nature of snow melting on the mountains, catastrophic floods are not frequent. High water levels may also occur in autumn, usually in November, due to more rainfall.

Present chapter includes analysis of the DRB climate characteristics and isohyets map has been also included. Isohyet map has been taken from the "Vodoprivreda" magazine, Belgrade, paper no. 2 –"Principal Hydrographic Characteristics of the Drina River Basin and Hydro-Meteorological Data", 2004.

Isohyet map of the DRB was developed for the period from 1946 to 1991 and as such is representative enough for the analyses presented here. It is clear that the collection of all necessary precipitation data from the measurement stations could be used for "update" of the isohyet map, but this would exceed the scope of this project. Present chapter also includes definition of intra-annual rainfall distribution by basins for the 1970 to 1984 period, since for this period rainfall data exist for the majority of stations. Several stations from all subject basins were selected for processing.

Spatial distribution of average annual rainfall sums is shown in the form of the isohyets map in the Figure 4-3 below.

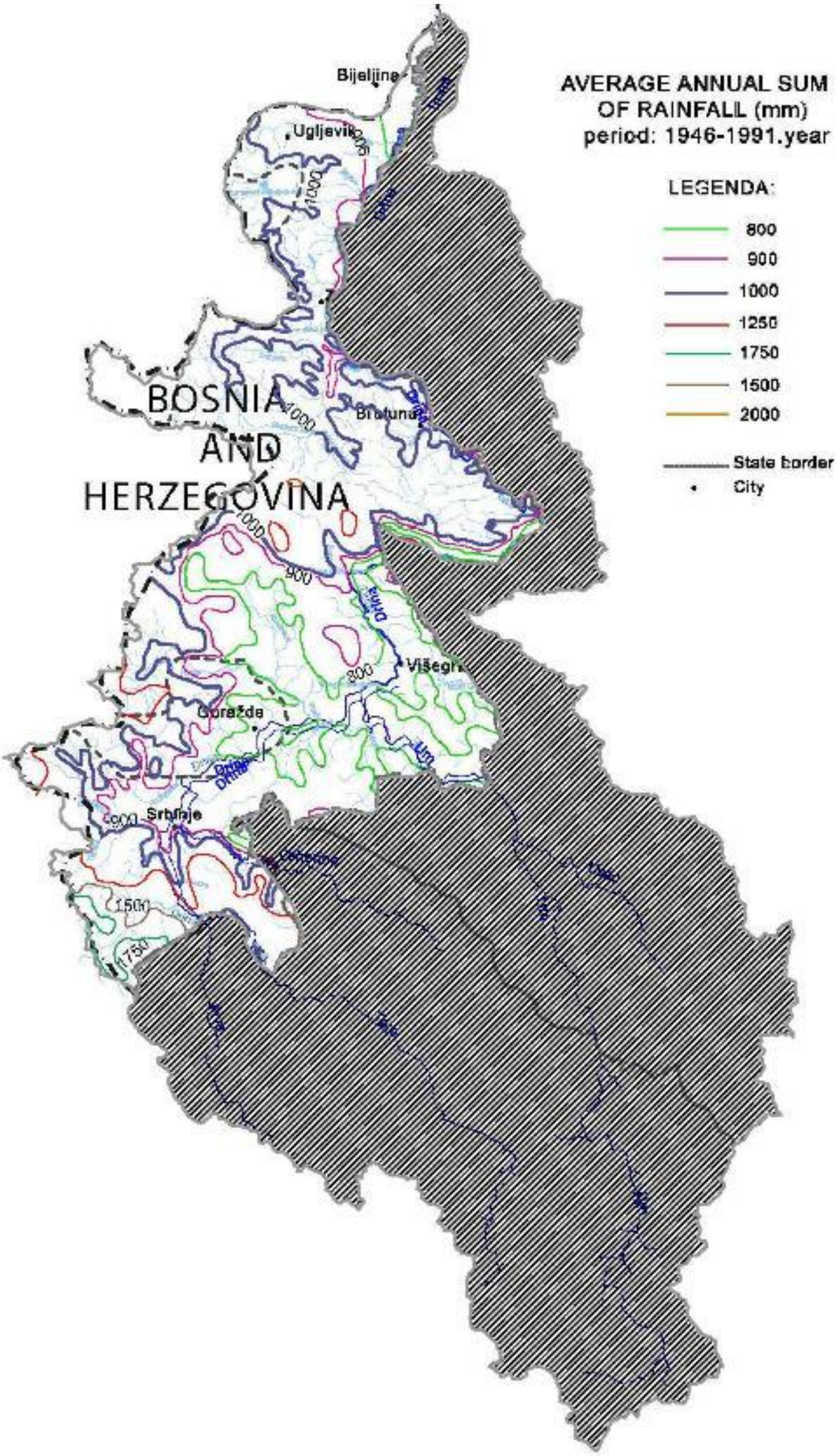


Figure 4-3: Isohyet map of the DRB in BiH

Average annual rainfall in the DRB, for a longer period, is approximately 1,030 mm. Average multi-annual rainfall for the 1946 to 1991 period ranges between 700 mm in the eastern segment of the basin (Badovinci-

Sjenica) and 2,300 mm (Gornje Lipovo), i.e. 3,000 mm, in the source area of the Lim River on the Prokletije Mountain in Montenegro. South-western segment of the basin is more rainfall-abundant than the north-western segment. Since the Drina River cuts through two mountain ranges of the Dinara System (Javor Mountain-Tara Mountain and Majevica Mountain-Cer Mountain), rainfall depressions are located in between them. Depression of rainfall in the broad area between two mountain ranges, from the town of Sjenica to the town of Višegrad, is particularly pronounced.

The rainfall regime has been analyzed on the basis of available data from meteorological stations in the DRB. Intra-annual rainfall distribution for selected rainfall stations has been defined by basins for the period from 1970 to 1984 and presented in the following Figure 4-4 to Figure 4-5 inclusive.

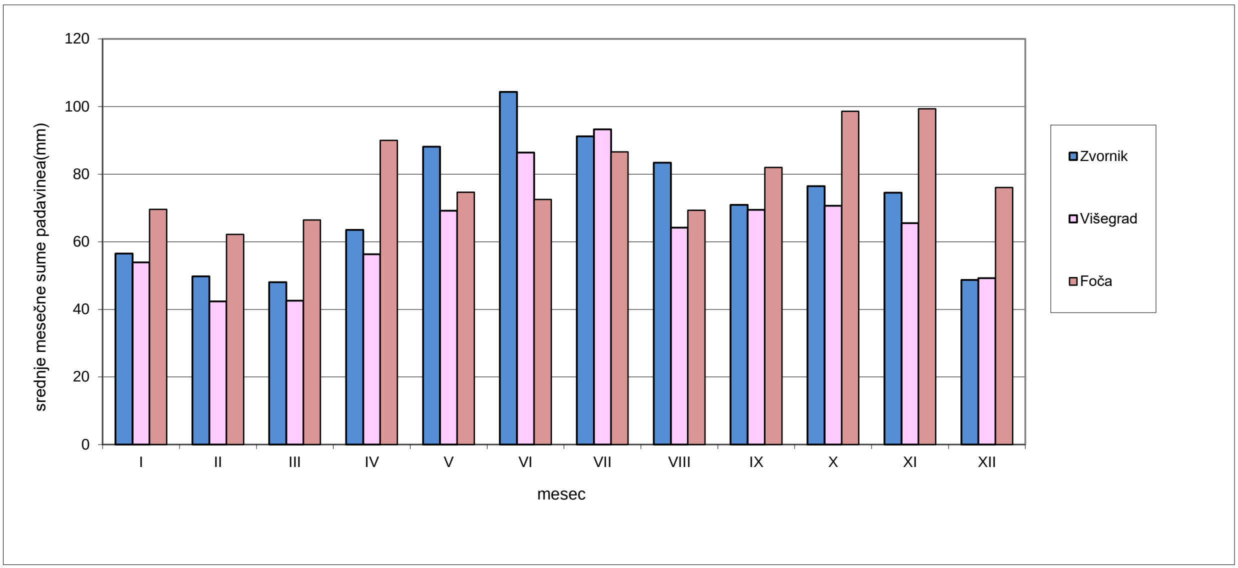


Figure 4-4: Intra-annual rainfall distribution on selected rainfall stations along Drina River from 1970 to 1984

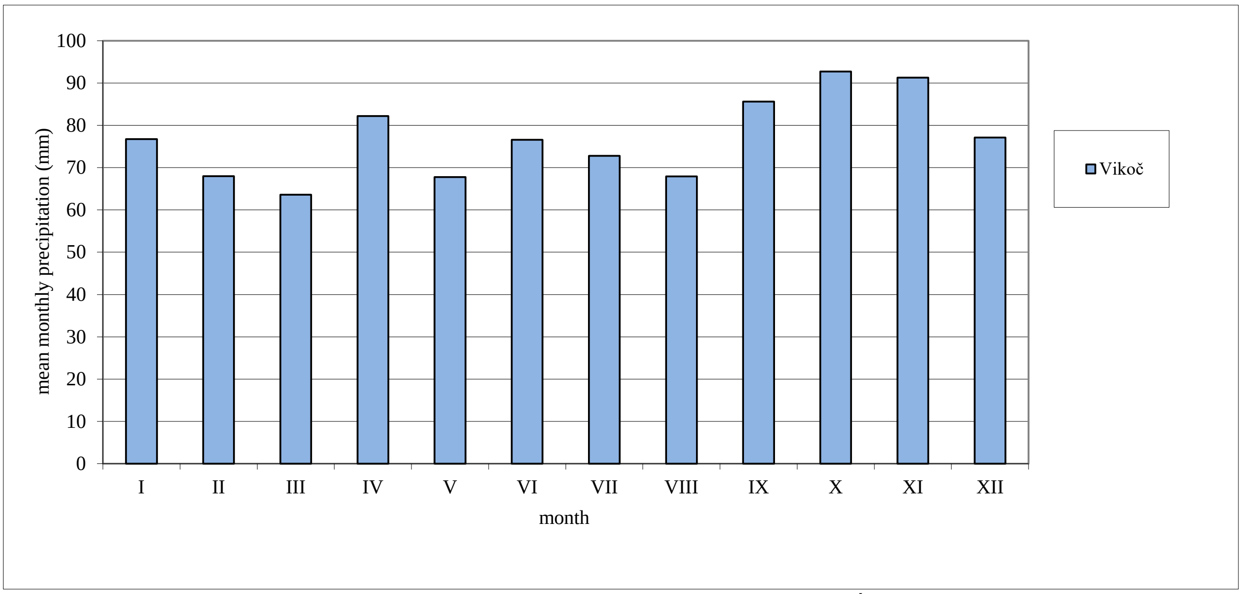


Figure 4-5: Intra- annual rainfall distribution on selected rainfall stations along Ćehotina River from 1970 to 1984

The previous charts show that maximum monthly rainfall sums occur in period from October to November (upper parts of the basin), i.e. in period from May to July (middle and lower parts of the basin) while the minimum values occur mainly early in the year (in February and March). The following Figure 4-6 presents selected rainfall stations used to define intra-annual rainfall distribution in the DRB in BiH.

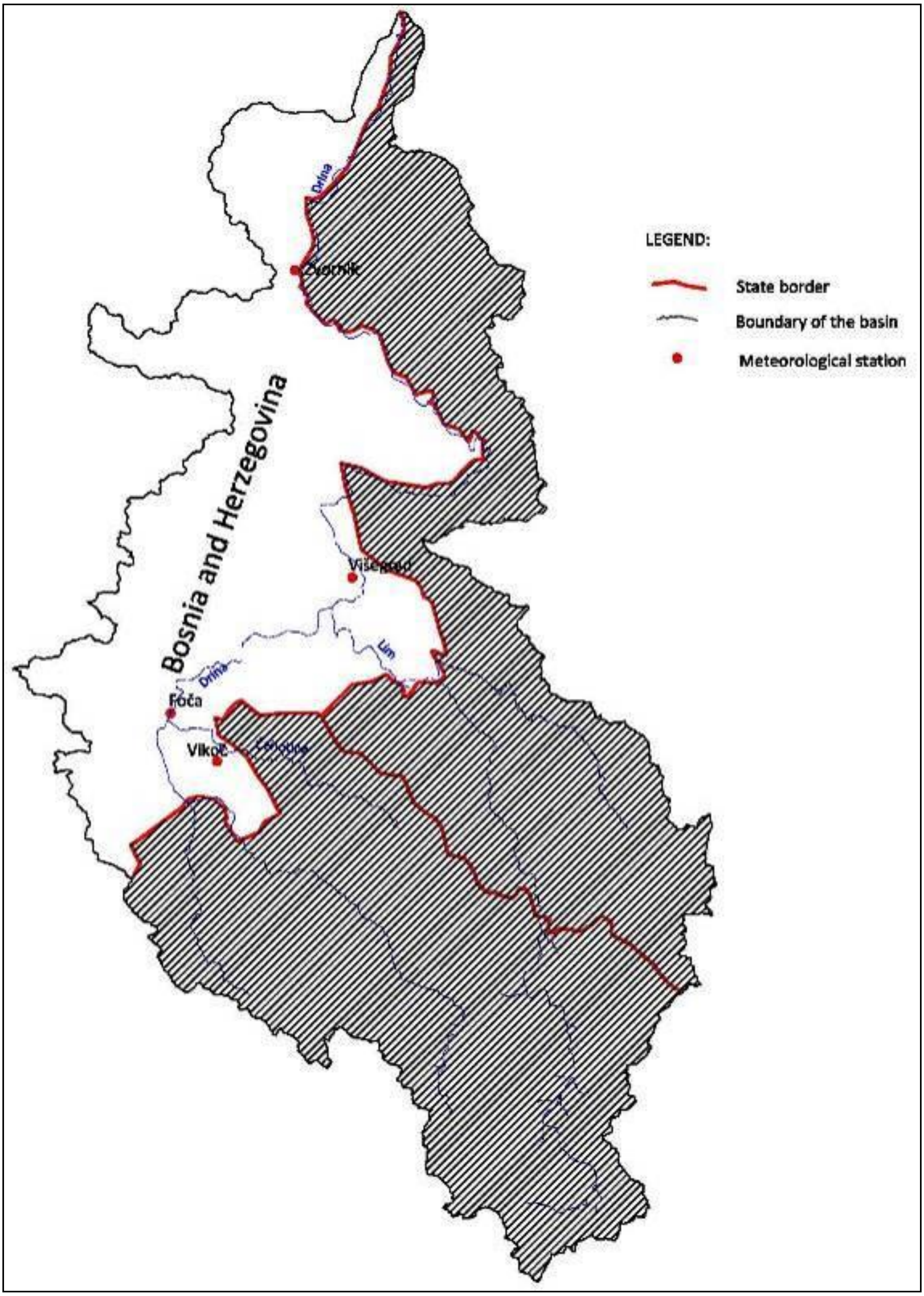


Figure 4-6: Selected rainfall stations in the DRB in BiH used for definition of intra-annual rainfall distribution

4.2 Hydrological data

As already mentioned, in terms of available hydro-meteorological knowledge, the DRB falls into the category of well-studied basins, studied over a relatively long period. First regular water level observation activities were initiated in 1888 on three water measurement stations along the Drina River, while the first hydrometric measurements of discharge were initiated in 1924 on several hydrological stations along Drina River, Tara River and Rzav River.

Monitoring and measuring hydro-meteorological phenomenon in the DRB are officially conducted by authorized institutions (Republic Hydro-Meteorological Service of Republic of Srpska and Federal Hydro-Meteorological Service). In former SFRY, observation, measuring and archiving of hydro-meteorological data was executed by hydro-meteorological services of the republics (Serbia, Montenegro, and BiH). Federal Hydro-Meteorological Service (FHMS) collected data from the republic hydro-meteorological services only from selected hydrological stations in order to publish the data in the form of the "Yearbook of the Hydro-Meteorological Service of Yugoslavia" ("Hydrological Yearbook " and other.). FHMS worked on development of the "Hydrological and Meteorological Database". Partial hydro-meteorological databases were also developed within the republic hydro-meteorological services. Contents of the subject database, as well as their status and availability for potential users, is not known to the professional audience.

As already mentioned above, by means of a large number of significant projects , the "Jaroslav Černi" Institute for Development of Water Resources collected and systematized hydrological data of the DRB, and majority of available data records are in original form or processed, and archived in the "Drina" Hydro-Information System ("Drina" HIS), which is constantly being populated with newly arriving data.

4.2.1 Review and Assessment of the Available Hydrological Data

Hydrological data from 24 hydrological stations in the DRB in BiH were analyzed, those that were active previously, i.e. in the history of hydrological value measurement on the rivers of the Drina River or they were active by certain point in time and than they were abandoned. Majority of the stations are on the Drina River (7), then the Lim River (2), Ćehotina River (2) and other Drina River tributaries. Period covered by present analysis is from 1946 to 2012. Data sources were official hydrological yearbooks of FPR of Yugoslavia (1945 to 1962), SFRY (1963 to 1991), FR Yugoslavia (1992 to 2003), then Serbia (2004 to 2012), BiH (from 2001 to 2012) and hydrological yearbooks for the Sava River basin (2006 to 2011). It should be noted that in addi-tion to stations shown here, several other stations were identified which were not taken into considera-tion as they have never started to operate in the real sense of the word or they were insignificant, i.e. there are not enough information on their exact locations and periods of operation ("Avdagića Luke" HS, "Rabitlja" HS and others).

The following Table 4-2 presents analyzed hydrological stations in the DRB in BiH with their basic data.

Table 4-2: Hydrological stations in the DRB in BiH

No	Station name	River	Location	Established	Status
1	"Višegrad most"	Drina	RS	1890	Non-existent since 1990
2	"Orahovci"	Drina	RS	1974	Non-existent since 1989
3	"Međeđa"	Drina	RS	1958	Non-existent since 1989
4	"Goražde"	Drina	FBiH	1962	Active
5	"Foča Most"	Drina	RS	1888	Active
6	"Foča uzvodno"	Drina	RS	1927	Non-existent
7	"Bastasi"	Drina	RS	1898	Non-existent
8	"Strmica"	Lim	RS	1958	Non-existent since 1989
9	"Rudo"	Lim	RS	1892	Active
10	"Foča Aladža"	Ćehotina	RS	1892	Inactive
11	"Vikoč"	Ćehotina	RS	1898	Non-existent
12	"Ustibar Most"	Poblačnica	RS	1926	Non-existent

No	Station name	River	Location	Established	Status
13	"Ustiprača"	Prača	RS	1925	Non-existent
14	"Otričevo"	Prača	RS		Non-existent
15	"Strgačina"	Radojna	RS	1963	Non-existent
16	"Višegrad Lipa"	Rzav	RS	1924	Non-existent since 1990
17	"Igoče"	Sutjeska	RS	1926	Non-existent
18	"Oplazići"	Bistrica	RS	1926	Non-existent
19	"Kušlat"	Drinjača	RS	1957	Non-existent
20	"Ugljevik"	Janja	RS	1962	Non-existent
21	"Šekovići"	Drinjača	RS	1962	Non-existent
22	"Mesići"	Prača	RS	1901	Non-existent
23	"Rogatica"	Rakitnica	RS	1926	Non-existent
24	"Umac"	Zeleni Jadar	RS	1962	Non-existent

A total of 24 hydrological stations has been analyzed on the territory of BiH (23 on the territory of the RS and one on the territory of FBiH), with 148,903 available data on daily discharges and 114,601 data records on daily water levels.

In addition to hydrological data quantified as available for the period from 1946 to 2012, "Drina" HIS includes data for an earlier period (from 1926 to 1945), as well as for the period after 2012. In that context, "Drina" HIS includes 14,245 available data records (7,305 daily discharges, 6,940 daily water levels) for the period from 1926 to 1945 and 501 data records (0 daily discharges, 501 daily water levels) for the period from 2013 to 2014. A presentation of the availability of the number of hydrological data records (daily values of water level and discharges) is given in the following Figure 4-7.

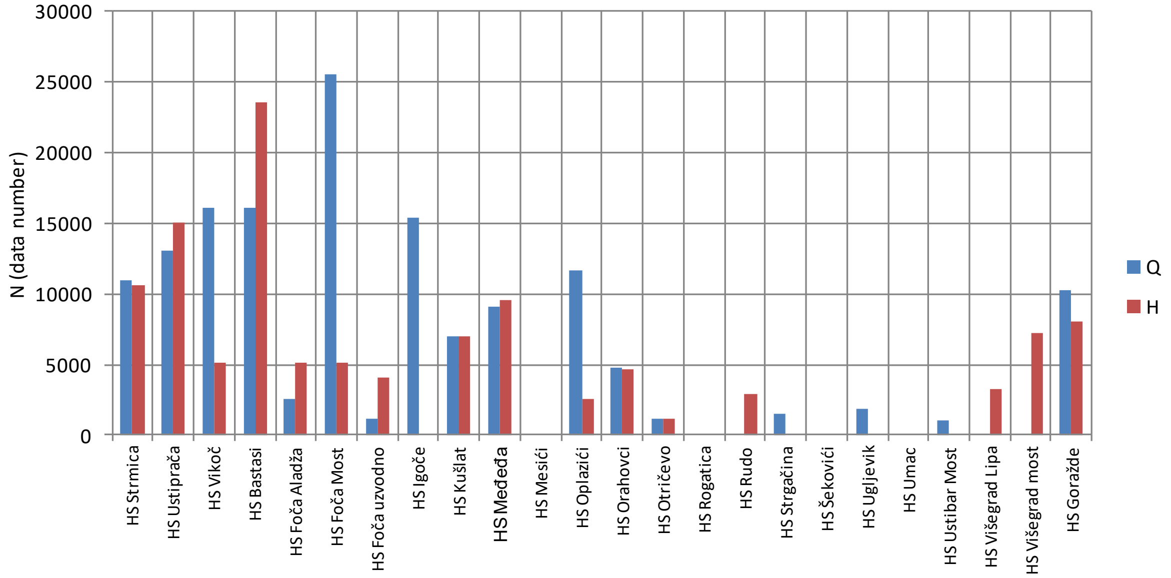


Figure 4-7: Overview of available data (Q and H) from the hydrological stations in the DRB in BiH

Spatial positions of the hydrological stations within the part of the DRB in BiH is provided in Figure 4-8 .

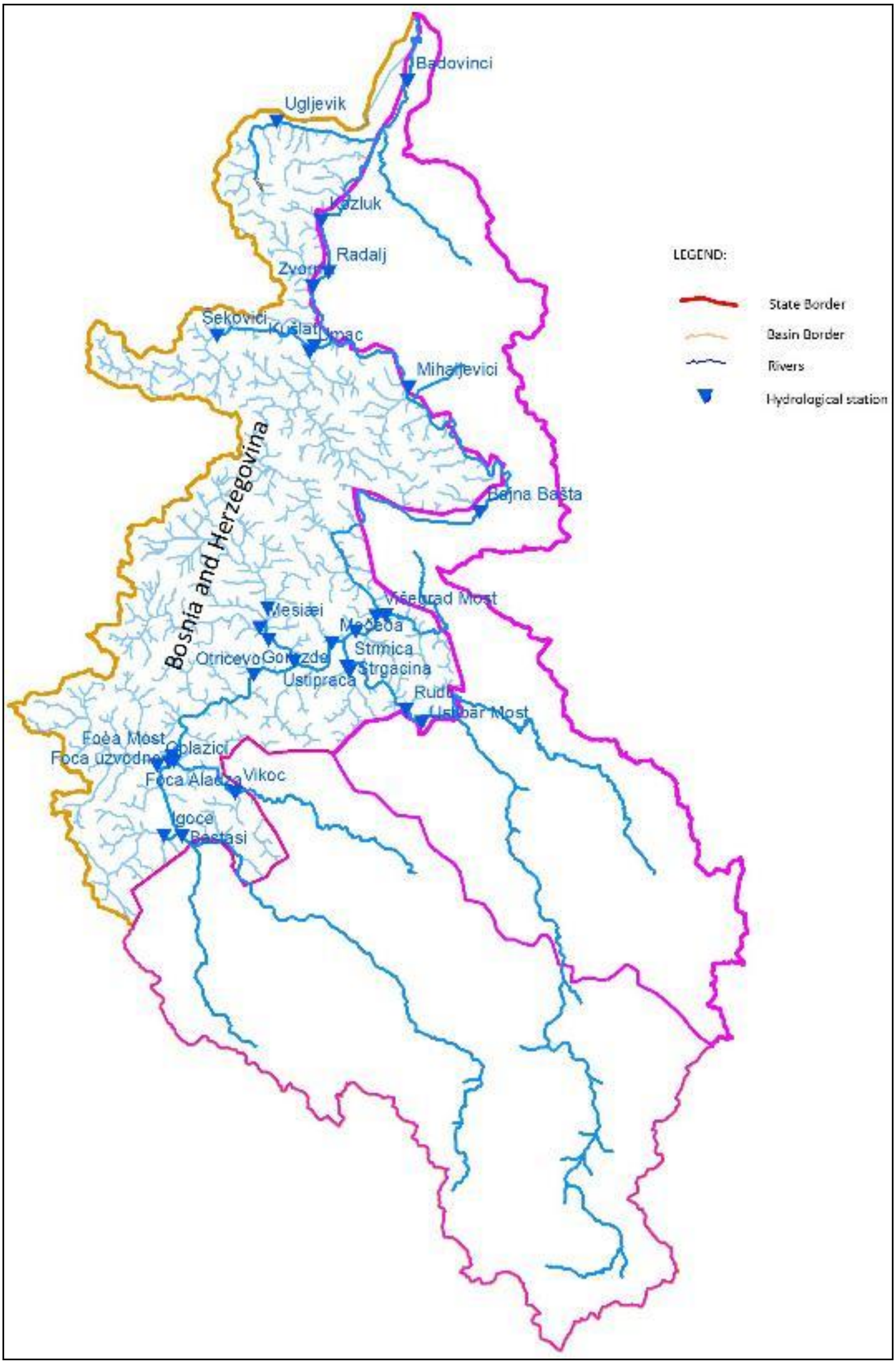


Figure 4-8: Hydrological stations in the DRB in BiH

4.2.2 Processing and Gap-Filling of Hydrological Data

Calibrating of the hydrological model parameters required gap-filling of daily discharge values for 11 hydrological profiles in the DRB. The period from 1970 to 1984 was selected as adequate, because in the DRB there has been identified good availability of both hydrological and meteorologically gauged data. Certain number of selected hydrological profiles (9) had complete data series on daily discharges (i.e. water levels), these being:

- "Bajina Bašta" (Drina River),
- "Kozluk/Radalj" (Drina River),
- "Goražde" (Drina River),
- "Foča Most" (Drina River),
- "Foča uzvodno (upstream)" (Drina River),
- "Strmica" (Lim River),
- "Oplazići" (Bistrica River),
- "Vikoč" (Ćehotina River) and
- "Foča Aladža" (Ćehotina River).

During the analyzed period there were no complete daily discharge (i.e. water level) series from the folowing stations (2), these being:

- "Badovinci" (Drina River) and
- "Višegrad" (Drina River).

The following Figure 4-9 presents mean annual discharges on the analyzed hydrological profiles for the period from 1970 to 1984 with completed mean daily discharges.

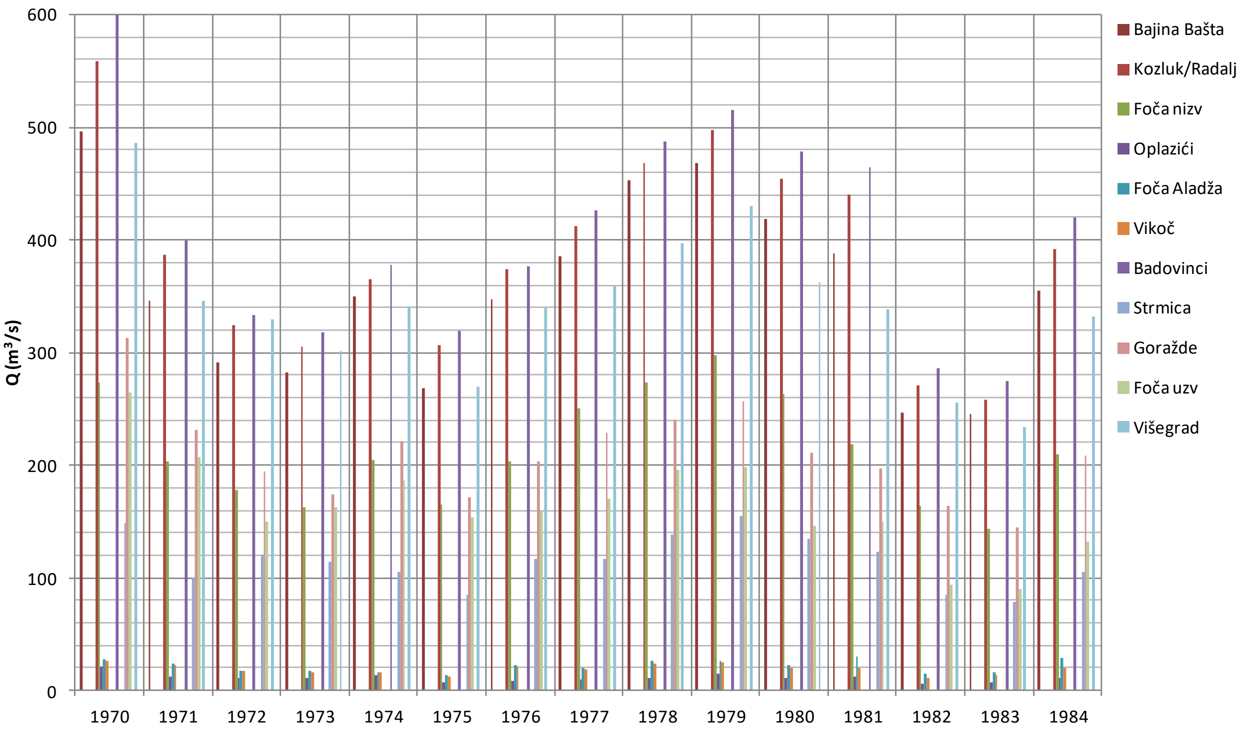


Figure 4-9: Mean annual discharges on the analyzed hydrological profiles for the period from 1970 to 1984

Discharge on the "Badovinci" HS for the complete analyzed period was computed by means of data from the upstream station "Kozluk/Radalj" HS and one on biggest tributary to the Jadar River, "Lešnica" HS:

$Q_{Badovinci} = Q_{Kozluk/Radalj} + 2.071 \cdot Q_{Lešnica}$

Although measurements for the "Višegrad Most" HS do exist, they were not used as the hydrological station is occasionally under the water level of the "Bajina Bašta" storage. Discharges on the "Višegrad Most" HS were computed by means of data from the upstream stations, "Strmica" HS on the Lim River, "Goražde" HS on the Drina River and "Ustriprača" HS on the Prača River and inter-basin contribution:

$Q_{Višegrad} = Q_{Strmica} + Q_{Goražde} + Q_{Ustriprača} \cdot\cdot 1.15.$

Conclusion is that the majority of daily discharge data for hydrological model parameter calibration is original, i.e. measured, and that only 22.7% (30/132 years) of data were gap-filled in by the means of aforementioned procedures.

4.3 Hydrological Model

Substantial efforts were invested in development of the Hydro-Information System of the Drina River ("Drina" HIS, "Jaroslav Černi" Institute, 2002 to 2011) in the previous period, with the focus on development of the forecast hydrological model. Completely calibrated and verified forecast model with daily discretization was delivered in 2011 when successful inflow forecast started on major hydro-profiles in the DRB.

Hydrological model development, methodology improvement, further model calibration (updating formed parameter sets) and transition to six-hour time interval of discretization were some of the activities that were continued after 2011.

So far (as demonstrated below by results), the model reliably forecasts high and medium discharges, with somewhat less reliable forecast of low discharges that is still satisfactory.

Hydrological model applied was distributed and based on the physical laws describing transformation of surface (direct) and subsurface (base) runoff. Spatial decomposition of the model implies basin area subdivision on convex elements of irregular shape, where each element is characterized by specific features (vertical filtration coefficient, porosity, characteristic wetness...) included in the calculation of the vertical water balance.

The developed model is composed of a series of hydrological system elements describing natural phenomena and processes in simple terms. Calculation of rainfall transformation into runoff on selected hydraulic profiles was conceptualized to simulate vertical water streaming and formation of subsurface and surface runoff. Input values are rainfall and meteorological parameters, while the outputs are subsurface and surface runoff on characteristic hydraulic profiles. Vertical water balance is calculated in distributed manner for the entire basin area.

The second segment of the hydrological model is (conditional horizontal) water streaming, i.e. transformation of computed components of vertical water balance (from the vertical segment) through the linear reservoir system. The detailed methodology applied to the modeling is described in Annex 4-1.

4.3.1 Overview of Results – Mean Weekly Discharges

The present chapter presents the results of modelling according to the methodology and procedure described in Annex 4-1. Results are shown for the hydraulic profiles on outlet river sections of respective sectors.

Calibration

Hydrological model calibration was conducted for the period from October 1st 1971 to September 29th 1977. Start and end of the simulation were assigned to the start of the hydrological year when the soil is mainly dry and autumn rains are about to begin. The following Table 4-3 provides calibration assessment according to criteria described in Annex 4-1. Values are related to aggregate weekly series of observed and modelled discharges.

Table 4-3: Calibration efficiency assessment on the hydraulic profiles of respective sectors

No.	Hydraulic profile	River	Assessment of model efficiency			
			NSE	RSR	R	Comment (according to NSE and RSR criteria)
1	"Šćepan polje"	Tara	0.855	0.381	0.926	very good
2	"Šćepan polje"	Piva	0.824	0.419	0.909	very good
3	"Foča"	Drina	0.850	0.387	0.927	very good
4	"Prijepolje"	Lim	0.755	0.495	0.874	very good
5	"Strmica"	Lim	0.753	0.497	0.874	very good
6	"Višegrad"	Drina	0.839	0.401	0.926	very good
7	"Bajina Bašta"	Drina	0.814	0.432	0.909	very good
8	"Zvornik"	Drina	0.825	0.418	0.913	very good
9	"Mouth of the river"	Drina	0.819	0.425	0.911	very good

The following Table 4-4 provides values of characteristic discharges for observed and modeled series on outlet profiles of respective sectors.

Table 4-4: Overview of observed and modelled values of weekly discharges (calibration)

No.	Hydraulic profile	River	Discharge - observed (mean annual values)			Discharge - simulated (mean annual values)		
			Q_{avg}	Q_{min}	Q_{max}	Q_{avg}	Q_{min}	Q_{max}
1	"Šćepan polje"	Tara	78.10	32.37	205.14	75.24	29.70	204.72
2	"Šćepan polje"	Piva	67.01	25.35	179.02	68.10	24.14	164.14
3	"Foča"	Drina	189.60	79.90	437.28	181.40	71.80	456.03
4	"Prijepolje"	Lim	74.70	28.97	210.41	76.05	31.92	215.28
5	"Strmica"	Lim	108.82	50.15	255.91	110.97	53.30	260.75
6	"Višegrad"	Drina	320.17	157.24	707.08	320.58	141.89	769.15
7	"Bajina Bašta"	Drina	314.99	112.18	746.60	339.45	152.38	795.12
8	"Zvornik"	Drina	344.46	134.77	787.24	358.95	164.59	825.37
9	"Mouth of the river"	Drina	354.51	137.73	807.72	373.85	174.71	848.25

As apparent from the previous two tables, hydrological model generates very good match between observed and modelled series. Multi-annual average (calibration period – 7 years) of mean weekly discharges generates very little deviations from the measured values. Also, differences between average multi-annual maximum weekly discharges indicate small deviations from measured values, meaning that the flood waves and flood periods are well modelled. Somewhat bigger deviations occur with low discharges, but the values are still satisfactory. Reason for that is the methodology of the linear reservoirs system use for base runoff transformation. The following study period was planned for introduction of nonlinear reservoirs system, which would improve matching of hydrograph recession branches significantly.

The following charts (Figure 4-10 to Figure 4-12 inclusive) present the examples of intra-annual distribution of weekly discharges during the calibration period. More results are presented in Annex 4-2.

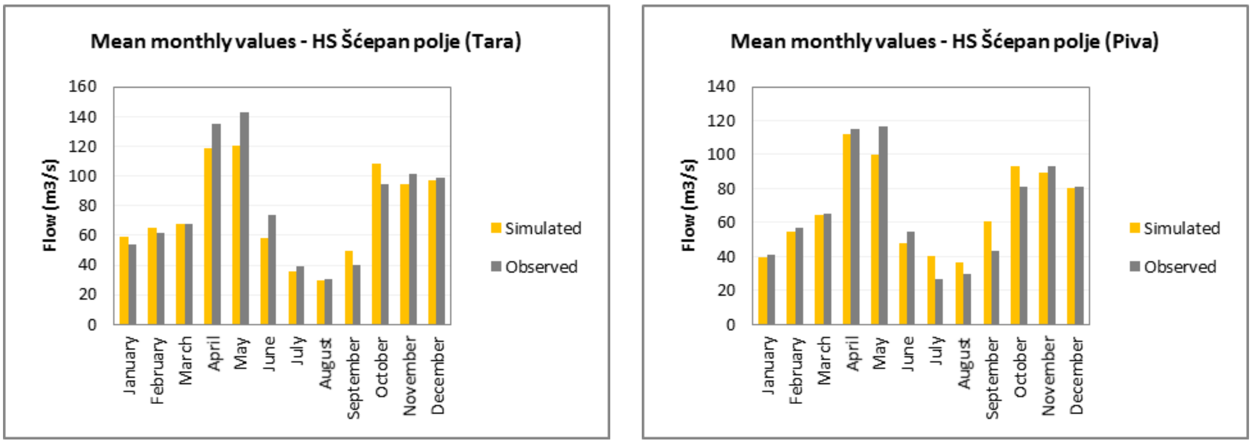


Figure 4-10: Mean monthly values of weekly discharges(calibration period)

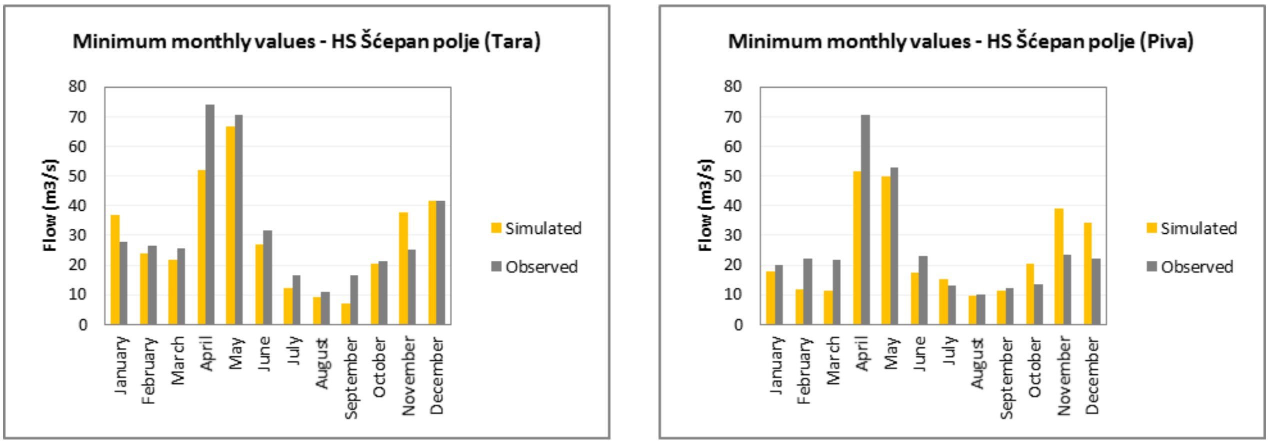


Figure 4-11: Minimum monthly values of weekly discharges (calibration period)

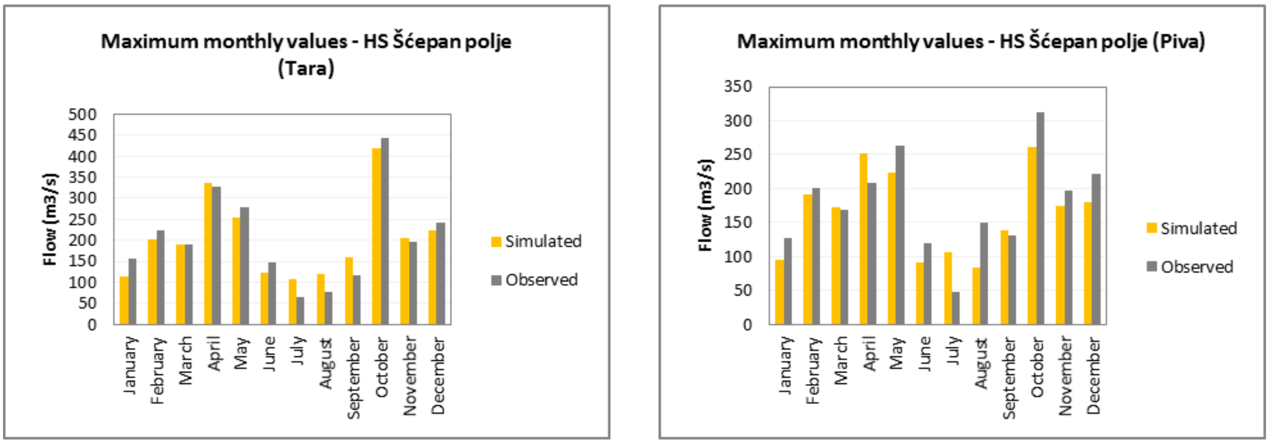


Figure 4-12: Maximum monthly values of weekly discharges (calibration period)

Model verification is presented in Annex 4-3.

4.4 Hydrological Analyses - Calculation of Medium, Low and Flood Discharges

4.4.1 Analysis of Mean Monthly and Annual Discharges

Methodology

Hydrological regime determination for the DRB required gap filling of data missing from the hydrological stations. The tools integrated into the “Drina” Hydro-Information System, i.e. hydrologic model and VNC mathematical model were used for gap-filling-of mean monthly discharge time series on hydrological stations in the DRB. The core of the VNC model (which in the past was several times used in the DRB with success) is generation of correlation dependencies between standardized variables, various combinations of cause-effect relationships and different hydro-meteorological time series.

The model is basically developed for spatial interpolation of hydro-meteorological data on profiles where no observation and measured data exist. However, the model was also adapted to the need to gap-fill and extend interruptions in existing hydro-meteorological data series from measurement stations.

Hydrological Data

Hydrological analysis of mean monthly discharges was conducted for the DRB covering total of 19,982 km^2 up to the mouth into the Sava River. Average visible basin yield is q=19.8 $l/km^2/s$. Hydrological stations are located along the main Drina River course ("Foča Most" HS, "Bastasi" HS), on the Ćehotina River ("Vikoč" HS), on the Sutjeska River ("Igoče" HS) and on the Bistrica River ("Oplazići" HS). Position of the analyzed hydrological stations in the DRB is presented in the following Figure 4-13 together with the hydrographic grid and state borders.

Mean monthly discharges from the analyzed hydrological stations are mainly available for the period up to 1990. After that period (from 1990 to 2012), data on mean monthly discharges from stations in BiH are mainly unavailable. The period from 1926 to 1945 was analysed within the comprehension of the hydrological processing period since certain station in the DRB include discharge measurements from this period. However, this is about a small number of stations in the basin that do not cover the entire basin and they are also characterized by large number of missing data records. Consequently, the 1946 to 2012 period was selected for analysis at all hydrological stations. Available series of mean monthly discharges from the analyzed hydrological stations are presented in the following Table 4-5.

Table 4-5: Available monthly discharge data from analyzed hydrological stations in the DRB in BiH from 1946 to 2012

No	Hydrological station	River	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
1	Bastasi	Drina	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2	Foča Most	Drina	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
3	Vikoč	Ćehotina	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
4	Igoče	Sutjeska		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
5	Oplazići	Bistrica									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

No	Hydrological station	River	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	Bastasi	Drina	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
2	Foča Most	Drina	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
3	Vikoč	Ćehotina	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■
4	Igoče	Sutjeska	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			■	
5	Oplazići	Bistrica	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					

No	Hydrological station	River	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	Bastasi	Drina																						
2	Foča Most	Drina														■	■	■	■	■				
3	Vikoč	Ćehotina																						
4	Igoče	Sutjeska																						
5	Oplazići	Bistrica																						

Legend:
Unavailable data

Time series of monthly discharges were gap-filled for all stations with missing data by the means of the VNC mathematical model ("Drina" Hydro-Information System). Filling-in was conducted for the upper course of the Drina River for the stations on the Drina River ("Bastasi" HS, "Foča" HS) and the Ćehotina River ("Vikoč" HS). Additionally, gap-filling of monthly discharge series was conducted for small rivers, such as the Bistrica River ("Oplazići" HS) and the Sutjeska River ("Igoče" HS). Gap-filling of monthly discharge series in south segments of the Drina River course included use of hydrological data from the "Mratinje" storage on the Piva River, as well as data from "Višegrad" storage taken from the "Drina" HIS.

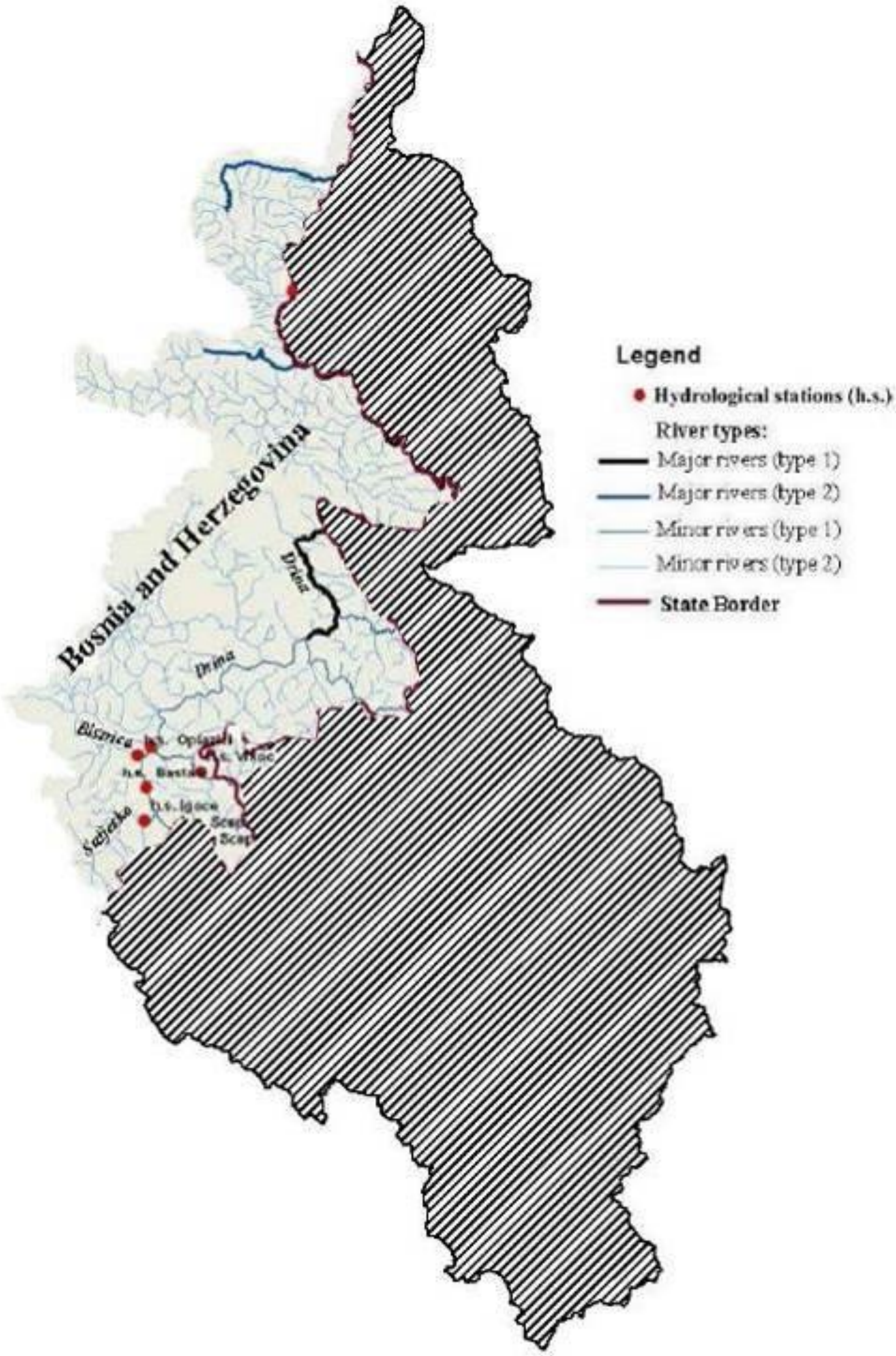


Figure 4-13: Layout of analyzed hydrological stations in the DRB in BiH together with hydrographic grid and state borders

Storage (dam) profiles required transformation of regulated monthly discharge series into unregulated to meet the requirements of the VNC model application ("Drina" Hydro-Information System). VNC model parameters estimation was conducted for the historic period by the means of application of input hydro-meteorological series and output monthly discharge series for the hydrological station profile subject to gap-filling.

Hydrological Analysis Results

Average discharges are the characteristic of the water regime pointing to the water yield of the basin area. Present study analyzed characteristic water regimes in the DRB on the hydrological stations along the main

Drina River course and its tributaries, such as Ćehotina River, Bistrica River and Sutjeska River (Figure 4-13). Hydrological stations were selected in line with the available data. Results of the hydrological analysis are shown in the following Table 4-6, showing numerical indicators of water regime for each analyzed hydrological station in the DRB and the characteristics of the basin, such as basin area *F*, mean annual discharge *Q*, standard deviation of annual discharges σ_Q, mean basin yield *q* and skewness C_s.

Table 4-6: Analyzed hydrological stations in the DRB in BiH

No.	Hydrological station	River	F (km^2)	Q (m^3/s)	σ_Q (m^3/s)	q (l/km^2/s)	C_s
1	"Bastasi"	Drina	3,172	143.5	31.7	45.2	1.031
2	"Foča Most"	Drina	5,446	195.8	41.9	35.9	0.779
3	"Vikoč"	Ćehotina	1,296	17.6	4.1	13.6	1.211
4	"Igoče"	Sutjeska	270	13.8	4.1	51.3	2.285
5	"Oplazići"	Bistica	423	11.9	3.5	28	1.582

Legend F (km^2)-basin area, Q (m^3/s)- mean annual discharge, σ_Q(m^3/s)-standard deviation of annual discharges, q (l/km^2/s)-mean basin yield, C_s-skewness

Spatial distribution of water resources of a basin area is presented by means of the map of isolines of specific water yield. Based on the specific water yield from analyzed hydrological station presented in previous table one cannot generate the map of isolines since it requires large number of hydrological stations. Therefore, map of isolines of specific water yield q (l/km^2/s) was generated for the period from 1946 to 1991 for the entire DRB. During that period, a significantly larger number of hydrological stations were available. Based on the map presented in the following Figure 4-14 one may comprehend the regime of the river run-off regime formed in the DRB, as well as the spatial distribution of available water. Southern segments of the DRB are far more water-abundant than the northern and central segments of the basin. Since southern basin segments are in the mountainous area are receiving more rainfall quantities, subject basin segment generates specific water yield of 40 to 50 l/km^2/s. Detailed analysis of the map of isolines of the specific water yield leads to the conclusion that the most water-abundant basin segments are the segments of the Tara River, Piva River and Sutjeska River, followed by the southern basin segments of the Lim River. Central segments of the DRB provide specific water yield between 10 and 20 l/km^2/s, while the specific water yield in the north basin segment is less than 10 l/km^2/s. One can conclude from aforementioned that water allocation in the DRB is heterogeneous in spatial terms.

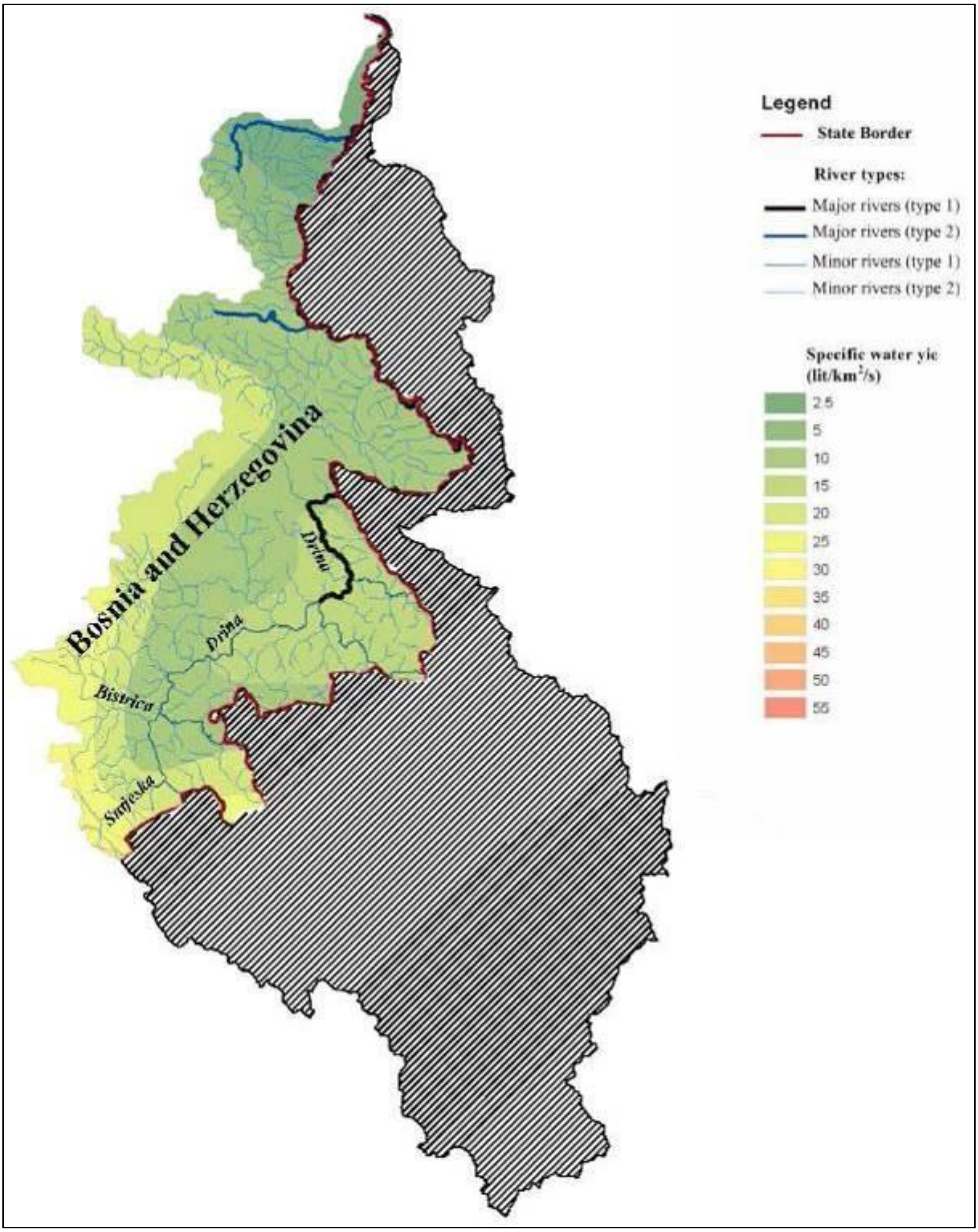


Figure 4-14: Map of isolines of specific water yield q (l/km²/s) in the DRB in BiH

For the purpose of comprehending inter-annual discharge distribution, Figure 4-15 presents graphic indicators of the module coefficient K by months for analyzed hydrological stations. Module coefficients K (-) are calculated by means of $K(i)=Q_{month}(i)/Q$, where $Q_{month}(i)$ is the monthly discharge during the month i, and $Q(i)$ is the mean multi-annual discharge. Additionally, for the purpose of comprehending intra-annual hydrological regime, the Table 4-7 presents the values of mean monthly discharges from analyzed stations.

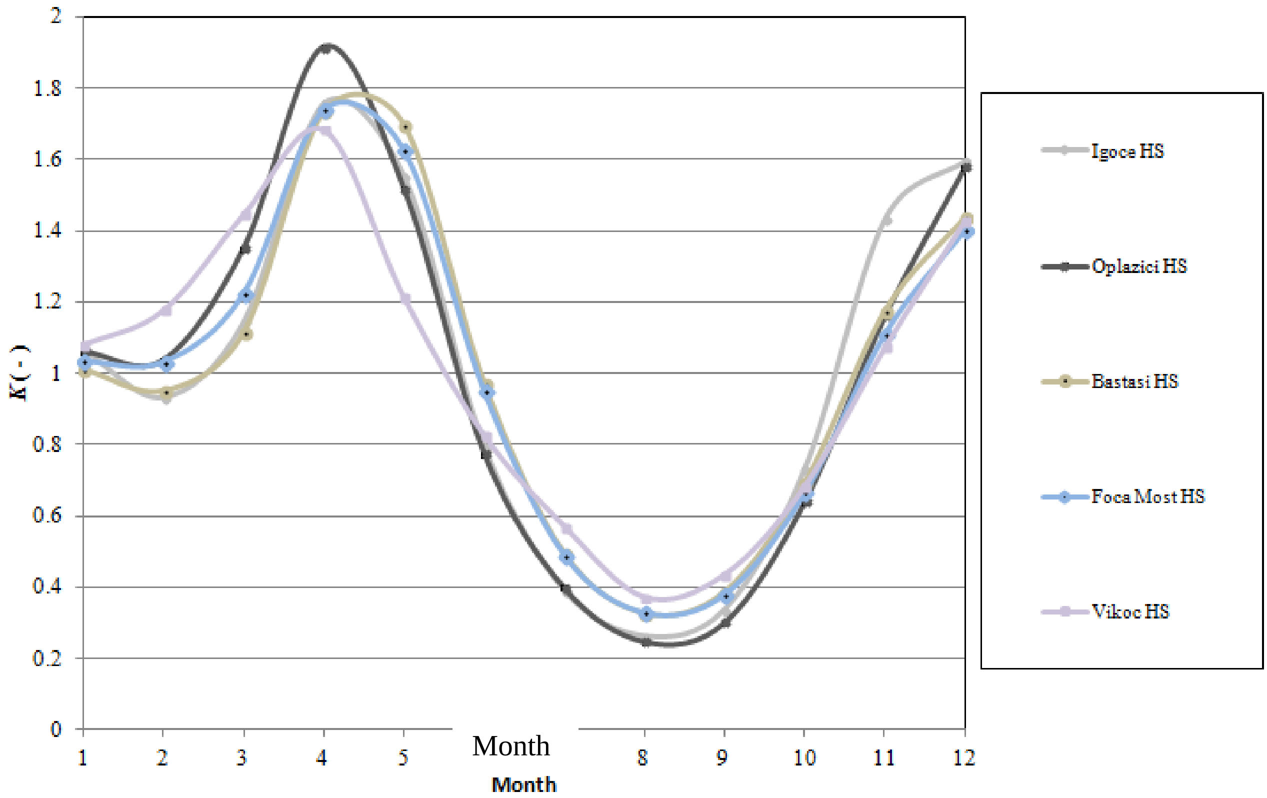


Figure 4-15: Intra-annual distribution of discharges in the DRB in BiH presented by means of module coefficients of the monthly discharges K on analyzed hydrological stations in the DRB

The previous Figure 4-15 shows the heterogeneous time distribution of discharges in the DRB. Tributaries, such as Ćehotina River, Bistrica River and Sutjeska River, follow the intra-annual distribution of the Drina River discharges to a greater extent. However, Sutjeska River, Uvac River and Ćehotina River deviate from the seasonal pattern of the Drina River. The Drina River is characterized mainly by the snow-rain regime with abundant water in spring, due to snow melt and spring rainfall, with pronounced minimum discharges during August and September. The most abundant intra-annual period is April and May and, then, November and December.

Table 4-7: Intra-annual distribution of discharges presented in the form of mean monthly discharges on analyzed hydrological stations in the DRB in BiH

No.	Hydrological station	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7	Q_8	Q_9	Q_{10}	Q_{11}	Q_{12}	Q_{annual}
1	"Bastasi"	145.0	136.5	159.9	248.9	243.5	139.5	70.9	47.0	55.7	99.6	168.9	206.4	143.5
2	"Foča Most"	202.6	202.3	239.9	340.5	318.3	186.1	96.3	64.7	74.8	130.6	217.8	275.0	195.7
3	"Igoče"	14.7	12.9	15.8	24.3	21.5	11.0	5.4	3.6	4.7	10.2	19.9	22.1	13.8
4	"Oplazići"	12.6	12.3	16.0	22.7	18.0	9.2	4.7	2.9	3.6	7.6	13.8	18.7	11.9
5	"Vikoč"	19.1	20.8	25.5	29.7	21.4	14.6	10.1	6.6	7.7	12.1	19.0	25.2	17.6

For the purpose of illustration of the hydrological regime on analyzed hydrological stations in the DRB, here are presented mean, minimum and maximum annual discharge values (a); mean, minimum and maximum monthly discharge values (b); monthly discharge duration curves (c). Aforementioned parameters are shown in following five figures (Figure 4-16 to Figure 4-20 inclusive).

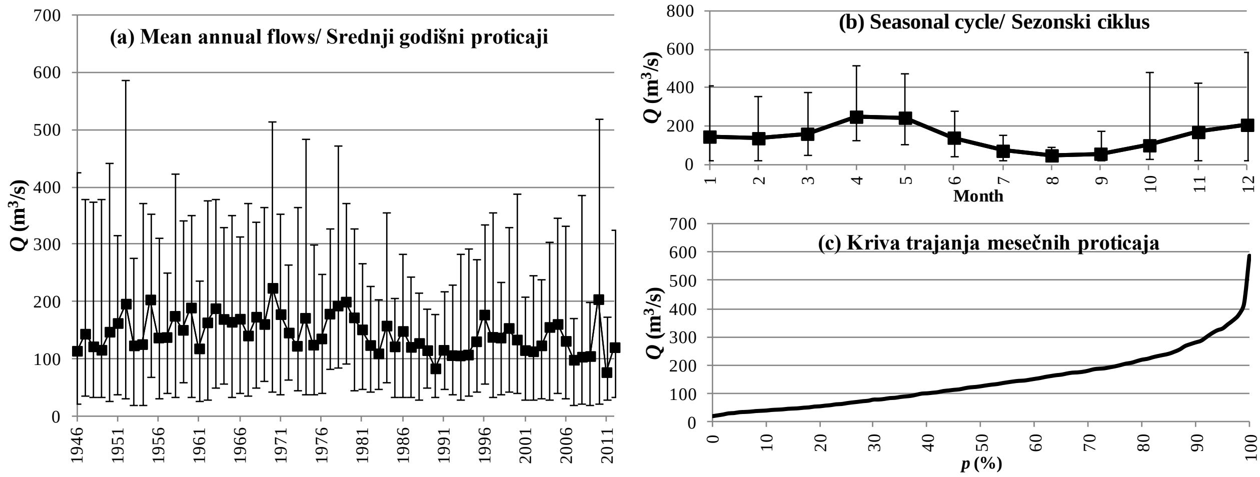


Figure 4-16: "Bastasi" HS on the Drina River: mean, minimum and maximum annual discharges (a); mean, minimum and maximum monthly discharges (b); monthly discharge duration curves (c)

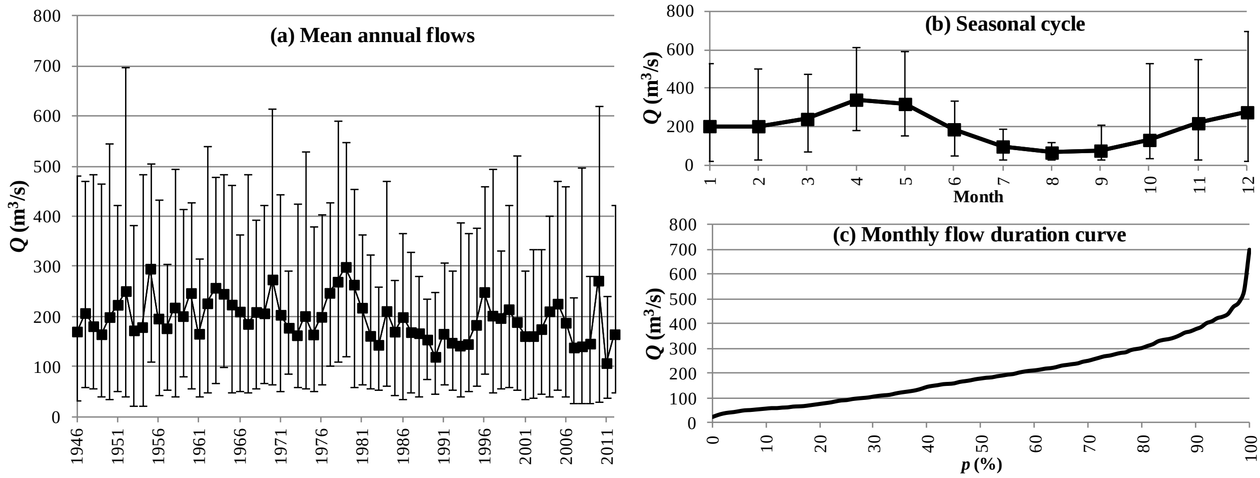


Figure 4-17: "Foča Most" HS on the Drina River: mean, minimum and maximum annual discharges (a); mean, minimum and maximum monthly discharges (b); monthly discharge duration curves (c)

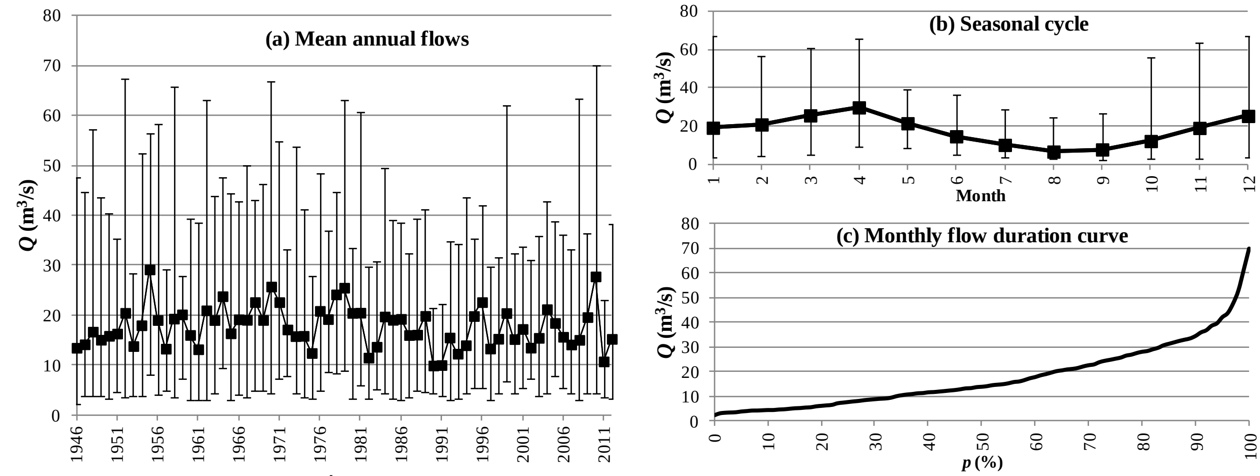


Figure 4-18: ""Vikoč" HS on the Ćehotina River: mean, minimum and maximum annual discharges (a); mean, minimum and maximum monthly discharges (b); monthly discharge duration curves (c)

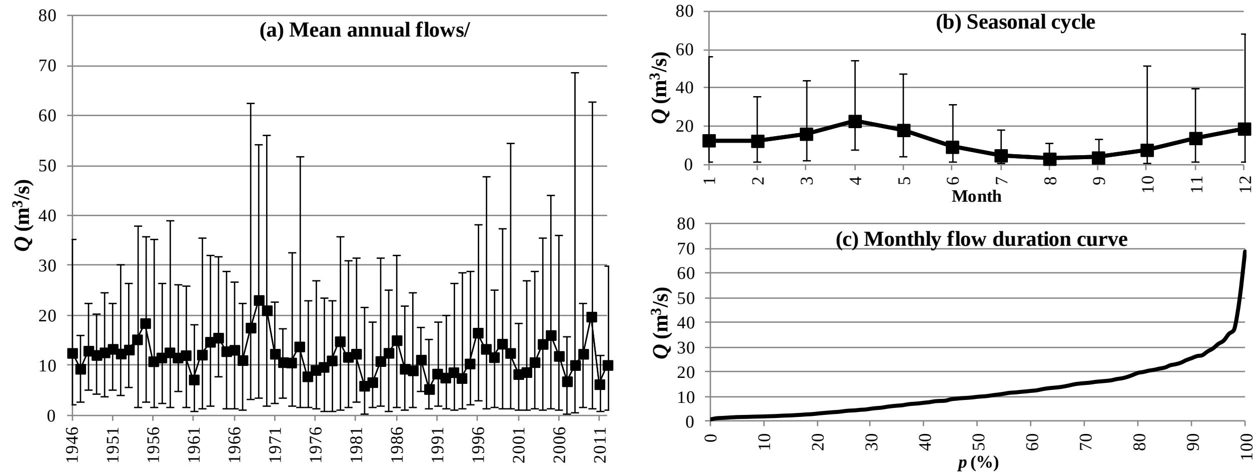


Figure 4-19: "Oplazići" HS on the Bistrica River: mean, minimum and maximum annual discharges (a); mean, minimum and maximum monthly discharges (b); monthly discharge duration curves (c)

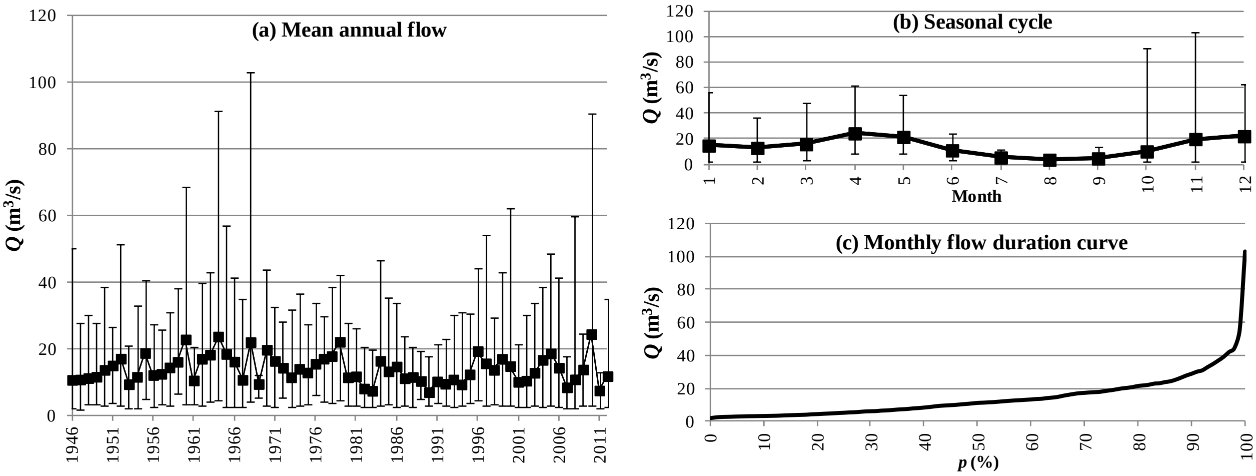


Figure 4-20:"Igoče" HS on the Sutjeska River: mean, minimum and maximum annual discharges (a); mean, minimum and maximum monthly discharges (b); monthly discharge duration curves (c)

4.4.2 Trends and Multi-Decadal Oscillations

Methodology

<u>Mann-Kendal Trend Test</u>

Many trend analyses are based on a well-known Mann-Kendall Trend Test. Subject test is non-parametric and is based on member ranking in time series. Time series members are ranked to compare each time series member to data sequence in time. Statistics test is computed as follows:

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sign(Q_i - Q_j),$$

where Q is the mean annual discharge in time step i and j, $sign(Q_i{-}Q_j)$ is equal to +1 if Q_i large than Q_j and −1 vice verse. If it turns out that S>0 than the time series is under downtrend and for S<0 we have an uptrend. Mathematical expectation and variance for test statistics S are as follows:

$$E(S) = 0,$$

$$Var(S) = \frac{n(n-1)(2n+5)}{18} = \sigma^2.$$

Eliminating the effect of serial correlation required use of variance correction for test statistics *S*. This approach means that the series with autocorrelation contains *N* members and that the effective number of members that are not correlated is less than *N*.

For a time series of annual discharges, standardized variable Z_s is calculated by means of the Mann-Kendall test as follows:

$$Z_s = \begin{cases} \frac{S-1}{\sigma}, & S > 0 \\ \frac{S+1}{\sigma}, & S < 0 \\ 0, & S = 0 \end{cases}$$

where Z_s follows standard normal distribution. If Z_s is above 1.96, corresponding to significance threshold α=0.05, hypothesis H_0 that significant trend in the annual discharge time series exists is adopted. Otherwise, hypothesis H_0 that the trend is statistically significant is rejected and alternative hypothesis H_1 is adopted.

Multi-Decadal Oscillations by Application of Continuous Spectrum

Continuous spectrum provides an answer to the question of the character of periodicity intensity change under the conditions of continuous values of frequency *f*. Subject issue is very important, since defining periodical components of random process in practice is very difficult and setting their periods *a priori*, that is, their frequency, is also very difficult. Spectrum *S*(*f*) can be used to identify and estimate sinusoidal components of unknown frequencies. Comparing to pediograph – discrete spectrum, the spectrum is more suitable for practical application as it can discover all components for any value of the frequency, i.e. periodicity.

Spectral function *S*(*f*) is estimated as follows:

$$S(f) = 2\left[C(0) + 2\sum_{\tau=1}^{N-1} C(\tau)\cos(2\pi\tau f)\right]; \quad 0 \le f \le 0.5,$$

where $C(\tau)$ is the covariance function for time shift τ, *f* is the value of subject frequency, while *N* is the total number of time series members.

For the spectrum, *S*(*f*), to be easily interpreted, it would be necessary to correct its function resulting from the previous function, i.e. to correct the value of covariance function $C(\tau)$. Blackman-Tukey method, or in short *B-T* method, was used to estimate the spectrum *S*(*f*) of mean annual discharges. Under this method, it is necessary to weight the covariance function $C(\tau)$ by certain number of steps, where calculation does not include all *N*-1 time shifts τ, but only the first, i.e. higher values of covariance function (*M* values) are used, as shown in the following function:

$$\hat{S}(f) = 2\left[C(0) + 2\sum_{\tau=1}^{M} \lambda(\tau-1)C(\tau)\cos(2\pi f\tau)\right], \quad 0 \le f \le 0.5$$

where $\lambda(\tau)$ is the weight coefficient of covariance function, while $M(<N)$ is the length of condensed covariance function (τ=1,2, ...,*M*). Value of coefficient $\lambda(\tau)$ is calculated as follows:

$$\lambda(\tau) = 0.5\left(1 + \cos\left(\frac{\pi\tau}{M}\right)\right), \quad \tau = 0, \ldots M$$

When the length M is defined, Blackman-Tukey window is formed. Based on the previous function, one can conclude that $\lambda(\tau)$ value can range between 1, with zero shift ($\tau = 0$), and 0 at the last shift of window width $\tau = M$, and that the average value of weight coefficient is 0.5. General recommendation for adoption of M value is that it should be

$$(1/20)N < M < (1/3)N$$

Since the spectrum $S(f)$ area is equal to variance σ_Q^2 of the annual discharge time series within the frequency f domain of 0 to 0.5, normalized spectrum is determined as follows:

$$\hat{s} = \frac{\hat{S}(f)}{\hat{\sigma}_Q^2},$$

where $\hat{S}(f)$ is the spectrum function estimated by means of B-T method, and $\hat{\sigma}_Q^2$ is the sample variance of annual discharge series.

Results

Analysis of the long-term time series changes was conducted for five hydrological stations in the DRB as shown in next Table 4-8. Research of long-term discharge changes was conducted by means of trend analysis and periodicity analysis. Annual discharge trend was analysed on stations by means of Mann-Kendall test with variance correction of statistics test, as a consequence of serial correlation of annual discharges.

Annual discharge trend testing was conducted for the period from 1946 to 2012. The table below shows mean annual discharge trend testing results, where S is the sum rank series, Z_s is statistics test and p is the probability of trend occurrence in the time series.

Table 4-8: Mean annual discharge trend analysis for analyzed hydrological stations byf Mann-Kendall test from 1946 to 2012:

Hydrological station	"Bastasi"	"Foča"	"Vikoč"	"Igoče"	"Oplazići"
River	Drina	Drina	Ćehotina	Sutjeska	Bistrica
***S*:**	524	510	152	182	400
Z_s:	**2.269**	**2.130**	0.692	0.852	1.621
***p*(%):**	97.5	97.1	50.9	60.7	89.3

Legend: S - sum rank series, Zs – statistics test, p - probability of trend occurrence

Results from the previous table show that annual discharges on all stations in the DRB have a downward trend. The largest trend intensity has been recorded in the upper course of the Drina River on "Bastasi" HS and "Foča Most" HS. Subject stations showed significant discharge downward trend at the significance threshold of α=0.05. Other stations recorded no statistically significant annual discharge downtrend.

Graphic interpretation of statistics test Z_s of Mann-Kendall test for annual discharges on analyzed hydrological stations is shown in the next Figure 4-21. Apart from statistics test value Z_s, critical values of statistics test for confidence thresholds α=0.05, α=0.10, α=0.20 and α=0.50 were presented.

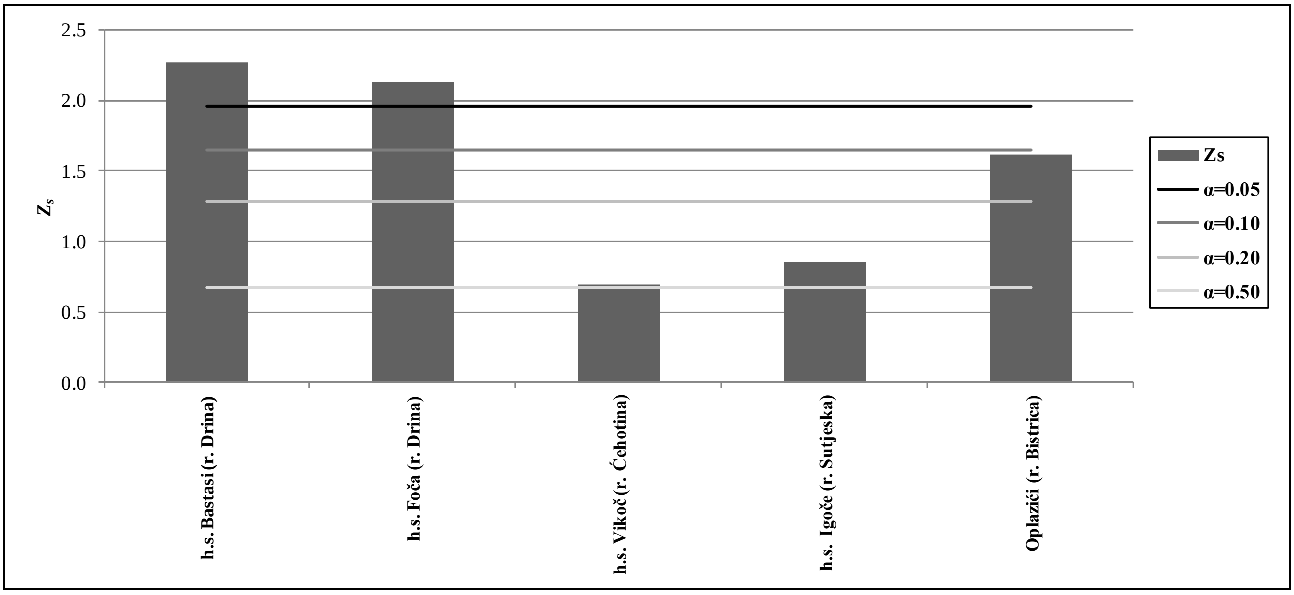


Figure 4-21: Statistics test Zs of Mann-Kendall test of mean annual discharges at the analyzed station at significance thresholds α=0.05, α=0.10, α=0.20 and α=0.50 from 1946 to 2012

Results shown in the previous figure indicate that all stations have recorded annual discharge downward trend. Significant trend was recorded on 2 out of 5 stations at significance threshold α=0.05. Additionally, all stations recorded annual discharge downward trend at significance threshold α=0.50.

As opposed to trend analyses recording monotonous annual discharge changes indicting time series upward or downward trend, periodicity analysis is used to determine cyclical internal structure of time series. Annual discharge cyclicality is reflected in spectral function $S(f)$ jump at significant frequencies. Cumulative pediograph, as per *B-T* method, was used to determine the spectrum $S(f)$ of annual discharges.

For the purpose of easier interpretation of spectral function, covariance function $C(\tau)$ was condensed and weighted. Condensing covariance function is performed on the basis of $M=N/3$, while the weighting of the subject function is performed by means of the Blackman-Tukey window. Results of periodicity analysis presented through normalized spectrum $s(f)$ of annual discharges on analyzed hydrological stations (the following Figure 4-22).

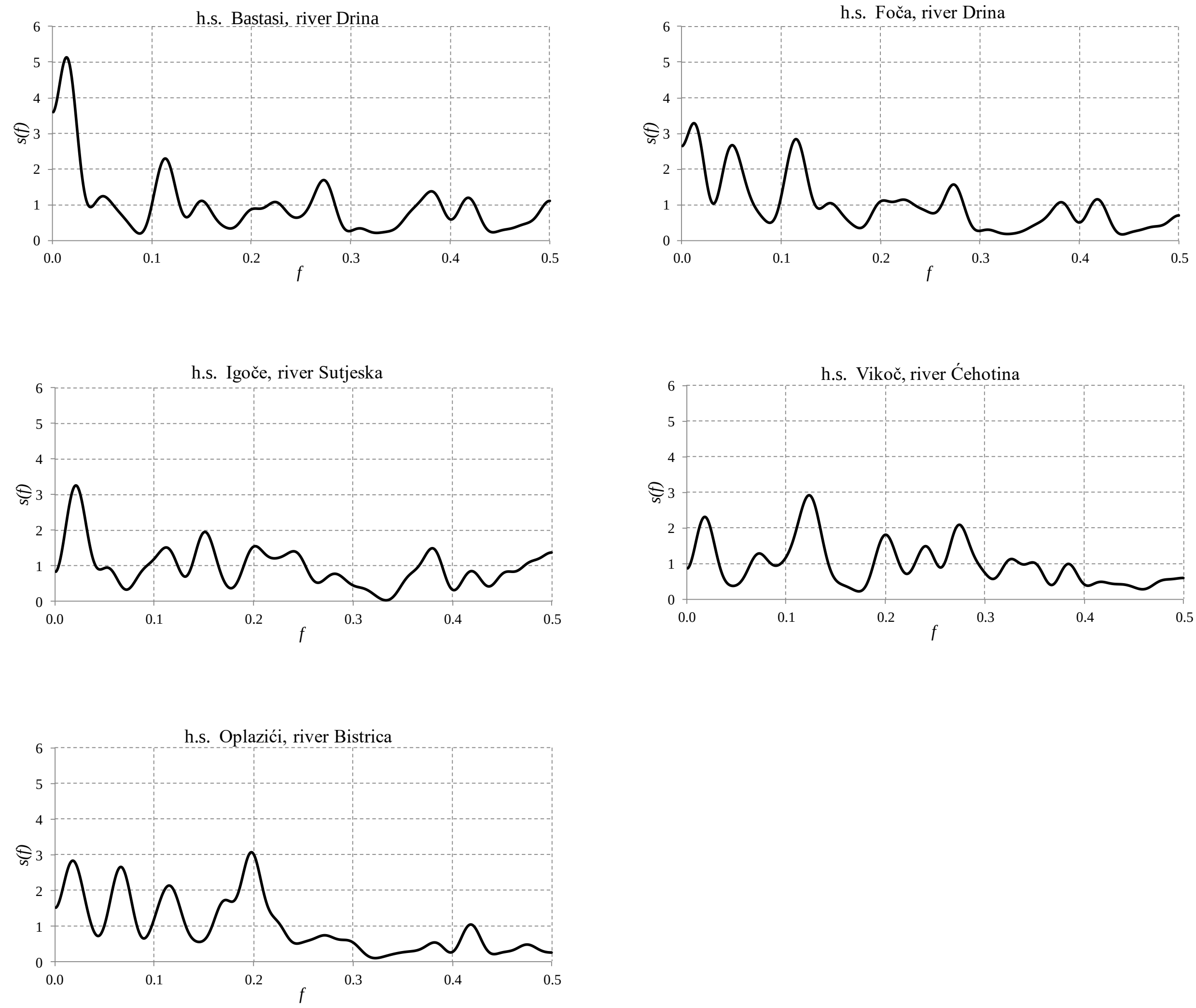


Figure 4-22: Normalized spectrum s(f)of mean annual discharges on analyzed stations according to B-T method from 1946 to 2012

Results of the annual discharge periodicity analysis shown in the two figures above indicate that there are significant periods in the low and high frequencies domain, i.e. high and low periods. Such time series of annual discharge are characterized by cyclical structure in different time scales, such as the multi-decadal and time scale of several years. The first six significant periods of annual discharges from the normalized spectrum *s*(*f*) are shown in Table 4-9 below.

Table 4-9: The first six significant periods of the normalized spectrum s(f) of annual discharges on the analyzed stations for the period from 1946 to 2012

River	Hydrological station	Spectre	1st period	2nd period	3rd period	4th period	5th period	6th period
Drina	Bastasi	*f*	0.013	0.113	0.272	0.38	0.05	0.417
		T	**76.9**	**8.8**	**3.7**	**2.6**	**20.0**	**2.4**
		s(f)	5.139	2.290	1.685	1.369	1.231	1.187
	Foča	*f*	0.012	0.114	0.273	0.381	0.05	0.417
		T	**83.3**	**8.8**	**3.7**	**2.6**	**20.0**	**2.4**
		s(f)	5.106	2.271	1.676	1.365	1.231	1.187
Ćehotina	Vikoč	*f*	0.017	0.273	0.122	0.383	0.416	0.499
		T	**58.8**	**3.7**	**8.2**	**2.6**	**2.4**	**2.0**
		s(f)	4.850	1.676	1.566	1.332	1.182	1.100
Sutjeska	Igoče	*f*	0.02	0.111	0.379	0.051	0.281	0.418
		T	**50.0**	**9.0**	**2.6**	**19.6**	**3.6**	**2.4**

River	Hydrological station	Spectre	1st period	2nd period	3rd period	4th period	5th period	6th period
		s(f)	4.229	2.270	1.365	1.228	1.192	1.182
Bistrica	Oplazići	*f*	0.017	0.114	0.271	0.381	0.418	0.197
		T	**58.8**	**8.8**	**3.7**	**2.6**	**2.4**	**5.1**
		s(f)	4.850	2.271	1.682	1.365	1.182	0.828

Legend: f – significant frequency, T – significant period, s(f) normalized spectrum

From the results shown in Table 4-9 above it can be concluded that the annual discharges in the DRB on analyzed stations have similar periodicity. Periods from this table can be also classified in six groups with mean values and standard deviations in years: 71.1±13.1, 21.2±1.2, 8.7±0.2, 3.5±0.4, 2.6±0.1 and 2.3±0.2.

In order to illustrate the multi-annual periodicity of annual discharges on analyzed stations, time series were smoothed by application of the local regression method loess (*locally weighted scatterplot smoothing*) with 12 step window width. Annual discharges and smoothed annual discharges are shown in Figure 4-23.

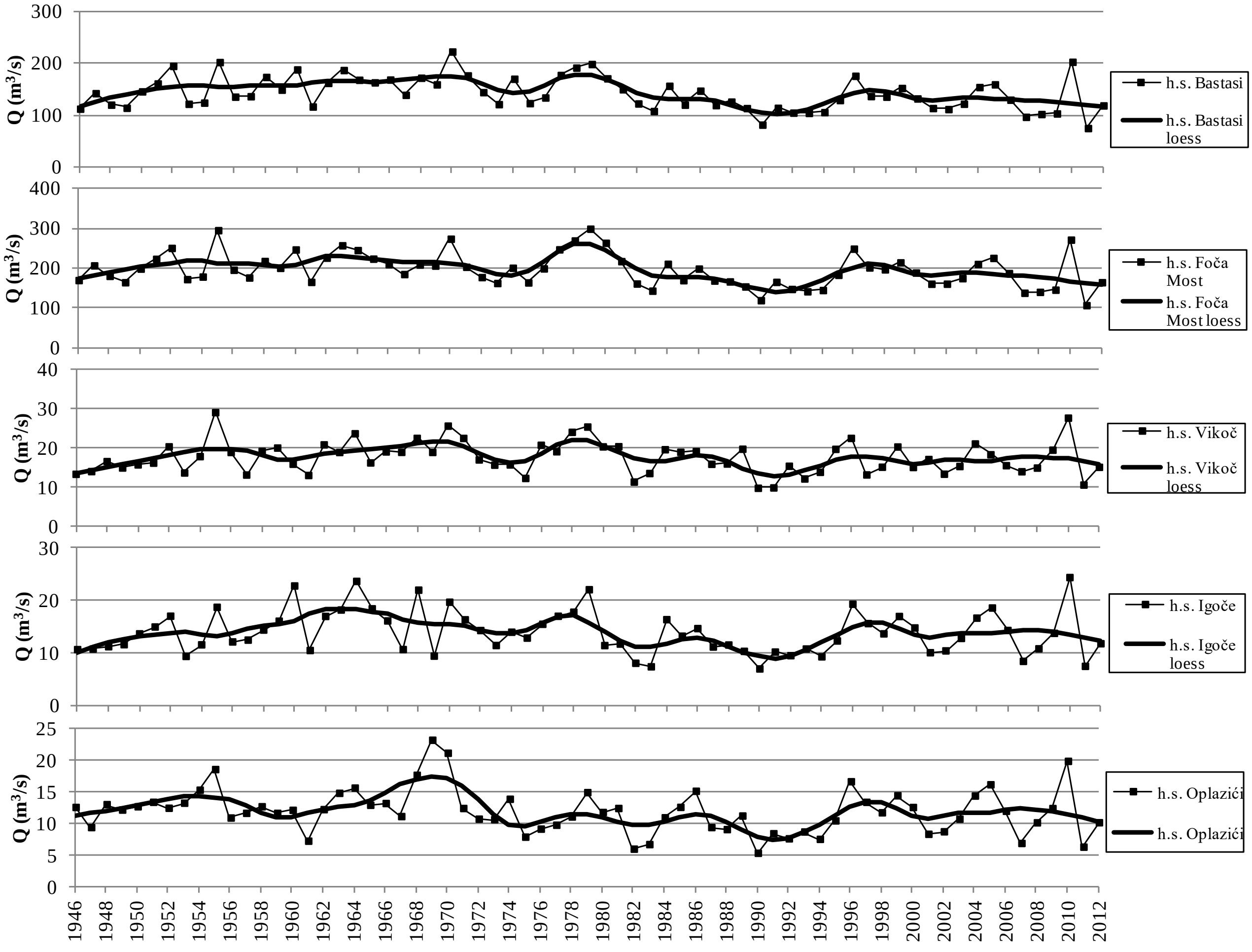


Figure 4-23: Annual discharges and smoothed annual discharge as per loess (locally weighted scatterplot smoothing) method on analyzed stations from 1946 to 2012

The Figure 4-23 above indicate that smoothed time series have harmonized multi-decadal oscillation on all analyzed stations in the DRB. Change between multi-annual periods with more or less water is taking place in synchronous manner in the DRB.

4.4.3 Analysis of Flood Discharges

Flood Discharges Calculation Settings

Flood discharge analysis in the DRB was conducted for the purpose of present design on representa-tive hydrological stations in the Drina River and its most significant tributaries, Ćehotina River and Lim River.

Subject activities required collecting relevant available data on maximum discharges in every year (maximum daily discharge ($Q_{max,day}$) and absolute, i.e. current maximum discharge ($Q_{abs,max}$) from the hydrological station profiles. Data were collected and analyzed, and corrections were made. Missing data were filled in by means of generating respective correlation relationships.

The following step was calculation of probabilities. The following distributions were used: log-Pearson 3, Pearson 3, Gumbel and log-Normal distribution. After the theoretical distributions have been de-fined, theoretical and empirical distributions were compared by means of $N\omega^2$, $\chi 2$ and Kolmogorov tests.

Periods of the data used and calculations were related to are as follows:

1) Longer period covering available data up to 2012 to include flood waves data from 2013 and 2014,
2) Shorter period covering available data up to 1975 (only for the Drina River) representing the DRB coverage with structures without 5 out of 7 significant storages ("Piva", "Višegrad", "Uvac", "Lazići" and "Otilovići").

The second period is 40 years shorter, but in certain segments of the DRB it portrays natural discharges more realistically. In addition to analyses of the two aforementioned periods, analyses and defining of flood discharges with the upper confidence interval limit of 95% were conducted for period (1) since these values of flood discharges were used in earlier designs for the hydro-technical facilities in the DRB.

Gap Filling of Calculation Input Data

Six representative hydrological stations along the Drina River were analyzed (322 km of the river course), "Badovinci" HS (17.2 km from the confluence), "Zvornik/Radalj" HS (64.5 km), "Bajina Bašta" HS (164 km), "Višegrad" HS (230.7 km), "Foča" HS (298.2 km) and "Bastasi" HS (318 km).

The remaining hydrological stations along the Drina River for which certain data series were available, "Goražde" HS, "Foča uzvodno" HS, "Orahovci" HS, "Međeđa" HS and "Mihaljevići" HS have not been used for the analyses of flood discharges, due to one or several following reasons: smaller amount of measured data, certain stations were flood after the construction of reservoirs or they are close to some of the 6 selected stations.

The most complete data set is from the "Zvornik/Radalj" HS where 70/89 data records on absolute maximum discharges were available, i.e. 89/89 data records of maximum daily discharges for every year subject to analysis. Missing data were gap-filled by the means of generating correlation:

$Q_{abs,max}=1.0447 \cdot Q_{max,day}+153.17$, $R=0.957$

Hydrological station data from 1968 and 2010 were corrected in line with recorded outlets on the "Bajina Bašta" HPP and the "Zvornik" HPP. The "Bajina Bašta" HS had available 48/89 data records on absolute maximum discharges were available, i.e. 89/89 data records of maximum daily discharges for every year subject to analysis. However, in certain years there was $Q_{abs,max}<Q_{max,day}$ and, thus, corrections were made for the subject years. Missing data were gap-filled by the means of the generating correlation:

$Q_{abs,max}=0.99 \cdot Q_{max,day}+325.23$, $R=0.903$

Hydrological station data from 1968 and 2010 were corrected in line with recorded outlet discharges on "Bajina Bašta" HPP and "Zvornik" HPP.

Due to short time in operation, the "Badovinci" HS had available only 20 data records for $Q_{abs,max}$ and $Q_{max,day}$. For that reason, defining of the missing data records required use of correlation dependencies:

$Q_{abs,max\ (Badovinci)}=0.86 \cdot Q_{abs,max\ (Zvornik/Radalj)}$, R=0.96

"Višegrad most" HS (old stone bridge in Višegrad) profile had available 50/89 data records of maximum daily discharges for every year subject to analysis (as of 1990, "Višegrad" HPP data were used) and a small number of useable values of absolute maximum discharges. Missing data on maximum daily discharges were gap-filled by the means of generating correlation:

$Q_{max,day\ (Višegrad)}=Q_{max,day\ (Bajina\ Bašta)} \cdot 1.0075\text{-}126.16)$, R=0.926

Absolute maximum discharges were defined using the following formula:

$Q_{abs,max\ (Višegrad)}=1.01 \cdot Q_{max,day\ (Višegrad)} \cdot (Q_{abs,max(Bajina\ Bašta)}/\ Q_{max,day(Bajina\ Bašta)})$

"Foča" HS on the Drina River had available 54/89 data records on absolute maximum discharges were available, i.e. 89/89 data records of maximum daily discharges for every year subject to analysis. In a number of years $Q_{abs,max}$ was below $Q_{max,day}$ (15) and, thus subject values were examined, i.e. corrected. Generated correlation dependency:

$Q_{abs,max}=Q_{max,day} \cdot 1.2474\text{-}32.39$, R=0.956

was used.

"Bastasi" HS profile had available 40/89 data records on absolute maximum discharges were available, i.e. 89/89 data records of maximum daily discharges for every year subject to analysis. In a number of years $Q_{abs,max}$ was below $Q_{max,day}$ (13) and, thus subject values were examined, i.e. corrected. Generated correlation dependency:

$Q_{abs,max}=Q_{max,day} \cdot 1.1641+83.85$, R=0.933

was used.

One can notice in the analysis of the subject period that construction of significant storages in the DRB made absolute maximum discharges lower, i.e. major storages started to alleviate flood discharge waves to certain extent.

Two representative hydrological stations were analyzed along the Ćehotina River, "Vikoč" HS (25.3 km) and "Foča Aladža" HS (0.7 km).

The most complete data set is from "Vikoč" HS where 17/89 data records on absolute maximum discharges were available, i.e. 89/89 data records of maximum daily discharges for every year subject to analysis. In a number of years (2) there was $Q_{abs,max}=<Q_{max,day}$ and, thus subjects value were corrected. Missing data were gap-filled by the means of the generating correlation:

$Q_{abs,max}=0.9711 \cdot Q_{max,day}+50.524$, R=0.8613

"Foča Aladža" HS had available 10/89 data records on absolute maximum discharges were available, i.e. 89/89 data records of maximum daily discharges for every year subject to analysis. Missing data were gap-filled by the means of the generating correlation

$Q_{abs,max\ (Foča\ Aladža)}=0.9327 \cdot Q_{abs,max\ (Vikoč)}\text{-}4.366$, R=0.8811

Two representative hydrological stations were analyzed along the Lim River: "Strmica" HS (6.3 km from the confluence) and "Priboj" HS (48.7 km).

"Priboj" HS had available only 52/89 data records on absolute maximum discharges were available, i.e. 89/89 data records of maximum daily discharges for every year subject to analysis. In a number of years (12) there was $Q_{abs,max}$=<$Q_{max,day}$ and, thus subjects value were corrected. Missing data were gap-filled by the means of the generating correlation:

$Q_{abs,max}=0.8374 \cdot Q_{max,day}+159.89$, R=0.8689

"Strmica" HS had available only 18/89 data records on absolute maximum discharges were available, i.e. 89/89 data records of maximum daily discharges for every year subject to analysis. In a number of years (7) there was $Q_{abs,max}$=<$Q_{max,day}$ and, thus subjects value were corrected. Missing data were gap-filled by the means of the generating correlation:

$Q_{abs,max}=1.116 \cdot Q_{max,day}+44.756$, R=0.9768

Analyzed hydrological stations on the Lim River show no distinguishable trend of absolute maximum discharge changes, as expected, since most of the basin is natural (no built-up storages). When the Uvac River waters were transported to the Lim River basin in (construction of the "Bistrica" HPP), mean and low discharge changes occurred both on the Uvac River and the Lim River downstream of the "Potpeć" HPP: however, flood discharge changes on "Priboj" HS and "Strmica" HS were not identified.

Drina River Calculation Results

Flood discharge probability calculations were conducted on six representative hydrological stations along the Drina River, "Badovinci" HS, "Zvornik/Radalj" HS, "Bajina Bašta" HS, "Višegrad" HS, "Foča" HS and "Bastasi" HS. The following theoretical distributions were defined: log-Pearson 3, Pearson 3, Gumbel and log-Normal distribution. Log-Pearson 3 distribution had the best match to the empirical distribution on all analyzed profiles.

Table 4-10: Maximum flood discharges on the representative stations along the Drina River (processing period (1))

Hydrological station	"Badovinci" HS	"Zvornik/Radalj" HS	"Bajina Bašta" HS	"Višegrad most" HS	"Foča" HS	"Bastasi" HS
Chainage (km)	16.5	90	187	232	288	317
Return period (years)	Q_{max} (m³/s)					
1,000	5,335	6,000	6,595	7,415	5,841	3,864
500	4,976	5,615	6,008	6,588	5,089	3,457
200	4,460	5,058	5,234	5,584	4,184	2,996
100	4,039	4,599	4,709	4,859	3,529	2,676
50	3,657	4,182	4,198	4,227	2,997	2,357
20	3,153	3,626	3,554	3,468	2,383	1,957
10	2,764	3,195	3,081	2,941	1,974	1,665
5	2,357	2,740	2,609	2,441	1,601	1,377
2	1,740	2,043	1,937	1,779	1,135	972

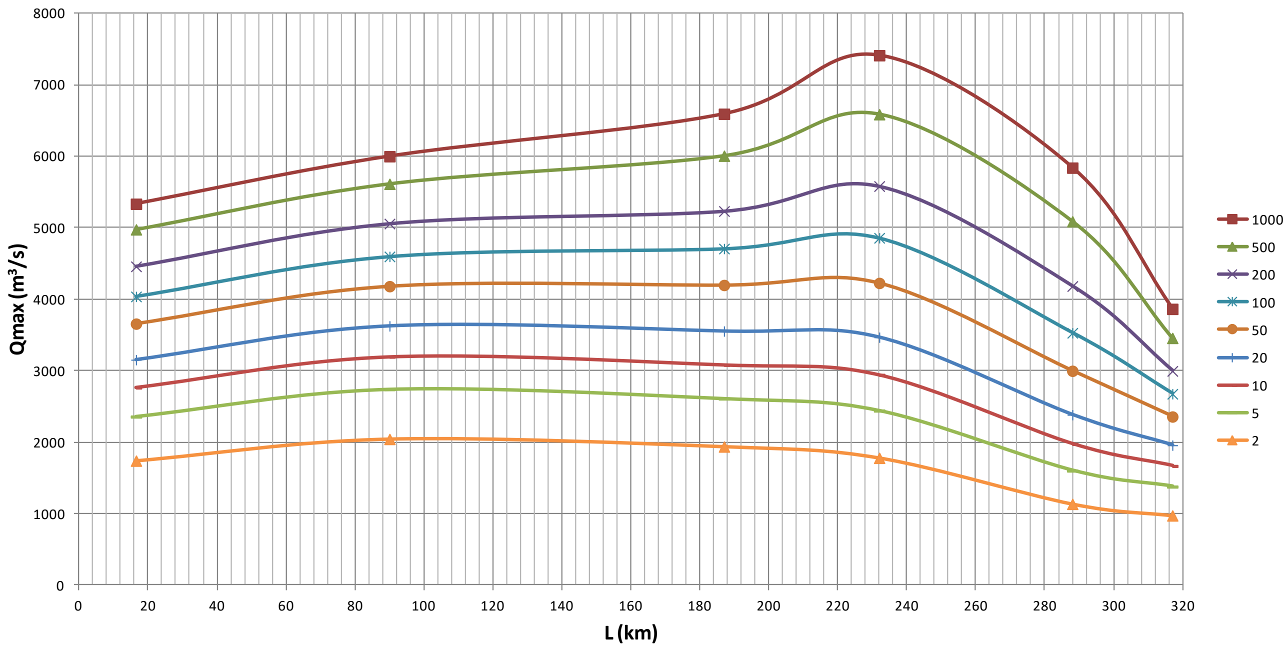


Figure 4-24: Maximum flood discharges on the representative stations along the Drina River (processing period (1))

The Table 4-10 and Figure 4-24 above indicate that flood discharges of certain probability increase from the town of Šćepan Polje to the town of Višegrad and that they start to drop going downstream towards the confluence with the Sava River. Flood discharge decrease from the town of Bajina Bašta up to the confluence is logical and can be explained with the morphological characteristics of the Drina River (downstream of the town of Bajina Bašta inundations are wider, i.e. the Drina River here is characterized by significant spillovers under the conditions of flood discharges). Lower value of flood discharges on the "Bajina Bašta" profile relative to the "Višegrad" profile have no grounds in the morphology of the Drina River bed, but they can be explained by the fact that the "Bajina Bašta" storage has a higher flood retention capacity then the "Višegrad" storage.

Table 4-11: Maximum flood discharges with 95% confidence intervals – upper limit, on the representative stations along the Drina River (processing period (1))

Hydrological station	"Badovinci" HS	"Zvornik/Radalj" HS	"Bajina Bašta" HS	"Višegrad most" HS	"Foča" HS	"Bastasi" HS
Chainage (km)	16.5	90	187	232	288	317
Return period (years)	Q_{max} (m³/s)					
1,000	6,392	7,145	7,982	9,213	7,473	4,802
500	5,907	6,627	7,180	8,055	6,389	4,233
200	5,219	5,890	6,141	6,675	5,114	3,599
100	4,666	5,290	5,449	5,703	4,217	3,168
50	4,175	4,755	4,789	4,873	3,506	2,746
20	3,537	4,056	3,974	3,903	2,710	2,230
10	3,058	3,527	3,393	3,251	2,199	1,866
5	2,571	2,985	2,832	2,655	1,752	1,517
2	1,875	2,199	2,079	1,914	1,228	1,057

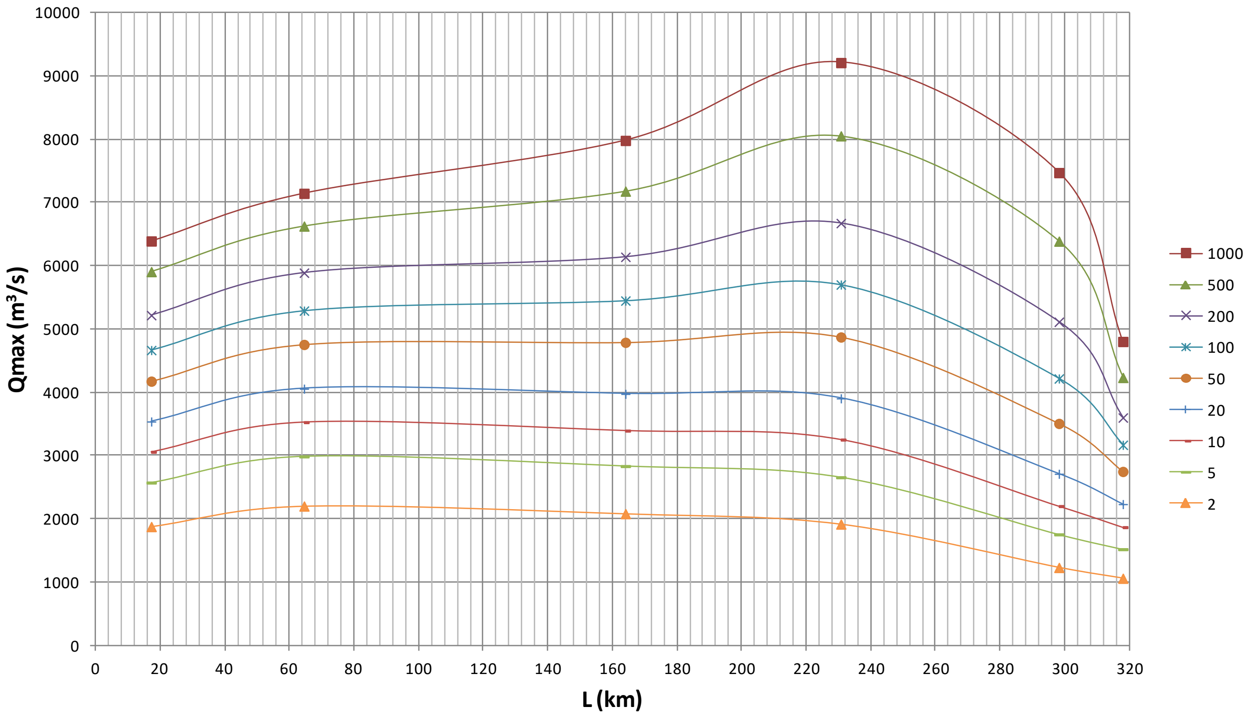


Figure 4-25: Maximum flood discharges with 95% confidence intervals – upper limit, on the representative stations along the Drina River (processing period (1))

The Table 4-11 and Figure 4-25 above indicate that flood discharges of certain probability are under the same trends as in case of "ordinary" probabilities, only with higher values.

Table 4-12: Maximum flood discharges on the representative stations in the Drina River (processing period (2))

Hydrological station	"Badovinci" HS	"Zvornik/Radalj" HS	"Bajina Bašta" HS	"Višegrad most" HS	"Foča" HS	"Bastasi" HS
Chainage (km)	16.5	90	187	232	288	317
Return period (years)	Q_{max} (m^3/s)					
1,000	5,529	6,429	7,763	7,512	6,114	3,835
500	5,134	5,970	6,971	6,743	5,362	3,473
200	4,601	5,350	5,980	5,787	4,454	3,056
100	4,192	4,875	5,248	5,097	3,806	2,763
50	3,806	4,425	4,617	4,484	3,258	2,468
20	3,298	3,835	3,854	3,735	2,614	2,090
10	2,909	3,383	3,320	3,205	2,178	1,810
5	2,505	2,913	2,809	2,696	1,775	1,528
2	1,896	2,205	2,124	2,004	1,257	1,121

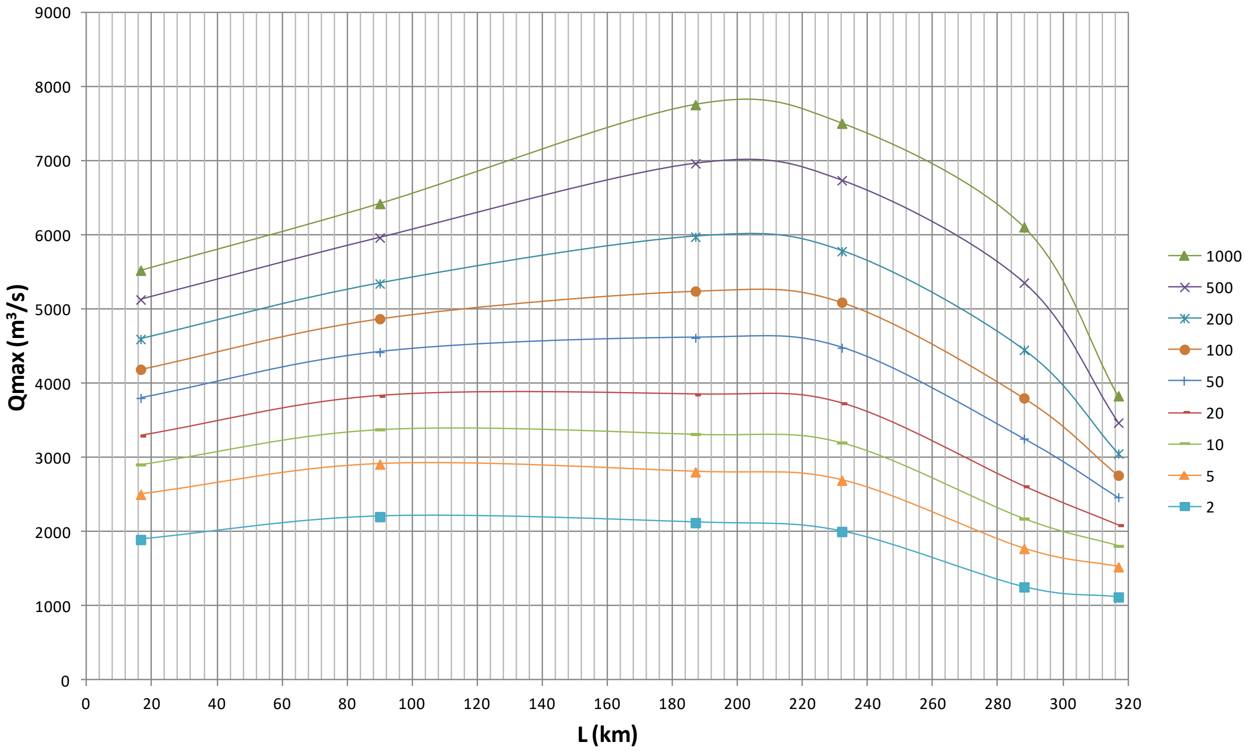


Figure 4-26: Maximum flood discharges on the representative stations on the Drina River (processing period (2))

The Table 4-12 and Figure 4-26 above indicate that flood discharges of certain probability increase from the town of Šćepan Polje to the town of Bajina Bašta (which is more logical relative to the results for the entire period) and that they start to drop going downstream towards the confluence with the Sava River. Calculation results display a better match, but all values are somewhat higher relative to the results of the full processing period; that is attributed to the phenomenon of flood wave alleviation after major storages were built in the DRB.

Overview of Data Sources

Data sources used for aforementioned analyses were official Hydrological Yearbooks of the Kingdom of Serbs, Croats and Slovenians (from 1926 to 1929), Kingdom of Yugoslavia (from 1930 to 1941), FPR of Yugoslavia (from 1945 to 1962), SFRY (from 1963 to 1991), FR of Yugoslavia (from 1992 to 2003), Serbia (from 2004 to 2013), BiH (from 2001 to 2013), Montenegro (2012) and hydrological yearbooks of the Sava River (from 2006 to 2010), as well as data from "Zvornik" HPP, "Bajina Bašta" HPP, "Višegrad" HPP and "Piva" HPP.

Flood discharges before 1926 were not used in the subject analyses as there were no available data from the hydrological stations in the DRB. Before 1918, major portion of the DRB was on the territory of the Ottoman Empire and Serbia, where no systematic water level and discharge observations were conducted on the rivers. Certain number of stations in the DRB was setup in XIX century (at the time the territory of Austrian-Hungarian Monarchy), but data from the subject stations were not available. As regards to the "prominent" 1896 flood, there are only estimations (Philipp Ballif (1899), Miladin Pećinar (1939), various scientific papers and other) of what it was on the hydrological station profiles on the Drina River, as well as the hypotheses that this was not only a "straightforward" flood, but that there was a rockfall on the Lim River ("huge rockfall") that created flood discharge. There is no doubt that the history of the DRB included a major flood, but it was unfortunately left unrecorded. Data are particularly poor for the Drina River tributaries. If one decides to use "estimated" data on flood discharges on the Drina River, then there is a question how to qualify and which flood discharges to use for the Piva, Tara, Ćehotina, Lim and other tributaries of the Drina River? Apart from the November 1896 flood wave, stories were also told about the Drina River floods from January 31, 1731, December 11, 1763, 1799, 1864, 1903 and other remembered floods. Authors of the subject analyses believe that, in engineering terms, it would not be correct to use only one of the historic "estimated" flood values from only one river (the Drina River) without considering flood values from major Drina River tributaries or using other historic floods.

There is no doubt that construction of major storages in the DRB started to alleviate major flood discharges and, thus, today's conditions of flood discharge propagation are different from those from previous centuries. Therefore, we believe that flood discharge analyses based on 89 years of available (measured) data are representative for further use and application.

The Ćehotina River Calculation Results

Flood discharge probability calculations were conducted on 2 representative hydrological station on the Ćehotina River, "Vikoč" HS and "Foča Aladža" HS. Theoretical distributions were defined: log-Pearson 3, Pearson 3, Gumbel and log-Normal distribution. Gumbel distribution had the best match to the empirical distribution.

Table 4-13: Maximum flood discharges on the representative stations along the Ćehotina River (processing period (1))

Hydrological station	"Brodarevo" HS	"Bijelo Polje" HS
Chainage (km)	98	128
Return period (years)	Qmax (m^3/s)	
1,000	494	447
500	462	417
200	418	378
100	386	348
50	353	318
20	309	278
10	275	247
5	239	215
2	186	166

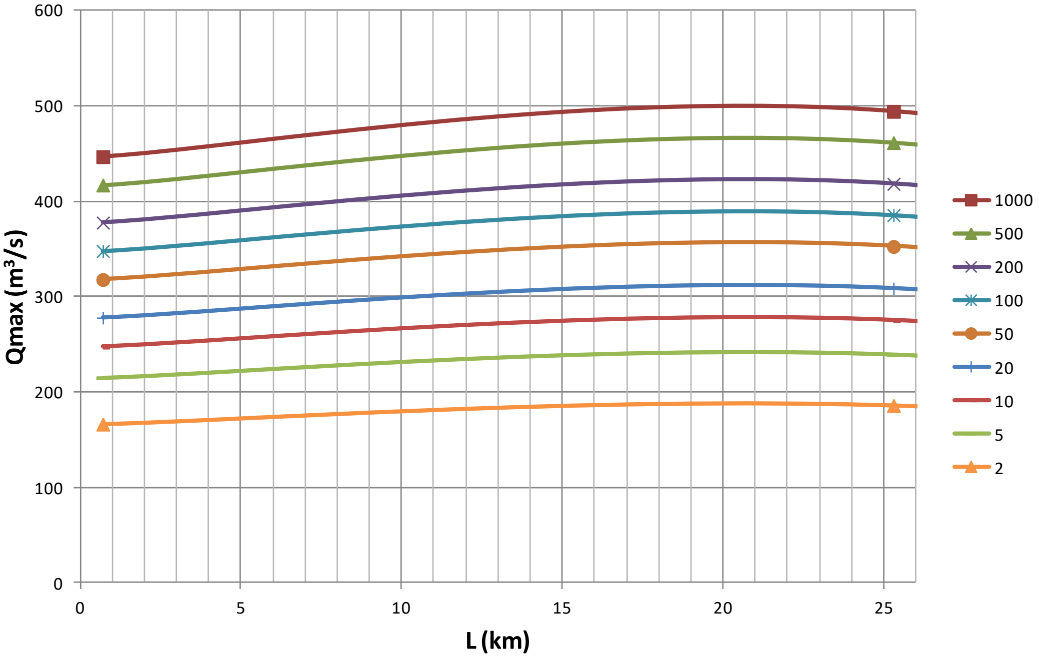


Figure 4-27: Maximum flood discharges on the representative stations along the Ćehotina River (processing period (1))

The Table 4-13 and Figure 4-27 above indicate that flood discharges of certain probability increase from the "Vikoč" HS towards the confluence with the Drina River. As expected, results are logical and harmonized. Obviously, "Otilovići" dam and storage do not hinder the natural water flow regime to any significant extent

Table 4-14: Maximum flood discharges with 95% confidence intervals – upper limit, on the representative stations along the Ćehotina River (processing period (1))

Hydrological station	"Vikoč" HS	"Foča Aladža" HS
Chainage (km)	25.3	0.7
Return period (years)	Qmax (m^3/s)	
1,000	579	524
500	536	484
200	479	433
100	437	395
50	395	357
20	341	307
10	300	270
5	258	232
2	199	178

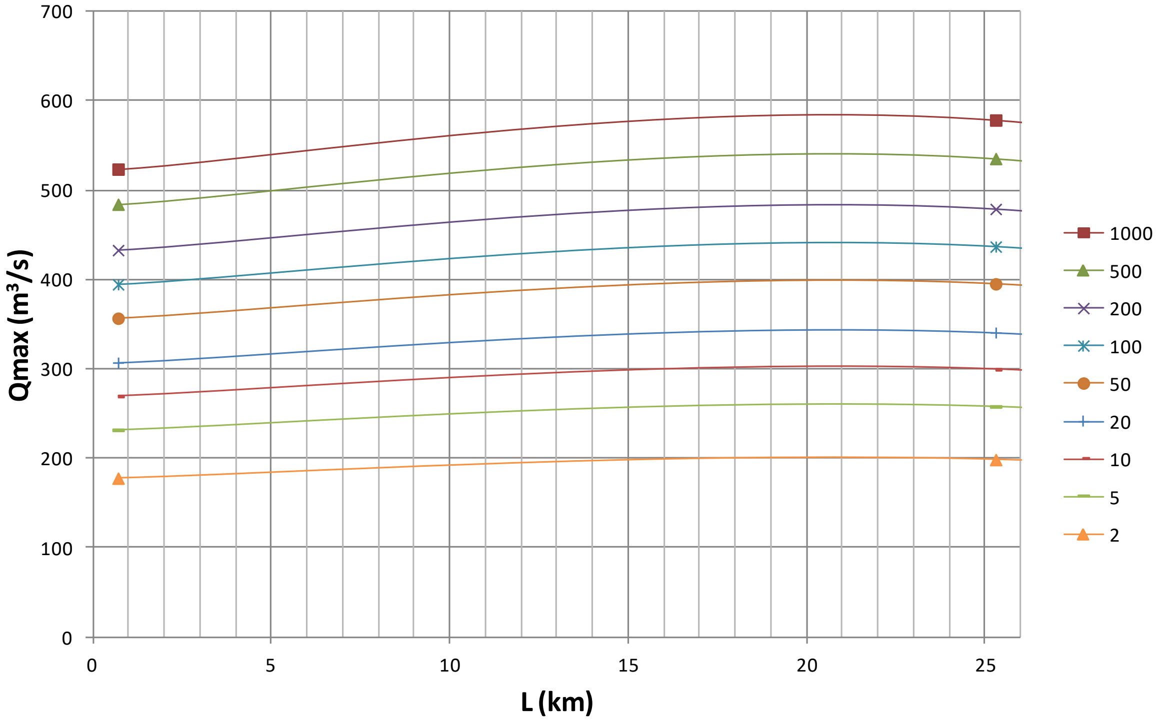


Figure 4-28: Maximum flood discharges with 95% confidence intervals – upper limit, on the representative stations along the Ćehotina River (processing period (1))

The Table 4-14 and Figure 4-28 above indicate that flood discharges of certain probability follow the same trends as in case of the probabilities without confidence intervals, with somewhat higher values.

The Lim River Calculation Results

Flood discharge probability calculations were conducted on two representative hydrological station along the Lim River, "Strmica" HS and "Priboj" HS. The following theoretical distributions were defined: log-Pearson 3, Pearson 3, Gumbel and log-Normal distribution. Log-Pearson 3 distribution had the best match to the empirical distribution.

Table 4-15: Maximum flood discharges on the representative stations in the Lim River (processing period (1))

Hydrological station	"Strmica" HS	"Priboj" HS
Chainage-L (km)	6.3	48.7
Return period (years)	Qmax (m³/s)	
1,000	2,525	1,655
500	2,179	1,509
200	1,758	1,325
100	1,515	1,186
50	1,288	1,064
20	1,029	912
10	859	802
5	706	695
2	519	547

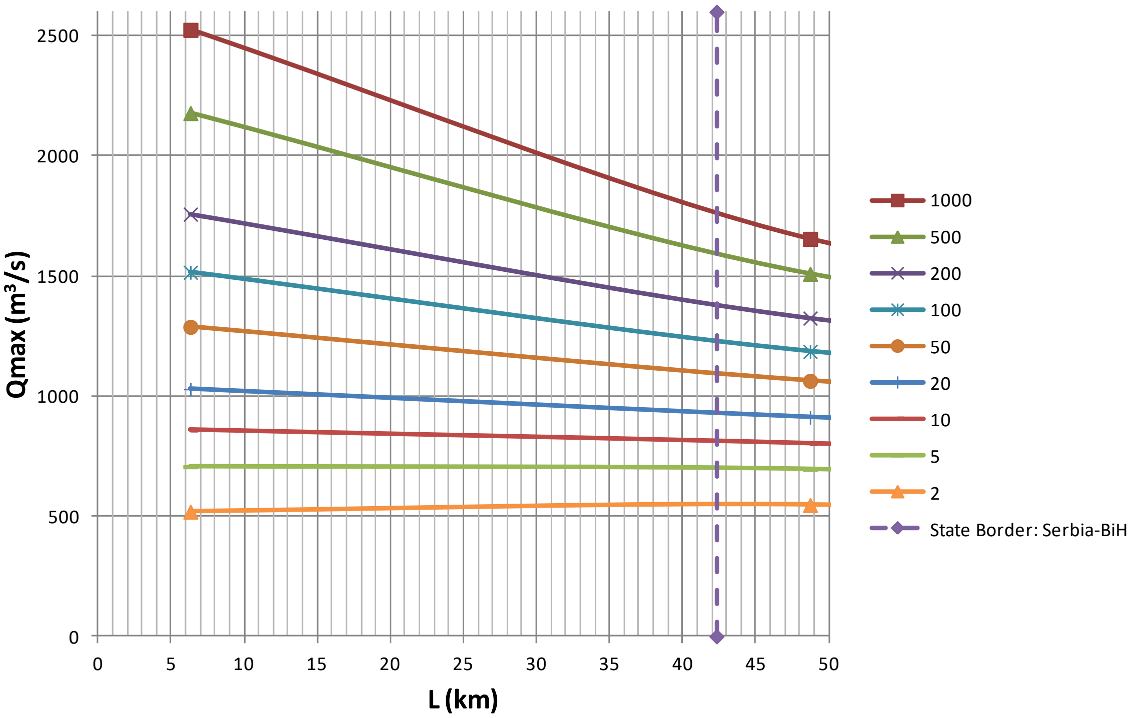


Figure 4-29: Maximum flood discharges on the representative stations along the Lim River (processing period (1))

The Table 4-15 and Figure 4-29 above indicate that flood discharges of certain probability grow from the "Priboj" HS towards the confluence with the Drina River. As expected, results are logical and synchronous. Obviously, "Potpeć" dam and storage does not hinder the natural water flow regime to any significant extent. This was expected since this is the storage with daily or possible weekly regulation.

Table 4-16: Maximum flood discharges with 95% confidence intervals – upper limit, on the representative stations on the Lim River (processing period (1))

Hydrological station	“Strmica” HS	“Priboj” HS
Chainage-L (km)	6.3	48.7
Return period (years)	Qmax (m^3/s)	
1,000	3,193	1,957
500	2,698	1,763
200	2,114	1,520
100	1,786	1,341
50	1,487	1,186
20	1,155	997
10	946	866
5	764	741
2	557	578

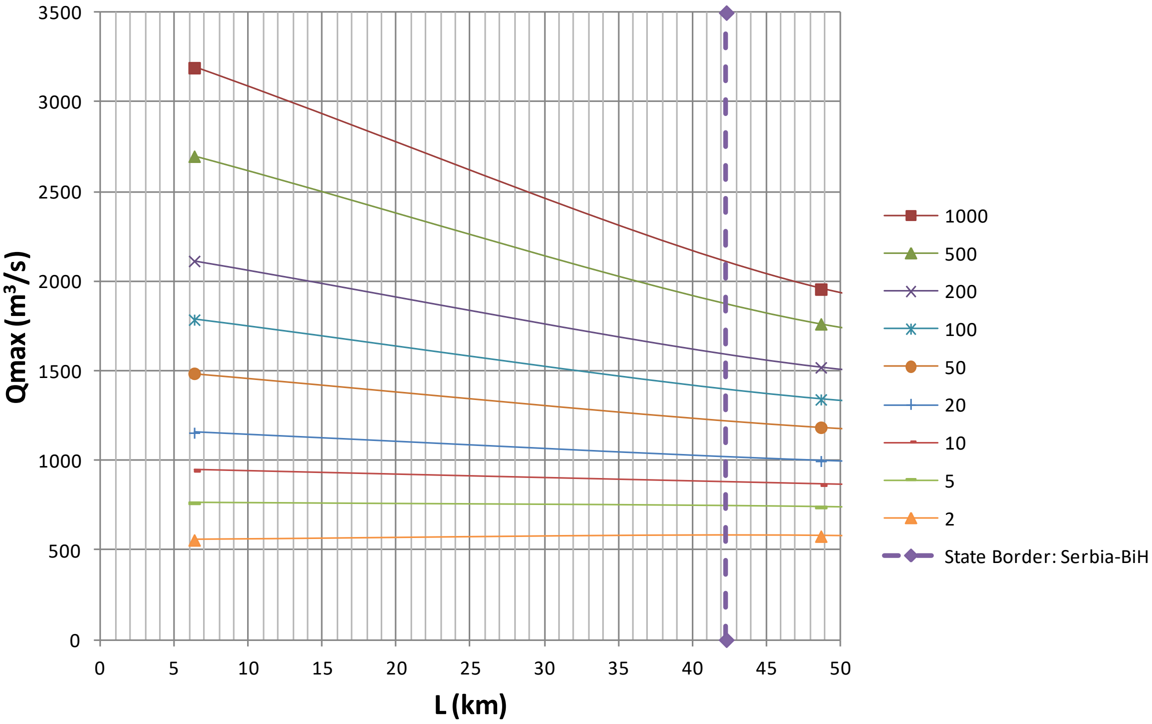


Figure 4-30: Maximum flood discharges with 95% confidence intervals – upper limit, on the representative stations along the Lim River (processing period (1))

The Table 4-16 and Figure 4-30 above indicate that flood discharges of certain probability follow the same trends as in case of the probabilities without confidence intervals, with somewhat higher values.

The probabilities of flood discharge occurrence on the analyzed hydrological stations are presented in Annex 4-4 of Volume 2.

4.4.4 Low Discharges

Methodology

Studying low discharges of the river course is of particular importance for all branches of water management and of special importance for river course quality protection.

Applicable low discharges are determined as a percentage share of the mean multi-annual discharge by means of application of the Tennant method. The following Table 4-17 presents the procedure for determination of low discharge in a river according to Tennant method as a percentage share of annual discharge in wet and dry seasons.

Table 4-17: Determination of low discharge by means of Tennant method, as a percentage share of annual discharge Q during wet and dry seasons with respective narrative discharge descriptor

Discharge narrative description:	Wet season	Dry season
Outstanding	40%·Q	60% Q
Excellent	30%·Q	50%·Q
Good	20%·Q	40% Q
Fair	10% Q	30% Q
Poor or Minimum	10% Q	10% Q

Determination of low discharge requires application of cumulative empirical distribution of minimum monthly discharges according to the Alexeyev method. Empirical distribution is compared to the set of theoretical distributions, such as Pearson 3, log-Pearson 3, Log-Normal, Weibull and Gumbel. Theoretical probability with the best match according to χ^2 test and Kolmogorov test, at significance threshold α=0.05, is adopted.

Results

In order to better assess low discharges, it is necessary to use time series as long as possible, because that reduces the uncertainty of their assessment. River discharge consists not only out of annual oscillations or seasonal cycles, but also from the multi-annual variation of water regime that defines the alteration of arid and water-abundant multi-annual episodes. The selection of the processing period from 1946 to 2012 allows for the inclusion of multi-annual periodic changes. It is necessary to point out that for low discharges assessment have been used monthly series of non-regulated discharges at the considered river profiles.

Based on the minimum monthly discharge series from each station, cumulative probability was determined by means of Alexeyev method. In addition to empirical probability, theoretical probabilities, such as Pearson 3 (P3), log-Pearson 3 (LP3), log-Normal (LN), Weibull and Gumbel were used. Analysis of the match between the theoretical and empirical distribution functions, in most cases, resulted with the best match for LP3 probability. Respective values of theoretical distributions for different cumulative probabilities p of minimum monthly discharges are shown in the following Table 4-18.

Table 4-18: Probability p of occurrence of the minimum monthly discharges on the profiles of analyzed hydrological stations for the period from 1946 to 2012

No	Hydrological station	River	Distribution	p – (probability of minimal monthly flows)								
				0.50	0.60	0.70	0.80	0.90	0.95	0.975	0.98	0.99
1	"Bastasi"	Drina	LP3	36.5	33.5	30.6	27.6	24.1	21.7	19.9	19.4	18.0
2	"Foča"	Drina	LP3	51.0	46.5	42.2	37.6	32.1	28.2	25.1	24.3	22.1
3	"Vikoč"	Ćehotina	Gumbel	4.4	4.0	3.7	3.3	2.8	2.5	2.2	2.1	1.9
4	"Igoče"	Sutjeska	Gumbel	3.0	2.8	2.6	2.4	2.1	1.9	1.7	1.7	1.6
5	"Oplazići"	Bistrica	LP3	2.9	2.6	2.4	2.1	1.7	1.40	1.2	1.1	0.96

Apart from the probabilistic characteristics of minimum monthly discharges, low discharges of the river course can be also defined as percentages of multi-annual discharges in accordance with the Tennant method. Table 4-19 presents different percentage shares of mean annual discharge Q on analyzed hydrological stations in line with Table 4-18.

Table 4-19: Percentage share of mean annual discharge Q on analyzed hydrological stations for the period from 1946 to 2012

No	Hydrological station	River	0.60·Q	0.50·Q	0.40·Q	0.30·Q	0.20·Q	0.10·Q
1	"Bastasi"	Drina	86.1	71.8	57.4	43.1	28.7	14.4
2	"Foča Most"	Drina	117.5	97.9	78.3	58.7	39.2	19.6
3	"Vikoč"	Ćehotina	10.6	8.8	7.0	5.3	3.5	1.8
4	"Igoče"	Sutjeska	8.3	6.9	5.5	4.1	2.8	1.4
5	"Oplazići"	Bistrica	7.1	6.0	4.8	3.6	2.4	1.2

4.5 Adopted Hydrological Statistical Parameters

Principal characteristics of water regimes in a basin area are annual discharges, low discharges and flood discharges. Analyzed hydrological stations in the DRB were analyzed with data from the “Drina” HIS database for the years 1946 to 2012. Mean monthly discharges on analyzed hydrological sta-tions were filled in by in accordance with the presented methodology. This is how monthly discharge time series were formed for the synchronous period from 1946 to 2012.

It should be noted that annual discharge trend and periodicity analysis suggests that long-term charges are taking place on all hydrological stations in the DRB, and that they exert significant influence on estimation of average discharges. Discharge downtrends were registered on all stations for the period from 1946 to 2012 period, and statistically significant trend at significance threshold α= 0.05 was reg-istered in the upper course of the Drina River and Lim River. Majority of hydrological stations registered annual discharge trend close to confidence threshold α= 0.05. Otherwise annual discharge downward trends observed in South-East Europe, as opposed to the region of North Europe that were registered discharge upward trends. Negative annual discharge trends in the basins of South-East Europe were presented in numerous studies and papers.

Effect of long-term annual discharge changes, in the form of gradual discharge change as demonstrated through annual discharge trend and cyclical discharge change through multi-decadal discharge oscillation, has reflected on estimation of average annual discharges on analyzed hydrological stations. Average annual discharges registered in the period from 1946 to 2012 are lower than the ones from previous analyses covering different processing periods.

Average discharges Q and low discharges on low discharges on analyzed hydrological stations in the DRB were determined on the basis of hydrological analyses for the period from 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 (next Table 4-20).

Table 4-20: Average annual discharges and low discharges on the profiles of analyzed hydrological stations for the period from 1946 to 2012

No.	Hydrological station	River	Average flows		95% min. Q_{month}		Tennant Model (Wet /Dry)
			Q	q	Distribution	$Q_{0.95\%}$	$Q_{10\%}$
1	"Bastasi"	Drina	143.5	39.0	LP3	21.7	14.4
2	"Foča"	Drina	195.8	35.9	LP3	28.2	19.6
3	"Vikoč"	Ćehotina	17.6	13.6	Gumbel	2.5	1.8
4	"Igoče"	Sutjeska	13.8	51.3	Gumbel	1.9	1.4
5	"Oplazići"	Bistrica	11.9	28.0	LP3	1.4	1.2

Legend: *Q-mean multi-annual discharge, q-specific yield of the basin, $Q_{95\%}$-95% guaranteed minimum monthly discharge, $Q_{10\%}$- 10% mean annual discharge value*

Mean annual discharge duration curves are presented by means of numerical values in the following Table 4-21 for analyzed hydrological stations in the DRB for the period from 1946 to 2012.

Table 4-21: Mean annual discharge on analyzed hydrological stations in the DRB from 1946 to 2012

Monthly flow duration curve (%)	0	5	10	20	30	40	50	60	70	80	90	100
"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

Flood discharges in the DRB were determined independently of average discharges and low discharges. Analysis was conducted for 10 hydrological stations in the Drina River, Ćehotina River and Lim River. Data on maximum daily and absolute annual maximum discharges on hydrological stations were used in calculations.

Processing period for the Drina River was from 1926 to 1975, and for Drina River and other analyzed rivers from 1926 to 2014. The following Table 4-22 shows the values of flood discharge peaks on analyzed hydrological station in the DRB.

Table 4-22: Flood discharges of different return periods T on analyzed hydrological stations in the DRB (processing period 2)

Hydrological station	River	*T* - return period (years)								
		1,000	500	200	100	50	20	10	5	2
"Badovinci"	Drina	5,529	5,134	4,601	4,192	3,806	3,298	2,909	2,505	1,896
"Radalj"	Drina	6,429	5,970	5,350	4,875	4,425	3,835	3,383	2,913	2,205
"Bajina Bašta"	Drina	7,763	6,971	5,980	5,248	4,617	3,854	3,320	2,809	2,124
"Višegrad Most"	Drina	7,512	6,743	5,787	5,097	4,484	3,735	3,205	2,696	2,004
"Foča Most"	Drina	6,114	5,362	4,454	3,806	3,258	2,614	2,178	1,775	1,257
"Bastasi"	Drina	3,835	3,473	3,056	2,763	2,468	2,090	1,810	1,528	1,121
"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	2,525	2,179	1,758	1,515	1,288	1,029	859	706	519
"Priboj"	Lim	1,655	1,509	1,325	1,186	1,064	912	802	695	547

5 Groundwater

5.1 Hydrogeological characteristics of the Drina River Basin

BiH is located in the central part of Dinarides, which forms the southern branch of the Alpine mountain building orogeny. According to Skopljak et al. (2011) BiH comprises about 25% of the Dinarides. This area is characterised by specific geological structures and intense tectonics that lasted from the Permian to Quaternary.

Hydrogeological classification of BiH was presented by Skopljak, Hrvatović, Zigić and Pasić-Skripić (2011) that accepted geotectonic zoning of the Dinarides of BiH carried out by the Hrvatović (2006). Six hydrogeological regions with significantly different geological structure, hydrogeological and hydrochemical characteristics were discerned as follows:

- Allochthonous Palaeozoic and Triassic,
- Dinaric carbonate platform,
- Dinara ophiolitic zone
- Bosnian flysch
- Sava-Vardar zone, and
- Post-orogenic Oligocene, Neogene and Quaternary formations

The three main aquifer types falling into these regions are:

- Karst aquifer
- Intergranular aquifer
- Fissured aquifer

As mentioned above, carbonate rocks predominate in the DRB and they are very suitable for the development of karst processes that are a significant hydrogeological feature. The term karst represents terrains with complex geological features and specific hydrogeological characteristics. The karst terrines are composed of soluble rocks, including limestone, dolomite, gypsum, halite, and conglomerates. As a result of rock solubility and various geological processes operating during geological time, a number of phenomena and landscapes were formed that gave the unique, specific characteristics to the terrain defined by this term. The chemical reaction describing limestone dissolution is:

$$CaCO_3 + CO_2 + H_2O = Ca^{2+} + 2HCO_3^-$$

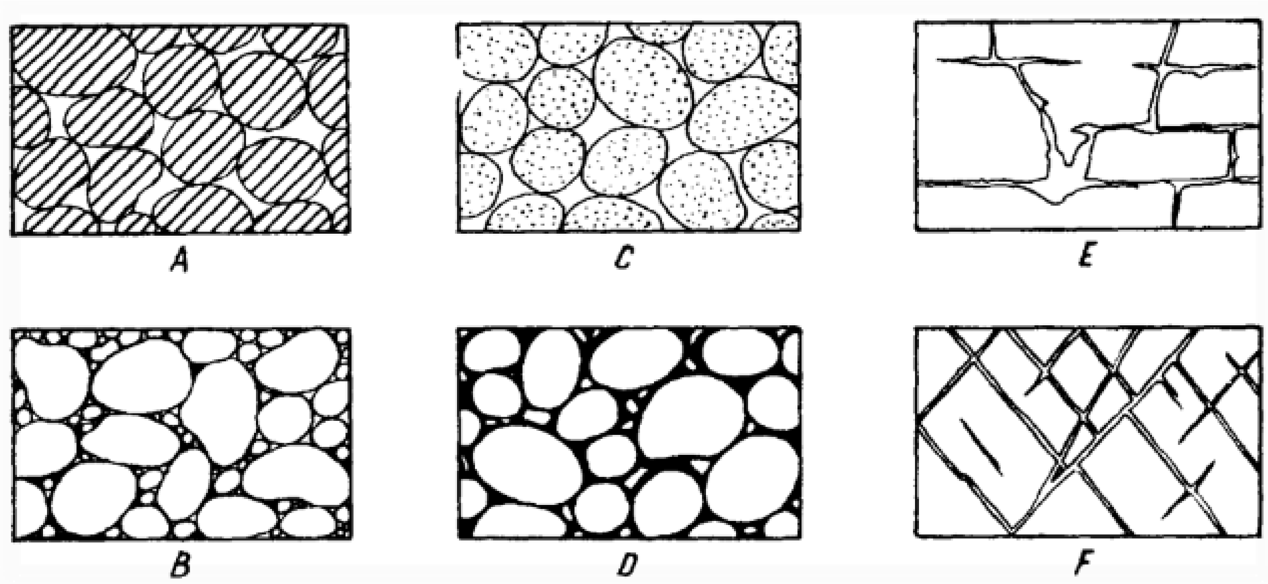
Analogous to term karst, karstification involves complex geologic processes, forming a specific surface morphology, and specific type of underground porosity, or specific hydrogeological conditions. Karstification (rock corrosion) is a chemical dissolution process by the water in soluble rocks - limestone and similar carbonate rocks e.g. dolomite, marble, calcareous marls, though karstification occurs within the formations of gypsum and salt. Within the karst of this geotectonic unit exist syncline regions build up of impermeable flycsh beds. In the process of karstification water has a fundamental role, primarily as a result of duality between the kinetics of chemical reactions and velocity water circulation.

The intensity and depth of karstification process depend upon many factors. According to Dragišić (1998) the intensity depends upon: i) presence of the soluble rocks, ii) fissuring, permeability and porosity of rocks where air and surface water can circulate, iii) a geological-structural setting and contemporary climate that can accelerate or slow down the karstification process and iv) crustal movements that can determine acceleration or deceleration of the karstification process.

Most intensive karstification processes occur in fissures or fault zones. The solution effect from the groundwater depends upon the content of carbonic acid in the groundwater. The terrain in the BiH part of the DRB (especially the south and central part) is very suited to the development of the karst process. Tectonic movements during the Paleogene, Neogene and later during the Quaternary, created an old karst plateau, incised by deep canyons. The karstification depth ranges from a few meters to over 2,000 meters. Karstic features are numerous and characterized by surface and underground forms including cracks, gorges, dry valleys, sinkholes, caves and potholes.

5.2 Porosity and aquifer types of the Drina River Basin

Porosity is the limiting factor in defining aquifers in the BiH part of the DRB. There are essentially two types of porosity; primary and secondary. Primary porosity was created when the rocks were formed and secondary porosity includes pore spaces, cracks and voids created after the lithification processes.
Many rocks are characterized by the presence of both primary and secondary porosity (porosity of composite type). The following types of porosity are presented in Figure 5-1.



A - well-sorted alluvial material; B - badly sorted alluvial material, low porosity, C - well sorted pebbles of porous material, very high porosity, D - well sorted material, but the porosity decreased due to cementing; E - rocks with cavernous porosity; F - fractured rocks with porosity; A, B, C, D - primary porosity, E, F - secondary porosity (According to Meinzer)

Figure 5-1: Types of Aquifer Porosity in the DRB (after Meinzer)

5.3 Groundwater availability

Taking the approach form above, the hydrogeological units shown on the hydrogeological map of BiH part of DRBcan be identified (see Figure 5-2):

- Aquifer with fractured permeability,
- Aquifer with inter-granular permeability,
- Aquifer with karstic permeability,
- Aquifer with limited groundwater,
- Aquifer with limited/or without groundwater,
- Aquifer with mixed permeability

The karstic aquifers with good permeability dominate the DRB and have fissure-cavernous porosity with substantial groundwater accumulations in them, and are the most significant water-bearing rocks in BiH comprising great thicknesses of several thousands of meters. Significant porosity of these water-bearing formations is a result of intensive karst processes that have greatly increased the dimensions of syngenetic and tectonic fissure porosity.

The inter-granular aquifers comprising sands and gravels (river alluvium) follow the main river channels and are primarily in the north of the part of the DRB, near to the confluence with Sava River, but also in isolated pockets on the main Drina channel in areas where the river flow has slowed.

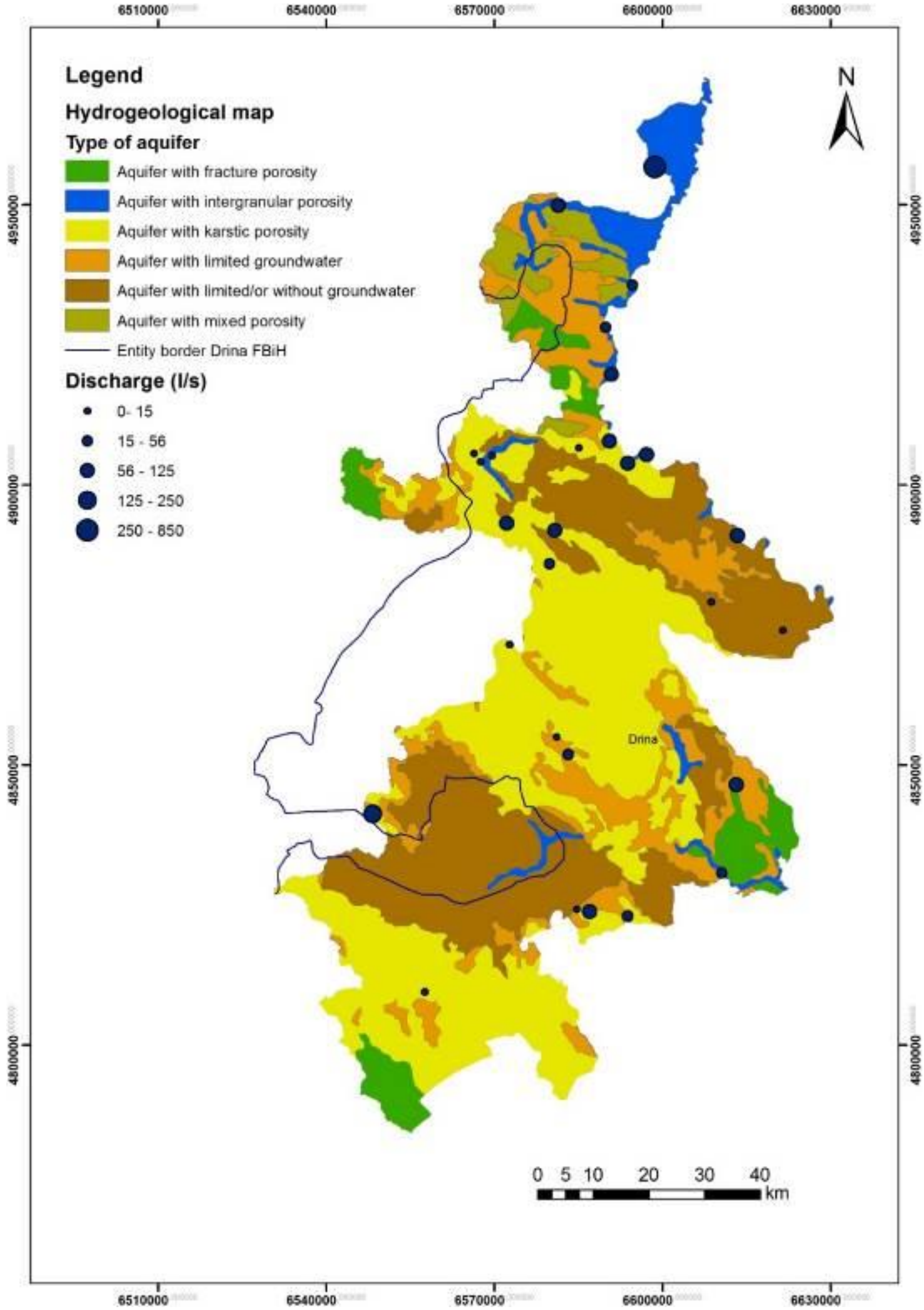


Figure 5-2: Hydrogeological map for the DRB in BiH

Knowledge on the flow regime of the karst and granular aquifers within the DRB is inadequate. Limited systematic long-term monitoring of individual elements of the regime have been performed and only for certain karst areas as well as for a certain number of capped karst springs, which are connected to water supply systems for larger settlements.

From the information available, it is possible to compile a hydrogeological map of the DRB indicating the spatial extent of the different types of aquifers and showing the minimum spring yields, based on licenced abstractions as sources of water supply for the municipalities in the basin (see Figure 5-2).

Springs with highest yields occur on the point of contact of permeable and impermeable rocks and in the areas of interganular porosity (river alluvium). The flows of the springs in the DRB vary due to the climatic conditions (through precipitation) and the largest flows are measured in the late autumn and early winter, with the minimum flows observed in the summer months (primarily August and September). The ratio between the minimum and maximum flow (Q min and Q max) rate for the springs is difficult to quantify, due to lack of data, but it is quite likely that the ratio could be 1:100 or even more.

There are more than twenty springs in the DRB (in RS only) with a minimum yield in excess of 5 l/s. Table 5-1 below provides indications of the spring sources that are licenced for municipal water supply requirements. A total of 1,365 l/s of minimal capacity is therefore currently used, but according to the data obtained from the ongoing EU IPA Project (Eptisa 2015) more than 5,170 l/s of water supply is available as a reserve in the BiH part of the DRB (RS only) and is currently unused.

Table 5-1: List of principal spring sources that are abstracted for water supply in DRB

Name of source	Municipality/city	Type of source	Minimum capacity (l/s)
Nikolina voda	Milići	Karst cavernousity	30
Jadar	Srebrenica	Surface water	90
Bjelovac	Bratunac	Concentrated	32
Tisca	Vlasenica	Karst cavernousity	240
Vidovica vrelo	Vlasenica	Karst cavernousity	6
Kreljeva voda	Han Pijesak	Karst cavernousity	12
Gerusa	Sokolac	Karst cavernousity	5
Ziličina	Rogatica	Karst cavernousity	45
Seljani	Rogatica	Karst cavernousity	25
Dobrun	Višegrad	Karst cavernousity	58
Cicelj	Čajniče	Karst cavernousity	80
Katanska vrela	Čajniče	Karst cavernousity	60
Zova	Rudo	Karst cavernousity	62
Lučka vrela	Foča	Karst cavernousity	100
Zelinjsko polje	Zvornik	Concentrated	40
Sopotnik	Zvornik	Karst cavernousity	25
Djevanje	Zvornik	Karst cavernousity	15
Tilić Ada	Zvornik	Concentrated	80
Janjari	Ugljevik	Concentrated	40
Grmič	Bijeljina	Concentrated	320
		Total	**1,365**

5.4 Delineation of Groundwater Bodies

The application of the term groundwater body (GWB) is defined in Article 2 and Article 7 of the WFD. The specific methodology for defining GWB is contained in Annex 5-1 of this report. During the preparation of the Sava RBMP a total of only seven GWB were defined for the Sava Basin with only two allocated for the DRB (see Background paper No 2 – Sava RBMP 2013). Since then the EU IPA Project "Capacity Building in the Water Sector" has been implemented and is still ongoing. Now a much more detailed delineation of the GWB in BiH has been obtained. Based on documentation provided a total of six GWB have been delineated in the DRB with three other GWB that "skirt" the western boundary of the basin.[17] This information is provided in Figure 5-3 and listed in Table 5-2 below.

[17] Data obtained from "Report on Groundwater" May 2015, Capacity Building in the Water sector – EU IPA – Eptisa Consultants

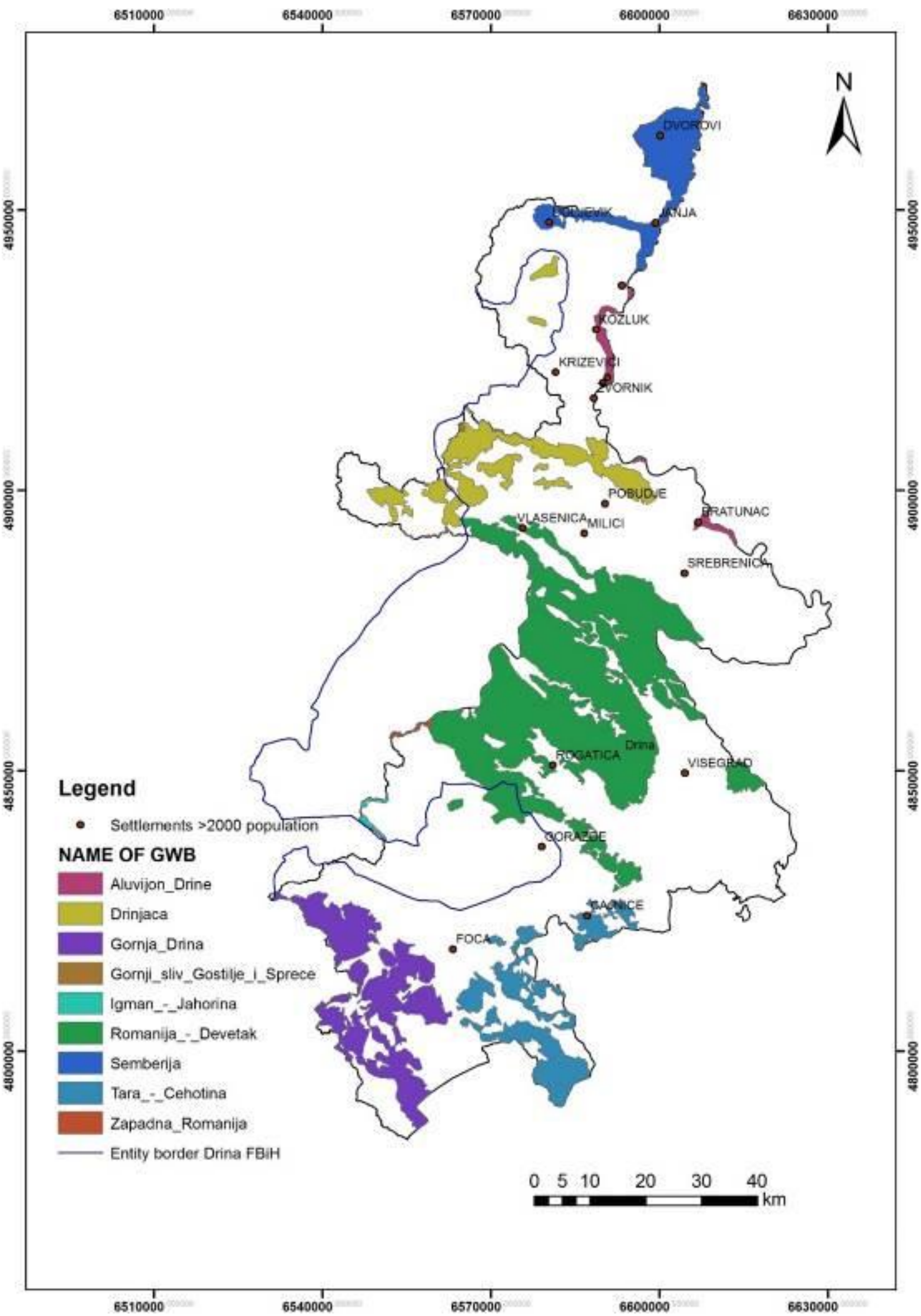


Figure 5-3: Defined GWB in DRB in BiH based upon recent EU IPA Project

Table 5-2: List of defined GWB in BiH part of DRB

Ref No	GWB Coding	Map Abbr	Affiliation	Name of GWB	Area in RS BiH km²	Area in FBiH km²	Total Area km²	Est. area in DRB km²

Ref No	GWB Coding	Map Abbr	Affiliation	Name of GWB	Area in RS BiH km²	Area in FBiH km²	Total Area km²	Est. area in DRB km²
13	BA_BO_GW_K_1	IJ	IE	Igman – Jahorina	197.9	383.1	581	15
15	BA_BO_GW_K_2	ZR	IE	Zapadna Romanija	465.7	299.3	765	20
16	BA_DR_GW_K_4	DR	IE	Drinjaca	193.5	65.5	259	255
17	BA_BO_GW_K_3	GO	IE	Gornji sliv Gostilje i Sprečel	65.6	96.4	162	15
20	BA_DR_GW_I_2	SM	RS/TBA	Semberija	465.3	0	465.3	372
21	BA_DR_GW_I_1	AD	RS	Drina Alluvium	34.1	0	34.1	34.1
22	BA_DR_GW_K_3	RD	FBiH/RS/TBA	Romanija – Devetak	1229.65	107.9	1337.5	1330
23	BA_DR_GW_K_2	TĆ	RS/TBA	Tara – Ćehotina	245.2	0	245.2	245.2
24	BA_DR_GW_K_1	GD	RS/TBA	Gornja Drina	454.6	9.3	463.9	450
	TOTAL				**3351.55**	**961.5**	**4313**	**2736.3**

Source EU IPA – Eptisa
Legend: TBA = Transboundary Aquifer, RS = Republik Srpska, FBiH = Federation, IE = Inter water body

GWB lying within the DRB

GWB skirting western edge of the DRB

#13 Igman - Jahorina

The group of water bodies "Igman - Jahorina" (BA_BO_GW_K_1) belongs to the Bosna river and is located in the central part of BiH, mainly south of Sarajevo. This GWB has inter water body character, the northeast and the southeast end of GWB located in RS and the remainder in FBiH. The GWB has a total of five separate smaller units all falling into the same group.

#15 Zapadna Romanija

The group of water bodies " Zapadna Romanija " (BA_BO_GW_K_2) located in the eastern part of BiH belonging to the Bosnia river and with inter water body character as the southeastern part of GWB is in RS and the remainder in FBiH. This GVT is elongated direction SE - NW and extends from Sokolac to Vares, including Mount Romanija, Sljeme, Star and Ozren.

#16 Drinjaca

The group of water bodies "Drinjača" (BA_DR_GW_K_4) is located in the east of BiH and belongs to the Drina basin. This GVTPV has inter water body-character, because the far northern and western parts of the group are located in FBiH, while the rest remains in RS. The total area of the water body amounts to 259 km^2 of which 242 km^2 is autogenous and 17 km^2 is allogenic.

#17Gronji basin Gostilje and Spreča

The group of water bodies "Gronji basin Gostilje and Spreča" (BA_BO_GW_K_3) is located in the eastern part of BiH and has inter water body-character, as the eastern part of the GWB is located in RS and the western part in FBiH. This GWB consists of five physically separate small water bodies with similar characteristics. The "upper basin Gostilje and Spreča" spreads between Konjuha in the west and Borogova in the east, in the south it includes the northern slopes of Javornik, and in the north is the limit of the valley of the river Spreča. Less than 2 km² is allogenic in origin

#20 Semberija

The group of water bodies "Semberija" (BA_DR_GW_I_2) is located in the northeastern part of BiH and is completely in RS, but has transboundary aquifer characteristics. The GWB stretches south of Janja, to Bijeljina and further line-Obarska-Crnjelovo (western border). The GWB continues west of Janja to Ugljevik (Janjarski field) in the form of a strip about 2 km wide, which usually follows the boundaries of the River Janja alluvial plains Janja. To the north, the GWB is limited by the Sava River and the border with Serbia and Croatia, and to the east, the Drina River (the border with Serbia).

#21 Drina Alluvium

The group of water bodies "Drava alluvium" (BA_DR_GW_I_1) is located in the eastern part of BiH and lies completely within RS. It extends from Bratunac in the south, and continue through Drinjača and Zvornik to Šepak north, along the river Drina for a length of approximately 70 km. The Drina River forms the eastern boundary of GWB, also the state border with Serbia. The GWB is made up of four separate units of the same rock type (fluvial sediments of the Drina River, with a width of between 300-600 m). These four areas are Bratunac field, Zelinjsko field, an area of Tilić ade to Rocevic, and the Drina River alluvium in Šepka (Branjeva). The last of this group of four is located directly south of the GWB "Semebrija" and east of GWB "Drinjača".

#22 Romania - Devetak

Group of groundwater bodies "Romania - Devetak" (BA_DR_GW_K_3) is located in the extreme east of BiH and has inter water body character. Most of the GWB is in RS (almost 97% of the area), with the remaining 3% in FBiH. The GWB can also be considered a transboundary aquifer, as the water bearing rocks extend east into Serbia.

#23 Tara-Ćehotina

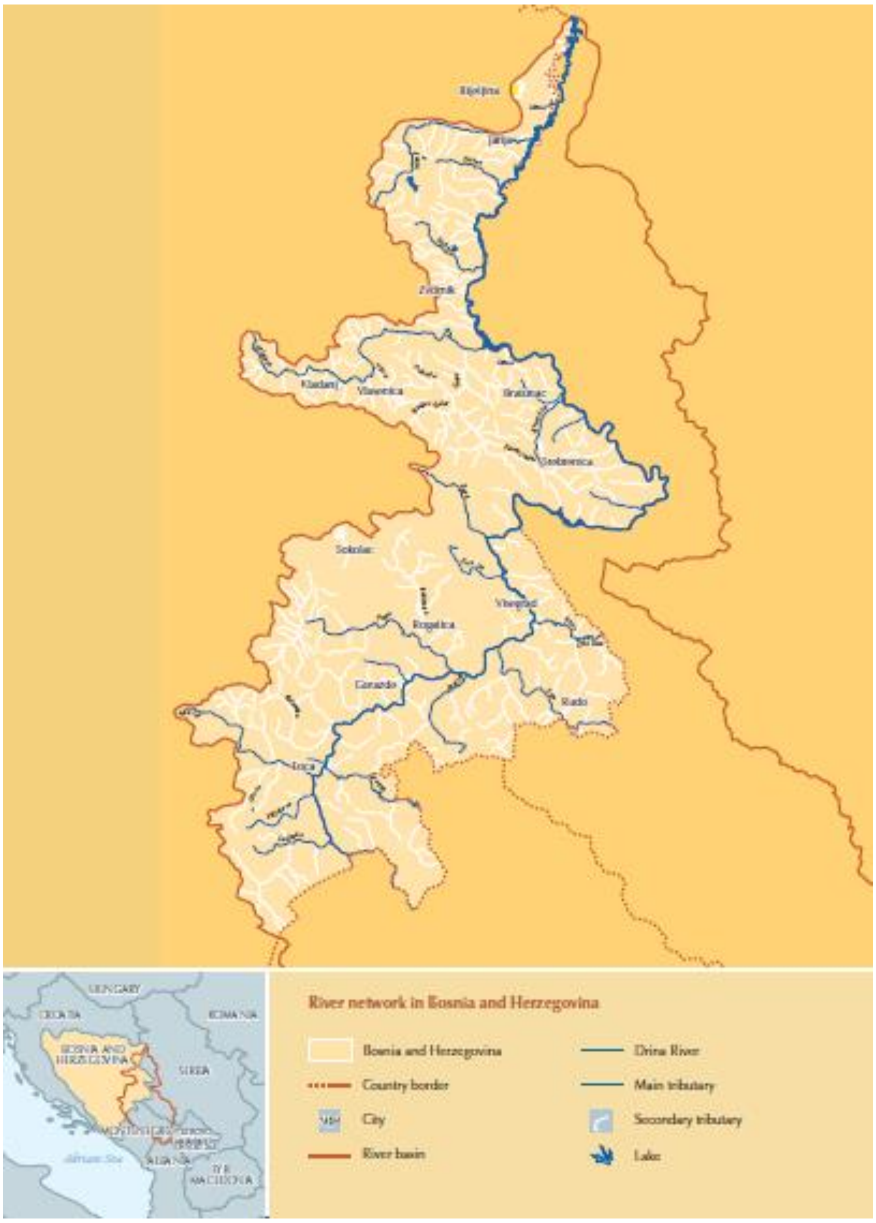
The group of water bodies "Tara-Ćehotina" (BA_DR_GW_K_2) is located in the eastern part of BiH and is entirely within the RS. This GWB is elongated in a NW-SE direction and extends from Foca in the northwest to the eastern slopes of Obzira and Ljubisnja and then to the state border with Montenegro. This GWB has transboundary characteristics and is present in Montenegro.

#25 Gornja Drina

The group of water bodies "Gornja Drina" (BA_DR_GW_K_1) is located in the eastern part of BiH. About 98% of the GWB is in RS with only a very small part remaining in the west in the FBiH. This GWB is elongated NW-SE direction and extends from Treskavica in the NW, across the slopes of Lelija, Zelengora, Volujak and Maglic to the state border with Montenegro. About 27.4 km^2 of the GWB is allogenic, while the rest represents autogenous karst present in the form of massive limestones.

6 Water Quality

This section provides a summary of the water quality in the BiH part of the DRB, including an inventory and assessment of the main characteristics and trends based on existing data on water quality for surface water and for groundwater gathered by the main institutions: the Water Agency for the Sava River District in RS and the Water Agency of Sava River District in FBiH; and the Hydro-meteorological Institutes of the two entities. This is followed by an analysis of the water quality from specific locations within the DRB. The section then provides a review of the pollution hotspots and breaks this down into sectors covering domestic, industrial or agriculture disposal.



Source: REC 2011

Figure 6-1: Overview of the BiH part of the DRB

6.1 Classification of water quality and monitoring

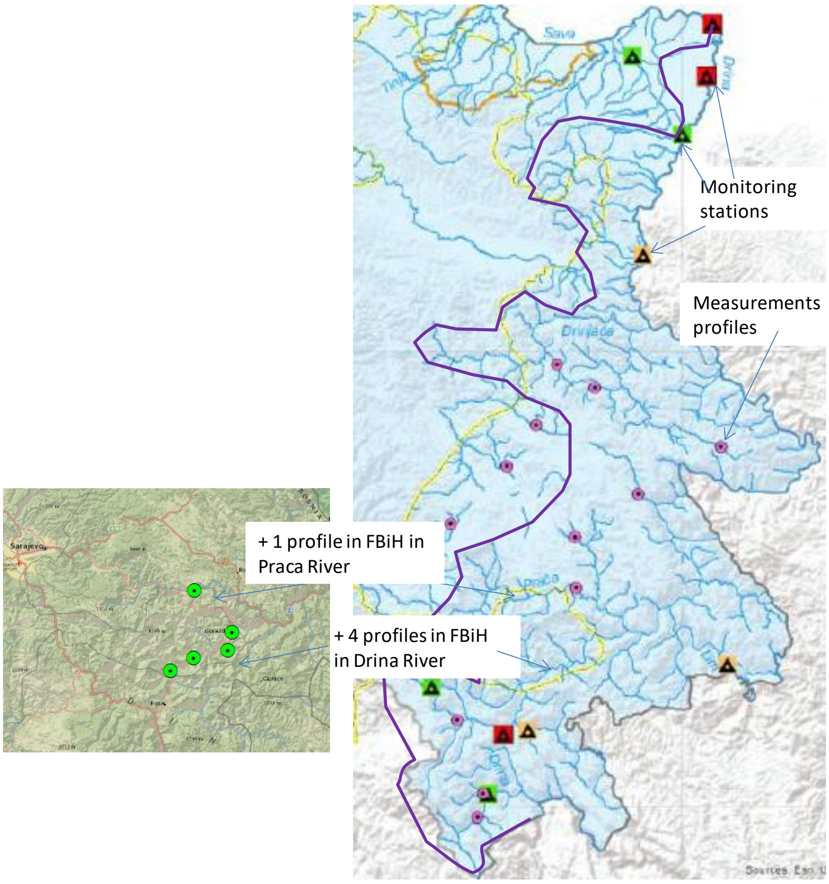
The Law on Waters of both entities FBiH and RS obliges public institutes and private companies using water and having wastewater discharge to measure and control the water quality.

Historically, water quality was monitored since the sixties but regular monitoring was interrupted during the war. Reestablishment of the monitoring started in 2005. Main improvement of the water quality monitoring occurred since 2007 in order to meet the requirements of WFD (EPTISA, Sava River Basin characterisation report 2015).

Nowadays, the surface monitoring of the water quality covers a major part of the DRB. Indeed, in the FBiH part of the DRB, there are 4 monitoring profiles in the Drina River and 1 monitoring profile in the Prača River (see Figure 6-2). In the RS-BiH there are 4 monitoring profiles in the Drina River, and there are 12 monitoring profiles in the tributaries (see Figure 6-2). The chemical, physical and biological surface water and groundwater parameters are regularly measured at these profiles.

The water quality of the Drina River is also measured in Serbia with 12 sampling stations in the Drina River that are used by the Serbian Environmental Protection Agency (SEPA) and the Serbian Hydro-meteorological Service (RHMS).

Therefore, in the following the water quality characterization of the Drina River is a synthesis of the BiH monitoring station on the Drina River, compared with the Serbia monitoring to control consistency.



Source: Management plan Sava River Basin of RS-BiH - Monitoring, EPTISA 2015 and data of the Water Agency of Sava River District, FBiH

Figure 6-2: Moniroring stations and regular measurement profil in the BiH part of the DRB

The classification of the water quality in RS is provided by the Decree on Water Classification and Categorization of Water Courses ("RS OG", No 42/01) and on the Law of waters ("RS OG", No 50/06). However, according to the Draft Strategy of integrated water management (June 2015), this Decree did not define limit values for all biological and physical-chemical parameters as required on EU Directive and for some specific parameters, the prescribed limit values do not comply with these EU regulations. Table 6-1 summarizes the limit values for the main parameters and the definition of the classes. In FBiH, until 2014, the quality of the surface water was regulated according to the Regulation on Categorization of Waterways

("OG SR BiH", No. 42/67), on the Regulation on the classification in Yugoslavia located in BiH, 1980, and on the regulation of hazardous and harmful substances in water ("OG FBiH", No. 43/07).

In January 2014, the Decision on the characterization of surface water and groundwater was issued in the "FBiH OG", No. 1/14, which has been harmonized with the EU Directives. This decision provides the reference conditions and parameters to determine the status of surface water and groundwater and for monitoring of water.

Table 6-1: Limits of hazardous substances for determination of surface water classes in RS

Parameter	Class I	Class II	Class III	Class IV
Definition based water uses	Drinking, food industry and salmonids farming	Recreation, water sports, Cyprinids farming and drinking and food industry only after treatment	Irrigation and in industries except for food industry	In industries, but only with treatment
Parameters	Limit values	Limit values	Limit values	Limit values
pH	6.8–8.5	5.8–8.5	6.0–9.0	6.0–9.0
Dissolved oxygen (mg/L)	>8	8–6	6–4	4–3
BOD_5 (mgO_2/L)	<2	2–4	4–7	7–20
NH_4^+ (mg/L)	<0.13	0.13–0.26	0.26–0.52	0.52–1.29
NO_2^- (mg/L)	<0.03	0.03–0.1	0.1–0.16	0.16–0.66
NO_3^- (mg/L)	<4.43	4.43–22.15	22.15–44.3	44.3–110.8
Sulphate (mg/L)	<50	50–75	75–100	100–150
Suspended solid (mg/L)	<10	10-30	30-80	80-100

Source: Bosna sema educational institutions, 2007, Decree on Water Classification 2001.

As mentioned above, the Drina River is also monitored in Serbia. In order to have a complete picture of the water quality in the Drina River, the Serbian results on Drina water quality are compared with the BiH data below.

In Serbia, there are two types of classification. One is the Water Quality Index (WQI) based on the national regulations on water quality of Serbia. WQI includes the analysis of nine physical - chemical and one microbiological element. On a scale from zero to 100, the water quality is ranked from "very poor" to "excellent". The WQI classification is described in Annex 6-1.

The other classification used in Serbia proposes Class I to V, depending on the concentration of hazardous substances in surface water. The classification is almost comparable to the BiH classification as can be seen in Table 6-2.

Table 6-2: Concentration limits of hazardous substances for the determination of surface water classes

Class	Concentration of hazardous substances in surface water
Class I (1)	Measured value is ≤ AAC and the ecological status is excellent
Class II (2)	Measured value is ≤ AAC
Class III (3) and Class IV (4)	Measured value is > AAC and ≤ MPC
Class V (5)	Measured value is > MPC

AAC = Average annual concentration; MPC = Maximum permissible concentration

Source: SEPA "Results of testing of surface and groundwater quality in 2013".

(1) Class I corresponds to an excellent ecological status according to the regulation that prescribes the parameters of the ecological and chemical status of surface waters. Surface waters belonging to this class are compatible with the limit values of water quality requirements for the functioning of ecosystems and fish protection (salmonids and cyprinids) and can be used for the following purposes: drinking water supply with pre-treatment filtration and disinfection, swimming and recreation, irrigation, industrial use (process and cooling water).

(2) Class II corresponds to a good ecological status according to the classification given in the regulation that prescribes the parameters of the ecological and chemical status of surface waters. Surface waters belonging to this class are compatible with the limit values of water quality requirements for the functioning of ecosystems and for fish protection (cyprinids) and can be used for the same purposes and under the same conditions as the surface waters belonging to class I.

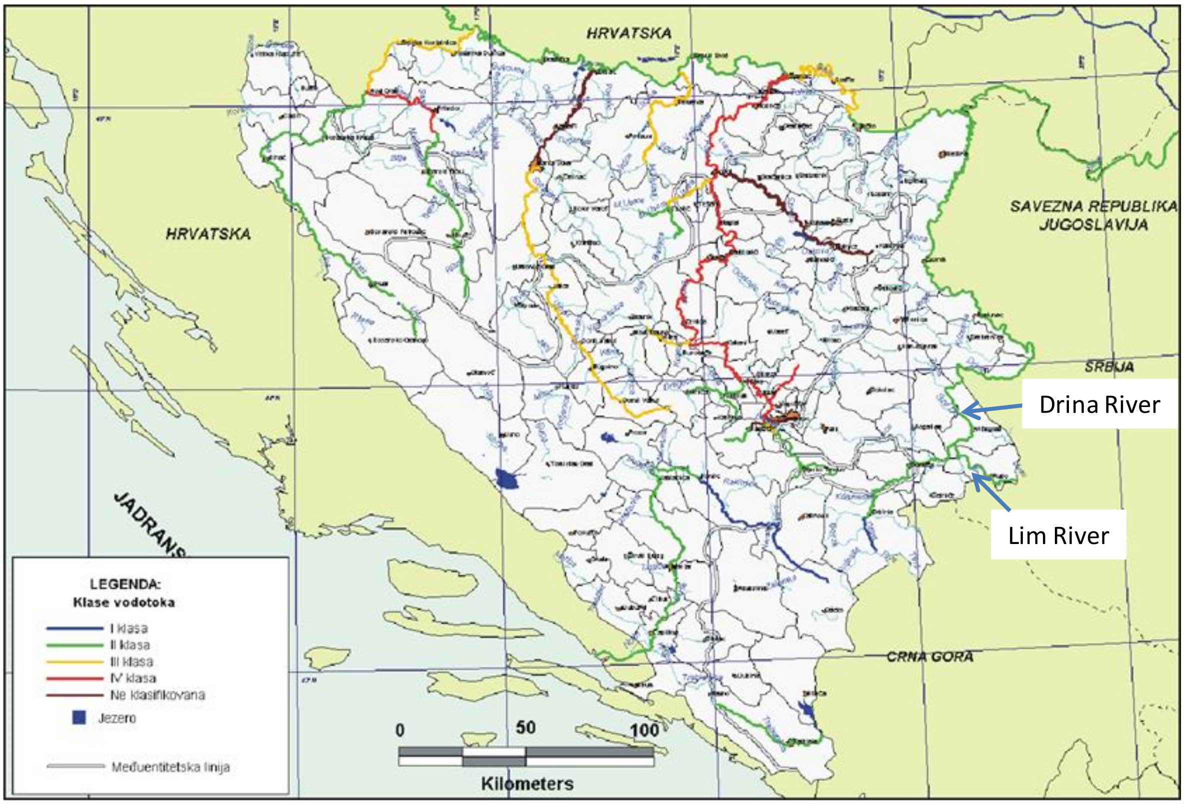
(3) Class III corresponds to a moderate ecological status according to the classification given in the regulation that prescribes the parameters for the ecological and chemical status of surface waters. Surface waters belonging to this class are compatible with the limit values of water quality for living conditions and protection of cyprinids and can be used for the following purposes: drinking water supply by previous treatment through coagulation, flocculation, filtration and disinfection, swimming and recreation, irrigation, industrial use (process and cooling water).

(4) Class IV corresponds to a weak ecological status according to the classification given in the regulation that prescribes the parameters for the ecological and chemical status of surface waters. Surface waters belonging to this class may be used for the following purposes: drinking water supply with the use of a combination of the abovementioned treatments and improved methods of treatment, irrigation, industrial use (process and cooling water).

(5) Class V corresponds to a poor ecological status according to the classification given in the regulation that prescribes the parameters for the ecological and chemical status of surface waters. Surface waters belonging to this class are not used for any purpose.

6.2 Water quality in the Drina River Basin before 1990

The purpose of the following two sections is to analyse whether there was any noticeable change in water quality before 1990, i.e. before the conflicts that ensued in the Balkans from 1990 -1995. During this period from 1965 to 1991, the monitoring was performed by the hydrometeoroligical Institute. There were four monitoring profiles in the Drina River (at Višegrad), one monitoring profile at the mouth of the Ćehotina River and one profile at the mouth of the Lim River. The physical and chemical parameters were measured periodically, three times a year (spring, summer and autumn), while the biological parameters weremeasured twice a year (summer and fall). The following Figure 6-3 gives the classification of the Drina and the Lim rivers in BiH in 1986.



Source: FMHZ-FBiH: Map made in the International Management Group (IMG), Sarajevo 2000

Figure 6-3: Classificationof the BiH rivers according to the results of monitoring in 1986 (in blue: Class I and in green: Class II)

According to the Regulation on Categorization of Waterways ("OG SR BiH", No. 42/67), before 1990, the Lim River was classified in Class II and the Drina River in Class I at the only upstream and in class II for entire river. No more archive report on the water quality in the DRB has been found in the relevant agency.

The average concentration values during the period 1985-1991 measured at the BiH station downstream of Gorazde and provided in the Water Management Strategy for FBiH (2012) are as follows:

- BOD5 (mg O_2/l) ≈3
- Suspended matter (mg/l) ≈26
- Saprobic index ≈1.9

These results confirm that during the period preceding the war, the Drina River was on average of good quality, noted in class II.

In order to compare with the BiH data, the following paragraphs describes the result for the Drina River stemming from the Serbian monitoring. The classification is given according to the Table 6-2, which is comparable to the BiH classification (Table 6-1). Overall, the analysis of results of water quality before 1995 for the Drina River shows that it belonged in average to Class II, as described below.

1975

In 1975, the Drina River water quality was tested eight times at the profiles for Bajina Bašta and Balatun. The water quality for the Drina at Bajina Bašta was clearly within Class II. On the Balatun profile (at the confluence of the Drina river with the Sava), the water quality deteriorated and was on the cusp between Class II and Class III. Biological results from three seasonal sampling periods (not winter) at Bajina Bašta, provided a saprobity index between 1.4 -1.7, while on the Balatun profile they provided a range from 2.1 to 2.3. The water in the Drina was beta mezosaprobic belonging to Class II. The Bajina Bašta site also had a large number of indicators of olygo-saprobic water that indicated water quality deterioration.

1980

A similar analysis can be made on the Drina River during the 1980s (10 sets of readings) at four profiles namely: Bajina Bašta, Vitkovići, Radalj and Balatun. Results show a similar range of readings, with saprobiological analysis showing Class II characteristics.

1985

Results from a 1985 analysis on the Drina River at Bajina Bašta, Vitkovići, Radalj and Crna Bara profiles show respective water qualities of Class I /II, Class II /III, Class I /II and Class II. Occasional hazardous and noxious substances recorded have high concentrations of nickel and nitrate (two cases) and arsenic (one case).

The saprobiological analysis of the profiles Bajina Bašta, Vitkovići, and Radalj shows good conditions belonging to Class II, while the Balatun-Crna Bara profiles were Class III and the cusp of Class II/III respectively.

1990

Further analysis in 1990 on the Drina River (at Bajina Basta, Ljubovija, Kozluk, Jelav and Crna Bara) showed water quality of Class II to Class II /III. Elevated concentrations of mercury and nitrate were noted at Kozluk and Crna Bara. Further, at Jelav, higher concentrations of phenol were measured. The saprobiological analysis indicates Drina River belongs to Class II at Bajina Bašta, Ljubovija and Kozluk, while at the profiles of Jelav and Crna Bara Class II/III is found.

1995

During 1995, water quality analysis was performed on the Drina River at Bajina Bašta, Ljubovija, Jelav and Badovinci. At Bajina Bašta and Jelav the quality is Class II /III and at Ljubovija and Badovinci it is Class II. The saprobiological analysis of the water of the river Drina indicates a moderate organic pollution of the watercourses. Samples indicate beta-mezosaprobic water with Bacillariophyla organisms present, indicating polluted water. The saprobity results indicated water quality of Class II, while in one analysis at Ljubovija oligo-beta-mezosaprobic water was noted indicating Class I-II.

6.3 Water quality in the Drina River Basin after 1995

Generally, the water quality in the DRB has been improving after the war from class II/III to class I/II. This is mainly due to the reduction/closure of industrial facilities in the basin and the slow development of new industry and agriculture.

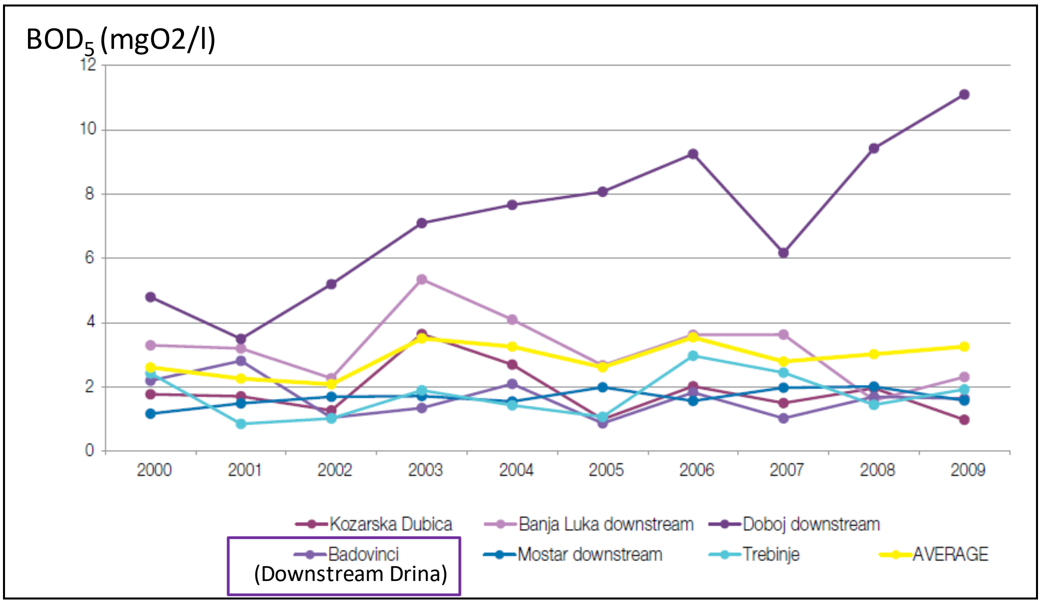
6.3.1 Main trend of pollution in the Drina River

Oxygen consuming substances in the Drina River
According to the state of environment report for BiH 2012, the recorded values of the concentration of organic substances in the Bodovinci profile in the lower Drina River since 2000 show that the state of the Drina River is good considering the content of oxygen in water and the saturation of water with Oxygen. The data available at the station downstream Goražde (in the water management strategy of the FBiH 2012) corresponds to the average of the monitoring period 2005-2007. This data is only indicative because the series is too short to conclude on a representative average value.

Organic pollution in the Drina River
The organic pollution in the Drina River is mainly caused by untreated municipal and industrial wastewaters. It is indicated by the Biochemical Oxygen Demand in a five-day sample (BOD_5). A high level of organic pollution can have a harmful impact on the aquatic ecosystems.

Figure 6-4 shows the trend of the BOD_5 from 2000 to 2009 in the monitoring profiles of the BiH rivers. The Drina River profile is in light purple (Badovinci). It can be observed that the average value of BOD_5 is quite stable in the lower part of the Drina and always under the value of 2 mg/l of O_2; the lower section of the Drina is in Class I.

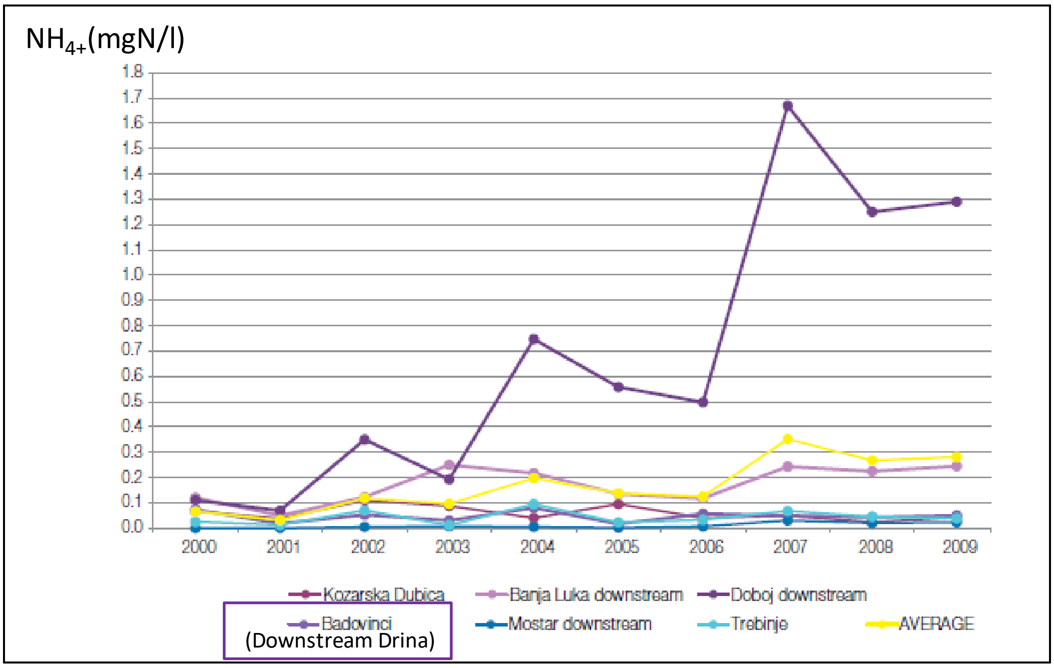
The average value of the BOD_5 concentration downstream Goradze during 2005-2007 is around 2 mg/l O_2, which is of same order of magnitude as the concentration in the lower Drina section during this period.



Source: Water Agencies in BiH (State of environmental report for BiH, 2012)
Figure 6-4: Average values of BOD5 (mg O_2/l) in the rivers of BiH – In light purple, the Drina river section

Ammonium pollution in the Drina River

This pollution is mainly caused by urban and agricultural wastewaters. The Figure 6-5 shows the trend of ammonium (NH_4+ component) from 2000 to 2009 in the monitoring profiles of the BiH rivers. The Drina River profile is again in light purple. It can be observed that the average value of the ammonium is quite stable in the lower part of the Drina River and always under the value of 1 mg/l of N: the lower section of the Drina is in Class I.



Source: Water Agencies in BiH (State of environmental report for BiH, 2012)

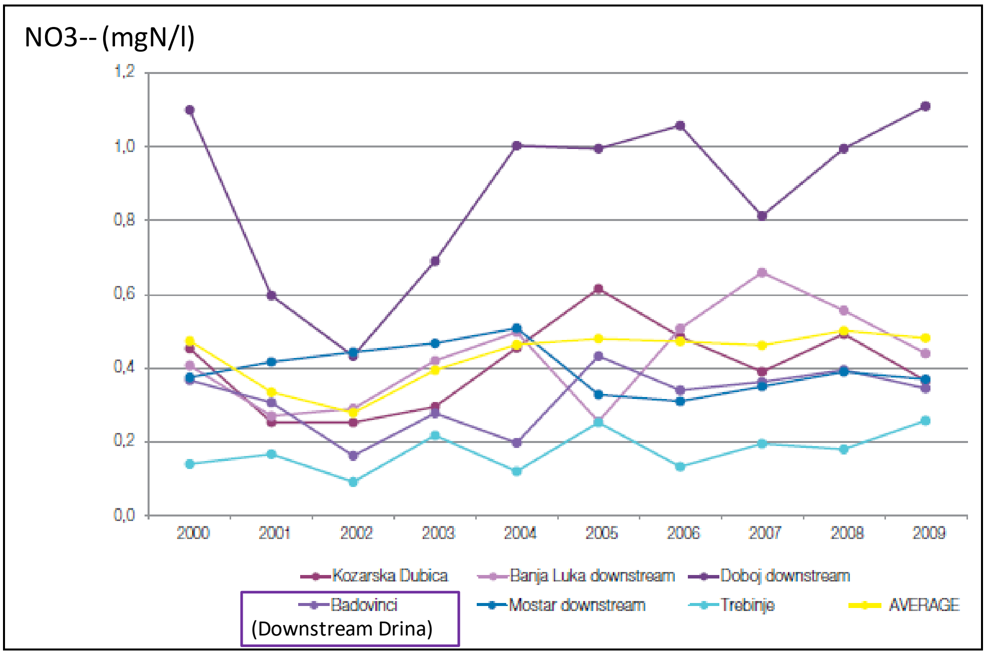
Figure 6-5: Average values of NH4+ (mgN/l) in the rivers of BiH – In light purple, the Drina river section

These results are supported by results of the Bajina Bašta station (in Serbia): for the oxygen results (which depend on the organic and ammonium loads) the Drina River at the Bajina Bašta section is in Class I (according to the Serbia classification, which is comparable to the BiH classification).

Nutrients pollution in the Drina River

The nitrate load in rivers is mainly caused by agriculture and industry. As previously, the trend since 2000 is shown at the BiH monitoring river stations in Figure 6-6.

At the Badovinci profile in the Drina River, the value of nitrate has increased after 2004. However, the concentration remains largly below the limit value of 4.43 mg/l of N: the water quality of lower Drina River is in Class I.



Source: Water Agencies in BiH (State of environmental report for BiH, 2012)

Figure 6-6: Average values of NO3--(mgN/l) in the rivers of BiH – In light purple, the Drina river section

This result is supported by the measurements of nutrient load at the Bajina Basta station of Serbia. Nitrate, total nitrogen and orthophosphate show Class II, total phosphorus Class I/II and all others (nitrites and ammonium ion) Class I, regarding the Serbian classification.

It can be noted that accumulation reservoirs or lakes, characterized by stagnant water, are more sensitive to phosphorus concentrations and are subject to the process of eutrophication. This is not represented by the two profiles at Badovinci or Bajina Basta that are located in the streaming flow.

6.3.2 Present status

The last data transmitted by the EU IPA Project (Eptisa 2015) provides a present state of the main physical-chemical characteristics of the rivers in the Sava Basin, shown in Figure 6-7 and Figure 6-8.

The ecological[18] and chemical[19] status of the Drina River has been assessed based on the water quality parameters (draft plan of the water management RS-BiH and FBiH, 2015).

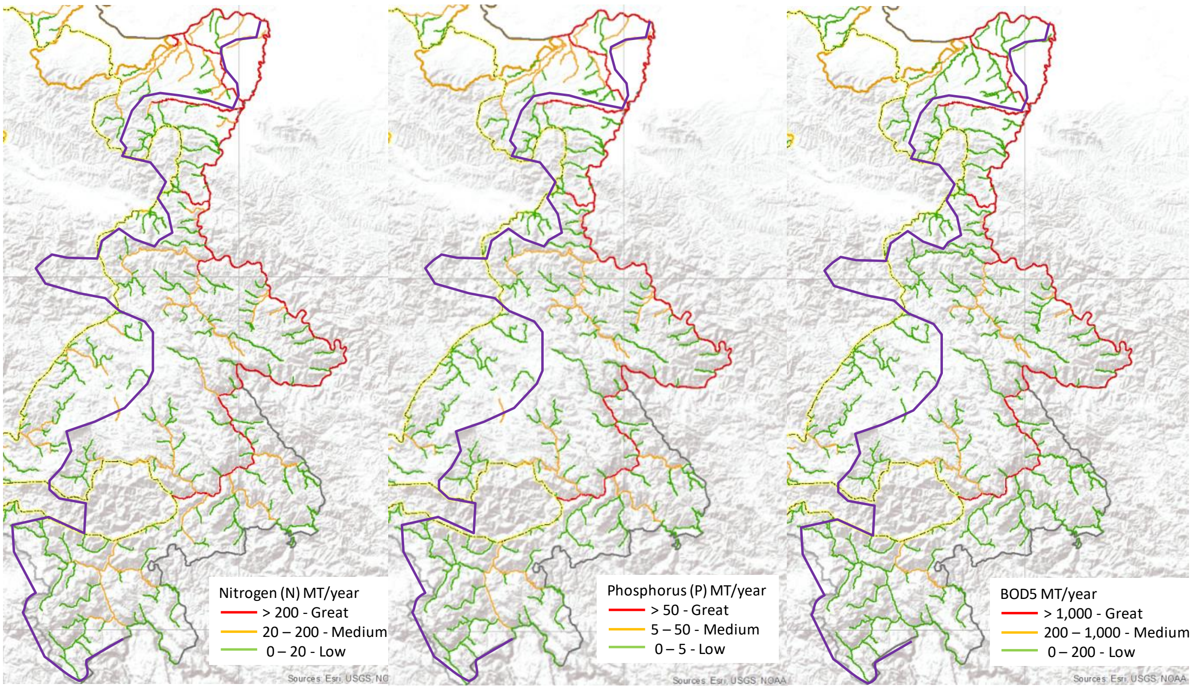
The upstream Drina River up to Goradze has low to medium loads. It is chemical and ecological status is of good quality.

The downstream of the Drina River has high Nitrogen, Phosphorus and organic loads. The ecological status from Gorazde to Višegrad and from Zvornik to the mouth is classified as moderate status. From Goražde to Višegrad, the chemical status is bad with moderate charge level and from Zvornik to the mouth chemical status is bad with high charge level.

The tributaries are generally of good quality considering the main organic and chemical loads.

[18] Ecological status: this criterium for the classification of the water quality regroups all the physic-chemical and biological quality parameters and hydromorpholoical parameters

[19] Chenical status: this criterium for the classification of the water quality regroups all the hazardous and toxic substances



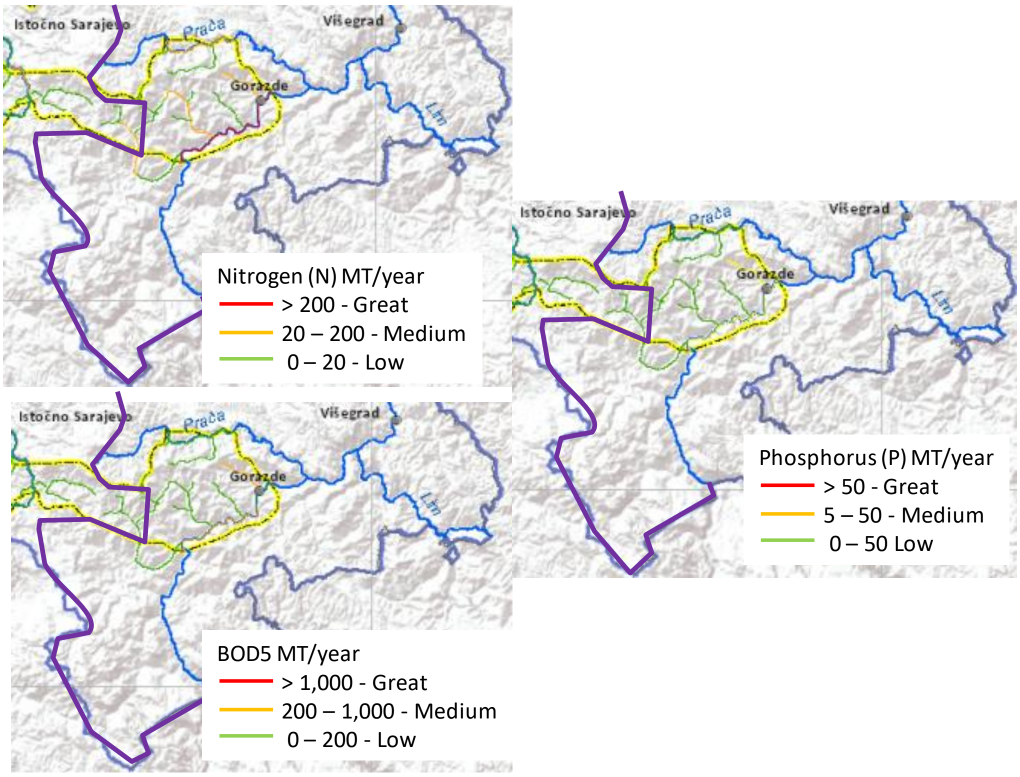
Total Nitrogen (N) load | Total Phosphorus (P) load | Total Organic (BOD5) load

Source: Draft Management plan Sava River Basin of RS-BiH, EPTISA 2016

Red line: bad quality, orange line. Medium quality, green line: good quality regarding the concerned source of load

In purple: the limit of the DRB in BiH

Figure 6-7: Main load of surface water in the RS-BiH part of the DRB



Source: Draft Management plan Sava River Basin of FBiH, EPTISA 2016

Red line: bad quality, orange line. Medium quality, green line: good quality regarding the concerned source of load

In purple: the limit of the DRB in BiH

Figure 6-8: Main load of surface water in FBiH part of the DRB

The data of the monitoring in 2015 (data per month) for these main elements are given in Table 6-3 (minimum and maximum value during the year):

Table 6-3 Minimum and maximum values of the main physic-chemical parameters in the Drina River

Parameters	Drina River – Foca (upstream)	Drina River - Pavlovića most (downstream)
Dissolved oxygen (mg/L)	7.08 to 12.05	6.7 to 11.2
BOD_5 (mgO_2/L)	1.02 to 5.3	0.78 to 8.6
NH_4^+ (mg/L)	0.014 to 0.98	0.01 to 1.29
NO_2^- (mg/L)	0.002 to 0.08	0.002 to 0.1
NO_3^- (mg/L)	0.31 to 6.95	0.11 to 2.26
Suspended solid (mg/L)	1.6 to 11.3	1 to 99.9 (due to flood)

Source: Public Water Institute of RS-BiH

The data confirms that the upstream Drina River has low loads and belongs to Class I/II (good ecological status). However, the water quality of the downstream Drina River is poorer, belonging to class II/III (moderate ecological status).

6.3.3 Biological water quality in the Drina River

Water quality is best illustrated by the recent study (International surveillance monitoring, 2015) where samples for biological analysis were taken at locality Foča on Drina river. Based on the samples taken on Drina River at Foča in 2015, water quality has been determined by a saprobity index based on biological parameters.

Th Saprobity index has been calculated upon the analysis of phytoplankton, phytobenthos and macrozoobenthos. There were two sampling occasions for each group, done in May, June and August.

For phytoplankton, sampling has been done on 11th of May and 10th of August and 11 and 12 taxons have been recorded, respectively, with a significant increase in number of individuals in the second sample. Dominant species are *Diatoma vulgare* and *Fragillaria crotonensis* and subdominant *Cyclotella sp.* and *Gomphonema sp*. Calculated saprobity index was 1,78 and 1,96, respectively.

For phytobenthos, sampling has been done on 9th of June and 10th of August and 15 and 23 taxons have been recorded, respectively, with a significant increase in number of individuals in the second sample. Dominant species are *Diatoma vulgare* and *Achnanthes sp*. and subdominant *Cocconeis placentulla* and *Achnanthes minutissima* Calculated saprobity index was 1,90 and 1,92, respectively.

For phytobenthos, sampling has been done on 9th of June and 10th of August and 14 and 11 taxons have been recorded, respectively, with a significant drop in number of individuals in the second sample. Calculated Shannon and Weaver saprobity index was 1,87 and 1,82, respectively while Zelinka-Marvan saprobity index was calculated at 1,72 and 1,96, respectively.

Based on the calculated saprobity indexes, it can be said that biological parameters classify Drina river water quality as β-mesosaprobic.

The biological parameter measurements from 2010 to 2013, resulting from the Serbian monitoring, given in Annex 6-2 are consistent with these measurements. They show that since 2010 in the Drina River:

- Saprobiological analysis of phytobenthos in the monitoring profiles indicates moderate organic pollution of the watercourse.

- The water quality status based on a saprobiologic analysis of benthic communities of macro-invertebrates was obtained using the Zelinka-Marvan saprobity index. Organisms characteristic for the β-mesosaprobic (Zelinka-Marvan quality classification) zone dominate the examined profiles in 2013. This corresponds to class II of Serbian water quality.
- Analysis of the benthic diatoms community, using the diatom index EPI-D, indicated that the quality of water in the examined period, on Badovinci and Bajina Basta profiles, improved from class II in 2011 to Class I in 2013. It is to note that values of the diatom index are directly correlated with low concentrations of nutrients in the water.

6.4 Hotspots

The TOR for the project required an assessment of the hotspots for potential sources of pollution. As it can be seen in the above characterisation, the water quality in the DRB is generally good. However, it can be seriously affected from different sources of pollution. This section provides a general classification of hotspots and then reviews the pollution inventory prepared for the Bosnian part of the DRB undertaken by REC in 2011.

6.4.1 General classification of hotspots

Hotspots are the most important sources of environmental pollution within the BiH part of the DRB. These can be summarised as follows:

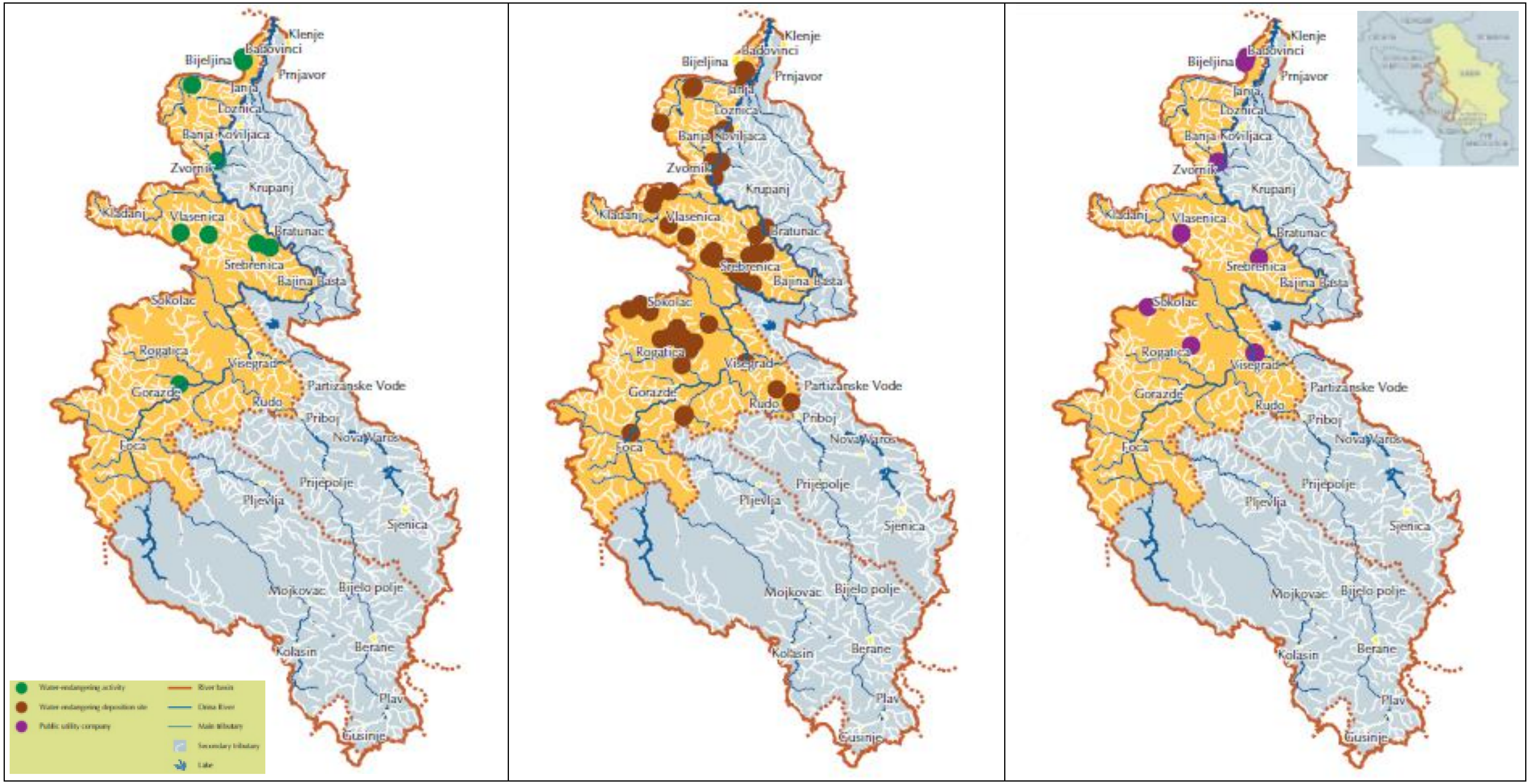
- Industrial waste, especially from mining operations
- Agricultural runoff – there are a number of farms in the BiH part of the DRB)
- Municipal solid waste disposal (especially indiscriminate "fly tipping") and a limited number of sanitary landfills,
- Urban wastewater, due to the lack of adequate treatment, and
- To a lesser extent, air pollution from thermal power plants (Ugljevik and Gacko TPP in the DRB and Tuzla TPP nearby), and from small local sources, such as households (wood burning during winter), from vehicle emissions (especially in the corridors of state roads of class I and II) and from agriculture (inadequate use of agrochemicals). However, the air quality analysis, Section 2.4.4 shows that the DRB is not substantially affected by air pollution.

In 2011, REC undertook the pollution inventory according to methodology developed within the framework of the ICPDR. The methodology and assessment procedure required: i) the identification and registration of potential sources of pollution based on existing data; and ii) a risk assessment and classification; sites with no significant threat, sites where immediate measures can be applied to remove hazards, and sites suspected to be sources of pollution and where further oriented investigation is needed.

The inventory obtained an overview of all potential water-endangering activities (WEA) and water-endangering deposition sites (WED) in the DRB. Due to lack of data on wastewater quality and quantity, the public utility companies (PUC) that were responsible for the wastewater hotspots were separated. The known location of these sites (WEA, WED and PUC) are shown on the Figure 6-9 below and more details are provided in Annex 6-3.

The inventory results indicated that WEA in the FBiH were only really present in the municipalities of Gorazde, Pale-Prača, Ustikolina and Kladanj. In the municipalities of Teočak and Sapna, there are no activities that could be considered as a significant and/or potential threat to water quality.

In the past, there were some major industries operating in the Goražde area including the UNIS Pobjeda ammunition factory and the Azot chemicals factory, built in 1953 and 1954 respectively, that were the pillars of economic development. These companies, together with the wire processing factory in Kopači and the Drina construction company, employed more than 11,000 people and were the main contributor to the economic development of Goražde.



Source: REC 2011

Figure 6-9: Pollution Sources for BiH Part of the DRB from REC Report covering WEA, WED and PUC

Today very few industrial companies are in operation, with UNIS Pobjeda reorganised and reduced. Other facilities include Sabix, a small furniture production company established in 2002; Bijela voda, a factory that exploits mineral water spring below Vranovina and Muris, a small factory producing juices. By far the biggest threat in FBiH part of the DRB is from the communal dumpsite in Goražde that represents a threat to the Drina River and groundwater bodies.

In RS, over 90 percent of municipal wastewater is discharged directly into rivers. Other potential sources of pollution include industrial facilities with inadequate, or no, treatment systems, agricultural activities and solidwaste disposal. According to the findings of the inventory, in RS there are nine industrial sites identified and classified as potential pollution sources through WEA. These include the coal-mining site in Ugljevik, the bauxite-mining site in Zvornik and the lead and zinc-mining site in Srebrenica.

In addition, 62 deposition sites (WED) were identified as having a risk class of between 15 and 60, and untreated wastewater outlets (PUC) were identified in 17 municipalities, including Bijeljina, Zvornik and Visegrad.

The Consultant has also reviewed other sources of information including regional and municipal spatial plans and the most recent documents from the EU IPA project (Eptisa 2015 to ascertain additional information.

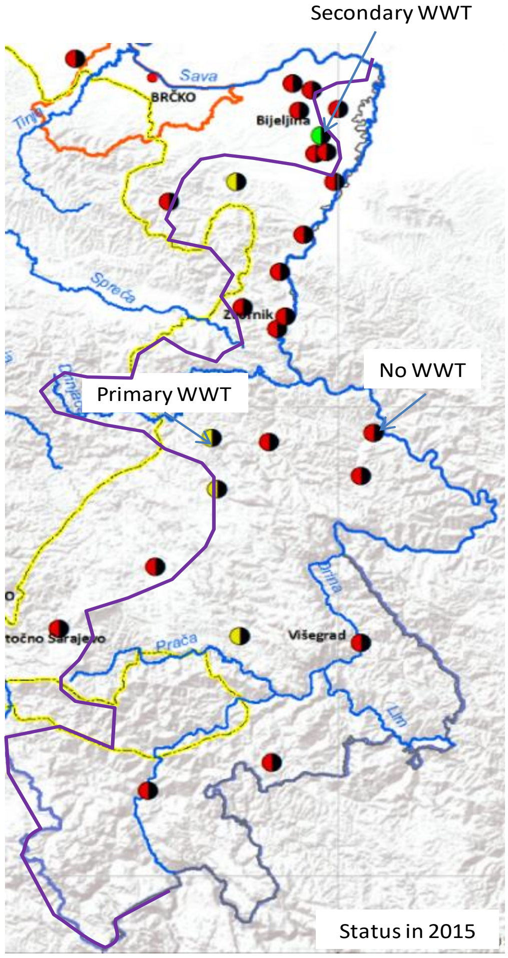
6.4.2 Municipal hot spots

According to inventory (REC 2011), the spatial plan 2015 of RS and the Sava river basin characterisation 2015, within the RS part of the DRB, more than 90% of the municipal wastewater is discharging directly into rivers without treatment.

In the DRB, the status of the waste water treatment in 2015 is given in Figure 6-10 for RS. There is no wastewater treatment in the FBiH.

Generally, all the municipal hotspots are located downstream of wastewater outfalls from the main settlements on the tributaries and on the main Drina River.

This includes those settlements mentioned in the previous section (e.g. Goražde, Bijeljina, Zvornik and Višegrad etc.).

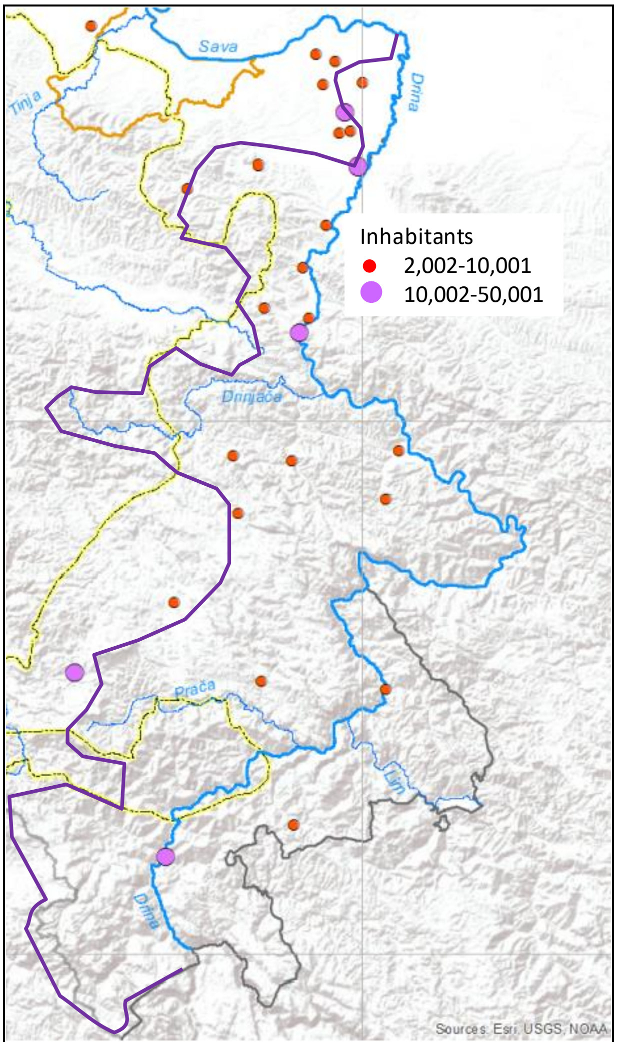


Draft Management plan Sava River Basin of RS-BiH, EPTISA 2016

In purple line the limit of the DRB

Figure 6-10:Watsewater treatment in RS BiH in 2015

Sewage systems for waste water exist only in important urban centres. None of the municipalities and the PUC that operate water and sanitation have WWTP with the exception of Biljejina and the sewage is generally not separated from the storm water drainage. However, in Biljejina, the sewage system and the sanitation is inadequate, leading to environmental pollution. All sewage therefore flows into river courses. The EU IPA project has provided more details on the main urban sources of wastewater in the BiH part of the Basin and this information is shown in Figure 6-11 below.



Urban source of wastewater

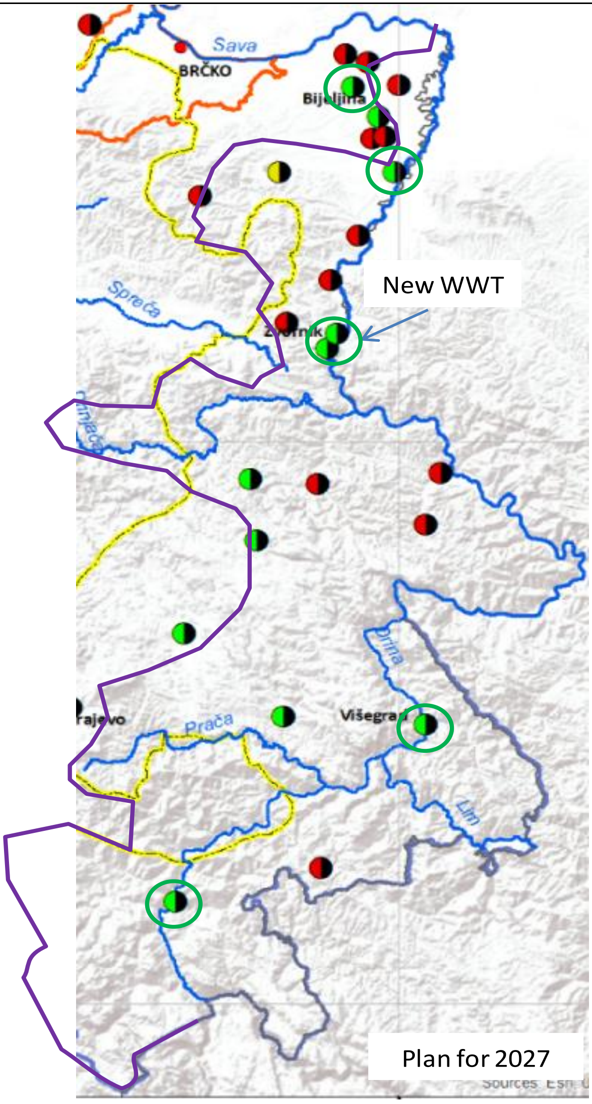
EU IPA Project (Eptisa 2015)
BiH part of the DRB (delimited by the purple line)

Figure 6-11: Main sources of urban wastewater in the RS

The management plan of FBiH plans by 2027 a new waste water treatment (WWT) facility in Goražde. The management plan of RS-BiH plans by 2027 six new WWT facilities as shown in Figure 6-12. By 2039, all the DRB will be equipped with WWT facilities. That will significantly improve the water quality of the Basin.

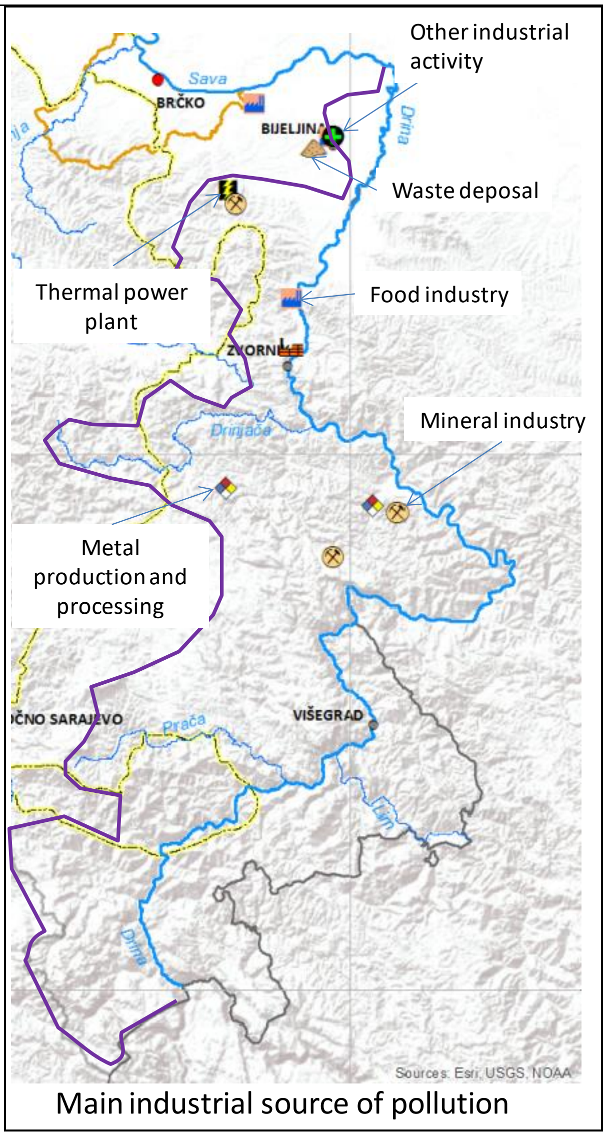
6.4.3 Industrial hot spots

As mentioned in Section 6.4.1, the most polluting centres of industrial activity are located at nine sites in the BiH part of the DRB. The four biggest potential industrial pollution sources are coal mining in Ugljevik, bauxite mining in Zvornik (deposit of red sludge) and lead and zinc mining in Srebrenica. The deposal of tailings form the flotation facilities began in the early 60s. At the Srebrenica base lead and zinc mine, there are currently tens of locations where contaminated mine waters emerge from the surface and flow into local watercourses of the Raška River and then on the Drina River. Pollution ranges from iron contamination to the full range of heavy metals associated with lead and zinc ores. The EU IPA project has provided more detailed update on the main industrial pollution sources of wastewater in the BiH part of the Basin and this information is shown in Figure 6-13 below.



Draft Management plan Sava River Basin of RS-BiH, EPTISA 2016
In purple line the limit of the DRB

Figure 6-12: Waste water treatment in RS-BiH in 2027



EU IPA Project (Eptisa 2015)
part of the DRB (delimited by the purple line)

Figure 6-13: Main sources of industrial pollution in the RS-BiH

6.4.4 Landfills and disposal sites

Since 2003, the generation of municipal wastes has been constantly increasing. This trend is expected to continue due to tourism and economy development and also to the change in consumption patterns. Organized and systematic solid waste collection is mainly available in urban settlements.

Households generate the majority of municipal waste. Thermal power plants and metallurgic industry are the second main source of solid waste.

According to the State of environment report for BiH 2012, the annual amount of solid wastes in BiH in 2010 is 332 kg per capita (Agency for Statistics of BiH). It increased to 340 kg/capita in 2011 and remained stable for 2012. The average amount generated by RS is 263 kg/capita, the rest by the FBiH and the BD.

There is no waste incineration or mechanical and biological waste treatment in BiH. Landfill disposal is the only current option for solid waste management.

The Federal Office of Statistics of BiH shows that in the whole territory, there are 91 registered waste disposal sites being operated: 41 registered landfills in RS, 49 in FBiH and 1 in BD.

Unfortunately, hundreds of illegal dump sites are still used for municipal wastes' disposal; in total, there are an estimated 1,100 "wild" dumpsites in BiH, including 270 in RS and 340 in FBiH.

According to the Environmental Protection Strategy 2008-2018 of FBiH, only 36% of the population is served by a sanitary landfill. The waste collection in general covers only 66% of the generated waste and about 95 % of this waste collection is disposed of in non-sanitary disposal sites. In the short term (2-3 years), additional sanitary landfills in construction will allow an increase of 45% of the population served by landfills.

In the DRB and within the BiH borders, the status of the registered landfills is given in Table 6-4. There are three registered sanitary landfills: Sarajevo and Tuzla at the border, as well as Bijeljina.

Table 6-4: Status of landfill sites in the BiH part of the DRB

Region	Munucipalities	Population[20]	Landfill site	Status
Bijeljina	RS: Bijeljina, Ugljevik, Lopare FBiH: Čelić, Teočak	167,459	Brijesnica landfill in Bijeljina	In operation
Zvornik	RS: Zvornik, Osmaci, Milići, Srebrenica, Bratunac, Vlasenica, Šekovici FBiH: Kalesija, Sapna	187,995	Crni Vrh landfill in Zvornik	In construction
East Herzegovina (border of the DRB)	RS : Berkovići, Bileća, Gacko, Ljubinje, Nevesinje, Trebinje, Istočni Mostar	72,769	Metiljave doline landfill in Gacko	Feasibility studies or siting process
Sarajevo-Romanija region (border of the DRB)	RS: Višegrad, Kalinovik, Novo Goražde, Čajniče, Foča, Rogatica, Rudo	63,102	Carevo Guvno landfill in Cajnice	Feasibility studies or siting process

Source: Action plan for the implementation of the landfill directive – RS, EU IPA Project Eptisa, September 2014

In the Bijeljina, Zvornik and Istočno Sarajevo sub-regions and in and around the border of the DRB, there are still about 80,185 people that must be served by landfills. However, the situation of establishing regional landfills is still not defined.

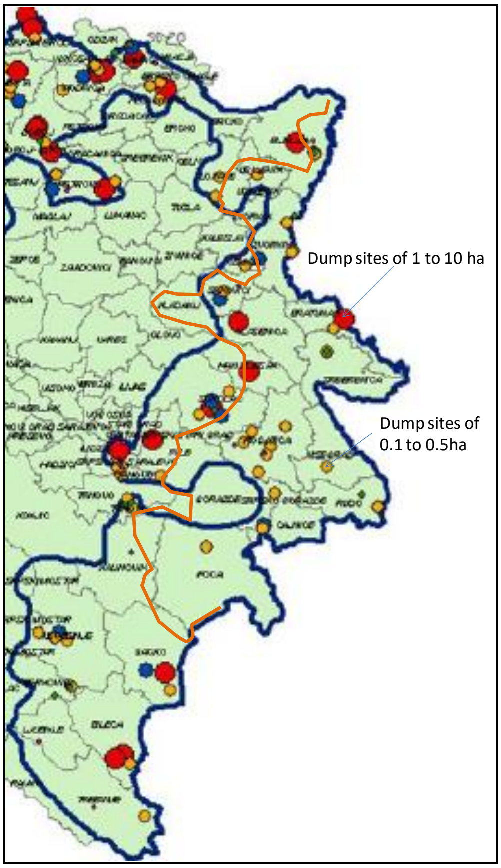
The DRB is also influenced by "wild" waste deposition. The following Figure 6-14 shows the location of the identified "wild" landfills that are located in the RS part of the DRB in BiH. It is clear that most of them are very close to the rivers of the DRB.

There is no collected data about the official composition of solid wastes prior to 2008 in BiH. According to the data from the Agency for statistics of BiH, the largest portion of the total waste generation is non-hazardous waste (97%).

The composition of generated solid waste in BiH in 2009 is shown in Figure 6-15. Among the special categories of waste, there was an estimated 8,150 t of medical waste and 5,000–12,000 t of tyres waste.

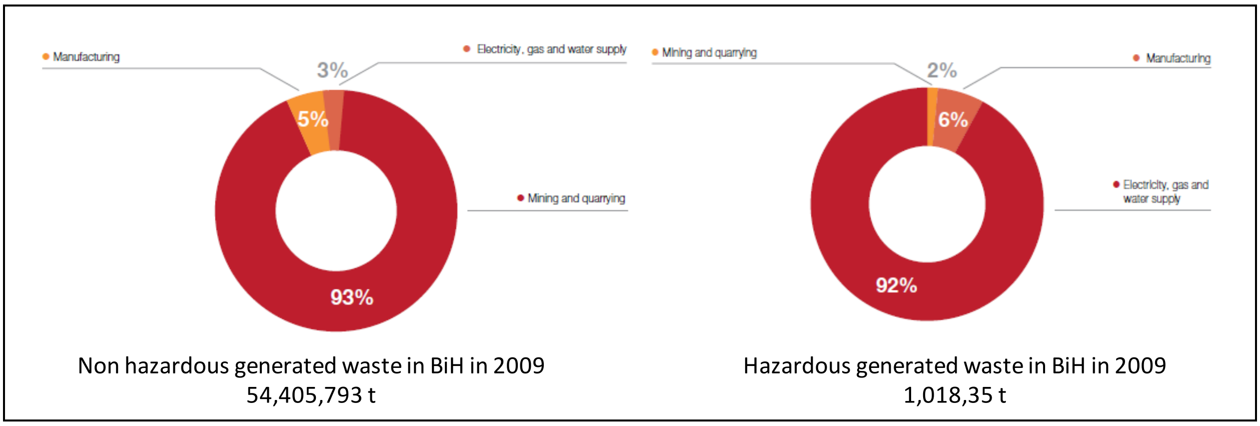
In 2009, the recycling quantity of solid waste was very low, less than a mere 5 %.

[20] Preliminary results of the 2013 Census of Population, "Households and Dwellings in Bosnia and Herzegovina", Agency for Statistics of BiH



Source: Environmental Protection and Energy Efficiency Fund of RS, EPTISA project 2014
(DRB border in orange line)

Figure 6-14: Illegal landfills in the RS of the DRB



Source State of environmental report for BiH, 2012

Figure 6-15: Composition of generated wastes in 2009 in BiH

In RS, a study of the composition of municipal waste was conducted by a public company "DET-OT" in the Ramići landfill Banja Luka, in October and November 2010 (outside the DRB). The municipal solid waste was composed of 49.8 % of biodegradable municipal waste (BMW). A more recent study (RANSMO-CARDS[21] project) indicated that the BMW is about 44% to 65% for the four tested municipalities. The quantity of BMW is therefore significant and it is necessary to improve the sorting of the waste and its recycling in order to reduce the waste disposal in landfills. The targets for the national strategy of BiH are to reach a maximum proportion of 50 % of BMW to landfill in 2013 and a maximum of 35% in 2016.

[21] CARDS :Community Assistance, Development and Stabilization - RANSMO: EU funded project for Development of National Environmental Monitoring System

It is considered that BMW management is also of importance in the DRB. Regarding hazardous waste of special categories such as medical waste, around 50% is exported to European countries.

As mentioned earlier in Section 6.4 solid waste disposal is an important source of water pollution in the DRB and many WED sites were identified by the REC 2011 inventory (See Figure 6-9). There are many sources of diffuse organic and chemical pollution.

In addition, it is seen that approximately 30% of the solid waste that is not appropriately disposed of in landfills ends up in the riverbeds. As seen in Figure 6-16 below, numerous "wild" dumpsites are near rivers, in flood plains or even in the riverbeds, causing large agglomerations of floating waste. Any flood event leads to the transport of solid waste by the streaming flow.

Figure 6-16: Floating waste on the Lim River near the confluence with Drina River ("Visegrad" reservoir) in 2012

The International Commission for the Protection of the Danube River (ICPDR) website provides an indication of the volume of floating waste for the year 2008. In the BiH part of the DRB, the solid waste was estimated to be 90,000 t in 2008 (for a population of 310,000). A total of 20,000 t ended up in the Drina River (22%). This floating pollution of the Drina River and its tributaries is a significant concern for the environment, as it can negatively affect the aquatic ecosystems. In addition, it creates a serious challenge for hydropower and can affect the energy production, due to ingress of floating debris into mechanical systems (e.g. turbines) and thus causing internal damage.

The national strategy for waste management, the implementation of the landfill directive in RS and the law on waste management in BiH have significantly contributed to improve the landfill management since 2000: creation of landfill sites, reduction of BMW disposal, increase of the recycling treatment, reinforcement of the permit system and control of existing and new landfills.

Education is clearly seen as a priority measure for improving the situation. BiH has already performed project (with the REC) such as education for sustainable development in primary schools located in the DRB (in 10 schools for RS and FBiH).

However, in most areas covered by waste collection, there is still a lack of waste collection statistics. There is obviously a lack of waste sorting at source; moreover, the overall recycling capacity is still insufficient. Monitoring of the impact of the landfills on the environment would allow improving the mitigation measures and the waste management.

6.4.5 Agricultural hot spots

Agriculture makes up an important part of the DRB and the prime source of pollution of the surface and groundwater in BiH. During dry years, emissions of organic bulk contamination leads to 5.6 MT of BOD_5/day and 25.2 MT/day of N. The BiH part of the DRB is responsible for about 12.5% of these organic emissions (Environmental review 2004, 2011).

The main agriculture hotspots are located in large pockets of farmland, particularly surrounding the cities of Gorazde, Bratunac and encompassing the Semberija area in the far north of the DRB (Figure 6-17).

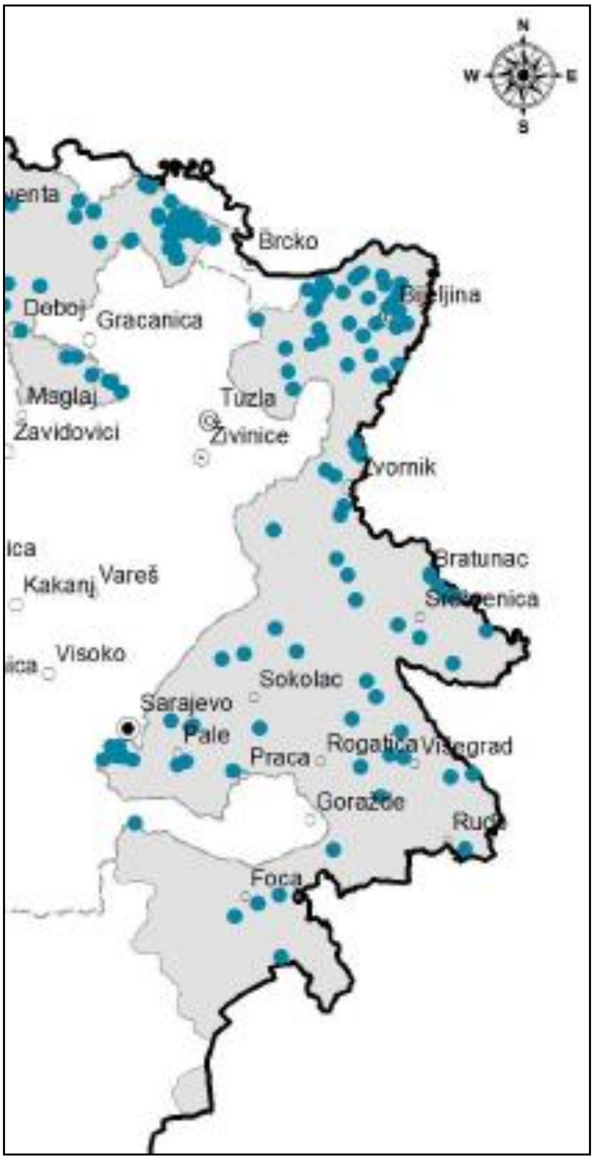
Agricultural pollution originates from uncontrolled and excessive use of agrochemicals, improper use of pesticides and fertilizers, and others discharges such as farm slurry etc.

6.4.6 Contaminated soil

Soil contamination is present in some areas of the DRB due to:

- Deposition of ash particles (from coal burning) and gases from the air,
- Fly ash and slag disposal at landfill sites,
- Mining activity,
- Outflows of contaminated water,
- Uncontrolled and excessive use of agrochemicals,
- Improper use of pesticides and fertilizers, etc.
- Erosion, infiltration into the ground and run-off processes on this contaminated soils lead to surface and groundwater pollution.

The soil is contaminated by: i) Changes in the structure of the soil layer, mostly due to indiscriminate disposal of overburden that mixes different types of materials in the substrate making the soil very heterogeneous; ii) the lowering of the groundwater levels near open pit or underground mines negatively impact on reducing the agriculture productivity of the surrounding land and making the soil more prone to erosion, and iii) degradation of the soil from changes in land use, such as mining, from exploitation of gravel, quartz sand, stone, granite and from taking agricultural land for general construction works.



Source:EU IPA Project (Eptisa 2015)

Figure 6-17: Location of farms in the BiH part of DRB

At these locations increased amounts of harmful chemical substances (e.g. sulphur, heavy metals such as copper, arsenic, chromium and cadmium) are found

7 Water Use

7.1 Water management regions in BiH part of the DRB

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. For water use calculations, the BiH part of the DRB is subdivided into three regions as shown in Figure 7-1.

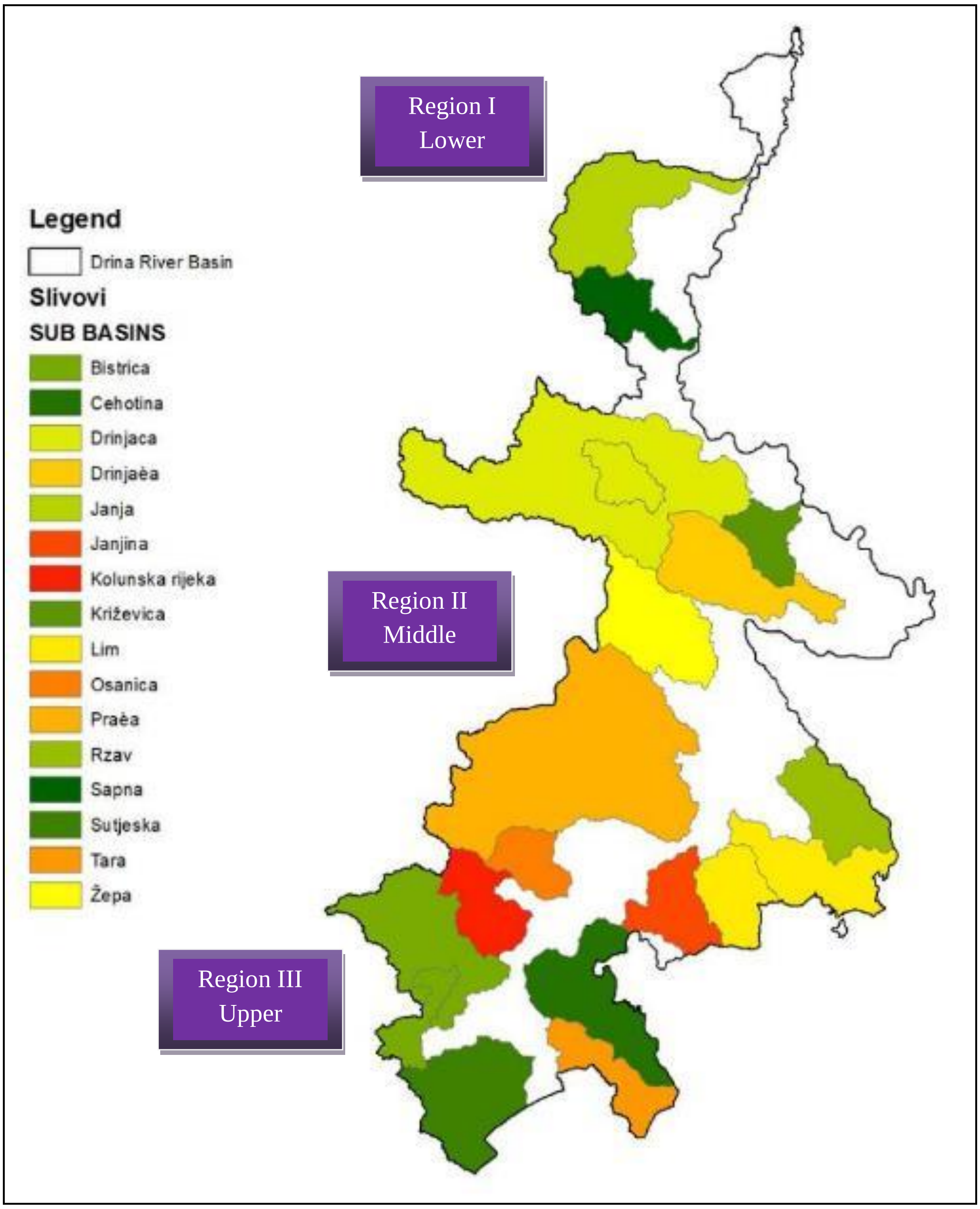


Figure 7-1: Proposed Water Management Regions

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.

7.2 Water demands in the Drina River Basin

Water demands for the BiH part of the DRB fall into the following categories:

- Domestic consumption
- Industrial consumption
- Irrigation
- Fish farms and
- Hydropower

7.2.1 Public (domestic) water consumption

There are no reliable records of domestic water consumption available at DRB level in BiH. The documentation used is from a combination of sources including BiH Statistical Office, the UNECE 2012 Environmental Performance Review, the recent country note by World Bank IAWD, as well as the ongoing EU IPA project for "Capacity Building in the Water Sector" which is being implemented by Eptisa. For consumption norms covering domestic supply, an average per capita consumption estimate for the two entities was 222 litres/capita /day (l/c/d) for RS and 168 l/c/d for FBiH. These rates are similar to other European countries. However, these per capita rates do not include water losses.

Average water losses (non-revenue water - NRW) in utility companies in BiH range from 48-55% (IAWD 2015), which is below the average for the region. However, there is wide variation between municipalities and NRW can reach as high as 70%-80% when taking into account the combined urban and rural water use. There is considerable scope for improvement, as in many European countries, losses are between 10-25% and in Germany are as low as 7%.[22]

Population estimates for the DRB are from data contained in the draft 2013 census and adapted for use in the most recent EU IPA project (Eptisa), which provides data at municipality level taking into consideration settlements situated within the DRB. Calculating the DRB population with the per capital domestic consumption estimates mentioned above, the estimated domestic water consumption in the DRB, equates to 23.2 Mm³/year (see Table 7-1). Taking into consideration NRW, this could amount to 36 Mm³/year.

Table 7-1: Domestic water use in DRB by Municipality

No	Municipality	Entity	Area (km²)	Population 2013 census	Density (inh/km²)	Actual Population in the DRB	Density in DRB (inh/km²)	Domestic Use in DRB (Mm³/yr)
	RS		9025	392,277	43.5	246,336	39.5	19.96
1	Bijeljina	RS	733.9	114,663	156.2	32,113		2.60
2	Lopare	RS	292.6	16,568	56.6	4,379		0.35
3	Ugljevik	RS	165.2	16,538	100.1	13,726		1.11
4	Zvornik	RS	376.1	63,686	169.3	63,652		5.16
5	Milići	RS	279.3	12,272	43.9	12,251		0.99
6	Bratunac	RS	293.5	21,619	73.7	21,592		1.75
7	Šekovići	RS	237.2	7,771	32.8	6,366		0.52
8	Vlasenica	RS	225.3	12,349	54.8	12,313		1.00
9	Čajniće	RS	274.6	5,449	19.8	5,439		0.44
10	Han Pijesak	RS	322.9	3,844	11.9	1,188		0.10
11	Novo Goražde	RS	119	3,391	28.5	3,389		0.27
12	Pale	RS	492.8	22,282	45.2	1,615		0.13
13	Rogatica	RS	645	11,603	18	11,599		0.94
14	Rudo	RS	347.6	8,834	25.4	8,830		0.72
15	Sokolac	RS	693.5	12,607	18.2	,826		0.07
16	Srebrenica	RS	526.8	15,242	28.9	15,228		1.23
17	Višegrad	RS	448.1	11,774	26.3	11,740		0.95
18	Foča	RS	1134.6	19,811	17.5	19,800		1.60

[22] UNESCO-IHE Water Losses in the Distribution System

No	Municipality	Entity	Area (km²)	Population 2013 census	Density (inh/km²)	Actual Population in the DRB	Density in DRB (inh/km²)	Domestic Use in DRB (Mm³/yr)
19	Gacko	RS	735.9	9,734	13.2	126		0.01
20	Kalinovik	RS	681.2	2,240	3.3	164		0.01
	FBiH		**982.6**	**58,120**	**59.1**	**52,446**	**62.4**	**3.22**
21	Sapna	FBiH	118	12,136	102.8	11,985		0.73
22	Teočak	FBiH	29	7,607	262.3	7,600		0.47
23	Kladanj	FBiH	331	13,041	39.4	7,680		0.47
24	Foča- Ustikolina	FBiH	169.4	2,213	13.1	2,103		0.13
25	Goražde	FBiH	248.8	22,080	88.7	22,052		1.35
26	Pale-Prača	FBiH	86.4	1043	12.1	1,026		0.06
	Total		**10,007.6**	**450,397**	**45**	**298,782**	**40.9**	**23.18**

When breaking down the above information into Water Management Regions (WMR) as shown in Table 7-2 and in Figure 7-1 it can be seen that the Middle Basin (Water Management Region II) has the most demand (11.1 Mm³/ year) with Upper Basin Basin (WMR III) the least demand (1.6 Mm³/year).

Table 7-2: Domestic water use in DRB by WMR

WM Region	WM Region Name	Entity	Municipality/ Settlement	Municipal Area (km²)	Area in DRB: Est based on Pop (km²)	Area in DRB: % of Mun Pop	Population in DRB	Per Capita Demand (Mm³/year)
I	LOWER	RS	Bijeljina	733.9	205.54	28.01%	32113	2.6
		RS	Lopare	292.6	77.34	26.43%	4379	0.4
		RS	Ugljevik	165.2	137.11	83.00%	13726	1.1
		RS	Zvornik	376.1	376.10	99.95%	63652	5.2
		FBiH	Sapna	118	118.00	98.76%	11985	0.7
		FBiH	Teočak	29	29.00	99.91%	7600	0.5
			Sub Total	**1,714.8**	**943.1**		**133,455**	**10.4**
II	MIDDLE	RS	Milići	279.3	279.30	99.83%	12251	1.0
		RS	Bratunac	293.5	293.50	99.88%	21592	1.7
		RS	Šekovići	237.2	194.31	81.92%	6366	0.5
		RS	Vlasenica	225.3	225.30	99.71%	12313	1.0
		RS	Čajniće	274.6	274.60	99.82%	5439	0.4
		RS	Han Pijesak	322.9	99.79	30.91%	1188	0.1
		RS	Novo Goražde	119	119.00	99.94%	3389	0.3
		RS	Pale	492.8	35.72	7.25%	1615	0.1
		RS	Rogatica	645	645.00	99.97%	11599	0.9
		RS	Rudo	347.6	347.60	99.95%	8830	0.7
		RS	Sokolac	693.5	45.44	6.55%	826	0.1
		RS	Srebrenica	526.8	526.80	99.91%	15228	1.2
		RS	Višegrad	448.1	448.10	99.71%	11740	1.0
		FBiH	Kladanj	331	194.93	58.89%	7680	0.5
		FBiH	Foča- Ustikolina	169.4	160.98	95.03%	2103	0.1
		FBiH	Goražde	248.8	248.8	99.87%	22052	1.4
		FBiH	Pale-Prača	86.4	86.4	98.37%	1026	0.1
			Sub Total	**5,741.2**	**4,225.6**		**145,237**	**11.1**
III	UPPER	RS	Foča	1134.6	1,134.60	99.94%	19800	1.6
		RS	Gacko	735.9	9.53	1.29%	126	0.0
		RS	Kalinovik	681.2	49.87	7.32%	164	0.0
			Sub Total	**2,551.7**	**1,194**		**20,090**	**1.6**
TOTAL			**TOTAL**	**10,007.7**	**6,363**	**100.0%**	**298,782**	**23.18**

Municipalities in the RS and FBiH are provided with water through a central municipal water supply system, but also by a large number of water supply systems to local communities, small rural, group and individual systems. Using data obtained from the EU IPA Eptisa Report (data only available for RS), about 57% of the population in the municipalities covering the DRB are receiving a public water supply. Around 43% rely upon rural water supply systems (comprising some piped water supply systems to the local communities, indvidial wells, springs and surface water sources).

There are some municipal centres (e.g. Sokolac) that have insufficient water supply coverage. In addition, there are other settlements where adequate water supply systems are developed, but they are prone to pollution, especially those that rely upon river alluvium. It therefore follows that a better strategy for securing water supply in the future needs to be increasingly based upon development of larger regional systems, with more use of reservoirs that can provide high security of supply without interuptions.

In FBiH part of the DRB water supply networks are usually in very poor conditions especially because of very old pipes. Losses in these systems are generally greater due to these older water supply networks. Initiatives in this region are primarily directed to reconstruction of water supply networks aiming at decrease of losses. The most densely populated municipality in the DRB part of the DRB is Goražde that despite water abstraction facilities with satisfactory capacities has pronounced problems in water supply. These problems are caused by a poor water supply network and also by frequent interruptions in the work of drinking water treatment plants at the surface water abstraction structures. The municipality of Kladanj also has inadequate supply, mostly due to the worn-out water supply network creating high losses, but also due to water quality problems in the source area in rainy periods, with frequent interruptions in water supply. The municipalities of Pale FBiH, Foča FBiH, Teočak and Sapna are mostly rural areas, with small water supply systems or with systems still under construction.

Table 7-3 below contains technical details of the amount of urban water supply and water abstractions and water losses. Estimated water losses from the urban water supply systems are on average around 51% for RS, but much higher for FBiH at 82%, which is partly in line with World Bank IAWD estimates mentioned earlier. The higher losses in FBiH being mainly attributable to older water pipe network.

Table 7-3: Details on water abstractions, delivery and losses in DRB Municipalities (2011)

No	Municipality	Number population		Abstracted (Qsr,dn)			Delivered			Losses		
		2013 census	Urban Q (2011)	(l/s)	(m^3/year)	l/c/d	(m^3/year)	l/c/d	%	(m^3/year)	l/c/d	%
1	Bijeljina	114,663	80,000	300	9,460,800	324	4,730,400	162	50	4,730,400	162	50
2	Lopare	16,568	3,000	15	473,040	432	236,520	216	50	236,520	216	50
3	Ugljevik	16,538	4,000	30	946,080	648	520,344	356	55	425,736	292	45
4	Zvornik	63,686	24,000	75	2,365,200	270	1,064,340	122	45	1,300,860	149	55
5	Milići	12,272	8,000	30	946,080	324	473,040	162	50	473,040	162	50
6	Bratunac	21,619	8,000	45	1,419,120	486	709,560	243	50	709,560	243	50
7	Šekovići	7,771	3,000	15	473,040	432	212,868	194	45	260,172	238	55
8	Vlasenica	12,349	8,000	55	1,734,480	594	867,240	297	50	867,240	297	50
9	Čajniće	5,449	2,900	25	788,400	745	433,620	410	55	354,780	335	45
10	Han Pijesak	3,844	3,000	25	788,400	720	394,200	360	50	394,200	360	50
11	Novo Goražde	3,391	1,500	7	228,400	417	Flat			Big Losses		
12	Pale	22,282	14,000	50	1,576,800	309	946,080	185	60	630,720	123	40
13	Rogatica	11,603	9,000	85	2,680,560	816	1,206,252	367	45	1,474,308	449	55
14	Rudo	8,834	3,000	25	788,400	720	433,620	396	55	354,780	324	45
15	Sokolac	12,607	14,000	65	2,049,840	401	922,428	181	45	1,127,412	221	55
16	Srebrenica	15,242	5,000	40	1,261,440	691	630,720	346	50	630,720	346	50
17	Višegrad	11,774	8,000	70	2,207,520	756	1,214,136	416	55	993,384	340	45
18	Foča	19,811	17,000	120	3,784,320	610	1,702,944	274	45	2,081,376	335	55
19	Gacko	9,734	6,006	34	1,083,892	494	433,556	198	40	650,336	297	60
20	Kalinovik	2,240	1,500	17	529,805	968	158,941	290	30	370,863	677	70
RS Sub Total or Average		**392,277**	**222,906**	**56**	**35,585,617**	**558**	**17,290,809**	**272**	**49**	**18,066,407**	**293**	**51**
21	Sapna	12,136	2,073	nd	nd	nd	nd	nd	nd	nd	nd	nd
22	Teočak	7,607	2,817	nd	nd	nd	nd	nd	nd	nd	nd	nd
23	Kladanj	7,660	4,241	nd	nd	nd	nd	nd	nd	nd	nd	nd
24	Foča- Ustikolina	2,213	974	nd	nd	nd	nd	nd	nd	nd	nd	nd
25	Goražde	22,080	12,512	nd	nd	nd	nd	nd	nd	nd	nd	nd
26	Pale-Prača	1,043	341	nd	nd	nd	nd	nd	nd	nd	nd	nd
FBiH Sub Total		**52,739**	**22,958**	**223**	**7,022,432**	**656**	**1,232,226**	**115**	**18**	**5,790,206**	**541**	**82**
	Total	**450,397**										

Source RS: Eptisa Report Action Plan For Implementation of the Drinking Water Directive Sept 2014
Source FBiH: Water Management Strategy FBiH 2012
nd= No data Q = questionnaire l/c/d = liters per capita per day

BiH overall has traditionally enjoyed a good level of service for water and sanitation, with 88% of overall population having access to piped water and 91% for flush toilets. Access to publicly provided services is lower, at 58% for public water supply (this relates well to the above figure of 57% provided in the Eptisa Report) and 31% for sewerage. Only 3% of the population is connected to wastewater treatment plants.

Groundwater is predominantly used for water supply. According to the Water Management Strategy of FBiH, around 84% of all water is abstracted from aquifers and springs (e.g. karst, fractured and intergranular aquifer) and the remaining 16% from rivers, artificial reservoirs and natural lakes. A similar proportion is abstracted from RS where 87% comes from aquifer and the remaining 13% from rivers, artificial reservoirs and natural lakes. World Bank IAWD suggests 81% of water supply is from groundwater.

7.2.2 Industrial consumption

Calculating industrial consumption for the DRB in BiH is difficult as there is a lack of specific information at the DRB level. The EU IPA Eptisa Project has indicated an amount of 70 l/c/d to be used for RS. Applying this across the complete DRB (including FBiH) and using a calculated population of the DRB as 298,782 and applying the 70 l/c/d allocation then the water use within the DRB will be around 7.6 Mm³/year. This can be split according to the WMR as shown in Table 7-4 below.

Table 7-4: Annual Industrial Water Consumption for WMR in DRB in BiH

WM Region	River System	Surface area in Sub Basin in km²	Surface area in Sub Basin in %	Estimated Total Population in DRB	Density of Population n/km²	Industrial Use in DRB (Mm³/yr)*
I	LOWER	943.09	14.82%	133,455	141.51	3.4
II	MIDDLE	4,225.57	66.41%	145,237	34.37	3.7
III	UPPER	1,194.00	18.77%	20,090	16.83	0.5
	Total	**6,362.66**	**100.00%**	**298,782**	**46.96**	**7.6**

Source: JV Consultant own calculations

7.2.3 Irrigation

Irrigation water is usually only applied during the summer months that represents the main growing season (comprising 5 months May to September). Similar to industry, it is difficult to provide an indication of the water use for irrigation at the basin level.

From a national perspective, the most recent EPR for BiH (UNECE 2011) indicates there have been no significant changes in agricultural use of freshwater, over the past 10 years. The most recent State of the Environment Report for BiH indicates that the amount of irrigated area nationally has fallen from 11,660 ha in 1990 to around 4,630 ha today. There is potential to irrigate up to 74,000 hectares (REC 2000). Consequently, most schemes are in poor condition and obsolete, and cover only 2 per cent of arable land. The estimated water demand in FBiH is 1.1 Mm³/year to 1.27 Mm³/year in the Sava River catchment area (including DRB) and for RS the estimated amount is about 6.8 Mm³.

Future development plans for BiH indicate that the land cover under irrigation will increase, in order to foster the BiH economy. In the DRB, one of the most important agriculture areas with a highquality land is Semberija in RS of BiH situated along the Lower Drina and Sava River with a total area planned for irrigation of about 43,700 ha, and significant need for irrigation taking into account the lowest level of precipitation detected there.

In order to provide some indication of water use in irrigation in the DRB the Consultant has calculated the total BiH irrigation use per year in the Sava catchment (8 Mm³/year) by the total population in the SRB in BiH (about 3 million) and arrived at an amount of 2.7 m³/capita/year. Applying this amount to the estimated population in the WMRs of the DRB for 150 days each year provides an amount of 18 l/c/d. This provides a total amount of irrigation us in the DRB of 1.9 Mm³/year. This is shown in Table 7-5 below.

Table 7-5: Annual Irrigation Water Consumption for WMR in DRB in BiH

WM Region	River System	Surface area in Sub Basin in km²	Surface area in Sub Basin in %	Estimated Total Population in DRB	Density of Population n/km²	Irrigation Use in DRB (Mm³/yr)
I	LOWER	943.09	14.82%	133,455	141.51	0.8
II	MIDDLE	4,225.57	66.41%	145,237	34.37	0.9
III	UPPER	1,194.00	18.77%	20,090	16.83	0.1
	Total	**6,362.66**	**100.00%**	**298,782**	**46.96**	**1.9**

Source: JV Consultant own calculations

7.2.4 Fish farms

The main species used for aquaculture in BiH are Salmonids, mainly rainbow trout produced in tanks and cages that benefit from the plentiful water resources in mountain areas. The annual production of land based trout farms depends on the available quantity of water. As a rule of thumb, fish farmers calculate fish production of 100 kg per year on a 1 litre per second water supply, hence supplying 1 MT of trout on around 12-14 litres per second water is necessary. The majority of Salmonids' farms have hatcheries, but only a few farms are specialized solely in the production and sale of stocking material (fish fry).

Acording to FAO[23], there are 151 fish farms in BiH covering an area of 2,888 hectares (29 km²) which have a total water volume of 310,852 m³ through a combination of ponds, tanks and cages. Some 67 farms or around 44% are unlicensed. Licensing procedures are very complex and unclear even to the acting authorities and this is the reason why there are so many unlicensed facilities. In RS, the licensing procedure for establishing a land based fish farm comprises seven steps commencing with the Municipality, which must agree to convert the land. The MAFWM must then issue a licence for water utilisation. An engineering company must elaborate a plan and then another autonomous company must approve the plan. Municipal licences must then be obtained for building construction, for using electricity, for road use. A licence from the fire department is necessary and an ecological licence. Based on the provision of the previous licenses MAFWM must then provide a final agreement for establishing the fish farm, followed by the final permission from MAFWM.

In FBiH the process is similar, but the procedure must also be prepared in relation to the Law on Concessions. This makes the entire procedure more complex than in RS. Thus, the following steps are needed for obtaining a permit in the FBiH: An expert company must be used to obtain permits for aquaculture. Information must include; indication of the fishing area or zone where aquaculture activities will be performed, details of the production area must be provided (number and size of ponds, tanks or cages), the type of cultured species, an expert study on the justification of aquaculture activities, followed finally by the concession for water utilization issued in accordance with specific laws.

Some 74% of all fish farms get their water from surface water sources while most of the rest (22 %) use spring water. These fish farms use water totalling 797 Mm³/year within all BiH.

The fish farms generally use free-flowing water diverted from rivers and streams, hence even though there is substantial water use, the abstracted volumes return to the rivers and lakes, while the water needs for the fish themselves need to be included as part of the environmental flow. It is assumed there is no water losses and all water is returned to rivers.

7.2.5 Hydropower

Unlike irrigation, hydropower does not retrieve water from a river stream. Water is at most diverted from the river on a limited, stretch, between the water intake and the power plant.

[23] FAO 2015, Analysis of the Fishery and Aquaculture Sector in Bosnia and Herzegovina

Depending on the type of hydropower scheme (run-of-river or accumulation), the discharge regime of the river may be marginally (run-of-river) to strongly modified (seasonal water transfer). The total annual water volume released after the power plant (water volume processed by the HPP plus water volume spilled in the river at the dam site, if any) is however not affected.

Under warmer latitudes, evaporation from a reservoir may reduce the amount of water of the river; however, this difference is small. At most, around 2% of the natural discharge may be lost – less than the accuracy of the discharge gauging stations.

The only case where the water regime of a river is substantially modified is by a diversion from one valley into another. The water discharge is greatly reduced in the river from which the water is diverted; but the diverted volume is added to the river discharge where the power plant stands (with or without seasonal transfer, depending on the hydropower type). The total annual discharge of both valleys remains unchanged.

In BiH, five hydropower schemes work according to a run-of-river operation pattern. The impact of these HPPs on the river regime is therefore minimal in quality and quantity. Three hydropower schemes are conceived as storage type. Their impact is also minimal in terms of water quality, but it is sensible in terms of water quantity (discharge variations downstream of HPPs). More information about the water use in HPP is given in Chapter 8.

7.3 Water management regional demand

7.3.1 Summary of water use

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 7-6 below. 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 7-6: Allocation of Water Demand in the Water Management Regions of DRB

WMR	River System	Surface area in Sub Basin in km²	Surface area in Sub Basin in %	Estimated Total Population in DRB	Density of Population n/km²	Domestic Use in DRB (Mm³/yr)	Industrial Use in DRB (Mm³/yr)*	Irrigation Use in DRB (Mm³/yr)	Total Use in DRB (Mm³/yr)
I	LOWER	943.09	14.82%	133,455	141.51	10.4	3.4	0.8	14.7
II	MIDDLE	4,225.57	66.41%	145,237	34.37	11.1	3.7	0.9	15.7
III	UPPER	1,194.00	18.77%	20,090	16.83	1.6	0.5	0.1	2.3
	Total	**6,362.66**	**100.00%**	**298,782**	**46.96**	**23.2**	**7.6**	**1.9**	**32.7**

7.3.2 Key assumption

The Consultant has made certain assumption regarding water returns to the basin (through surface water or to the groundwater). These are as follows:

- Some 80% of domestic water use is returned to the system as wastewater
- Some 20% of industrial water use is returned to the system as wastewater
- Some 20% of irrigation water is returned to the system but only for 5 months of the year, from May to September.
- 100% of water for fish farming is returned to the system (which includes evaporation)
- 100% of water for hydropower use is returned to the system (which includes evaporation)

The Consultant has then assessed the flow required in each of the rivers to cater for the demand based on the following assumptions: When assessing the minimum flow for each of the rivers in the WMR it is assumed that:

- Domestic demand must be delivered for 24 hours of the day for 365 days of the year
- Industrial demand must be delivered for 24 hours of the day for 365 days of the year
- Irrigation demand must be delivered for 24 hours of the day for 150 days (5 months) of the year
- Minimum Environmental Flow must be available, which includes requirements for fish farming
- Requirement for hydropower

7.3.3 Net water use

Taking into consideration the water returns to the system, the net water use within the three WMR of BiH is shown in Table 7-7. Estimated net water use in the DRB is around 12.2 Mm³/yr. With the application of NRW, then this amount rises to around 18 Mm³/year.

Table 7-7: Net Water Use in the Water Management Regions of DRB

WM Region	River System	Surface area in Sub Basin in km²	Surface area in Sub Basin in %	Estimated Total Population in DRB	Total Gross Water Use in DRB (Mm³/yr)	Total Water Returns (Mm³/yr)	Net Water Use (Mm³/yr)
I	LOWER	943.09	14.82%	133,455	14.7	9.2	5.5
II	MIDDLE	4,225.57	66.41%	145,237	15.7	9.8	5.9
III	UPPER	1,194.00	18.77%	20,090	2.3	1.4	0.8
	Total	**6,362.66**	**100.00%**	**298,782**	**32.7**	**20.4**	**12.2**

7.4 Environmental Flow

Environmental flow (EF) is considered as the minimal quantity of water necessary in a river for maintaining healthy, natural ecosystems. It takes into account the minimal flow required for habitats and migration as well as water quality factors.

The World Bank describes the environmental flow 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" (R. Hirji and R. Davis, 2009).

The Water Frame Work Directive of the European Community does not use explicitly the term of “environmental flows”. It requires the states of the community to guarantee a good ecological status in surface and underground water bodies.

There is no universal definition of the environmental flow (EF) and more than a hundred formulas can be found in the scientific papers to calculate the value of the EF. Some of them are based on hydrological statistical values characterizing the flow discharge (hydrological method); some are based on the hydraulic characteristics of the river like depth, velocity, wetted perimeter (Hydraulic rating methods) and others on aquatic ecosystem characteristics (Habitat simulation method and Holistic methodologies).

7.4.1 Legal environmental flow

Focusing on the DRB, the following Table 7-8, contains a summary of the acceptable environmental flow defined from legislation for BiH.

Table 7-8: Environmental flow definition from legislation of BiH

Legislation reference	Text of Legislation (translated)
	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.

Legislation reference	Text of Legislation (translated)
	(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% probability phenomenon. (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	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 50/2006, 92/2009, 121/2012, **Article 65** (Ecological acceptable flow definitions)	(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. (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, 2007, **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) … c) by- law, in cooperation with Ministry, establishes methodology for establishment of ecologically acceptable flow, from Article 65 of this law, d) …

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.

This rulebook has been adopted on the basis on the Water Law and nowadays it is in force. 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.

In RS, the FBiH 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: $Q_{95\%}$.

Drina River crosses both FBiH and RS. It shows that there is a need for cooperation in all the country in order to require a coherent EF along the river stream.

7.4.2 Environmental flow estimation based on hydrological characteristics

In order to have an order of magnitude of the environmental flow of the Drina River and its main tributaries to integrate in the water balance model for the future scenarios of the water management in the basin, we focus on definition of the minimal acceptable EF in the rulebook of FBiH (point 1 below) and of the Water Law of RS (point 2 below). We compare the results with the values that would be obtained by applying the definitions of EF in Serbia (point 3 below) and with other common formula. All calculations are based on hydrological method. At this stage of the study, the hydraulic and ecologic characteristics of the rivers in the DRB are not known enough to test other types of methodologies.

1) FBiH rulebook method (Article 11).
This method compares the average discharge MQ (average of the mean annual discharge over a minimal period of 10 years) with the average minimal discharge $Q_{min,\,av}$ (average of minimal annual discharge over a minimal period of 10 years) and average decade discharge (average of the mean annual decade discharge over a minimal period of 10 years) if available. If no daily data to calculate the decade discharge are available, then the EF is equal to 10 % of the MQ for May to October and equal to 15% of MQ for November to April.
2) RS-BiH Method: EF=$Q_{95\%}$ which is the mean monthly flow that happens with a 95% probability (Vučijak N. et al., 2007)
3) Serbia method: EF=10% of the average flow (MQ)
4) USA method: Recommended minimal value of EF= 10% of MQ in Autumn-Winter seasons and 30% of MQ for spring and summer seasons, (World Bank 2003)
5) Lanser Method: Value of EF varying from 5 to 10% of MQ, (European small power association)
6) Guaranteed environmental flow method (GEP) which is calculated for two periods, from October to March and from April to September and which depends on the value of $Q_{95\%}$, $Q_{80\%}$ (mean monthly flow that happens with the 80% probability) and of MQ (WWF 2009).

The hydrological characteristics of the rivers are extracted from Chapter 4 and hydrological measurements from 1961 to 2012 (annual average values). Obtained values of environmental flows using the aforementioned methods are summarized in the following Table 7-9 and Table 7-10.

Table 7-9: Main hydrologic characteristics for the EF calculation based on hydrological measurements

Rivers (Hydrological stations)	MQ (m^3/s)	$Q_{95\%}$ (m^3/s)	$Q_{80\%}$ (m^3/s)	$_{AV}Q_{min}$ (m^3/s)
Upper Drina (Bastasi)	143.5	21.7	27.6	41.1
Middle Drina (Foča Most)	192.9	28.2	37.6	55.9
Middle Drina (Bajina Bašta)	334.4	54.5	64.9	92.2
Lower Drina (Radalj)	364.9	57.2	68.1	108.3
Lower Drina (Badovinci)	373.8	No data	No data	174.7
Ćehotina Upstream(Vikoč)	17.6	2.5	3.3	4.77
Lim Upstream(Priboj)	91.9	18.2	21.8	29.8
Sutjeska Middle (Igoče)	13.8	1.9	2.4	3.17
Bistrica Middle (Oplazići)	11.9	1.4	2.1	1.74

Table 7-10: Estimation of the EF in the BiH part of DRB according to different methods

Rivers (Hyrological stations)	EF values (m^3/s)					
	1) FBiH	2) RS-BiH	3) Serbia	4) USA	5) Lanser	6) GEP
Upper Drina (Bastasi)	14.3[a]/21.5[b]	21.7	-	14.3[c]/43.0[c]	7.2 - 14.3	21.5[e]/27.6[f]
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
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

Rivers (Hyrological stations)			EF values (m^3/s)			
	1) FBiH	2) RS-BiH	3) Serbia	4) USA	5) Lanser	6) GEP
Sutjeska Middle (Igoče)	1.4/2.1	1.9	-	1.4/4.14	0.70 – 1.38	1.9/2.4
Bistrica 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.

It appears that EF for RS method (2) are in general slightly higher than EF calculated for FBiH (1) for the cold period (November to April) and the EF for Serbia method corresponds to the EF calculated for FBiH for the warm period (May to October). Therefore, for the 2 entities and the 2 countries, the EF are in the same range of magnitude. The FBiH method gives then a compromise and takes also into account the seasonal variation that brings an ecological improvement compare to a constant EF value. The Lanser method provides the lower values of the EF and the USA and GEP method leads to higher values.

7.4.3 Environmental flow downstream of dams

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. Chapter 8 provides the existing and planned dams in BiH. Table 7-11 below provides for each dam the minimal environmental flow defined or proposed for the hydroelectric schemes.

Table 7-11: 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	50
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

The given environmental flows for these dams are issued from chapter 8. They generally correspond to values of RS method (2) and for the new dam Ustikolina, to the FBiH method (1).

7.4.4 Critical ecological water quantity

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 (Vucijak et al 2007):

- Minimum flow speed of 0.3 m/s
- Minimum mean flow depth of 0.2 m

Hydraulic modelling of the Drina River and its main tributaries is required to estimate the environmental flow value to guarantee the above minimal velocity and depth of the flow.

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.

7.4.5 Proposed environmental flow for BiH

The environmental flow of the rivers of the Drina River Basin for BiH must be a compromise between the guarantee of maintaining the ecological function and components of the rivers (quality and quantity of water) and the socio-economical uses of the water resources. In addition, since the DRB covers the three riparian countries, a harmonization of the methodology for calculation of the EF should be established, at least for border rivers.

The JV Consultant considers that the FBiH method gives a good compromise between environment and water use. In addition, it covers the values of the RS-BiH and of the Serbia methods.

Therefore, for the Drina River which is shared between the RS, FBiH and Serbia, the Consultant proposes to harmonize the minimal EF values based of the FBiH method (1) for the future development scenarios. However, for the tributaries that cross only RS, the Consultant proposes to apply the RS method (2). The resulting EF values at the upstream and downstream locations for each WRM are provided in Table 7.12.

Table 7-12: Minimum EF values for DRB River Sub Basins in BiH

WMR	River Sub Basin	Minimum EF values (m^3/s)	
		May to October	November to April
Upper reg.	Ćehotina	2.5	2.5
Upper reg.	Sutjeska	1.9	1.9
Upper reg.	Bistrica	1.4	1.4
Middle reg.	Lim	18.2	18.2
Upper reg.	Drina	14.5^a- 19.5^b	21.5^a – 29.0^b
Middle reg.	Drina	19.5 – 36.5	29.0 – 54.5
Lower reg.	Drina	36.5 – 37.5	54.5 – 56.5

^{a}: Upstream value ^{b}: Downstream value

7.4.6 Future demand for 30 and 50 years

Three future demand scenarios for water use were made. These were:

- High Growth Scenario, taking the population growth experienced in the DRB from 1971 to 1991. This equated to a compounded annual growth rate of +0.1812%. So, this growth rate was projected forward from 2013 (date of last census) for 30 years (2044) and for 50 years (2064). As there was no data from the DRB for industrial and irrigation growth, the Consultant used the pro rata amount per inhabitant mentioned in Section 7.2.2 and 7.2.3.
- Flat Growth Scenario, taking the population in the DRB from the 2013 census and keeping this constant for 30 years (2044) and for 50 years (2064). Industrial growth and irrigation growth also remain constant.
- Real Growth Scenario, taking the population growth experienced in the DRB over the past 20 years from 1991 to 2013. This equated to a compounded negative annual growth rate of -0.9945%. So, this negative growth rate was projected forward from 2013 (date of last census) for 30 years (2044) and for 50 years

(2064). As there was no data from the DRB for industrial and irrigation growth, the Consultant used the pro rata amount per inhabitant mentioned in Section 7.2.2 and 7.2.3.

This information is summarised in Table 7-13 below, but does not take into consideration NRW that is assumed to improve in future. 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.

Table 7-13: Future Total Water Use Projections in the DRB

SCENARIO	DOMESTIC Mm³/yr			INDUSTRIAL Mm³/yr			IRRIGATION Mm³/yr			TOTAL WATER USE Mm³/yr		
	2015	2044	2064	2015	2044	2064	2015	2044	2064	2015	2044	2064
HIGH GROWTH (+0.1812%) Mm³/yr	23.26	24.51	25.42	7.66	8.07	8.37	1.86	1.96	2.03	32.78	34.55	35.82
FLAT GROWTH (0%) Mm³/yr	23.18	23.18	23.18	7.63	7.63	7.63	1.85	1.85	1.85	32.66	32.66	32.66
REAL GROWTH (-0.9945%) Mm³/yr	22.72	17.00	13.92	7.48	5.60	4.59	1.82	1.36	1.36	32.02	23.96	19.87

The Consultant is therefore of the opinion that the actual water use within the DRB will be somewhere between the Flat Growth and Real Growth Scenarios, with overall water use varying between 32.02 and 32.66 Mm³/year at present day, to 23.96 to 32.66 Mm³/year in 2044 and 19.87 to 32.66 Mm³/year in 2064.

In terms of water returns to the system for domestic, industrial and irrigation, the same assumptions as shown earlier in this chapter (Section 7.3.2) apply. A summary of this information is shown in Table 7-14 below.

Table 7-14: Future Water Returns in the DRB

SCENARIO	DOMESTIC RETURNS Mm³/yr			INDUSTRIAL RETURNS Mm³/yr			IRRIGATION RETURNS Mm³/yr			TOTAL WATER RETURNS Mm³/yr		
	2015	2044	2064	2015	2044	2064	2015	2044	2064	2015	2044	2064
HIGH GROWTH (+0.9%)	18.61	19.61	20.33	1.53	1.61	1.67	0.37	0.39	0.41	20.51	21.62	22.42
FLAT GROWTH (0.0%)	18.54	18.54	18.54	1.53	1.53	1.53	0.37	0.37	0.37	20.44	20.44	20.44
REAL GROWTH (-0.7%)	18.17	13.60	11.14	1.50	1.12	0.92	0.36	0.27	0.27	20.03	14.99	12.33

Taking the future total water use and subtracting future water returns, the net future water use for the BiH part of the DRB is shown in Table 7-15 below. At the present day, net water use varies from 11.98 Mm³/year to 12.27 Mm³/year. Total net water use over the 30- and 50- year timeframe varies from 8.97 Mm³/year to 12.93 Mm³/year in 2044 to between 7.54 Mm³/year and 13.41 Mm³/year in 2064 for the respective real growth and high growth scenarios.

Table 7-15: Future Net Water Use Projections in the DRB

SCENARIO	NET DOMESTIC USE Mm³/yr			NET INDUSTRIAL USE Mm³/yr			NET IRRIGATION USE Mm³/yr			TOTAL NET WATER USE Mm³/yr		
	2015	2044	2064	2015	2044	2064	2015	2044	2064	2015	2044	2064
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

7.5 Identification of Key Drivers

The JV Consultant made a first attempt at identifying the key drivers and key issues related to IWRM for the

BiH part of the DRB, specifically relating to the WMR I Lower basin, WMR II Middle basin, and WMR III Upper basin.

The key drivers are listed below, but their prioritisation (with the exception of population) cannot be achieved at this stage; this will be done during the preparation of the Investment Prioritisation Framework (IPF) when optimal and selected developments for the DRB have been agreed.

Socio-economic development has a strong influence on future water availability and sectoral water demand in the three WMR, but especially in the WMR I lower basin that have the majority of the residing population. In general, therefore, the key drivers of change are:

- Water supply for the population,
- Flood security for the population
- Water supply for agriculture(irrigation)
- Water supply for industry
- Hydropower production
- Environmental conservation
- Recreation and tourism
- Fisheries

7.5.1 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 (WWTP) and the implementation of adapted landfills far from the riverbanks and the flood plains.

7.5.2 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, which are provided in more detailed in Chapter 9. Furthermore, a restrictive policy of housing construction permitting procedures needs enforcement to prevent construction of housing on floodplains not protected from floods.

7.5.3 Water supply for agriculture (irrigation)

Water supply for irrigation is generally flat as there are no new irrigation areas considered in the BiH part of 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 WMR in the DRB for BiH 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. More water saving irrigation techniques (e.g. drip irrigation) therefore need further consideration for most optimal results. Sanitary protection around licenced spring sources should also be considered to protect aquifers and groundwater supplies.

7.5.4 Water supply for industry

The water supply for industry is not a significant issue for the WMR 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.

7.5.5 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 be marginally (run-of-river) to strongly modified (seasonal water transfer).

7.5.6 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.

7.5.7 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, the Consultant believes that enforcing the minimum environmental flow in all the WMR will mitigate this issue.

8 Hydropower

8.1 Introduction

In the existing conditions, utilization of the hydropower potential is one of the most important ways of using water resources of the Drina River and its tributaries. In the part of the Drina basin located on the territory of Republic of Srpska there are three dam 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 problem pertaining to the unused water potential is recognized and analyzed in a number of technical documents. Several projects of new hydropower plants exist. Unfortunately, these planned facilities are not yet realized, due to conflicts of interest between stakeholders, unsolved property relations, environmental issues, unattractive economic parameters, etc.

BiH disposes over significant primary energy resources; for example, estimated hydropower potential amounts to approximately 6,800 MW, out of which has been used only approximately 35% in terms of capacity, i.e. approximately 38% in terms of the maximum possible electricity generation.

This chapter focuses on the present state of energy balance, existing and planned HPPs, as well as main investments costs, which are updated. It should be noted that all analyses presented hereunder are based on available data. In line with the early stage of the project, the values relating to the investment costs are estimated in accordance with the accuracy of the available data. Some of these values may thus present an uncertainty in the range of +/– 20%.

8.2 Energy Usage in BiH

Key indicators of energy consumption effects in a country are: (i) energy consumption per capita, as a measure of country's degree of development, (ii) electricity consumption per capita and (iii) energy consumption per thousand USD or EUR of generated gross domestic product (BDP) - energy intensity, as a measure of society's degree of organization. As is the case for the entire BiH, statistical indicators for FBiH do not match the principal energy consumption indicators for some similar countries. It shows that: (i) BiH consumes almost 40% less energy compared with the average consumption in South-East European countries, three times less compared with the average for 25 EU countries and almost 40% less compared with the global average; (ii) BiH uses 25% less electricity compared with the average consumption in South-East European countries, two and half times less compared with the average of 25 EU countries and by 30% less compared with the global average and (iii) BiH, as the other South-East European countries, consumes much energy per unit social product, almost five times more than 25 European Union countries and two and half times more compared with the global average [1].

Energy intensity in BiH in 2006 amounted to approximately 0.6 toe/000$, while global average is 0.3 and OECD countries' average is 0.18. This indicator is particularly influenced by consumption of energy for heating of buildings, where consumption in BiH ranges from 120 to 200 kWh/m^2 per annum, while in highly developed European countries it ranges between 30 and 50 kWh/m^2 per annum. [1] Data more recent than these are not available, in [7], from 2012 are given the data earlier than 2000. In this sense, these are the most recent data on energy intensity in BiH.

8.3 Electricity Generation in BiH

8.3.1 Generation structure

Electricity is in BiH generated exclusively from hydropower potential and coal.

On the entire BiH territory in 2014. was generated 15,030 GWh, out of which 5,821 GWh in hydropower plants, 8,921 GWh in thermal power plants, and 289 GWh was generated in small HPPs, solar power plants, wind power plants and industrial power plants [2].

Transmission network was supplied with 14,472 GWh generated in HPPs and TPPs, as well as 3,162 GWh from other power systems. From it for consumption in power plants was delivered 14 GWh, to the high-voltage customers 2,410 GWh, and to other power systems 5,998 GWh, while losses amounted to 305 GWh [2].

Distributive network was supplied with 269 GWh from HPPs and TPPs, 289 GWh from other power plants, as well as GWh from the neighbouring power systems. From it was delivered 4,606 GWh to households and 3,858 GWh to other customers, while losses amounted to 1,018 GWh [2].

Electricity generation structure in BiH is presented in the following picture.

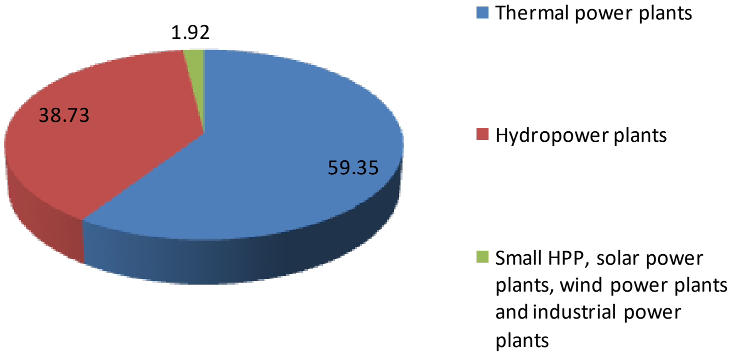


Figure 8-1 Electricity generation structure in BiH for 2014 [2]

An overview of electricity generation and consumption in Federation BiH and Republic of Srpska for the period from 2010 to 2014 is given in the following tables [2].

Table 8-1: Electricity generation in ERS from 2010 to 2014 (GWh) [2]

	2010	2011	2012	2013	2014
Hydropower plants	3,246.91	1,817.09	1,832.77	2,920.91	2,522.09
Thermal power plants	2,856.00	3,449.76	3,251.70	3,390.12	3,133.66
Small and industrial power plants	62.11	28.61	43.04	73.98	82.39
Total	6,165.02	5,295.46	5,127.51	6,385.01	5,738.14

Table 8-2: Electricity generation in EP BiH from 2010 to 2014 (GWh) [2]

	2010	2011	2012	2013	2014
Hydropower plants	2,094.61	1,113.63	1,086.63	1,854.43	1,542.61
Thermal power plants	5,012.79	6,138.01	5,367.80	5,549.53	5,786.99
Small and industrial power plants	182.77	100.82	115.40	150.59	188.97
Total	7,290.17	7,352.47	6,569.83	7,554.55	7,518.57

Table 8-3: Electricity consumption in ERS from 2010 to 2014 (GWh) [2]

	2010	2011	2012	2013	2014
Distributive consumption	3.552,19	3.556,16	3,551.14	3,567.50	3,526.02
Transmission losses					
Major customers	110,26	124,08	119.18	126.21	155.87
Power plants' own consumption	12,96	14,23	13.62	13.26	14.12
Total	3.645,41	3.694,47	3,683.94	3,706.97	3,696.01

Table 8-4: Electricity consumption in EP BiH from 2010 to 2014 (GWh) [2]

	2010	2011	2012	2013	2014
Distributive consumption	4.232,92	4.284,17	4.340,28	4.401,52	4.392,55
Transmission losses					
Major customers	371,43	417,17	446,23	448,20	442,76
Power plants' own consumption					
Total	4.604,35	4.701,34	4.786,52	4.849,72	4.835,31

In [3] are given somewhat different data related to electricity generation and consumption on the BiH territory. According to this source the gross electricity generation in BiH in 2014 amounted to 16,160 GWh, out of which 5,935 GWh in hydropower plants, 9,822 GWh in thermal power plants, and 403 GWh in industrial plants. The corresponding values of net generation (generation at the plant outlet) are 5,908 GWh, 8,921 GWh and 343 GWh, respectively. As it can be seen, the differences are not drastic (they are probably due to somewhat different methodologies); therefore from [2] can be used for subsequent analyses.

Final electricity consumption structure is presented in the following charts.

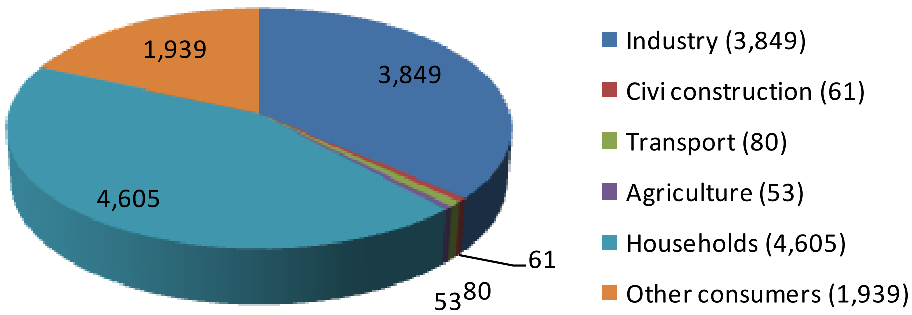


Figure 8-2: Final electricity consumption structure in BiH for various activities [3]

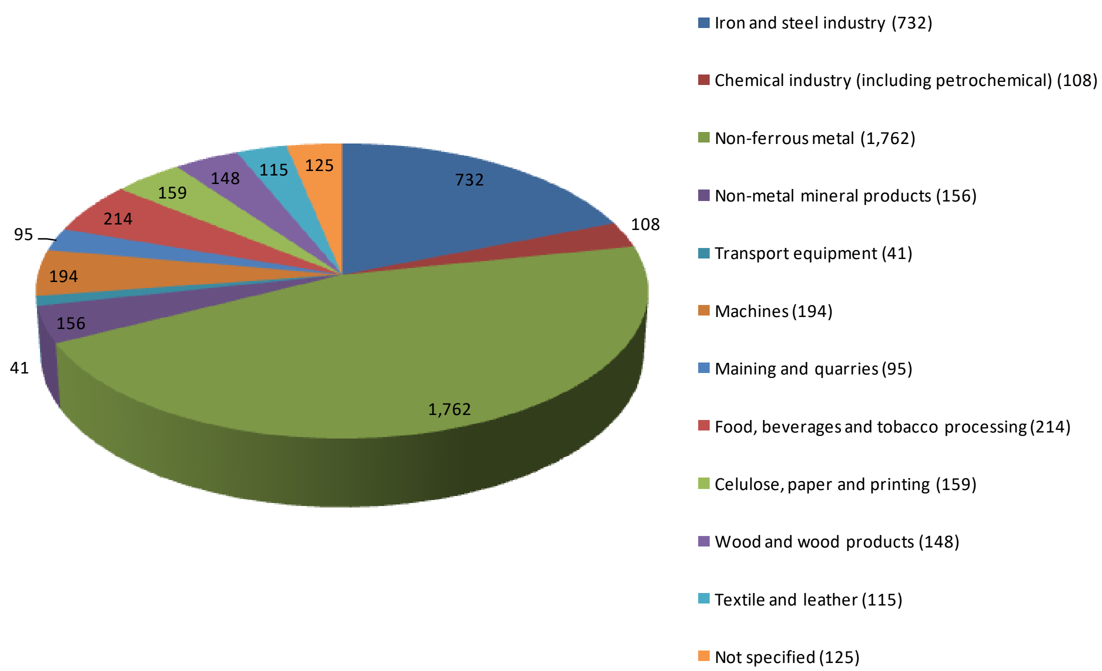


Figure 8-3: Final electricity consumption structure in BiH in industry [3]

8.3.2 Generation capacity

➢ **Federation BiH**

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 run-of-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. The principal data on these hydropower plants are given in the following Table 8-5.

*Table 8-5: Key data on hydropower plants in FBiH**

Basin	Plant name	Year of commission	Number of units	Unit power (MW)	Plant power (MW)	Mean annual production (GWh)
Trebišnjica	"Čapljina"	1979-80	2	220	440	620
Neretva	"Rama"	1968	2	80	160	650
	"Jablanica"	1954-1958	6	6x33 (since 2008.)	180	770
	"Grabovica"	1982	2	57	114	334
	"Salakovac"	1982	3	70	210	410
	"Mostar"	1987	3	25	72	310
Vrbas	"Jajce I"	1957	2	30	60	233
	"Jajce II"	1954	3	10	30	197
Trebižat	" Peć-Mlini"	2004-2005	2	15	30	82
Total			**23**		**1,296**	**3,606**

*Data presented in the table were obtained from "Elektroprivreda" BiH. They differ to a certain extent from the data given in [1], but are more recent and can be considered more reliable.

The system disposes over 23 production units in hydropower plants in total.

Nine production units are available to the transmission system at the 220 kV voltage level, while the remaining fourteen production units are available to the transmission system at the 110 kV voltage level. In terms of possible annual production, at the 110 kV voltage level are available 1,514 GWh, or 41% of the possible annual production of hydropower plants [1].

The mean annual production given for hydropower plants is the design value; in planning of production balance is used a value that corresponds to 0.7 of the mean hydrological year.

An equivalent hydropower plants' MW has an age of 33 years [1].

Total capacity combined with thermal power plants amounts to 2,454 MW and 9,717 GWh [1].

- **Republic of Srpska**

Republic of Srpska is considered a region rich in hydropower potential. The total technically usable hydropower potential of Republic of Srpska amounts to approximately 3,200 MW installed power and 9,500 GWh of mean annual electricity production. Out of that is being used approximately 2,420 GWh/year. Power potential of locations with expected installed power under 0.5 MW (micro and mini hydropower plants) at the territory of Republic of Srpska has not been investigated in detail [4].

At the territory of Republic of Srpska there are four hydropower plants ("Višegrad" HPP, "Trebinje I" HPP, "Trebinje II" HPP and "Bočac" HPP) and a certain number of small hydropower plants.

Republic of Srpska also obtains a certain amount of energy from the "Dubrovnik" HPP that is located on the territory of Republic of Croatia and utilizes the water from the Trebišnjica River basin. Electricity generated in this power plant is currently being shared between the "Elektroprivreda RS" company and the "Hrvatska elektroprivreda" company using the 50:50 ratio [4].

The total installed power of hydropower plants (including small HPPs) amounts to 736 MW, with the expected mean annual production of 2,420 GWh [4].

Electricity generation completely satisfies the needs for electricity on the territory of the RS and surplus electricity is being sold to other power systems.

8.4 Electricity consumption, transmission and distribution

8.4.1 Capacity of distribution system in FBiH

In Federation BiH in 2006 have been registered 842,113 customers [1]. Losses in the system include transmission and distribution losses. Transmission losses are within technically acceptable limits and range from 2% to 3%. Distribution losses in "EP BiH" are 10% and in "EP HZ HB" 19.88%. One of the priorities presented in [1] is reduction of energy losses in distribution system, what requires comprehensive investigation which would be used for definition of measures directed at increase of efficiency of the distribution system. A major challenge to future growth and development of the electric power system in BiH/FBiH is beyond doubt an extremely unfavorable structure of electricity consumption. It indicates that the regulation in power did not create adequate measures that can directly contribute to creation of the electric power system.

The structure of electricity consumption in FBiH is given in Table 8-6 below.

Table 8-6: Structure of electricity consumption in FBiH [1]

No.	Consumer category	Number of consumers		Consumption in GWh	
		JP "EP HZ HB" d.d. Mostar	JP "EP BiH" d.d. Sarajevo	JP "EP HZ HB" d.d. Mostar	JP "EP BiH" d.d. Sarajevo
1	Direct > 110 kV	3	6	1,875	543
2	35 kV	3	47	174	338
3	10 kV	100	505	126	541

No.	Consumer category	Number of consumers		Consumption in GWh	
		JP "EP HZ HB" d.d. Mostar	JP "EP BiH" d.d. Sarajevo	JP "EP HZ HB" d.d. Mostar	JP "EP BiH" d.d. Sarajevo
4	110, 35, 20 (10) kV	106	552	2,175	1,422
5	Households	166,518	607,773	676	1,742
6	Other 0.4 kV	14.920	47,125	2,312	638
7	Public lightning	1,232	3,881	21	60
8	Low voltage 0.4 kV	182.670	658,779	925	2,439
9	Net consumption			3,100	3,861
10	Transmission losses			70	159
11	Distribution losses			261	404
12	System losses			331	563
13	Gross consumption			3,431	4,424
	Total FBiH		**842,113**		**7,855**

8.4.2 Electricity transmission and distribution at the territory of RS

Transmission grid at the territory of the RS consists of lines with 400 kV, 220 kV and 110 kV voltage levels. The total length of all transmission lines within the power system of the RS amounts to 2,395 km, i.e. approximately 38% of the total length of all transmission lines within BiH [4].

The grid with the highest voltage level has been built in a satisfactory way; it is connected into a loop on the territory of BiH, and is also strongly connected to neighboring power systems of Serbia, Montenegro and Croatia. Transmission capacity of 400 kV lines is extremely high, so their load is most often under 30% of the maximum allowed value (approximately 1,000 MW per line), what allows for further increase in transmission over this grid in the future (until 2030). The boundaries between BiH and neighboring countries are not being congested from the BiH side, i.e. transmission grid can support market transactions within, outside of, and via the power system of BiH.

Electricity distribution is organized by the means of five independent distribution system operators (electricity distribution companies), namely "Elektrokrajina" (232 thousand customers), "Elektro Doboj" (88 thousand customers), "Elektro Bijeljina" (100 thousand customers), "Elektrodistribucija Pale" (51 thousand customers) and "Elektrohercegovina" (27 thousand customers) [4].

Losses and unrecorded electricity consumption are among of the biggest problems encountered by distributive network operators in Republic of Srpska. Indicators on continuity of electricity delivery at the territory of the RS are considerably less favorable than the values usual for European systems. Indicators on commercial service quality are in a considerable number of cases in accordance with European experience.

The high voltage grid within BiH territory is presented in the following Figure 8-4.

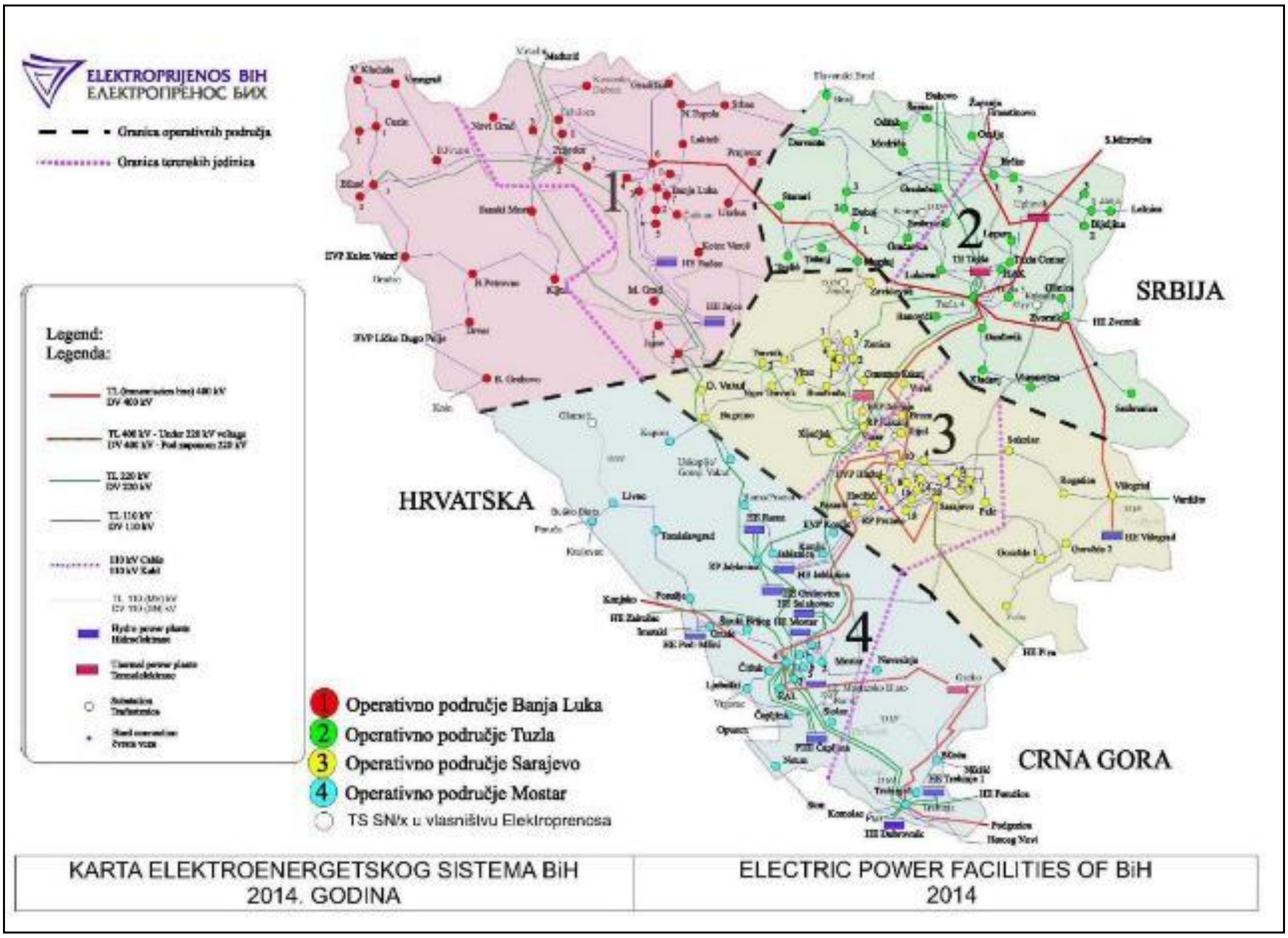


Figure 8-4: High Voltage Grid in BiH [1]

8.4.3 Future projections

➢ **Federation BiH**

Annual rate of increase of electricity consumption in the period from 2000 to 2006 in Federation BiH amounted to approximately 4%. Annual rate of increase in peak load amounted to 11% what clearly indicates the growing share of large consumers in electricity consumption. Consumption structure, consumption increase of 2.29% annually and peak load increase of 3.24% annually in the zone of balance responsibility of the JP "EP HZ HB", as well as the consumption increase of 4.43% annually and peak load increase of 2.43% annually in the zone of balance responsibility of the JP "EP BiH" were used for a forecast of consumption in Federation for the period until 2020; it was determined that the rate of increase in consumption will correspond to 3.24% for consumers in the zone of balance responsibility of the JP "EP HZ HB" and 4.43% for consumers in the zone of balance responsibility of the JP "EP BiH". Rate of increase in consumption for the entire Federation BiH during this period amounts to 4% [1].

In the following Table 8-7 is given an overview of installed/planned powers and production in the electric power system of the Federation BiH.

Table 8-7: Overview of installed/planned power and production of the FBiH [1]

Category	Installed power / mean annual production	Year				
		2005	2010	2015	2020	2025
Hydropower plants	MW	849	939	1,278	1,736	2,198
	GWh	2,285	2,452	3,568	5,066	6,810
Pumped-storage hydropower plants	MW	440	440	1,144	1,144	1,144
	GWh	400	400	1,595	1,595	1,595

Category	Installed power / mean annual production	Year				
		2005	2010	2015	2020	2025
Renewable sources	MW	1,289	1,567	3,018	3,496	3,958
	GWh	2,685	3,367	6,729	8,265	10,009

It can be stated that the plan for 2015 presented in the table above was not realized. For the "Bjelimići" PSHPP even the technical documentation at the Preliminary Design level was not completed.

In the following Table 8-8 is given an overview of available production capacity for the period from 2005 to 2020/2030.

Table 8-8: Overview of production capacity in FBiH for the period from 2005 to 2020/30 [1]

Production capacity	Year			
	2005 to 2010	2010 to 2015	2015 to 2020	2020 to 2030
	MW			
Capacity of new HPPs	60	1,043	458	462
Capacity of rehabilitated HPPs	180	90	0	839

It can be stated that the plan for 2015 presented in the table above was not realized.

➢ **Republic of Srpska**

Document [4] analyzes three development scenarios related with energy consumption:

- Scenario S1: this scenario includes a higher growth of GDP. The principal characteristic of this scenario is a rapid growth of gross domestic product (desirable economy development scenario), with application of classical technologies, but without active governmental measures.
- Scenario S2: this scenario includes a higher growth of GDP with application of additional measures. The principal characteristic of this scenario is a rapid growth of gross domestic product with application of energy efficiency measures and incentives related to use of renewable energy sources.
- Scenario S3: this scenario includes a lower growth of GDP. The principal characteristic of this scenario is a slow growth of gross domestic product with application of classical technologies, but without application of active governmental measures.

Energy consumption in scenario S1

According to this scenario the increase in electricity consumption would amount to [4]:

- During the period from 2005 to 2010: 2.5%,
- During the period from 2010 to 2015: 3.9%,
- During the period from 2015 to 2020: 4.2%,
- During the period from 2020 to 2025: 2.9% and
- During the period from 2025 to 2030: 2.6%.

Energy consumption in scenario S2

According to this scenario the increase in electricity consumption would amount to [4]:

- During the period from 2005 to 2010: 2.4%,
- During the period from 2010 to 2015: 3.5%,
- During the period from 2015 to 2020: 3.8%,
- During the period from 2020 to 2025: 2.8% and
- During the period from 2025 to 2030: 2.7%.

Energy consumption in scenario S3

According to this scenario the increase in electricity consumption would amount to [4]:

- During the period from 2005 to 2010: 2.3%,
- During the period from 2010 to 2015: 2.8%,
- During the period from 2015 to 2020: 3.3%,
- During the period from 2020 to 2025: 2.7% and
- During the period from 2025 to 2030: 1.8%.

The total electricity consumption on the transmission network should increase from 3,620 GWh in 2010 to from 5,590 to 6,460 GWh in 2030 (depending on the scenario) [4].

8.4.4 Development of the power sector

➢ **Potential of the Federation BiH**

According to earlier studies developed in the "Elektroprivreda (Electric Power Industry) of BiH", this territory disposes over a very valuable power potential of surface watercourses.

FBiH not only has the capacity to satisfy its own needs, but, provided that it develops an adequate model of financing of construction of production and related capacities, has the potential to increase its GDP due to sales of electricity on the electricity market.

The total hydropower potential available for use amounts to 5,555.4 MW, i.e. 21,840 GWh. Hydropower plants built so far have the installed power of 2,725 MW and mean annual production of 10,365 GWh and that corresponds to less than 50% of the possible potential. Construction of new generation capacities with the installed power of 442.5 MW, i.e. mean annual production of 1,281.68 GWh, during the analyzed period was also envisaged; this would increase the use of the total available potential to 57.03% in terms of power, i.e. 53.31% in terms of production. The reliability of data on hydropower potential of river basins in terms of power and energy need to be verified by additional investigations, also taking into account the estimation of the impact of climate change upon hydrological conditions.

Below is given more detailed information for the Drina River Basin only [1]:

- Total estimated possible power of HPPs amounts to 1,796 MW, out of which has been built 724 MW (40.3%) and designed another 66 MW, what would lead to an exploitation degree of 43.99% and
- Total estimated possible mean annual production of HPPs amounts to 8,354 GWh, out of which has been built 3,284 GWh (39.3%) and designed another 255 GWh, what would lead to an exploitation degree of 42.36%.

The data listed above correspond to the construction of the "Ustikolina" HPP; its construction was envisaged for 2013 (but not realized).

➢ **Development of power sector on territory RS**

The principal objective in the electricity sector is to secure permanent and high-quality supply of electricity to all customers on the territory of the RS at market-determined and acceptable prices, in a way that is in accordance with the principles of environmental protection.

The main assumptions necessary for planning of development of electricity sector in the RS are complete opening and regulation of the electricity market in accordance with EU directives dated January 1st 2015 [4].

Until the end of the analyzed period (2030) can be expected an increase in power system load factor from present 55% to approximately 64% [4].

One of the objectives is also reduction of the total losses in electricity distribution from 17.2% in 2008 to 6.5% in 2030 [4].

The total need for electricity in the RS is currently being satisfied by production in domestic power plants and surplus electricity is being exported to other markets - between 20 and 30% of the total production. Supply reliability is high, in the view of the fact that domestic sources of primary energy are being used. According to expected electricity consumption scenarios the existing production capacities are sufficient for satisfaction of the total electricity needs until approximately 2020 or 2025.

All existing hydropower plants will be in operation until the end of the analyzed period, under the assumption of application of certain activities related to rehabilitation of electric-mechanical facilities and civil structures.

The RS government has awarded several concessions for construction of hydropower plants, namely "Ulog" HPP, "Krupa" HPP, "Banja Luka niska (low)" HPP and a significant number of concessions for construction of small HPPs, with the total power of approximately 210 MW and expected mean annual production of 650 GWh [4].

In view of that fact shall be promoted and developed new projects related to harnessing of hydropower potential of watercourses in the RS. Locations of structures regarded as primary candidates for construction until 2030 are:

- "Buk Bijela" HPP and "Foča" HPP - construction expected in the period until 2020 and
- The "Gornji Horizonti" project ("Dabar" HPP, "Nevesinje" HPP and "Bileća" HPP) - expected completion of the project in the period until 2016 or 2020.

The process of preparation and construction of hydropower plants is quite long (from 10 to 15 years). Therefore, it will be necessary to perform activities not only within the abovementioned projects related to construction of hydropower plants, but also to prepare the documentation for and develop construction of other hydropower plants, i.e. "Sutjeska" HPP, "Paunci" HPP, "Mrsovo" HPP, HPPs on Middle Drina and "Dubrovnik II" HPP.

At a number of watercourses, the hydropower potential will have to be shared with the neighboring states/entities and the harnessing of that potential will have to be in accordance with future agreements to be concluded with all interested parties. All open issues related to past investments into development of power plants will also have to be resolved by agreements to be concluded with all interested parties, with the complete protection of the RS's interests.

As it was already mentioned, the grid with the 400 kV voltage level has a satisfactory structure, is connected into a loop on the territory of BiH and is strongly connected to all power systems in the neighboring states, Serbia, Montenegro and Croatia. Exceptions to this are the region around Banja Luka, which is supplied in the radial manner, using one 400 kV line, and the radial connection of the "Višegrad" HPP that is achieved via the 400 kV grid. The 400 kV grid has great significance in establishment of even stronger connections to power systems of neighboring states (for example, Prijedor-Bihać-Zagreb, "Višegrad" HPP-Pljevlja and internal 400 kV connections within the RS, Banja Luka-Prijedor and Gacko-"Buk Bijela" HPP) [1].

The 220 kV grid within the RS plays an important role in electricity transmission. The "Prijedor 2" and "Trebinje" TS 220/110 kV significantly contribute to the reliability of supply to the wider area around Prijedor and Trebinje. The 220 kV grid in the RS has a satisfactory structure [4].

At the territory of the RS is also developed the 110 kV grid. It is necessary to solve the issues related to the radial supply to certain TS 110/x kV. For the lines which have smaller conduit cross-sections are envisaged reinforcement of certain section in urban zones and construction of double 110 kV overhead lines with the conduits with the 240 mm^2 cross-section in non-urban zones, preferably using the existing corridors [4].

The "Elektroprenos BiH" company shall in the future be able to provide connection of all power plants and new customers according to the (n-1) criterion stipulated in the Grid Code [5]. In case of intensive power plant construction, such that the installed power of production plants on the territory of RS would considerably exceed domestic needs, it might become necessary to additionally reinforce grids with higher voltage levels. This primarily holds true for the 400 kV grid, as this would allow for export of electricity to the South-Eastern European market and other markets (to Italy, Turkey and Middle Europe).

For the territory of Republic of Srpska is characteristic a considerable share of 110/MV direct transformation, i.e. electricity distribution without the intermediary action of the 35 kV grid and 35/10(20) kV transformation owned by the distribution network operator [4]. Direct transformation is locally prevalent on the territory covered by the "Elektrokrajina" company. On the contrary, the 35 kV grid is extremely well developed on the territory covered by the "Elektro Doboj" company.

In the long term the objective is to have a system with one medium voltage level (20 kV) and one direct transformation (110/20 kV). Therefore, the development of the medium voltage network is based upon two, partly connected, principles, these being the gradual replacement of the 10 kV voltage level by the 20 kV one and gradual introduction of direct transformation 110/10(20) kV, along with the elimination of the 35 kV grid.

Renewable energy sources

The total hydropower potential in Republic of Srpska within the power range from 0.5 to 10 MW can be estimated to 1,500 GWh/year. Hydropower potential of small hydropower plants considered candidates for construction amounts to approximately 212 MW, i.e. approximately 650 GWh /year. Hydropower potential of small hydropower plants with the installed power lower than 0.5 MW (micro and mini hydropower plants) on the territory of Republic of Srpska has not been investigated [4].

In Republic of Srpska in operation are six small and mini hydropower plants with the total installed power of 16.95 MW and mean annual production of 68.14 GWh [4].

The RS government awarded concessions for construction of 107 hydropower plants (47 concessionaires in total), with total installed power of 281.67 MW and expected mean annual production of approximately 1,400 GWh. 90% of these plants are small hydropower plants [4].

Investments

RS faces a development-investment cycle which includes large investments into energy sector. Envisaged investments into electricity sector during the subject period amount to [4]:

- From 2010 to 2015: 3,132 million KM,
- From 2016 to 2020: 1,397 million KM,
- From 2021 to 2025: 675 million KM and
- From 2026 to 2030: 378 million KM.

References

1. "Strateški plan i program razvoja energetskog sektora Federacije BiH", Sarajevo, 2009.

2. "Izveštaj o radu državne regulatorne komisije za električnu energiju za 2014. godinu", Tuzla, 2014.

3. "Statistika energije", br. 7, godina VII, Agencija za statistiku Bosne i Hercegovine, Sarajevo, 2015.

4. "Strategija razvoja energetike Republike Srpske do 2030. godine (prijedlog)", Banja Luka, 2012.

5. "Mrežni kodeks", Nezavisni operater sistema u Bosni i Hercegovini, Sarajevo, 2011.

6. "Izvješće o stanju okoliša u Bosni i Hercegovini", Ministarstvo vanjske trgovine i ekonomskih odnosa BiH, 2012.

8.5 Existing hydropower plants in the basin

Two existing HPP schemes are located on middle ("Bajina Bašta" HPP) and lower ("Zvornik" HPP) section of Drina River along the boundary line between BiH and Serbia. Both dams and reservoirs are partially located on territory of BiH while powerhouses are located on territory of Serbia ("Bajina Bašta" HPP) or on both river banks/states ("Zvornik" HPP). Actual layouts are presented on the following pictures.

Figure 8-5:"Zvornik" dam and reservoir location

Figure 8-6:"Bajina Bašta" dam and reservoir location

Since the operation of both HPPs is managed by EPS, their main characteristics are presented within the "Serbia- IWRM Study and Plan – Background Paper – Draft-Volume 1 – Main report" (August 2015).

Only one HPP with all appurtenant facilities is located on the BiH territory – the "Višegrad" HPP.

"Višegrad" dam and reservoir are located on Drina River (stationery km 245+000). The main structures were built in the 1985–1989 period. "Višegrad" dam is a concrete dam, 79.5 m high and 280 m long.

Appurtenant structures comprise the following: gated spillway with the maximal capacity of 6,000 m^3/s, bottom outlets with the maximal capacity of 5,000 m^3/s and stilling basin. Powerhouse is located next to spillway part. In the powerhouse are installed three generating units, with total power of 345 MW.

The environmentally guaranteed flow is 50 m^3/s.

During its previous operation, this HPP has proved its reliability and worked almost without any major defects. During the last two years have been performed complex rehabilitation works whose objective was to reduce seepage beneath the dam. Based on the results obtained in October 2014, water loss caused by seepage was reduced by approximately 70%.

The main characteristics of the "Višegrad" HPP with corresponding structures are presented below:

- Reservoir:[24]

Total volume	161 Mm^3
Live volume	105 Mm^3
Max. OEL	336 m a.s.l.
Normal OEL	333-336 m a.s.l.
Min. OEL	319 m a.s.l.

- Dam

Type	Concrete - gravity
Crest elevation	339 m a.s.l.
Height	79.5 m

- HPP

Type	Non-diversion
Max. head	44.4 m
Installed discharge	800 m^3/s
Installed power	333 MW
Annual electricity production	1,010 GWh
No of units	3
Type of turbine	Kaplan vertical

[24] Mm^3 = millions of cubic metres; m.a.s.l = metres above sea level

Figure 8-7: "Višegrad" dam and HPP

8.6 Management of hydropower plants (reservoirs)

- **Federation BiH territory**

In Federation BiH there is only one reservoir that influences watercourses in the Dina River Basin, the "Snježnica" reservoir.

The "Snježnica" dam was built on the Rastošnica River, upstream of its mouth into the Janja River, with the purpose of supply of water to the "Ugljevik" TPP. The Rastošnica River develops from several streams at the northern slopes of the Majevica Mountain. The Janja River flows into the Drina River in vicinity of the eponymous settlement in the municipality of Bijeljina.

General direction of Rastošnica River flow is from south to north, with tendency of local turns in direction of north-west. Mean discharge at the "Snježnica" dam profile amounts to 456 l/s and the minimum one is 20 l/s.

The construction height of the dam is 58 m. By construction of the dam was formed a reservoir with the total length of 5 km, measured along the alluvial plain, with the maximum elevation of 298.5 m.a.s.l. and the minimum operating water level in the reservoir of 275.00 m a.s.l. The total reservoir volume amounts to approximately 20.265 million m^3 and its active volume to approximately 18.264 million m^3.

Water from the reservoir is used for regulation of water lack in the natural Janja River flow. Water is discharged through the middle dam outlet into the regulated Rastošnica River bed and Janja River bed, from which water is extracted to be used in the "Ugljevik" TPP.

"Snježnica" dam structures also include the "Snježnica" SHPP that uses the extracted water.

- **Republic of Srpska territory**

In the DRB in Republic of Srpska is located the "Višegrad" reservoir (active volume is 105 million m^3) and on the boundary between Republic of Srpska and Serbia are located "Bajina Bašta" reservoir (total volume 340 and active volume 218 million m^3) and "Zvornik" reservoir (active volume 18.0 million m^3). All reservoirs listed above were formed as parts of hydropower plants.

The operation of "Piva" reservoir and HPP on the Piva River also has a large impact on Drina River flow regime (their operation also has a large impact on the Piva River). "Piva" HPP has for a number of years operated in the peak-load regime (at present moment it is not quite clear how its operation would look like in the future). The total volume of the "Piva" reservoir amounts to 880 million m^3 and allows for annual flow regulation.

It should be noted that during the previous operation of the "Piva" HPP in the peak-load regime there was no reservoir downstream of it that would regulate the water leaving the turbines and reduce the detrimental effects of its operation.

The reason for that is during the design of the "Piva"HPP it had been expected that its construction will be followed by construction of the "Buk Bijela" HPP (so-called "high" HPP). The regular water level in the reservoir of the downstream plant should have been identical to the "Piva" HPP tailrace water level, so that it could have been used for regulation of discharges that leave the "Piva" HPP.

The lack of construction of the "Buk Bijela" HPP led to several serious issues.

First of all, it should be noted that the "Piva" HPP has no smaller unit that could be used for discharging the ecological flow which cannot be discharged by means of an outlet (without hydropower use). Due to that, during certain longer periods (especially in summertime), the Piva River bed downstream of the "Piva" HPP can contain an unsatisfactory amount of water. This fact concerns Republic of Srpska as well, as a long section of its boundary runs along the downstream reach of the Piva River.

The second, very unfavourable, effect of operation of the "Piva" HPP is peak-load regime without downstream flow regulation. HPP start leads to a propagation of a wave with the discharge equal to 240 m^3/s; this is not really desirable in the view of the fact that the population of the downstream town of Foča actively uses Drina river banks.

Both listed problems could be solved by construction of the "high" "Buk Bijela" HPP and at least the latter one could be solved by construction of the system composed of "low" "Buk Bijela"HPP and "Foča" HPP.

It is necessary to develop a management strategy for the "Piva" HPP and reservoir (its flow regulation devices), in order to avoid the possibility of an inadequate manoeuvre creating a flood wave even more detrimental than “natural” ones.

"Bajina Bašta" HPP and "Bajina Bašta" PSHPP operate in the peak-load regime; during the operation of one unit from the reservoir is discharged the amount of water larger than the ecological flow (45 m^3/s). The retention action of the reservoir itself can have a positive impact on alleviation of effects of flood discharges.

It would be necessary to develop a management strategy that could help avoiding a possible superposition of flood waves which could be caused by inadequate operation of dams’ five spillway fields.

This model should not have an impact only upon the operation of the "Bajina Bašta" reservoir, but also upon the operation of the "Zvornik" reservoir. Its operation has to be synchronized with the operation of the upstream reservoir and opening of its sector gates should lead to reduction of flood wave downstream of it.

It should be borne in mind that the "Zvornik" reservoir has a small volume and that it is almost completely filled, so that the "Zvornik" HPP operates in run-of-river regime, or with incomplete daily regulation. The ecological flow equal to 50 m^3/s is being regularly discharged from the reservoir. Reservoir operation cannot really mitigate the effects of a flood wave, but it can make it more dangerous, should an adequate gate manoeuvre lead to superposition of flood wave peak and spilling.

Therefore, in the future it will be necessary to pay attention to development of management strategy for all existing reservoirs that have regulated spillways, in order to avoid the possibility of generation of flood discharges higher than the one under natural conditions. It is also to consider as soon as possible the construction of structures along the upper part of the Drina River watercourse, between the “Piva" reservoir and the "Bajina Bašta" reservoir.

Figure 8-8 below illustrates the location of all existing power plants in the DRB. Figure 8-9 provides an overview of longitudinal profiles of the various rivers in the DRB, as well as the location and data for the existing power plants.

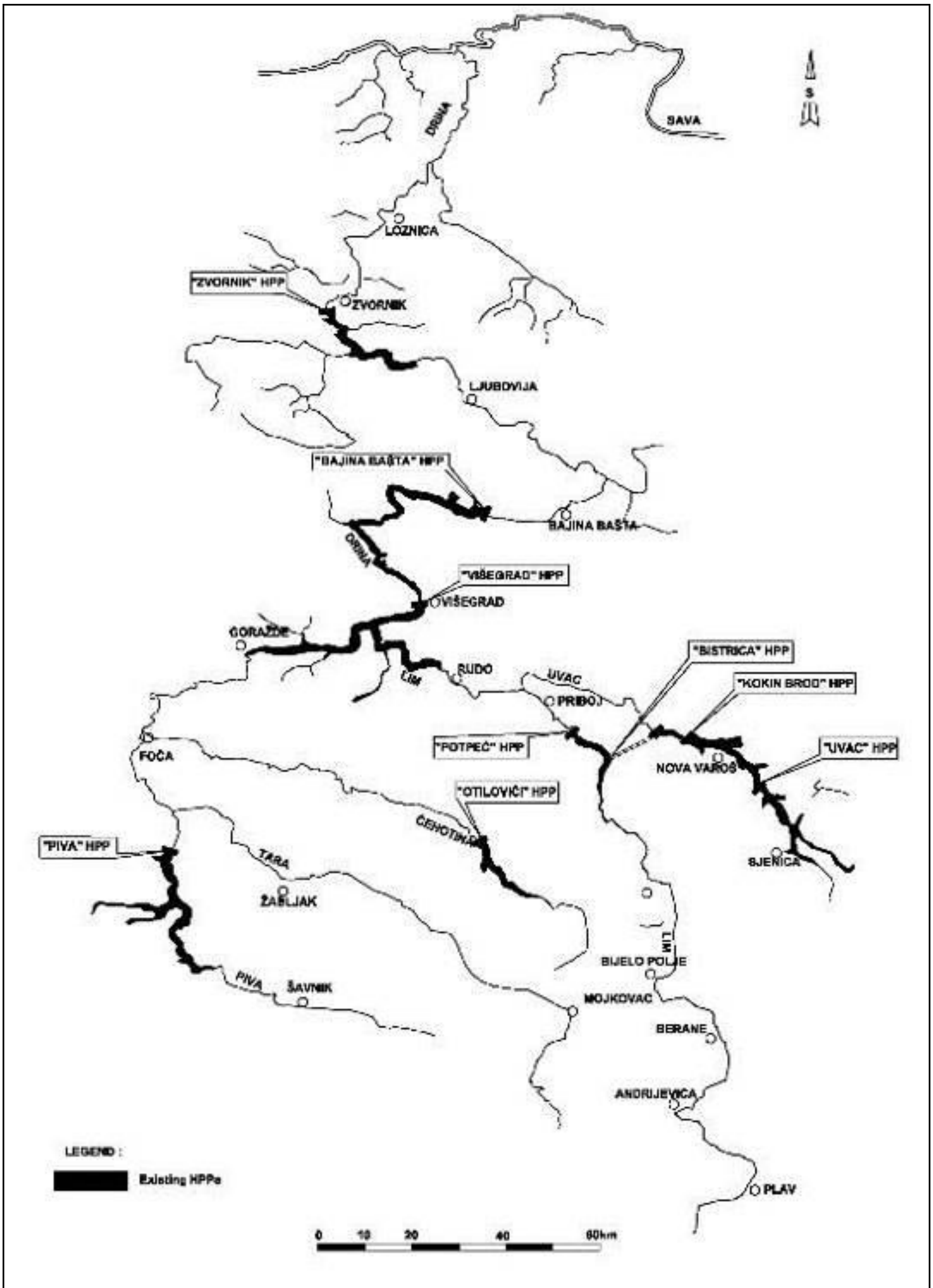


Figure 8-8: Existing HPPs in the Drina River Basin

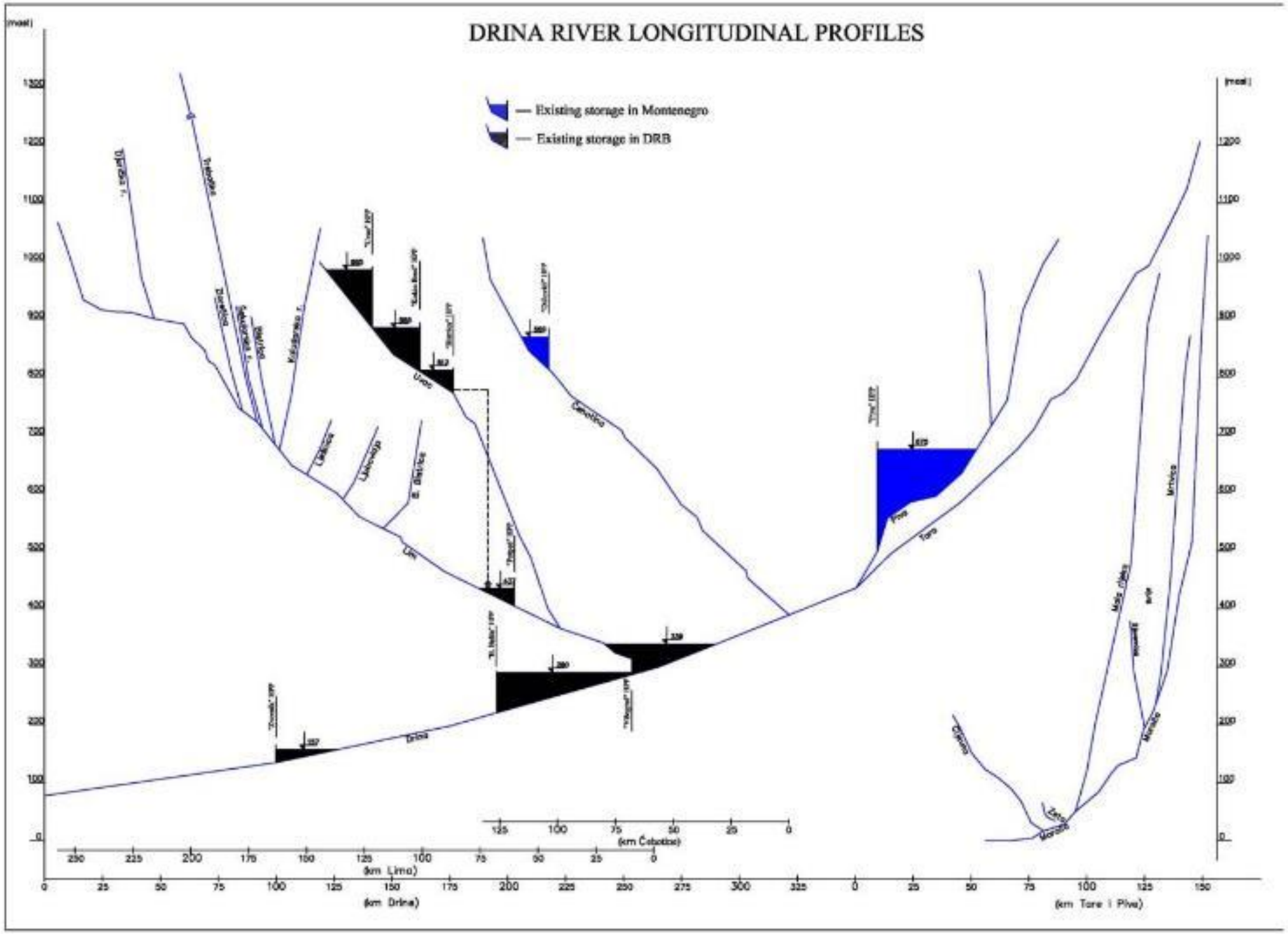


Figure 8-9: Existing HPPs in the Drina River Basin – longitudinal profiles

8.7 Planned hydropower plants

8.7.1 Introduction

So far in the DRB have been built 9 hydropower plants ("Uvac" HPP, "Kokin Brod" HPP, "Bistrica" HPP, "Potpeć" HPP, "Piva" HPP, "Višegrad" HPP, "Bajina Bašta" HPP, "Bajina Bašta" PSHPP and "Zvornik" HPP) with the total installed power of 1,932 MW and the average annual production of 6,350 GWh, as well as the "Otilovići" storage. They are shown in the Figure 8.6 above.

The following sections will cover analyzed hydropower plants along the following rivers in BiH (Republic of Srpska and FBiH):

- Drina River,
- Sutjeska River,
- Lim River and
- Ćehotina River.

In the Inception Report it was stated that the existing technical documentation includes technical solutions for 41 relevant HPPs in DRB in total. The list of planned HPPs is based on valid planning documents. They are presented in the following Figure 8.7.

Initial Selection of Hydropower Plants

In the Inception Report, 41 hydropower plants were identified to be further analysed. These hydropower plants have been mentioned in planning and strategic energy related documents (Water Master Plans, Energy Sector Strategies etc.).

After a more thorough consideration of these plants it was decided that it would be beneficial to somewhat reduce this number of projects in order to facilitate the formulation of development scenarios. Another reason for this is that the available planning and strategic documents refer to projects whose technical documentation level differs very much for them and their feasibility. In these documents, it is for instance possible to find a project for which a Final Design Report was developed and even some expropriation was performed, next to a project which is sketched only conceptually, with very unreliable bill of quantities and cost estimate. Unfortunately, in these documents such "meta-data" for projects included in them have not been discussed.

Another important issue in relation with the selection of projects was the time frame of the project implementation. The realization chances of a project may increase or decrease in time. For example, a project can be considered unviable at a certain point in time due to environmental restrictions (as is the case in many locations in Montenegro). This project may possibly become more viable in future, provided that the restrictions are withdrawn in the meantime. However, one should bear in mind that in DRB (and in Western Balkans in general) spatial planning leaves much to be desired and illegal construction of structures (especially residences) is very often not adequately sanctioned. This phenomenon introduces serious legal and property-related issues that can significantly endanger future construction of hydropower plants. This is, for instance, the case for the Lim River and its technically usable hydropower potential, which is now seriously reduced due to lack of systematic planning and urban development, as well as illegal construction.

Therefore, it was decided to consider only those hydropower plants that fulfil the following conditions:

- The projects are not burdened by any restrictions that would make them unviable in the following mid-term period (for example, in next 20 to 30 years),
- The projects are described in an adequate technical documentation, at least at the level of Conceptual Design Report,
- The projects have not been abandoned, i.e. there has been some ongoing activity related to them in last 20 years, like development or update of technical documentation etc.

Below is given the list of projects in all DRB countries that have not been further developed in Country Reports, along with the corresponding argumentation:

- "Buk Bijela" ("high") HPP and "Foča" HPP hydropower system: this project is the most important hydropower project in DRB and Western Balkans, however the environmental restrictions imposed by Montenegro make it unviable in the foreseeable future;
- "Milovci" HPP: this project requires sharing of hydropower potential between Montenegro and BiH - the combination of "Vikoč" HPP, "Gradac" HPP and "Mekote" HPP make consideration of "Milovci" HPP unnecessary.

All properties of the main HPPs facilities presented hereafter (dams, storages, conduits, powerhouses etc.) are based on the documentation cited in the references.

Figure 8-10 and Figure 8-11 illustrate respectively the geographical location of all the planned HPPs (installed power > 2 MW) and their position along the longitudinal river profiles.

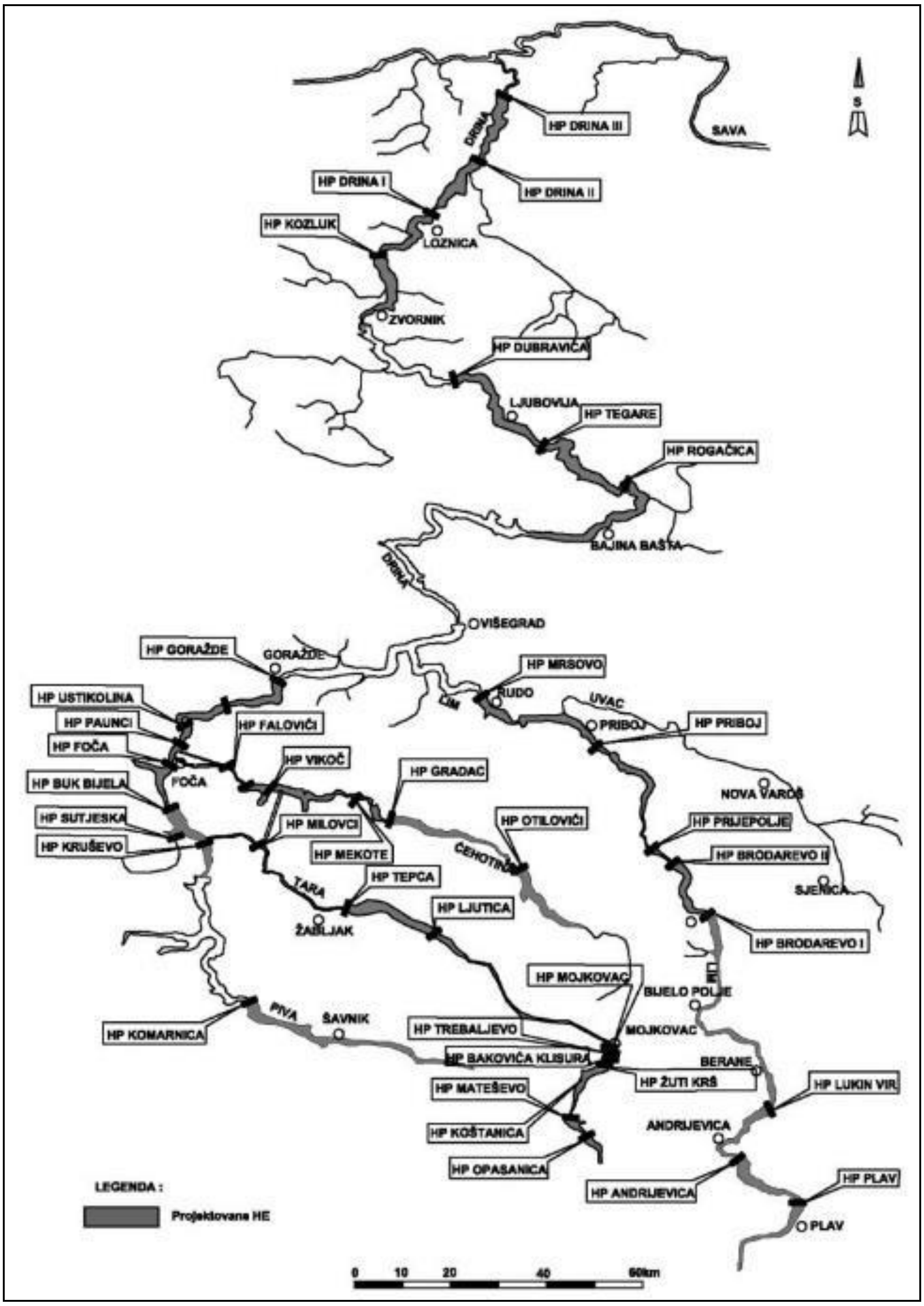


Figure 8-10: Planned HPPs within Drina River Basin

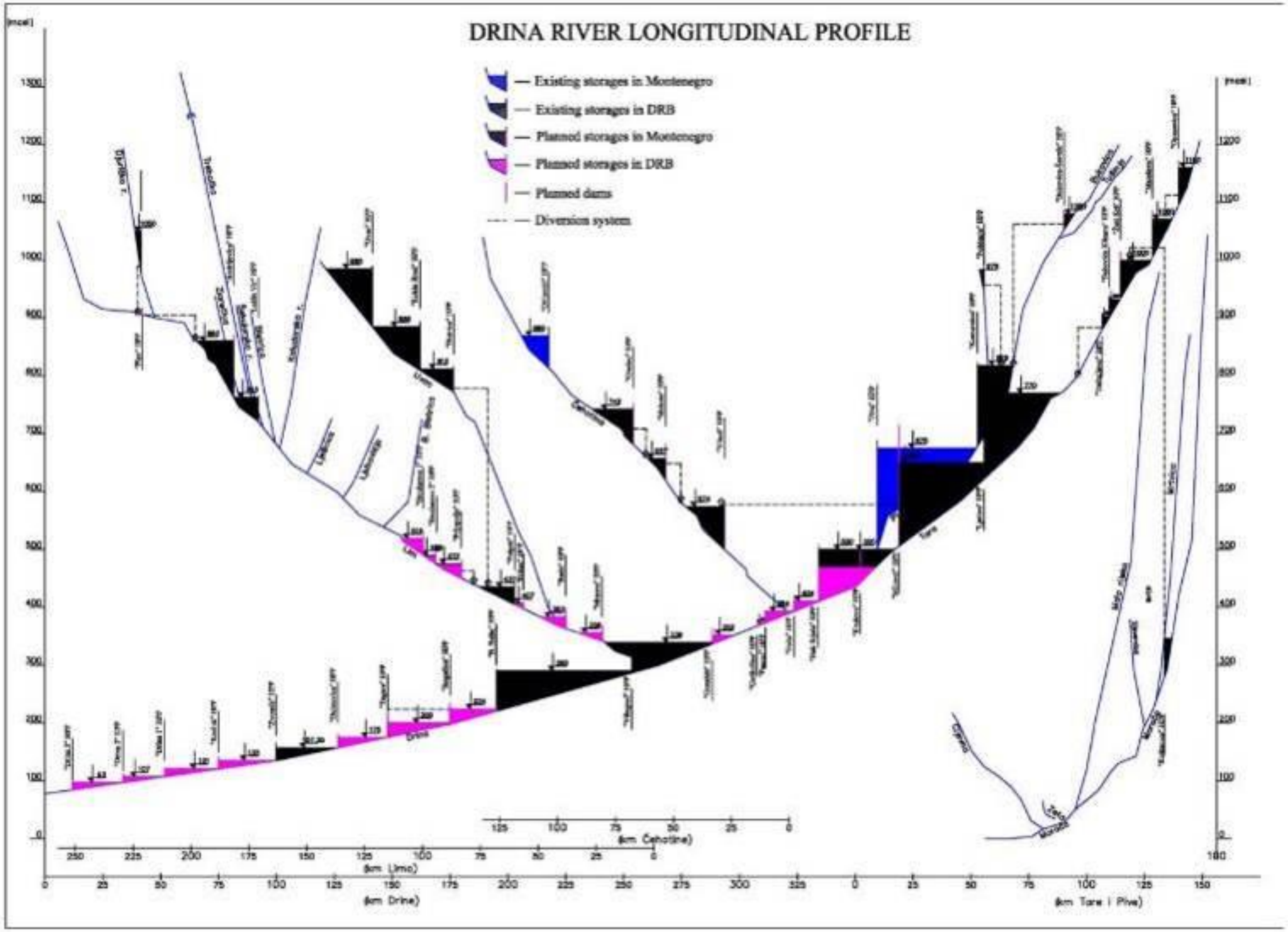


Figure 8-11: Planned HPPs within the Drina River Basin – longitudinal profiles

8.7.2 Analysed HPPs along Drina River

For reading convenience, the Drina River course is divided into three sections:

- Upper section ("Upper Drina River"): from the boundary between Montenegro and BiH to the headrace of the existing "Višegrad" HPP,
- Middle section ("Middle Drina River"): from the tailrace of the existing "Bajina Bašta" HPP to the headrace of the existing "Zvornik" HPP and
- Lower section ("Lower Drina River"): from the tailrace of the existing "Zvornik" HPP to the confluence with the Sava River.

Upper Drina River

Upper Drina is considered the most important section of all three mentioned above. This river section runs through the BiH (primarily the Republic of Srpska) territory. Harnessing of Upper Drina hydropower potential has an interesting history.

"Buk Bijela" HPP is the most important and attractive hydropower plant along the upper part of the Drina River course, with a long history. The "Buk Bijela" profile (12 km upstream of Foča) controls the basin area of approximately 4,000 km^2 (20% of the total DRB), from which is generated 44% of the discharge available at the confluence of Drina River and Sava River and where average discharge amounts to approximately 170 m^3/s.

In 1965, after it was decided that the "Piva" HPP on the Piva River shall be built, the regular water level of the "Buk Bijela" storage was set to 500 m a.s.l. It is important to note that approximately one third of this storage would belong to the Montenegro territory; this required an agreement between Serbia and Montenegro regarding the approach to construction, financing, sharing of power and generated electricity etc.

Preliminary Design Report for the "Buk Bijela" HPP was completed in 1970, followed by investigation works and Main Design Reports for diversion tunnels. In 1974, the construction of this HPP has begun and the source of financing was a loan from the International Bank for Reconstruction and Development. However, the construction came to a halt in 1976. The principal reason for this decision were unresolved disputes with Republic of Montenegro, primarily related to protection of the Tara River canyon and transfer of water from Tara River into Morača River.

In the same year started the negotiations with Montenegro about future construction and operation of the "Buk Bijela" HPP. After numerous analyses and studies, it was decided that Montenegro should get one third of the available power and generated electricity and the construction was continued.

Additional investigation works indicated that the existing technical documentation needs to be updated and this was done between 1983 and 1985. The Main Design Report was completed in 1987 and was positively reviewed by IBRD.

During the mid-nineties of 20th century was developed the Preliminary Design Report for the "Foča" HPP, the plant that should serve as the compensation basin for the "Buk Bijela" HPP.

In 2001 and 2002 was developed the bidding documentation for execution of civil works and in 2002 was made public the request for proposals regarding concession for construction and operation of "Buk Bijela" and "Foča" HPP.

However, during the bidding process Montenegro again raised the issue of protection of the Tara River canyon and the "Durmitor" national park. Due to the pressure of "green" NGOs and expected inclusion of the Tara River canyon and the "Durmitor" national park into the UNESCO list of world heritage the entire process was terminated.

Existing technical documentation envisages the following HPPs along the upper part of the Drina River:

- "Buk Bijela" ("low") HPP (BiH - Republic of Srpska),
- "Foča" ("low") HPP (BiH - Republic of Srpska),
- "Paunci" HPP (BiH - Republic of Srpska),
- "Ustikolina" HPP (BiH - Federation BiH) and
- "Goražde" HPP (BiH - Federation BiH).

"Buk Bijela" ("high") HPP and "Foča" ("high") HPP as a system are a project that cannot be considered feasible at the time. They are worth mentioning because of their historical importance and with the objective of better understanding of hydropower potential of the subject area.

Middle Drina River
The "Middle Drina River" is considerably less attractive than "Upper Drina River" and harnessing of its potential was analyzed by the means of the following HPPs:

- "Rogačica" HPP (capacity is to be shared equally between Serbia and BiH - Republic of Srpska),
- "Tegare" HPP (capacity is to be shared equally between Serbia and BiH - Republic of Srpska) and
- "Dubravica" HPP (capacity is to be shared equally between Serbia and BiH - Republic of Srpska).

Lower Drina River
The "Lower Drina River" is considerably less attractive than both "Upper Drina River" and "Middle Drina River" and harnessing of its potential was analyzed by the means of the following HPPs:

- "Kozluk" HPP (capacity is to be shared equally between Serbia and BiH - Republic of Srpska),
- "Drina I" HPP (capacity is to be shared equally between Serbia and BiH - Republic of Srpska),
- "Drina II" HPP (capacity is to be shared equally between Serbia and BiH - Republic of Srpska) and
- "Drina III" HPP (capacity is to be shared equally between Serbia and BiH - Republic of Srpska).

These technical solutions are presented below.

"Buk Bijela" ("low") HPP
Location of dam and HPP

"Buk Bijela" dam and HPP are planned at the Drina River, at the chainage km 334+550, approximately 11.6 km upstream of the city of Foča and at approximately 11.5 km downstream of the mouth of Piva River and Tara River at Šćepan Polje (border between Montenegro and BiH (Republic of Srpska)). The location belongs to the municipality of Mješaji and the nearest town is Foča.

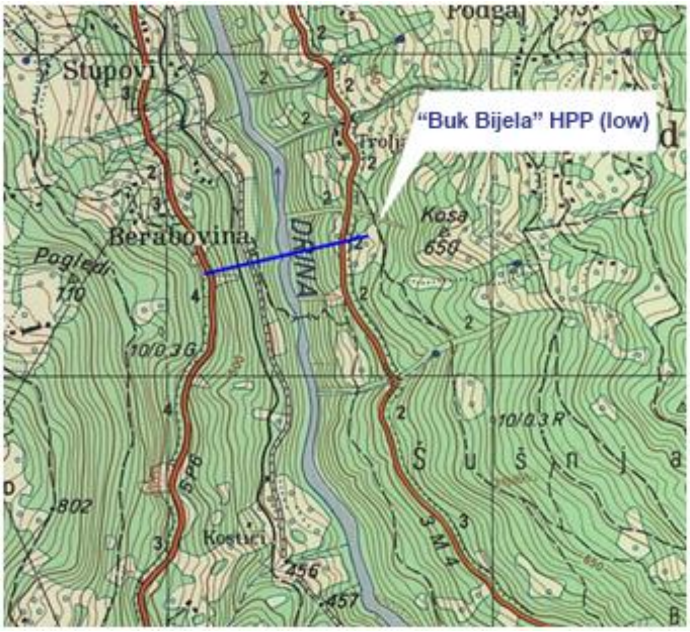


Figure 8-12: Wide location area

Figure 8-13: Narrow location area

Figure 8-14: Satellite image of HPP location

Profile hydrological properties

Basic profile hydrological properties (as given in the original technical documentation) are:

- Basin surface area: 4,158.3 km^2,
- Mean discharge: 162.37 m^3/s,
- Ecological flow: 24.4 m^3/s (minimum mean monthly discharge with 95% availability),
- Flood discharge referent for design of spillways: 3,790 m^3/s ($Q_{0.1}$, one gate closed).

Dam properties

"Buk Bijela" dam height was chosen based upon the condition that the storage should not disturb the natural flow regime at the "Šćepan Polje" profile under the conditions of the mean multi-annual Tara River discharge (70 m^3/s) and under the conditions of the "Piva" HPP installed discharge (240 m^3/s).
Basic dam properties are:

- Dam type: concrete, gravity dam,
- Dam height: 36 m (maximum construction height 57.80 m),
- Total length along the crown: 197.3 m,
- Maximum dam width at the crown: 15.5 m,
- Storage evacuation structures: two gated spillways and one bottom outlet and
- Total evacuation capacity: 3,790 m^3/s.

Storage properties

Basic storage properties are:

- Regular water level: 434.0 m a.s.l.,
- Maximum water level: 434.0 m a.s.l.,
- Minimum operating water level: 420.5 m a.s.l.,
- Total volume: 15.7 million m^3,
- Active volume: 11 million m^3,
- Inactive volume: 4.7 million m^3,
- Ratio between active volume and mean annual inflow: 0.002,
- Total length: 11.5 km,
- Greatest width: approximately 135 m,
- Surface area: 123.3 ha and

- Highest depth: approximately 34 m.

Conduit properties
The plant belongs to the non-diversion type.

HPP/Powerhouse properties
Basic HPP/powerhouse properties are:

- Plant type: non-diversion,
- Unit type: Kaplan with vertical shaft,
- Number of units: 2 +1,
- Installed discharge: 2 x 150 + 50 = 350 m^3/s,
- Tailrace water level: 403 m a.s.l.,
- Gross head: 31.0 m,
- Rated net head: 29 m,
- Installed power (active): 2 x 40.1 + 13.3 = 93.5 MW,
- Installed power (apparent): 2 x 45 + 15 = 105 MVA,
- Mean annual electricity generation: 332.34 GWh and
- Connection voltage: 110 kV, 400 kV.

Computation results:
Computation results include:

- Adopted ecological flow: 24.40 m^3/s,
- Mean annual electricity generation: 375.33 GWh and
- Investment costs: 195.5 million Euros.

<u>**"Foča" ("low") HPP**</u>
Location of dam and HPP
"Foča" dam and HPP are planned at the Drina River, at the chainage km 324+678, approximately 10 km downstream of the planned "Buk Bijela" HPP and approximately 1.6 km upstream of the new bridge in town. The location belongs to the municipality of Foča and the nearest town is Foča.

Figure 8-15: Wide location area

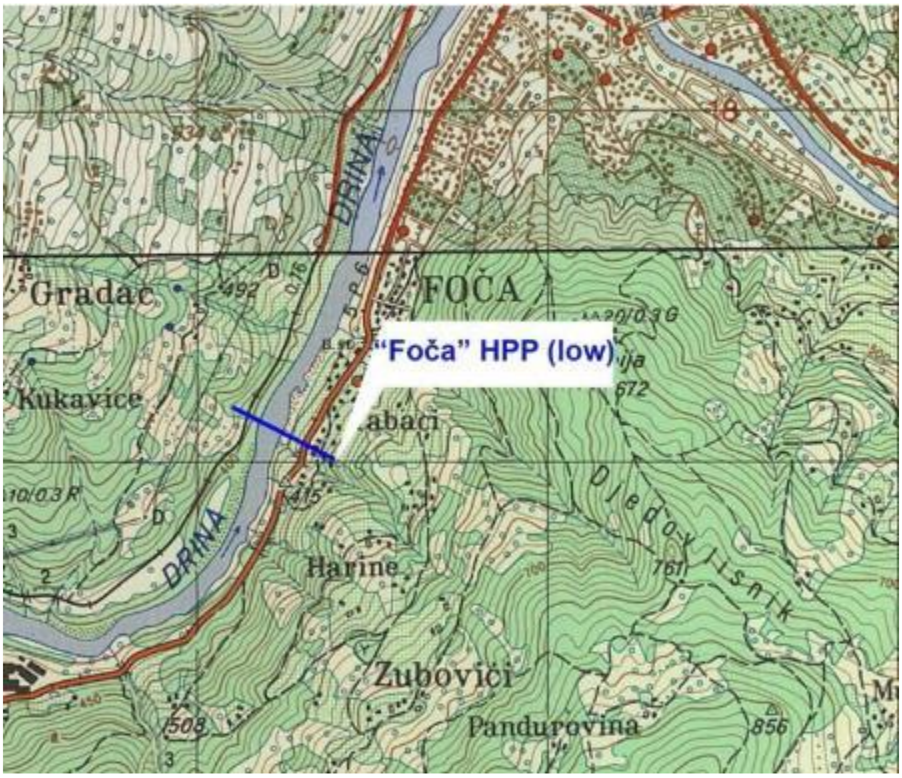


Figure 8-16: Narrow location area

Figure 8-17: Satellite image of HPP location

Profile hydrological properties

Basic profile hydrological properties (as given in the original technical documentation) are:

- Basin area: 4,691.8 km^2,
- Mean discharge: 178 m^3/s,
- Ecological flow: 26.7 m^3/s (minimum monthly discharge with 95% availability) and
- Flood discharge referent for design of spillways: 5,600 m^3/s ($Q_{0.1}$).

Dam properties
Basic dam properties are:

- Type: gravity, concrete,
- Height: 43.4 m (construction height), 21 m (above riverbed),
- Length along the crest: 208.4 m,
- Width at the crest: 13.1 m,
- Storage evacuation structures: gated spillway, 4 fields and
- Total evacuation capacity: 5,600 m^3/s.

Storage properties
Basic storage properties are:

- Regular water level: 403 m a.s.l.,
- Maximum water level: 404.2 m a.s.l.,
- Minimum operating water level: 396.0 m a.s.l.,
- Total volume: 6.7 million m^3,
- Active volume: 4.6 million m^3,
- Inactive volume: 2.1 million m^3,
- Ratio between active volume and mean annual inflow: 0.001,
- Length: 10 km,
- Width: approximately 170 m and
- Surface area: 0.905 km^2 (at the regular water level).

Conduit properties
The plant belongs to the non-diversion type.

HPP/Powerhouse properties
Basic HPP/powerhouse properties are:

- Plant type: non-diversion,
- Unit type: 2 x bulb + 1 x "S"-type,
- Number of units: 2 + 1,
- Installed discharge: 2 x 150 + 50 = 350 m^3/s,
- Tailrace water level: 387.8 m (larger units), 388.9 m (smaller unit),
- Gross head: 15.2 m (larger units), 16.2 (smaller unit),
- Head loss: 1.5 m (larger units), 2.5 m (smaller unit),
- Net head: 13.7 m,
- Installed power (active): 2 x 19.3 + 1 x 6.2 = 44.15 MW,
- Installed power (apparent): 50 MVA,
- Mean annual electricity generation: 175.87 GWh and
- Connection voltage level: 110 kV.

Computation results:
Computation results include:

- Adopted ecological flow: 27 m^3/s,
- Mean annual electricity generation: 199.24 GWh and
- Investment costs: 119.09 million Euro.

"Paunci" HPP

Location of dam and HPP

"Paunci" dam and HPP are planned in the upper part of the Drina River course, at the chainage km 314+665, between the planned upstream "Foča" HPP and the planned downstream "Ustikolina" HPP. The location belongs to the municipality of Paunci and the nearest town is Foča.

By construction of the "Paunci" HPP will be created a storage that reaches up to the mouth of the Ćehotina River into the Drina River, i.e. up to the town of Foča.

Figure 8-18: Wide location area

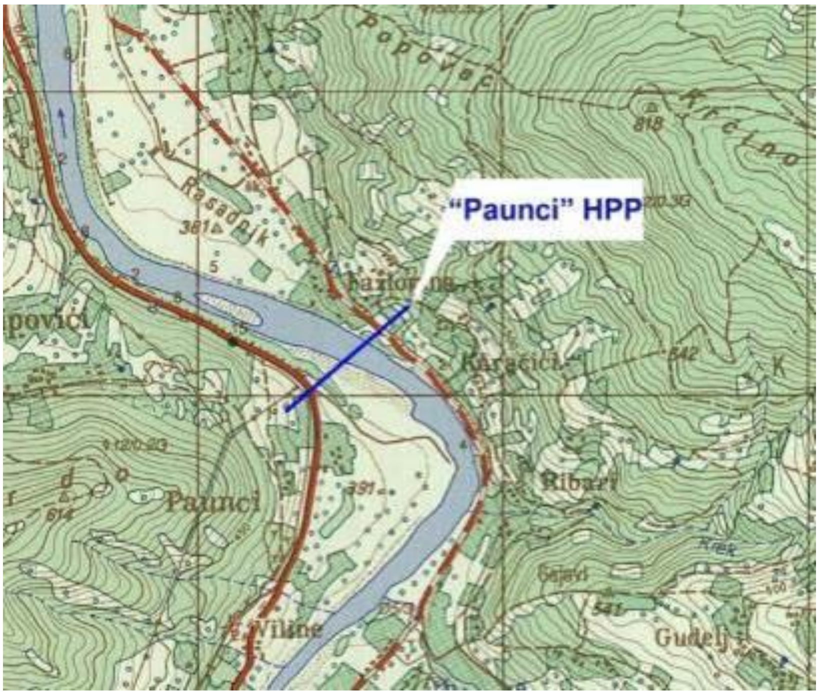


Figure 8-19: Narrow location area

Figure 8-20: Satellite image of HPP location

Profile hydrological properties

Basic profile hydrological properties (as given in the original technical documentation) are:

- Mean discharge: 201.43 m^3/s,
- Ecological flow: 30.5 m^3/s ($Q_{95\%}$) and
- Flood discharge referent for design of spillways: 8,716 m^3/s ($Q_{0.1}$, 95% confidence interval).

Dam properties
Basic dam properties are:

- Type: concrete, gravity,
- Crest elevation: 387 m.a.s.l.,
- Height: 35.7 m (construction height),
- Total length along the crest: 290 m (approximate),
- Width at the crest: 8.00 m,
- Storage evacuation structures: gated spillway and
- Total evacuation capacity: 8,716 m^3/s.

Storage properties
Basic storage properties are:

- Regular water level: 384 m a.s.l.,
- Maximum water level: 386 m a.s.l.,
- Minimum operating water level: 381.5 m a.s.l.,
- Total volume: 5.00 million m^3,
- Active volume: 2.50 million m^3,
- Inactive volume: 2.50 million m^3 and
- Total length: approximately 7.98 km.

Conduit properties
The plant belongs to the non-diversion type.

HPP/Powerhouse properties
Basic HPP/powerhouse properties are:

- Plant type: non-diversion, run-off-river,
- Unit type: bulb,
- Number of units: 3,
- Installed discharge: 2 x 200 + 50 = 450 m^3/s,
- Tailrace water level: 372.50 m.a.s.l.,
- Gross head: 11.50 m,
- Net head: 10.7 m,
- Installed power: 43.21 MW and
- Mean annual electricity generation: 166.90 GWh.

The smallest unit is intended to run on ecological flow.

Computation results:
Computation results include:

- Adopted ecological flow: 30.20 m^3/s,
- Mean annual electricity generation: 169.40 GWh and
- Investment costs: 125.54 million Euros.

"Ustikolina" HPP

Location of dam and HPP
"Ustikolina" dam and HPP are planned at the Drina River, at the chainage km 305+285, 14 km away from the town of Goražde and 16 km away from the town of Foča. The location belongs to the municipality of Ustikolina and nearest town is Foča.

Figure 8-21: Wide location area

Figure 8-22: Narrow location area

Figure 8-23: Satellite image of HPP location

Profile hydrological properties

Basic profile hydrological properties (as given in the original technical documentation) are:

- Basin area: 6,248 km^2,
- Mean discharge: 204.70 m^3/s,
- Ecological flow: 33.00 m^3/s and
- Flood discharge referent for design of spillways: 5,204 m^3/s ($Q_{0.1}$).

Dam properties
Basic dam properties are:

- Type: gravity, concrete,
- Crest elevation: 375.50 m a.s.l.,
- Height: 38.50 m (construction height, 19.00 m above the natural terrain),
- Length along the crest: 207.50 m,
- Width at the crest: 15.00 m,
- Storage evacuation structures: gated spillway, 5 fields and
- Total evacuation capacity: 5,308 m^3/s.

Storage properties
Basic storage properties are:

- Regular water level: 373 m a.s.l.,
- Maximum water level: 373 m a.s.l.,
- Minimum operating water level: 371 m a.s.l.,
- Total volume: 8.23 million m^3,
- Active volume: 2.51 million m^3,
- Length: 9.35 km,
- Mean width: 152.7 m (at the regular water level) and
- Surface area: 1.414 km^2.

Conduit properties
The plant belongs to the non-diversion type.

HPP/Powerhouse properties
Basic HPP/powerhouse properties are:

- Plant type: non-diversion, run-off-river,
- Unit type: bulb,
- Number of units: 3,
- Installed discharge: 3 x 150 = 450 m^3/s,
- Tailrace water level: 358.28 m a.s.l. (for installed discharge),
- Gross head: 14.72 m (calculation), ranges between 9.82 and 17.166 m,
- Head loss: 0.22 m,
- Net head: 14.50 m (design head),
- Installed power: 60.48 MW (active) (note: total unit efficiency seems to be rather high),
- Installed power (apparent): 3 x 23 = 69 MVA,
- Mean annual electricity generation: 236.8 GWh and
- Connection voltage level: 110 kV.

Computation results:
Computation results include:

- Adopted ecological flow: variable (please refer to comment below),
- Mean annual electricity generation: 235.29 GWh,
- Investment costs: 109 million Euro,

Comment
According to the new Rulebook, ecological flow should amount to 38,0 m^3/s for the "dry period" and 57.0 m^3/s for the "wet" period (EPBiH).

"Goražde" HPP

Location of dam and HPP

"Goražde" dam and HPP are planned downstream of the future "Ustikolina" HPP (it is necessary to match former HPP properties to the latter HPP tailrace water level).

The location belongs to the municipality of Potrkuša and the nearest town is Goražde.

Figure 8-24: Wide location area

Figure 8-25: Narrow location area

Figure 8-26: Satellite image of HPP location

Profile hydrological properties:
Basic profile hydrological properties (as given in the original technical documentation) are:

- Mean discharge: 212 m^3/s,
- Flood discharge referent for design of spillways: 3,822 m^3/s.

Dam properties
Basic dam properties are:

- Height: 44.0 m (construction height),
- Width at the crest: 8.5 m,
- Storage evacuation structures: gated spillway (radial gates), 5 fields and
- Total evacuation capacity: 3,850 m^3/s.

Storage properties
Basic storage properties are:

- Regular water level: 357.00 m a.s.l.,
- Maximum water level: 357.00 m a.s.l.,
- Minimum operating water level: 351.30 m a.s.l.,
- Total volume: 3.16 million m^3,
- Active volume: 2.96 million m^3 and
- Surface area: 83.15 thousand m^2.

Conduit properties
The plant belongs to the non-diversion type.

HPP/Powerhouse properties
Basic HPP/powerhouse properties are:

- Plant type: run-off-river, non-diversion,
- Unit type: bulb with horizontal shaft,
- Number of units: 3,
- Installed discharge: 3 x 150 = 450 m^3/s,
- Tailrace water level: 347 m a.s.l.,
- Gross head: 10 m,
- Net head: 9.8 m,
- Installed power: 37 MW and
- Mean annual electricity generation: 169.9 GWh.

Computation results:
Computation results include:

- Adopted ecological flow: 33 m^3/s,
- Mean annual electricity generation: 147 GWh and
- Investment costs: 119 million Euros.

"Rogačica" HPP
Location of dam and HPP
"Rogačica" dam and HPP are planned at the middle part of the Drina River course, at the chainage km 173+250. The location belongs to the municipality of Rogačica; the nearest town is Bajina Bašta.

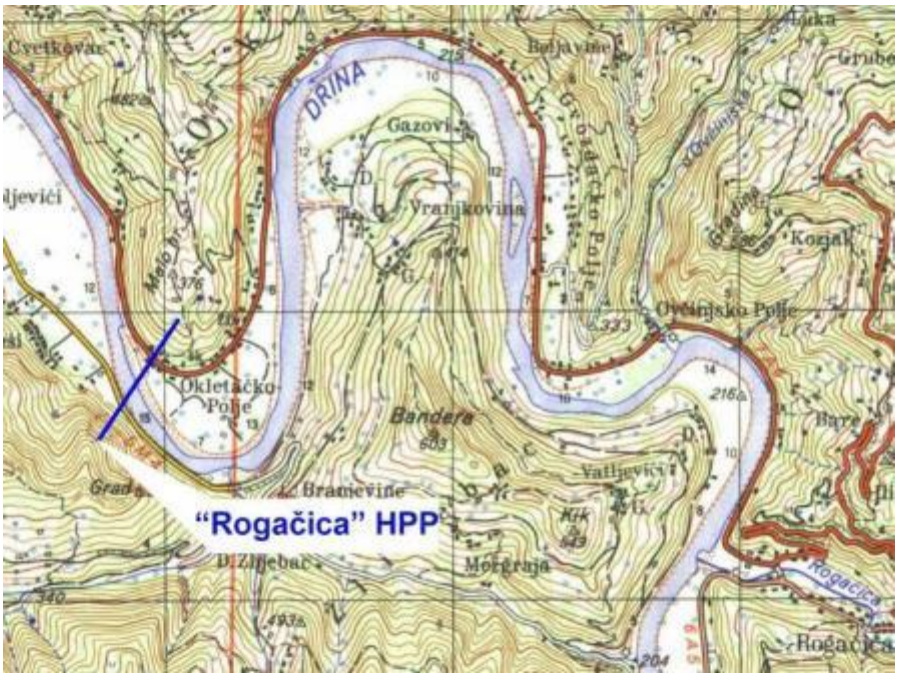


Figure 8-27: Wide location area

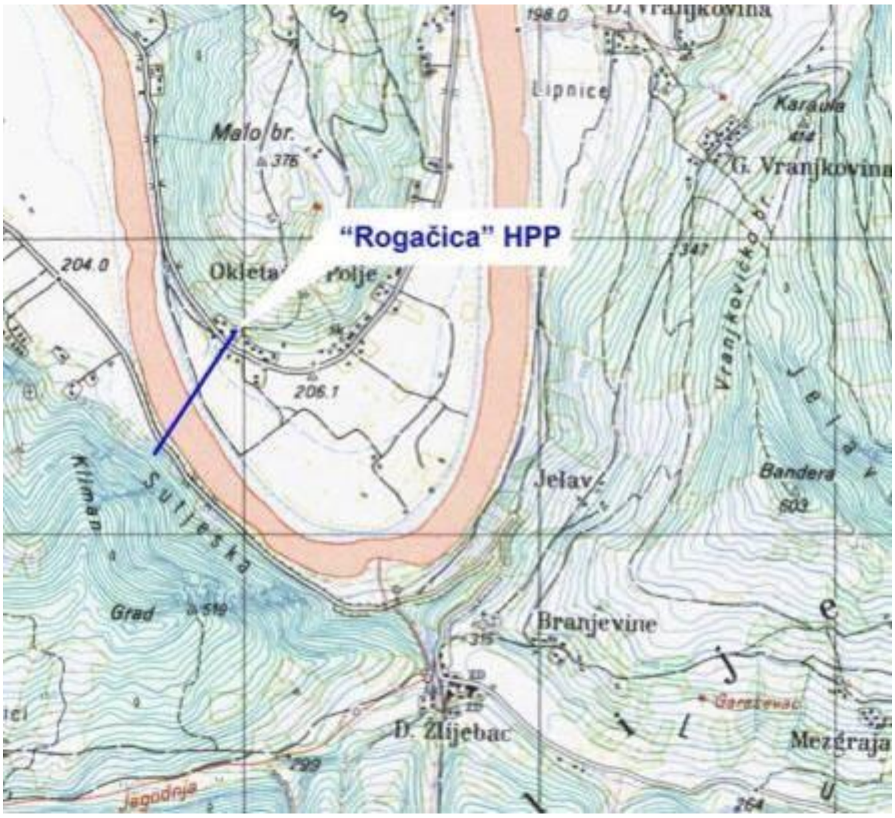


Figure 8-28: Narrow location area

Figure 8-29: Satellite image of HPP location

Profile hydrological properties

Basic profile hydrological properties (as given in the original technical documentation) are:

- Basin area: 15,159 km^2,
- Mean discharge: 330.2 m^3/s,
- Ecological flow: 60.5 m^3/s and

- Flood discharge referent for design of spillways: 7,175.1 m^3/s ($Q_{0.1}$).

Dam properties
Basic dam properties are:
- Type: gravity, concrete,
- Crest elevation: 223.0 m.a.s.l.,
- Height: 42 m (construction height),
- Length along the crest: 401 m (concrete part),
- Storage evacuation structures: gated spillways, 8 fields and
- Total evacuation capacity: 9,307 m^3/s (8 fields), 7,829 m^3/s (7 fields).

Storage properties
Basic storage properties are:

- Regular water level: 220.0 m.a.s.l.,
- Maximum water level: 220.0 m.a.s.l.,
- Minimum operating water level: 218.0 m.a.s.l.,
- Total volume: not determined, negligible,
- Active volume: not determined, negligible and
- Surface area: 5.82 km^2.

Conduit properties
The plant belongs to the non-diversion type.

HPP/Powerhouse properties
Basic HPP/powerhouse properties are:

- Plant type: non-diversion,
- Unit type: axial (bulb), double-regulation,
- Number of units: 4,
- Installed discharge: 4 x 200 = 800 m^3/s,
- Minimum unit discharge: 50 m^3/s (each unit can discharge ecological flow),
- Tailrace water level: 203.52 m.a.s.l. (at the installed discharge with 1.25 m dredging),
- Gross head: 16.48 m,
- Head loss: 0.4 m,
- Net head: 16.08 m,
- Installed power (active): 4 x 28.30 = 113.20 MW,
- Installed power (apparent): 4 x 33.00 = 132.00 MVA,
- Mean annual electricity generation: 413.42 GWh and
- Connection voltage level: 110 kV.

The installed discharge was adopted primarily in the view of the installed discharge of the upstream "Bajina Bašta" HPP with rehabilitated units and the possible addition of a fifth unit, as well as the installed discharge of the downstream "Zvornik" HPP after the planned rehabilitation (replacement) of units and streamlining with a power increase.

Computation results
Computation results include:

- Adopted ecological flow: 60.5 m^3/s,
- Mean annual electricity generation: 420.00 GWh and
- Investment costs: 243.26 million Euros.

"Tegare" HPP

Location of dam and HPP

"Tegare" dam and HPP are planned at the middle part of the Drina River course, at the chainage km 148+750. The location belongs to the municipality of Tegare; the nearest town is Ljubovija.

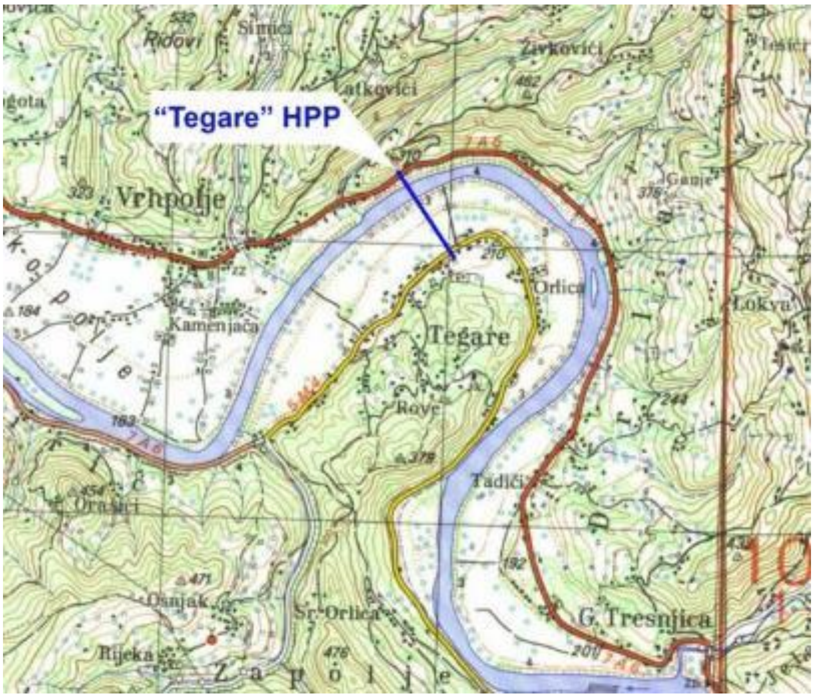


Figure 8-30: Wide location area

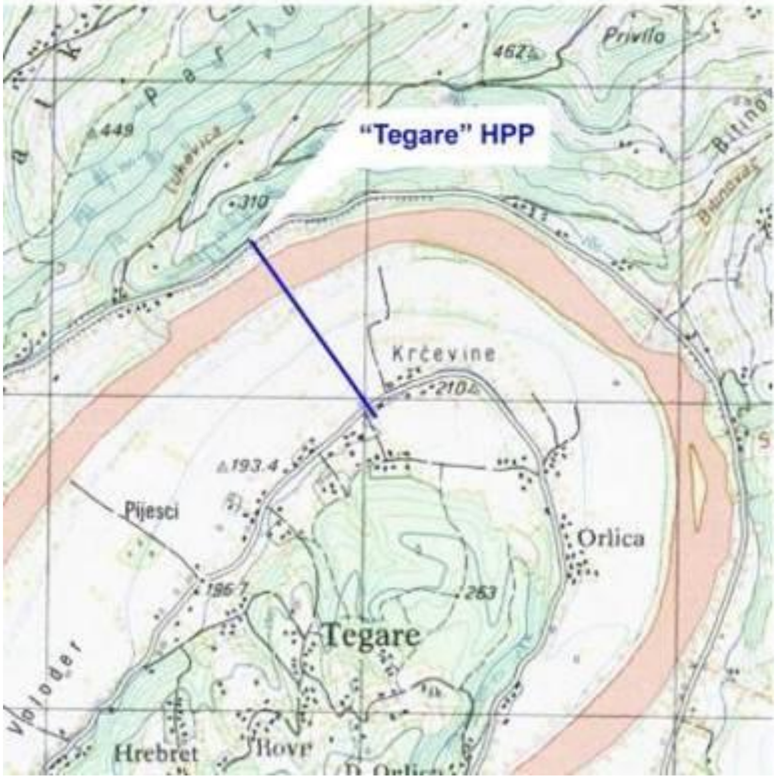


Figure 8-31: Narrow location area

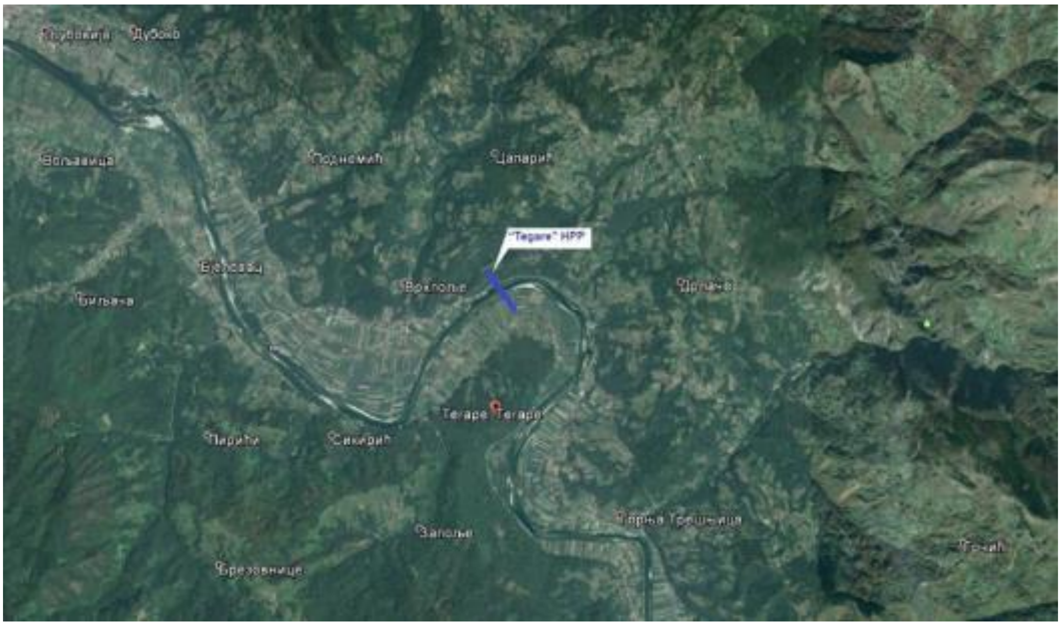


Figure 8-32: Satellite image of HPP location

Profile hydrological properties

Basic profile hydrological properties (as given in the original technical documentation) are:

- Basin area: 15,437 km^2,
- Mean discharge: 333.5 m^3/s,
- Ecological flow: 61.6 m^3/s and
- Flood discharge referent for design of spillways: 7,192.2 m^3/s ($Q_{0.1}$).

Dam properties

Basic dam properties are:

- Type: gravity, concrete,
- Crest elevation: 203.0 m a.s.l.,
- Height: 44.3 m (construction height),
- Length along the crest: 649.0 m (concrete part),
- Storage evacuation structures: gated spillways, 8 fields and
- Total evacuation capacity: 8.413 m^3/s (8 fields), 7,292 m^3/s (7 fields).

Storage properties

Basic storage properties are:

- Regular water level: 200.0 m a.s.l.,
- Maximum water level: 200.0 m a.s.l.,
- Minimum operating water level: 198.0 m a.s.l.,
- Total volume: not determined, negligible,
- Active volume: not determined, negligible and
- Surface area: 12.21 km^2.

Conduit properties

The plant belongs to the non-diversion type.

HPP/Powerhouse properties

Basic HPP/powerhouse properties are:

- Plant type: non-diversion,
- Unit type: axial (bulb), double-regulation,
- Number of units: 4,
- Installed discharge: 4 x 200 = 800 m^3/s,
- Minimum unit discharge: 50 m^3/s (each unit can discharge ecological flow),
- Tailrace water level: 182.20 m.a.s.l. (1 m dredging),
- Gross head: 17.80 m,
- Head loss: 0.4 m,
- Net head: 17.40 m,
- Installed power (active): 4 x 30.22 = 120.88 MW,
- Installed power (apparent): 4 x 36 = 144 MVA,
- Mean annual electricity generation: 448.05 GWh and
- Connection voltage level: 110 kV.

Installed discharge was adopted primarily in the view of the installed discharge of the upstream "Bajina Bašta" HPP with rehabilitated units and eventual additional fifth unit, as well as the installed discharge of the downstream "Zvornik" HPP after the planned rehabilitation (replacement) of units and streamlining with a power increase.

Computation results

Computation results include:

- Adopted ecological flow: 61.6 m^3/s,
- Mean annual electricity generation: 452.05 GWh and
- Investment costs: 281.94 million Euros.

<u>"Dubravica" HPP</u>

Location of dam and HPP

"Dubravica" dam and HPP are planned at the middle part of the Drina River course, at the chainage km 118+700. The location belongs to the municipality of Dubravica; the nearest town is Ljubovija.

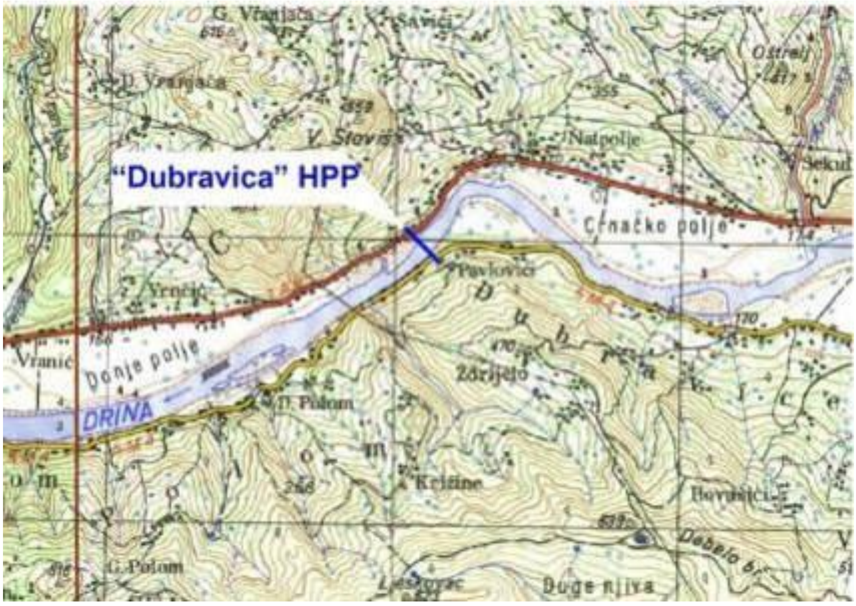


Figure 8-33: Wide location area

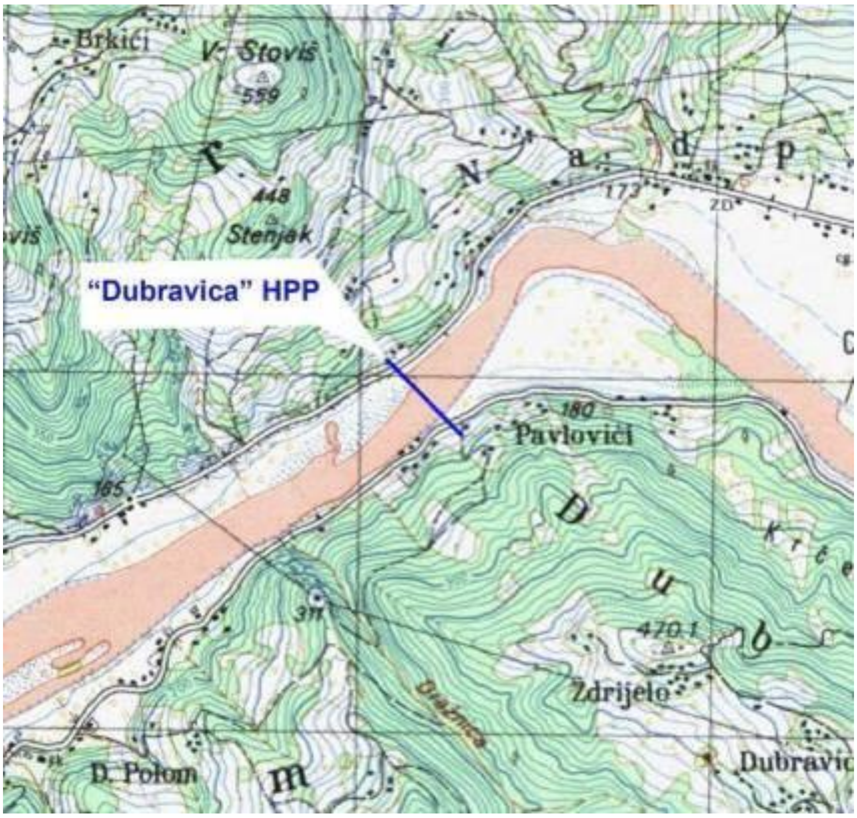


Figure 8-34: Narrow location area

Figure 8-35: Satellite image of HPP location

Profile hydrological properties

Basic profile hydrological properties (as given in the original technical documentation) are:

- Basin area: 15,997 km^2,
- Mean discharge: 340.4 m^3/s,
- Ecological flow: 63.8 m^3/s and
- Flood discharge referent for design of spillways: 7,223.1 m^3/s ($Q_{0.1}$).

Dam properties
Basic dam properties are:

- Type: gravity, concrete,
- Crest elevation: 178.0 m a.s.l.,
- Height: 39 m (construction height),
- Length along the crest: 348 m (concrete part),
- Storage evacuation structures: gated spillways, 8 fields and
- Total evacuation capacity: 9,459 m^3/s (8 fields), 7,865 m^3/s (7 fields).

Storage properties
Basic storage properties are:

- Regular water level: 175.0 m a.s.l.,
- Maximum water level: 175.0 m a.s.l.,
- Minimum operating water level: 173.0 m a.s.l.,
- Total volume: not determined, negligible,
- Active volume: not determined, negligible and
- Surface area: 19.23 km^2.

Conduit properties
The plant belongs to the non-diversion type.

HPP/Powerhouse properties
Basic HPP/powerhouse properties are:

- Plant type: non-diversion,
- Unit type: axial (bulb), double-regulation,
- Number of units: 4,
- Installed discharge: 4 x 200 = 800 m^3/s,
- Minimum unit discharge: 50 m^3/s (each unit can discharge ecological flow),
- Tailrace water level: 162.09 m (at installed discharge),
- Gross head: 12.91 m,
- Head loss: 0.4 m,
- Net head: 12.51 m,
- Installed power (active): 4 x 21.80 = 87.20 MW,
- Installed power (apparent): 4 x 26 = 104 MVA,
- Mean annual electricity generation: 335.48 GWh and
- Connection voltage level: 110 kV.

Installed discharge was adopted primarily in the view of the installed discharge of the upstream "Bajina Bašta" HPP with rehabilitated units and eventual additional fifth unit, as well as the installed discharge of the downstream "Zvornik" HPP after the planned rehabilitation (replacement) of units and streamlining with a power increase.

Computation results
Computation results include:

- Adopted ecological flow: 63.8 m^3/s,
- Mean annual electricity generation: 332.70 GWh and
- Investment costs: 344.93 million Euros.

<u>"Kozluk" HPP</u>

Location of dam and HPP

"Kozluk" dam and HPP are planned at the chainage km 60+200, in the vicinity of the Kozluk settlement. The location belongs to the municipality of Kozluk and the nearest town is Banja Koviljača.

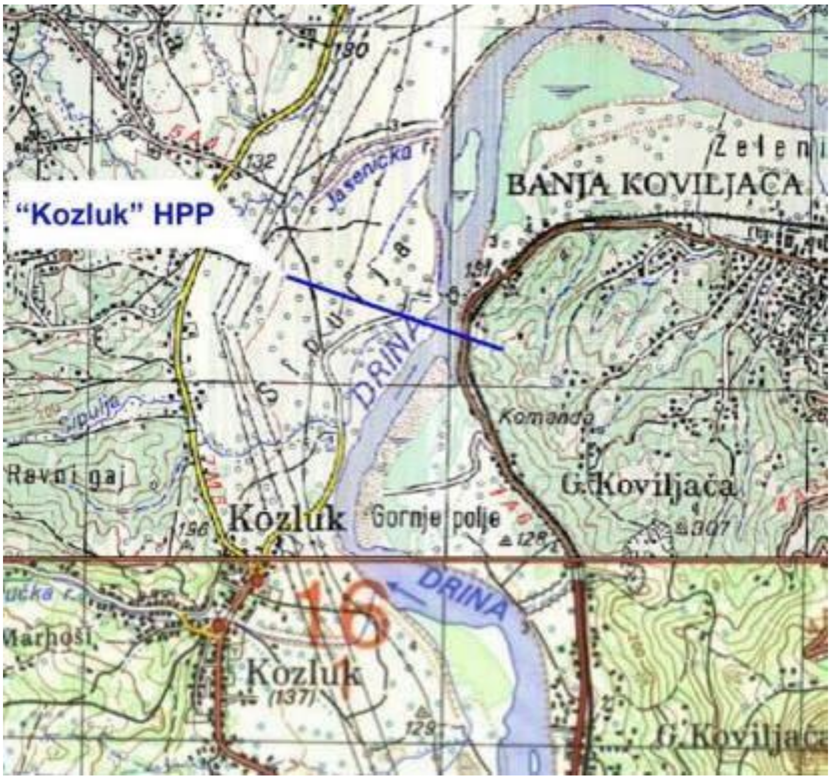


Figure 8-36: Wide location area

Figure 8-37: Narrow location area

Figure 8-38: Satellite image of HPP location

Profile hydrological properties
Basic profile hydrological properties (as given in the original technical documentation) are:

- Mean discharge: 369.9 m^3/s (for the "Zvornik" HPP profile),
- Ecological flow:71 m^3/s (for the "Zvornik" HPP profile) and
- Flood discharge referent for design of spillways: 13,090 m^3/s ($Q_{0.1}$).

Dam properties
Basic dam properties are:

- Type: gravity, concrete,
- Crest elevation: 137.50 m a.s.l.,
- Height: 31.7 m (construction height),
- Length along the crest: 309.2 m (approximate),
- Storage evacuation structures: gated spillway, 12 bays and
- Total evacuation capacity: 13,090 m^3/s.

Storage properties
Basic storage properties are:

- Regular water level: 135.0 m a.s.l.,
- Maximum water level: 135.0 m a.s.l.,
- Minimum operating water level: 129.5 m a.s.l.,
- Total volume: 70 million m^3,
- Length: 19.1 km and
- Surface area: 7.2 km^2.

Conduit properties
The plant belongs to the non-diversion type.

HPP/Powerhouse properties
Basic HPP/powerhouse properties are:

- Plant type: non-diversion,
- Unit type: Kaplan
- Number of units: 4,
- Installed discharge: 800 m^3/s,
- Tailrace water level: 121.00 m a.s.l.,
- Gross head: 14.0 m (operating head),
- Head loss: 0.4 m,
- Net head: 12.9 m,
- Installed power: 88.5 MW and
- Mean annual electricity generation: 376.0 GWh.

Present "Zvornik" HPP installed discharge amounts to 600 m^3/s, but it planned to be increased to 800 m^3/s, in order to align this part of the HPP cascade regarding discharges. Installed discharge of the "Bajina Bašta" HPP can be modified during the rehabilitation process and by installation of the fifth unit.

Computation results

Computation results include:

- Adopted ecological flow: 71.0 m^3/s,
- Mean annual electricity generation: 394.69 GWh and
- Investment costs: 306.04 million Euros.

<u>"Drina I" HPP</u>

Location of dam and HPP

"Drina I" dam and HPP are planned on the Drina River, at the chainage km 43+600, in the vicinity of the Kozjak settlement. The location belongs to the municipality of Kozjak; the nearest town is Loznica.

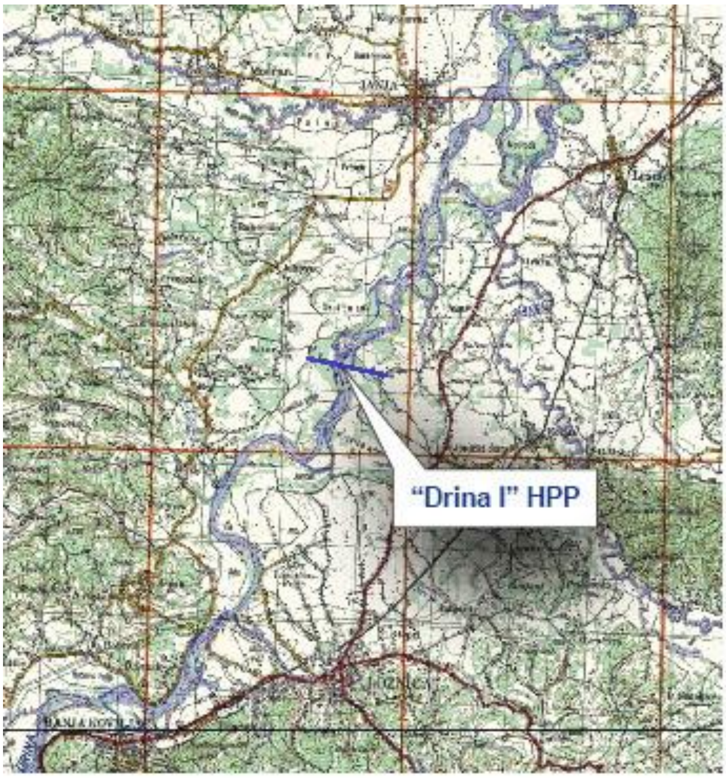


Figure 8-39: Wide location area

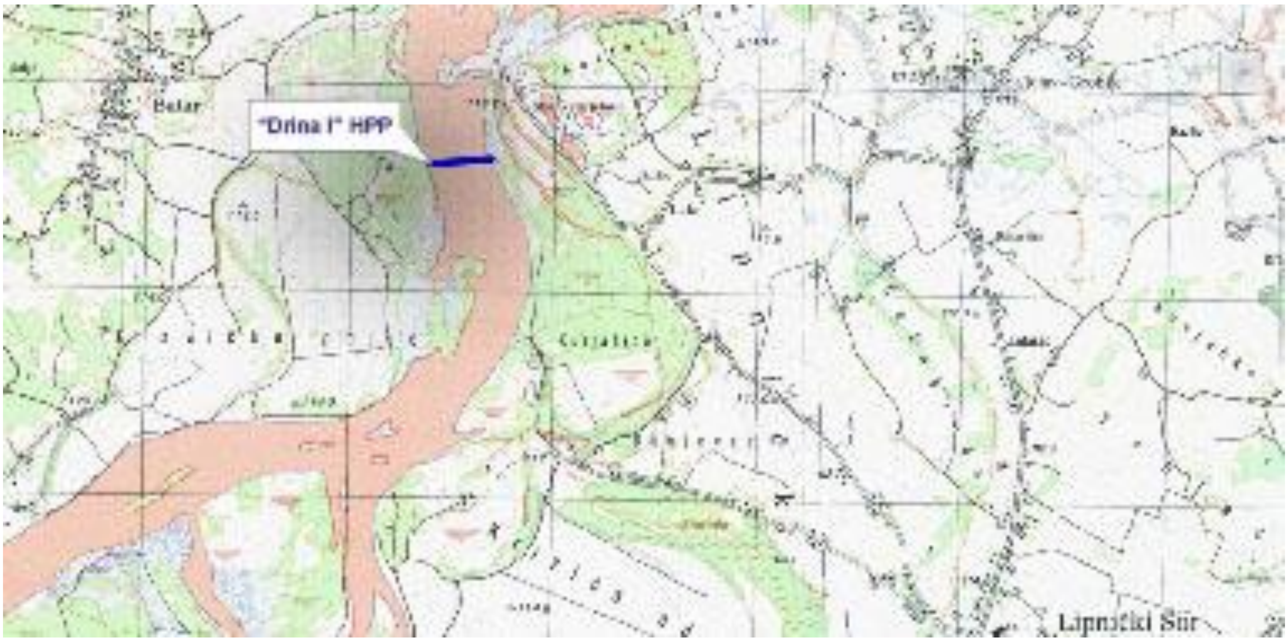


Figure 8-40: Narrow location area

Figure 8-41: Satellite image of HPP location

Profile hydrological properties
Basic profile hydrological properties (as given in the original technical documentation) are:

- Mean discharge: 372.5 m^3/s (for the "Zvornik" HPP profile) and
- Ecological flow: 71 m^3/s (for the "Zvornik" HPP profile, minimum monthly discharge with 95% availability).

Dam properties
Basic dam properties are:

- Type: gravity, concrete,
- Crest elevation: 123.5 m a.s.l.,
- Height: 34.0 m (construction height),
- Length along the crest: 221.7 m (approximate),
- Storage evacuation structures: gated spillways, 8 bays and
- Total evacuation capacity: 7,000 m^3/s.

Storage properties
Basic storage properties are:

- Regular water level: 121 m a.s.l.,
- Maximum water level: 121 m a.s.l.,
- Total volume: 85 million m^3,
- Length: 16.6 km and
- Surface area: 14.2 km^2.

Conduit properties
The plant belongs to the non-diversion type.

HPP/Powerhouse properties
Basic HPP/powerhouse properties are:

- Plant type: non-diversion,
- Unit type: Kaplan
- Number of units: 4,
- Installed discharge: 800 m^3/s,
- Tailrace water level: 108.0 m,
- Gross head: 13 m (operating head),
- Head loss: 0.2 m,
- Net head: 12.8 m,
- Installed power: 87.70 MW and
- Mean annual electricity generation: 363.7 GWh

The present "Zvornik" HPP installed discharge amounts to 600 m^3/s, but it is planned to be increased to 800 m^3/s, in order to align this part of the HPP cascade regarding discharges. The installed discharge of the "Bajina Bašta" HPP can be modified during the rehabilitation process and the installation of the fifth unit.

Computation results
Computation results include:

- Adopted ecological flow: 71.0 m^3/s,
- Mean annual electricity generation: 349.95 GWh and
- Investment costs: 289.79 million Euros.

"Drina II" HPP

Location of dam and HPP

The "Drina II" dam and HPP are planned on the Drina River, at the chainage km 28+200, in the vicinity of the Novo Selo settlement. The location belongs to the municipality of Novo Selo; the nearest town is Bijeljina.

Figure 8-42: Wide location area

Figure 8-43: Narrow location area

Figure 8-44: Satellite image of HPP location

Profile hydrological properties
Basic profile hydrological properties (as given in the original technical documentation) are:

- Mean discharge: 384.60 m^3/s (for "Zvornik" profile) and
- Ecological flow: 71 m^3/s (for "Zvornik" profile, minimum monthly discharge with 95% availability).

Dam properties
Basic dam properties are:

- Type: gravity, concrete,
- Crest elevation: 110.5 m a.s.l.,
- Height: 34.0 m (construction height),
- Length along the crest: 237.5 m (approximate),
- Storage evacuation structures: gated spillways, 8 bays and
- Total evacuation capacity: 7,000 m^3/s.

Storage properties
Basic storage properties are:

- Regular water level: 108 m a.s.l.,
- Maximum water level: 108 m a.s.l.,
- Total volume: 120 mil m^3
- Length: 15.4 km and
- Surface area: 22.8 km^2.

Conduit properties
The plant belongs to the non-diversion type.

HPP/Powerhouse properties
Basic HPP/powerhouse properties are:

- Plant type: non-diversion,
- Unit type: Kaplan

- Number of units: 4,
- Installed discharge: 800 m^3/s,
- Tailrace water level: 95.0 m,
- Gross head: 13.0 m (operating head),
- Net head: 12.96 m,
- Installed power: 87,8 MW and
- Mean annual electricity generation: 342.7 GWh.

The present "Zvornik" HPP installed discharge amounts to 600 m^3/s, but it planned to be increased to 800 m^3/s, in order to align this part of the HPP cascade regarding discharges. The installed discharge of the "Bajina Bašta" HPP can be modified during the rehabilitation process and the installation of the fifth unit.

Computation results
Computation results include:

- Adopted ecological flow: 71.0 m^3/s,
- Mean annual electricity generation: 369.51 GWh and
- Investment costs: 332.04 million Euros.

"Drina III" HPP

Location of dam and HPP

The "Drina III" dam and plant are planned on the Drina River, at the chainage km 8+600, in the vicinity of the Salaš Crnoborski settlement. The location belongs to the municipality of Salaš Crnobarski; the nearest town is Bijeljina.

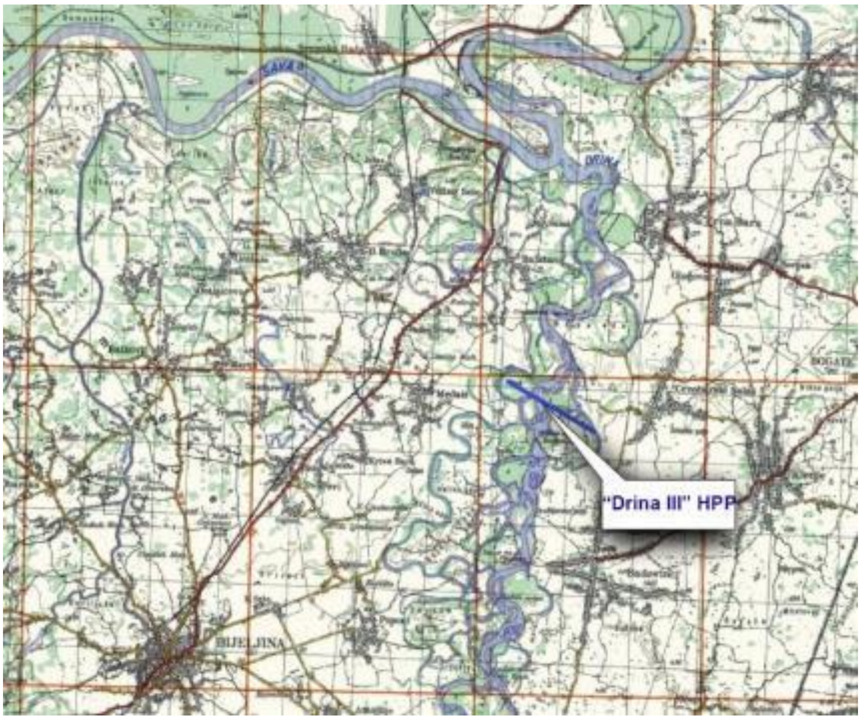


Figure 8-45: Wide location area

Figure 8-46: Narrow location area

Figure 8-47: Satellite image of HPP location

Profile hydrological properties
Basic profile hydrological properties (as given in the original technical documentation) are:

- Mean discharge: 385.10 m^3/s (for the "Zvornik" HPP profile) and
- Ecological flow: 71 m^3/s (for the "Zvornik" HPP profile", minimum monthly discharge with 95% availability).

Dam properties
Basic dam properties are:

- Type: gravity, concrete,

- Crest elevation: 97.5 m a.s.l.,
- Height: 31.0 m (construction height),
- Length along the crest: 237.2 m (approximate),
- Storage evacuation structures: gated spillways, 8 bays and
- Total evacuation capacity: 7,000 m^3/s.

Storage properties
Basic storage properties are:

- Regular water level: 95 m a.s.l.,
- Maximum water level: 95 m a.s.l.,
- Total volume 160 million m^3,
- Length: 19.6 km and
- Surface area: 42.7 km^2.

Conduit properties
The plant belongs to the non-diversion type.

HPP/Powerhouse properties
Basic HPP/powerhouse properties are:

- Plant type: non-diversion,
- Unit type: bulb with horizontal shaft,
- Number of units: 4,
- Installed discharge: 800 m^3/s,
- Tailrace water level: 79.60 m,
- Gross head: 15.40 m,
- Net head: 17.76 m,
- Installed power: 101 MW and
- Mean annual electricity generation: 469.10 GWh.

The present "Zvornik" HPP installed discharge amounts to 600 m^3/s, but it planned to be increased to 800 m^3/s, in order to align this part of the HPP cascade regarding discharges. The installed discharge of the "Bajina Bašta" HPP can be modified during the rehabilitation process and the installation of the fifth unit.

Computation results
Computation results include:

- Adopted ecological flow: 71.0 m^3/s,
- Mean annual electricity generation: 417.12 GWh and
- Investment costs: 431.23 million Euros.

8.7.3 Analyzed HPPs along Sutjeska River

The Sutjeska River flows into the Drina River near the village of Kosmano (in the municipality of Foča), at the elevation of 437 m a.s.l.

The use of its hydropower potential would be impossible in case of construction of the "Buk Bijela" ("high") HPP with the regular water level of 500 m a.s.l. However, the reduction of this water level in the case of the "Buk Bijela" ("low") HPP would make it possible, with the "Buk Bijela" storage being the tailrace for the plant built on the Sutjeska River.

Existing technical documentation envisages the following HPP on the Sutjeska River:

- "Sutjeska" HPP (Republic of Srpska).

This technical solution is presented below.

"Sutjeska" HPP

Location of dam and HPP
"Sutjeska" dam is planned at the "Jelovački Krš" profile". The location belongs to the municipality of Igoče and the nearest town is Foča. "Sutjeska" HPP is actually a system composed of two HPPs, a non-diversion and diversion one.

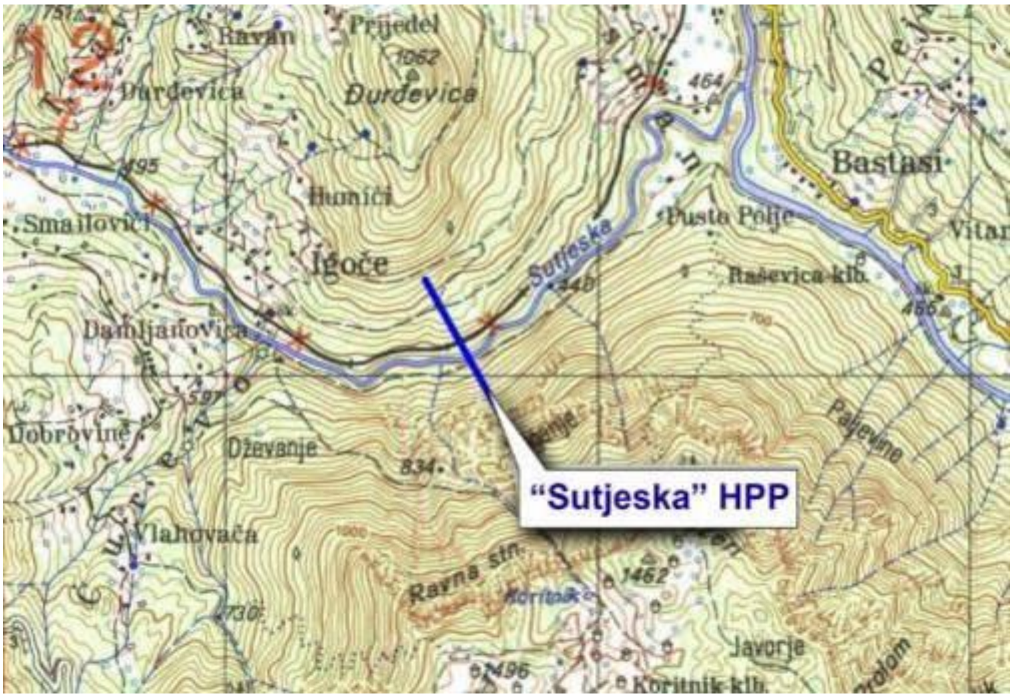


Figure 8-48: Wide location area

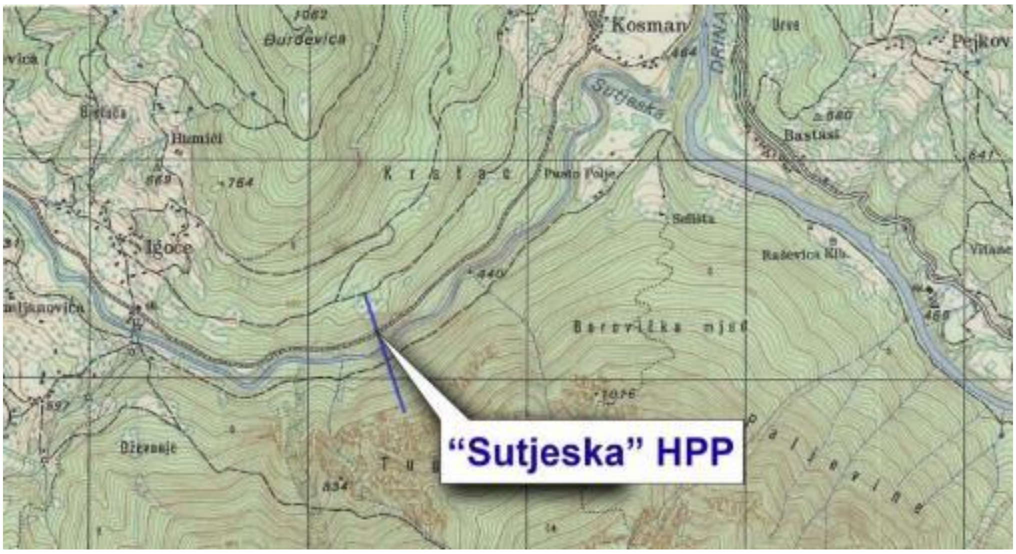


Figure 8-49: Narrow location area

Figure 8-50: Satellite image of HPP location

Profile hydrological properties
Basic profile hydrological properties (as given in the original technical documentation) are:

- Mean discharge: 14.5 m^3/s,
- Ecological flow: 2.07 m^3/s (minimum monthly flow with 95% availability) and
- Flood discharge referent for design of spillways: 668.89 m^3/s ($Q_{0.01}$).

Dam properties
Basic dam properties are:

- Type: rock fill with clay core,
- Crest elevation: 538 m a.s.l.,
- Width at the crest: 8 m,
- Storage evacuation structures: shaft spillway and bottom outlet and
- Total evacuation capacity: 668.89 m^3/s (spillway).

Storage properties
Basic storage properties are:

- Regular water level: 522 m a.s.l.,
- Maximum water level: 536 m a.s.l.,
- Minimum operating water level: 495 m a.s.l.,
- Total volume: 52.17 million m^3,
- Active volume: 45.26 million m^3 and
- Inactive volume: 6.91 million m^3.

Conduit properties
Basic properties of the common water conduits are:

- Tunnel length: 237 m and
- Tunnel diameter: 4.60 m.

Basic properties of the water conduits for the SHPP are:

- Penstock length: 360 m and
- Penstock diameter: 1.1 m.

Basic properties of the water conduits for the HPP are:

- Tunnel length: 1,452.0 m,
- Tunnel diameter: 4.60 m,
- Penstock length: 130.0 m and
- Penstock diameter: 3.60 m.

HPP/Powerhouse properties
Basic SHPP/powerhouse properties are:

- Plant type: diversion,
- Unit type: Francis with horizontal shaft,
- Number of units: 1,
- Installed discharge: 2 m^3/s (uses ecological flow),
- Tailrace water level: 445.93 m a.s.l.,
- Gross head: 83.6 m,
- Head loss: 1.12 m,
- Net head: 75.50 m (66.00 m nominal, for turbine selection),
- Installed power: 1.46 MW and
- Number of operating hours: 8.760.

Basic HPP/powerhouse properties are:

- Plant type: diversion, storage-type,
- Unit type: Francis with vertical shaft,
- Number of units: 2,
- Installed discharge: 2 x 25 = 50 m^3/s,
- Gross head: 100.6 m,
- Head loss: 9.60 m,
- Net head: 91.00 m,
- Installed power: 44 MW and
- Mean annual electricity generation: 95.62 GWh.

Computation results:
Computation results include:

- Adopted ecological flow: 2 m^3/s,
- Mean annual electricity generation: 9.63 + 61.81 = 71.44 GWh and
- Investment costs: 67 million Euros.

8.7.4 Analyzed HPPs along Lim River

Lim River flows through four countries, Montenegro, Albania (it then re-enters the Montenegro territory), Serbia and BiH (Republic of Srpska).
On the territory of BiH (Republic of Srpska) is located the lower part of the Lim River course. On this territory it flows into the Drina River, near the village of Međeđa. Along this part of its course there is only one planned HPP, the "Mrsovo" HPP that is practically in construction. Therefore, here will be presented the existing technical documentation for the following HPP on the Lim River in Republic of Srpska:

- "Mrsovo" HPP (Republic of Srpska).

This technical solution is presented below.

"Mrsovo" HPP

Location of dam and HPP

"Mrsovo" dam and HPP are planned at the Lim River at the chainage km 17+850, at approximately 9 km downstream of the bridge in the town of Rudo. Upstream of the HPP on the Lim River is located the existing "Potpeć" HPP, while downstream of it is located the existing "Višegrad" HPP (on the Drina River). The location belongs to the municipality of Mrsovo and the nearest town is Rudo.

Figure 8-51: Wide location area

Figure 8-52: Narrow location area

Figure 8-53: Satellite image of HPP location

Profile hydrological properties
Basic profile hydrological properties (as given in the original technical documentation) are:

- Basin area: 5,570 km^2,
- Mean discharge: 112.5 m^3/s,
- Ecological flow: 31.3 m^3/s (minimum monthly discharge with 95% availability) and
- Flood discharge referent for design of spillways: 2,574 m^3/s ($Q_{0.1}$).

Dam properties
Basic dam properties are:

- Type: concrete,
- Storage evacuation structures: gated spillway, 4 fields + bottom outlet and
- Total evacuation capacity: 2,574 m^3/s ($Q_{0.1}$) (spillway).

Storage properties
Basic storage properties are:

- Regular water level: 355 m a.s.l.,
- Maximum water level: 355 m a.s.l.,
- Minimum operating water level: 347 m a.s.l. and
- Active volume: 7.7 million m^3.

Conduit properties
The plant belongs to the non-diversion type.

HPP/Powerhouse properties
Basic HPP/powerhouse properties are:

- Plant type: non-diversion,
- Unit type: Kaplan,

- Number of units: 3,
- Installed discharge: 260 m^3/s,
- Tailrace water level: 338.2 m a.s.l. (for installed discharge),
- Gross head: 16.80 m,
- Head loss: 0.50 m (assumed),
- Net head: 16.30 (14.50 m nominal - used for turbine selection),
- Installed power (active): 36.80 MW,
- Installed power (apparent): 41.00 MVA,
- Mean annual electricity generation: 138 GWh and
- Connection voltage level: 110 kV.

Computation results
Computation results include:

- Adopted ecological flow: 31.3 m^3/s,
- Mean annual electricity generation: 141 GWh and
- Investment costs: 94 million Euros.

8.7.5 Analyzed HPPs along Ćehotina River

The Ćehotina River flows through north-western part of Montenegro and the eastern part of the Republic of Srpska (BiH) (it enters its territory near the town of Vikoč) and flows into the Drina River near the town of Foča.

On the BiH (Republic of Srpska) territory there is certain unused River Ćehotina hydropower potential between the boundary with Montenegro and the mouth into River Drina.

Existing technical documentation envisages the following HPP on the Ćehotina River in BiH:

- "Vikoč (Luke)" HPP
- "Falovići" HPP (dam is located on Ćehotina River while HPP is diversion type located on Drina River)

This technical solution is presented below.

"Vikoč (Luke)" HPP

Location of dam and HPP
"Vikoč" dam and HPP are located at the Ćehotina River, at the chainage km 21+500, in vicinity of the the settlement Luke, approximately 4 km far from the settlement Vikoč.

The location belongs to the municipality of Vikoč and the nearest town is Foča.

Figure 8-54: Wide location area

Figure 8-55: Narrow location area

Figure 8-56: Satellite image of HPP location

The present technical solution refers to the "Luke" variant. "Godijeno" variant was also developed.

Profile hydrological properties
Basic profile hydrological properties (as given in the original technical documentation) are:

- Mean discharge: 20.7 m^3/s,
- Ecological flow: 2.11 m^3/s and
- Flood discharge referent for design of spillways: 695 m^3/s.

Dam properties
Basic dam properties are:

- Type: arched (dome), concrete,
- Height: 103 m,
- Width at the crest: 3.0 m,
- Storage evacuation structures: spillway (lateral) and bottom outlet and
- Total evacuation capacity: 695 + 136 = 831 m^3/s.

Storage properties
Basic storage properties are:

- Regular water level: 574.0 m a.s.l.,
- Maximum water level: 576.3 m a.s.l.,
- Minimum operating water level: 540.0 m a.s.l.,
- Total volume: 146 million m^3,
- Active volume: 105 million m^3 and
- Surface area: 5.423 km^2 (at the water level of 580 m a.s.l.).

Conduit properties
The plant belongs to the non-diversion type.

HPP/Powerhouse properties
Basic HPP/powerhouse properties are:

- Plant type: non-diversion,
- Unit type: Francis,
- Number of units: 2,
- Installed discharge: 2 x 22.5 = 45 m^3/s,
- Tailrace water level: 487.2 m a.s.l. (assumed)
- Gross head: 86.8 m (assumed),
- Head loss: 0.4 m (assumed),
- Net head: 86.4 m (construction head),
- Installed power: 2 x 16.66 = 33.32 MW and
- Mean annual electricity generation: 129.8 GWh.

Computation results
Computation results include:

- Adopted ecological flow: 2.11 m^3/s,
- Mean annual electricity generation: 102.29 GWh and
- Investment costs: 108 million Euros.

Comment
Actual calculated mean annual discharge is 17.6 m^3/s which is by approximately 15% smaller than one cited in available documentation.

"Falovići" HPP
Location of dam and HPP
"Falovići" dam is located at the Ćehotina River at the "Grad" profile, approximately 2.56 km upstream of the Godijeno settlement. The location belongs to the municipality of Falovići and the nearest town is Foča.

"Falovići" HPP system consists of the "Miljakovići " HPP and "Falovići" SHPP (using the ecological flow equal to 4.0 m^3/s). Diversion HPP powerhouse is planned in the vicinity of the Miljakovići settlement, at the Drina River, approximately 3 km downstream of Foča.

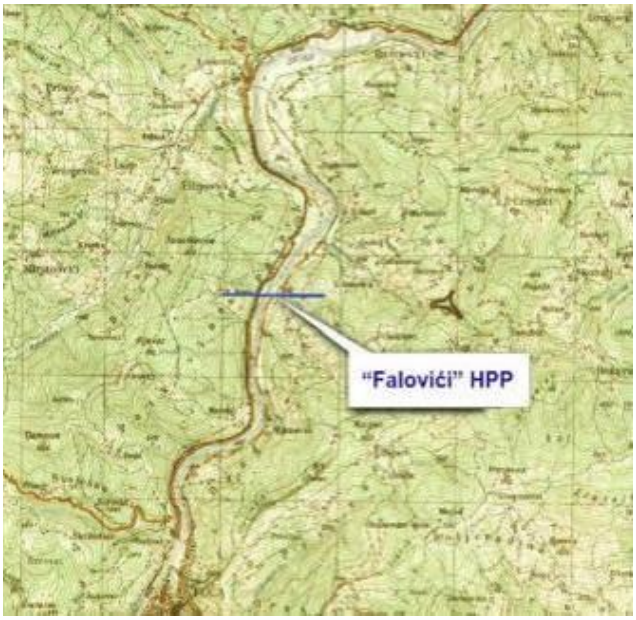


Figure 8-57: Wide location area

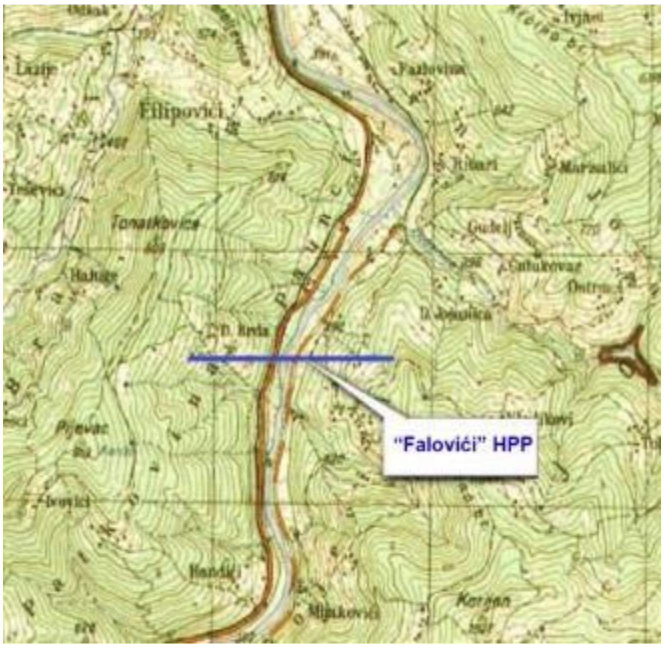


Figure 8-58: Narrow location area

Figure 8-59: Satellite image of HPP location

Profile hydrological properties
Basic profile hydrological properties (as given in the original technical documentation) are:

- Basin area: 1,290.70 km^2,
- Mean discharge: 18.21 m^3/s,
- Ecological flow: 2.58 m^3/s (minimum monthly discharge with 95% availability) and
- Flood discharge referent for design of spillways: 670.6 m^3/s ($Q_{0.01}$, 95% confidence interval).

Dam properties
Basic dam properties are:

- Type: arch concrete,
- Crest elevation: 505 m a.s.l.,

- Height: approximately 60 m (construction height),
- Length along the crest: 156.6 m,
- Storage evacuation structures: spillway, 3 field + 2 bottom outlets and
- Total evacuation capacity: 670.6 m^3/s (spillway).

Storage properties
Basic storage properties are:

- Regular water level: 502 m a.s.l.,
- Maximum water level: 502 m a.s.l.,
- Minimum operating water level: 482 m a.s.l.,
- Total volume: 24 million m^3,
- Active volume: 16.5 million m^3 and
- Inactive volume: 7.5 million m^3.

Conduit properties
Basic properties of water conduits for the diversion ("Miljakovići ") HPP are:

- Tunnel length: 10,343 m,
- Tunnel diameter: 4.5 m,
- Penstock length: approximately 130 m and
- Penstock diameter: 3.2 m.

HPP/Powerhouse properties
Basic non-diversion SHPP/powerhouse properties are:

- Plant type: non-diversion,
- Unit type: Francis with horizontal shaft,
- Number of units: 1,
- Installed discharge: 2.58 m^3/s (ecological flow),
- Tailrace water level: 465 m (assumed),
- Gross head: 37 m (assumed),
- Net head: 36.5 (32.5 m "construction" head),
- Installed power (active): 0.8 MW,
- Installed power (apparent): 1.0 MW,
- Mean annual electricity generation: 6.5 GWh and
- Connection voltage level: 6,3 kV.

Basic diversion HPP/powerhouse properties are:

- Plant type: diversion,
- Unit type: Francis with vertical shaft,
- Number of units: 2,
- Installed discharge: 2 x 22.5 = 45 m^3/s,
- Tailwater level: 384 m.a.s.l. ("Paunci" storage),
- Gross head: 118 m,
- Head loss: 8 m,
- Net head: 110 m,
- Installed power (active): 2 x 21 = 42 MW,
- Installed power (apparent): 2 x 24 = 48 MW,
- Mean annual electricity generation: 118 GWh and
- Connection voltage level: 6,3 kV.

Computation results

Computation results include:'

- Adopted ecological flow: 2.58 m^3/s,
- Mean annual electricity generation: 120 GWh and
- Investment costs: 108 million Euros.

"Buk Bijela" PSHPP

Location of dam and HPP

The hydropower facility PSHPP Buk Bijela consists of a dam at a site located about 12.50 km upstream of the confluence of the Vrbnička River with the Drina River. The Vrbnička River is the left tributary of the Drina River.

Figure 8-60: Wide location area

The construction of the dam would create an artificial lake with an active storage capacity of approximately 101 million m^3 intended for pump/turbine operation; the generating units would be located in an underground powerhouse. This one contains two reversible pump turbines fed with water by a headrace system consisting of a 7,300 m long concrete lined tunnel and 1,906.50 m long concrete-encased steel penstock. The water used for energy generation is released into the lower reservoir of Buk Bijela by a 320 m long outlet tunnel.

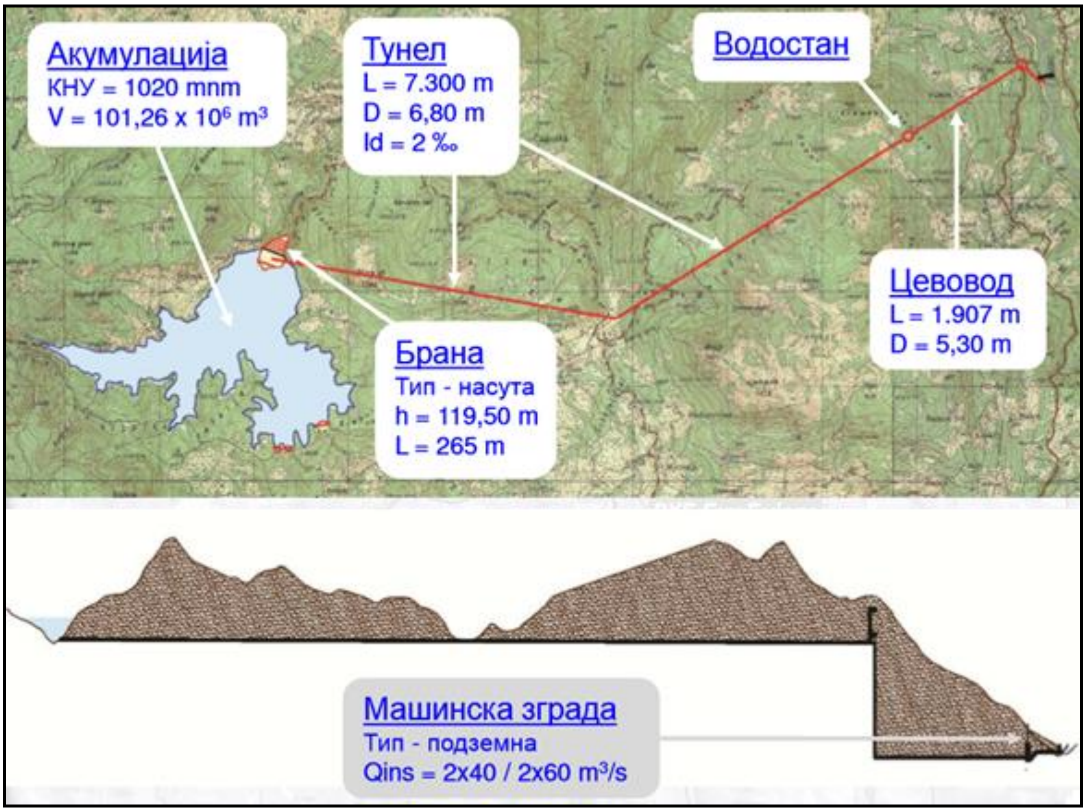


Figure 8-61: Narrow location area and longitudinal profile

Technical data of the planned Pumped Storage HPP Buk Bijela:

Storage reservoir
Minimum operating level of PSP Buk Bijela (MinOL) .... 935.00 m asl
Normal backwater level (NWL) .... 1020.00 m asl
Maximum backwater level (MWL) .... 1021.00 m asl
Storage capacity at MinOL .... 2.05 million m^3
Storage capacity at NWL .... 101.26 million m^3

Dam
Dam type .... fill dam with clay core
Dam crest elevation .... 1022.00 m asl
Construction height .... 119.50 m
Dam width at crest .... 8.00 m
Upstream dam face slope .... V:H = 1:1.70
Downstream dam face slope .... V:H = 1:1.65
Berm levels on downstream dam slope .... 942, 962, 982, 1002 m asl
Berm width .... 2.00 m
Clay core width at crest .... 3.25 m
Maximum width of clay core at the bottom of foundation pit .... 62.25 m
Slope of upstream and downstream face of clay core .... V:H = 1:0.25
Thickness of filter layers .... 3.00 m

River diversion structures
Type of diversion .... single stage
Type of structure .... diversion tunnel, upstream and downstream cofferdam
Reference design discharge .... $Q_{5\%} = 94\ m^3/s$

Flood discharge structures
Type of structure .... shaft spillway, outlet tunnel and stilling basin
Reference design discharge .... $Q_{0.01\%} = 285\ m^3/s$

Headrace tunnel

Length	7,300 m
Diameter	6.80 m
Lining thickness	0.60 m
Longitudinal gradient	2‰

Penstock

Number of penstocks	1
Length	1,906.50 m
Diameter	5.30 m
Thickness of steel lining	45 mm
Thickness of concrete lining	1.00 m

Powerhouse

Generating unit type	pump/turbine
Number of generating units	2
Rated discharge in turbine mode	120 m^3/s
Rated discharge in pumping mode	80 m^3/s
Installed capacity in turbine mode	600 MW
Installed capacity in pumping mode	600 MW
Maximum net head (pump/turbine)	601.10 / 595.90 m
Minimum net head (pump/turbine)	507.40 / 486.60 m
Rated net head (pump/turbine)	586.90 / 566.00 m

Outlet tunnel

Length	320 m
Diameter	6.80 m

The estimated investments for the construction of PSHPP Buk Bijela are in the amount of 376.1 million euro.

8.8 Computation methodology

8.8.1 Electricity production calculations

All mean annual production figures presented in the subsections on individual HPPs in the Section 8.5 were determined through the plant data collected from the existing technical documentation and the hydrology data presented in Chapter 4. No modifications to the plant parameters were made.
The plant parameters include:

- Installed discharges,
- Diameters and lengths of water conveying structures (tunnels and penstocks),
- Gross heads, head losses and net heads,
- Estimated turbine, generator and transformer efficiencies etc.

Equipment efficiencies were adopted upon the plant installed power, as listed in the available technical documentation. The hydrology data had the form of a discharge duration curve (a series of 100 probability-discharge data sets) as presented in the example below (see Figure 8-62).

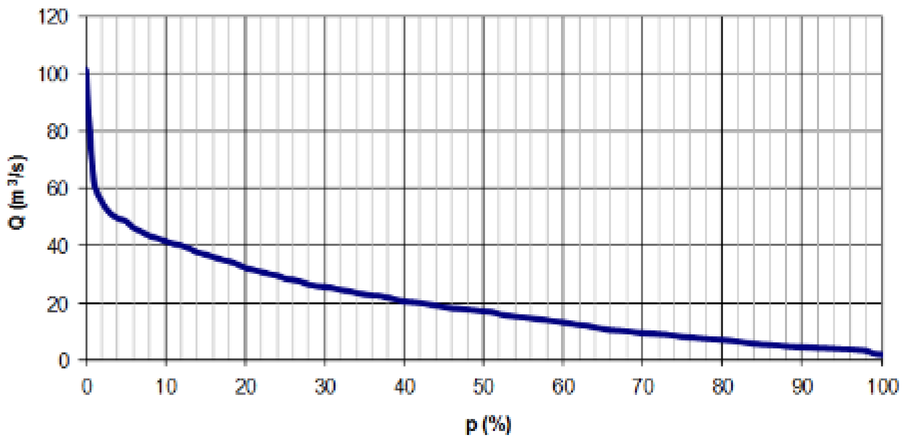


Figure 8-62: Discharge duration curve at the "Vikoč" HPP profile (average discharge 17.6 m^3/s)

For all HPPs, the computation was performed as if they belonged to the run-of-river type. The reason behind this approach was that any type of computation based on the use of the HPP storage would require management algorithms that are too complex to be developed for the present purpose and generally depend upon the electricity market conditions and role of each individual plant in the electric power system in which it is supposed to operate (both being unknown currently).

The values of ecological flows at the HPP profiles were adopted from the available technical documentation or as 10% of the mean annual discharges (if no data was available in the documentation).

The ratio of the minimum discharge through a unit to its rated discharge was adopted as 0.3 for axial-type (Kaplan etc.) turbines and 0.4 for Francis-type turbines (actual values can differ depending on turbine construction, but these values represent good approximations).

8.8.2 Updated Investment Costs for HPPs

Investment costs are updated / estimated based on available data from existing technical documentations and adopted common unit prices for main works and equipment, as cited below.

The main input data of this estimation are: Bill of Quantities, description of structures and equipment, drawings, data related to expropriation and roads and other structures relocations contained in the existing technical documentation. Given that the technical documentation has been prepared at different periods (ranging from the 1980`s until today) and with usage of different currencies, in order to analyse the planned HPPs on a consistent basis, investments costs are recalculated/estimated based on the following:

- Costs of civil works (CW) are estimated in accordance to adopted current market unit prices based on available data and information from actual projects within the region of interest;
- Preparatory construction works (PCW) are estimated to amount to 5% of main civil works;
- Costs for mechanical (ME) and electromechanical equipment (EE) for powerhouses are estimated based on "Estimating E&M powerhouse costs" ("Water Power and Dam Construction", February 2009);
- Costs for hydro-mechanical equipment (HME) are estimated to be approximately 30% of ME+EE costs for powerhouse (based on experience from similar projects). This percentage has been adjusted to the complexity of required equipment;
- Investor costs are adopted in range from 10 to 15% of all costs cited above (CW+PCW+ME+HME+EE). These costs include structures relocation, expropriation, design and investigation costs. Investor costs are carefully evaluated based on the specificities of certain facilities and required expropriation. In cases with high costs of expropriation mentioned percentages have been adjusted;
- Working capital is adopted as 1% of all costs cited above

All cited percentages are based on experience gained from other similar projects. The current market unit prices for the main civil works are presented in the following Table 8-9.

Table 8-9: Unit prices for civil works (Euros)

Works	Units	Unit price (Euro)
EARTH WORKS		
Excavations		
Common	m^3	3.5
Rock	m^3	9.0
Tunnel (V category)	m^3	50.0
Tunnel (VI category)	m^3	60.0
Fill works		
Stone	m^3	7.0
Earth	m^3	6.0
Filters	m^3	15.0
Clay core	m^3	9.0
CONCRETE WORKS		
Channel (5 kg/m^3 reinforcement)	m^3	100.0
Slabs, walls, blocks (60 kg/m^3 reinforcement)	m^3	120.0
Dam, massive concrete (80kg/m^3 reinforcement)	m^3	135.0
Arch dam, surge tank (120 kg/m^3 reinforcement)	m^3	160.0
Tunnel, reinforced concrete apron (60 kg/m^3 reinforcement)	m^3	180.0
REINFORCEMENT		
Reinforcement	t	1,000.0
POWERHOUSES		
Area up to 500 m^2	m^2	500.0
Area above 500 m^2	m^2	1,200.0

The current market unit prices for structures relocation and expropriation are in the following Table 8-10.

Table 8-10: Unit prices for structures relocations and expropriation (Euros)

Structures	Units	Unit price (Euro)
Roads		
Macadam road	km	125,000
Asphalt road	km	300,000
Land		
Agriculture land	ha	20,000
Houses		
House	unit	35,000

The updated investment costs for the planned HPPs are presented in to the following Table 8-11.

Table 8-11: Updated investment costs for planned HPPs based on actual quantities of works and equipment and current unit prices (million Euros) – source (#1-11 + 14): Elektroprivreda Republike Srpske

No	Name of HPP/SHPP	River	NI (MW)	Civil works	HME	ME	EE	Investor Expenses	Working Capital	TOTAL
1	Buk Bijela "low"	Drina	115	83.0	12.3	23.7	51.9	22.8	1.9	195.5
2	PSHPP Buk Bijela	Drina/Vrbnička rijeka	600	191.0	9.2	56.4	49.2	23.5	3.7	376.1
3	Foča "low"	Drina	52	50.4	9.3	20.3	22.4	15.5	1.1	119.1
4	Paunci	Drina	43	59.8	36.6		15.5	12.3	1.2	125.5
5	Rogačica	Drina	113	121.9	80.0		6.8	34.7		243.3
6	Tegare	Drina	121	143.4	79.6		6.9	52.1		281.9
7	Dubravica	Drina	87	128.3	70.4		6.0	140.3		344.9
8	Kozluk	Drina	88	120.4	13.6	33.4	28.0	107.6	3.0	306.0
9	Drina I	Drina	88	158.8	10.5	33.4	27.5	56.7	2.9	289.8
10	Drina II	Drina	88	212.9	9.5	33.4	27.9	45.0	3.3	332.0
11	Drina III	Drina	101	291.1	9.5	33.4	29.0	64.0	4.3	431.2
12	Ustikolina	Drina	60	55	10	20	13	10	1	109
13	Goražde	Drina	37	66	9	18	15	11	1	119
14	Sutjeska	Sutjeska	44	97.2	9.0		11.3	20.5	1.4	139.4
15	Mrsovo	Lim	37	46	8	15	12	12	1	94
16	Falovići	Cehotina/Drina	43	76	5	8	6	11	1	108
17	Vikoč	Cehotina	33	85	3	6	5	10	1	108

The total installed power of all planned hydropower plants in Republic of Srpska reaches 1,750 MW. The total cost of all investments amounts to some 3,700 million Euros. This leads to an average unit cost of the installed megawatt of 2.12 million Euros. This is in the range of usual prices for this kind of project.

8.9 Small hydropower plants in the Drina River Basin

In the Drina River basin there are ongoing activities on SHPP construction for a number of years.

One of the most important earlier documents which included a systematic overview of possible projects was the "Hydropower Background Paper on Tributaries in the Basin of the Upper Drina River Watercourse"", which was prepared by the "Elektroprivreda BiH" in 1984. The documentation for SHPPs described in this report was developed at the level of a study or Basic Design Report.

Since the publication of this document has been continued the development of the documentation for a certain number of SHPPs presented in it, while some of them were commissioned. A certain number of projects that had not been mentioned in this document has also been developed. A more detailed overview of the SHPPs for which are available more recent data is given below.

8.9.1 Federation BiH

At the Federation BiH territory have been built the following SHPPs:

- on the Čemernica River: "Čemernica" SHPP and
- on the Osanica river: "Osanica 1" SHPP (1.28 MW) and MHE "Osanica 4" SHPP (0.63 MW).

The construction of the "Kaljani" SHPP on the Prača River is under way.

The construction of the following SHPPs is planned:

- on the Prača River: "Banja stijena" SHPP and "Prača" SHPP,
- on the Kolunska river: "Ustikolina" SHPP, "Kiseljak" SHPP, "Jabuka" SHPP, "Modro polje" SHPP, "Račići" SHPP and "Tihuljići" SHPP,
- on the Ljajička River: "Ljajička rijeka" SHPP,
- on the Mazlinska River: "Mazlina" SHPP and
- on the Miloševićev Creek: "Marisolići" SHPP.

A Request for Proposals related to the award of concessions for the SHPPs on the Kolina River has also been published, primarily for the "Kolina 4" SHPP (519 kW) and "Kolina 5" SHPP (196 kW).

8.9.2 Republic of Srpska

According to the Registry of Concession in the Republic of Srpska the concessions for the construction of the following HPPs and SHPPs have been issued:

- on the Lim River: "Mrsovo" HPP,
- on the Sutjeska River: "Sutjeska 2A" SHPP, "Sutjeska 2B" SHPP and "Sutjeska S-3" SHPP,
- on the Ćehotina River: "Luke" SHPP, "Falovići" SHPP and "Godijeno" SHPP,
- on the Bistrica River: "Bistrica B-1" HPP, "Bistrica B-2A" HPP, "Bistrica B-3" HPP, "Bistrica B-4" SHPP, "Bistrica B-5A" SHPP and "Gornje Pale" SHPP,
- on the Drinjača River: "Šekovići" SHPP, "Ispod Kušlata" SHPP, "Čajkuša" SHPP, "Medaševac" SHPP, "Barski potok" SHPP, "Pećina Tišća" SHPP and "Parni Lug" SHPP,
- on the Drinjača River tributary: "Vrelo Gačići" SHPP,
- on the Prača River: "Ustiprača" SHPP, "Dub" SHPP and "Mesići-Nova" SHPP,
- on the Janjina River: "Janjina J-1" SHPP and "Janjina J-2" SHPP,
- on the Rzav River: "Rzav 1" SHPP, "Rzav 2" SHPP, "Rzav 3" SHPP, "Rzav 4" SHPP and "Rzav 5" SHPP,
- on the Govza River: "Govza B-G-1 Jeleč" SHPP,
- on the Jadar River: "Kušlat" SHPP,
- on the Studeni Jadar River: "Gornji Zalukovik II" SHPP,
- on the Zeleni Jadar River: "Jovana" SHPP,
- on the Lukavica River: "Lukavica-Milići" SHPP,
- on the Sućeska River: "Sućeska R-S-1" SHPP and "Sućeska R-S-2" SHPP,
- on the Jabušnica River: "Jabušnica J-1" SHPP and "Jabušnica S-J-2" SHPP,
- on the Hrčavka River: "Hrčavka S-H-1" SHPP, "Hrčavka S-H-2" SHPP and "Hrčavka S-H-3" SHPP,
- on the Žepa River: "Žepa" SHPP,
- on the Rakitnica River: "Ušće" SHPP and "Podgaj" SHPP and
- on the Oteša River: "Oteša B-O-2" SHPP.

According to the available information the following SHPPs have been built and commissioned:

- on the Sutjeska River: "RS-1" SHPP and "RS-2" SHPP,
- on the Bistrica River: "Bobar" SHPP (located between the "Bistrica B-2A" (S)HPP and "Bistrica B-3" (S)HPP profiles),
- on the Prača River: "Ustiprača" SHPP, "Dub" SHPP, "Mesići" SHPP and "Mesići-Nova" SHPP (5 MW, near Rogatica),
- on the Oteša River: "Oteša B-O-2" SHPP,
- on the Trtorišnica River: "Čemerno" SHPP,
- on the Tišća River: "Tišća" SHPP,
- on the Zeleni Jadar River: "Jovana" SHPP and
- on the Studeni Jadar River: "Zalukovik" SHPP.

For a certain number of SHPS has also been developed higher-level technical documentation, even to the Final Design Report level.

9 Flood Hazards and Risks

Almost all tributaries in the DRB are torrents, i.e. streams characterised by rapid development of a flood wave (flood surge) that is usually triggered by intensive precipitation induced by cyclonic activity in the Mediterranean basin (most often by that developed in the Genoa bay). As already known, torrents have short concentration times (in a small sub-catchment the rising limb can last several hours) and very large runoff volumes, 1 to 1.5 $m^3/s \cdot km^2$, or even more than 2 $m^3/s \cdot km^2$ for smaller tributaries. For large tributaries, the flood peak discharge with a probability of occurrence of 1% (100-year return period) is up to 12 or even 17 times greater than the corresponding average discharge value, whilst for small tributaries the ratio value is even more amplified – it reaches 20 or even 25.

Torrential flows cause soil and channel degradation. 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 largest peak discharge recorded so far in the DRB occurred in November 1896. According to one of the latest statistical analyses[25] the estimated recurrence probability of this flood event is approximately 0.5% (200 years return period). During that flood event the stone bridge over the Drina River was overtopped. The hypothetical 0.1%-flood discharge (having 1,000 years return period), at the "Zvornik" measurement station, could be estimated to approximately 16,000 m^3/s, but this is a highly uncertain estimate. The flood records also include flood events from 1952, 1968 and 1974 with the following peak discharge values measured at "Foča" measurement station[1]: 3,220 m^3/s (1952), 3,950 m^3/s (1968) and 2,850 m^3/s (1974). The latest catastrophic floods in the Drina River basin, as stated by the same source[1], occurred on December 7th, 2010 and on May 15th, 2014. The peak discharge, recorded at "Radalj" (former "Zvornik") measurement station on December 7th, 2010 was 4,900 m^3/s (2% probability of occurrence, or 50 years return period) whereas that from May 15th, 2014 flood amounted 3,500 m^3/s (2,5% probability of occurrence, or 40 years return period). As claimed by official records of the Republic Hydrometeorological Service of Serbia the peak discharge in 2010 was 4,450 m^3/s and it occured on 2nd December at 19:15, whereas that of May 15th 2014 was 3,940 m^3/s. The corresponding water levels were 660 cm or 136.07 meters above sea level (m a.s.l.) and 623 cm or 135.70 m a.s.l., respectively. According to recently published results of statistical analysis of high flows in the DRB[26], recurrence probabilities of the two flood events may be estimated to approximately 2% for the 2010 flood and 5% for the 2014 flood. Peak discharges at "Goražde" gauging station in BiH and "Radalj" gauging station in Serbia occurred on the same date during the 2010 flood event, i.e. on 2nd December. The greatest discharge at "Goražde" was 3,098 m^3/s[27]. Its recurrence probability may be estimated to approximately 20%[28].

9.1 Flood prone areas in the Drina River Basin

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 3,500 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.

[25] Zavod za Vodoprivredu, Jun 2014, Preliminary flood risk assessment in Republika Srpska, Bijeljina
[26] Zavod za Vodoprivredu, Bijeljina, Institut za vodoprivredu "Jaroslav Černi", Beograd, November 2015, Inception report of the Preliminary Design for Flood Protection from the Drina River in BiH
[27] Federal Hydrometeorological Service, Hydrological Yearbook for the year 2010
[28] Institut za hidrotehniku Građevinskog fakulteta u Sarajevu, april 2013, Preliminary flood risk assessment for streams of category I in FBiH, Sarajevo

The latest catastrophic floods in the Drina River basin occurred on December 2nd, 2010 and on 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. Goražde municipality suffered from the following damages during 2010 flood[29,30]: 200 houses, 32 commercial buildings and 50 livestock pens were flooded, 1.0 km of traffic roads were damaged, power distribution cables were cut due to collapse of distribution poles, rip-rap protection was damaged, two bridges were overtopped and water quality was deteriorated in private wells and in the water intake for public water supply system. Approximately 500 people were evacuated. In the area of Ustikolina village 26 houses, 13 commercial offices and 42 ha under orchards and farmlands were flooded, 1.25 km of traffic roads was damaged, power distribution cables were cut due to collapse of distribution poles, telephone connections were cut off and water quality was deteriorated in private wells. The estimated direct and indirect damages in Goražde and Ustikolina are 15.75 KM[6]. The Consultant did not have information on the flooded area and damage in FBiH for the 2014 flood event. In the downstream flat arable lands of Semberija, 83,60 km^2 of farming and construction lands were flooded in 2010. The flooded area was even greater during the 2014 flood event – the total flooded area was 106.14 km^2. The 2010 flood endangered approximately 10,000 people and caused damage to residential buildings and plants. The total estimated damage (direct and indirect) for this flood event is approximately 33 million KM or approximately 17 million Euros[31]. Although the recorded peak discharge during the latest flood event (May 15th, 2014), was less than in the previous episode, the damages were even more severe (the streets in the centre of the town of Bijeljina were covered with water). Approximately 14,500 people were endangered during this flood event, and the total estimated damage (direct and indirect) was approximately 101 million KM or approximately 52 million Euros[8]. The increased damage is attributed to the backwater effect from the confluence with the Sava River.

In the upper course of the Drina River, the existing flood plain in Novo Goražde in BiH is occupied by unlicensed construction of the refugee settlement, which is exposed to frequent flooding. In the Rudo municipality in BiH the area of approximately 6,860 ha is endangered by floods.

9.2 Flood protection infrastructure and measures

The existence of large reservoirs in the upstream part of the DRB (in Montenegro, Serbia and BiH) makes the propagation of flood waves/surges through the basin less adverse than it would be in native conditions. These reservoirs are part of the following hydropower systems (the initial reservoir volumes are given in parentheses): "Uvac" HPP (213 million m^3), "Kokin Brod" HPP (273 million m^3), "Bistrica" HPP (7 million m^3), "Potpeć" HPP (44 million m^3), "Piva" HPP (880 million m^3), "Višegrad" HPP (161 million m^3), "Bajina Bašta" HPP (340 million m^3) and "Zvornik" HPP (89 million m^3). The "Zvornik" reservoir volume has been considerably reduced over years of operation due to reservoir sedimentation thus allowing only the storage for the daily excess of demand. One of the major problems arises from the fact that the release management of excess water from the reservoir through bottom outlets and spillways, that was originally planned to rest on the results of the mathematical optimisation models, is not correctly applied. Hence the control of water release equipment (sluice gates etc.) during flood times that would allow for management in accordance with the Q_{max} minimization criterion, is not providing the optimal effect. The present management methods, allegedly based upon operator's long "experience", can lead to inefficient management of sluice gates on the dams that could generate a flood wave with a discharge larger than the one that would have been developed under natural conditions. On the other hand, attenuation of flood waves that propagate toward the River Lim from the direction of the River Uvac is very efficient due to action of two large reservoirs – "Uvac" and "Kokin Brod".

The following problems hamper the completion of protection systems, especially along the lower course of the Drina River:

[29] Hydro-Ingenieure and Heis, June 2012, Framework for flood management on the Drina River – Final Report for the WB
[30] Institut za hidrotehniku Građevinskog fakulteta u Sarajevu, april 2013, Preliminary flood risk assessment for streams of category I in FBiH, Sarajevo
[31] Zavod za Vodoprivredu, Bijeljina, Institut za vodoprivredu "Jaroslav Černi", Beograd, November 2015, Inception report of the Preliminary Design for Flood Protection from the Drina River in BiH

- The major part of the state boundary between Serbia and BiH no longer runs along the line of the river, because of the unstable, meandering Drina channel that has been constantly moving to the East thus causing confusion on issues of responsibility.[32]
- Similarly, the flood protection works in Semberija that were planned to start in 2014 but have yet not begun, are hindered by numerous private construction works on the left bank financed by citizens of BiH who built their properties on the territory of the neighbouring country. High levees are planned further away from the present river course to take into account the fact that the state border does not follow its meandering course. However, these uncontrolled construction works on the flood plain make the flood protection more difficult.
- These flood protection works have also been delayed due to, among other reasons, the expectation of new hydropower developments (in a form of a cascade system) along the lower course of the Drina River (downstream of Zvornik) that would necessitate higher flood embankments, to mitigate increased flood levels;
- In addition, flood protection systems (flood embankments) on the DRB are fragmentary and the works on both river banks have not been harmonized.

The existing flood protection systems include:

- The upper course of the Drina River, the left bank:
  - Revertment upstream of the main town bridge (upstream bridge) in Goražde made of hexagonal concrete blocks (1.2 km, slope 1:2);
  - Revertment between two bridges (the main town bridge and the road bridge) in Goražde that extends to the top of the embankment (0.7 km);
  - River engineering works on the Podhranjski brook in the center of Goražde in the length 0f 0.8 km – banks are supported with concrete slabs and streambed is covered with large stone slabs.

- The upper course of the Drina River, the right bank:
  - Revertment between two bridges (0.7 km) in Goražde that continues upstream of the main town bridge (0.3 km) made of hexagonal concrete blocks with the parapet wall above its crest;
  - Flexible revertment downstream of the road bridge in Goražde (0.7 km)

- The lower course of the Drina River, the left bank:
  - Embankment and parapet wall in Zvornik (2.5 km, 1% flood, 0.8 m freeboard);
  - River engineering works in Zvornik (2 km), rip-rap protection (5.7 km);
  - River engineering works along the stretches of the Hoča River, Gradina River, Kozlučka River, Tršićka River and Jasenička River, in the total length of 3.6 km; however, these works are fragmentary and should be completed (existing structures should be interconnected). In the Karakaj area it is important to protect the new Ekonomija settlement.

[32] The Drina River was considered the boundary between Serbia and BiH. It is, of course, still the natural boundary between the two countries, but there is also a true, legal, boundary that was very well defined by geodetic survey. There is an evident tendency of the Drina River channel to move towards the East, while the legal demarcation line remains in its position. Migrants (refugees from the latest Balkan war) have settled in the flood prone areas by building their new homes with no construction permission. Now, different financial institutions do want to support the construction of embankments in Bosnia (Bijeljina, Goražde etc.), but not in Serbia. On the other hand, Serbia has a problem with investments for the protection of Bosnian citizens who illegally build their houses on the territory of the Republic of Serbia.

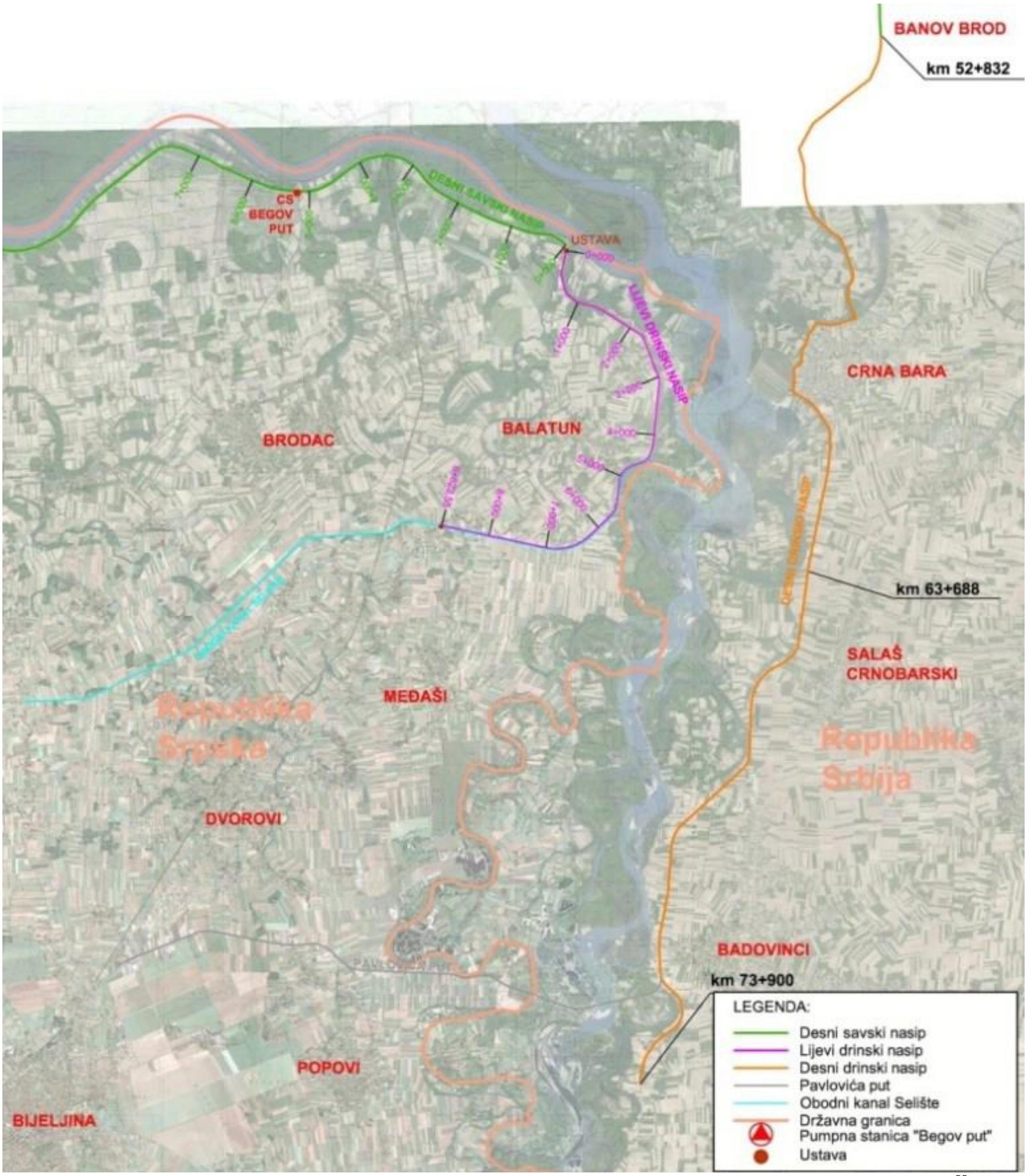


Figure 9-1: Layout of the existing flood protection structures in Semberija – Republika Srpska (BiH) and Republic of Serbia[33]

[33] Zavod za Vodoprivredu, Bijeljina, Institut za vodoprivredu "Jaroslav Černi", Beograd, November 2015, Inception report of the Preliminary Design for Flood Protection from the Drina River in BiH

There some important observations related to the existing flood protection infrastructure:

The total length of the infrastructure on the right bank is greater than that on the left bank, but it suffers from the lack of interconnection between different stretches. Neither bank is systematically protected from erosion, i.e. neither riverbank nor riverbed stabilisation works were performed, except from some localised river training works on the protection of several endangered outer banks in river bends. As such, they had no significant effect on the pronounced meandering of the Drina River course.

Along the middle course of the River Drina (from Višegrad to Zvornik) fragmentary river engineering works in the following tributaries: Jadar River, Drinjača River, Lovnica River, Križevica River, Crvena River and Glogovska River, were performed. The total length of these works is approximately 6 km. Generally speaking, the works were performed, only at locations where traffic communications were endangered.

The list of other equally important locations at the left bank of the Drina River in the vicinity of Bratunac that should be protected from the erosion and the river training works in the following tributaries: Zeleni Jadar River and Studeni Jadar River in Milići, Drinjača River and Lovnica River in Sekovići, Križevica River and Glogovska River in Bratunac, Križevica River and Crvena River in Srebrenica etc.

A cascade system of a string of run-of-river-type (non-diversion type) hydropower plants is planned to be built along the middle course of the Drina River. Therefore, it will be necessary to harmonize all works with the engineering design based upon the adopted high water levels of the future dams. That is also one of the reasons behind the delay of some of the works, especially in the zone of Bratunac, because the decision on the cascaded system layout has not yet been definitively adopted.

The upper course of the Drina River is the river reach from Višegrad to the confluence of Piva and Tara Rivers. It is planned to extend further upstream the existing cascade hydropower systems built along the middle course. Thus, the flood protection infrastructure and measures on this stretch of the Drina River, as well as along the course of all its tributaries will be dependent upon the accepted system layout (i.e. the adopted maximal water level in the reservoir at the dam-site). In this part of the basin the following works are important:

- In the Sokolac municipality: river engineering works in the Resetnica River through the urban area of Sokolac (2.5 km, optimally 5 km), Kajnak (0.8 km) and the completion of the initiated works directed at the regulation of the Rakitnica River in Rogatica (2.1 + 0.5 km);
- In Višegrad: the completion of all river bank protection structures and the continuation of river engineering works in the Rzav River, upstream of the existing works (minimum 0.6 km);
- In Novo Goražde: embankments and rip-rap protection of the banks corresponding to the backwater levels of "Višegrad" HPP have been erected. However, the unlicensed construction of the refugee settlement on the flood plain makes their protection against flooding a very complicated task;
- In Goražde: erection of embankment (6.281 km) with a parapet wall (2.790 km) on the right bank and flexible stone revetment (1.110 km) with the parapet wall (4.615 km) on the left bank;
- In Pale-Prača, on the stream Prača: river engineering works which include enlargement of the aggraded stream channel, embankment and flexible revetment erection (2.704 km); in Hrenovici: river engineering works which include enlargement of the aggraded stream channel, embankment and flexible revetment erection (3.293 km) and placement of a cascade of concrete check dams for channel bed stabilisation;
- In Čajnče: the completion of river engineering works in the Janjina River and Vrelo River in accordance with the urban planning; the works should also include riverbed stabilization;
- In the Rudo municipality, where the area of approximately 6,860 ha is endangered by floods, it is necessary to perform river engineering works within the urban area in accordance with the urban planning;
- In Ustikolina, on the Drina River: erection of flexible stone revetment (0.394 km); on the Kosovska river: erection of concrete embankment (0.215 km) with the parapet wall and placement of a cascade of 5 concrete check dams for channel bed stabilisation;

- In the Foča municipality: the course of the Ćehotina River through the town was regulated (in the total length of 0.4 km) and it is necessary to continue river training works further upstream as well as to protect the right bank against the erosion up to the river confluence, in the total length of 1.6 km. In accordance with the water plan of Serbia and Montenegro the town of Foča would be located between two reservoirs – the upstream one that belongs to the "Foča" HPP and the downstream one that belongs to "Paunci" HPP. Such a position sometimes offers some added value to the urban area, i.e. the capacity for recreation, tourism etc. This, of course, requires proper infrastructure and other prerequisites, i.e. a proper connection of the urban area with facilities on the shore should exist. The river engineering works in the channel of the Drina River would be a necessary part of the construction works related to the "Foča" HPP and "Paunci" HPP, to ensure the town safety under the conditions of asynchronous operating regimes of the two HPPs. The "Foča"" HPP/reservoir is planned to act as the compensation basin for the "Buk Bijela" HPP, which is intended for peak-load operation. Without the "Foča" reservoir daily water level oscillations in the town of Foča would be of the order of several meters; and
- In Miljevina: Bistrica River endangers Miljevina and it is necessary to build an embankment (0.65 km long) and carry out urban flood protection infrastructure including necessary river training works (a stretch of about 1.27 km).

Among the latest designs, the most urgent ones are those related to flood protection of Semberija region and Goražde. This prioritisation resulted from detailed socioeconomic analysis[34] and preliminary flood risk assessment[35]. These analyses proved that the two regions are particularly vulnerable because of the lack of existing embankment interconnection (Semberija) and severe erosion of the riverbed and banks due to incomplete construction of revetments and crests. Moreover, these structures in Goražde area were designed to protect only against high-frequency, low-inundation discharges of up to 2,730 m^3/s instead of about 4,080 m^3/s (1% recurrence probability), which is the minimum standard protection for commercial and (semi-) urbanised areas. A third major factor that raises the imminent flooding risk is that the structures, where in place, are no longer adequate or will soon lose their functionality due to lack of maintenance and modernization during the past two decades in the wake of the armed conflict.

There are four main designs already prepared for the Goražde area. Banks of the Drina River in both Goražde and Ustikolina should be protected against erosion with flexible revetments/embankments whose height should provide protection against 1% recurrence probability flood. This also requires reconstruction of the existing rivetments whose height should be increased by 0.80 m. Both designs for the Prača River (in Pale and Hrenovica) are concerned with the river training measures aiming at reduction of stream channel aggradation i.e. at improving channel conveyance, thus saving embankment size and a quantity of the building material. Embankments for both stretches of the Prača River are designed for the 1% flood with 0.50 m free board.

The design for the flood protection of Semberia polder it is prepared in accordance with the corresponding Conceptual Design Report with the Feasibility Study completed in 2014 (Zavod za vodoprivredu (Water Resources Institution) from Bijeljina). The design criteria are presented here because they are important for other protection projects as well:

- It is necessary to complete the flood protection system for the riparian area on the left bank of the Drina River, using embankments with partitions, in accordance with the concept presented in the study "Regulacija i uređenje rijeke Save u Jugoslaviji" ("River training and bank stabilisation of the Sava River in Yugoslavia"), in order to connect that system to the flood protection system for the area on the right bank of the Sava River. This is the manner to achieve an integral and functional "over-partition" protection of Semberija and that part of Posavina (which is very important, because both Semberija on the left bank, and Podrinje on the right bank of the lower course of the Drina River, depend upon the degree of protection of the system along the Sava River);
- The degree of the flood protection against 1% floods probability (100 years return flood) shall be effected through an increase in the height of existing flood protection structures by 1.2 m, up to the point

[34] Hydro-Ingenieure and Heis, June 2012, Framework for flood management on the Drina River – Final Report for the WB
[35] Zavod za Vodoprivredu, Jun 2014, Preliminary flood risk assessment in Republika Srpska, Bijeljina

where backwater effect of Sava River diminishes, and by 0.80 m further upstream along the principal course of its main tributary - Drina River;

- It is necessary to take into account the flood regimes under natural conditions, without taking into account the action of the reservoirs (this increases the safety level, since the reservoirs are not being managed in the optimum manner);
- Embankments shall be constructed exclusively at the BiH territory (Republic of Srpska), bearing in mind the fact that the boundary between BiH and Serbia along certain reaches does not run along the Drina River, but is displaced to the west, along the tracks of abandoned watercourses (characteristic for the Drina River) through which ran the river during the time of the Berlin Congress (1878) when the demarcation lines were determined;
- Embankment shall be effected with the cooperation and coordination with Serbia, taking into account the new hydrological analyses of floods, not only during design activities, but also during the execution of the works;
- Bearing in mind the length of the new embankments (approximately 33.36 km), they should be erected in three phases, in accordance with the priorities determined by the damage analysis;
- The construction of Phase I and II protection embankments shall complete the "Kaseta Semberija" ("Semberija Polder ") protection system.

These works are urgent, high-priority investments because the two locations have such a topography that keeps them especially vulnerable to high flows as water easily overtops river banks which are, at these spots, much lower in comparison with other locations along the Drina and its tributaries.

Finally, one important note:

It is very important that the river training and flood protection measures planned along the middle and lower reaches of the Drina River are harmonized with the designs of the planned hydropower (cascade) systems along the corresponding river reaches.

After the 2014 huge flood events in the Sava River basin, the following priority list of projects (see Table 9-1) was presented to the European Commission for the purpose of applying to funds for the flood damage recovery:

Table 9-1 EC Proposed Projects in DRB for alleviation and prevention of the damage caused by flood events

Proposed project Title	Municipality	River Basin	Budget (Euro)	Beneficiary(ies)
Janja River rehabilitation, Janja-Bijeljina	Bijeljina	Drina	3,579,043	PU Vode Srpske and Municipality Bijeljina
River bank protection of Drina River, Bijeljina	Bijeljina	Drina	13,119,399	PU Vode Srpske and Municipality Bijeljina
Regulation of Janja River, Municipality Ugljevik	Ugljevik	Drina	3,405,185	PU Vode Srpske and Municipality Ugljevik
Rehabilitation of erosive river bank, Tabanci, Tršić, Zvornik and Flood protection of settlement Ekonomija from Drina and Sapna Rivers	Zvornik	Drina, Tabanci	2,546,946	PU Vode Srpske and Municipality Zvornik
River Bank Protection and regulation of four tributaries of the Drina River, Bratunac	Bratunac	Drina, Križevačka, Kravička, Slapnička and Glogovska	3,003,358	PU Vode Srpske and Municipality Bratunac
River regulation, Bistrica River, Miljevina	Foča	Drina	1,692,478	PU Vode Srpske and Municipality Foča
River regulation, Vrelo River, Čajniče	Čajniče	Drina	393,560	PU Vode Srpske and Municipality Čajniče
Rehabilitation of the Drinjača River Bed			2,700,000	PU Vode Srpske and Municipality Sekovici

Proposed project Title	Municipality	River Basin	Budget (Euro)	Beneficiary(ies)
Rehabilitation of the Stormwater Pumping Stations	Kozarska Dubica, Novi Grad, Gradiška, Srbac, Brod, Bijeljina, Samac, Rača		15,000,000	PU Vode Srpske

Source: adapted from WBIF-IPF4 Floods Gap Analysis (September 2015)

These projects were identified by stakeholders during stakeholders' meetings and individual consultations organised in the course of preparation of the document entitled *Flood prevention and management – Gap analysis and needs assessment in the context of implementing EU Floods Directive* that was presented to the EU Commission in September 2015. Although they are a result of consultations with the central state administrations and local water and flood management agencies and, as such, are in line with the national priorities in the field of flood management, it is considered that they still do not correspond to the official priorities of the country.

As indicated in the *Gap analysis*, most of the proposed structural projects include more than one intervention. They typically concern dike construction/rehabilitation or channel construction/ rehabilitation with riverbed regulation and floodway rehabilitation and regulation. Additionally, there is also a project for pumping station rehabilitation, which aims at reducing a flood risk.

Table 9-2 below provides a summary of the total flood projects (149 in total) where EC funds have been requested by each state of the former SFRJ. Those shaded in blue are the portion thereof that is requested/required for the flood related and special interventions in the DRB. Of a total of 29 proposed projects with a budget amounting to 99.3 M € almost 50% pertains to BiH (14 projects with the estimated budget of 43.7 M €.

Table 9-2: EC Flood Projects and Budget Summary for DRB countries and those related to Drina River Basin

Country	No projects	Total Budget (M Euro)	No DRB related prjoects	DRB Budget (M Euro)	Flood Related interventions				Special Interventions			
					Dyke rehabilitation/ Construct	Channel rehabilitation/ construct	Riverbed regulation/ floodway rehabilitation	Pumping station rehab / Constructtion	Reservoir Construction	Road Rehabilitation / Contracution	Brisge rehabilitation / contruction	Other
BiH	87	231.09	14	43.7	Y	Y	Y	Y		Y	Y	Y
Montenegro	11	116.3	5	32.8	Y		Y			Y		
Serbia	51	128.03	10	22.8	Y	Y	Y	Y		Y	Y	Y
Total	**149**	**475.42**	**29**	**99.3**								

Source: adapted from WBIF-IPF4 Floods Gap Analysis (September 2015)

9.3 Hydraulic modelling of the flood prone areas

As previously mentioned in the Inception Report, hydraulic modelling aimed at identifying flood risks in the DRB will be independent from the main part of the basin modelling with WEAP etc. The analysis of the flood risk in the DRB is related to operation of the existing and planned reservoirs. The role of hydraulic model in this project would therefore be to analyse the flood risks under assumptions and scenarios that could contribute to flooding. Such are the situations of the sudden releases from the reservoirs that coincide with high downstream water stages and also the coincidence with floods in the Sava River. The flood prone areas of the Drina River Basin are mainly limited to the lower basin part downstream of the Bajina Bašta reservoir. These areas generally include the Semberija region (in BiH) and the Mačva region (in Serbia), which are at risks from both fluvial and groundwater flooding.

At this stage of the project, the Consultant believes that 1D hydraulic model is sufficient to provide a good insight into the potential flooding problems and will use standard software packages such as HEC-RAS to perform hydraulic analysis of the vulnerable reaches.

9.4 Current flood hazards and risks assessment

The Drina basin is endangered by:

- Flood waves that propagate along the river valleys;
- Urban flooding from sewage inside already flood-protected zones caused by the absence, or insufficient capacity of sewerage and storm water drainage systems;
- Internal waters in the flood protected areas due to the absence or insufficient capacity of existing drainage systems;
- A free migration of the main channel in the river valley, which results in a systematic movement of the river corridor towards the East. This requires river training works especially those aiming at riverbank stabilisation. (The free migration is particularly pronounced along the lower course of the DRB and it can be claimed that of all European rivers the Drina River is along this reach almost intact, i.e. by now there might have been only minor river engineering works);
- A lack of riverbank stabilisation even in settlements, where "urban-type" river training works should be exercised for safety reasons, as well as for urban planning purposes (there is no urbanely access to river frontage via quays or jetties);
- A torrential river flow and accompanying erosion processes, which eventually result in aggradation of a riverbed and consequent increase in water levels, reduced discharge capacities that increase the probability of main-channel overflow in minor tributaries at larger discharges;
- Uncontrolled dredging of sand and gravel that alters riverbed morphology and might also trigger flow destabilisation.

According to Floods and landslides risk assessment for the housing sector in Bosnia and Herzegovina (2015), the town of Bijeljina is with its flood index risk of 100 on the top of the list of municipalities most affected by flooding and with its total index risk of 94 it is third on the list of municipalities most affected by combined effects of flooding or landslides. Goražde is on the 11th place on the later list with total index risk of 71. Among municipalities in FBiH, Goražde is considered as an area of high flood risk[36], while the area of Ustiprača is assessed as an area of moderate flood risk.

[36] Institut za hidrotehniku Građevinskog fakulteta u Sarajevu, april 2013, Preliminary flood risk assessment for streams of category I in FBiH, Sarajevo

10 Climate Change

Bosnia and Herzegovina is a member of the United Nation Framework Convention on Climate Change (UNFCCC) since 2000 and of the Kyoto Protocol since 2007. As a non-Annex I member country, BiH is not required to decrease its greenhouse gas (GHG) emissions. However, it is obligated to report on its national GHG emissions, to systematically observe and research the climate and the climate change impact and vulnerability of its natural resources and economy, as well as to identify measures of adaptation to climate change.

In BiH at state level, MOFTER is responsible for coordinating activities and international relations in the environmental sector. However, at the entity level the environmental issues in BiH are the responsibility of the entity governments, namely, the Ministry of Environment and Tourism of Federation of BiH; the Ministry of Spatial Planning, Civil Engineering and Ecology of Republic of Srpska (the seat of the UNFCCC Focal Point for BiH) and the Department for Communal Works in Brčko District.

Bosnia and Herzegovina submitted its Initial National Communication (INC) to the UNFCCC in 2010 and its Second National Communication (SNC) in 2013. Third National Communication (TNC) is currently being prepared and it is expected to be submitted by the end of 2016. Designated National Authority (DNA) for implementation of Nationally Appropriate Mitigation Actions (NAMA) has been established. Intended Nationally Determined Contribution (INDC) report was adopted in October 2015.

10.1 Climate change projections under the IPCC SRES scenarios

Measurements in BiH have shown an increase in mean annual temperature between 0.4 and 0.8 °C during the period 1981-2010 with respect to the reference period 1961-1990. The temperature increase has been noted in all seasons, but it is most pronounced during the vegetation period (up to 1°C). Although a significant change in the precipitation amount has not been observed during this period, a decrease in the number of days with rainfall over 1 mm and an increase in the number of days with intensive rainfall have caused a change in annual rainfall distribution. Observed temperature growth and change in precipitation pattern have increased climate variability and the occurrence of extreme events in BiH.

In the BiH's SNC analyzed are climate change projections under the A1B and A2 IPCC SRES scenario for the two future periods: 2001-2030 (under the A1B) and 2071-2100 (under the A1B and A2). Results are obtained using the coupled regional climate model EBU-POM to dynamically downscale simulations of two global climate models, namely SINTEX-G and ECHAM5.

All projections indicate higher temperature in all seasons over the territory of BiH with respect to the reference period 1961-1990. The mean annual temperature increase varies from 0.4-1 °C for the period 2001-2030 under the A1B scenario to 3.4-4 °C for the period 2071-2100 under the A2 scenario. In all simulations, the largest temperature increase is projected for summer months (June, July, August), from 0.5-1.4 °C for the 2001-2030 under the A1B scenario to 4.6-4.8 °C for the 2071-2100 period under the A2 scenario.

Precipitation change projections vary for different simulations. For the period 2001-2030 under the A1B mean annual precipitation change ranges from -20 to +10 % with respect to the referent period (1961-1990). Precipitation increase is projected in the northeastern parts of BiH, thus in northwestern parts of the DRB, while precipitation deficit increases to the southwest, i.e. upstream the DRB.

For the period 2071-2100 all simulations predict annual precipitation decrease from 0 to 30 %. Some projections show increase in seasonal precipitation during the winter and spring in some parts of BiH (up to 30%), whilst all converge towards summer rainfall deficit up to even 50% in comparison to the referent period. Annual precipitation change in the BiH part of the DRB is negative in this time period and it is smaller under the A2 (up to -15% in the central and southern parts of the DRB) than A1B scenario (up to -20% in the most southwestern parts of the DRB).

10.2 Ensemble climate change projections under the RCP scenarios

In order to estimate climate change and its uncertainty in the DRB under the IPCC Representative Concentration Pathways (RCP) scenarios, an ensemble of RCMs has been created. Four RCMs have been selected from Med-CORDEX project (www.medcordex.eu) based on the data availability. Changes in mean 2 m temperature and precipitation are analyzed for two 30-years periods, namely 2011-2040 and 2041-2070, with respect to the reference period, 1961-1990. Two IPCC scenarios were considered: RCP 4.5, as a “middle line” and RCP 8.5 as a GHG intensive scenario.

All RCMs under the RCP 4.5 scenario project a temperature increase over the entire DRB in all seasons for both future periods. For the 2011-2040 period the ensemble median shows an increase in mean annual temperature of 1.1 °C with respect to the reference period, averaged over the BiH part of the DRB. The largest heating is projected for summer season (JJA) of 1.4 °C, while the smallest change is expected in autumn (SON), 1 °C. Winter (DJF) and spring (MAM) changes are about 1.2 °C. For the 2041-2071 period, projected heating in all seasons is larger than in previous period. Ensemble median shows a mean annual temperature increase of 2 °C for the BiH part of DRB. Summer season again has the largest heating of 2.5 °C, smallest increase is predicted in spring (1.7 °C), while in winter and autumn expected change is about 2.1 °C with respect to the reference period.

Ensemble median of annual precipitation change shows a decrease under the RCP 4.5 in both future periods for the BiH part of the DRB, with drying during spring and summer and winter and autumn as seasons with more precipitation. For the period 2011-2040, the annual precipitation decrease is about -1% with respect to the 1961-1990 period. However, spatial distribution of the ensemble median is uneven, with a precipitation increase in northern parts (up to 5% for MAM and DJF and up to 10% for DJF and SON) and smaller increase or deficit in the south regions of the BiH part of the DRB (increase up to 5% for DJF, decrease up to -10% for MAM and SON and -15% in summer). For the latter period, 2041-2070, the ensemble median annual precipitation change is larger in almost all seasons. Annual precipitation change averaged over the BiH part of the DRB is -5%, increase in autumn and winter is 5 and 9% respectively, decrease in spring is -3%, while the largest deficit is projected in summer, about -30%. Once again northern parts expect precipitation increase in most seasons (up to 15% for DJF, 10% for SON and 5% for MAM). During summer most severe change, up to -40%, is projected in western, southern and northernmost parts and slightly smaller, up to -30%, in the remaining BiH part of the DRB.

Table 10-1: Ensemble median seasonal temperature and precipitation change averaged over the BiH part of the DRB under the RCP 4.5 scenario.

	(2011-2040) - (1961-1990)		(2041-2070) - (1961-1990)	
	Temperature anomaly (°C)	Precipitation change (%)	Temperature anomaly (°C)	Precipitation change (%)
Winter (DJF)	1.2	5.2	2.1	8.6
Spring (MAM)	1.2	-3.2	1.7	-3.2
Summer (JJA)	1.4	-3.5	2.5	-30.3
Autumn (SON)	1.1	3.4	2.1	4.8
Annual	1.1	-1.3	2.0	-5.0

Under the RCP 8.5 scenario all RCMs predict temperature increase in all seasons larger than those under the RCP 4.5 in both periods, although intra-seasonal changes are less pronounced. Ensemble median of mean annual temperature averaged over the BiH part of the DRB show an increase of 1.4 °C for 2011-2040 in respect to the reference period. Seasonal changes are 1.3 °C for DJF, MAM and SON and 1.5 °C in summer. In the latter period, 2041-2070, annual temperature increase is projected to be 2.7 °C, while seasonal changes are in the range from 2.5 °C in spring to 2.8 °C in summer.

Ensemble median of annual precipitation change averaged over the BiH part of the DRB shows overall decrease of -3% for 2011-2040 in respect to the reference period. An increase is projected in winter (5%), in autumn and spring there is virtually no change, while in summer precipitation deficit of about -8% is expected. Precipitation increase is simulated for northern parts of the BiH area of the DRB in winter (up to 10%), spring and autumn (up to 5%), while in the rest of the region smaller increase in expected during winter (5%) and decrease in spring and autumn (up to -5% and -10% in the southernmost parts). Summer season is expected to be dryer in all BiH areas of the DRB, but less in northern parts (-5%) and more in the rest (-10% and up to -15% in the middle of the basin and southernmost areas). For the period 2041-2070 projected annual precipitation decrease is about -8%, in spring -4%, autumn -9% and summer -30%, while winter is the only season with projected surplus of about 3% in respect to the reference period. Spatial distribution of the ensemble median precipitation change in winter shows an increase of about 10% in the middle areas of the BiH part of the DRB and 5% in the rest. In spring, projected increase in precipitation is about 5% in the southern parts, while in other areas precipitation deficit is expected up to -5% in the middle and -10% in the south. During autumn precipitation deficit is changing zonally, from -5% at the north to -15% in the south. Summer change is once again the most severe ranging between -20 and -40% in the southernmost and middle parts of the basin.

Table 10-2: Ensemble median seasonal temperature and precipitation change averaged over the BiH part of the DRB under the RCP 8.5 scenario.

	(2011-2040) - (1961-1990)		(2041-2070) - (1961-1990)	
	Temperature anomaly (°C)	Precipitation change (%)	Temperature anomaly (°C)	Precipitation change (%)
Winter (DJF)	1.3	5.1	2.7	3.2
Spring (MAM)	1.3	0.0	2.5	-4.0
Summer (JJA)	1.5	-8.1	2.8	-29.6
Autumn (SON)	1.3	0.3	2.6	-8.9
Annual	1.4	-2.5	2.7	-8.1

Uncertainty of the projected temperature and precipitation change is bigger for the period 2041-2070 than for the 2011-2040. Summer and spring season have the largest ensemble span for the temperature change, in both periods and both scenarios. Range for the precipitation change is more or less uniform across the seasons, with an exception of summer that has the largest ensemble span. This difference is more pronounced in the second period, 2041-2070, for both scenarios.

10.3 Impact of climate change on hydrological regime

BiH's SNC identifies water resources, agriculture, forestry, biodiversity and human health as the most vulnerable sectors to climate change. At the same time, there is a lack of hydrological and crop modelling and identification and protection of the most vulnerable areas and species.

Observed and projected temperature growth alongside with the change in the annual precipitation distribution and precipitation deficit, especially during the summer months, reduction in summer river flows and increase in the frequency and intensity of heat waves, droughts and floods that will be more widespread and last longer. Temperature increase during the winter months will reduce snowfall and influence the water budget. Since 2000, there have been five years in BiH were very dry to extremely dry drought conditions have prevailed (2000, 2003, 2007, 2011, 2012) and five years where there have been extreme flood events.

Climate change impacts in agriculture include earlier start and longer vegetation period due to the temperature increase and higher irrigation demands due to the reduced precipitation, especially during the summer, and increased evapotranspiration. This may lead to reduced yields and increased occurrence of agricultural pests and crop diseases. Positive effects of climate change may enable breeding of late crops and Mediterranean crops, as well as lower frost risk during the winter and spring.

In forestry, climate change may cause transformation of forest ecosystems, higher tree mortality due to pests and diseases, while higher temperatures may increase the risk of forest fires.

The Water and Climate Adaptation Plan (WATCAP) for the Sava River Basin (World Bank, 2015) assessed the climate change impacts to hydrological regime in this basin for the periods 2011-2040 and 2041-2070, under the A1B scenario. Results of five different regional climate models were used as an input to the HEC-HMS hydrologic model that was developed for the whole Sava River Basin. The DRB is represented in the model by five sub-basins. The only hydrological station in BiH's part of the DRB included in the hydrologic model is the Foča station on the main Drina River. Median values of five simulations show a very small increase in annual streamflow for the period 2011-2040 with respect to the referent period 1961-1990 over whole DRB (Foča station 0.9 %, the Drina mouth 2.9%). Seasonal flow projection decreases only in the spring season, while the largest increase is shown for the winter season, over the whole DRB. For all seasons, a larger change is noted at the Drina River's mouth in comparison to the Foča station.

Median values for the period 2041-2070 show larger changes at both points for all seasons, but smaller change in annual flow (-0.5% for the Drina mouth and 1% for the Foča station). Negative change of streamflow is noted in the summer and spring, and it is larger during the summer, while winter and autumn show streamflow increase. For all seasons, except for the winter, larger change is noted at the Drina River's mouth than at the Foča station.

11 Monitoring

11.1 Monitoring infrastructure

11.1.1 Introduction to Monitoring

The goal of monitoring is to ensure prompt system observation, provide information required for system management and operation and create conditions required to comprehend situation and behaviour of natural and water management (technical) systems. Monitoring also has to create conditions required to evaluate environmental impacts on the system and vice versa, including evaluation of change tendencies in time and space.

For example, meteorological monitoring systems provide data on weather, while hydrological ones provide data on discharges and water levels in rivers, lakes and storages, as well as data on groundwater. Such information can be used in control of natural catastrophes and can support water resources management decisions.

Technological advances have made the automation of hydrological and meteorological networks increasingly affordable and also attractive to planners and policy makers.

Still, the development of a monitoring network is not an easy task. Many projects do not manage to tailor monitoring systems to meet beneficiary needs. In less developed countries it may be difficult to establish sustainable monitoring and this calls for serious decisions, like choosing between a robust system without real-time data, or less reliable real-time system etc.

Shortage of O&M specialists can also present a serious challenge to reliable operation of monitoring systems.

Successful monitoring is also a pre-requisite for implementation of international treaties and directives (WFD, for example).

11.1.2 Types of Monitoring

In this section some common monitoring activities are presented. These comprise of different kinds of monitoring activities, including:

- Hydrological,
- Meteorological,
- Environmental etc.

Hydrological monitoring
Hydrological monitoring includes:

- Surface water monitoring and
- Groundwater monitoring.

Collected surface water data includes:

- Discharges,
- Water levels,
- Water temperature,
- Sediment transport data etc.

Surface water regime is defined on the basis of measurements, using analyses of principal hydrological characteristics required to perceive total available surface water quantities, and their spatial and time distribution. Average discharge is a feature of the water regime and describes the water abundance in the basin area.

The following types of data records are observed in the hydrological stations:

- Water level in the river profile. Continuous water measurement in the river profile generates the level curve. Generating dependency between the level and measured discharge provides the "discharge curve". The hydrograph in the profile – the discharge, is generated indirectly by reading the discharge curve.
- Discharge in the river profile. Modern measurement instruments are used to measure discharge in the river profile directly.

Hydrological image of the basin should be complemented with discharge information from the dam profiles (hydraulic structures), as the dam profiles are a kind of "control point" in the basin. Dam profiles are the places of observation of:

- Level on the dam profiles. Levels measured are the headrace and/or tailrace water levels used as the energy, i.e. balance parameters.
- Discharge on a hydraulic structure is the measurement of the discharge on:
    - Power plant / Pumping station,
    - Spillway,
    - Outlet or
    - Tunnel/Penstock.

Regarding monitoring of surface water quality, WFD, for example, defines three types of monitoring:

- Surveillance monitoring,
- Operational monitoring and
- Investigative monitoring.

Surveillance monitoring is aimed at monitoring large-scale and long-term development of natural conditions and impacts of human activity. It can be performed by both hydro-meteorological services and river basin agencies. Due to its large-scale and long-term perspective it can be used in order to coordinate the design of programs developed at the national level and to ensure international reporting. This type of monitoring shall be performed in order to provide overall surface water status within the DRB, especially within lakes, storages and main Drina River tributaries. Special attention should be given to estimation of pollution transfer within the basin. Typical parameters to be monitored include the ones related to water quality (biological, chemical etc.), as well as pollutants.

Operational monitoring is aimed at monitoring of water bodies considered to be at risk with respect to environmental quality and to assess changes in their status due to the application of anti-pollution measures. It is generally performed for water bodies endangered by a significant point source or significant diffuse pollution.

Investigative monitoring is performed in relevant cases of pollution, which is not sufficiently investigated at present.

Collected groundwater data usually includes:

- Levels and
- Water quality.

Groundwater level monitoring requires the use of wells for piezometric level observations. The necessary number of such wells depends on a number of parameters and should be increased in areas where water abstraction rates are high or their impact is now known.

Groundwater quality monitoring requires the existence of adequate wells. The main sources of pollution of groundwater are urban, industrial and agricultural activities, due to lack of communal wastewater collection network, wastewater treatment plants, incorrect use of fertilizers etc.

Meteorological monitoring
Meteorological stations are used to observe the following types of data:

- Air temperature is one of the basic climatologic elements. Its direct functional dependency is linked to the latitude (radiation balance, i.e. duration of insolation), longitude and altitude.
- Relative air humidity is a degree of air saturation with water vapour.
- Waterway regime directly or indirectly depends on the rainfall in the basin area. Therefore, rainfall is the most important climatologic element.
- Water vapour pressure is used as the measure of the water content (while in state of vapour) in air.
- Water table evaporation is dependent upon the climatologic area, also very important for the water balance.
- Cloudiness is the sky coverage by clouds in tens of coverage or in %. It depends on vertical movement of air masses.
- Insolation is the duration of sunshine.
- Wind is a very important climatologic element and is often considered as a determining factor of the climate area.

Beside these parameters, it is also necessary to measure the snow layer thickness and water content in snow, if it is possible. Water content in snow is especially important during winter months and spring.

Data from the meteorological stations are required to perceive the climate of an area, i.e. indirectly to assess the water regime. The climate of an area is conditioned by the geographic position and land relief.

11.1.3 Classification of Monitoring Stations

In accordance with the information presented in the previous section monitoring station networks are composed of the following types of stations:

- Hydrological (surface) stations,
- Surface water quality measurement stations,
- Groundwater level measurement stations
- Groundwater quality measurement stations and
- Meteorological stations.

Some types of stations can be combined, i.e. established at the same site.

Hydro-meteorological services have a special meteorological stations classification, as follows:

- main stations,
- regular stations,
- climate stations and
- precipitation stations.

The principal difference between main and regular meteorological stations is in the number of measured parameters and measurement frequency.

Main meteorological stations measure:

- Temperature (once per hour),
- Relative humidity (once per hour),
- Cloudiness – type and quantity (once per hour),
- Wind direction and speed (once per hour),
- Air pressure (once per hour),
- Insolation (once per hour),
- Visibility (once per hour),
- Prevailing weather type (once per hour),
- Precipitation type (once per hour),
- Precipitation quantity (once per six hours),
- Minimum and maximum temperature (twice per day) and
- Snow layer thickness (twice per day).

Main meteorological stations are operated by their staff and measurements are made "manually". Most main stations are equipped with additional automatic stations that record principal parameters, most often with a 10-minute time step.

Regular meteorological stations measure principal parameters once per six hours; the measurement process stops after 6 PM UTC (Coordinated Universal Time), sometimes even after 3 PM UTC. Precipitation quantity is measured once per day. These stations are less suitable for operative use than the main ones.

Climate and precipitation stations deliver measured data once per month, unless they are automatic. Most of them are not automatic, but operated by the staff that performs measurements once or twice per day; these measurements are sent to corresponding hydro-meteorological services once per month. These measurements are not used for operative (daily) monitoring activities, but only for analyses a posteriori.

11.1.4 Monitoring infrastructure in DRB

In order to obtain a reliable hydrological and meteorological data related to DRB it is necessary to set-up a network of monitoring stations fulfilling the necessary criteria in terms of the quality and quantity of observed data, balanced spatial distribution of monitoring stations and sufficiently long historical data series.

The information presented in this section was collected from a number of sources, including Consultant's archives, hydrologic and meteorological yearbooks etc.

Some information has been collected by means of the questionnaire sent to all relevant entities in the DRB that are managing own monitoring systems or using other ones.

Historical development - situation in SFRY

Some 99% of the DRB area stretches over the three states that formerly belonged to SFRY. In order to better comprehend the present situation, it is useful to gain an insight into historical development of the DRB monitoring network.

It can be estimated that in SFRY just before the war there were some 76 hydrological stations and 90 meteorological stations.

After the breakup of SFRY, existing monitoring stations were transferred to jurisdictions of newly created states. Some of the stations continued their operation, some did it with certain interruptions, some ceased to operate and some new stations were established. The following Table 11-1 shows all previously operational hydrological stations.

Table 11-1: Previously operational hydrological stations with historic data

No.	Name	River	Position of the measurement station	
			X	Y
1	Goražde	Drina	7337398	4837909
2	Badovinci	Drina	7369130	4960360
3	Bajina Bašta	Drina	7383990	4871480
4	Bistrica	Bistrica	7396060	4814901
5	Brodarevo	Lim	7396575	4788072
6	Čedovo	Vapa	7420785	4796194
7	Kokin Brod	Uvac	7402773	4820049
8	Kozluk	Drina	7351316	4931468
9	Krstac	Vapa	7419319	4797980
10	Lešnica	Jadar	7363341	4944895
11	Man. Mileševo	Mileševka	7395835	4803865
12	Mihaljevići	Drina	7369387	4897228
13	Priboj	Lim	7382190	4825580
14	Prijepolje	Lim	7389726	4804692
15	Prijepolje	Mileševka	7392220	4805540
16	Radalj	Drina	7352865	4920900
17	Radijevići	Uvac	7411598	4807087
18	Uvac	Uvac	7378980	4829975
19	Vardište	Crni Rzav	7373795	4847002
20	Zavlaka	Jadar	7379409	4924284
21	Zvornik	Drina	7349632	4917940
22	Bastasi	Drina	7322602	4804609
23	Foča Aladža	Ćehotina	7320972	4820072
24	Foča Most	Drina	7320572	4821159
25	Foča uzvodno	Drina	7319992	4819857
26	Igoče	Sutjeska	7318858	4804691
27	Kušlat	Drinjača	7349861	4905589
28	Međeđa	Drina	7353553	4844456
29	Mesići	Prača	7338582	4847585
30	Oplazići	Bistrica	7317540	4819180
31	Orahovci	Drina	7358445	4846764
32	Otričevo	Prača	7340466	4845012
33	Rogatica	Rakitnica	7340237	4851606
34	Rudo	Lim	7368805	4830610
35	Strgačina	Radojna	7357122	4838557
36	Strmica	Lim	7356578	4839613
37	Šekovići	Drinjača	7329920	4907860
38	Ugljevik	Janja	7342100	4952030
39	Umac	Zeleni Jadar	7348950	4904427
40	Ustibar Most	Poblačnica	7372093	4828057
41	Ustiprača	Prača	7345727	4840647
42	Vikoč	Ćehotina	7333568	4813535
43	Višegrad Lipa	Rzav	7364541	4850065
44	Višegrad most	Drina	7362625	4850022
45	Andrijevica	Lim	7401956	4732887
46	Bakovići	Plašnica	7378300	4745710
47	Berane	Lim	7408181	4746979
48	Bijelo Polje	Lim	7397540	4765600
49	Bioče	Lješnica	7407110	4754753
50	Biogradsko jez.	Biogradsko jez.	7386323	4750842
51	Bistrica	Tara	7373450	4763530
52	Crna Poljana	Tara	7380741	4737662
53	D. Vusanje	Grlja	7404800	4710569
54	Dobrakovo	Lim	7401294	4778514
55	Dužki Most	Komarnica	7332740	4764163
56	Đulići	Zlorečica	7401181	4728233
57	Đurđevića Tara	Tara	7361982	4778852
58	Gradac	Ćehotina	7350428	4807092
59	Gubavač	Bjelop. Bistrica	7400958	4774398
60	Gusinje	Grnčar	7404974	4713975
61	Kolašin	Tara	7379100	4743970
62	Krstac	Piva	7325895	4786469
63	Pivski Manastir	Sinjac	7323612	4775534
64	Plav	Lim	7412386	4719339
65	Pljevlja	Ćehotina	7367120	4801070
66	Podbišće	Štitarica	7383298	4754681
67	Pošćenje	Komarnica	7342893	4762423
68	Ravna Rijeka	Ljuboviđa	7396897	4761146
69	Šavnik	Bijela	7345448	4756875
70	Šavnik	Bukovica	7345990	4758140
71	Šcepan Polje	Tara	7326461	4803126
72	Šćepan Polje	Piva	7326010	4801260
73	Široki Profil	Pridvorica	7341990	4758811
74	Tepca	Tara	7344158	4787606
75	Trebaljevo	Tara	7379933	4747489
76	Zaton	Lim	7400840	4762032

The following Table 11-2 shows all previously operational meteorological stations in the entire DRB.

Table 11-2: Previously operational meteorological stations with historic data

No.	Name	Position of the measurement station		Value observed
		X	Y	
1	Andrijevica	7402149	4733344	r
2	Bajevo Polje	7328844	4765696	r, t, h
3	Berane	7407639	4744419	r, t, h
4	Bijelo Polje	7398214	4766778	r, t,
5	Bistrica	7373670	4763233	r, t
6	Đurđevića Tara	7361175	4781071	r
7	G. Bukovica	7349193	4767201	r
46	Prača vrelo	7305722	4845840	r, t
47	Rogatica"PE"	7339751	4852734	r
48	Sokolac	7323604	4869666	r
49	Strmica	7356798	4839565	r
50	Šekovići	7328225	4908584	r
51	Tjentište	7313292	4803454	r, t, h
52	Vikoč	7330983	4811732	r

No.	Name	Position of the measurement station		Value observed
		X	Y	
8	Grabovica	7343380	4767485	r
9	Kolašin	7379906	4743873	r, t, h
10	Kosanica	7364374	4787453	r
11	Krnja Jela	7361312	4754069	r
12	Mojkovac	7384531	4757579	r
13	Mratinje	7322382	4793569	r
14	Nikšić	7332521	4738901	r, t, h
15	Plav	7413053	4718451	r, t, h
16	Plužine	7324765	4780147	r
17	Pljevlja	7365876	4802289	r, t, h
18	Podgorica	7359843	4700103	r, t, h
19	Rožaje	7432137	4744694	r, t,
20	Stožer	7380803	4776070	r
21	Šavnik	7344893	4758076	r, t,
22	Šcepan Polje	7326122	4803849	r
23	Žabljak	7347998	4779583	r, t, h
24	Bukovik	7417834	4809085	r
25	Goražde	7336014	4839967	r, t, h
26	Kalesija	7331262	4924795	r, t, h
27	Kladanj	7314766	4901377	r, t, h
28	Osječani	7331293	4845412	r
29	Bijeljina	7361320	4956157	r, t, h
30	Borike	7348327	4862468	r, t, h
31	Crkvine	7371566	4741787	r
32	Čemerno	7306514	4792244	r, t,
33	Dobro Polje	7298372	4831988	r
34	Drinjača	7346136	4905317	r
35	Foča	7320929	4822106	r, t, h
36	Grabovica	7328083	4899303	r
37	Gradac	7351042	4808019	r
38	Han Pijesak	7335900	4884932	r, t, h
39	Kalimanići	7337664	4865782	r
40	Kalinovik	7293651	4821492	r
41	Kovačevići	7348654	4834038	r
42	Kramer Selo	7331485	4858406	r
43	Metaljka	7350024	4823353	r, t, h
44	Nadromanija	7311436	4864302	r
45	Prača	7319242	4849315	r, h

No.	Name	Position of the measurement station		Value observed
		X	Y	
53	Višegrad	7360284	4851532	r, t, h
54	Vlasenica	7334731	4897348	r, t, h
55	Vranići	7331127	4834276	r
56	Vrbnica	7310475	4810479	r
57	Zelengora	7287506	4811563	r
58	Zvornik	7347869	4918199	r, t, h
59	Aljinovići	7406512	4800160	r
60	Bajina Bašta	7384059	4871487	r, t,
61	B. Koviljača	7357171	4933926	r
62	Basare	7422794	4814973	r
63	Brodarevo	7396968	4789063	r
64	Buđevo	7423327	4778602	r
65	Desić	7383149	4944011	r
66	Dobroselica	7395836	4831770	r
67	Duga Poljana	7437039	4790390	r
68	Džurovo	7388498	4815790	r
69	Gostinica	7404270	4865083	r
70	Goševo	7410507	4777867	r
71	Jagodići	7393436	4885628	r
72	Krupanj	7369622	4915508	r
73	Loznica	7357856	4936049	r, t, h
74	Ljubovija	7371033	4894757	r, t, h
75	Mali Zvornik	7350815	4916916	r
76	Mokra Gora	7378446	4850449	r
77	Nova Varoš	7403862	4815023	r
78	Perućac	7373083	4870002	r, t,
79	Planina	7358948	4913756	r
80	Priboj	7380958	4826295	r
81	Prijepolje	7390283	4805809	r, t
82	Rogačica	7390765	4877574	r
83	Sjenica	7420051	4792696	r, t, h
84	Tara-Mitrovac	7373782	4865814	r, t, h
85	Tekeriš	7381754	4935835	r
86	Ugao	7423984	4768616	r
87	Uvac	7378302	4831885	r, t,
88	Zabrđe	7364575	4826176	r
89	Zaovine	7368080	4859916	r
90	Zlatibor	7395904	4844767	r, t, h

Legend: r – rainfall, t – temperature, h – humidity, s – snow layer thickness, v - wind

Present situation
Presently in BiH there are 2 active hydrological stations (one in RS and one in FBiH) and in 19 active meteorological stations (18 in RS and 1 on FBiH).

Due to its volume, the data on presently active hydrological stations in BiH are given in Annexes 11-1 (Republic of Srpska) and 11-2 (Federation BiH), while the data on meteorological stations are given in given in Annexes 11-3 (Republic of Srpska) and 11-4 (Federation BiH).

11.2 Organisation of the Monitoring

11.2.1 Overview of monitoring organisations in DRB

Monitoring in DRB is performed by a number of organization, including:

- Ministries and related institutions,

- Electric Power Industries,
- Organizations involved in meteorology, hydrology, WRM and geological observations,
- Water supply and sewage companies,
- Fisheries,
- Small hydropower plants etc.

An overview of the most important organizations is given in the following Table 11-3.

Table 11-3: Most important institutions concerned with monitoring in the DRB

Item	Serbia	Montenegro	RS	FBiH
Basin area (km^2)	6,002	6,219	6,242	840
Basin area percentage (%)	30.5	31.6	31.7	4.2
Percentage of the territory covered by the basin (%)	7.7	45.0	25.7	3.2
Separate Ministry of water resources management	NO	NO	NO	NO
Ministries	MAEP EPA State Water Directorate Ministry of Internal Affairs Sector for emergencies	MARD Directorate for WRM	MAFWRM	MAWRMF MOFTER
Electric Power Industry	EPI of Serbia HPPs on Drina River and Lim River	EPCG	Electric Power Industry of Republic of Srpska "Hydropower Plants on Drina River" a.d. Višegrad	Electric Power Industry of BiH
Public companies	State HMS of Serbia Srbijavode	HMSS GSS	State HMS Public institution "Water of RS WRM Service Water Institute Bijeljina	Federal HMS Water Agency for Sava River District

MAEP =Ministry of Agriculture and Environmental protection, EPA = Environmental Protection Agency, MAFWRM = Ministry of Agriculture, Forestry and Water Resources Management, MAWRMF = Ministry of Agriculture, Water Resources Management and Forestry, MOFTER = Ministry of Foreign Trade and Economic Relations of BiH, HMS = Hydro Meteorological Service, EPCG = Electric Power Industry of Montenegro EPI = Electric Power Industry, HMSS = Hydro-Meteorological and Seismologic Service, GSS = Geologic Survey Service, WRM = Water Resources Management, FBiH = Federation of Bosnia and Herzegovina

11.2.2 Overview of Monitoring organisaitons in BiH

The organizations actively involved in monitoring in the part of the DRB in Federation BiH are:

- Federalni hidrometeorološki zavod (Federal Hydro-Meteorological Service),
- JP "Elektroprivreda BiH" (PC "Electric Power Industry of BiH"),
- Agencija za vodno područje rijeke Save (Water Agency for Sava River District) and
- International Sava River Basin Commission (regional organization).

The organizations actively involved in monitoring in the part of the DRB in Republic of Srpska are:

- Republički hidrometorološki zavod (State Hydro-Meteorological Service),
- Javna ustanova "Vode Srpske" (Public Institution "Waters of Republic of Srpska")
- " Institut za vode Bijeljina" ("Water Institute" Bijeljina),
- " Elektroprivreda Republike Srpske" ("Electric Power Industry of Republic of Srpska "),
- ZP "Hidroelektrane na Drini" (DC "Hydropower Plants on Drina River Višegrad"),
- Ministarstvo poljoprivrede, šumarstva i vodoprivrede Republike Srpske (Ministry of Agriculture, Forestry and Water Resources Management of Republic of Srpska) and
- International Sava River Basin Commission (regional organization).

More information on most important organizations is given in Annex 13-2.

11.3 Data exchange

11.3.1 Data management

Introduction
Possibilities of data exchange are to large extent determined by methods of management of collected data. There are various recommendations and coordination bodies dealing with the issues of data management globally and in the region (WMO Commission for Hydrology, WHYCOS program etc.).

Data management in BiH institutions
There is a number of data management and information systems used by BiH organizations, including:

- Hydras (Federal HMS, HMS of RS and PUC "Elektroprivreda BiH"),
- Demas (FHMS and RHMS RS),
- CLIDATA (Federal HMS) and
- MCH (HMS of RS).

Hydras 3 data management system for hydro-meteorological networks is a complete system of data collection, processing, interpretation, evaluation and transfer from sensors and stations. Software system developer is company OTT from Germany. The system includes own database and time series manipulation tools in meteorology, hydrology and water quality monitoring. System also provides dedicated map views, automatic data import and export, precise station data reading control and other useful options.

Demas (Data Evaluation Management Alarm Software) is a software developed by the company SEBA from Kaufbeuren, Germany. The company produces measurement equipment (sensors, data loggers etc.) for flow measurement, monitoring of groundwater level etc. Data acquisition is performed by the means of dedicated software, which includes the following packages:
- DEMASdb: graphical interface for data acquisition and storage and management of data stored in databases developed by the developer, or in standard SQL databases,
- DEMASvis: module for data evaluation and
- DEMASole: module for automatic data transfer from measurement stations etc.

CLIDATA software system is being developed by the Czech company ATACO. This system is an advanced environment for work with climate-related data and is built around an Oracle database. It supports import of data from other systems, text files, databases, as well as extraction of data from paper forms. Data in the system is verified using several levels: upon the data value range for gross errors, upon known correlations, as well as upon tables that contain extreme values. Only verified data can be included into monthly and yearly reports. The system is related to GIS data, so it allows for a variety of analyzes based upon spatial distribution of observations.

MCH is a database intended for management of meteorological, climatologic and hydrological data. The development of this database had started in Mexico, but is now being performed by WMO; now it is available to WMO members upon request. It is generally based upon the MySQL platform. It includes tools for data import and export, visualization of time series and spatial data, as well as the procedures for data validation and quality control. It also includes the tools for entering meta-data and resources (stations, equipment etc.) management.

11.3.2 Global Data Exchange

Global data exchange has been effectuated for quite some time by means of international cooperation and organizations founded for the subject purpose. The most significant is the World Meteorological Organization - WMO established in 1950 on the foundations of the International Meteorological

Organization – IMO, founded as far back as in 1873. In 2013, WMO had 191 members (states and territories) and it now serves as the specialized agency of the United Nations for meteorology, operational hydrology and related geophysical sciences.

Resolution No. 40 issued by the subject organization prescribed the practices in exchange of meteorological and related data and recommendations for commercial activity implementation. Annex I of the subject resolution defined the set of data and products that should be exchanged unconditionally and free of charge. All members of WMO should observe subject recommendations and, thus, data and products defined in Annex I of the Resolution No. 40 have been exchanged in the DRB accordingly.

In May 1999, on XIII Congress of WMO held in Geneva, the Resolution No. 25 has been adopted. Subject resolution is about hydrological data and product exchange. Adoption of the subject resolution mandated WMO members to expand and improve, to the greatest possible extent, free and unlimited international hydrological data and product exchange in accordance with the requirements of WMO in the sphere of science and technical programs to contribute to disaster risk reduction, better population safety and additional socio-economic benefits.

In 2005 was published a report of the Global Climate Observing System - GCOS related to data exchange in global hydrological and meteorological network, where the lack of standards has been identified as the crucial problem. This was repeated in the Hydrological Practice Guidelines of WMO of the Hydrological Commission, in the amended version from 2008.

WMO and the Open Geospatial Consortium – OGC established the joint Hydrology Domain Working Group – HDWG to deal with this problem. Work of HDWG produced the standard WaterML 2.0, adopted by OGC as the official data exchange standard for exchange between the information systems as regards to observation related to hydrological cycle.

Convention on Cooperation for the Protection and Sustainable Use of the Danube River from 1994 ("Official Gazette of FRY", International Treaties 4/03) was based on the standard principles of environmental protection – the principle of prevention and the principle "polluter pays". Subject Convention set the legal, administrative and technical safety measures of sustainable use of all waters in the Danube River basin for the purpose of preserving and recovering the ecosystem and fulfilling other conditions of importance for human health. Subject document defined the data exchange on general conditions of aquatic environment, research results, emissions and measured data, measures undertaken to mitigate cross border effects, on regulations in the field of wastewater and hazardous materials, etc. Also, it has been envisaged to set up a warning and general alarm declaration system within the basin in cases of pollution accidents or floods.

Data exchange issue is also treated in the Water Framework Directive – WFD from 2000. Although the DRB countries are still not EU member countries, activities compliant to WFD have been implemented for the purpose of regulatory harmonization and implementation of pre-accession agreements.

Meteorological data are exchanged between countries by the means of coded SYNOP reports. In this manner are exchanged only the data coming from the main meteorological stations. The data have earlier been available each six hours, then each three hours, and now the data from certain stations are available once per hour –coded and decoded. These data are published on Web sites of hydro-meteorological services of Serbia, Montenegro, Republic of Srpska and Federation BiH, as well as on the sites belonging to various companies and organizations.

Codes used for decoding of SYNOP reports are given at the address:

SYNOP dekode: http://weather.unisys.com/wxp/Appendices/Formats/SYNOP.html

While other meteorological codes are available at:

http://www.usno.navy.mil/NOOC/nmfc-ph/RSS/jtwc/pubref/References/WMOcodes.html

11.3.3 Data Exchange in the Region

The DRB is located in the Western Balkans region which experienced several military and political conflicts in the last twenty years, consequences of which are still visible. Traces of this turbulent period are still present, both in the network of monitoring stations as well as in the water resources management data exchange. However, there are regional initiatives focused on regulating monitoring and data exchange in the field of WRM.

International Sava River Basin Commission (ISRBC) was established to implement the Framework Agreement in the Sava River Basin (FASRB). Its goal is establishment of the international navigation regime, establishment of sustainable water management and undertaking measures of danger prevention and localization. Since the Drina River is the tributary of the Sava River, all initiatives of the subject commission are also related to the DRB. BiH and Serbia are members of the World Commission and are actively participating in implementation of recommendations and decisions. Subject activities are based on international agreements, such as:

- Agreement between the Council of Ministers of the BiH and the Government of the Republic of Croatia on Water Management Relations (entered into force on January 31st 1997) and
- Agreement between the Council of Ministers of the BiH and the Government of the Republic of Croatia on cooperation on protection against natural and civil disasters (signed on June 1st 2001).

Article 4 of the FASRB has regulated data exchange between the members of ISRBC. Subject responsibility related to exchange of hydrological and meteorological data has been analyzed in detail in the Guidelines of Hydrological and Meteorological Data and Information Exchange in the Sava River Basin. Data exchange as regards to publication of the Hydrological Yearbook of the Sava River basin, as well as the integrated web presentation of current water level values, has been based on data exchange related to monitoring stations of line institutions in the ISRBC member countries.

Project of establishment of the Geographic Information System of the Sava River (SavaGIS) is under implementation. The system has been planned to include the Hydrological Information System (HIS). All documents developed in the project and implemented by ISRBC are available for public on http://www.savacommission.org/. Data used for document development have been usually produced by the authorized institutions of ISRBC member countries and granted for use.

After the floods that hit the settlements in the Sava River basin in May 2014, joint data exchange related work has been intensified, especially in emergency cases. Results have been presented in the Preliminary Flood Risk Assessment in the Sava River Basin from July 2014. The report has stressed out the importance of data exchange and regional cooperation in flood prevention and localization of flood damage. It has also pointed to the lack of the bilateral agreements on water resources management between Croatia and Serbia, as well as between BiH and Serbia. Montenegro has been also excluded from bilateral agreements, which is of the special significance for the DRB.

According to the Flood Protection Protocol from the FASRB, ISRBC member countries are obliged to exchange information of significance for flood defence (the protocol has been signed, but still not in effect). Data is exchanged for the Sava River basin management purposes and must not been given to third entities. The organization is allowed to exchange only data collected by its own means. Data ownership is not transferred to the organization receiving data. Upon request, data will be provided within 30 days (60 if processing is required), while regular data transfers are subject to harmonization of time schedule (hourly, daily and similar).

Meteorological data from the main stations in the region are exchanged by the means of SYNOP reports.

A part of these data is publicly available via Web sites belonging to hydro-meteorological services, as well to certain companies and organizations that own automatic stations.

In certain cases are made special arrangements between the companies that perform measurements and users. For example, the "Meteos Media" company performs the six-hours inflow forecasting up to 7 days ahead for the "Piva" HPP, "Potpeć" HPP and "Višegrad" HPP, using the "Meteosar" system. For this purpose, the company uses data collected by 4 automatic stations owned by the "Višegrad" HPP. These data are not publicly available; the same holds true for certain other data related to inflows and discharges on HPP profiles along the Drina River. The company stores its data in a MySQL base.

Transfer of data from the stations owned by the "Višegrad" HPP into the "Meteos Media" company MySQL database is performed via the GSM network and Lambrecht software once per hour.

11.3.4 Data Exchange in the DRB

Data exchange in the DRB is sporadic and disorganized. Although the national hydro-meteorological services are members of the World Meteorological Organization (WMO) and, thus, a limited international data exchange is present, it is very difficult to obtain data from other countries beyond subject limits.

Best practices application can definitely help to achieve improvements in individual institutions, but additional problem in the DRB is the fragmentation of responsibilities between the states and entities.

11.4 Conclusions and recommendations

General position of all entities from the DRB is that there is room for monitoring and data exchange improvements through joint investments and harmonization of development programs. One of the possible directions is development of unified hydrological and meteorological monitoring system for the Drina River Basin.

This system should establish standard platform and procedures for data collection. control and distribution, as well as the usage of the database containing hydrological and meteorological data from the Drina River Basin.

A realistic goal of the monitoring system improvement and prognostic system development would be to provide data with the 1-hour time step (period between submissions of data from automatic hydrological stations would be even shorter).

Hydrological and other analyses performed within this report have also clearly indicated a need for updating and improving the DRB monitoring network and data exchange practice. From the previous sections it is obvious that the number of hydrological stations in DRB used to be considerably higher than it is today. The main problem with the establishment of new stations is their high price.

In general, it can be stated that main deficiencies identified in organization of monitoring and data exchange in water resources management in BiH are lack of organization, conditions of equipment and infrastructure, lack of finances and human resources, as well as the lack of standard platforms and procedures of data management.

Improvement of the present situation includes the following activities:

- Improvement to the monitoring network,
- Improvement to data management systems and
- Improvement to data exchange practices.

11.4.1 Improvements to the monitoring network

It is obvious that the present network of hydrological and meteorological stations needs to be improved. The present number of stations is not adequate and introduction of new stations is necessary.

Monitoring network improvement would include control and calibration of the existing stations, as well as the establishment of new stations in the basin at the locations that are not adequately covered (particularly in the upper parts of the basin).

Regarding the existing stations, it is necessary to improve the operation of stations that provide only manual measurements. At these profiles, it is necessary to add automatic stations, so that water level values can be determined practically in "real" time (each 10, 20, 30 and 60 minutes). Presently in the basin there are stations with measurements available only once per day (at 7 AM), or, sometimes not even once.

In regard of the basin coverage with hydrological stations it can be stated that the situation is particularly unfavorable in case of water quality and groundwater level measurements. This is especially unfavorable in view of the fact that there are no reliable estimations of the capacity of underground reservoirs that receive and store water during certain time periods.

The general guidelines for establishment of new meteorological stations are:

- Basin coverage with meteorological stations should be as good as possible and
- International recommendations require that one meteorological station should be available for each 80 to 100 km^2 of basin area (provided that the spatial distribution of the stations is uniform enough and there are no significant relief changes).

DRB covers an area of almost 20,000 km^2, so at least 200 to 250 stations would be necessary (actually more, as the spatial of the existing stations is also not ideal). As presently there are somewhat more than 100 of stations active, it obvious that there is plenty of room for improvement in this area.

Two further aspects of improvement are equipment check and refurbishment of existing equipment at the stations. One example of the need for refurbishment is related to the damages caused by recent floods. This means that it will be necessary to reassess the characteristics of the discharge profiles and discharge curves for a number of stations, as the reliability of the data is seriously compromised. The Consultant is aware of the fact that such necessary works are very costly and that there are not enough financial resources available within the competent institutions to undertake such activities.

In the same time, it will be necessary to check whether some of the stations are under the influence of existing storages.

In DRB there are many measurement stations that perform measurement for their use (industrial companies etc.) but are not a part of the network. Network conditions could be improved by their inclusion, if it is possible.

It is obvious that there is a number of measurement stations that were active prior to 1990, but are not used any more. It would be beneficial if some of these stations could be reactivated.

It is suggested to check the adequacy of the existing monitoring programs (sampling frequency etc.).

General guidelines for establishment of meteorological stations are:

- Stations should be established in larger settlements, at suitable micro-locations,
- If it is necessary to establish new stations outside large settlements, it is convenient to chose locations close to important roads, from which they can be easily accessed,

- It is necessary to establish a sufficient number of meteorological stations at higher elevations in order to obtain the best possible insight into precipitation in the basin,
- In order to secure meteorological stations, it is recommended to place them in the realms already protected by physical and technical measures and
- Meteorological stations should operate automatically, without any staff.

The lack of meteorological stations is particularly pronounced at higher elevations.

During the establishment of new stations, it is necessary to overcome a number of technical problems. This is especially pronounced if the stations have to be established away from settlements and important roads, i.e. protected areas. Such stations have to be secured physically and technically, using resistive wire-steel fences of certain height (for example 3 m), in order to prevent equipment damage caused by wild animals or people (accidental or on purpose).

It is recommended to equip new meteorological stations with devices for measurement of snow layer thickness and water content in the snow (if this is not possible that it will be necessary to provide an estimation of water quantity base upon the other measured meteorological parameters). On new stations should also be possible measurements of solar radiation intensity, as well as soil humidity and temperature.

To existing stations should at least be added the option of automatic snow layer thickness.

In case that adequate financial means should be available, it is recommended to measure the following parameters on the new stations:
- Temperature,
- Precipitation quantity,
- Snow layer thickness,
- Water quantity in snow,
- Dew point temperature,
- Air humidity,
- Wind parameters at heights of 2 and 10 m,
- Air pressure,
- Solar radiation and
- Soil temperature and humidity at depths of 10, 20 and 50 cm (these measurements are important for the estimation of soil saturation with water and run-off calculation).

In case that only limited financial means should be available, it is recommended to measure the following parameters:
- Temperature,
- Precipitation quantity,
- Snow layer thickness,
- Air humidity,
- Wind parameters at the height of 2 m and
- Air pressure.

This list of parameters is the minimum one and the number of measured parameters should not be reduced any further.

Regarding the order of establishment of automatic stations, it is recommended to first establish the ones located in towns and settlements and then at the locations of "regular" station (according to the WMO classification).

Beside spatial coverage, mentioned above, it is also necessary to analyze the altitude coverage issue. For the entire basin, based upon its properties and adopted criteria (percentage of basin area above certain elevation, average basin elevation, total area, number of existing stations and their elevations), it is necessary to determine the optimum stations' elevation distribution. At the same time, it is necessary to take into account the criterion related to orientation of meteorological stations located at mountain slopes in terms of cardinal directions and prevailing winds.

11.4.2 Improvement to data management system

One of the priorities of data management improvement is an introduction of the data management system and data quality control. Such systems require hardware redundancy and data replication in several locations. To that extent, relevant services should be equipped with the hardware, software and IT experts of the respective service. Clearly, this segment requires significant financing and, thus, it is recommended to adopt regional strategy of procurement of similar or identical data management systems to reduce to cost of use.

At present moment, various institutions in DRB use different data management software platforms. From the communication with the stakeholders, it can be concluded that there is a tendency toward software unification (for example, certain institutions in BiH and Serbia have shown interest in WISKI used by Serbian SHMS). The consultant supports such attitudes, but is also aware that it is difficult to recommend specific activities as the optimum platform, having in mind the serious requirement of some of them (high purchase/subscription price, high software requirements, complex training etc.).

An alternative to software unification would be development of a "roof" platform that would coalesce data previously collected by the means of existing systems.

11.4.3 Improvement to data exchange practices

Improvement to data exchange procedures would include introduction of standard procedures and software, as well as free access to all data for all users.

Initially it would be necessary to develop a study describing the baseline - the capabilities of the software packages presently used by various institutions. The purpose of this study would be to determine whether differences in software platforms among the institutions can be considered the bottleneck for more successful data exchange.

Should this be the case, then the recommended amendments to the data management systems should represent an important step forward.

Another step would be to enforce data exchange obligations on all subjects in DRB. Although there is a significant number of agreement and treaties in power, the result still cannot be considered satisfactory.

Conditions for data exchange are mostly fulfilled and it would also be necessary to develop the roof platform mentioned above. Subjects that collect data would make them available via a Web or FTP server and roof application would gather them and make them available via a dedicated server. The application would be gradually expanded with the modules for data control and validation and other functions.

In this sense, the Consultant supports the application of ISRBC recommendations.

12 Legislative Set up and Framework

This chapter provides an overview of the most important legislation in the water resources management (WRM) sector in Bosnia and Herzegovina (BiH). (The Overview includes legislation valid by the October 2015). Taking into consideration specific features of constitutional organization of BiH as a state, the chapter identifies relevant regulations adopted at State level and then provides detailed presentation of regulations adopted by relevant authorities at entity level in the two entities: Republic of Srpska (RS) and Federation of BiH (FBiH).

As per the assignment defined in the TOR, relevant internal regulations and strategic document, international agreements, relevant EU regulations have been collected and analysed, as well as other documents related to water management, environmental protection and other sectors of relevance for WRM. The chapter highlights the fundamental legal issues of importance for WRM in the Drina River Basin (DRB), and indicates future development of the legal framework and what will be the future impacts on DRB development and management.

12.1 Introduction

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 in FBiH, the Law on Water (LW) ("OG FBiH", No. 70/06). In accordance with the Constitution of FBiH, some cantons have adopted separate laws regulating the water management sector. One of them is Bosansko-Podrinjski Canton Goražde (BPCG) with its Law on Water ("OG BPCG", No. 6/10). 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.

Furthemore, regulations in the environment sector are of special importance for WRM. A complete system of codes in the environmental sector were developed in both entities, and basic regulations on the sector were also adopted in BPCG (within FBiH) and BD. In accordance with the constitutional power, system of regulations in both entities was also developed in other sectors of relevance for water management (e.g. energy, agriculture, transportation, utility services, tourism, fishery, etc.).

I. REGULATIONS IN BIH AT STATE LEVEL

12.2 General Remarks

1) 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. (See list in Annex 12-1).

2) The fact that the system of regulations governing access to information as state level, in addition to regulations governing this sector at entity level, may be of some general relevance for WRM.[37] Rules of the Consultations about Preparation of Legislation were adopted by the Council of Ministers of BiH in

[37] However, according to Ombudsman's assessment, not even 14 years after the start of application of the law no one can say that "transparent and open work of authorities" has been ensured, not one may talk about "developed awareness among both citizens and government representatives of a necessity for authorities to act as prescribed by the Law." Annual Report on the Results of Activities of the Institution of the Ombudsman for Human Rights of BiH for 2014, Banja Luka, March 2015, p. 40.

September 2006 ("OG BiH", No. 81/06, 80/14) to serve as a framework of consultations with public and civil society organizations ministries and institutions are to use in drafting public regulations.

12.3 International Cooperation

In terms of BiH powers[38], activities in the field of international cooperation are of special importance. BiH state level institutions are mainly related to coordination of activities in international cooperation, including signing and implementation of international agreements under which BiH is a member state. The procedure of signing and implementation of international agreements is regulated by a law adopted at BiH state level ("OG BiH", No. 29/2000, 32/13).

Reports on implementation of several international agreements have been prepared and distributed at state level: The Fifth National Report (Convention on Biological Diversity) prepared by BiH in 2014.[39] The Second National Communication (UNFCC submitted by BiH in 2013).[40] The Second National Report on Implementation of the Aarhus Convention in BiH submitted in 2013.[41]

12.3.1 International Multilateral Agreements in the WRM Sector

BiH membership in international agreement in WRM and/or environmental protection and other relevant sectors, in some part, is the result of the SFRY related succession processes, as well as the result of international agreements signed by BiH line authorities. The important issues are as follows (See Annex 12-3 for the full list of agreements).

a) 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 Defence ("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).
b) BiH is not the member of the Protocol on Civil Liability to the Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes and the Convention on the Transboundary Effects of Industrial Accidents.[42] BiH is also not a member of the Convention on the Law of the Non-Navigational Uses of International Watercourses (1997).
c) As regards to the FASRB, the most important problems of implementation of relevance for the DRB are the following issues: flood defence, hydropower plant management, deposit management, water protection and regulating the status of Montenegro.[43]
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". 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.
d) The biggest problems in application of international agreement in the field of water management (and/or of relevance for water gnerally) are related to the fact that bilateral agreements regulating water management relations with Serbia, i.e. Montenegro, have not yet been signed (even though MOFTER has initiated the procedure).[44]
e) It is estimated that cooperation within the Neretva and Trebišnjica River basins is of great importance for cooperation in the DRB.

[38] For details of responsibilities see Chapter 13.
[39] https://www.cbd.int/doc/world/ba/ba-nr-05-en.pdf (19/9/2015)
[40] http://unfccc.int/resource/docs/natc/bihnc2.pdf (19/7/2015)
[41] http://www.unece.org/fileadmin/DAM/env/pp/NIR_2014/Drugi_nacionalni_izvje%C5%A1taj_o_provedbi_Aarhuske_konvencije_u_BiH.pdf (4/6/2015)
[42] Otherwise, the Protocol did not enter into force.
[43] Responses from the Questionnaire: MOFTER, FMAWMF, FMET.
[44] Response from the Questionnaire: MOFTER

12.3.2 International Multilateral Agreements in the Energy Sector

BiH is the member of the Treaty Establishing Energy Community ("OG BiH", No. 9/06), together with seven other members, including the DRB countries: Serbia and Montenegro. In the last meeting of the Ministerial Council of the Energy Community (October 16, 2015), BiH was warned for failure to adopt certain regulations.[45]

BiH as a party to the Energy Community Treaty is liable to implement to *acquis* related to renewable energy sources and shall implement the Directive 2009/28/EC of the European Parliament and Council. By the Decision of the Energy Community Ministerial Council D/2012/04/MC-EnC: Decision on implementing the Directive 2009/28/EC and modification to the Article 20 of the Energy Community Treaty were modified the General national targets regarding the share of energy from renewable sources in the final gross energy consumption in 2020; for BiH the target share of renewable energy sources in the final gross consumption for 2020 amounts to 40%.

12.3.3 Bilateral/Trilateral Agreements and Cooperation

The following issues are important:

a) 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.[46] 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).

b) BiH signed the Agreement between the Government of the Republic of Croatia and the Council of Ministers of BiH regulating water management relations ("OG BiH", No. 6/96) and the Agreement between the Council of Ministers of BiH and the Government of the Republic of Croatia on co-financing maintenance of the regional sewer system Komarna – Neum – Mljetski Canal (signed on July 11, 2004).

c) 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.

d) Agreements on cooperation in some other sectors were signed with Serbia: including tourism ("OG BiH", 08/11), veterinary medicine ("OG BiH", No. 09/11), etc; and also with Montenegro in the field of veterinary medicine ("OG BiH", No. 02/12), and tourism ("OG BiH", No. 12/10), etc.

12.3.4 Other International Multilateral Agreements relevant to WRM and Protection

The following issues are important:

a. BiH is the member of a majority of crucial international multilateral agreement in the environment sector (See the list in Annex 12-3). However, BiH is not the member of the Protocol on Pollutant Release and

[45] Decision of the Ministerial Council of the Energy Community D/2015/10MC-EnC: on imposing measures on BiH pursuant to Article 92(1) of the Treaty; Decision of the Ministerial Council of the Energy Community D/2015/04MC-EnC: on the failure by BiH to comply with certain obligation under the Treaty, https://www.energy-community.org/portal/page/portal/ENC_HOME/INST_AND_MEETINGS?event_reg.category=E14340 (22/10/2015).

[46] Report on the work of the Council of Ministers in 2014, The Council of Ministers, Sarajevo, March 2015, p. 26.

Transfer Registers (PRTR) to the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, as well as the Amendments to the Convention (2005). BiH is not a member of the amendment to the Espoo Convention on Environmental Impact Assessment (EIA) in a Transboundary Context (Sofia, 2001, and Cavtat, 2004) as well as of the Protocol on Strategic Environmental Impact Assessment (SEA) (Kiev, 2003).

b. Regarding membership in international agreements regulating internal waterways navigation, BiH is a member of the European Agreement on Main Inland Waterways of International Importance (AGN), 1996. However, BiH is not the member of the following: Budapest Convention on the Contract for the Carriage of Goods by Inland Waterways (CMNI) (2001) and the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN 2007)

c. BiH signed a Memorandum of Understanding (MOU) on the Institutional Framework of the Disaster Preparedness and Prevention Initiative for South Eastern Europe ("OG BiH", No. 12/08).

12.3.5 Other Forms of International/Regional Cooperation - Euro regions

Territorial units from BiH participate in international cooperation within three Euro regions: Drina-Sava-Majevica (BiH, Croatia and Serbia)[47] and Adriatic-Ionian Euro region (Albania, Croatia, Italy, Slovenia, Montenegro, BiH)[48] and Danube-Drava-Sava (Croatia, Hungary, BiH).[49]

MSDCEEP assessed cooperation within Euro regions as "good". Common projects in the sector of environmental protection (Establishing the "Drina" Biosphere Reserve) are under implementation. Part of the reserve as a transboundary protected area would be protected areas in Serbia: National Park "Tara" and Nature Parks "Mokra Gora" and "Zaovina".

12.4 Harmonization of National Regulations with EU Regulations at BiH Level

BiH is the potential candidate for EU membership. The Stabilization and Association Agreement was signed in June 2008. Interim Agreement on Trade and Trade-Related Matters is in force as of July 2008.

Harmonization of internal regulations with EU regulations is implemented in line with association process dynamics of the potential member country and the results of projects the country decided to take part in. Procedure of harmonization of internal regulations with EU regulations is the part of the legislative procedure on BiH level, i.e. both entities. To that extent, the procedure has been regulated by BiH state level legislation, as well as the legislation in both entities. (For a list of regulations and other relevant documents related to EU integration, refer to Annex 12-2).

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. Authors/proponents of regulations are obliged to supplement draft regulations with instruments of harmonization for compliance control and confirmation by the Directorate of European Integrations. After the analysis, the Directorate issues a compliance opinion. This decision is mandatory for the ministries and other institutions in BiH. Entities and Brčko District BiH, i.e. institutions of the subject tiers of government, conduct their own activities. Sector representatives participate in respective working groups /projects dealing with "strategies" in the environment sector, but they do not analyse the existing legislation on lower tiers of government.

[47] http://euroregiondsm.com/sr/index.php
[48] http://www.adriaticionianeuroregion.eu/index.php?option=com_content&view=article&id=68&Itemid=53&lang=hr
[49] http://www.ddseuro.org/portal/index.php?option=com_frontpage

12.4.1 General Assessment of Harmonization

General assessment indicates that BiH progress in EU integrations is limited and hindered with certain barriers related to dynamics of political and economic reform and the need for strengthening the EU integration coordination instruments. For the purpose of improving EU integrations in all line authorities at all tiers of government, a 2015 – 2018 Reform Agenda and action plan has been adopted.

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 addressed.[50]

For a more detailed assessment of the level of harmonization of individual regulations in the water sector with EU regulations see relevant sections describing the level of harmonization of RS regulations (Section 12.16) and FBiH regulations (Section 12.28).

12.5 Strategic Documents

The Flood Defence and River Management Action Plan (2014 – 2017) for BiH at state level was adopted in November 2014 as a reaction to catastrophic floods caused by rainfall between May 14 and May 19, 2014.

II REPUBLIC OF SRPSKA

12.6 General Review of Regulations Governing Water Management

According to the provisions of the LW ("OG RS", No. 50/06, 92/ 09, 121/12), 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.

12.6.1 Water Areas and Water Bodies

Article 23 of the LW stipulated that "for the purpose of managing waters on the territory of the Republic", the following River Basin Areas have been established: a) Sava River Basin Area, and b) Trebišnjica River Basin Area. The Sava River Basin Area includes one segment of the Sava River basin with sub-basins: Una, Vrbas, Ukrin, Bosna, Drina rivers and basins of other direct tributaries of the Sava River. Trebišnjica River Basin Area includes the Trebišnjica River basin with sub-basins of Mušnica, Sušica, predominant segment of sub-basins of Dubrovačka River (Ombla), with joining ground courses with more than one hundred sources located within the regions from Duboka Ljuta to Metković, and from Metković to Svitansko-Deransko Mud, as well as the relevant segment of the Neretva River basin.

[50]BiH 2014 Progress Report, European Commission, Brussels, 8/10/2014, p. 43.

Based on the aforementioned provisions, Decision on Boundaries of the River Basin Areas (Districts) and Basins on the Territory of the RS ("OG RS"", No. 98/2006) was adopted to set territory of the river basin areas (districts) as principal water management units, "aimed at coordinating measures within specific areas in accordance with the European standards and laws" as follows: a) Sava River Basin Area (district) and b) Trebišnjica River Basin Area (district).

Boundaries of the Drina River basin area are set within the Sava River Basin Area, as a direct Sava River tributary, with pertaining sub-basins (Item 5 of the Decision).

12.6.2 Water Classification and Categorization

According to Article 41 of the LW, Regulation on Water Classification and Watercourse Categorization ("OG RS", No. 42/2001) set criteria for classification and executed classification of surface and ground water quality, as well as watercourse categorization. Classification of surface water has been conducted on the basis of two groups of criteria: general (ecological status of water) and criteria of specific hazardous and toxic substances arriving to water as a result of industrial and other anthropogenic activities.

12.6.3 Water acts and Planning Documents

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.[51]

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).

12.6.4 Monitoring

Article 44 of the LW stipulated that the Water Agency is responsible for realization of the program of water monitoring while only institutions specialized for water and environmental sector that meet the set expertise criteria are responsible for implementation of all activities of water condition monitoring (monitoring) or for just some of them.[52] The Law stipulated adoption of a separate by-law (together with the minister in charge of ecology) to include "description of activities in relation to water condition monitoring and conditions which have to be met by specialized institutions".[53] 11 water management laboratories from RS possess the Resolution on Approval issued by the Ministry of Agriculture, Forestry and Water Management of RS,[54] and

[51] If during the procedure of adoption of the legal water enactment, and especially water guidelines, it has been determined that there are reason that indicate that the facility, installation or proposed activity located or taking place on the territory of the RS will have negative impact on water resources on the territory of the FBiH, line authority of the Republic will obtain opinion of the line authority of the FBiH before adoption of the legal water enactment – Article 1 of the Law on Amendments and Addenda to the LW ("OG RS", 92/09).

[52] Monitoring of surface water's quality, the RS systematically implemented since 2000. By 2007, tests were performed on 15 watercourses and 23 measuring profiles. In 2007, surface water monitoring network has been revised in order to be as far as possible, in line with the Water Framework Directive. The monitoring network for rivers (catchment area of more than 4000 km^2) "is based on the criteria established in the framework of the International Commission for the Protection of the Danube River.". Integrated Water Management Strategy of the Republic of Serbian 2015-2014, Draft, Government of the Republic of Serbian, Banja Luka, June 2015, p. 42.

[53] Meeting of the Coordination Team for Establishment of Unified Monitoring System, established as per the resolution of the Government of the RS from 2013 was held in October 2015 http://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mps/media/vijesti/Pages/M_02.aspx (20/10/2015).

[54] http://www.voders.org/index.php/vp-naknade/laboratorije-za-utvrdivanje-ebs/18-laboratorije (4/9/2015).

the Rulebook has defined the requirements water management laboratories need to meet ("OG RS", No. 44/01).

The rule on environmental monitoring is also stipulated in the Law on Environmental Protection (LEP). Monitoring liabilities are set by virtue of environmental permit.

12.6.5 Minimum Sustainable Discharge (Ecologically Acceptable Discharge)

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) Until the by-law has been adopted, ecologically acceptable discharge will be established on the basis of hydrologic features of water body for characteristic seasons, as minimum average monthly discharge with ninety-five per cent guarantee. 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).

12.6.6 Financing

Financing is a distinct subject of regulation by virtue of a separate chapter of the LW (Chapter XI, Article 188-195). Article 188 of the Law stipulates that resources for performing works and tasks in accordance with the law, functioning and maintenance of real estate and water facilities of general interest, keeping values and constructed water facilities and systems, taking measures of public investment and capital construction of water facilities, according to this law, are provided from: a) special water fees, b) revenue based on rental of public water property, c) general part of budget of the RS and local government units, d) donations.
Regulation on the Method, Procedure and Deadline for Setting and Payment of Special Water Fees and the Decision on Rates of Special Water Fees have regulated subject issues in detail.[55]

“Currently, the biggest deficiency ... is the lack of solidarity in the system, which was the backbone of water management system financing through the general water management charge until the start of this century. General water management charge, or allocation from the republic or local budget, should serve as the backbone of the operational and capital maintenance of water management facilities and assets against harmful water effects, as well as the investment support in case of major investments in the system of defence against water and water protection.”[56]

The LFFEP of RS (“OG RS”, 117/11, 63/14) stipulated that the Fund resources are used to finance environmental protection, energy efficiency and renewable energy sources. Users of the Fund resources may be legal and natural entities.

12.6.7 International Cooperation

LW of RS has no special provisions related to implementing international cooperation, but it indicates international agreements that are compulsory for BiH (Article 2e; Article 21, 29 and 4; Articles 75 and 5; 79 and 4; 129 and 5; 150 etc.). According to provisions of Article 2, purpose of the law, *inter alia*, is "e) fulfilling liabilities arising from international agreements which are obligatory for BiH.”"

According to provisions of Article 21 of the Law, the "RS manages the waters in the way established by this Law and performs duties which BiH has as an international legal entity."

[55] Difficult operational conditions in the water management sector are mainly attached to the inability to set “realistic charges”, i.e. the inability to collect even "reduced charge". Draft Integrated Water Management Strategy of RS 2015-2014, p. 26.

[56] Integrated Water Management Strategy of the Republic of Srpska, Draft, Government of the Republic of Srpska, Banja Luka, June 2015, p. 137, 138. Additionally, it is estimated that there is a “lack of human resources required not only for financing model implementation and development, but for the development of the sector as a whole, as well as a low-level fees polluters or users pay for polluted, acquired or used resources and, thus, create inability to apply the principle of aid and subsidy to those entities investing in protection of and preserving the resources”.

Coordination of plans for river basin management in the international water territories can be additionally regulated by international agreements obligatory for BiH (Article 31. p. 3).

Activities of the Water Agency include, *inter alia*, "Participates in cooperation related to coordination of production of development and implementation of integral plans of water management with responsible organizations from FBiH for the needs of BiH, i.e. with competent international authorities for regions of international river basins." (Article 178),

River Basin District Council, *inter alia*, "considers and gives opinion about any issue from water sector which is important for the RS, BiH, inter- entity cooperation or international obligations" (Article 185). Water Inspection of the RS can cooperate with appropriate neighbouring inspections and exchange information about occurrences, problems and the way of solving specific issues (Article 201).

Cooperation of the RS with the Republic of Serbia and Montenegro
The following applies:

a) RS signed the Agreement on Special Parallel Relations with FRY, i.e. Serbia. Inter alia, the Agreement stipulated developing cooperation in the field of natural resources use and environmental protection.

According to assessment from the Draft Integrated Water Management Strategy, current issues of cooperation with Serbia include: joint development of the lower course of the Drina River, particularly the segment of the river course from the confluence of the Jadar River and the Drina River confluence to the Sava River, including the zone of confluence, coordination of sand and gravel exploitation activities on both sides of the Drina River in line with the goals of regulation and development of the lower course, joint planning and implementation of integrated hydropower systems on the Middle and Lower Drina River, as the project of integrated development, use and protection of the subject river valley, implementation of river power plants with several steps, complex land reclamation and river bank protection, and elaborating the possibility of joint development of the navigable route up to Zvornik, protection of the water quality in the Drina River and its tributary Lim River, aligning pre-typology and typology of surface water on border watercourses in line with the recommendations of the EU WFD.

Segment related to energy, the RS and Serbia have agreed to "establish Mixed Energy Committee aimed at intensifying cooperation, above all, in further integration of electric power systems of Serbia and RS." Before that, line ministers of the RS and Serbia signed with the Italian Minister of Economic Development a common statement on utilization of hydro potentials in the middle course of the Drina River.

For the purpose of improvement of cooperation with Serbia and project implementation in the fields of energy, water management, agriculture, tourism, etc., a project covering 13 municipalities on the territory of Serbia and 12 on the territory of the RS was formulated.

b) It was estimated that the more important issues of cooperation of RS with Montenegro include "solving the acute problem of unsafe and irregular work of HPP Piva, which peak regime operations with sudden load boosts endanger safety in that segment of the river course on the territory of the Republic of Srpska, especially in the zone of Foča; Eliminating ecologically unsustainable operation of HPP Piva"”; ... "Solving the issue of common use of the Tara River for rafting and tourism ..."; "Agreement on common use of the Ćehotina River with the storage in Milovci."

c) MSDCEEP expects the signing of the agreement with three interested parties of the RS, Serbia and Montenegro on prevention of arrival of the floating waste in the Drina River. FHMO, starting from the position that there is an “insufficient focus on the Drina River in the Sava Commission”, has proposed development of the Annex to the Sava River Agreement and has estimated that, except for Slovenia, all other countries are directly interested.

12.6.8 Inter-Entity Cooperation

LW stipulated the rules of inter-entity cooperation related to cooperation between authorities in the procedure of legal water enactment issuing, i.e. announcing, notifying and consulting interested parties and public (Article 130), role and activities of the River Basin District Council (Article 185) and inter-entity cooperation of inspection services (Articles 205, 206). Line water agencies of RS and FBiH are obliged to cooperate within the scope of inter-entity cooperation (Article 31). Procedures and other requirements related to coordination of river basin management plans with respective plans prepared in the FBiH, may be established under mutual memorandums or harmonized by-laws of line ministries.

Certain aspects of inter-entity cooperation have been regulated by the LEP (EIA, SEA, environmental permit, etc.), i.e. by a separate chapter (XII).

12.6.9 Inspection

Inspection oversight of application of present law and by-laws and enactments based on this law is under jurisdiction of the Republic Inspection Authority (Article 196 of the LW).

Inter-entity cooperation of inspection authorities has been regulated in Articles 205 and 206 of the Law.

Performance of certain specialized activities for the needs of inspection oversight (control, expertise and similar) that require special technical equipment and specialized experts or implementation of scientific methods and procedures can be assigned to authorized or qualified institutions (institutions, companies, laboratories) which perform such activities and which are stipulated by the law (Article 207).

Inspection system of the RS is made of the Republic Inspection Authority (Inspectorate) and inspections in local government units (Article 2 of the Law on Inspections in the RS (""OG RS"", No. 74/10, 109/12 and 117/12).[57]

12.6.10 Ensuring Regulatory Compliance

Ensuring regulatory compliance in BiH, as a whole, is often connected with the problems of the rule of law and the problems either inherited or in different ways connected with events that took place former Yugoslavia. Judicial reform is one of the priority goals. Problems in judiciary sector point to the need for strengthening independence and transparency of judicial authorities by building anti-corruption instruments, etc.[58]

As estimated, proceedings related to water inspection filings "are still subject to sluggishness and inefficiency of court proceedings. Out of total 32 violation filings processed by the court in 2014, 14 were subject to conditional sentence, seven proceedings were terminated and eleven were subject to fines (34%). Total amount to fines ruled was 32,700 KM."[59]

Transposition of the Directive 2008/99/EC on Environmental Protection by means of criminal law is at the very beginning.

[57] Planned amendments to this law undergoing adoption procedure in the National Assembly of RS, have set "redefining powers of inspector aimed at creating efficient mechanism for ensuring regulatory compliance and, thus, to, *inter alia*, redefine the powers of the inspectors of the Republic Inspection Authority, as well as of the inspectors in local government units, in terms of allowing all inspectors, i.e. all inspection profiles, irrespective of the type of activity and the powers of inspector, to exercise (specific) inspection oversight ..".

[58] See, e.g., 2015 Alternative Progress Report: Political Criteria, Initiative for Monitoring the European Integration of BiH, Sarajevo, July 2015, http://adi.org.ba/wp-content/uploads/2015/08/Alternativni-izvje%C5%A1taj-o-napretku-BiH-2015.pdf (16/9/2015).

[59] Info on Operations of Republic Inspection Authority in 2014, Republic Inspection Authority, Banja Luka, March 2015, p56

12.7 Regulations in Environment Sector

The environment sector is regulated by a group of separate laws and by-laws. One may speak about a separate system of codes in the environment sector. In addition to the LEP ("OG RS", No. 71/12)[60] , separate laws have regulated fields of air protection, waste management and nature protection.

12.7.1 Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA)

EIA (regulated by the LEP, ("OG RS"", No. 71/12, and respective by-laws) is conducted in two phases: a) During the procedure of previous impact assessment, decision shall be made about: 1) the obligation to prepare the impact analysis, and 2) about the scope of the impact assessment, if impact assessment preparation is obligatory, and b) During the procedure of environmental impact assessment (Article 61).

The Rulebook on projects for which an EIA is underway and on the criteria for deciding on the obligation to conduct an EIA and on the scope thereof ("OG BiH", No. 124/12) stipulated projects that are always subject to impact assessment include, *inter alia*, power industry (hydroelectric power generation facilities_with 5 outputs or more for individual facilities, thermo power plants and other facilities with incineration capacity of 50 MW and more, construction of overhead transmission lines of 220kV and more length of which is 15 km and longer, etc.). Part related to water management includes the obligation of the EIA as follows: 1) pumping underground water or enrichment of underground water where the annual volume of pumped or enriched water is equal to 10,000,000 m^3 and more, 2) hydro-technical facilities for water resources transport 3) wastewater treatment facilities with a capacity for 50,000 person equivalent (PE) or more, 4) dams and other installations for water retention and storage where the water inflow or the water additionally stored is 10,000,000 m^3 and more (Article 2).[61]

SEA has been regulated in Chapter VI of the LEP (Article 48-58). SEA is to be conducted for plans, programs and master plans (plans and programs) in the field of spatial and urban planning or land use, agriculture, forestry, fisheries, hunting, energy, industry, transportation, waste management, water management, telecommunications, tourism, preservation of natural habitat and flora and fauna, that are setting the framework for future development projects stipulated by regulations governing the environmental impact assessment.

BiH is the member of Espoo Convention on EIA in Transboundary Context from 2009, but not a member of the Protocol on Strategic Environmental Impact Assessment.

As assessed, Directive 2001/42/EC is fully transposed through provisions of the LEP and the Rule Book on the Contents of the Report on SEA ("OG RS", No. 28/13), and the Rulebook on Criteria for Deciding on the Obligation to Conduct EIA ("OG RS", No. 28/13).

12.7.2 Access to Information and Public Participation in Decision-Making

Access to information and public participation in decision-making are regulated in special regulations and strongly underlined in the LW. One of the goals of the Law is to "ensure public participation in decision making related to waters, including public access with full, correct and timely information about water conditions, activities undertaken by users or persons polluting water and about activities undertaken by officials and institutions in charge" (Article 2).

[60] Latest amendments and addenda to the Law ("OG RS", No. 79/15, adopted on 10/9/2015), *inter alia*, precisely regulated the procedures related to the environmental impact assessment, environmental permit, etc.

[61] According to provisions of Article 3, projects that are subject to individual Ministry's decision on need to conduct impact assessment, *inter alia*, include 9) hydroelectric power generation facilities (projects that are not covered in Article 2 of present Rule Book), e) waste management: 1) wastewater treatment facilities (projects that are not covered in Article 2 of present Rule Book).

Regulation on the Procedure of Public Participation in Water Management ("OG RS"", No. 35/2007) stipulated the procedure of public participation in application and implementation of the LW by officials and institutions in charge, in accordance with the Law on Free Access to Information and other regulations, as well as participation in the procedure and application of the EU WFD and other regulations. Rules regulating procedure of public participation are stipulated for: 1. Adoption of the Water Management Strategy, 2. Adoption of the Water Management Plans, 3. Adoption of the Water Management Programs, 4. Adoption of individual decisions in water sector by officials and institutions in charge, 5. Proposing regulations governing the water sector, 6. Informing public on operations of authorities and accidents, and 7. Participation in management and operation of the officials and institutions in charge of the water sector.

The LEP also stipulated compulsory elements related to access to information and public participation in decision making (Article 33-42). Line authorities shall ensure public participation in: a) procedures of the environmental impact assessment, and b) procedures related to issuing environmental permits (Article 39).

BiH is the member of the Aarhus Convention. As assessed, Directive 2003/4/EC on access to information is fully transposed. As regards to the Directive 2003/35/EC on public participation in development of the plans and programs in the field of environmental protection assessment is similar.

12.7.3 Protection of Nature

Protection of nature has been regulated by numerous regulations.[62] Article 25 of the Law on Nature Protection stipulated that areas with exceptional biological, geological, ecosystem or landscape diversity have been declared protected areas. Identifying and declaring an area as protected has been regulated by Articles 36-38 of the Law. Rules of protection of wild species have been stipulated separately (Article 43-46). Protected natural resources have been defined in Article 46 to cover protected areas, protected species and protected minerals and fossils.

The Law on the National Park “Sutjeska” ("OG RS", No. 121/12) stipulated the boundaries of the park, protection regime and the rules of management and development of the National Park. National Park Sutjeska is located in the forest, mountainous area in north-east RS, on the border between BiH and Montenegro.[63] The RS Nature Protection Strategy was adopted in 2011.

LW includes separate provisions related to nature protection (Articles 70-77), i.e. sensitive areas (Articles 78-84).

BiH is the member of crucial international agreements in the field of nature protection. As assessed, only partial transposition of the Directive 2009/147/EEC on wild birds and Directive 92/43/EEC on habitats (49% and 48%) has been effectuated.

12.7.4 Forestry

Policy and planning management and use of forests and forest lands are regulated by the Law on Forests and other regulations. Basins in the RS have been seriously endangered by the erosion processes and torrents. The development of these processes is influenced by many factors, including "poor condition of the existing forest fund, dominated by degraded forests ..., with insufficient protection functions."[64]

Forestry Development Strategy of RS for the period from 2011 to 2012 defines, among other things, the strategic goals and guidelines and stresses the importance of forestry to economic development.

[62] Size of protected area is 0.9% of the territory of RS. 18 areas are protected: 4 nature reserves, 2 national parks, 11 nature monuments and 1 area of resources management. http://www.nasljedje.org/sr_RS/prirodno-nasljedje/2011-08-30-08-20-03/289 (4/9/2015). Additionally, RS has 10 protected structures of geological heritage.
[63] http://www.npsutjeska.net/?jez=en (4/10/2015)
[64] Integrated Water Management Strategy of the Republic of Srpska 2015-2014, Draft, p. 95.

12.7.5 Fisheries

The Law on Fisheries ("OG RS"", No. 72, 2012) defined the term "fishing water" as "all inland (natural and artificial) waters with fish stock for fishing, except for water: a) in fish ponds and b) in storages (lakes or running water) that are used for drinking water intake that according to the law regulating the water sector, are subject to decisions on source protection" (Article 6).

The Law has also regulated permitting requirements (fishing rights) for economic and sport-recreational fishing, as well as a method of fishing water management during the permit period.[65] Special and specific fish stock protection is ensured through special habitats (Article 62).

12.7.6 Environmental Permit and Risk Management

Environmental permitting procedure and prevention of major disasters have been regulated by relevant provisions of the LEP.

Article 81 of the LEP stipulated that the "minister shall adopt a decree defining facilities that are allowed for construction and operation only with environmental permit." As per aforementioned, Rulebook on Facilities that are Allowed for Construction and Operation Only With Environmental Permit ("OG RS", 124/12) stipulated, inter alia, that the Ministry in charge of environmental protection shall issue environmental permit for the following projects: a) for projects that are always subject to impact assessment, b) for projects that are subject to the Ministry's individual decision on obligation to conduct impact assessment, and v) for projects that are subject to the Ministry's decision on obligation to conduct impact assessment even though the project did not reach prescribed threshold, if the evaluation has indicated that subject project could have significant environmental impact.

Liabilities of line entities related to facilities potentially causing major disasters have been regulated in provisions of Articles 103-110 of the LEP.

BiH is the member of the Convention on the Transboundary Effects of Industrial Accidents as of 2013 The Industrial Emission Directive 2010/75/EU has been partially transposed (48%).

12.7.7 Floods

LW prescribed several liabilities for different entities related to floods. One of the purposes of the law is ensuring integrated water management including "organizing flood defence and defence against other negative impacts potentially caused by water" (Article 2). Protection against harmful water effects is related to flood and ice defence in watercourses, and protection against erosion and torrents (Article 90 of the LW).[66]

Measures and activities of flood defence are classified as follows: planning phase, preparatory phase, active flood defence phase and post flood phase (Article 94). Plan of Protection against Harmful Water Effects is adopted by the Government.

Law on Emergency Protection and Rescue ("OG RS", No. 121/12) has regulates, *inter alia*, protection against and rescue from floods and other disasters on water and under water (Article 86).

Transposition of the Directive 2007/60/EC on floods is in initial stages (20%).

12.7.8 Waste Management

Waste management has been regulated by the Law on Waste Management (LWM) ("OG RS", No. 111/13). Entities in charge of waste management are as follows: a) Government, b) Ministry, v) Environmental Protection and Energy Efficiency Fund of the RS, g) local government unit, and d) specialized organization

[65] For details see: BiH Fisheries and Aquaculture Sector Analysis, FAO, Regional Office for Europe and Central Asia, 2015.
[66] Floodable region has been defined as "an area next to water courses which can be flooded at time of flood if water current floods over watery soil to wider area, no matter whether it is protected by water protection facilities" (Article 92).

for waste research (Article 23). In accordance with provisions of Article 64 of the Law, exercising one or more activities in the field of waste management is the subject of licensing, as follows: a) waste collection license, b) waste transport license, v) waste storage license, g) waste treatment license, and d) waste disposal license.

The Rule Book on Requirements of Wastewater Outlet in the Public Sewer ("OG RS", No. 44/2001) stipulated, *inter alia*, the limit values of hazardous and harmful substances to be outlet to public sewer, as well as the method of control of wastewater.

Management of the special water flows (batteries and car batteries, waste oil, waste tires, electric and electronic waste, fluorescent lamp waste, waste containing PCB, POPs waste, asbestos containing waste, waste, i.e. unusable vehicles, medical waste, titan-dioxide waste) has been regulated in Chapter VII of the Law.

BiH is the member of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. Directive 2008/98/EC on waste has been only partially transposed (41%), as well as the Directive 94/62/EC on packaging waste. Transposition of the Directive 1999/31/EC on landfills is in initial stages (20%).

12.7.9 Chemicals

Chemicals and biocide management has been regulated by special laws: Law on Chemicals ("OG RS", No. 25/09) with 23 by-laws and the Law on Biocides ("OG RS", No. 37/09) with 14 by-laws, and all under jurisdiction of the Ministry of Health.

Legal entity excising activities of production, wholesale and use of hazardous chemicals is obliged to register in the court register. Natural entity exercising retail sale of hazardous chemicals and products containing hazardous chemicals, and the natural entity using hazardous chemicals or products for the specific purposes must obtain license from the relevant authority (Article 60).

For the purpose of improvement of cooperation and participation in shared responsibility in international trade of hazardous chemicals, in accordance with the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, the Ministry shall apply procedure of prior information, as well as the procedure of prior informed consent on impacts of subject substance on human health and environment (PIC procedure) (Article 49).

The Ministry shall define the List of Substances Causing Concern requiring authorization in EU (Article 41).

BiH is the member of the Rotterdam Convention as of 2007 and POPs Convention as of 2010.

12.7.10 Soil Protection

Provisions on soil protection are contained in several systemic laws of the RS as per type of land (agricultural, construction, forest, etc.).

Water permit is required for water use, emptying storages, release of wastewaters into water and for disposal, i.e. release of hazardous materials on public water property, agricultural, construction and forest land and trade of products of hazardous materials which reach water after use (Article 142, LW). Special segment (Chapter IX) of the Law refers to limitations of the rights of land owners and land users.

Goals of basic geological survey are, inter alia, defining the status and features of rocks and soil to be used for spatial planning and defining suitability of terrain for spatial and urban plans, and terrain protection against landslide, erosion, floods, earthquake, underground water regime and other natural disasters. (Art. 5

of the Law on Geological Survey, "OG RS", No. 110/13). Detailed geological survey[67], developing and auditing geological documents, keeping records of mineral resources reserves and technical supervision of geological survey activities shall be exercised by the legal entity holding the geological survey license (Article 111).

During and upon completion of mineral resources exploitation work, the concessionaire,[68] shall restore original purpose of the exploitation field land or develop other use, in accordance with approved land recultivation design, and/or to undertake land protection measures for land subjected to works and measures of protection and rehabilitation of environment and water for the purpose of safeguarding human lives and health and property (Article 26 of the Law on Mining, "OG RS", No. 59/2012).

Directive 2006/21/EC on waste from extractive industries has been only partially transposed (38%), similar to the Nitrate Directive (91/676/EEC) which is only 34% transposed.

12.7.11 Air Protection and Climate Changes

According to provisions of Article 2 of the Law on Air Protection ("OG RS", No. 124/11) air protection shall be exercise by: a) establishment, maintenance and improvement of a unified air quality management system on the territory of the RS, b) preservation and improvement of air quality through defining and implementing measures in the field of protection to prevent or mitigate harmful effects on human health and/or environment, v) avoiding, preventing and mitigating pollution affecting ozone layer and climate changes, g) monitoring, obtaining and assessing relevant air quality data based on measurements and standardized methods, etc.

Preventing and reducing air pollution affecting climate changes shall be conducted by means of measures of mitigation of GHG emission and monitoring emission of subject gases, and monitoring quantities of subject gases removed through capture (Article 50). Measures and plans of mitigation of climate changes are the part of the information system (Article 67), and the funds for air protection financing are used also for measures in the field of climate change (Article 71).

Transposition of the Directive 2003/87/EC on emission allowance trading scheme has not started yet (0%).

12.8 Energy

12.8.1 General Overview

Energy has been ruled by a special group of regulations, the principal elements of which are the Law on Energy, and the laws regulating rights and responsibilities of various entities in individual energy sectors (Law on Electric Power, Law on Gas, Law on Oil and Oil Derivate). Special place is also taken by the regulations governing concession regime for research and use of natural resources and building energy facilities (Law on Concessions and Law on Public-Private Partnerships).[69] By-laws have regulated in detail certain issues related to tariffs and licensing energy activities, energy market opening, supervisions of the energy market, etc.

Requirements and methods of mining resources exploitation under and above ground, river or lake bottom or under, construction, use and maintenance of mining facilities, mining designs, mining geodetic surveys and plans, protection measures, supervision and other issues related to use of mineral resources on the territory of the RS have been regulated by the Law on Ministries ("OG RS", No. 59/2012).

[67] Including geological survey during exploitation of all types of mineral resources, as well as hydro-geological survey for the purpose of intake of all types of underground water and their protection.
[68] Mineral resources is also “water underground” (Article 3 d).
[69] This should be supplemented by laws regulating power transmission activities in BiH (Law on Transmission, Regulator and Operator of Electric Power System in BiH, Law on Establishment of an Independent System Operator in BiH, Law on Establishment of Electric Power Transmission Company in BiH).

12.8.2 Renewable Energy Sources

RS has developed separate regulation governing individual issues of relevance for incentivizing generation from renewable energy sources. The foundation of the legal system is the Law on Renewable Energy Sources and Efficient Cogeneration ("OG RS", No. 39/13, 108/13)[70], and the Action Plan of the RS for Renewable Energy Sources Use that has been also adopted. According to the Law, Regulatory Commission for Energy of the RS has adopted relevant by-laws. In accordance with Article 5 of the Rulebook on Incentivizing Generation from Renewable Energy Sources and Efficient Cogeneration ("OG RS", No. 39/13, 114/13, 88/14) types of incentives available for electricity generation from renewable energy sources or through efficient cogeneration are as follows: a) preferences for grid connections; b) preferences for grid access (dispatching); v) right to compulsory electricity purchase; g) right to guaranteed purchase price ("feed-in" tariff); d) right to premium for own electricity or market trading.

Commitment defined in the RS 2030 Energy Development Strategy is focused on “intensifying administrative support to RES development.”[71]

12.9 Tourism

The RS Tourism Development Strategy 2010 – 2020 includes tourism potentials in the water sector. Tourism services also include "tourism services on water" (Article 52 of the Law on tourism, ("OG RS", No. 70/11, 67/13). Regulation on the manner and conditions for provision of rafting as a tourist activity ("OG RS", No. 10/11) was adopted.

12.10 Construction and Spatial Planning

According to Article 60 of the Law on Spatial Planning and Construction ("OG RS", No. 40/13) location requirements shall be issued by the administrative authority in charge of spatial planning in local government unit where construction is applied for. As an exception to Paragraph 1 of present article, the Ministry shall issue location requirements for construction implemented in the area of two or more local government units, as well as for the following types of structures: a) structures of high dams that are subject to technical observation provisions, d) power and other structure and facilities for electric power generation, except for solar facilities with photovoltaic cells and other facilities using all forms of renewable energy sources of installed power of 250 kW, e) inter-regional and regional water supply facilities, f) wastewater treatment facilities for settlements with more than 50,000 inhabitants, o) hydro land reclamation systems for irrigation of areas larger than 50 ha, and for drainage of areas larger than 300 ha, p) fish ponds of area of 50 ha and larger, etc.
Construction permitting issue has been regulated in similar manner (Article 127).[72]

12.11 Agriculture and Irrigation / Drainage

Together with food industry, agriculture is one of the leading economic sectors and strategic goals of RS. Supporting investments in irrigation and drainage systems is one of the priorities of 2016-2020 Strategic Plan of Agriculture and Rural Areas Development in the RS.[73]

LW in several instances points to connections between water management and agriculture. Article 59 points to good agricultural practices which will be applied in the areas where waters are polluted by nitrates and crop protection agents or in the areas being under risk of such kind of pollution. Water guidelines, approvals

[70] Amendments of this law ("OG RS", No. 79/15, adopted on 10/9/2015) stipulated, *inter alia*, increase from 5 to 10% of funds collected for incentivizing generation from renewable energy sources and efficient cogeneration in the Environmental Protection and Energy Efficiency Fund.
[71] Republic of Srpska 2030 Energy Development Strategy, p. 45.
[72] Construction approval for projects with potential significant environmental impacts shall be issued by administrative authority in charge of construction, upon previously obtained decision on approval of the study or environmental permit (Article 61, p. 4 of the LEP).
[73] As of 2004, activities of reconstruction and putting in operation of existing and development of new irrigation systems have been initiated owing to the credit arrangement of the World Bank and assistance by international donors.

and permits will be obtained, if it is not prescribed otherwise with this Law, for activities related to water intake in all economic sectors and activities, especially, for: agriculture, 3) water supply etc. (Article 121).

Water permit is necessary for water use and for disposal, i.e. release of hazardous materials on agricultural land and trade of products of hazardous materials which reach waters after use (Article 142).

12.12 Water Transportation

Transportation and handling of hazardous materials and substances on surface water is regulated in line with the regulations in the field of transportation of hazardous goods and regulations in the field of river (and road) transportation, so as to eliminate or minimize the possibility of uncontrolled release (Article 63 of the LW). The Law on Inland Navigation of the RS ("OG RS", No. 58/03, 33/06, 1/08, 100/11) has regulated subject issues with more details.[74]

12.13 Utility Services

Utility services have been regulated by a special group of regulations. General framework has been set in the Law on Local Government ("OG RS", No. 101/04) that stipulated that municipality is responsible, *inter alia*, for "setting water management requirements, issuing water management approvals and water management permits for facilities and works set by law" (Article 22).

Article 2 of the Law on Utility Service ("OG RS", No. 124/11) has defined activities of, *inter alia*, water production and supply, wastewater treatment and drainage, public space cleaning in inhabited places, drainage of precipitation and other water off the public space, etc. as activities of "special public interest".

Subject of concession may be, *inter alia*, utility services, except for water supply of population, as well as construction, maintenance and use or reconstruction and modernization of utility facilities, waste management and treatment in accordance with special regulations, except for waste covered by utility activities (Article 6, Par. 1, It. 1 of the Law on Concessions).

Responsibilities of the communal police have been regulated by Article 9 of the Law on Communal Police of RS (“OG RS”, 28/13) to include, *inter alia*, communal-inspection oversight of application of regulations governing maintenance and use of facilities for drinking water supply of settlements and population and public sources and fountains, 4) public sewage networks, 5) wastewater treatment and drainage facilities and precipitation drainage from settlements, etc.

12.14 Business Law and Investments

Founding business entities, management of business entities, rights and responsibilities of founders, partners, members and shareholders, merging and reorganization (status changes and changes in legal form of the business entity), as well as liquidation of business entities have been regulated by the Law on Business Entities of RS ("OG RS", No. 127/08, 58/09, 100/11 and 67/13). Bankruptcy has been regulated by a separate Law on receivership ("OG RS", No. 67/02, 77/02, 33/03 and 96/0312/10 and 16/10). Activities of public enterprises are subject to the Law on Public Enterprises ("OG RS", No. 75/04).

According to the Law on Foreign Investments ("OG RS", No. 25/02 and 24/04, 52/11 and 68/13), legal entities owned by the foreign investor shall have the same rights, responsibilities and liabilities as legal entities owned by domestic legal or natural entities.

Law on Concessions ("OG RS", No. 59/13), Article 6, stipulated that subject of concession, *inter alia*, may be the use of public water resources. Decision on initiating concession awarding procedure shall be made by the Government, i.e. assembly of the local government unit (conceder) (Article 12).

[74] Water transport in the RS takes place on the Sava River which is open for international navigation. Part of the Sava River in the RS includes the docks of the Brčko Port Authority, Šamac Port, Gradiška docks (to grow into the port), pier for liquid cargo in Brod Refinery, wherry with transversal navigation in Srpac and Crnjelovo near Bijeljina.

12.15 Status of Scientific Research Organizations

Principal regulation governing scientific and research activities in RS is the Law on Scientific-Research Activities and Technological Development ("OG RS", No. 6/12, 33/14). According to premises of 2012 – 2016 RS Scientific and Technological Development Strategy, some of the seven recommended priority thematic areas of scientific and research activities are agriculture (including research in plant sciences, forestry, fishing, cattle breeding, veterinary medicine, agricultural biotechnologies) and food; energy and energy efficiency (including renewable energy sources); and environmental protection and climate changes.[75]

12.16 Harmonization of National Regulations with EU Regulations

12.16.1 Procedure

Article 17 of the Rules of Procedure of the Government of RS stipulated that before forwarding to the committees, for putting on session agenda of drafts and proposal of laws, development strategies, regulations, decisions, other regulations and general decrees, proponent is obliged to obtain, *inter alia*, two opinions: opinion of the Republic Secretariat of Legislation (compatibility with the Constitution and legal system of the Republic and the method of harmonization of regulations with the European Union regulations); and opinion of the Ministry of Economic Relations and Regional Cooperation (on compliance of laws and other general decrees with the EU regulations, on impact of laws and other regulations and general decrees on introduction of new formalities, such as approvals, consents, permits and similar, directly affecting the operations of business entities, and on analysis of effects of the development strategy, law, other regulation and general decree that are subject to the Government decision to undergo procedure as per methodology of regulatory impact assessment). The draft laws, other regulation or general decree is supplemented with an explanation containing, *inter alia*, part related to compliance with the European Union regulations (Article 37).

12.16.2 Harmonization Assessment

The Water Framework Directive (WFD) has been partially transposed through provisions of the LW.[76] As assessed, around 75% of provisions of the Directive have been transposed in internal regulations. Full transposition is expected in 2017 with adoption of by-laws. Provisions of the WFD still awaiting transposition are shown in Table 12-1 below.

Table 12-1: Planned harmonization of individual provisions of the WFD and the LW of RS

Art No	Relevant article of the Directive 2000/60/EC	Deadline
Art. 3.1	Where ground waters do not fully follow a particular river basin, they shall be identified & assigned to the nearest or most appropriate RBD.	
Art. 6.3	For each RBD, register or registers of Protected Areas shall be kept under review & up to date.	
Art. 7.1	MS shall identify, within each RBD: - all bodies of water used for abstraction of water intended for human consumption providing more than 10m³ a day as an average or serving more than 50 persons, & - those bodies of water intended for such future use.	2017
	MS shall monitor, as per Annex V, those bodies of water which according to Annex V, provide more than 100m³ a day as an average.	2017
Art. 8.1	MS shall ensure establishment of monitoring programs of water status for establishing a coherent & comprehensive overview of water status within each RBD: ….	

[75] 2012 – 2016 RS Scientific and Technological Development Strategy, National Assembly of the RS, Banja Luka, July 2012, p. 45.
[76] Additionally, the LW has direct reference to the WFD (2000/60/EC), as a regulation that will serve as a base for implementation of specific measures stipulated by the Law (classification of the values of ecological status quality elements, Art. 41; general principles, Art. 3; definition, Art. 4. p.2; characterization of the types of water structures and bodies, and their status, Art. 5; characterization of underground water structures and bodies, Art. 6; preventing derogation of surface and underground water status, Art. 7; goals of integrated water management, Art. 22; RBMP, Art. 26; program of measures, Art. 27; goals of environmental protection in the RBMPs, Art. 35, etc.).

Art No	Relevant article of the Directive 2000/60/EC	Deadline
	- for groundwater such programs shall cover monitoring of chemical & quantitative status;	
	- for protected areas above programs shall be supplemented by those specifications contained in EU legislation under which individual protected areas have been established.	
Art. 8.2	Art. 8.1 programs shall be operational at latest by 22.12.2006. unless otherwise specified in concerned legislation. Such monitoring shall be in accordance with Annex V requirements.	
Art. 7.2	For each Art. 7.1 body of water, in addition to meeting Art. 4 objectives, for surface water bodies including quality standards established at EU level under Art.16, MS shall ensure that under water treatment regime applied, & in accordance with EU legislation, resulting water will meet Dir. 80/778/EEC requirements, as amended by Dir. 98/83/EC.	2017
Art. 9.1	MS shall take account of the recovery principle of costs of water services, including environmental & resource costs, having regard to Annex III economic analysis, & the polluter pays principle.	
	MS shall ensure by 2010 - that water pricing policies provide adequate incentives for users to use water resources efficiently, & thereby contribute to this Dir. environmental objectives; an adequate contribution of different water uses, disaggregated into at least industry, households & agriculture, to the recovery of the costs of water services, based on Annex III economic analysis & taking into consideration the polluter pays principle.	
Art. 11.3	"Basic measures" are minimum requirements to be complied with & shall consist of: … (b) Measures deemed appropriate for the purposes of Art. 9; … (d) measures to meet Art. 7 requirements … (g) for point source discharges liable to cause pollution, a requirement for prior regulation, … (i) for any other significant adverse impacts on the status of water identified under Art. 5 & Annex II, …	
Art. 11.8	Programs of measures shall be reviewed, & if necessary updated at latest by 22.12.2015 & every 6 years thereafter. Any new or revised measures established under an updated program shall be made operational within 3 years of their establishment.	
Art. 14.1	MS shall encourage active involvement of all interested parties in Dir. implementation, in particular in the production, review & updating of River Basin Management Plans. MS shall ensure that, for each RBD, they publish & make available for comments to public including users: ….	
Art. 14.3	Arts.14.1 & 14.2 shall apply equally to updated River Basin Management Plans.	
Art. 22.4	Art. 4 environmental objectives & environmental quality standards established pursuant to Annex IX & Art. 16.7, & by MSs under Annex V for substances not on the list of priority substances & under Article 16.8 in respect of priority substances for which EU standards have not been set, shall be regarded as environmental quality standards for Art. 2 point 7 & Art. 10 of Dir. 96/61/EC.	
Art. 22.5	Where a substance on list of priority substances adopted under Art. 16 is not included in Annex VIII to this Dir. or in Annex III to Dir. 96/61/EC, it shall be added thereto.	
Art. 22.6	For bodies of surface water, environmental objectives established under the first RBMP required by this Dir. shall, as a minimum, give effect to quality standards at least as stringent as those required to implement Dir. 76/464/EEC.	
Annex V[77]	1. Surface Water status	2017
	2. Groundwater status	2017
Annex IX	Emission limit values and environmental quality standards	2017
Annex X	Priority substances[78]	

Source: "Monitoring transposition and implementation of the EU environmental acquis", Bosnia and Herzegovina – Table of Concordance, Year 18 (2015), Tables: The Ministry of Foreign Trade and Economic Relations.

[77] Amended by Directive 2008/32/EC
[78] Annex X is replaced by the text set out in Annex I to the Directive 2013/39/EU.

Directive on urban wastewater (91/271/EEC) has been transposed 49%. Full transposition is expected in 2017. In addition to the LW, some provisions of the subject directive have been transposed also through by-laws regulating wastewater release in surface water, i.e. release of wastewater in public sewer, etc.

Nitrate Directive (91/676/EEC) has been transposed 34%. Directive (2006/7/EC) on bathing water has been transposed 20%. No deadlines for full transposition of the directive have been set.

Transposition of the Directive 86/278/EEC on waste sludge is in initial stages (38%).

Transposition of the Directive on underground water (2006/118/EC) is in early stages. As assessed, subject directive has been transposed 17%. Development of internal regulations aimed at transposition of the directive has started and the full transposition is planned for 2017.

Transposition of the Directive on water quality standards (2008/105/EC) is also in early stages. The directive has been transposed 16%. No deadline for full transposition has been set.

Situation with the transposition of the Directive on floods (2007/60/EC) is similar. The directive has been transposed 20%. Major share of transposition is planned for 2017.

Transposition of the Directive on quality control (2009/90/EC) is in early stages – around 20%. No deadline for full transposition has been set.

Transposition of the Directive on drinking water (98/83/EC) has not started yet, and no deadline for full transposition has been set.

b) Transposition of EU directives in nature protection is only partially achieved. The Habitats Directive (92/43/EEC) has been transposed through provisions in the Law on Nature Protection (around 48%). The transposition of the Birds Directive (2009/147/EEC) has been achieved with around 50%. There is no information on the planned deadline for full transposition of these two directives in the internal legal system.

12.17 Strategic Documents

12.17.1 Strategic Documents in the Water Sector

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.

Republic Civil Defence Authority is in charge of coordination, harmonization, monitoring and guiding of the RS Flood Defence Plan ("OG RS", No. 6/14).

12.17.2 Strategic Documents in Energy and Development Sector

Special segment of 2030 Energy Development Strategy defined position in regard to renewable energy sources. As assessed, "hydropower plant development potentials ... are significant and largely unused, and as regards to RES ... stress is on small watercourses, i.e. development of small HPPs."

Total hydropower potentials within the range 0.5 to 10 MW is estimated at 1500 GWh/year. Energy potentials in small hydropower plants recognized as development candidates amount to around 212 MW, i.e. around 650 GWh/year. Energy potentials for small hydropower plants of installed power below 0.5 MW (micro and mini hydropower plants) has not been examined in the area of the RS.[79]

Government of RS has adopted the RS Action Plan of Renewable Energy Source Use (2014). Values of electric power generated from renewable energy source to be subject to incentives until 2020 have been defined.

12.17.3 Other Strategic Documents of Importance for IWRM

Several strategic documents may carry special importance for WRM. Government of RS has adopted Nature Protection Strategy (2011), Air Protection Strategy (2011), Basics of Protection, Use and Development of Agricultural Land of RS, as the Component of Land Planning and Use Process (2009), Strategy of Chemical Safety of the RS 2012 - 2016, 2016-2020 Strategic Plan of Agriculture and Rural Areas Development in the RS, Spatial Plan of the RS until 2026, etc.

RS has adopted several documents related to other fields potentially relevant for water management. (See list in Annex 12-4). Document "2015 Economic Policy of the Republic of Srpska", includes a segment related to water management and other relevant fields.

FEDERATION OF BiH

12.18 General Review of Regulations Governing WRM

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.[81] 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.

The canton shall have the competence to exercise activities and tasks allocated to it by this Law, and the organization of the performance of these tasks shall be regulated by a cantonal regulation (Article 167).[82] As per aforementioned, some cantons enacted separate laws regulating water management. Bosansko-Podrinjski Canton Goražde is one of them ("OG BPCG", No. 6/10).[83]

[79] P. 45, 46. The following period is planned for, *inter alia*, the following issues: examination of remaining unprocessed hydro potentials on small water courses (measurements and hydrological analyses) to create prerequisites for development of subject locations; reconsidering the procedure of permitting aimed at streamlining and simplification of the entire procedure and creating equal conditions on the entire territory of the RS (for example, issuing urban and ecological approval, development of spatial plans, equalizing procedure and duration of amendments to spatial plans, eliminating overlapping of activities and jurisdiction), etc.
[80] The first LW of FBiH was adopted in 1998, and then (2003), the LWP of the FBiH. For other regulations see the list in Annex I.
[81] Legal reform of the water sector, and harmonisation with EU requirements as part of the stabilization and association process is the First Strategic Objective defined in the Water Management Strategy of FBiH 2010-2022. p. 183.
[82] Canton can adopt a regulation to transfer certain responsibilities under its jurisdiction to a city and/or municipality on its territory.
[83] In addition to Tuzlanski Canton, Zeničko-Dobojski Canton, Srednjebosanski Canton, Sarajevo Canton and Posavski County.

12.18.1 Water Areas and Water Bodies

For the purposes of water management within the territory of BiH, i.e. the Federation, the following river basin districts: 1. Sava River Water Area, and 2. Adriatic Sea Water Area (Article 23 of the LW). The Sava RWA includes a part of the international river basin of the Danube River (part of the international Sava River sub-basin) on the territory of BiH, i.e. the FBiH. The Adriatic Sea RWA includes portions of the international river basins of the Neretva River with the Trebišnjica River, the Cetina and the Krka rivers on the territory of BiH, i.e. the FBiH.

The borders of river basins and water areas within the territory of the FBiH shall be established by the Government of the Federation as proposed by the Federal Ministry. In accordance with the Decision on Borders of River Basins and Water Areas within the Territory of FBiH ("OG FBiH", No. 41/07), the following river basins have been identified on the territory of the FBiH: 1. Part of the international river basin of the Danube (part of the international Sava River sub-basin), 2. Part of the international river basin of the Neretva River with the Trebišnjica River, 3. Part of the international river basin of the Cetina River, and 4. Part of the international river basin of the Krka River.[84]

FMAWMF shall delimit a water property for Category I surface waters, and cantonal ministry responsible for waters shall delimit a water property for Category II surface waters (Article 8 of the LW).

Area of BPCG is entirely within the Sava River Water Area (Article 23 of the LW of BPCG).

12.18.2 Water Classification and categorisation

In accordance with the Decree on categorisation of watercourses ("OJ SR BiH:, No. 42/67) watercourses and coastal sea are divided into four classes. Drina River is in II Class. (Art. 3). II class of waters are the waters which are in the natural state can be used for bathing and recreation, for water sports, for fish farming of other kinds of fish (…), or which, with usual methods of treatment (....) may be used for drinking and food industry (Art. 2 of the Regulation on classification of waters and coastal waters of Yugoslavia within boundaries of SRBiH "OJ SRBiH", No. 19/80).

Classification of the status of bodies of surface water and groundwater shall be based on the level of alterations resulting from human activity (Article 32 of the LW). The status of a surface water body shall be determined either by ecological status or chemical status, by the worse one. The ecological status of surface water bodies shall be classified as high, good, moderate, poor or bad. The chemical status of surface water bodies shall be classified as good or bad. The classification shall be carried out in accordance with the reference conditions established in a by-law.

Determination of types of water bodies of surface water and characterization of water bodies of surface waters is exercised by means of the methodology set in Appendix 1 of the Decision on Characterization of Surface and Ground Waters, Reference Requirements and Parameters for the Assessment of Water Status and Water Monitoring ("OG FBiH", **No.** 1/14). Appendix 2 of the Decision set water stresses (pollution, intake, morphological alterations and other human activities) and method of water impact assessment. Characterization includes determination of reference requirements for each type of water body of surface water, in line with the criteria corresponding to "high" ecological status.

Reference values of physical-chemical and biological parameters of quality corresponding to the values of high status of individual parameters have been also set.

Single criteria for determination of underground water reserves, requirements of categorization and classification, calculation method and recording the underground water reserves have been set by the Rule

[84] Delimitation of water property (organized by the line water area agency for category I surface waters; organized by the institution set in the cantonal regulation for category I surface waters) includes definition in the field, method of delineation and entry into the water cadastre of the information system (water cadastre), as well as entry into the water cadastre, i.e. cadastral records and cadastral plans of municipalities for relevant area (cadastral registry). Rulebook on Procedures for Delimitation of Water Property and the Identification of Land Parcels Belonging to the Public Water Property ("OG FBiH", No. 26/09).

Book on Categorization, Classification, Calculation of Underground Water Reserves and Record Keeping ("OG FBiH", No. 47/2011).

12.18.3 Water Acts and Planning Documents

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).[85]

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.[86] 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.

LW of BPCG has allocated water acts related responsibilities between the cantonal authorities and municipal authorities (Article 42). Also, the LW of BPCG stipulated adoption of specific planning documents by Canton, i.e. municipality, for category II surface waters (Article 37).

12.18.4 Monitoring

Article 43 of the LW of FBiH stipulated that, on the proposal by the Federal Minister, the Federation Government shall adopt, *inter alia*, regulations on: the monitoring of waters and the contents of the water monitoring program. Quality monitoring of wastewater and effluents from the wastewater treatment plants shall only be carried out by the authorized laboratory (Article 64, p. 3).

Decision on Characterization of Surface and Ground Waters, Reference Requirements and Parameters for the Assessment of Water Status and Water Monitoring ("OG FBiH", No. 1/14) stipulated, *inter alia*, monitoring and the contents of the water monitoring program. Agency of the Water Area shall prepare, set up and implement monitoring program for all surface and underground water in accordance with the provisions of present Decision. Types of water monitoring and implementation methods are described in

[85] Additionally, preliminary water approval, water approval and water permit shall be issued for activities that may: 1. temporarily or permanently degrade the water quality, or impede the improvement of the existing quality; 2. have an adverse impact on aquatic or semi-aquatic ecosystems; 3. increase the risk of flooding or erosion; 4. significantly reduce water quantities, change the morphology of a watercourse, impede the recreational use of surface waters etc. (p. 2).

[86] The cantonal ministry in charge of water shall have the competence to issue water enactments for: 1. water abstraction of quantity not exceeding 10 liters per second; 2. wastewater discharge from settlements with up to 2000 inhabitants; 3. abstraction of material from Category II surface waters; 4. construction of hydroelectric power plants, when the plant is located on Category II surface waters with capacity of up to 5 MW; 5. construction of water reservoir located on Category II surface waters and within the territory of the canton concerned; 6. construction of flood protection structures on Category II surface waters, provided that the activities concerned do not affect Category I surface waters.

Appendix 11 of present Decisions. Special decree has regulated monitoring in the areas susceptible to eutrophication and sensitive to nitrates ("OG FBiH, No. 71/09).

12.18.5 Minimum Sustainable Discharge (Ecologically Acceptable Discharge)

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).

LW of BPCG (6/10-605) stipulated that legal and natural entities conducting water intake and pumping activities (except for general water use) shall be responsible for ensuring ecologically acceptable discharge as a minimum discharge ensuring preservation of the natural equilibrium and ecosystems related to water (Article 27).

12.18.6 Financing

LW stipulated that funds to exercise activities and tasks defined by this Law shall be provided by means of the following: 1. general water charges; 2. special water charges; 3. revenue generated by lease of the public water property; 4. Federation, cantonal, town and municipal budgets; 5. credit funds; 6. funds provided for in special legislation; 7. donations and other funds in accordance with the law (Article 168).[87] Procedures related to general and special water charge have been regulated in details in the Rulebook on Accounting Methods, Procedures and Deadlines for Accounting, Payments and Control of Payment Obligations on the Basis of General Water Charges and Special Water Charges ("OG FBiH", No. 92/07). Decision on Special Water Charges ("G FBiH", No. 46/07, 10/14) stipulated the amount of special water charges for: 1. Use of surface and underground waters, 2. Water use for electric power generation, 3. Water protection, 4. Extraction of materials from watercourses and 5. Flood defence.

According to assessment from the Water Management Strategy of FBiH 2010-2012, implementation of the strategic goal of institutional framework of action ("Efficient institutional organization and administration capable of implementing the accession process and implementation of EU requirements in the water sector") will require 11,200,000 BAM,[88] while the total estimation for implementation of the Strategy goals is 2,760,695,000 BAM.

According to data of the Environmental Protection Fund, structure of total revenues from charges in 2014 (BAM 28,069,890) is as follows: revenues as per the LW (BAM 6,269,853 or 22%), revenues as per the Law on the Fund (BAM 20,662,013 or 74%) and as per the LWM (BAM 1,138,024 or 4%). Biggest revenues were generated from the revenues as per the Law on the Fund, i.e. from environmental charges paid by legal and natural entities for motor vehicle registration BAM 14,463,477 or 51%.[89]

Several projects have been financed by various international sources in the previous period. Funds of the World Bank, EU, European Investment Bank and Development Bank of BiH play special roles.[90]

[87] LW (Article 177) stipulated that 15% revenues generated from general and special water charges collected as per public water property lease on category I of surface waters go to the Environmental Protection Fund of the FBiH, 40% to the line agency or water area; and 45% to the cantonal budget. Revenues generated from public water property lease on category II of surface waters go to the cantonal budget.

[88] Water Management Strategy of FBiH 2010-2012, p. 290.

[89] Report on Work Program and Financial Plan Implementation in the Environmental Protection Fund of the FBiH for 2014, ("OG FBiH", No. 14/2015, p. 27. 2015 Work Plan of the Government of FBIH envisaged "improvement of the existing legal framework by means of adoption of the new Law on Environmental Protection and Energy Efficiency Fund". 2015 Work Plan of the Government of FBIH, Sarajevo, July 2015. p. 281.

[90] Water Management Strategy of FBiH 2010-2012, p. 293-298.

12.18.7 International Cooperation

LW of FBiH has also not singled out provisions on international cooperation. Similar to the LW of RS, certain responsibilities related to implementation of international agreement[91] have been mentioned in several provisions.[92] According to provision of Article 39 of the Law, coordination of the preparation of international river basin management plans may be additionally regulated by international agreements to which BiH is a party (p. 3), i.e. the procedure for the publication of an adopted water management plan within an international river basin may be additionally regulated by international agreements which BiH is a party to (Article 40). The general objectives of the Water Information System are "the exchange and consolidation of information internally - within the water sector, and externally - with external and international institutions." (Art. 98).

Agency of Water Area, *inter alia*, "participates in the coordination of the drafting and implementation of water management plans together with the competent organizations from the Republic of Srpska at the level of Bosnia and Herzegovina, or with authorities competent for the region of the international sub-basin of the Sava River and the international river basins of the Neretva and Cetina rivers,", i.e. exercises activities related to the implementation of projects financed by the international institutions or funded from the Budget of the Federation, as decided by the Federal Ministry (Article 156). Advisory Council of the Water Area, *inter alia*, reviews and comments on water management issues of relevance to inter-entity cooperation, to BiH as a whole and the international commitments of BiH (Article 165).

12.18.8 Inter-Entity Cooperation

One segment of provisions of the LW stipulated rights and responsibilities related to inter-entity cooperation. The Federal Ministry shall ensure that the coordination of all activities with the ministry of the Republic Srpska in charge of water is established and maintained so as to ensure a uniform water management strategy for the whole of BiH (Article 24. p. 6).[93] Inter-entity cooperation of water inspection authorities has been regulated in provisions of Articles 199-202, and informing interested parties and public in the procedure of water enactment issuance in case of inter-entity impacts in provisions of Articles 123 and 124. Advisory Council of the Water Area, *inter alia*, reviews and comments on water management issues of relevance to inter-entity cooperation, to BiH as a whole, and the international commitments of BiH (Article 165).

12.18.9 Inspection

The Federal Ministry shall exercise the administrative supervision of the implementation of this Law and regulations adopted pursuant to this Law, as well as the administrative supervision of the Agencies of Water Areas with regard to the implementation of tasks delegated to them under this Law (Article 179 of the LW). The law has prescribed spate rules for the Federal Water Inspections and Cantonal Water Inspections.

Relations between the federal and cantonal water inspection have been regulated in Article 195 of the LW. Certain technical activities for the inspection requiring special technical equipment and specialized experts or the application of scientific methods and procedures, may be delegated to relevant authorized and certified institutions (Article 189).

Inspections have been also regulated by the LW of BPCG (Article 59-63).

[91] Art. 2, I. 9; Art. 24 – Water management Strategy; Art. 25 – Water Management Plans; Art. 38 – Public Consultations; Art. 68 – Decision on Source Protection; Art. 120 – Water Enactment Application; Art. 123 – Cooperation between authorities in the water enactment issuance procedure; Art. 130 – Amendments to water enactments, Art. 190 – Inspection procedures.
[92] For the list of international agreements see Annex III.
[93] See: Article 39 - Water Management Plan Development Coordination; Article 40 - Adoption of water management plans; Article 43 - The Provisions of the Federation Government; Article 55 - Wastewater Discharge Limit Values; Article 68 - Decision on Source Protection; Article 74 - Designation of vulnerable and less vulnerable zones; Article 106 - Access to WIS information, etc.

12.18.10 Ensuring Regulatory Compliance

System of basic regulations creating prerequisites for the rule of law has been established within the legal system. However, as assessed, functioning of the legal system in FBiH, similar as in RS, is subjected to major risks and ensuring regulatory compliance is a special challenge for line authorities. Assessments of the European Commission point to the need for stronger government control instruments in the entire BiH. 2014 – 2018 Justice Sector Reform Strategy on BiH level has been adopted.

Process of transposition of the Directive 2004/35/EC on environmental liability has not started yet.
There is no data as regards to transposition of the Directive 2008/99/EC on the protection of the environment through **criminal** law.

12.19 Regulations in the Environment Sector

Principal laws and by-laws in the field of environmental protection include, in addition to the LEP ("OG FBiH", No. 33/03), regulations on waste management, air protection and nature protection. Activities related to development of the new LEP are underway. Draft LEP is undergoing adoption procedure in the Parliament of FBiH.[94] Adopted by the House of Peoples on 18/2/2014. Public hearing on the Draft LEP of FBiH was organized during 2014.[95] Work Plan of the Government of FBiH envisaged development of the draft law in IV quarter of 2015.

LEP is in force in BPCG ("OG BPCG", No. 5/05, 11/10, 8/11). Activities of initiating the procedure of development of the Cantonal Environmental Protection Action Plan of BPCG 2016-2022 are underway.

12.19.1 EIA and SEA

Chapter nine of the LEP of FBiH (Articles 53-65) is about environmental impact assessment. Article 4 of the Rule Book on Plants and Facilities Requiring EIA and Plants and Facilities that May be Constructed and Commissioned Only with Environmental Permit ("OG FBiH", No. 19/04 from 10/4/2004) stipulated "plants and facilities requiring environmental impact assessment procedure".[96]

"Plants and facilities for which environmental impact assessment is exercised on the basis of control by the Federal Ministry" are also stipulated.[97] Public participation procedure has been regulated by special provisions of the LEP.

EIA, from among cantonal responsibilities, regulated by virtue of provisions of Articles 36-42 of the LEP of BPCG.

Directive 2001/42/EC related to the strategic environmental impact assessment has been transposed with around 74%.

12.19.2 Access to Information and Public Participation in Decision-Making

[94] http://www.parlamentfbih.gov.ba/dom_naroda/bos/parlament/propisi/El_materijali/Zakon%20o%20zastiti%20okolisa_2014.pdf
[95] http://www.aarhus.ba/vijesti/83-odrzana-javna-rasprava-o-nacrtu-zakona-o-zastiti-okolisa-fbih-u-mostaru.html
[96] This includes power facilities, such as "facilities for hydropower generation with the output power above 5 MW for individual facilities or above 2 MW for several facilities located in a sequence with a distance less than 2 km", facilities in water management (under predefined conditions of underground water abstraction, facilities of water resources transportation between river basins, wastewater treatment facilities, as well as "dams and other installations for retention or permanent storage of water where new or additional water quantity retained or stored is above 2 million m³."
[97] This category includes, *inter alia*, "facilities for hydropower generation with the output power above 1 MW", as well as infrastructure projects, including constructions on inland watercourses, canals and flood defence structures, dams and other facilities designed for long-term water retention or storage where new or additional water quantity retained or stored is above 1 million m³, underground water abstraction or artificial refill of underground water where the annual quantity abstracted or refilled is equal or above 1 million m³, installations for water resources transportation between river basins, etc.

a) Law on Free Access to Information of FBiH ("OG FBiH", No. 32/01, 48/11) is a general law on free access to information, and access to information of the water information system has been regulated by Article 106 of the LW.

b) One of the goals of the LW is also "ensuring public participation in water-related decision-making" (Article 2), and public participation in the establishment of water management plans is one of the principles of water management (Article 3). Mandatory public consultations are also related to preparation of the water management plan. Informing interested parties and public has been set as an obligation of the line authority to be exercised before issuance of the preliminary water approval (Article 124). Also, the ruling on the issued water approval must be made available to interested parties and the public on request (Article 126).

Decree on Establishment and Appointment of Members of the Advisory Council of the Sava River Water Area ("OG FBiH", No. 77/09) stipulated that members of this body are also representatives of the citizens' association.

c) LEP of FBiH includes detailed provisions regulating access to information and public participation.

d) BPCG (LW and LEP) regulations stipulate access to information and public participation, too.

As assessed, the Directive 2003/4/EC on access to information has been transposed 65%, and the Directive 2003/35/EC on public participation 80%.

12.19.3 Protection of Nature

Measures of protection of nature have been regulated by the Law on Nature Protection and by-laws. As regards to the categorization of protected water resources, Article 65 of the LW of FBiH from 2006 stipulated declaration of protected areas with various purpose of protection: "(…) areas designated for the abstraction of drinking water, areas designated for the protection of economically important aquatic species, bodies of surface water designated for recreation, including areas designated for bathing, areas vulnerable to eutrophication and areas sensitive to nitrates, areas designated for the protection of habitats of plant and animal species or aquatic species where the maintenance or improvement of water status is an essential prerequisite for their survival and reproduction." Subject areas shall be determined in accordance with the regulations on environmental protection and nature protection (Article 77).

12.19.4 Forestry

The mountainous zones of the Drina river sub-basin are covered with high mixed forests which have an important role in the protection of underground aquifers against incidental pollutions caused by deep erosion in karstified areas. The hilly zones are covered with deciduous forests with significant counter-erosion role and the role of equalizing the temperature fluctuations and the water drainage dynamics.[98]

Forestry has been regulated by a special group of regulations, central part of which was the Law on Forests (ceased to exist as per the ruling of the Constitutional Court)[99] and the Law on Seeds and Planting Materials for Forest and Horticultural Trees and Bushes ("OG FBiH", No. 71/05, 8/10). Work Plan of the Government of the FBiH envisaged, inter alia, "implementation of m measures related to adoption of the law on forests of FBiH", "development of the general part of the Forest Program of the Federation of BiH", etc.

12.19.5 Fisheries

Similar to RS, fisheries in the FBiH are regulated by the Law on Fresh Water Fisheries ("OG FBiH", No. 64/04). The requirements of fishing in FBiH have been regulated in similar manner.

[98] Water Management Strategy, p. 27.
[99] By virtue of the Ruling of the Constitutional Court No. U-26/08 from 14/04/2009 ("OG FBiH", No. 36/09), as of 27/11/2009, the Law on Forests ("OG FBiH", 20/02, 29/03 and 37/04) shall cease to exist. Later ruling of the Constitutional Court ("OG FBiH", No. 34/11), as of 06/12/2011, Rule Book on Forests ("OG FBiH", No. 83/09, 26/10, 38/10 and 60/11) shall cease to exist.

12.19.6 Environmental Permit and Risk Management

a) Procedure of issuance of environmental permits has been regulated by provisions of the LEP (Articles 65-74), including the circumstance when operations of a facility may cause significant negative consequences in the area of another state or entity. Facilities requiring environmental permits have been regulated by a separate regulation. Environmental permits are under jurisdiction of the Federation and Canton.[100]

The LW has connected issuance of the environmental permit and preliminary water approval (Article 112). An environmental permit for facilities and plants requiring such permit under the LEP shall be issued on the basis of the preliminary water approval for buildings or structures requiring a preliminary water approval under this Law.[101]

b) Risk management has been also regulated by provisions of the separate Chapter X of the LEP (Article75-85). Article 9 of the Rule Book on Plants and Facilities Requiring Environmental Impact Assessment and Plants and Facilities that May be Constructed and Commissioned Only with Environmental Permit stipulated plants and facilities subjected to the greatest hazard of major Accidents, that are subject to environmental permitting by the Federal Ministry. All plants and facilities, including storages, with hazardous substances in quantities above legal quantities (Article 10 and Article 11 of the Rule Book) are plants and facilities potentially causing major accidents that are subject to environmental permitting by the Federal Ministry.

c) According to the LEP ("OG BPCG"", No. 5/05, 11/10 and 8/11), by-laws of BPCG have regulated environmental permitting form facilities under jurisdiction of the canton.

Directive 2010/75/EU on industrial emissions has been transposed 67%, Directive 2001/80/EC - LCP 80%, and Directive 2012/182/EU - Seveso III, almost completely (96%).

12.19.7 Floods

One of the purposes of the LW is "reduction of risks of floods and other negative effects of water" (Article 2, i. 6).[102] To that extent, the Law elaborates in individual provisions respective rights and responsibilities of various entities (Article 14 - Types of structures in respect of their intended use, Article 33 - Artificial or heavily modified water bodies, Article 85 - Protection against harmful effects of waters, Article 86 - Endangered areas, Article 91 - Surveillance, forecasting and early warning, etc.). The scope of protection from harmful effects of waters and the necessary measures shall be defined by the following plans: specials flood and ice protection plans, erosion protection plans and extraordinary water pollution protection plans (Article 90). Prohibitions in flood-prone areas are set in Article 96 of the Law.

Law on Protection and Rescue of People and Material Property from Natural and Other Disasters ("OG FBiH", No. 39/03 and 22/06) includes epical provisions on "protection and rescue on water and under water" (Article 79-82). Federal Operational Flood Defence Plan (FOFDP) has defined implementation of measures of active defence against floods and ice in times of direct threat of large flood discharges, during the flood discharges and elimination of flood consequences.[103]

BPCG has adopted cantonal flood defence plan in 2013.

Directive 2007/60/EC on floods has been transposed 83%.

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[100] Total 801 permits were issued in the Federation during 2004 – 2014. For data on permits issued by cantonal authorities see: http://www.fmoit.gov.ba/ba/page/84/statistika-o-od (22/10/2015).

[101] The application for the preliminary water approval shall be submitted by the authority in charge of the issuance of environmental permits. In cases of facilities, plants or activities which shall be subject to the environmental impact assessment procedure before obtaining an environmental permit, the authority in charge of the issuance of water enactments shall take part in such environmental impact assessment on request by the authority conducting the environmental impact assessment procedure concerned.

[102] A flood-prone area is the area along a watercourse that may be flooded during a flooding event as a result of the overflow of water from its bed, regardless of whether the area is protected by flood control structures (Article 87).

[103] For draft FOFDP, stipulating cessation of the Federal Operational Flood Defence Plan ("OG FBiH", No. 7/11), see: http://fmpvs.gov.ba/upload_files/1443000455-Nacrt%20%20FOP-a%20sa%20obrazlozenjem.pdf (4/9/2015). The draft is undergoing public hearing procedure.

12.19.8 Waste Management

Waste management has been regulated by a separate law ("OG FBiH", No. 33/03, 72/09) and respective by-laws. Exercising activities of water treatment and disposal requires permit, unless specified otherwise by present law (Article 12).[104] Transboundary movement of hazardous waste has been regulated by separate Rule Book ("OG FBiH", No. 07/11). Collection and treatment of municipal waste is exercised in line with a special regulation on utility services.

According to conclusions of the Federal Waste Management Plan (2012-2017), majority of landfills are subject to disposal of all types of hazardous and non-hazardous household waste, including bulky waste, demolition waste, medical waste, waste originated in industrial facilities, etc.[105]

Wastewater release, in addition to provisions of the LW, has been also regulated by the Regulation on Conditions of Wastewater Release to Natural Recipients and Public Sewage System ("OG FBiH", No. 4/12).

According to the LWM in BPCG, Waste Management Plan of Bosansko-Podrinjski Canton has been adopted. There is no regional landfill and waste is disposed on unorganized municipal dumpsites, capacities of which are already full. Location of the regional landfill has been defined in 209, but the Feasibility Study has not been developed yet.

The Waste Framework Directive 2008/98/EC is in early stages of transposition (27%).

Transposition of majority of EU Directives (except for Directive 94/62/EC o packaging waste which has been transposed 61%), has either not started at all or is in initial stages: Directive 2006/66/EC on batteries, Directive 96/59/EC on PCB/PCT, Directive 2000/53/EC on waste vehicles, Directive 1999/31/EC on landfills.

12.19.9 Chemicals

BiH level regulation is in application in FBiH.[106] House of People of the Parliamentary Assembly accepted the Draft Law on Chemicals and Draft Law on Biocides – 27/6/2013. Government of the FBiH, i.e. Federal Ministry of Health, planned development of the two legal documents in 2015. [107]

The transposition of EU regulations to the field of chemical management in FBiH has either not yet started, or is in the initial stages.

12.19.10 Soil Protection

Agricultural land protection has been regulated by a separate Law on Agricultural Land ("OG FBiH", No. 52/09). Agricultural Land Management Strategy has been adopted in 2011.

Land use for construction has been regulated in Chapter V (Articles 34-77) of the Law on Spatial Planning and Land Use in the FBiH ("OG FBiH", No. 2/06, 72/07, 32/08, 4/10, 13/10, 45/10).

LW includes several provisions related in various ways to land. Limitations to the rights of land owners and users have been regulated by special provisions of the Law (Articles 140-151).

[104] Special waste management has been regulated in by-laws: medical waste ("OG FBiH", No. 77/08), waste of animal origin ("OG FBiH", No. 8/08), packaging and packaging waste ("OG FBiH", No. 83/10), hazardous waste from the list of waste or contents of which is unknown ("OG FBiH", No. 9/05).
[105] Page 35.
[106] Law on Food ("OG FBiH", No. 50/04) is in force in BiH, Law on Phytopharmacutical Resources of BiH ("OG FBiH", No. 49/04), etc.
[107] 2015 Work Plan of the Government of FBiH, Sarajevo, July 2015, p. 177, 179.

12.19.11 Air Protection and Climate Changes

Law on Air Protection ("OG FBiH", No. 33/03, 4/10) has regulated technical requirements of prevention or reduction of emissions in the air caused by human activity to be applied in production process, planning air quality protection, special sources of emission, cadastre of emissions, air quality, monitoring and penalties for legal and natural entities.
Strategy of Adaptation to Climate Changes and Low Emission Development in BiH has been adopted (2013). BiH has delivered the Second National Communication in the field of climate changes in 2013.

LW does not include provisions referring to climate changes as a circumstance or a factor of significance for measures stipulated.

Directive 2008/50/EC on ambient air quality has been transposed 74%. However, transposition of the Directive 2003/87/EC on emission trading has not started yet.

12.20 Energy

12.20.1 General Overview

Energy is regulated by separate legislation in FBiH with the central role played by the Law on Electric Power ("OG FBiH", No. 66/13), Law on Renewable Energy Sources Use and Efficient Cogeneration ("OG FBiH", No. 70/13, 5/14), ("OG FBiH", No. 52/14), Law on Mining of FBiH ("OG FBiH", No. 26/10), Law on Geological Survey of FBiH ("OG FBiH", No. 9/10), etc.

Regulatory Commission shall stipulate criteria, requirements and procedures of licensing electric power activities (Article 84), i.e. issue, renew, transfer or revoke licenses (Article 87). Electric power supply and trading permits is issued as: 1) Electric power supply permit – Rank I Permit, 2) Electric power supply permit – Rank I Permit (Article 91).

12.20.2 Renewable Energy Sources

Law on Renewable Energy Sources Use and Efficient Cogeneration stipulated that RES include "renewable non-fossil energy sources" part of which is also "hydropower".[108] The Law stipulated, *inter alia*, incentives for RES use (Articles 20-30). Development and use of RES in BiH, as well as the national goals in terms of RES share in total final power consumption in BiH until 2020, as set in the National Action Plan of Renewable Energy Sources Use in BiH (Article 4). Action Plan of Renewable Energy Sources Use has been adopted by line authorities of FBiH in 2014.[109]

Using water force for electric power generation and other driving purposes has been covered by the term "water use" from Article 44 of the LW.

12.21 Tourism

Tourism is regulated by provisions of several key laws. The Law on Tourism Activities ("OG FBiH", No. 32/09), has defined, *inter alia*, tourism service in nautical tourism (Article 43), as well as the tourism services in rafting (Article 49).

According to assessments of 2008 – 2018 FBiH Tourism Development Strategy,[110] "crucial recognizable feature of Bosansko-Podrinjski Canton in the context of future tourism development is undoubtedly the Drina River."[111]

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[108] In addition to wind, sun, geothermal sources, waves, flux and reflux, biomass, landfill gas, gas from waste treatment facility and biogas (Article 3, i. u).
[109] For the Registry of Renewable Energy Sources and Cogeneration Projects updated on 05/06/2014 see: http://fmeri.gov.ba/registar-projekata-obnovljivih-izvora-energije-i-kogeneracije.aspx (16/9/2015).
[110] Strategy was not officially adopted by the competent authority in FBiH.
[111] p. 124.

12.22 Construction and Spatial Planning

Law on Spatial Planning and Land Use in the FBiH ("OG FBiH", No. 2/06, 72/07, 32/08, 4/10, 13/10, 45/10) envisaged that planning on all tiers of government in the Federation must comply with separate regulations in the fields of environmental protection, cultural – historic, building and natural heritage, soil, air, forest, water, health, as well as protection of energy, mining and industrial facilities, infrastructure facilities and communication facilities, as well as protection of sport, tourism, defence and safety structures and their infrastructure (Article 4).

Area of special features of the Federation shall be set particularly for: 1) areas of construction of large hydropower structures (installed power above 30 MW) as set in the Federal Spatial Plan; 2) basin area of the hydro storage for regional water supply when two or more cantons have not ensured joint supply; etc. (Article 17).

Construction works on a structure may start only as per the construction approval (Article 53). In case of construction on inter-state border, jurisdiction of issuing construction approval shall be defined by virtue of an agreement between two or more states (Article 54).

Rules related to issuing construction approval have been regulated also by the Law on Spatial Development and Construction of BPCG ("OG BPCG"", No. 15/09, 4/13).

12.23 Agriculture and Irrigation / Drainage

Law on Agriculture ("OG FBiH", No. 88/07, 4/10, 7/13) has regulated: objectives and measures of agricultural policy, users of rights, definition of agricultural household, definition of a farmer, institutional support, information in agriculture and register keeping, administrative and inspection oversight, penal provisions, as well as other issues of relevance for agriculture.

Support to investments in agricultural households includes, *inter alia*, construction of the irrigation system (Article 20), and measures of land protection policy include adopting the agricultural land development program (drainage, irrigation, land management and other) (Article 27).

Strategic goals of agricultural sector have been defined by means of the 2015 - 2019 Midterm Strategy of Agriculture Sector Development in FBiH. As estimated, 1% of arable land is irrigated in FBiH.[112] Development of the Action Plan irrigation and farm enlargement is planned on the foundations of the existing program “Basics of Land Development – Irrigation Program and Farm Enlargement Program in FBiH”.

12.24 Water Transportation

In the FBiH, "navigation is occasional in one segment of the Neretva River watercourse, from Gabela to Metković, around 4 km, and along the sea coast, around 24 km. One segment of the Sava River runs through the Federation of BiH, in the municipality of Odžak".[113] The principal regulation governing water transportation is the Law on Inland and Marine Navigation of the FBiH ("OG FBiH", No. 73/05), with several by-laws also adopted.

12.25 Utility Services

Republic of BiH had the Law on Utility Services ("OG SR BiH", No. 20/90). As planned (Work Program of the Federal Government), activities on development of the Framework Law on Utility Services will be conducted “continuously in 2016“.

[112] 2015 - 2019 Midterm Strategy of Agriculture Sector Development in FBiH, Ministry of Agriculture, Water Management and Forestry, Sarajevo, May 2015, p. 17. Majority of existing systems of internal drainage are in poor shape, primarily due to inadequate or no maintenance, war and post war damages, as well as to general neglect of the system status p. 199.
[113] 2010-2022 FBiH Water Management Strategy, p. 136.

Law on Utility Services of BPCG ("OG BPCG", No. 9/13) defined the "utility services of individual utility consumption" as, *inter alia*, "drinking water supply; wastewater drainage and treatments" etc.

12.26 Business Law and Investments

Statutory law regulating founding, activities, management and cessation of business entity in FBiH is the Law on Business Entities ("OG FBiH", No. 23/99, 45/00, 2/02, 6/02, 29/03, 68/05, 91/07, 84/08, 88/08, 7/09, 63/10 i 75/13). Cessation of a "sound and healthy" business entity has been regulated by the Law on Liquidation procedure ("OG FBiH", No. 29/03), while the bankruptcy has been regulated by the Law on Receivership ("OG FBiH", No. 29/03, 33/04 and 47/06). This should be supplemented with the Law on Trade and Related Activities ("OG FBiH", No. 35/09).

Subject of concession in FBiH (Law on Concessions, "OG FBiH", No. 40/02, 61/06) may also be, inert alia, watercourse and other water use; construction of hydropower structures; construction and use or use of hydro storages; research and/or use of energy and other mineral resources, etc.[114] Disputes arising from concession awarding jurisdiction between the Federation and canton shall be settled by the Special Joint Commission for Concessions from Article 8, Paragraph 2 of present law (Article 5).[115]

Permitting public-private partnership projects is under jurisdiction of the Canton and municipalities on the territory of the Canton shall be implemented in accordance with the Law on Public – Private Partnerships (2013) BPC Goražde.

12.27 Status of Scientific Research Organizations

Scientific research activities have been regulated by the Framework Law on Basics of Scientific-Research Activities and Coordination of Internal and International Scientific-Research Cooperation of BiH ("OG BiH", No. 43/09). FBiH has no separate law regulating this field, but some cantons do (Sarajevo, Tuzla).

12.28 Harmonization of National Regulations with EU Regulations

12.28.1 Procedure

Office of the Government of FBiH for Legislation and Harmonization with EU Regulations prepares technical legal opinion in terms of compliance with EU legislation. Harmonization of internal regulations with EU regulations has been regulated by virtue of the Rules of Procedure of the Government of the FBiH ("OG FBiH", No. 25/03, 3/06, 14/07, 28/07, 69/09, 79/09). Article 27 stipulated that a law author is obliged, before forwarding the text to the Government, to harmonize the text of preliminary draft, draft and bills, i.e. other general acts, and to obtain the opinion, *inter alia*, of the Office of the Government of FBiH for Legislation and Harmonization with the European Union Regulations as regards to their compliance with the Constitution of the Federation and legal system and the methodological integrity of drafting.

2015 Work Program of the Federal Government defined strategic goal no. 2 "improvement of legal-institutional capacities, policies and plans in the water sector in the FBiH, in line with domestic needs and requirements of BiH approximation to EU standards in water protection and water resources protection whereby, in view of catastrophic 2014 floods, the central activity will be implementation of operational goals and measures of flood prevention and flood risk reduction."[116]

[114] Relation between the concession and preliminary water approval has been regulated in Article 113 of the LW.
[115] If the Government of the Federation has been deciding on awarding concession for specific resource as per Article 6 of present Law, when the resource is completely or predominantly located on the territory of one municipality, i.e. when the consequences of awarding concession will predominantly affects subject municipality, decision shall be made by the Government of Federation as per proposal of the line ministry with prior approval of the municipal council of the local community where the concession awarded will be located.
[116] 2015 Work Program of the Federal Government, FBiH, Government, Sarajevo, July 2015, p. 241.

12.28.2 Harmonization Assessment

As assessed, the Water Framework Directive (WFD) (2000/60 /EC) has been completely transposed in FBiH domestic regulations FBiH (around 95%). Full transposition is expected in 2018 with the planned adoption of the amendments and addenda to the LW. LW directly refers to the WFD in defining "hazardous substances" and "priority substances". The provisions of the WFD still not transposed in FBiH are shown in Table 12-2

Table 12-2: Planned harmonization of the LW of FBiH with WFD

Article No	Relevant article of the Directive 2000/60/EC	Deadline
	25. "Good groundwater chemical status"	2018
	27. "Available groundwater resource"	2018
	28. "Good quantitative status"	2018
Art. 3.5	Where a RBD extends beyond Community's territory, MS concerned shall endeavour to establish appropriate coordination with relevant non-MS, for achieving Dir. objectives throughout the RBD.	
Art. 22.6	For bodies of surface water, environmental objectives established under the first RBMP required by this Dir. shall, as a minimum, give effect to quality standards at least as stringent as those required to implement Dir. 76/464/EEC.	
Annex X	Priority substances[117]	2018

Source: "Monitoring transposition and implementation of the EU environmental acquis", BiH – Table of Concordance, Year 18 (2015), MOFTER

Directive on urban wastewater (91/271/EEC) has been transposed 93%. Transposition of remaining elements of the Directive has been planned for 2015.

Directive on drinking water (98/83/EC) has been almost completely transposed (around 97%). Provisions of Article 14 of the Directive are to be transposed. Deadline for adoption of required amendments and addenda of internal regulations and full transposition has not been set.

Major share of the Directive on floods (2007/60/EC) has been transposed (around 83%). Full transposition will be achieved in 2016.

Directive on ensuring quality standards (2009/90/EC) has been transposed in most part (89%) through adoption of the Rule Book on Characterization of Surface and Underground Water ("OG FBiH", No. 1/14). Required amendments to the LW have been planned for 2018 to implement full transposition of provisions of the Directive.

Directive on bathing water (2006/7/EC) has been transposed 21%. Full transposition is expected by 2018 through amendments of the LW, i.e. adoption of the by-law on bathing water.

Directive on water quality standards (2008/105/EC) has not started yet and no precise transposition plan has been defined. Deadline for full transposition has not been set.

Directive 86/278/EEC on waste sludge has been transposed 38%. There is no data on transposition of the Directive 2006/21/EC on waste from extractive industry.

Transposition of EU directives in nature protection has been significant. The adoption of the Law on Nature Protection ("Official Gazette of FBiH", No. 66/13) further improved transposition of the Birds Directive (2009/147/EEC). Around 71% of the Directive has been transposed so far. Transposition of annexes to the Directive has been planned in the form of relevant by-laws. The date of full transposition has not been set yet.

The Habitats Directive (92/43/EEC) has been also transposed through provisions of the newly adopted Law on Nature Protection. As estimated, subject directive has been transposed 82%. Transposition of the annexes

[117] Annex X is replaced by the text set out in Annex I of the Directive 2013/39/EU

has been planned through adoption of relevant by-laws. Expected date of full transposition has not been set yet.

12.29 Strategic Documents

12.29.1 Strategic Documents in the Water Sector

In accordance with Article 24 of the LW, Water Management Strategy is part of the Environmental Protection Strategy. The principal strategic document in the water management sector (Water Management Strategy of FBiH 2010-2022 has been adopted in December 2011[118]) is in stage one of implementation. The first of nine strategic goals defined are related to "Legal reform of the water sector arising from the need for adaptation to new social environment and adaptation to EU requirements in the field of water management, as a part of process of stabilization and association of BiH with EU."[119]

12.29.2 Strategic Documents in Energy and Development Sector

Document "Strategic Plan and Development Program of Energy Sector of the Federation of BiH" has been prepared as per Conclusion of the Parliament of the FBiH. Total hydro potential available for energy use is 21840 GWh. Hydropower facilities with installed power of 2725 MW and possible annual generation of 10365 GWh have been built so far, which is less than 50% of the available potentials. Elaborated period is planned for construction of new generation capacities with installed power of 442.5 MW, i.e. annual generation of 1281.68 GWh, and, thus total use of available potential will reach 57.03%, as regards to power, i.e. 53.31 % as regards to generation.[120]

12.29.3 Other Strategic Documents of Importance for IWRM

Several strategic documents have been adopted in different fields; some of them are the FBiH Environmental Protection Strategy 2008-2018, the Waste Management Plan 2012-2017, the Midterm Strategy of Agriculture Sector Development in FBiH 2015 - 2019, and the Industrial Policy Development in the FBiH, etc.

12.30 Identification of Main Issues concerning the WRM Legal Framework

One may draw the following conclusions from the analysis given above:

1. The complexity of code structure in water management derives, to large part, from the constitutional organization of the state. The issue of political system reform is underscored in public, but there are no common attitudes there. One of the lines of division and different views of part of public perception is related to the issue of stronger powers of central (BiH level) authorities; however, the functionality and efficiency of the legal system have not been adequately highlighted.
2. Two principal laws regulating water management (LW) are in force in the entities (RS, FBiH). Laws regulating water management are also in force in BDBiH. Several cantons within FBiH have their laws, among which is BPCG. There is also proposal of adoption of the law on BiH state level. Coordination of activities is considered to be an issue for detailed elaboration;
3. Regulations from other fields (for example, agriculture, veterinary medicine) adopted at BiH state level relate to some extent, (or may be relevant for) to water management. BiH state level authorities play a coordinative role in international cooperation, preparation and ratification of international agreements and reporting on implementation of international agreements. Entity legislation regulates water

[118] http://www.voda.ba/doc/SUV_FBiH_Prijedlog.pdf (1/10/2015).
[119] In addition to, Adequate integration of water management sector in economic system as a whole, with larger representation of the economic tools in the process of water resources management; Improving efficiency, transparency and accountability in water management; Provision of financial viability in water management and reform of water pricing system along with progressive introduction of economic water price; Efficient institutional organization and administration capable of implementing the accession process and implementation of EU requirements in the water sector; Increase in coverage and improvement of public water supply systems; Ensuring conditions for sustainable use of water in the areas whose development depends on market interest, etc.
[120] *Strategic Plan and Development Program of Energy Sector of the FBiH*, Sarajevo, February 2008, p. 60.

management policy and implementation of laws. Issue of coordination of international activities and rights and responsibilities of line entities has been regulated by virtue of provisions of entity laws on water.

4. Adoption of the LW (2006) was a significant step ahead in creation of the regulatory system in the field of WRM. However, one part of by-laws was not adopted.
5. Laws of both entities regulate system issues in the same (or similar) manner. Issue of inter-entity cooperation has been regulated by laws on water and other regulations. However, there are suggestions pointing to the need for improvement of inter-entity cooperation.
6. Bosansko-Podrinjski Canton Goražde within FBiH has a separate law regulating water management, with cantonal powers. There is a need for stronger coordination between the Federation and the Canton in implementation of regulations;
7. Separate systems of entities' codes have been also developed in other fields of relevance for water management (environment, energy, agriculture, tourism, etc.). Both laws on environmental protection regulate in similar manner the procedure of environmental permitting, environmental impact assessment, etc.
8. Both laws on environmental protection regulate the issue of inter-entity cooperation, but the coordination mechanisms should be strengthened.
9. Economic instruments in water management and environmental protection (although regulated by the entities laws) are still limited;
10. Activities related to harmonization of internal laws with EU regulations are underway and some results have been achieved. Dynamics of further harmonization has been planned. However, there are problems in implementing aligned approach to the process, as well as dynamics of harmonization;
11. Certain level of harmonization of domestic regulations with EU regulations has been achieved. WFD has been transposed significantly although there are still other provisions to be transposed in internal regulations;
12. Just initial level of harmonization has been achieved in regard to certain EU regulations, which is the reason why different entities need to align their activities. There are no data related to certain harmonization of internal regulations as regards to one part of EU regulations;
13. Issue of implementation of regulations in water management and environmental protection is considered open;
14. Strategic documents in water management exist in the entities. Further, adoption of a new strategic document in RS is underway;
15. Strategic documents from several other fields of relevance for water management have been adopted. However, RS has not adopted the Strategy of Environmental Protection.
16. Strategy of Adaptation to Climate Change and Low Emission Development in BiH has been adopted. However, issue of mutual compliance of individual strategic documents may be considered open;
17. BiH participates in international cooperation in the field of water management. BiH is a member of crucial international agreements in water management and environmental protection, including Danube and Helsinki Conventions on Water. BiH is not the member, similar to Serbia, of the New York Convention on the Law of the Non-Navigational Uses of International Watercourses (1997);
18. BiH participates actively in cooperation taking place according to the FASRB. Crucial issues of cooperation in the DRB are as follows: flood defence, hydropower plant management, deposit management, water protection and regulating the status of Montenegro.
19. RS developed certain forms of cooperation with Serbia within the Agreement on Special Parallel Relations;
20. BiH has not signed agreements in WRM with Serbia and Montenegro. This is considered one of the obstacles to integrated management of the Drina River;
21. BiH is the member of the Treaty Establishing Energy Community, but there are certain problems related to implementation of the treaty.

12.31 Perspectives in the Development of Regulations in the Field of WRM

The perspectives in the development of BiH regulations in the field of WRM are determined by several factors, among which the most important are as follows:

- The dynamics of EU integrations, i.e. the character, contents, status and dynamic of harmonization of regulations with EU regulations;
- The depth and character of water management system changes to be introduced by the process of EU integrations;
- The current level of economic development, institutional capacity and infrastructure conditions of significance for harmonization of regulations and WRM and environmental protection; and
- The current status of constitutional powers and possible directions of change in this domain.

Starting from the standpoint that directions and possibilities of regulatory developments in WRM in BiH are mainly related to perspectives of EU integration, then the process of harmonization of internal regulations with EU regulations may be considered a key factor in determining developments in this sector. The current status of harmonization of internal regulations with EU regulations indicate, inter alia, that it will take a lot of time to reach full harmonization of internal regulations with EU regulations. According to the Stabilisation and Association Agreement (SAA) it is planned to fully realize the activities in a transitional period of up to six years.[121]

Under current circumstances, one may expect that the process of harmonization of regulations will take between 5 and 10 years if supported by international institutions and EU in a systematic manner. This should also include consideration about the number of regulations in water management and environmental protection where the harmonization process has not yet started, or is in initial stages.

However, implementation of regulations in WRM and environmental protection may be considered as a completely different issue. Developing adequate infrastructure will not be possible without support of international community. This is primary due to the fact that, in view of the experiences of other countries that joined EU in the last enlargement cycle, large investments will be required. That means that this process, most likely, will take around thirty years. Subject process will be under the pressure of the functioning of the rule of law, discussions about political system reforms, as the factors beyond the water management system in a narrow sense of the word.

12.32 Recommendations

Based on the BiH WRM legal framework analysis given above, the following is recommended:

1. Undertaking further measures aimed at harmonization of internal regulations with EU regulations;
2. Preparation and adoption of required by-laws as per applicable laws on water;
3. Harmonization of regulations governing utility services with the regulations governing WRM; Adoption of the law to regulate utility services in FBiH; Adoption of the law on chemicals (in FBiH);
4. Intensifying activities of adoption of the water management plans;
5. Harmonisation of the strategic objectives of spatial development in the DRB countries:
6. It is required to invest efforts in transfusion of the strategy in sector policies and strategies;
7. Improve strategic planning and implementation of *acquis* in the field of environment and climate;
8. Adopting a Strategy of environmental protection and Waste management strategy in RS;
9. Develop a strategy of harmonization of internal regulation with EU regulations in the water management sector;
10. Improve harmonization of directives on strategic environmental impact assessment and public participation;
11. It is required to strengthen regulatory enforcement capacity in the field of industrial and hazardous waste;
12. Strengthening instruments of adjustment, coordination and involvement of various tiers of government in preparation and adoption of regulations and their harmonization with EU regulations;

[121] See also: Water Management Strategy of FBiH 2010-2022. p. 185. In the Integrated water management strategy of the RS 2005-2024 (Draft) the deadline for the harmonization of regulations in the water area with the EU has not been determined. Integrated Water Management Strategy of RS 2015-2014, Draft, p. 283.

13. Strengthening the transparency of the process of harmonization of internal regulations with EU regulations;
14. The following regulations are to be charged or adopted to strengthen FHMO capacities: Law on Hydro-Meteorological Activities (FBiH); LW of FBIH (either certain amendments to the existing law or adopt a new law); Adequate enactment should regulate the status and responsibilities of FHMO as regard to public reporting, EEA WMO and other; Regulations related to the quality management system-QMS;
15. Strengthening instruments of ensuring regulatory compliance, including relations between inspection and judicial authorities;
16. Regulatory reform to create more efficient financing system in the water sector, or of relevance for water sector;
17. Elaborate possibilities of ratification of the New York Convention on the Law of the Non-Navigational Uses of International Watercourses;
18. Intensifying activities related to signing an agreement on water management relations and energy with Serbia and Montenegro.

13 Institutional Assessment of Water Management Sector

The present chapter provides assessment of institutional capacities in the field of WRM in BiH. In accordance with the constitutional organization, capacities of line authorities will be introspected in the RS and the FBiH, entities responsible (to greater extent) for water resources management.[122] In line with the TOR the role and responsibilities of principal institutions in water management, environmental protection, and the energy sector are described, and data on human resources (staff numbers, educational and gender structure) will be provided. Main institutional issues of significance for water management in the Drina River basin (DRB) will be highlighted, and indications of how the institutional framework will develop in future and how will it treat water management issues in the basin will be presented.

13.1 Introduction

Analysis of institutional aspects of WRM in BiH is based on data contained in relevant documents (strategic documents, reports by line authorities, international organizations and other entities). Free access to important documents of line authorities and organizations is mainly allowed. The analysis also used data obtained from the "Institution Capacity Evaluation Questionnaire" completed by the main WRM entities (public administration institutions) during March and April 2015. The questionnaire was sent to 12 institutions: one BiH institution, five institutions of the RS and six institutions of the FBiH. Table below provides further details (see Table 13-1).[123]

Table 13-1: Response to "Institution Capacity Evaluation Questionnaire" in BiH

No.	Questionnaire delivered	Questionnaire filled out	Comments
BiH			
1.	Ministry of Foreign Trade and Economic Relations	Yes	Questionnaire received on 17/04/2015 Questionnaire almost completely filled out.
RS			
1.	Ministry of Agriculture, Forestry and Water Management	No	
2.	Republic Hydro-Meteorological Office	Yes	
3.	Public Institution "VodeSrpske" Bijeljina	Yes	Questionnaire received on 08/05/2015
4.	Ministry of Industry, Energy and Mining	No	
5.	Ministry of Spatial Planning, Civil Engineering and Environmental Protection	Yes	
FBiH			
1.	Ministry of Agriculture, Water Management and Forestry	Yes	Questionnaire received on 17/04 /2015 Questionnaire almost completely filled out.
2.	Agency of the Sava River Water Area	Yes	Questionnaire received on 16/04/2015
3.	Federal Hydro-Meteorological Office of BiH	Yes	Questionnaire received on 16/04/2015 Questionnaire almost completely filled out.
4.	Federal Ministry of Energy, Mining and Industry, Energy Sector	No	
5.	Federal Ministry of Environment and Tourism	Yes	Questionnaire received on 20/04/2015 Questionnaire almost completely filled out.
6.	Ministry of Economy, Bos-Podrinjski Canton Gorazde	No	
	TOTAL	**8-Yes 4-No**	

Eight institutions have filled out the questionnaire, one BiH institution, three from RS and four from FBiH. The questionnaire included five groups of questions related to: organization, training and capacity building,

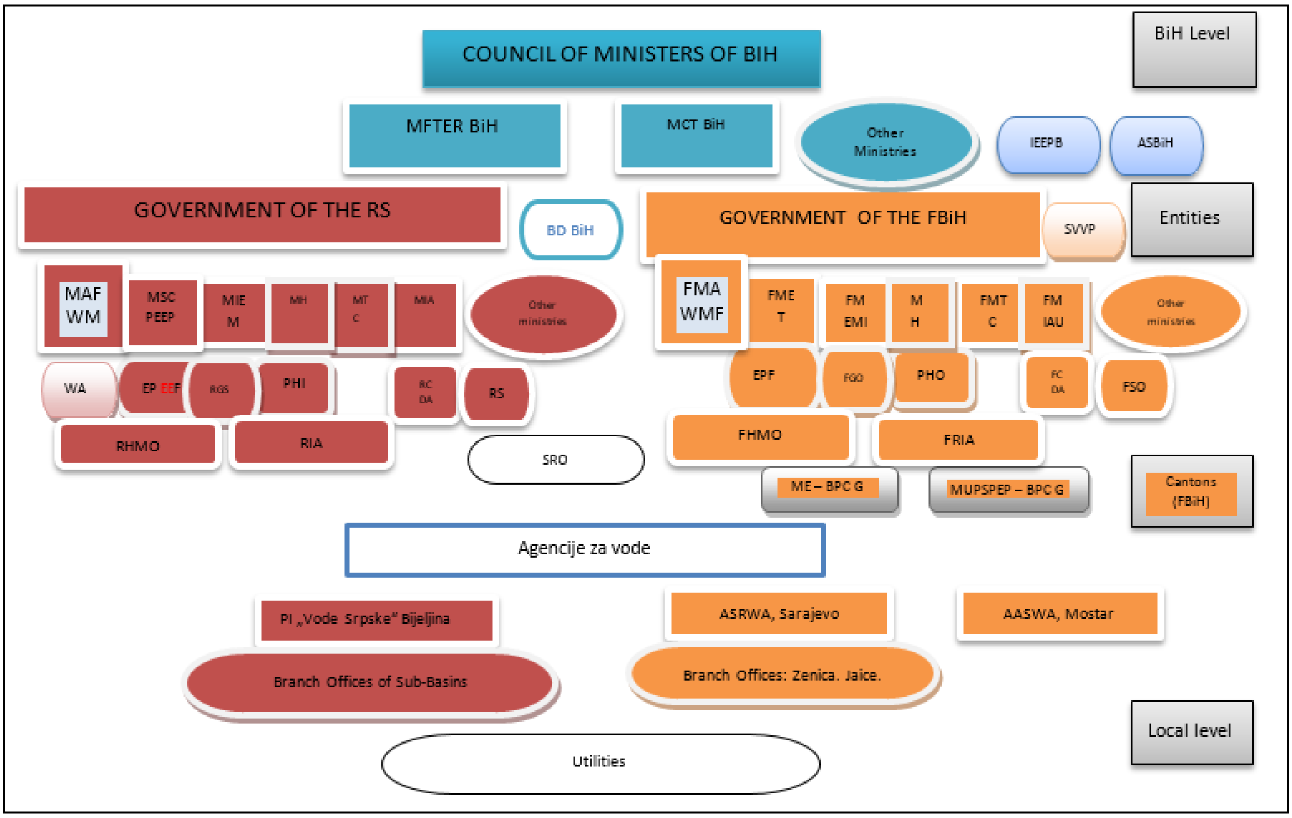
[122] According to the provisions of Article I, Item 3, Annex 4 of the Constitution of the Bosnia and Herzegovina, General Framework Agreement for Peace in Bosnia and Herzegovina, BiH consists of RS and FBiH. Article III, of Annex 4 lists the responsibilities of BiH. According to Item 3. (a) (stating that "all state functions and responsibilities that were not explicitly assigned to the institutions of Bosnia and Herzegovina, shall be the functions of Entities"), water management shall be the responsibility of entities. This should be coupled with responsibilities of the institutions of the Brčko District of BiH (BDBiH), in accordance with subsequent arbitrage.

[123] As estimated, data collection by means of the Questionnaire is useful, but it also carries certain deficiencies. It is difficult to availability and interest among system institutions. Conceptually, the questionnaire should be limited to the minimum amount of data, i.e., defining the term "institutional capacities" determines the number and relevance of individual institutions versus the system as a whole. Discussion with stakeholders based on data contained in the first version of analysis should serve as a contribution to accurate definition of the baseline situation, as well as to the accuracy of further activities.

monitoring, cooperation (in the country and with the countries of the DRB) and harmonization and application of regulations. A significant number of relevant information too voluminous to be contained within the present report is contained in annexes to present report (See Annex 13-1).

13.2 Identification of the Water Management System Entities in BiH

The water management entities system structure in BiH is set in accordance with the current constitutional responsibilities of individual tiers of government: BiH, entities (cantons in FBiH) and local level. Figure 13-1 below provides an inidcaiton of the interrelationships of these stakeholders.



Abbreviations: MoFTERBiH – Ministry of Foreign Trade and Economic Relations of BiH, MCT BiH – Ministry of Communication and Transport of BiH, IEEPB – Inter-Entity Environmental Protection Body, BD BiH – Brčko District BiH, MAFWM – Ministry of Agriculture, Forestry and Water Management, WAC – Water Area Council, MSPCEEP – Ministry of Spatial Planning, Civil Engineering and Environmental Protection, EPEEF – Environmental Protection and Energy Efficiency Fund of RS, MIEM – Ministry of Industry, Energy and Mining, RGSO – Republic Geologic Survey Office, MH – Ministry of Health, MTC – Ministry of Transportation and Communications, MIA – Ministry of Internal Affairs, RCDA – Republic Civil Defense Authority, RHMO – Republic Hydro-Meteorological Office, RIA – Republic Inspection Authority, PHI – Public Health Institute, FMAWMF – Federal Ministry of Agriculture, Water Management and Forestry, WAAC – Water Area Advisory Council, FMET – Federal Ministry of Environment and Tourism, EPF – Environmental Protection Fund, FMEMI – Federal Ministry of Energy, Mining and Industry, FGO – Federal Geological Office, FMTC – Federal Ministry of Transportation and Communications, FMIA – Federal Ministry of Internal Affairs, FCDA – Federal Civil Defense Authority, FHMO – Federal Hydro-Meteorological Office, FIA – Federal Inspection Authority, FSO – Federal Statistics Office, PHO – Public Health Office, ME BPCG – Ministry of Economy, Bosnian-Podrinje Canton Goražde, MUPSPEP BPCG – Ministry of Urban Planning, Spatial Planning and Environmental Protection, Bosnian-Podrinje Canton Goražde, SRO – Scientific Research Organizations, ASRWA – Agency of the Sava River Water Area, AASWA – Agency of the Adriatic Sea Water Area.

Figure 13-1: Institutional framework of water management in BiH

As shown in Figure 13-1, operations related to coordination of specific activities within the BiH level are executed by the Ministry of Foreign Trade and Economic Relations of BiH (MFTER), as well as several other bodies. Memorandum of Understanding between FBiH and RS on water related issues was signed in 1998 by the governments of entities, to establish the inter-entity coordination mechanism in the water sector. The Memorandum established the Inter-Entity Commission for Coordination of Activities Related to Water, the scope of responsibilities was defined, as well as the model and requirements of operation. With the aim of aligned work of the line authorities of RS and FBiH, Inter-Entity Environmental Protection Body was established.

Anyway, the most important segment of activities in the water management sector is under the responsibilities of two entity ministries and three water area agencies.[124]*TheFederal Ministry of Agriculture, Water Management and Forestry (FMAWMF) in FBiH*, and the *Ministry of Agriculture, Forestry and Water Management (MAFWM) in RS. Public Institution "VodeSrpske"* based in Bijeljina, is in charge of the basins of the Adriatic Sea and Black Sea in RS. *In FBiH, the Agency of the Sava River Water Area based in Sarajevo* is in charge of the Black Sea basin and the *Agency of the Adriatic Sea Water Area* based in Mostar is in charge of the Adriatic Sea basin.

Two ministries of health from two entities are in charge of drinking water quality issues, the Ministry of Health and Social Welfare in RS, and the Federal Ministry of Health in FBiH. Certain responsibilities related to water are also located in the ministries primary responsibilities are related to environmental protection, ministries in charge of energy and mining, ministries with primary responsibilities for transportation, then civil defense authorities, i.e. emergency management, etc. Hydro-meteorological offices, and/or inspection authorities hold special responsibilities in water management, each in line with relevant regulations and specific role in the system.

Line cantonal ministries exercise certain activities in FBiH, while the cantonal ministries of Bosnian Podrinje Canton Goražde (BPCG) play very important roles in DRB.

Line authorities of the Brčko District BiH (BDBiH) exercise certain responsibilities in water management, according to their responsibilities and in line with the predefined position of BDBiH.

Local government units, i.e. utilities play respective role locally (water production and distribution, sanitary and technical activities, including water quality and public water supply and sewage management, wastewater treatment and drainage, etc.).

13.3 Public Administration Institutions in BiH

Public administration institutions in BiH are grouped as follows:

1. Institutions directly responsible for water management and environmental protection;
2. Institutions responsible for activities in the energy sector;
3. Institutions responsible for other sectors that might exert impact on WRM;
4. Institutions responsible for alignment of the national regulations with EU regulations;
5. Local government.

Information on the most important public administration institutions responsible for WRM is given within the following groups as follows:

<u>Group I – WRM and environmental protection</u>

BiH

- Ministry of Foreign Trade and Economic Relations
- Ministry of Communication and Transport of BiH
- Inter-Entity Environmental Protection Body;

Republic of Srpska

- Ministry of Agriculture, Forestry and Water Management
- Ministry of Spatial Planning, Civil Engineering and Environmental Protection
- Public Institution "VodeSrpske" Bijeljina
- Ministry of Health and Social Welfare of the Republic of Srpska
- Republic Hydro-Meteorological Office
- Republic Inspection Authority

[124] See Annex 13-1 for a detailed table breakdown of responsibilities of individual entities.

Federation BiH
- Federal Ministry of Agriculture, Water Management and Forestry
- Federal Ministry of Environment and Tourism
- Agency of the Sava River Water Area
- Agency of the Adriatic Sea Water Area
- Federal Hydro-Meteorological Office
- Federal Inspection Authority

Bosnian-Podrinje Canton Goražde
- Ministry of Economy
- Ministry of Urban Planning, Spatial Development and Environmental Protection

Brčko District BiH
- Department of Agriculture, Forestry and Water Management; Sub-department of Forestry and Water Management
- Department of Spatial Planning and Property-Legal Issues, Sub-department of Spatial Planning, Urban Planning and Environmental Protection

Group II - Energy
Republic of Srpska
- Ministry of Industry, Energy and Mining
- Regulatory Commission for Energy RS (Regulator)

Federation of BiH
- Federal Ministry of Energy, Mining and Industry
- Regulatory Commission for Energy in FBiH

Bosnian-Podrinje Canton Goražde

Group III – Institutions from other sectors of relevance for WRM
BiH
- Ministry of Foreign Affairs of BiH
- Ministry of Civil Affairs

Republic of Srpska
- Ministry of Public Administration and Local Government
- Public Health Institution "Institutzajavnozdravstvo"

Federation of BiH
- Ministry of Justice (Public Administration Institute)
- Public Health Institution of the Federation of BiH
- Public Health Institution (cantonal)-PI Public Health Institute BPC Goražde

Group IV – Harmonization of national regulations with EU regulations
- Directorate of European Integrations in BiH
- Republic Secretariat of Legislation, Government of the Republic of Srpska
- Department of Legislation and Compliance with the European Union Regulations,
- Government of the FBiH

Group V – Local Government Units
Republic of Srpska
Federation of BiH

13.3.1 WRM and Environmental Protection

WRM and Environmental Protection at BiH level

Capacities

Group I – Institutional capacities in BiH are shown below in Table 13-2.

Table 13-2: Job systematizations and total staff numbers in public administration institutions responsible for water management and environmental protection in BiH

Initiation	Job systematization	No. of positions in job systematization	Total staff number	Date	Comments
I WRM and environmental protection					
MFTER BiH	---	232	172 (out of which 129 civil servants)	31/12/2013	
MFTER BiH, Sector for Natural Resources, Energy and Environmental Protection	---	---	33	17/04/.2015	Source: “Questionnaire”
MFTER BiH, Water Resources Division	5	5	5[125] (4 civil servants and 1 independent officer)	17/04/2015	
MCT BiH	---	---	---		Data available on the Ministry’s webpage
Inter-Entity Environmental Protection Body	8	8	8[126]		

Data on job systematization and the number of positions in job systematization were available for MoFTERBiH, and the Inter-Entity Environmental Protection Body. MoFTER has 232 positions in job systematization, out of which five jobs with the same number of positions in the Water Resources Division, while the Inter-Entity Environmental Protection Bodyhas eight positions in job systematization with the same number of positions (four from RS and four from FBiH). See Annex 13-2.

MoFTER has total of 172 staff members (129 civil servants), 33 in the Sector for Natural Resources, Energy and Environmental Protection and five in the Water Resources Division (four civil servants and one independent officer).

Data on educational structure is available only for the Water Resources Division of MoFTER where 80% of staff members hold bachelor degrees and 20% are with high school education or less (See Table 13-3).

Age structure data was available for the Sector for Natural Resources, Energy and Environmental Protection of MoFTER where the average age of staff member is around 50 and for the Water Resources Division where the average age of staff member is around 47.4.

Gender structure data was available only for the Water Resources Division of MoFTER with more women (60%) versus men (40%) among staff members. See Annex 13-2 for more details.

Table 13-3: Staff education, age and gender structure in BiH institutions – state level

[125] Same piece of data on MoFTER having 5 staff members in the Water resources Division is present in the "Institution Capacity Evaluation Questionnaire", MoFTER.

[126] Inter-Entity Body has no official webpage and no visual presentation of the organizational structure or staff data (education, age and gender structure, etc.) are available.

Institution	PhD	Master Degree	Bachelor Degree	Associate Degree	High School or lower	Average age (in years)	Men	Women	Comments
I WRM and environmental protection									
MFTER BiH, Sector for Natural Resources, Energy and Environmental Protection	---	---	--	---	---	Around 50	---	---	Source: Questionnaire/ Data related to the Sector were not provided
MFTER BiH, Water Resources Division	---	---	80%	---	20%	Around 47.4	40%	60%	Source: Questionnaire
MCT BiH	---	---	---	---	---	---	---	---	Data available on the Ministry's webpage.
Inter-Entity Environmental Protection Body	---	---	---	---	---	---	---	---	The body has no official webpage.

Table 13-4 below provides a general assessment of the capacities of MoFTER and their cooperation with DRB.

Table 13-4: General assessment of MoFTER capacities and cooperation within DRB

Instit.	Assessment	Priorities and problems in cooperation in DRB
MoFTER	More staff members are required for the ministry to be able to implement relevant responsibilities. This is primarily related to the Water Resources Department. Hydro engineers and lawyers are a priority; MoFTER has no staff training plan and all trainings are carried out through the Civil Service Agency of BiH, EU projects and other donor projects. Topics to be covered in trainings are EU legislation and responsibilities in WRM; MoFTERBiH is completely financed by the state budget; For the purpose of capacity strengthening, currently required are additional office space and equipment, as well as the new Rule Bok on Job Systematization of MoFTERBiH. Main problems of cooperation with other entities in the state are as follows: lack of regulatory alignment on all tiers of government, lack of information and data, lack of coordination mechanism in BiH EU integration processes. More staff members are expected in the Water Resources Division in the next 10 or 20 years, and that the quantity of work will increase during the same period in line with the implementation of water management related projects, as well as in view of new obligations related to EU;	Main obstacles in WRM in DRB are as follows: lack of finances, lack of data, inadequate coordination between the central and local level, lack of staff members, low political priority. The most important challenges affecting the regional cooperation perspectives in the following decade in WRM in DRB are as follows: lack of finances, lack of data related to water, inability to rely on historic data and unusability of existing data, climate changes, population growth, urban development, etc. Cooperation between the countries of DRB should be improved in the following fields: WRM, floods, energy, nature protection, climate change. Some believe that signing the international agreement between the three countries (BiH, Montenegro and Serbia) on cooperation inIWRM would contribute to cooperation and problem solving. The biggest problems in implementation of international agreements in water management (and/or of relevance for water) are related to the fact that no bilateral agreement on water management relations with Serbia and Montenegro has been signed yet. As regards the implementation of the Framework Agreement on the Sava River Basin – the most important problems of relevance for the Drina River are as follows: Flood defence; Management of hydro storages; Deposit management; Status of Montenegro. Cooperation within the Euroregion is assessed as "good". The biggest priority of MFTER in the following 10 and 20 years in terms of accelerated improvements in WRM in DRB are: implementing obligations set in EU and domestic regulations inWRM; coordination of line entity ministries; cooperation with international institutions;

Source: *"Institution Capacity Evaluation Questionnaire"* MFTER

See Annex 13-2, Table 6: Documents (opinion, approvals, etc.) issued by MoFTER during 2010-2014.

<u>Jurisdiction and Organization</u>

<u>Ministry of Foreign Trade and Economic Relations of BiH (MoFTER BiH)</u>

MFTER, 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.

MoFTER BiH is organized through the following organizational units: 1) Sector for Foreign Trade Policy and Foreign Investments; 2) Sector for International Trade Relations; 3) Sector for Customs Policy and Tariff; 4) Sector of Economic Development and Entrepreneurship; 5) *Sector of Natural Resources, Energy and Environmental Protection;* 6) Sector for Legal and General Affairs; 7) Sector for Agriculture, Food, Forestry and Rural Development; 8) Inspectorate (See Annex 13-2 Figure 1: Organizational Structure of MoFTER BiH).[127]

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.

<u>Ministry of Communication and Transport of BiH (MCT BiH)</u>
MCTBiH is, *inter alia*, in charge of river and maritime transport.

Organizational structure of MCTBiH is as follows: 1) Legal and Financial Affairs Sector; 2) *Transport Sector;* 3) Transport Infrastructure, Project Preparation and Implementation Sector; 4) Communication and Informatization Sector; 5) Inspectorate; 6) Directorate of Civil Aviation of BiH; 7) BiH Railway Regulatory Board. Transport Sector has two divisions: Road and Railway Transport Division and *Air, Water and Pipeline Transport Division.*[128]

<u>Inter-Entity Environmental Protection Body</u>
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 inter-entity environmental issues.[129] 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.

WRM and Environmental Protection in RS
<u>Capacities</u>
Institutional capacities in RS are shown below in Table 13-5.

Table 13-5: Job systematizations and total staff numbers in public administration institutions responsible for water management and environmental protection in RS

Initiation	Job systematization	No. of positions in job systematization	Total staff number	Date	Comments
<u>I WRM and environmental protection</u>					
MAFWM	116	167[130]	---[131]		
MAFWM, Water Management Sector	5	5	---		

[127] http://www.mvteo.gov.ba/o_nama/Nadleznosti/default.aspx?id=29&langTag=bs-BA, (25/09/2015)
[128] http://www.mkt.gov.ba/Default.aspx?langTag=bs-BA&template_id=99&pageIndex=1, (25/09/2015)
[129] For details see Part III of the *Decision on Establishment of the Inter-Entity Environmental Protection Body*. See: http://www.fbihvlada.gov.ba/bosanski/zakoni/2006/odluke/265bos.htm, (25/09/2015).
[130] Out of which 92 are civil servant jobs, 22 jobs are appointees and 2 jobs are assistants to minister (Article 17, paragraph 1 of the *Rule Book on Job Systematization in MAFWM*).
[131] Webpage of MAFWM of the RS has no data on total staff number.

Initiation	Job systematization	No. of positions in job systematization	Total staff number	Date	Comments
I WRM and environmental protection					
PI "VodeSrpske" Bijeljina	---	---[132]	29		
MSPCEEP	54	62[133]	49	31/12/2013	
MSPCEEP, Environmental Protection Sector	12	12	----[134]		
MHSW	---	---	---		No data
RHMO	62	78	68		Source: "Questionnaire"
RHMO	62	78	62	31/12/2013	
RIA	116	370	218 inspectors	In 2014	
RIA	3	12[135]	---		

Note: sources given in Annex 13-2

The following points are noted:

- MAFWM has 116 jobs in job systematization with 167 positions, but total stuff numbers are not available on internet.
- PI "VodeSrpske" has more male staff members (62%) versus female staff members (38%).
- RHMO has 68 staff members (data from "Questionnaire"). In late 2012, subject institution had 62 staff members out of total 78 jobs in job systematization.
- MSPCEEP had 49 staff members in late 2013 out of total 62 jobs in job systematization.
- RIA has 218 inspectors. Total staff member numbers in this institution is higher as only data on inspectors were available, and no total staff numbers were available. Subject institution has total 370 jobs in job systematization with 12 positions in the Water Inspection Sector.
- Data on the Ministry of Health and Social Welfare of the Republic of Srpska are not available via internet.

Data on education, age and gender structure was available only for RHMO RS. Most staff members (74%) of this institution hold high school or lower degrees, and the remaining 26% staff members hold university degrees. The average age of staff members in the Office is 43. The Majority of staff members of RHMO RS are men (60%) (See Table 13-6).

Table 13-6: Staff education, age and gender structure in authorities in charge of WRM in RS

Institution	PhD	Master Degree	Bachelor Degree	Associate Degree	High School or lower	Average age (in years)	Men	Women	Comments
I WRM and environmental protection									
MAFWM	---	---	---	---	---	---[136]	---	---	Data not available on internet
PI "Vode Srpske" Bijeljina	---	---	---	---	---	---[137]	62%	38%	
MSPCEEP	---	---	---	---	---	---[138]	---	---	Data not available via internet
MHSW	---	---	---	---	---	---	---	---	Data not available on internet
RHMO RS	---	---	26%	---	74%	43	60%	40%	Source: Questionnaire

[132] Webpage of PI "Vode Srpske" has no data on job systematization, staff age or gender structure.
[133] Out of which 39 are civil servants, 20 are appointees, 2 advisors and 1 chief of staff of the Ministry.
[134] Webpage of MSPCEEP has no data on total staff number.
[135] Out of which one job – Head of the Water Inspection Sector – is on needed basis.
[136] Webpage of MAFWM of the Republic of Srpska has no data on staff education, age or gender structure.
[137] Webpage of PI "Vode Srpske" has no data on staff education or age structure.
[138] Webpage of MSPCEEP has no data on staff education, age or gender structure.

RIA	---	---	---	---	---	---[139]	---	---	Data not available on internet

Table 13-7 below provides a general assessment of the capacities of RS institutions and their cooperation with DRB.

Table 13-7: General assessment of RS initiations capacities and cooperation in DRB

Instit.	Assessment	Priorities and main institutional problems in cooperation in DRB
MAFWM	X	X
PI "Vode Srpske"	"Before the war, water sector in BiH, in the Republic of Srpska, had high quality staff members of various profiles with the best world reputation. Serious stagnation in terms of large new structures in the field of water left serious consequences. Departure of the best staff members was not coupled with timely renewal." (Source: *Integrate Water Management Strategy of the Republic of Srpska 2015-2024*, Draft, Banja Luka, June 2015, p. 284). PI "VodeSrpske" has staff training plan.[140]	The most important challenges affecting the regional cooperation perspectives in the following decade inWRM in DRB are as follows: lack of finances, lack of aligned legislation and more conflicting water use methods, financial crisis, climate changes, lack of international agreement on cooperation between BiH (FBiH, Republic of Srpska), Montenegro and Serbia, etc. "Institution Capacity Evaluation Questionnaire" has no data on the biggest obstacles in WRM in DRB. Second in the line are as follows: inadequate coordination between the Ministry and public authorities on the state level, inadequate coordination between the central and local level, lack of data, inadequate or unforeseeable international support, inadequate information or public participation and lack of funds. Third in the line are lack of staff and low political priority. Cooperation between the countries of DRB should be improved in the following fields: WRM, floods, energy, nature protection, climate change. Signing the international agreement between the three countries (BiH, Montenegro and Serbia) on cooperation inIWRM would contribute to cooperation and problem solving.
MSPCEEP	The biggest problems related to monitoring are the lack of measurement stations and accredited measurement bodies. To establish air monitoring, it is required to procure specific number of automatic air quality measurement stations. Trainings are carried out through EU funded projects and projects funded by international organizations. Current project: '' Regional EU Accession Network in the field of Environment and Climate Change''- EKRAN	The most important challenges affecting the regional cooperation perspectives in the following decade in WRM in DRB are as follows: lack of international agreement on cooperation between BiH (FBiH, Republic of Srpska), Montenegro and Serbia, inadequate implementation of international agreements, lack of aligned legislation, climate changes, etc. Cooperation with DRB countries should be improved especially problems related to floating waste arriving from Montenegro andSerbia creating major problems in storages of the hydropower plants in the DRB, as well as problems related to tourism undergoing development phase in the Drina River towns. Signing the international agreement between the three countries (BiH, Montenegro and Serbia) on cooperation in IWRM would contribute to cooperation and problem solving.
RHMZ RS	Main institutional problems RHMO RS has to deal with currently are lack of staff and office space, as well as poor budget required to meet legal obligations. Representatives of RHMO of the Republic of Srpska believe that in the next 3 years the Office should be provided with the building to create adequate work conditions for staff. In long-term sense, establishment of the automatic operational monitoring and development of the meteorological and hydrological forecast model are required. More staff is needed for RHMO RS to exercise its authorities. Organizational segments to be strengthened are as follows: hydrological and meteorological monitoring, data analysis and hydrological measurements. Required staff profiles are civil engineers – hydrologists and electric engineers. As regards to equipment to be procured by RHMO RS to strengthen capacities, as estimated, it will be required to procure automatic measurement stations with supporting software and data transfer and storage servers, flow metering tools, transfer metering tool and an off-road vehicle.	RHMO cooperates with the hydro-meteorological services in DRB which is assessed as "on a high level". However, there are problems in terms of cooperation with hydropower systems. Hydropower systems on the Drina River have their own hydrological and meteorological monitoring, but data are not delivered to the Hydro-Metrological Office. The most important challenges affecting the regional cooperation perspectives in the following decade inWRM in DRB are as follows: lack of finances, lack of data related to water, inability to rely on historic data and unusability of existing data, financial crisis, increased water droughts, lack of international agreement on cooperation between BiH (FBiH, Republic of Srpska), Montenegro and Serbia, etc. Priorities of RHMO RS in the following 10 or 20 years in terms of accelerated progress in WRM in DRB are as follows: a) Establishment of an operational automatic hydrological and meteorological monitoring, currently in very poor shape; b) Measurement of deposit transportation, not implemented as of 1991; c) Hydrological measurements in all hydrological stations and defining new lines water level/discharge dependence;

[139] Webpage of RIA has no data on staff education, age or gender structure.
[140] "*Institution Capacity Evaluation Questionnaire"* is incomplete, i.e. only few questions in chapters I and II were responded.

Instit.	Assessment	Priorities and main institutional problems in cooperation in DRB
	RHMO RS expects significant staff improvements in the following 10 or 20 years, especially hydro technical profiles with university degrees. As regards to jurisdiction and scope of work, office expects to preserve its jurisdiction supported with staffing, technical and financial conditions ensuring better performance in line with obligations set in laws; RHMO RS has not staff training plan. In terms of additional trainings required for current staff members, required are manipulation of contemporary measurement tools, as well as trainings in maintenance of automatic measurement stations. Topics to be covered in trainings are as follows: IT, electro-techniques, statistical data analysis, foreign languages and trainings in suspended deposits transportation measurement; The biggest problems of monitoring are as follows: lack of measurement stations (hydrological and meteorological); lack of staff for data monitoring and analysis.	d) Development of the hydrological model of the Drina River together with Serbia and Montenegro and aligning data on water balance. RHMO has specific forms of cooperation with DRB countries within international agreements in water management. It is believed that cooperation within the rivers of Neretva and Trebišnjica is very important for DRB. No access to cooperation within the Euroregion. Signing the international agreement between the three countries (BiH, Montenegro and Serbia) on cooperation in the energy sector would contribute to cooperation and problem solving.

Source: *"Institution Capacity Evaluation Questionnaire"*

Jurisdiction and Organization

Ministry of Agriculture, Forestry and Water Management (MAFWM)

The Ministry 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.); as well as the *Public Institution "VodeSrpske", Bijeljina;* Branch Office of the Vrbas River Basin, Banja Luka; Branch Office of the Bosna River Basin, Doboj; Branch Office of the Una River Basin, Prijedor; PE "Šume RS" Sokolac.

Principal organizational units of the Ministry are as follows: 1) Department of Agriculture, Food Industry and Rural Development; 2) Department of Technical Agricultural Services; 3) Department of Veterinary Medicine; 4) Department of Forestry and Hunting; 5) *Department of Water Management.* See annex 13-2 Figure 2: Organizational Structure of MAFWM RS

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). For details see Table in Annex 13-2.

PI "VodeSrpske"

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 and 92/09) 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.[141]

[141]http://www.voders.org/index.php/vode-srpske/o-nama/4-o-nama, (25/09/2015)

PI "VodeSrpske" is organized through: 1) Department of Water Management of the Regional Sava River Basin; 2) Department of Water Management of the Regional Trebišnjica River Basin; 3) Department of Economic and Legal Affairs; 4) Department of Maintenance of Flood Control Facilities. (See Annex 13-2 Figure 8: Organizational Structure of PI "Vode Srpske" Bijeljina).

PI "VodeSrpske" includes branch offices of sub-basins based in Banja Luka, Prijedor, Doboj and Zvornik and the Department of Water Management of the Regional Trebišnjica River BasininTrebinje.[142] (See Annex 13-2 Table 25: Documents issued by PI "Vode Srpske" during 2010-2014).

Ministry of Spatial Planning, Civil Engineering and Environmental Protection(MSPCEEP)

MSPCEEP RS 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.[143]

Activities stipulated by the Law on Ministries and from the Ministry's scope of work are performed in the following organizational units: 1) Office of the Minister; 2) Department for Urban and Physical Planning; 3) Department for Construction; 4) *Department for Environmental Protection;* 5) Department for Projects Coordination and Development; 6) Secretariat. (See Annex 13-2 Figure 3: Organizational Structure of MSPCEEP RS).

Ministry of Health and Social Welfare (MHSW RS)
MHSW exercises administrative and other technical activities related, *inter alia*, to health safety of water, provisions and objects of general use, as well as activities in the field of medical waste management.

Republic Hydro-Meteorological Office (RHMO RS)
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). (See Annex 13-2 Figure 4: Organizational Structure of RHMO of the RS).

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.[144]

Hydrology Department – In addition to regular and special water level observation on hydrological stations in the Republic of Srpska and publishing regular and special hydrological newsletters, hydrological service

142 http://www.voders.org/index.php/vode-srpske/kancelarije-slivova, (27/09/2015)
143 http://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mgr/OMin/Pages/Splash.aspx, (26/09/2015) See *Rule Book on Internal Orgazniation and Job Systematization in MSPCEEP*,Banja Luka, March 2012, Article 10, paragraph 1).
144 http://www.rhmzrs.com/о-заводу/дјелатност-завода.html, (26/09/2015)

of RHMO exercises hydro-metrical discharge measurements on hydrological station profiles, as well as structuring water level and discharge dependency, i.e. Q-H curve.[145]

Activities of the *Ecology Department* include, *inter alia*, *systemic observations and measurement of the surface and subsurface water quality characteristics* in the hydrological station network, *monitoring pollutant transportation through the waterways and pollution accidents*, basic observation data processing and *development of the information system* required for reporting.

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

Republic Inspection Authority – Inspectorate of the Republic of Srpska
Inspectorate of RS is an independent republic authority established by the Law on Inspection in RS (OG RS, no. 74/10). Inspection system of RS is made of the inspections of the Republic Inspection Authority (Inspectorate) and inspection of the local government units (*Law in Inspection in RS*, Article 2, paragraph 1). Delegated inspection oversight activities on the local government unit territory are exercised by inspectors in local government units, *inter alia*, water inspector, environmental inspector and sanitary safety inspector (*Law on Inspection in the Republic of Srpska*, Article 3, paragraph 2). Inspectorate activities are subject to supervision by the Government of RS (*Law on Inspection in the Republic of Srpska*, Article 7, paragraph 1).

Inspectorate exercises inspection, administrative, technical and other activities through the inspectorates organized in the following inspections: 1) Food Inspection; 2) Market Inspection; 3) Agriculture; 4) Forestry; 5) Veterinary Medicine; 6) *Water;* 7) Technical; 8) Traffic; 9) Urban Planning-Construction and *Environmental Inspection;* 10) Labor Inspection; 11) Health; 12) Educational and 13) Fire Protection Inspection (Article 11, paragraph 2 *of the Law in Inspection in the Republic of Srpska)*. (See Annex 13-2 Figure 5: Organizational Structure of the Republic Inspection Authority).

Water Inspection exercises inspection oversight in regulatory compliance related to: water, nature protection in the water sector and other fields set by laws (Article 22 *of the Law -on Inspection).*

Urban Planning-Construction and Environmental Inspection, exercises inspection oversight in regulatory compliance related to, *inter alia*, environmental protection, ecology, waste management and other fields set by law (Article 5 *of the Law in Inspection)*.
Traffic Inspection, *inter alia*, exercises inspection oversight in regulatory compliance related to waterway traffic and other fields set by laws (Article 24 *of the Law in Inspection).*

Health Inspection, exercises inspection oversight in regulatory compliance related to water used for sanitary-recreational needs and curative water and other fields set by laws (Article 27 *of the Law in Inspection)*.

Inspectorate will strive to strengthen staff capacities. Staff shortage is particularly visible in the form of the lack of inspectors in several inspections, including the Environmental Inspection. Lack of environmental inspector in local communities (19 officers), that is, in municipalities and cities, is evident, as well as the lack of republic inspectors (3 officers).[146]

Considering that administrative oversight of legal compliance of documents adopted is conducted by the line ministries, the Inspectorate is only partially exercising administrative oversight of the inspectors in the local government units. *To that extent, it is believed that inspections should be organized through a single tier.* Some of the strengths of such organizational methodare as follows: streamlined management and

[145] http://www.rhmzrs.com/хидрологија/о-одјељењу.html, (26/09/2015)
[146] *Information on operations of the Republic Inspection Authority in 2014, p.* 7.http://inspektorat.vladars.net/index.php?option=com_content&view=category&layout=blog&id=86&Itemid=115&lang=sr-cyr, (27/09/2015)

monitoring, avoiding overlapping of inspections in the same business entity in a single day or in a short period and other.[147]

WRM and Environmental Protection in FBiH

Capacities

Group I Data on institutional capacities in FBiH are shown in Table 13-8 below.

Table 13-8: Job systematizations and total staff numbers in institutions of the F BiH

Initiation	Job systematization	No. of positions in job systematization	Total staff number	Date	Comments
I WRM and environmental protection					
Federal Ministry of Agriculture, Water Management and Forestry (FMAWMF)	---	185	100[148]	31/12/2011	
FMAWMF, Water Sector	---	---[149]	9		Source: Questionnaire
Federal Ministry of Environment and Tourism	---[150]	96	42[151]	31/12/2013	
Federal Ministry of Environment and Tourism, "Sector for Water"	---	---	7		Source: Questionnaire
Agency of the Sava River Water Area, Sarajevo	---[152]	117	72[153]	31/12/2013	
Agency of the Adriatic Sea Water Area, Mostar	---	44	22	31/12/2013	
Federal Hydro-Meteorological Office	---	---[154]	87	31/03/2015	Source: Questionnaire
Federal Inspection Authority	----[155]	219 (10 main federal inspectors and 159 federal. inspectors)	151 (out of which 120 federal inspectors)	in 2012	

Note: Sources given in Annex 13-2.

From the available data, according to the job systematization, highest number of positions was planned in the Federal Inspection Authority, 219 (out of which 10 main federal inspectors and 159 federal inspectors), than in the Federal Ministry of Agriculture, Water Management and Forestry with 185 positions, and in the Agency of the Sava River Water Area with 117 positions.

According to available data, the highest number of staff members, among institutions analysed, is in the Federal Inspection Authority with 151 (out of which 120 federal inspectors). Second in the line is the

[147]*Information on operations of the Republic Inspection Authority in 2013, p*. 5.
[148] Although the Rule Book on Job Systematization has set 185 jobs, 2011 FBiH Budget approved 100 staff members (civil servants and appointees).
[149] Webpage of FMAWMF has no data on job systematization or total staff numbers.
[150] Webpage and the Rule Book on Internal Organization of FMET has no visual presentation of organizational structure, nor data on total staff numbers, education and gender structure, average staff age and similar.
[151] Although the Rule Book on Internal Organization and Job Systematization has set 95 staff members. 2013 FBiH Budget approved allocation only for 45 staff members in FMET.
[152] Webpage of ASRWA: http://www.voda.ba/ has no data on job systematization, staff numbers, education or gender structure, nor there are any kind of report that could be used to obtain such data.
[153] The same piece of data on total staff number (72) is given in the "Questionnaire" of ASRWA.
[154] Webpage of FHMO has no data on job systematization or total staff numbers. Information Register Index for FHMO indicates that FHMO has data on total staff numbers, education and national structure, but such data is not available on FHMO webpage. See: http://fhmzbih.gov.ba/latinica/O-NAMA/FHMZ-registar.php, (26/09/2015)
[155] Data on job systematization is not included in *2012Work Report of the Federal Inspection Authority*, Sarajevo, January 2013, and only the piece of data on total number of positions was provided. Webpage of the Federal Authority has no Rule Book on Internal Job Systematization.

Federal Ministry of Agriculture, Water Management and Forestry with 100 staff members, and then the Federal Hydro-Meteorological Office with 87 staff members (see Table 13-9).

FMAWMF, Water Sector has the highest number of staff members (11%) holding doctoral degrees, while FMET is behind with one per cent less (10%). 1% of staff members in ASRWA holds doctoral degrees. FMET has the highest number of staff members holding master degrees (20%), followed by FMAWMF with 11%.

ASRWA has the highest number of staff members with bachelor degrees (75%), followed by FMET and FMAWMF, Water Sector with 70% and 67% of staff members with bachelor degrees, respectively.

FHMO has 6% of staff members with high school diplomas, while ASRWA has 1% of staff members with the mentioned education level.

Majority of staff members of FHMO (66%) hold high school diplomas or less, while that figure in the Agency of the Sava River Water Area is 23%.

FHMO employees far more men (63%) versus women, while all other institutions (FMAWMF, Water Sector; FMET, ASRWA and AASWA) employ significantly more women (FMEOT as many as 80%).

Table 13-9: Staff education, age and gender structure in the institutions of the FBiH

Institution	PhD	Master Degree	Bachelor Degree	Associate Degree	High School or lower	Average age (in years)	Men	Women	Comments
I WRM and environmental protection									
FMAWMF, Water Sector	11%	11%	67%	---	11%	52,5	33%	67%	Source: Questionnaire
FMET	10%	20%	70%	---	---	52	20%	80%	Source: Questionnaire
ASRWA	1%	5%	75%	1%	23%[156]	45	38%	62%	Source: Questionnaire
AASWA	---	---	---	---	---	---	---	---	Data not available on internet
FHMO	---	2%	26%	6%	66%[157]	48	63%	37%	Source: Questionnaire
FIA	---	---	---	---	---	---	---	---	Data not available on internet

Note: Sources given in Annex 13-2.

Table 13-10 below provides a general assessment of the capacities of FMAWMF, FMET, ASRWA and FHMO capacities and their cooperation with DRB.

Table 13-10: General assessment of FMAWMF, FMET, ASRWA and FHMO capacities and cooperation in DRB

Instit.	Assessment	Priorities and main institutional problems in cooperation in DRB
FMAWMF	Principal problems in cooperation with other entities in the country originate from: lack of alignment of policies in various tiers of government and the lack of environmental and water policies in BiH. FMAWMF has the staff training plan and trainings are conducted within the Civil Service Agency. Topics to be covered in future trainings are EU legislation in environment and water;	FMAWMF cooperates with the Serbia and Montenegro through the activities of the Sava and Danube Commissions. The most important challenges affecting the regional cooperation perspectives in the following decade inWRM in DRB are as follows: more conflicting water use methods, lack of international agreement on cooperation between BiH (FBiH, Republic of Srpska), Montenegro and Serbia, inadequate implementation of international agreements, lack of aligned legislation, etc. Biggest priorities of FMAWMF, Water Sector in the following 10 and 20 years in terms of accelerated progress in WRM in DRB are as follows:

[156] Sum of percentages related to ASRWA staff education structure is 105%. Data taken from the "Questionnaire".
[157] In addition to this, the Institutional capacity Evaluation Questionnaire includes the following staff education data: Master degree 2 staff members (or 2%); Bachelor degrees 22 (26%); Associate degree 5 (6%); High school 57 (65%) and unqualified 1 (1%).

Instit.	Assessment	Priorities and main institutional problems in cooperation in DRB
	Strengthening capacities will require FMAWMF to procure adequate IT equipment; Regulations to be changed to strengthen FMAWMF capacities are as follows: System laws of the Government of FBiH; Law on Water and Law on Environment; FMAWMF, Water Sector needs legal support to exercise jurisdictions, i.e. the Sector should engage the lawyer; Main institutional problems FMAWMF, Water Sector has to deal with currently is FMAWMF work plan for 2015, 3-year period, and for the long-term period development of the Water Management Strategy of the F BiH and water related strategic documents of BiH;	Application of adopted regulations and strategies; Alignment of adopted regulations with EU regulations in water and environment; Improvement of environment quality standards; Main obstacles inWRM in DRB are inadequate coordination between the central and local level, inadequate coordination between the Ministry and public authorities on the state level, third in the line is the low political priority, and among other obstacles are “different approaches and policies of different tiers of government”. The biggest problems in implementation of the Framework Agreement on the Sava River Basin – of relevance for the Drina River are as follows: storage management, flood risk management, deposit management, water protection. As regards to cooperation in DRB, cooperation within the rivers ofNeretva and Trebišnjica is assessed as “very important”. Prerequisites of improvement of cross-border cooperation between DRB countries are signing of bilateral agreements and water related protocols; Cooperation between the countries of DRB should be improved in the following fields: WRM, floods, energy, nature protection, etc. Signing the international agreement between the three countries (BiH, Montenegro and Serbia) on cooperation in the energy sector would contribute to cooperation and problem solving.
FMET	FMET has the staff training plan and trainings are conducted within the Civil Service Agency. Topics to be covered in future trainings are EU legislation in the environment and water sector; Regulations to be changed to strengthen FMET capacities are as follows: System laws of the Government of FBiH; Law on Water and Law on Environment; Equipment currently needed by FMET is adequate IT equipment; To exercise its jurisdictions, FMET, Environment Sector, will need more staff members, especially legal support to sector activities, as well as two professional officers, i.e. Sector needs a lawyer, biologist and chemical engineer;	The most important challenges affecting the regional cooperation perspectives in the following decade inWRM in DRB are as follows: more conflicting water use methods, lack of international agreement on cooperation between BiH (FBiH, Republic of Srpska), Montenegro and Serbia, inadequate implementation of international agreements, lack of aligned legislation, etc. Biggest priorities of FMET, Water Sector in the following 10 and 20 years in terms of accelerated progress in WRM in DRB are as follows: Application of adopted regulations and strategies; Alignment of adopted regulations with EU regulations in water and environment; Improvement of environment quality standards; Main institutional problems FMET has to deal with currently is work plan for 2015, 3-year period, and for the long-term period the Ministry will have to deal with the Federal Environmental Protection Strategy with the Action Plan; FMET is completely funded by the state budget; Main obstacles in WRM in DRB are inadequate coordination between the central and local level, inadequate coordination between the Ministry and public authorities on the state level, third in the line is the low political priority.
ASRWA	More staff is required for ASRWA to exercise its jurisdiction, i.e. almost all sectors should be strengthened, especially Water Management Sector and Planning Sector. ASRWA needs civil engineers - hydrotechnics; ASRWA conducts activities of professional development and additional education (professional exams, specialized trainings, master and doctoral studies...); Main institutional problem ASRWS has to deal with currently are amendments and addenda to the Law on Water, following three years will be devoted to the new law on water, and in long-term, implementation of the Water Management Strategy in the F BiH; It is expected that in the next 10 or 20 years the Agency will have around 100 staff members, and that it will have different organization of jurisdictions: The Agency should have powers in water management regardless of the waterway category (how to manage I category waterways regardless of waterways of other categories; how to manage the waterway being the category II waterway in the upper segment of the basin, and category I waterway in the middle and lower waterway, ...)	The most important challenges affecting the regional cooperation perspectives in the following decade inWRM in DRB are as follows: lack of finances, climate changes, lack of aligned legislation and more, lack of international agreement on cooperation between BiH (FBiH, Republic of Srpska), Montenegro and Serbia, lack of data related to water, inability to rely on historic data and unusability of existing data. Biggest priorities of ASRWA in terms of accelerated progress in WRM in DRB are as follows: Waterway development using domestic funds and the World bank funds. Creation of the hydrological monitoring for the Drina River wherein the monitoring carried out by the Agency in the Federal segment of the basin will be the part of a unified Drina River monitoring.... Participation in harmonizing plans of hydropower structures (existing and planned) in DRB .... Main obstacles in WRM in DRB are lack of funds, inadequate coordination between the Ministry and public authorities on the state level, and the third in the line is the lack of data. Among other obstacles, ASRWA highlighted the following: “1) Finances are always a problem. There are programs for the federal segment of the basin, but until the World Bank got involved in the current problems of the basin, activities were very slow; 2) Still, there are no international agreements related to the Drina River (Montenegro-BiH–Serbia), there is no obligation to notify and alarm about flood discharges, it is still impossible to obtain the plan of operation of HPP Piva in Montenegro, inadequate management of which has caused major issues in hydrological sense on the Drina River during December floods 2010; 3) Due to the lack of adequate hydro-meteorological network of

Instit.	Assessment	Priorities and main institutional problems in cooperation in DRB
	Water management is under jurisdiction of entities. State umbrella institution is required to manage water. Problems: waterway, regardless of the category, is in both entities; left bank in one, and the right one in the other entity, ... Lack of harmony between the laws on water in different entities is another problem;	observation station in the basin, it is impossible to obtain basic data required for adequate water management in the Drina River". The organization exchanges data collected through monitoring with relevant international entities. The biggest problem in monitoring is the lack of funds to procure equipment for the basin area and monitoring system maintenance. The Agency is not officially authorized to pursue international cooperation. This is the function of state authorities. There was no cooperation with the Drina River basin countries. Signing the international agreement between the three countries (BiH, Montenegro and Serbia) on cooperation in the energy sector would contribute to cooperation and problem solving. It is required to pursue alignment of activities between different project conducted in DRB and use common results.
FHMO	More staff is required (currently, as well as in 10 and 20 years) for FHMO to pursue its activities. Also, engineers are needed in FHMO service, i.e. civil engineers – hydro technics or masters of civil engineering – hydro technics, meteorologists, physicists, as well as IT engineers, and the average staff age should be reduced. FHMO has the staff training plan. FHO has the Rule Book and the Program of Professional Development adopted by the Director, as follows: 75% through projects (including WMO), 20% through the Civil Service Agency and 5% with own funds; Additional training required for current staff members particularly important is "application of new technologies in hydrological and meteorological service – trainings related to new measurement instruments, data management; hydrological and meteorological forecast; Numerical modeling and quality management"; To strengthen current capacities and in the next year, FHMO will need to procure hydrological, meteorological and rainfall stations; field work gear: measurement equipment, vehicle, boats, protection equipment; data management equipment – software and hardware, and in long-term sense, radar would be required; Capacity strengthening would require amendments or adoption of the following regulations: Law on Hydro-Meteorological Affairs (FBIH); Law on Water of FBIH (amend existing law or draft new law); Relevant decree should regulate status and responsibilities of FHMO in terms of reporting to public, EEA WMO and other; Regulations related to quality management system -QMS;	The most important challenges affecting the regional cooperation perspectives in the following decade inWRM in DRB are as follows: more conflicting water use methods, lack of international agreement on cooperation between BiH (FBiH, Republic of Srpska), Montenegro and Serbia, inadequate implementation of international agreements, lack of aligned legislation, standards in the field of environment, climate change and lack of finances. Representatives of FHMO view the Office in the next 10 or 20 years as a contemporary hydro-meteorological service, equipped with modern instruments and other gear required to exercise jurisdiction and sufficient staff members, able to respond to goals and demands of community in line with international standards, as well as in line with international obligations; In terms of accelerated progress in WRM in DRB in the following 10 and 20 years, the biggest priority of FHMO is improvement of service stations, data management system, including early warning and forecast; Main institutional problems FHMO has to deal currently, as well as in the following 3 years, is coordination and cooperation, inter-department, inter-sectoral and inter-state; FHMO is completely funded by the state budget; Main obstacles in WRM in DRB are inadequate coordination between the Ministry and public authorities on the state level, entity and inter-entity level, second in the line is inadequate coordination between the central and local level, and the third is the lack of data. Other obstacles are "lack of initiative and will for integrated use of water resources ".

Source: "*Institution Capacity Evaluation Questionnaire*" FMAWMF, FMET, ASRWA, FHMO.

Jurisdiction and Organization

Federal Ministry of Agriculture, Water Management and Forestry (FMAWMF)

FMAWMF was established according to the Law on Federal Ministries and Other Federal Authorities ("OG FBiH", No. 58/02, 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.[158]

Organizational units of FMAWMF are as follows: 1) Minister; 2) Office of the Minister; 3) Secretary of the Ministry; 4) Agriculture and Food Sector; 5) Rural Development and Extension Sector; 6) Project

[158] *Three Year Plan of the Federal Ministry of Agriculture, Water Management and Forestry for 2015 - 2017,* Sarajevo, December 2014, p. *3-4.* See: http://fmpvs.gov.ba/upload_files/1440661291-plan%20rada.pdf, (27/09/2015)

Management Sector; 7) *Water Sector;* 8) Forestry Sector; 9) Veterinary Sector; 10) Finance and Accounting Sector; 11) Legal, Human Resources and General Affairs Sector; 12) Internal Audit Unit; 13) Information Technology Sector; 14) Federal Forestry Directorate; 15) Agricultural Payments Sector.[159]

Water Sector has two divisions: Water Management Division and Development and International Commitments Division. (See Annex 13-2 Table 33: Documents issued by FMAWMF during 2010-2014).

Federal Ministry of Environment and Tourism (FMET)

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).[160]

Core and internal organization units were established to exercise activities and tasks under jurisdiction of the Ministry. Core organizational units are as follows: 1. Office of the Minister; *2. Environmental Protection Sector; 3. Environmental Permits Sector;* 4. Tourism and Hospitality Sector; 5. Project Implementation Sector; 6. Legal, Financial and General Affairs Sector (Article 4, paragraph 1 of the Rule Book).

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*. *Environmental Permits Sector* has the following internal organizational units as follows: a) Division of Environmental Impact Assessment; b) *Division of Environmental Permits and Major Accident Prevention; c)* Division of Polluter Register, Information and Training; d) Division of Clean Development Mechanism Projects and Cooperation with DNA on State Level (Article 4, paragraph 3 of the Rule Book).

See Annex 13-2 Table 38: Documents issued by FMET during 2010 - 2014;

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 by-laws 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).

ASRWA manages water area covering one part of the international river basin of the Danube River (part of the international sub-basin of the Sava River) on the territory of FBiH. (For details of activities exercised by ASRWA see table in Annex 13-1).

Director of ASRWA is appointed to and relieved of duty by the Government of FBiH based on proposal of FMAWMF *(Law on Water*, Article 159, paragraph 1 and 2.). See Annex 13-2 Figure 12: Organizational Structure of ASRWA, Sarajevo

Agency of the Adriatic Sea Water Area, Mostar (AASWA)

[159] http://fmpvs.gov.ba/V_1/organizacija-bh, (27/09/2015)
[160] http://www.fmoit.gov.ba/ba/page/48/o-federalnom-ministarstvu-turizma-i-okolisa-fbih, (27/09/2015)

Activities of the Agency 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.[161]

Activities of the Agency have been set in Articles 29, 155 and 156 of the Law on Water. (For details see Annex 13-1).

Federal Hydro-Meteorological Office (Office or FHMO)
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]

Organizational structure of the Federal Hydro-Meteorological Office is as follows: 1) Director; 2) Secretary, assistants to director, advisors, centre managers; 3) Sector of Meteorological Measurements and Forecast; 4) Sector of Applied Meteorology; 5) *Sector of Hydrology; 6) Sector of Environmental Protection;* 7) Sector of General Affairs; 8) Centres.[163]

Sector of Hydrology has two divisions: Division of Hydrological Measurements and Division of Forecast and Water Balance. Sector of Environmental Protection also has two divisions: Division of Air Quality and *Division of Water Quality.*[164] *(See Annex 13-2 Figure 12: Organizational Structure of the Federal Hydro-Meteorological Office).*

Federal Inspection Authority (FIA)
Reform of inspection in the Federation of BiH meant establishment of the Federal Inspection Authority according to the Law on Inspection in the Federation of BiH ("OG FBiH", No. 69/05 and 73/14), as well as the Law on Amendments or Addenda of the Law on Federal Ministries and Other Authorities of the Federal Administration ("OG FBiH", No. 61/06). Amendments of the subject laws transferred jurisdiction of 10 federal inspections and 8 federal ministries to jurisdiction of the Federal Inspection Authority. The Authority officially started to work on January 1, 2007.[165] The Authority exercise inspection activities under jurisdiction of federal inspections, organized within the Authority according to the Law on Inspection in the FBiH[166].

Rule Book on Internal Organization of the Federal Inspection Authority adopted on 24/08/2011 by the Government of the Federation of BiH established the following organizational units: 1) Office of the Director; 2) Sector of Legal and General Affairs; 3) Sector of Complaints and Legal Protection; 4) Sector of Financial Affairs; 5) Sector of Technical Support and Planning-Analytical Affairs; 6) Inspectorate of Market-Tourism Inspection; 7) Inspectorate of Sanitary-Health-Pharmaceutical Inspection; 8) Inspectorate of the Labour Inspection; 9) Inspectorate of the Urban Planning-Ecological Inspection; 10) *Inspectorate of Traffic Inspection;* 11) Inspectorate of Agricultural Inspection; 12) Inspectorate of Forestry Inspection; 13) *Inspectorate of Water Inspection;* 14) Inspectorate of Veterinary Inspection; 15) Inspectorate of Technical Inspection (*Operational Report of the Federal Inspection Authority for 2013, p*. 1). See Annex 13-2 Figure 13: Organizational Structure of the Federal Inspection Authority.

[161]http://www.jadran.ba/index.php?option=com_content&view=article&id=57&Itemid=94, (27.09.2015.)
[162]http://fhmzbih.gov.ba/latinica/O-NAMA/FHMZ-StrateskiPlan.php, (27/09/2015)
[163]Webpage of FHMO has no description of jurisdictions by organizational segments of FHMO.
[164]http://fhmzbih.gov.ba/latinica/O-NAMA/FHMZ-shema.php#, (27/09/2015)
[165]*Operational Report of the Federal Inspection Authority for 2012*, Sarajevo, January 2013, p. 3. http://www.fuzip.gov.ba/uploaded/IZVJ%20%20FUZIP%202012.pdf, (27/09/2015)
[166]For details see: *Operational Report of the Federal Inspection Authority for 2014, p*. 1.http://www.fuzip.gov.ba/uploaded/izvjestaji/izvjestaj%20o%20radu%20FUZIP%20za%202014.pdf, (27/09/2015)

In 2012, the Inspectorate of Water Inspection had 5 inspectors (*Operational Report of the Federal Inspection Authority for 2012, p*. 24). Comparing to the applicable Rule Book, 67 positions are unoccupied, mainly inspectors. *Inspectorate of Traffic Inspection* oversees inland and naval traffic, i.e. development and safety of navigation of ships, floating objects and other vessels in inland and naval transport. In 2012, this inspectorate had 4 inspectors (*Operational Report of the Federal Inspection Authority for 2012, p*. 6, 20). Webpage of the Federal Inspection Authority has no data on staff education and gender structure, or average age of staff members.

Bosnian-Podrinje Canton Goražde

Law on Water of the Federation of BiH ("OG FBiH", No. 70/06) defined that the canton is responsible for activities and tasks transferred to canton jurisdiction by virtue of the Law on Water and, the organization of subject activities shall be regulated by canton laws. To that extent, **Ministry of Economy** exercises, *inter alia*, „administrative and other technical activities related to "water regime development, water protection, protection against harmful water effects, protection against erosion, torrents and disasters, population water supply, industrial water, hydro land reclamation, water use for energy and recreational purposes, proposing and implementing policies in industry and energy, protection and use of agricultural land, inspection oversight in line with responsibilities of the Ministry and administrative disputes, etc."

Jurisdiction of the Ministry are exercised through there sectors: Sector of Agriculture, Water Management and Forestry, Sector of Industry, Energy, Development and Entrepreneurship, Commerce, Hospitality and Tourism; Sector of Development Resources Management and Coordination.[167]

Ministry of Urban Planning, Spatial Development and Environmental Protection exercises, *inter alia*, "administrative and other technical activities related to spatial planning, construction and land development on a level of canton, preparation of programs required for adoption of spatial and urban planning documents, "ecology (environmental protection – air, soil, water, noise protection, urban greenery, forests), ... inspection oversight within jurisdiction of the Ministry", etc.

Ministry has two experts in "Environmental Protection".[168]

WRM and Environmental Protection in BDBiH

Certain activities of WRM are exercised by line authorities of BDBiH. One of the departments of the Government of BD BiH is the *Department of Agriculture, Forestry and Water Management* with its *Sub-Department of Forestry and Water Management*, as well as *Department of Spatial Planning and Property-Legal Issues, Sub-department of Spatial Planning, Urban Planning and Environmental Protection.* (For details of responsibilities see Annex 13-1)

13.3.2 Energy

Republic of Srpska

Ministry of Industry, Energy and Mining (MIEM)
Responsibilities of the MIEM are related to "administrative and other technical activities" in various fields, including electric energy policy, planning and implementing the energy strategy, balancing and long-term planning, monitoring safety and quality of electricity supply, exploitation of resources for electricity generation, development and construction of power facilities, granting concessions for exploration,

[167]http://mp.bpkg.gov.ba/ministarstvo/261/sektori (19/9/2015). See 2015 Government Program, Bosnian-Podrinje Canton Goražde, Goražde, March 2015.
[168]http://mu.bpkg.gov.ba/ministarstvo/47/organizacina-shema (19/9/2015).

construction and exploitation of power facilities, renewable energy sources promotion, participation in various activities in the field of energy and usage of natural resources at international level, etc.

Responsibilities of the Ministry also include geological research and exploitation of natural and technogenic mineral resources, including the resources for the production of construction materials, radioactive mineral resources, all types of salts and salt water, groundwater (potable, industrial, mineral, thermal, thermo-mineral) and geothermal resources, verification of mineral resources and keeping their register, granting concessions for exploration and exploitation of mineral resources, keeping a register of concessions granted in the field of energy, mining and geology, etc.

Ministry is divided into seven organizational units (Sector for Power Engineering, Sector for Energy, Sector for Mining and Geology, Sector of Industry, Sector for Small And Medium-Sized Enterprises Development, and the Secretariat of the Ministry).

Sector for Power Engineering has separate Department of Development Projects and Renewable Energy and the Department of General Power Engineering.

Sector for Power Engineering exercises administrative and technical activities related, *inter alia*, to preparation of the program of measures for intensive use of new and renewable energy sources, coordination of development projects, etc.

Regulatory Commission for Energy RS (Regulator) was established in 2002 according to the Law on Electric Power ("OG RS", No. 66/02, 29/03, 86/03, 60/07)**.** Principal responsibilities of the Regulatory Commission in electric power sector, *inter alia*, include issuing and revoking licenses for generation, distribution, and sale of electric power, etc.

Regulatory Commission is organized into four sector: Sector of Tariffs and Markets, Sector of Licenses and Technical Activities, Sector of Legal Affairs and Sector of Administrative Affairs.

Federation of BiH

Federal Ministry of Energy, Mining and Industry (FMEMI)

FMEMI exercises administrative, technical and other activities set by law related to jurisdictions of the Federation in energy, mining, geological survey; energy policy creation and geologic survey, and other activities set by law.

Ministry is organized in several sectors, among which are the Sector of Energy and Sector of Mining, including the Sector of Industry, Sector of Legal, Financial and General Affairs, Office of the Minister and Secretariat of the Ministry. The office for Metrology and Federal Directorate for Defence Industry are the part of the FMEMI.

Regulatory Commission for Energy in F BiH (RCE FBiH)

RCE FBiH was established by virtue of the Law on Electric Power ("OG of FBiH", No. 41/02, 24/05, 38/05, 83/11, 66/13). Responsibilities of the Regulatory Commission, as “specialized, independent non-profit organization in FBiH” include, *inter alia*, issuing, renewal, transfer or revoking licenses for generation, distribution, supply, sale of electric power and operators for renewable energy sources and cogeneration, etc.

Currently, RCE FBiH has 32 staff members, out of which 30 hold university degrees, one holds associate degree and one holds high school diploma.[169]

Bosnian-Podrinje Canton Goražde

Ministry of Economy (see chapter related to WRM in FBiH).

[169] http://www.ferk.ba/_ba/o-ferku/zaposleni/18373-struktura-zaposlenih 21/12/2012

13.3.3 Institutions from other fields of relevance for WRM

BiH

Ministry of Foreign Affairs

In accordance with the Article 8 of the Law on Ministries and other administrative bodies of BiH, Ministry of Foreign Affairs is responsible, inter alia, also for: the implementation of the established policy of BiH and development of international relations in accordance with the positions and directions of the Presidency of Bosnia and Herzegovina; proposing adoption of positions on issues of interest for foreign policy activities and the international position of BiH; ...; monitoring the situation and development of international relations of BiH with other countries, international organizations and other subjects of international law and international relations ...; ... Cooperation with international organizations, proposition to the Presidency of BiH membership or participation of BiH in the work of international organizations; ... Preparation and organization of international visits and meetings; preparation of bilateral and multilateral agreements etc.

Ministry of Civil Affairs is responsible for carrying out tasks and discharging duties which are within the competence of BiH and related to defining basic principles of coordination of activities, harmonization of plans of entity bodies and defining strategy at the international level in the fields of: health and social protection; pensions; science and education; labor and employment; culture and sport; geodetic, geological and meteorological affairs.

Food Safety Agency of BiH - established by the Council Decision of the Ministers of BiH ("Official Gazette of BiH", No. 22/05). Jurisdiction of the Agency is defined by the Law on Food of BiH ("Official Gazette of BiH", No. 50/04) in the Articles 52-69.

Republic of Srpska

Ministry of Public Administration and Local Government exercises activities related to citizens' associations (including those dealing with environmental protection and water), administrative oversight of local government units and regulatory compliance of documents adopted, activities related to the European integration strategy and policy in public administration and local government.

Public Health Institution "Institut za javno zdravstvo" is an institution in charge of potable water quality control and health safety and control of potable water sanitary safety. Monitoring and analyzing surface waterway quality for water used for water supply, as well as water used for sports and recreational purposes, including sub-surface water used for water supply. Monitoring quality of wastewater released to the recipient, etc.

Federation of BiH

Ministry of Justice, actually the Public Administration Institute as the part of the Ministry of Justice, exercises technical and other activities under jurisdiction of the Federation related, *inter alia*, to structuring local government system.

Public Health Institution of the Federation of BiH is in charge of monitoring, analyzing, studying and assessing health safety of potable water, dialysis water, recreation water, surface and waste water, and status of water supply in the field. Institution proposes and implements activities of improvement of the water health safety system. It is also responsible for testing, analyzing and evaluating impacts of environmental factors on human health and for proposing and participating in implementation of harmful effects prevention measures. It is also responsible for testing substances dangerous for human health and lives in water, rivers, sea, flora and fauna, etc.

PI Public Health Institute BPC Goraždeis responsible for control of the water source quality and potable water health safety in water supply facilities and distribution network within the area of the canton.

13.3.4 Harmonization of national regulations with EU regulations

a) Directorate of European Integration, as the "standing, independent and professional body of the Council of Ministers of BiH", exercises activities related to "harmonization of activities of BiH authorities, oversight of application of decisions adopted by BiH institutions related to activities required with the European integrations".

There is a separate Sector for BiH Legal System Harmonization with A*cquis*. In addition to aforementioned sector, there are other sectors as follows: Sector for Strategy and Integration Policy, Sector for EU Assistance Coordination, Sector for Translations in the Sphere of European Integrations, Sector for General and Common Service and Sector for Promotion of European Integrations.[170]

b) Republic of Srpska– activities related to "compatibility of transposed European Union regulations with domestic legislation" are exercised by the Republic Secretariat of Legislation, as the "technical service of the Government of the Republic of Srpska."

c) Federation of BiH - "technical legal opinion on regulations and their compliance with the European Union regulations and European principles and standards" is provided by the Office of the Government of the FBiH for Legislation and Compliance with the European Union regulations.

13.3.5 Local Government Units

Local government units in both BiH entities exercise their powers in the field of environmental protection (including water). Forms of organization in local governments are different: department of utility services, spatial development, urban planning, environment, development, inspection affairs, etc.

Local Government Units in the Republic of Srpska

Republic of Srpska has 63 municipalities and their power have been set by the Law on Local Government ("OG RS", No. 101/04, 42/05, 118/05, 98/13). Municipalities of RS have powers to include: organizing communal police; inspection oversight, in accordance with law. As regards to service provision, municipalities exercise specific functions in the field of environmental protection and other functions. Municipalities organize and ensure provision of utility services: *water production and delivery*, *wastewater treatment*, *storm water drainage and other rainfall* and other activities (*Law on Local Government*, Article 12, paragraph 1, items a and b).

Municipal power in the field of environmental protection are as follows: to ensure conditions of use and management of natural lakes, sources, public wells and public fountains taking care of their protection, and to create general conditions for cleanliness of river and lake shore in the subject area; to ensure general conditions and method of water supply system maintenance in rural areas, their use and to set sanitary-technical requirements of wastewater drainage; to set water management requirements, issue water management permits and water management licenses for facilities and works as set by law (*Law on Local Government*, Article 22, paragraph 1).

According to Article 12 of aforementioned law, RS municipalities hold autonomous powers related to public services, such as environmental protection and water management. Specific local government powers related to environmental protection and protection of natural resources are set in Article 22: identification of erosion areas and anti-erosion measures; management of natural lakes, springs, public wells and fountains; water supply management; prescribing emission limit values for hazardous substances as stipulated by law; publishing data on air quality and improving air quality as necessary; noise pollution prevention and noise measurement and other power stipulated by law.

Municipalities in both entities of BiH usually exercise their competencies in the field of water management and/or environmental protection through activities of various municipal *departments* with various names: department of utility services, economy, agriculture, spatial development, urban planning, environment,

[170] http://www.dei.gov.ba/dei/direkcija/default.aspx?id=9950&langTag=bs-BA (19/9/2015)

development, *inspections*, etc. For example, water management activities in Bijeljina are exercised by the Department of Economy and Agriculture, i.e. Department of Housing-Utility Services and Environmental Protection, in Ugljevik by the Department of Agriculture, i.e. the Department of Spatial Development and Housing-Utility Services (environment), in Zvornik by the Department of Economy, Agriculture and Social Affairs, in Rudo by the Department of Economy, Finance, Spatial Development and Inspection Affairs, in Lopare by the Department or Economy and Social Activities, i.e. the Department of Spatial Development and Housing-Utility Services (environment), and similar in Foča, Vlasenica, etc.

Local government unit exercises transferred activities of inspection oversight according to the principle of functional links with inspections and RS Inspectorate (Article 8, paragraph 1 of the *Law on Inspections in RS).* Local government units organize within the administrative service a special organizational unit for inspection affairs (Article 9, paragraph 1).

Association of Municipalities and Towns of RS exercises, *inter alia*, the following activities: organizing discussions on current issues of protection, development and improvement of local government, improving and developing public services and utility - housing services, urban planning, health, social welfare, education, culture and environmental protection, etc.[171]

Local Government Units in the Federation of BiH (Cantonal and Municipal Competencies)

Environmental management on a local level in BiH is high complex issue.

Federation of BiH has 10 cantons powers of which were defined in the Constitution of FBiH. Each canton has a government in charge of adopting cantonal laws (in compliance with FBiH legislation). *There is no unified form of organization or policy of ministries in charge of environmental issues on a cantonal level.*[172]

See Annex 13-2 Table 50: Cantonal Ministries of Environmental Protection in FBiH.

The following cantons have established cantonal authorities for inspection affairs integrating *urban planning-ecological inspectorates* responsible for oversight of application of environmental protection regulations: Tuzla Canton; Canton Sarajevo; Una-Sana Canton; Zenica-Doboj Canton; Bosnia-Podrinje Canton; West Hercegovina Canton. Other cantons have not established authorities for inspection affairs yet.[173]

BiH cantons include 79 municipalities. Scope of work, as well as powers of municipalities in FBiH, have been set by the *Law on Local Government Principles in the Federation of BiH* ("OG FBiH", No. 49/06 and 51/09).[174] The law stipulates the following powers as own powers of the local government units: defining and implementing spatial development and environmental protection policy; defining local government unit natural resources management policy and allocation of funds generated from their utilization; management, financing and development of activities and facilities of local utility infrastructure (water supply, wastewater drainage and treatment; solid waste collection and disposal, etc.); organizing and implementing measures of protection and rescue of people and material resources in case of major disasters and natural disaster; establishing and exercising inspection oversight of regulations under jurisdiction of local government unit; adopting regulations related to taxes, charges, contributions and fees under jurisdiction of local government unit, and other powers as set by present Law (Article 8, paragraphs 3-4.).

Association of Municipalities and Towns of FBiH is the organization of associated municipalities and cities established for the purpose of development of local government and improvement and protection of their common interest.

[171] http://www.alvrs.com/v1/index.php/sr/o-sogrs/o-nama (29/9/2015)
[172] http://www.unep.ba/kantonalni-i-lokalni-nivo.html, (27/09/2015)
[173] http://www.unep.ba/kantonalni-i-lokalni-nivo.html, (27/09/2015)
[174] http://www.fbihvlada.gov.ba/bosanski/zakoni/2006/zakoni/34bos.htm, (27/09/2015)

13.4 Role of Other Entities in Water Management

Water Institute - Bijeljina.
Table 13-11and Table 13-12 below provide details of staff number, education and gender structure.

Capacities
The Water Institute has 15 jobs in job systematization, and 25 staff members.

Table 13-11: Job systematizations and total staff numbers

Initiation	Job systematization	No. of positions in job systematization	Total staff number	Date	Comments
"Water Institute"Bijeljina	15	---[175]	25		

Note: Sources given in Annex 13-2

The majority of staff members of the "Water Institute" Bijeljina hold high school diploma (40%), than university degrees (32%), to be followed by master degrees (16%), and 4% of staff members of the Institute hold doctoral diplomas.

Table 13-12: Staff education, age and gender structure

Institution	PhD	Master Degree	Bachelor Degree	Associate Degree	High School or lower	Average age (in years)	Men	Women	Comments
"Water Institute"Bijeljina	4%	16%	32%	8%	40%	---[176]	33%	67%	

Note: Sources given in Annex 13-2

"Water Institute" Ltd. Bijeljina was established in 1999 to pursue water quality control on the territory of RS. Today, the Institut is 100% privately owned.[177]

Activities of the Water Institute are conducted through two organizational units: Water Quality Control Laboratory and Design Department. (See Annex 13-2 Figure 9: Organizational Structure of the Water Institute, Bijeljina and Figure 10: Organizational Structure of the laboratory sector and staff allocation by executive functions in the Water Institute, Bijeljina).

Institute for Protection of Cultural and Natural Heritage
Institute for Protection of Cultural and Natural Heritage is a republic administrative organization within the Ministry of Education and Culture of Serbia. Responsibilities of the Institute are regulated by the Law on the Republic Administration ("OG of the RS", No. 118/08 and 11/09). The Institute carries out administrative and other professional tasks related to identification of properties of cultural, historical and natural heritage, declaration of protected goods, the keeping of registers of protected goods, conditions for the use of protected resources, etc.

National Parks in the Republic of Srpska
RS has established two national parks: Sutjeska and Kozara. In accordance with the Law on National Parks ("OG RS", No. 75/10), supervision of management and activities of PI National Park "Sutjeska" is exercised by the Ministry of Spatial Planning, Civil Engineering and Environmental Protection of the Republic of Srpska.

National Park Kozara is managed by PI "National Park Kozara", founded by RS. Rights and responsibilities of the founder of PI are exercised by the Government of RS. PI "National Park Kozara" exercises activities

[175] Webpage of the "Water Institute" Bijeljina has no data on job systematization, staff gender structure or average staff age.
[176] Webpage of the "Water Institute"" Bijeljina has no data on average staff age.
[177] http://www.institutzavode.com/, (25/09/2015)

in accordance with the Law on National Parks and the Law on Protection of Nature in the Republic of Srpska, Law on Spatial Development, Law on Environmental Protection and the Law on Protection of Cultural Heritage.

Public and Other Enterprises on Water Management in FBiH

Institute for Protection of Monuments
Institute for Protection of Monuments of the Federal Ministry of Culture and Sports is responsible for the protection of the Cultural and Natural Heritage.

Management of protected areas are carried out by public enterprises and public institutions.

National Parks in the Federation of BiH
National Park “Una”
Public Enterprise National Park "Una" LtD. (Decision on Establishment was published in the "OG FBiH", No. 71/08), was established according to the Law on National Park "Una" ("OG FBiH", No. 44/08).[178]

Energy in the Republic of Srpska

Web Pages of MH "Elektoprivreda RS", "Elektrokrajina" Banja Luka and ZP "Hidroelektrane na Drini" Višegrad have no data on job systematization, or the number of positions as per job systematization.

Total staff number in 2014, in MH "Elektoprivreda RS", was 8,402, out of which "Elektrokrajina" Banja Luka had 1,580 staff members in late 2009.

ZP "Hidroelektrane na Drini" a.d. Višegrad has 156 staff members, 74 in the maintenance sector, 16 in the Investments and Development Sector, 14 in the Economy and Finance Sector, 50 in the General and Legal Affairs Sector and 2 in the Directorate (see Table 13-13).

Table 13-13: Job systematizations and total staff numbers in energy sector institutions in RS

Initiation	Job systematization	No. of positions in job systematization	Total staff number	Date	Comments
II Energy					
MH “Elektroprivreda RS”, Trebinje	---	---[179]	8.402	During 2014	
“Elektrokrajina” a.d. Banja Luka	---	---[180]	1.580	31/12/2009	
ZP “Hidroelektrane na Drini” a.d. Višegrad	---	---[181]	156		

Note: Sources given in Annex 13-2

The majority of staff members of ZH "Hidroelektrane na Drini" (88%) hold high school diploma or less, while 11% of staff members hold university degrees, with only 1% with associate degree (see Table 13-14).

Similar to "Hidroelektrane na Drini", the majority of staff members of "Elektrokrajina" Banja Luka hold high school diploma or less (84%), with 12% of staff members with university and 4% with associate degrees.

[178] http://nationalpark-una.ba/bs/historija.php?id=15/Javno%20preduze%C4%87e%20Nacionalni%20park%20%E2%80%9EUna%E2%80%9C (2/10/2015)
[179] Webpage of Elektroprivreda RS has no data on job systematization, staff education, gender or age structure.
[180] Webpage of “Elektrokrajina” Banja Luka has no data on job systematization.
[181] Webpage of ZP "HE na Drini" has no data on job systematization, staff gender or age structure.

Age of majority of staff members of "Elektrokrajina" Banja Luka, in the end of 2009, was between 41 and 65. This institution has far less women (only 24.5%) among staff members versus men (75.5%).

Table 13-14: Staff education, age and gender structure in energy sector institutions in the Republic of Srpska

Institution	PhD	Master Degree	Bachelor Degree	Associate Degree	High School or Lower	Average age (in years)	Men	Women	Comments
II Energy									
MH "Elektroprivreda RS", Trebinje	---	---	---	---	---	---	---	---	
"Elektrokrajina" a.d. Banja Luka	---	---	12%[182]	4%	84%	Majority between 41 and 65	75.5%	24.5%	Data on 31/12/2009
ZP "Hidroelektrane na Drini" a.d. Višegrad	---	---	11%	1%	88%	---	---	---	

Note: Sources given in Annex 13-2

Jurisdiction and Organization

MH "ElektroprivredaRepublikeSrpske", a.d. Trebinje (MH EP RS)

MH EP RS was organized according to the Decision of the Government of RS, no. 02/I-020-60/06 from 30/12/2005 as set by the Law on Companies ("OG RS", No. 127/08, 58/09, 100/11 and 67/13) and the Law on Public Enterprises ("OG RS", No. 75/04 and 78/11).

EP RS is a strategic company exercising activities of general interest, organized as the stock company. Parent company is 100% owned by the Republic of Srpska. Company owns 65% share of subsidiary companies except for the Research-Development Centre with 51% parent company share.[183]

Integral parts of MH EPRS are five companies exercising electric power generation activities, as follows: 1) ZP "Hidroelektrane na Trebišnjici" a.d. Trebinje; 2) ZP "Hidroelektrane na Drini" a.d. Višegrad; 3) ZP "Hidroelektrane naVrbasu" a.d. Mrkonjić Grad; 4) ZP "Rudnik i Termoelektrana" Gacko a.d. Gacko; 5) ZP "Rudnik i Termoelektrana Ugljevik" a.d. Ugljevik. (See Annex 13-2 Figure 6: Global Organizational Structure of EPRS with Subsidiary Companies and Figure 7: Organizational Structure of EP RS-Parent Company a.d. Trebinje).

Integral parts of MH EPRS are five companies exercising electric power distribution activities, as follows: 1) ZP "Elektrokrajina" a.d. Banja Luka; 2) ZP "ElektroDoboj" a.d. Doboj; 3) ZP "ElektroBijeljina" a.d.Bijeljina; 4) ZP "Elektrodistribucija Pale" a.d. Pale; 5) ZP "Elektrohercegovina" a.d.Trebinje.[184]

ZP "Hidroelektrane na Drini" a.d. Višegrad

From the perspective of available energy, the Drina River basin is among the best in Europe. With the average rainfall of 1,100 mm/year and high heads from 2.2‰ to 5.2‰ it offers opportunities for cost-effective electric power generation and guarantees the stability of the power supply system. Between 1976 and 1985, the only hydropower plant - HE Višegrad - in the Republic of Srpska was designed and built, and commissioned in 1989.

Comprehending the opportunities for utilization of the hydropower potentials of the Drina River basin in the Republic of Srpska resulted in identification of *unused technical potentials*, potentially usable *with hydropower plants above 10 MW, of 3,626.2 MW. Unused hydropower potentials of small waterways* potentially usable *with hydropower plants above 10 MW is 159.3 MW.*

[182] Total number of staff members holding university degrees is 208, which is 13.74%, as opposed to 12% shown on the chart. See: http://www.elektrokrajina.com/sr/o-nama/profil-kompanije/ljudski-resursi, (22/09/2015)
[183] http://www.ers.ba/index.php?option=com_content&view=article&id=14%3Arijecgeneralnogdirektora&Itemid=31&lang=ba, (26/09/2015)
[184] http://www.ers.ba/index.php?option=com_content&view=article&id=6&Itemid=22&lang=ba, (25/09/2015)

In terms of energy and economic potentials, the most attractive planned hydropower plants are HPS "BukBijela":

- HPP "“Buk Bijela" with installed power of 450 MW and average annual generation of 1,150 GWh,
- HPP "Foča" with installed power of 55.5 MW and average annual generation of 195 GWh.

Among other hydropower facilities, the following should be highlighted:

- HPP "Paunci"” on Drina River with installed power of 43.2MW and average annual generation of 156 GWh,
- HPP "Mrsovo" on Lim River with installed power of 43.8 MW and average annual generation of 165 GWh.[185]

The organizational structure of the enterprise incorporates four sectors (Maintenance Sector, Investments and Development Sector, Economy and Finance Sector, General and Legal Affairs Sector) and the Directorate.

Four small hydropower plants have been built so far in RS (Bogatići, Mesići, Tišća and Vlasenica). Unused potential of the Drina River is 3,567 GWh and Elektroprivreda RS planned construction on numerous small hydropower plants in DRB.

Energy in the Federation of BiH

Capacities

The total number of staff members in JP "EP BiH" in the end of 2014 was 4,894 (see Table 13-15).

Table 13-15: Job systematizations and total staff numbers in energy sector institutions in the Federation of BiH

Initiation	Job systematization	No. of positions in job systematization	Total staff number	Date	Comments
II Energy					
PE “ElektroprivredaBiH”, Sarajevo	---	---[186]	4,894	End of 2014	

Note: Sources given in Annex 13-2.

Majority of staff members in PE "EP BiH" was holding high school diplomas (75% of staff members). Second in the line were the staff members holding university degrees (18%), to be followed by associate degrees (3%), master degrees (2%), and doctoral degrees with only 0.2% of staff members in PE "EP BiH" (see Table 13-16).

Table 13-16: Staff education, age and gender structure in energy sector institutions in the Federation of BiH

Institution	PhD	Master Degree	Bachelor Degree	Associate Degree	High School or lower	Average age (in years)	Men	Women	Comments
II Energy									
PE „ElektroprivredaBiH“ Sarajevo	0,2%	2%	18%	3%	75%	---	---	---	

Note: Sources given in Annex13-2.

Jurisdiction and Organization

Public Enterprise "ElektroprivredaBosne is Hercegovine", Sarajevo (PE EPBiH)

[185] http://www.ers.ba/index.php?option=com_content&view=article&id=49&Itemid=80&lang=ba, (26/09/2015)

[186] *Rule Book on Organization of PE "“EP BiH"* d.d.-Sarajevo, February 2010, as well as the official webpage of PE "EPBiH", have no data on job systematization, number of positions as per job systematization, staff gender or age structure. http://www.elektroprivreda.ba/upload/documents/akti/43.%20Pravilnik%20o%20organizaciji.pdf, (22/09/2015).

PE EPBiH is a public enterprise operating as of 2004 according to the Law on Public Enterprises (OG FBiH, No. 8/05, 81/08, 22/09 and 109/12), as a shareholders' company *(Law on Companies*, "OG FBiH", No. 84/08, 88/08, 7/09 and 63/10). EPBiH is the company holding 100% ownership of seven coal mines, and another four companies exercising other activities with different ownership share structure (*Annual Report of PE EPBiH for 2013*, p. 6)[187].

With the companies under its majority ownership, PE EPBiH has been, according to the law, merged into a Concern with PE EPBiH as a parent company and other companies as subsidiaries (7 mines and 4 other companies). Subsidiaries employ around 10,000 people (*Annual Report of PE EPBiH for 2013, p*. 6).

The Enterprise has eight business units (BU): Hydropower Plants on the Neretva River, Jablanica; Thermopower Plant "Kakanj", Kakanj; Thermopower Plant "Tuzla", Tuzla; BU "Elektrodistribucija" Bihać; BU "Elektrodistribucija" Mostar; BU "Elektrodistribucija" Sarajevo; BU "Elektrodistribucija" Tuzla; BU "Elektrodistribucija" Zenica.

Bodies of the Enterprise are as follows: Assembly, Supervisory Board, Management, as management bodies, and Audit Committee (Annual Report of PE EPBiH for 2013, p. 6). (See Annex 13-2 Figure 14: Organizational Structure of PE "EP BiH" Sarajevo; Table 46: Electric Power Balance of PE "EP BiH" in 2013 and Table 47: Implementation of the Electric Power Balance (GWh) of PE "EP BiH").

Electric industry activities performed by JP Elektroprivreda BiH are as follows; Generation and distribution of electricity; Supply of electricity; Trading, representation and mediation on the local electricity market and other activities as set by the Statute.[188]

13.4.1 Scientific Research Institutions

Sector of Science and Culture of the Ministry of Civil Affairs of BiH is in charge of “coordinating activities with the line entity authorities and defining strategies in international sense in science and culture”. 2010 – 2015 BiH Science Development Strategy is currently under implementation.

Ministry of Science and Technology of RS exercises activities in accordance provisions of the Law on Scientific Research Activities and Technological Development ("OG RS", No. 6/12, 33/14). 2012 – 2016 Scientific Research Development Strategy of the Republic of Srpska is currently under implementation. Ministry is organized in two sectors (Science Sector and Technology Sector) and the Secretariat of the Ministry.

Science and Technology Sector of the **Federal Ministry of Education and Science**, is the central segment of the administration in charge of activities related, *inter alia*, to development of scientific research, development of scientific research organizations, encouragement of fundamental and applicable research, development of investment technologies and personnel of scientific research, monitoring innovations, etc. Implementation of activities set in 2012 - 2020 Strategy of Development of Scientific-Research and Research-Development Sphere is underway.

13.4.2 Civil Society Organizations

Civil Society Organizations inBiH, RS, FBiH and BD

According to assessment given in EPR (2011), non-governmental organizations in BiH play active role in advisory councils of river basins through water user associations, as regards to setting the level of fees in water or in certain current public campaigns related to issuing water permits (for example, to industrial polluters with toxic substances emissions).[189]

[187] http://www.elektroprivreda.ba/stranica/opce-informacije, and http://www.elektroprivreda.ba/stranica/izvjestaji-o-poslovanju, (27/09/2015)
[188] http://www.elektroprivreda.ba/stranica/opce-informacije, (27/09/2015)
[189] *Environmental Assessment, BiH*, Economic Commission of UN for Europe, UN, Network, Geneva, 2011, p. 102.

It is assessed that there are around 12,000 non-governmental organizations in BiH. Research conducted in 2006 by REC included 88 civil society organizations for environmental protection.[190]

To support the implementation of the Aarhus Convention in BiH, on 11/04/2013 a network of Aarhus Centres (Banja Luka, Sarajevo, Tuzla) has been formed, which represents a platform for the exchange of information between the competent institutions on the one hand and the public on the other hand.[191] Second national report on implementation of the Aarhus Convention was delivered to the Secretariat of the Convention in 2013.[192]

Law on Water of RS stipulated establishment of the River Basin Area Council, as the top advisory body. The law set that the Council shall be composed of the representatives of the Government of the republic of Srpska, representatives of the local government units on the territory of a specific river basin area, representatives of water users, non-governmental organizations of that area and scientific institutions.

Article 164 of the Law on Water of FBiH stipulated that non-governmental organizations in the water area are members of the Water Area Advisory Council according to predefine criteria.

Requirements of establishment, internal organization, registration, cessation of associations and foundations, as well as other issues of relevance for free and voluntary association of citizens and legal entities in BiH have been regulated by the laws on associations and foundations on all tiers of government and, thus, there are *four laws* in BiH regulating establishment and operation of the civil society organizations in BiH, RS, FBiH and BD. Differences between the four laws are minor[193].

All four laws stipulated that association shall be established by at least three natural entities or legal entities principle purpose of which is not profit. As opposed to other three laws, Article 2, Paragraph 2 of the Law on Associations and Foundations of the Brčko District stipulated that founders of the association must not be the state of BiH, entities, Brčko District, cantons, municipalities, state authorities, state enterprises, funds, as well as no other state institution or organization.

All four laws stipulated that associations shall acquire legal entity status by virtue of registration.

On BiH state level of government, associations shall be registered in the register of associations kept by the *Ministry of Civil Affairs and Communication of BiH* (Article 28, item 5 of the Law).[194]

Situation in *the Republic of Srpska*is somewhat different. Namely, register of associations and foundations is kept in two locations. Registration of associations and foundations in the register of associations or the register of foundations shall be exercised by the *primary court* in the seat of the district court where the association or foundation is based (Article 25, paragraph 1 of the Law).

Procedure of registration and cessation of associations and foundations is conducted as per provisions of the non-litigious procedure (Article 25, paragraph 2, of the Law). *Common Register of Associations and Foundations* for the territory of RS is kept by the *Ministry of Public Administration and Local Government of RS.* Subject ministry also keeps a common register of foreign and international non-governmental organizations with registered representative offices on the territory of the Republic of Srpska (Article 33,

[190] *NGO Direktorij – Bosnia and Herzegovina (BiH) Directory and Research of BiH Environmental Civil Society Organizations (CSO)*, Regional Environment Center for BiH. Sarajevo, Bosnia and Herzegovina 2006.
[191] http://aarhus.ba/mreza-ac-bih.html (18/8/2015)
[192] http://apps.unece.org/ehlm/pp/NIR/listnr.asp?wf_Countries=BA&Quer_ID=&LngIDg=EN&YearIDg=2014 (18/8./2015)
[193] Law on Associations and Foundations of Bosnia and Herzegovina ("OG of BiH", No. 32/01, 42/03, 63/08, 76/11); Law on Associations and Foundations of the RS ("OG of RS", No. 52/01 and 42/05); Law on Associations and Foundations ("OG of FBiH", No. 32/01, 45/02 and 42/03); Law on Associations and Foundations of the Brčko District ("OG of BD", No. 12/02, 19/07).
[194] Registration in the Register of Associations, Foundations, Foreign and International Associations and Foundations shall be conducted in accordance with the Law and the Rule Book on the Keeping the Register of Associations and Foundations of Bosnia and Herzegovina and Foreign International Associations and Foundations and Other Non-Profit Organizations ("OG of BiH", No. 44/10).

paragraph 1 of the Law). The Court that exercised registration of an association or foundation shall notify the authority in charge of a common register not later than eight days as of the day of registration, or amended registration (Article 33, paragraph 2 of the Law).

Article 26, paragraph 2 of the Law on Associations of *FBiH* stipulated that the *Register of Association shall be kept by the Federal Ministry of Justice*, if the statute of the association has defined that subject association shall be active in two or more cantons, and if the statute has defined association shall be active in one canton, the register of associations shall be kept by the cantonal authority. Article 26, paragraph 3 – Register of all foundations and all foreign non-governmental organizations shall be kept by the Federal Ministry of Justice**.**

In Brčko District, association shall acquire status of the legal entity by virtue of *registration in the Court Register of BD* (Article 2, item 1 of the Law). Decision on registration in the register of associations or foundations shall be made by the *Primary Court* (Article 28, paragraph 1).

Laws on Associations and Foundations of BiH, RS and BD stipulated that *registration of associations is voluntary act*, but that associations shall acquire status of legal entity by virtue of registration in the Register of Associations. However, the Law on Associations of *FBiH*stipulated *compulsoryregistration of associations* (Article 26, paragraph 1), and, thus, Article 11, paragraph 3 stipulated that “the association shall acquire the status of legal entity by virtue of registration in the Register. Legal actions undertaken before the registration in the register create an obligation only for persons who undertook subject actions”.

As far as the freedom action on a specific territory is concerned, Article 3 of the Law on Associations and Foundations in BiH stipulated that associations and foundations are free to act on the entire territory of BiH, regardless of the place of registration, while the Laws of RS (Article 7, paragraph 1) and FBiH (Article 5, paragraph 1) stipulated that associations and foundations are free to act on the territory of the other entity, without any further administrative responsibilities, if their actions are not contrary to the law and Constitution.

Article 3 of all four laws have identical stipulation that *the goals and activities* of the register association, i.e. foundation, *must not be related to involvement in election campaign, election candidate fund raising activities* or financing candidate and/or *political parties.*
Article 6 of the Laws of BiH, FBiH and BD and Article 8 of RS Law stipulated that exercising public powers may be delegated to an association or foundation by virtue of law, within the scope of their activities.

On the territory of FBiH, oversight of legality of operations conducted by associations and foundations is under jurisdiction of the line federal, i.e. cantonal, authority (Article 47, paragraph 1 Of the Law of the Federation of BiH). In RS, oversight of legality of operations conducted by associations and foundations is under jurisdiction of the line RS authority in charge of conducting oversight in the sphere activities of an association or foundation are related to (Article 43, paragraph 1). Also, RS stipulated that oversight of legality and earmarked use and management of funds of association and foundation is under responsibility of the body of association or foundation, as set by the statute and the Law on Associations, as well as the line republic authority (Article 36, paragraph 1).
BiH Law did not stipulate entity in charge of oversight of legality of operations conducted by associations and foundations.

13.5 Key Issues of Significance for Institutional Aspects of WRM inBiH

Based on an analysis of institutional organizations inWRM in BiH, the following conclusions are:

1. Institutional system in BiH has relatively clearly defined responsibilities of the principle segment of the most important institutions inWRM, but system complexity remains as one of the characteristics. On the BiH level of government, certain activities of significance for WRM (mainly related to coordination of international activities) are exercised by the Ministry of Foreign Trade and Economic Relations of BiH. In both the RS and the FBiH the principal power of policy creation in water management is held by the ministries in charge of agriculture and forestry, in additional to water management. Complexity of the

system is intensified further with the responsibilities held by cantons (in FBiH), and Brčko District BiH. Finally, certain responsibilities are in the hands of the local government units in both entities.

2. PI “VodeSrpske” (in RS), Agency of the Sava River Water Area and the Agency of the Adriatic Sea Water Area (in FBiH) manage water areas under their jurisdiction. Issue of mutual cooperation is regulated by the provisions of the entity laws on water. Forms of cooperation and coordination depend on specific circumstances and they are implemented in preparation of water related documents, preparation of the river basin area plans, preparation of regulatory compliance oversight, inspection affairs, etc.
3. One special problem for ASRWA is the method of regulation of responsibilities. It is assessed that the Agency should be responsible for water management regardless of the watercourse category.
4. Principle responsibilities related to water protection within the scope of environmental protection are in the hands of MSPCEEP (RS), and MET (FBiH). Energy related activities are under responsibility of the Ministry of Industry, Energy and Mining (in RS), and the Federal Ministry of Energy, Mining and Industry (in FBiH). Ministries of the two entities in charge of health issues are responsible for water health safety. Responsibilities of several other authorities may also be of relevance for individual aspects of water management and/or procedures implemented as regards to water management.
5. Present situation highlights the issue of character of links between individual system institutions and they should provide for water management system operation as a whole. This assumes presence of adequate and functional coordination instruments, which is another special challenge. In addition to MFTER’s responsibility, there are respective inter-entity cooperation bodies, and laws in both entities include special provisions regulating inter-entity cooperation. However, question of the current system efficiency may be raised.
6. For the purpose of strengthening coordination between the line entity authorities, some have highlighted a need to establish BiH Environmental Protection Agency, as well as BiH Water Agency.
7. Implementing cooperation between institutions within BiH is accompanied with problems that according to assessments of certain system entities are related, *inter alia*, to the following: lack of alignment between regulations of various level of government; lack of information and data; lack of satisfactory coordination mechanism for BiH’s EU integration process, etc.
8. Certain efforts to strengthen capacities of line institutions have been invested in the previous period, above all, due to presence of international assistance. However, capacities of existing institutions are not satisfactory nor in the segment related to human resources, nor in the segment related to technical equipment.
9. Although the existing system of financing the water sector (in both entities) recognizes certain classic forms of financing, subject system can be considered unsustainable.
10. BiH is a potential EU membership candidate. Progress in reforms directed to EU integrations is assessed as limited. Limited number of EU regulations has been transposed in the internal legal system of BiH (RS and FBiH). Situation is, partially, result of weaknesses in institutions.
11. There are several factors considered to be main obstacles inWRM in DRB, some of which are: lack of finances, lack of data, inadequate coordination, insufficient number of staff members, low political priority, etc. As regards to ASRWA, obstacles are also connected with the lack of international agreements related to the Drina River (Montenegro-BiH–Serbia), and the lack of obligation to notify and alarm in case of arrival of flood discharges.
12. The biggest problems in terms of regional cooperation in DRB are as follows: lack of finances; lack of water related data; inability to rely on historic data; unusability of existing data, lack of the international agreement between the countries in the basin, lack of alignment of regulations, etc.
13. One of very serious issues of cooperation between DRB countries is the issue of monitoring. MSDCEEP connected problems in implementing monitoring, before all, to “lack of measurement stations and accredited measurement bodies”. According to ASRWA, due to lack of adequate hydro-meteorological network of observation stations in the basin, it is impossible to collect basic data required for adequate Drina River WRM.
14. One of the problems is a floating waste. According to MSDCEEP, this issue creates major problems in storages of the hydropower plants in the Drina River basin, as well as problems related to tourism undergoing development phase in the Drina River towns.

15. The following fields that are to be subjected to improvementsin cooperation between DRB countries are as follows: WRM, floods, energy, environmental protection, climate changes, etc.
16. Cooperation within Euro – Region, implemented by one segment of institutions is assessed as "good".

13.6 Future Institutional Framework

Two principal factors determine the deliberation on development of the institutional framework for WRM in BiH. The first is the European integrations of BiH, and the second factor is functioning of the legal and political system of the country, in fact, the issue of orientation of possible changes in constitutional organization in BiH, something that is a subject of discussions by public and professional audience. Current WRM system is, mainly, composed of two relatively independent systems of institutions (Republic of Srpska and Federation of BiH), with certain common elements in the form of coordination functions on BiH level, in the segment related to international cooperation. At the same time, both system share a multitude of common elements, as well as certain specific features. Strengthening the functionality of the system includes, above all, eliminating weak spots in the system of coordination of activities of different entities. Considering the aforementioned, one may expect coordination instrument strengthening in all segments (between line ministries, inter-entity, vertical), irrespective of political system reform discussion.

Institutional development inWRM is largely connected with the dynamic of European integration of BiH, i.e. firstly with dynamics of harmonization of internal regulations with EU regulations, and then with capacities to apply regulations.

Creating conditions for full application of EU regulations depends upon a number of circumstances. Due to the relatively poor infrastructure in water management, the process could take more time compared to other countries in the region.

Judging by the experiences of other countries that have joined EU during the last cycle of enlargement of this organization, it is assessed that full application of regulations in water management will take a longer period, probably three decades. This is primarily due to expenses for infrastructure investments, meaning that without international support this is not feasible.

Second factor determining institutional development in WRM is, in a narrow meaning of the word, completely out of the water management institutional framework. Regardless of the direction of the changes of the government system organization (constitutional and other changes), issue of coordination in WRM remains a priority.

Further development of institutional framework should be viewed in the context of international institution strengthening and cooperation of BiH in international arena.

13.7 Recommendations

Based on the institutional framework analysis in WRM in BiH, the following has been recommended:

1. Strengthen institutional capacities of relevant authorities;
2. <u>More staff members</u>, especially staff members with special qualifications (RHMO needs strengthening in the area of hydrological and meteorological monitoring, data analysis and hydrological measurements, i.e. civil engineer – hydro technics, electrical engineer; FMAWMF, Water Sector is in a need of a legal support in the form of a new lawyer; FMET, Environmental Protection Sector, needs several staff members, especially legal support , as well as two relevant experts, lawyer, biologist and chemical engineer; FHMO needs several staff members including engineers for FHMO services, i.e. civil engineers – hydro technics or masters of civil engineering – hydro-techniques; meteorologists; physicists, as well as IT engineers. Young experts are also needed);
3. <u>Technical equipment of relevant authorities</u> (RHMO needs automatic measurement stations with supporting software and servers for data transfer and storage, flow metering instrument, deposit metering instrument, off-road vehicle; FMAWMF needs to procure respective IT equipment; FHMO needs

hydrological, meteorological and rainfall stations; Field work equipment: metering equipment, vehicle, boats, protection gear; Data management equipment – hardware and software, and a long-term need is a radar);

4. Strengthening capacities of institutions in charge of EU integrations, especially of activities of harmonization of domestic regulations with EU regulations inWRM;
5. Even though line entities are largely covered by training programs, it is required to develop staff training plan and secure implementation finances in the segment related to EU policies and regulation in the field of water management;
6. Develop specialized training plans for line hydro-meteorological initiations: RHMO needs trainings for metering instrument handling for modern technologies, as well as trainings in maintenance of automatic metering stations, i.e. following trainings: IT, electronics, statistical data analysis, foreign languages, suspended deposits transportation metering; FHMO needs additional trainings for existing staff members related to "application of new technologies in the hydrological and meteorological service – trainings related to new metering instruments, data management; hydrological and meteorological forecast; numerical modelling and quality management";
7. Development of the water sector approximation strategy;
8. Strengthening instruments of vertical and horizontal coordination of activities; (ASRWA pointed to the need for an "umbrella state level institution for water management", to ensure full coordination of activities in case of waterways requiring cooperation between two entities);
9. Strengthening the mechanism of cooperation between institutions in charge of EU integrations, including the process of harmonization of domestic regulations with EU regulations;
10. Strengthening entity authorities in charge for harmonization of domestic regulations with EU regulations;
11. Strengthening the instruments of cooperation between FMAWMF and line cantonal authorities;
12. Strengthening local government capacities;
13. Certain activities related to institutional strengthening will require regulatory amendments. As regards to FMAWMF, they are the systemic regulations of the Government ofFBiH; Law on Water and Law on Environmental Protection;
14. Development of a separate study on impact of the existing organization of the WRM system on implementation of water related objectives, including due consideration of objectives set in other sectors, with a recommendation of measures to be taken to improve WRM system functionality;
15. Reform of the water sector financing system. Entity governments should create sustainable, efficient and transparent water financing system with balanced and comparable financial requirements;
16. Development of comprehensive flood defence strategy including all elements and phases of activities;
17. Improvements and repair of the existing flood defences systems and building new in areas under threat; undertaking non-construction flood defence measures, especially preservation or rehabilitation of natural swamps and retention areas;
18. Strengthening transparency instruments in line water reduces management authorities;
19. Strengthening public-private partnerships inWRM;
20. Alignment and creation of a comprehensive and reliable surface and sub-surface water monitoring system, and monitoring data management and documenting;
21. Strengthening hydro-meteorological services in DRB.

14 Conclusions and Recommendations

14.1 Conclusions

Environment

A total of 23 surface water bodies were delineated by Sava RBMP, but according to ongoing process of BiH by laws for both entities (RS and FBiH) this number of SWB is 32. However more recent work on the EU IPA project indicate that there are 234 SWB in RS and 46 SWB in FBiH. From this total 26 SWB are delineated as heavily modified (HMWB) all in the RS.

There were seven GWB delineated in all of the Sava basin under the RBMP. The current EU IPA project has delineated six GWB within the BiH part of the DRB and a further three GWB skirting the western boundary of the basin.

Air quality is measured by the respective stakeholder institutions in RS and FBiH. Some monitoring is within the municipalities of Ugljevik and Gacko to oversee emissions from TPPs nearby. Generally, results indicate the DRB is outside of the influence of the high air pollution except in the north where ar quality at times causes elevated emissions of SO_2, CO, particulate matter NO_x. However, in December 2015, the Ministers of BiH adopted the National emission reduction plan (NERP) and gave their approval to the Ministry of Foreign Trade and Economic relations to deliver the plan to the Energy Community Secretariat. This National plan provides the reduction obligation of emissions of sulphur dioxide, nitrogen oxides and particle matters of combustion plants in BiH (boilers, thermal plants) from 2018 to 2027. Then, it is expected that this pollution will be reduced in medium term.

The DRB inBiH has 61% forest and 37% agriculture with the remaining comprise inland waters /wetland (about 1%) and other land and settlements (about 1%).

The Southern part of the DRB in BiH has a rich biodiversity, which is particularly evident in the Sujetska National Park. The most endemic forms are recognized within the flora of the higher plants (e.g. Serbian Spruce and Persian Walnut), which at the current state of knowledge is estimated to have 450 endemic taxa.

There are more than 47 species of fish, 35 species of amphibians and reptiles are present within the basin, whilst there are more than 230 species of bird (114 registered in Sutjeska National Park). There are more than 55 taxons of macroinverterates recorded in the Drina River.

When fish fauna is taken as an indicator of quality, the water ecological status of the Drina River and its tributaries is good to moderate according to the requirements of Annex V of the WFD. That means that in some river sections, fish ecosystems are close to undisturbed conditions while in other river sections fish ecosystems have been significantly altered.

The Danube Salmon is an endangered species endemic to the Danube basin occurs in the DRB.

In the forests of the upper catchments of BiH part of DRB, mammals such as the brown bear, wolf, chamois, wild cat and otter live, but they are rare and endangered. In particular, Drina River canyon and its tributaries are permanent habitats of the Eurasian Brown bear. Bats are well represented in the DRB part of BiH, with more than 30 species present some of them very rare, with the Drina providing a migration corridor.

Biodiversity of Lepidoptera is high; for other insects there are high numbers of endemic subspecies present in the DRB. Invasive insect species occur in the DRB but they are not well recorded.

There are five protected areas in the BiH part of the DRB (four in RS and 1 in FBiH), covering about 2.6% of the land area of the basin as well as four candidate sites as Emerald sites that set the ecological principles of Natura 2000 sites.

Even if the trend for fauna and flora species is difficult to assess due to a lack of homogeneous past and up to date data, the population of many endemic flora and fauna species are decreasing over the past few year, mostly due to human pressure.

Indeed, the main pressures on biodiversity and ecosystems are due to social activities and water use. This includes activities such as, fish farming (pollution of nutriments and invasive fishes), gravel exploitation (destruction of spawning sites and habitats), and wastes disposal near the rivers (huge amount of floating wastes and inadequate landfills). Furthermore, use of fertilizers for agriculture near to aquatic ecosystems (pollution), the development of tourism infrastructure (decreasing surface of the natural areas, interruption of ecological corridors) conversion of land use and construction of new dams all apply significant stress on the ecosystem. The main environmental pressure is drought, in particular for the small tributaries in the Basin and for riparian vegetation.

Socio-Economic

Forestry and some arable crops are significantly affected by drought. Industrial production is significantly lower than it was 20 years ago, but is showing some signs of levelling out. The fish farming industry appears to be growing, but many farms remain unlicenced, and they remain a potential source of downstream pollution from nutrients.

The population of the DRB is in general decline due to migration of younger people away to the cities or abroad. The rural population in the DRB is around 60% and it is increasingly ageing as shown by the Age Dependenc Ratio of 40/100. There are indications that literacy is improving in the DRB, but there are no recent official data. Unemployment in the DRB municipalities can range from 15% up to 65%.

Water Quality

The water quality in the BiH part of the DRB has improved in recent years due to a decline in industrial activity. However, uncontrolled disposal of solid waste, the amount of agricultural waste and no wastewater treatment are preventing Class I status. The water quality in the downstream Drina presents moderate ecological status with class II to III for main physic-chemical parameters. Pollution hotspots are at all the municipal centres as well as at industrial and mining site. Other hotspots are pockets of farmland and contaminated soil sites.

Water Use

In terms of assessing water use in the BiH part of the DRB, the region has three water management regions (WMR). These are the Lower Basin (WMR I) the middle part of the basin (WMR II) and the upperpart of the basin (WMR III) which receives waters upstream from Serbia (Lim) and from Montenegro (Piva, Tara and Ćehotina) as well as from internal sub-basin such as Sutjeska and Bistrica.

Domestic consumption has been estimated at 23.2 Mm^3/year with the WMR 1 and WMR II accounting for 93% of this. With the inclusion of NRW this could amount to 36 Mm^3/yr. Industrial use is set at 7.6 Mm^3/yr and irrigation use at 1.9 Mm^3/yr. Fish farming and hydropower plants, although water users are not considered to consume water, the water returning back into the water courses. Overall water demand for the DRB in BiH has therefore been estimated to be 32.7 Mm^3/year. A certain percentage of returns have been estimated implying that the overall net water use in the basin is 12.2 Mm^3/year.

In the FBiH legislation, ("Rulebook OG", No 04/13), the minimal value of EF is calculated based on the average mean discharge, the average minimum discharge and the average decade discharges over a minimal period of 10 years. The minimum EF is defined for two periods, from May to October (warm/dry seasons) and November to April (cold/wet seasons including spawning period). In RS, the Water Law (Article 65) defines the EF as the mean monthly flow occurring with a 95% probability ($Q_{95\%}$). In addition, there is a lack of a homogeneous methodology for all the three riparian countries of the DRB. The FBiH method is a good compromise between environment and water use. It is proposed to be applied for the Drina River which crosses the two BiH entities and the Serbia.

Three scenarios for future demand at the 30 year and 50-year time frame have been calculated for high growth, flat growth and real growth. It is considered that actual water use within the DRB will be somewhere between the Flat Growth and Real Growth Scenarios. Key drivers for change in the basin have been provided and need to be discussed with stakeholders covering water supply, flood protection, hydropower, environmental conservation, recreation/tourism and fisheries.

There is need for flood protection measures in flood prone areas in the DRB, near to major settlements. Most of the constructed drainage systems are not in operation, in general due to insufficient maintenance.

Hydropower

In BiH, three hydropower plants (HPPs) are in operation in the DRB for RS, and there are no HPP in the FBiH part of the basin.

Out of the many imagined new HPPs in DRB part of BiH, 16 have reasonable chances of being implemented. The total installed capacity of all planned hydropower schemes in RS BiH reaches 1,143 MW. The total cost of all investments amounts to some 2,700 million Euros. This leads to an average unit cost of the installed megawatt of 2.36 million Euros. This is in the range of usual ratio for this kind of projects.

Flood Hazards and Risks

The need for flood protection measures in the BiH part of the DRB is important. The EC recognised the need for flood damage recovery after floods in 2010 and the most recent floods of May 2014. In that respect a total number of 29 flood related projects planned in the DRB (covering all three riparian states)with a budget amounting to 99.3 M € were proposed and considered for funding Nearly 50% thereof are located in the BiH part of the DRB; i.e. 14 projects with the estimated budget of 43.7 M €.

It is very important that the regulation and protection measures planned along the middle and lower reaches of the Drina River are harmonized with the designs of the planned hydropower (cascade) systems along the corresponding river reaches.

Monitoring

There are no monitoring programs on aquatic ecosystems in the three riparian countries. We recommend monitoring the populations of the 4 targeted fish species: the Danube salmon (*Hucho hucho*), the Greyling (*Thymallus thymallus)*, the Bull head (*Cottus gobio*), the Brown trout (*Salmo labrax*). We also recommend monitoring the state of the remaining riparian vegetation along rivers.

Climate Change

BiH is a member of the UNFCCC and Kyoto Protocol and submitted the Initial National Communication in 2010, whilst the Second National Communication was submitted in 2013. As a non-Annex I member country, BiH is not required to decrease its greenhouse gas (GHG) emissions. However, it is obliged to report on its national GHG emissions, to systematically observe and research the climate and the climate change impact and vulnerability of its natural resources and economy, as well as to identify measures of adaptation to climate change.

Between periods 1981-2010 and 1961-1990 increases in mean annual temperature are observed in the range of 0.4 and 0.8 °C. There has not been a significant change in total precipitation amount, but there has been in distribution, which have increased climate variability and the occurrence of extreme events in BiH.

Short-term and long-term future climate scenarios are indicating temperature increases of 0.4 to 1°C for the period 2001-2030 (under the A1B scenario) and 3.4 to 4°C for the period 2071-2100 (under the A2 scenario) respectively. Precipitaiton change is highly varied depending on scenario and varies between -20% to +10 % in the short-term future to a decrease 0 to 30% in the long-term future. Some projections also indicate seasonal variation with increases in winter and spring and less rainfall in summer. This is likely to have significant impact in the forestry and agriculture sector with greater risk of forest fires and more reliance upon irrigation.

Legal

BiH has developed legislation in WRM at entity and at canton level (in FBiH) but it is complex due in part to the constitutional organisation. It is proposed to adopt WRM at state level but no detailed elaboration of the workings of such legislation currently exist. Further, the Law on Waters is adopted by both entities, but there needs to be much better inter-entity cooperation to improve the current status.

Under current circumstances, one may expect that the process of harmonization of EU regulations with BiH regulaitons will take between a further 5 and 10 years if supported by international institutions and EU in a systematic manner. This should also include consideration about the number of regulations in water management and environmental protection where the harmonization process has not yet started, or is in initial stages.

The Consultant believes and recommends that an international agreement between the three riparian countries (BiH, Montenegro and Serbia) on cooperation in the field of WRM would lead to better cooperation especially regarding IWRM. Besides strengthening the capacity, of the respective riparian institutional needs, there is need to make more effective use of the FASRB and related protocols.

Institutional

BiH institutional structure for WRM has relatively clearly defined responsibilities, but complexities in the system especially between state and entity and between entity and cantonal/municipal level are a constraint. In addition, there is lack of capacity, equipment and financial resources for the implementation of the institutional obligations and this is a major problem in both the short and long term. There is great need to strengthen the mechanisms of horizontal and vertical cooperation between competent authorities.

There is limited progress in reforms directed to EU integration. A limited number of EU regulationsare transposed in the internal legal system of BiH (RS and FBiH). This is in part a result of weaknesses in institutions and lack of capacity and financial resources.

Challenges regarding regional cooperation in DRB are: lack of finances; lack of water related data; inability to rely on historic data; unsuitability of existing data, lack of the international agreements between the countries in the basin and lack of alignment of regulations.

Management of water resources, floods, urban issues, energy, foreign investment, environmental protection and climate change are considered as priority areas of cooperation between the countries in the DRB.

14.2 Recommendations

Following the feedback from BiH stakeholders to the draft IWRM report and comments received during the workshop held in Belgrade 25-26 January 2016, the recommendations to this report have been prioritised. During the 25-26 January 2016 workshop, BiH stakeholders prioritised the recommendations, the results of which are available in Annex 14-1. Each recommendation was given a rating by the BiH stakeholders based on the following: "1" high priority, "2" medium priority and "3" low priority. More specific recommendations were also provided by MOFTER and the Ministry of Spatial Planning, Civil Engineering and Environmental Protection (MSPCEEP) RS BiH. An average for each recommendation was then obtained and these were ranked in order of importance and grouped under the main sectors (environment, socio-economic, hydropower, monitoring and legal and institutional etc.) for the four main outcomes of the project, namely:

- Outcome 1 - More effective data collection and analysis,
- Outcome 2 - Enhanced dialogue and coordination in the DRB,

- Outcome 3 - Better decision-making and management in the DRB as a multi-purpose water resource, and
- Outcome 4 - More effective application of EU WFD regulations and preparation of RBMP.

Hence, prioritised recommendations for Outcome 1 – "More effective data collection and analysis" are:

Environment

Recommendation	Priority
• Data exchange with other institutions	1
• Show the ecological status of all the rivers in the DRB on a map using fish species as indicators (according to Annex V of the WFD) in order to have a reference for surveying the trend of aquatic ecosystems. This will enable a decision- making tool related to the development of social and economic activities (implantation of dams, of gravel exploitation, of recreational activities, etc...).	1
• Hydraulic modelling is required in the main tributaries of the Drina River to obtain better understanding of the required EF to guarantee minimum velocity and depth of flow.	2
• Harmonization of the EF methodology is required in the whole DRB.	2
• Map riparian natural habitats as described in the Habitat Directive of the European Union (92/43/EEC) with their state of conservation.	2
• An inventory of the benthic fauna in the DRB is needed to ascertain the degree of endemism and quality of the riverbed and river water quality.	2
• Undertake inventory of invasive subspecies in the basin.	

HPP

Recommendation	Priority
• Carefully perform the monitoring of the dams' flow regime and improve data exchange between stakeholders. As important structures bearing a high potential risk, the dams are key elements of hydropower schemes.	1

Institutional

Recommendation	Priority
• Acquisition of Technical equipment for line authorities and additional equipment, especially for institutions dealing with regular monitoring	1
• Create the right conditions for the Water Information System operation;	2

Monitoring

Recommendation	Priority
• Follow up the Transboundary Diagnostic Analysis (TDA) as part of the DIKTAS made suggestions for priority actions in all the transboundary aquifer areas for i) establishment of a common groundwater monitoring program, and ii) harmonisation of criteria for delineation of source protection zones.	2
• Improved monitoring, enforcement and implementation of groundwater protection legislation in needed in the Basin. The Consultant would like to reiterate the recommendation from the DIKTAS Project on this subject, namely: a) full delineation of water source sanitary protection zones, and b) setting cost-efficient measures for groundwater protection.	2
• There is need to improve the monitoring of industrial and irrigation use at municipal/canton level, which should record water amounts used as well as the quality of the water that is being returned to the system	2
• Implement a monitoring program of fish ecosystem and riparian vegetation. We recommend monitoring four targeted fish species: the Danube salmon (*Hucho hucho*), the Greyling (*Thymallus thymallus*), the Bull head (*Cottus gobio*), the Brown trout (*Salmo labrax*). We also recommend monitoring the state of the remaining riparian vegetation along rivers. In order to be relevant, this monitoring program should be undertaken in	2

Recommendation	Priority
cooperation with the three riparian countries.	
• Implement a monitoring of benthic and aquatic flora species.	2
• Improve data gathering for minimum and maximum spring and autumn flows.	2
• Substantial increases in monitoring of aquifers to increase knowledge of the flow regime in the DRB.	2
• Undertake further groundwater tracer tests to provide an accurate assessment of the groundwater divide in the sub basins of the DRB	3
• Reinforce a central State Institute to centralize and coordinate the analysis of the biodiversity monitoring and the collected data.	3

Prioritised recommendations for Outcome 2 – "Enhanced dialogue and coordination in the DRB" are:

Environment

Recommendation	Priority
• Harmonise national regulations and foster cooperation between the three countries in the DRB in order to successfully implement biodiversity protection programs	1
• Taking into account the Spatial Plan RS BiH by 2025 (MSPCEEP), the following are important: o Spatial plan of special purpose integrates the land basin of Upper Drina, in order to comprehend and define the interests and needs of energy and protection of natural values; o Adequate waste management because of the strong problem of floating waste in the Drina River is due to the tributaries of the river Lim and Rzav from neighboring countries Montenegro and Serbia; o Work towards the establsihment of sewerage system for wastewater o In built-up areas and isolated dwellings to stimulate the construction of septic tanks o In economic zones introduce clean technologies with pre-treatment of waste water; - drafting the law on the national park " Drina ". Drina National Park.	1
• Reinforce the protection regime in protected areas in coherence with the requirements for nature protection and target species	2
• Strengthen education concerning the sorting of solid waste	2

Institutional

Recommendation	Priority
• Institutional strengthening and developing strategic and normative base in flood prevention and defence;	1
• Harmonisation of the strategic objectives of spatial development in the DRB countries;	1
• Reform of the existing system and improvements of financing in the field of water management and environmental protection (collection of funds, level of charges; charge payer databases; mechanisms of receivables collection from legal entities in long lasting court procedures; financial management, etc	1
• Strengthening institutional capacity, provision of finances and developing prerequisites of joint monitoring implementations within the DRB;	1
• Strengthening capacities of the public water management enterprises and efficiency improvements within public utility enterprises	1
• Further analysis of the most optimal ways for multi-lateral cooperation within the DRB;	1
• Improving coordination of financing in the field of water management with financing instruments from other fields (environment, agriculture, forestry, etc.); providing conditions for other funds and private capital to join to water sector development funds; creating conditions required to use EU funds and co-financing within fields where subject support is provided;	1
• Developing long-term water sector investment plan	2

• Raising awareness of the need to undertake significant measures in IWRM	2
• Strengthening public-private partnerships and encouraging investments in all water management segments in areas with such demand	2
• Undertaking measures for capacity improvements in local institutions;	2
• As regards to cooperation of hydro-meteorological services, it is required to upgrade the program of joint measurements, data exchange and harmonization and coordination of development programs and plans;	2
• Provide for operation of the administrative authority de-politicization instruments;	2
•	
• Abolishing the ban on new employment for organizations exercising highly technical activities; i.e. create possibilities for new employment in authorities requiring highly skilled staff (EPA, etc.);	2
• Establishing and improving long-term relations between state and scientific-research and educational institutions for the purpose of public administration capacity building;	2
• Establishing the Water Council (to elaborate and provide opinion on draft laws and other regulations related to water management issues; elaborate and provide opinion on draft water management strategies and plans; to recommend improvements in the water sector), that is, create conditions for operability of the Water Council and the National Water Conference;	2
• Further strengthening civil society organizations and building partnerships between public authorities, business entities and civil society organizations;	2
• Analyse the development of security risks in the field of water resources management by 2035 and the impact on institutional development;	2
• Establish expert centres for preparation and monitoring of implementation of the water sector investments;	2
• Strengthening links between the line republic level entities and entities exercising utility services. Examine the feasibility of extension of ministry's jurisdiction to utility services (drinking water supply by the public waterworks system and wastewater collection, drainage and treatment by public sewage system).	2
• Training decision makers in the field of significance, comparative experiences and perspectives of water management in the region;	3

Legal

Recommendation	Priority
• Intensifying efforts to establish bilateral agreements with neighbouring states in the field of WRM and energy with Serbia and BiH.	1

Prioritised recommendations for Outcome 3 – "Better decision-making and management in the DRB as a multi-purpose water resource", are:

Environment

Recommendation	Priority
• Control environmental flow	1
• Avoid and/or better regulate gravel exploitation within riverbeds	1
• Build new sanitary landfill away from groundwater protection zones and from riverbeds	1
• Close existing landfills and move them away from riverbanks and flood plains	1
• The concept of flood protection to be coordintated	1
• WWTP are needed at the main centres of population and for industry in order to reduce the pollution loads in the rivers	1
• Introduce larger part of clean energy	1
• Real consideration is necessary for the provision of multi-purpose reservoirs and flood retention basins to protect downstream settlements from flooding	1
• Control the technical compliance of vehicles	1

• Coordination of land use in particular agriculture	1
• Protect and/or restore riparian vegetation along rivers especially along smaller tributaries in order to prevent soil erosion, filter pollution and prevent floods	1
• Improve fish farming process and build nutrient precipitators in fish farms in order to prevent water pollution	2
• Limit fishing during drought periods	2
• For existing dams, flushing operation must be forbidden during the breeding period of targeted fish species (from March to May) and environmental flow must be controlled	2
• Mitigation of drought with HPP reservoirs	2
• Reduce hydropeaking during the fish breeding season	2
• Impose fish ladder, flushing procedure and regulation of water level fluctuation of the reservoirs for the new planned dams in order to mitigate their impacts.	2
• Management of protected forests	2
• All planned structures for RBMP within the DRB need to take into consideration the prevailing seismic conditions in their design. This is especially important for developments planned in the DRB in areas with higher seismic rating.	2

HPP

Recommendation	Priority
• To devote great care to the maintenance of the existing schemes. The reliable functioning of all structures and machines is a must for an efficient use of the natural resource.	1
• Strive to harmonize legal-administrative frameworks for developing cross-border HPPs. The largest potential for HPP development of the DRB in BiH resides in these types of HPPs. Take into account the spawning areas of the target fish and the high value wetland ecosystems in new HPP projects.	1
• Take into account the spawning areas of the target fish and the high value wetland ecosystems in new HPP projects.	2

Legal

Recommendation	Priority
• Strengthen regulation concerning riparian ecosystems in protected areas	2

Socio Economic

Recommendation	Priority
• Increase stricter control on sand and gravel extraction and improve policing of unlicenced operators	1
• More consideration to drip irrigation practices as they are more efficient and provide large reductions in overall water use.	2
• Improve water resources availability in summer to increase fish farming production in the DRB	2
• Record more effectively the number of tourists in protected areas (to ascertain values without endangering environment)	3

Prioritised recommendations for Outcome 4 – "More effective application of EU WFD regulations and preparation of RBMP", are:

Institutional

Recommendation	Priority
• Strengthening cooperation between the competent institutions, especially in view of the distribution of competencies between different levels of government, in terms of water management	1
• Improve employment opportunities and implement policy to attract and retain younger staff.	1

Recommendation	Priority
• Strengthen capacities of stakeholder bodies in charge of water management.	1
• Prepare and harmonise national regulations with EU regulations for institutional aspects of water management.	2

Legal

Recommendation	Priority
• Consistent implementation of obligations under international agreements	1
• Undertaking further measures aimed at harmonization of internal regulations with EU regulations	1
• Preparation and adoption of required by-laws as per applicable laws on water;	1
• Harmonization of regulations governing utility services with the regulations governing WRM; Adoption of the law to regulate utility services in FBiH; Adoption of the law on chemicals (in FBiH);	1
• Intensifying activities of adoption of the water management plans;	1
• Invest efforts in transfusion of the strategy in sector policies and strategies;	1
• Improve strategic planning and implementation of acquis in the field of environment and climate;	1
• Adopting a Strategy of environmental protection and Waste management strategy in RS;	1
• Strengthen regulatory enforcement capacity in the field of industrial and hazardous waste;	1
• Strengthening instruments of adjustment, coordination and involvement of various tiers of government in preparation and adoption of regulations and their harmonization with EU regulations;	1
• The following regulations are to be charged or adopted to strengthen FHMO capacities: Law on Hydro-Meteorological Activities (FBIH); LW of FBIH (either certain amendments to the existing law or adopt a new law); Adequate enactment should regulate the status and responsibilities of FHMO as regard to public reporting, EEA WMO and other; Regulations related to the quality management system-QMS;	1
• Regulatory reform to create more efficient financing system in the water sector, or of relevance for water sector;	1
• Develop a strategy of harmonization of internal regulation with EU regulations in the water management sector	2
• Improve harmonization of directives on strategic environmental impact assessment and public participation;	2
• Strengthening the transparency of the process of harmonization of internal regulations with EU regulations;	2
• Elaborate possibilities of ratification of the New York Convention on the Law of the Non-Navigational Uses of International Watercourses;	2

Socio Economic

Recommendation	Priority
• Stronger coherence between strategic and planned documents and environmental objectives.	1

15 REFERENCES

Ref #	Details of Reference
1	Agency for Statistics of the Bosnia and Herzegovina, 2015. Website: http://www.bhas.ba/saopstenja/2015/AQU_2014_001_01-sr.pdf
2	Aljtovski, M.E. 1973. Hidrogeološki priručnik. Građevinska knjiga, Beograd, 190-196 i 213-220.
3	Allendorf, F.W. & Waples, R.S. (1996). Conservation and Genetics of Salmonid Fishes. In Conservation Genetics: case histories from nature (Avise, J.C., & Hamrick, J.L. eds). Chapman & Hall, New York. 238-280 pp.
4	Analitika, Which parts of the territory will be included on the new Regional Park Komovi?, October 15 2014: http://portalanalitika.me/drustvo/vijesti/165771-koje-djelove-teritorije-obuhvata-novi-regionalni-park-komovi - On line information website
5	Anon, (2003): Guidance on Monitoring for Water Framework Directive. CIS Work group 2.7.
6	B92, 2014, Jalovina u Drini, država ne reaguje (Goaf in the Drina river, the States does not react), September 29, 2014: http://www.b92.net/info/komentari.php?nav_id=903510
7	Bajić, A., Šipoš, Š., Pejčić, Lj., Srećković, I., Demeny, F., Sokoray-Varga, S., F., Muller, T., Miljanović, B.(2012): Rearing and growth of the Danube Salmon, Hucho hucho (L.) in controled environment during early juvenile stages. II International Hucho Symposium, Lopusna, Poland. 19-22 September, 2012. p.16
8	Biotope d.o.o., 2012, Inventory of bat species in Tara NP, report of Biotope d.o.o., December 2012, (the PE Tara NP has the study)
9	BirdLife International: http://www.birdlife.org/ → see the map of the IBAs in BiH, Serbia and Montenegro
10	Birke, M., Reimann, C., Demetriades, A., Rauch, U., Lorenz, H., Harazim, B., Glatte, W. 2010. Determination of major and trace elements in European bottled mineral water – analytical methods, in Mineral Waters of Europe, Special Issue, Journal Geochem. Explor.107(3). 217-226.
11	Bistro 2014, http://www.bistrobih.ba/noviforum/viewtopic.php?f=69&t=1707 see picture 5 "Map of PAs in BiH" in paragraph 2.5 "Overview of Bosnian protected areas" and read PAs description (Bistro BiH is a Fishing association from Sarajevo, BiH)
12	Bogdanovic, S. 2000. Water law after Dayton: The current state of regulation in Bosnia and Herzegovina. Water International 25 (4): 534–543.
13	Bogdanović, S. 2004. The Sava River Basin – New Legal Frameworks for Shared Water Resources. Novi Sad: YUAWL – Yugoslav Association for Water Law.
14	Bosna sema educational institutions, Sarajevo college, BiH, Using bioindicators in the ecological assessment of fresh water's quality, 2007
15	BPK Goražde, 2010, Spatial plan of the Bosnian-Podrinje Canton Goražde for the period 2008-2028, draft version, March 201 http://www.bpkg.gov.ba/konkursi-oglasi-saopcenja/10160/prostorni-plan-bpk-gorazde-tenderska-dokumentacija
16	BPK Goražde, 2013, Spatial plan of the Bosnian-Podrinje Canton Goražde for the period 2008-2028, draft version, October 2013 http://mu.bpkg.gov.ba/prostorni-plan/727/nacrt-prostornog-plana-za-podrucje-bpk-gorazde-za-period-2008-2028-godine
17	Brilly M., Šraj M, Vidmar A., Primožič M., Koprivšek M. and Kavčič K., 2013. Pilot project on climate change: Component A3: Compilation of various existing climate change scenarios for the region, their expected impacts on water cycle and more specifically on frequency and magnitude of extreme flood events, Part 2: Climate change impact on flood discharge of the Sava River, Hydrology report, ISRBC
18	Buzaljko, R., Pamić, J. 1982. SFRJ OGK 1:100 000 Tumač za list Foča K 34-14. Savezni geološki zavod, 1-57, Beograd 1977.
19	CARDS Project: -Waste Recycling Pilot project 2004 2006
20	Ćehotina River HPPs System – Due Diligences, "Jaroslav Černi" Institute for the Development of Water Resources, Belgrade, 2008
21	CEPRES, 2011, Emerald Network in BiH, Presentation PPT hold by the Centre for Ecology and Natural Resources (CEPRES), Faculty of Science, Sarajevo University in Paris on January 26, 2011 http://www.coe.int/t/dg4/cultureheritage/nature/EcoNetworks/JP/Documents/2011/ppt/Bosnia_Emerald.pdf
22	Ciechanowski et al., 2005, *First records of Tadarida teniotis (Rafinesque*, 1814) (Chiroptera, Molossidae) from

Ref #	Details of Reference
	Serbia and Montenegro and from Bosnia and Herzegovina, Mammalia 69, 257-260
23	CIS (2003a) Common Implementation Strategy for the Water Framework Directive (2000/60/EC), Guidance document No. 2, Identification of Water bodies. European Communities, Luxembourg
24	CIS (2003b) Common Implementation Strategy for the Water Framework Directive (2000/60/EC), Guidance Document No. 9, Implementing the Geographical Information System Elements (GIS) of the Water Framework Directive. European Communities, Luxembourg
25	CIS (2009a) Common Implementation Strategy for the Water Framework Directive (2000/60/EC), Guidance Document No. 21, Guidance for reporting under the Water Framework Directive. Technical Report-2009-029. European Communities, Luxembourg
26	CIS (2009b) Common Implementation Strategy for the Water Framework Directive (2000/60/EC), Guidance Document No. 22, Updated Guidance on Implementing the Geographical Information System (GIS) Elements of the EU Water policy. Technical Report-2009-028. European Communities, Luxembourg
27	COE 2014, Description of the Emerald Network, http://www.coe.int/t/dg4/cultureheritage/nature/econetworks/default_en.asp
28	CORINE (2000): Digitalne CORINE Land Cover Map, European Environment Agency EEA i Joint Research Centre JRC.
29	Council of Ministers, 2012, Answers to the list of EU questions on Chapter 27, Sarajevo. http://www.dei.gov.ba/dei/dokumenti/uskladjivanje/default.aspx?id=10919&langTag=bs-BA.
30	COWI. 2012, Update of the Basis for the Water Resources Management of the Vrbas River Basin, World Bank – Module 1 – Hydrological and Water Resources Assessment.
31	COWI. 2012, Update of the Basis for the Water Resources Management of the Vrbas River Basin, World Bank – Module 2 – Hydropower Development Study
32	COWI. 2012, Update of the Basis for the Water Resources Management of the Vrbas River Basin, World Bank – Module 3 – Integrated Water Resources Management Assessment
33	Dević, N., Filipović, S. (2014): Assessment of hydrochemical properties of groundwater in karst. International Conference and Field Seminar, Karst Without Boundaries, DIKTAS Project, Trebinje.
34	DIKTAS, Protection and Sustainable Use of the Dinaric Karst Transboundary Aquifer System, Montenegro country report, Octobre 2012.
35	Dimitrijević, M.D. 1995: Geologija Jugoslavije. Geoinstitut, Spec. Publ., 1-205, Beograd.
36	Dimitrijević, M.D. 2001. Dinaridi and the Vardar Zone: a short review of the geology. Acta Vulcanology, 13, 1-8.
37	Dimitrijević, N. 1988. Hidrohemija. Univerzitet u Beogradu, Rudarsko-Geološki fakultet
38	Đoković, I. 1985: Primena strukturne analize na rešavanje građepaleozojskih tvorevina Drinsko-Ivanjičke oblasti. Geol. anali Balk. poluostrva, XLIX, 11-160, Beograd.
39	Đorđević, S. 1994. Procena kvaliteta sirove vode. Zbornik radova međunarodne konferencije “Kvalitet voda“, Čačak, 231-239.
40	Drešković N. et al. (2011): NATURA 2000- Bosna I Hercegovina. Ministarstvo vanjskih poslova Norveške.
41	Durov, S.A. 1948. Classification des eaux naturell et la representation graphique de leur composition. – Doclady Acad. Nauk SSSR, 59pp.
42	EEA, 2006, Corine land cover 2006, European Environment Agency: http://www.eea.europa.eu/data-and-maps/data/clc-2006-vector-data-version-3
43	EEA. 2010. *Environmental trends and perspectives in the Western Balkans: future productions and consumption patterns*, EEA Report, No. 1/2010, European Environment Agency. Copenhagen.
44	Environmental Protection Strategy of FBiH 2008-2018
45	EPTISA, February 2016 Draft River Basin Management plan of the Sava River Basin in FBiH (2016-2021) and supporting documents
46	EPTISA, February 2016 Draft River Basin Management plan of the Sava River Basin in RS BiH (2016-2021) and supporting documents
47	EU IPA - 2008 - Project Action plan for the implementation of the landfill directive, (Council Directive 99/31/EC) – BiH, RS- – Strenthening of BiH’s environmental Institutions for pre-accession funds , EnvIS - EPTISA project, September 2014
48	European Environmental Agency website
49	European Small Hydropower Association - Thematic Network on small hydroelectric plant - Environmental Group – Reserved flow –Short critical review of the methods of calculation http://www.esha.be/trash/tnshp-

Ref #	Details of Reference
	workshops/lausanne-workshop.html
50	FAO of the United Nations website www.fao.org/fishery/countrysector/naso_serbia/en
51	Food and Agriculture Organization of the United Nations, Regional Office for Europe and Central Asia – The fisheries and Aquaculture Sector in Bosnia and Herzegovina, preparation of IPARD Forest and Fisheries, Sector reviews in BiH – January 2015
52	Federal Geological Institute of Yugoslavia, 1970. Geological Map of SFR Yugoslavia, 1:500,000.
53	Federal Ministry of Environment and Tourism, 2009, Overview and state of biological and landscapes diversity in BiH: Land Of Diversity, First national Report of BiH for the Convention on biological Diversity, Sarajevo, 2009: http://aoa.ew.eea.europa.eu/tools/virtual_library/bibliography-details-each-assessment/answer_2133408925/w_assessment-upload/index_html?as_attachment:int=1
54	Federal Ministry of Physical Planning of the Federation of BiH, 2013, Spatial plan of the Federation of Bosnia and Herzegovina for the period 2008-2028, August 2013 http://www.vladatk.kim.ba/vlada-tk/dokumenti-tk/prostorni-plan-fbih
55	Filipović, I., Jovanovi, D. 2007: GK Srbije 1:50 000. Tumač za list Zvornik 2. Fond stručnih dokumenata "Geološkog instituta Srbije" (nepublikovano), Beograd.
56	Filipović, S., Rondović, D. 1980. Fizičko-hemijske i hemijske karakteristike voda za piće u Pljevaljskoj opštini. Glasnik Republičkog zavoda zaštite prirode – Prirodnjačkog muzeja, Titograd, 13, 153-160.
57	Fukarek, P. (1969): Osnovne prirodne karakteristike, flora i vegetacija Nacionalnog parka "Sutjeska". Akademija nauka i umetnosti Bosne i Hercegovine. Posebna izdanja. Knj. XI, Odeljenje prirodnih i matematičkih nauka, Knj. 3, Sarajevo.
58	Grupa autora (2010): Posebna osnova gazdovanja šumama za GJ „Crni vrh-Kamena Gora" 2001-2010. Služba uređivanja, Šumsko gazdinstvo "Prijepolje", Prijepolje.
59	Grupa autora (2013): Studija o procjeni uticaja na životnu sredinu projekta MHE „Hrčavka 1(C-X-2), 2(C-H-1), 3(C-X-3) - konačna studija. Projekat a.d. Banja Luka.
60	Hamzić, A. 2003 – Akvakultura u Bosni i Hercegovini, Sarajevo
61	HEIS Hydro-Engineering Institute Sarajevo –, EU Floods Recovery Program, November 2015, Floods and landslides risk assessment for the housing sector in Bosnia and Herzegovina
62	Holčik, J., Hensel, K., Nieslanik, J. & Skacel., L. (1988). The Eurasian Huchen, Hucho hucho, largest Salmon of the World. Joint edition published by Dr. W. Junk Publishers, Netherlands and VEDA, Bratislava.
63	Hrvatović, H. 2006. Geological Guidebook through Bosnia and Hercegovina. Geological Survey of Federation Bosnia and Hercegovina, 1-172, Sarajevo.
64	Hydro-Ingenieure and HEIS, June 2012, Framework for flood management on the Drina River – Final Report for the WB
65	ICPDR website: http://www.icpdr.org/main/publications/drina-rivers-floating-problem
66	Institut za hidrotehniku Građevinskog fakulteta u Sarajevu, april 2013, Preliminary flood risk assessment for streams of category I in FBiH, Sarajevo
67	Jaroslav Černi Institute. Belgrade. Serbia, 2014.Defining hydrological series of mean weekly discharges series unregulated flow for the period from 1926 to 2012 at the profiles of hydropower (river Drina and another rivers),
68	JCI - HIS "Drina" ver 1, Institut za vodoprivredu "Jaroslav Černi", Beograd, 2002,
69	JCI - HIS "Drina" ver 2, Institut za vodoprivredu "Jaroslav Černi", Beograd, 2005,
70	JCI - HIS "Drina" ver 2.1, Institut za vodoprivredu "Jaroslav Černi", Beograd, 2006,
71	JCI - HIS "Drina" ver 3.1, Institut za vodoprivredu "Jaroslav Černi", Beograd, 2011,
72	JCI - HIS "Drina" ver 3b, Institut za vodoprivredu "Jaroslav Černi", Beograd, 2014,
73	JCI 2011 - HIS "Drina" ver 3.1, Institut za vodoprivredu "Jaroslav Černi", Beograd.
74	JCI 2014 - Defining hydrological series of mean weekly discharges series unregulated flow for the period from 1926 to 2012 at the profiles of hydropower (river Drina and another rivers), Jaroslav Černi Institute for the Development of Water Resources. Belgrade. Serbia.
75	JCI 2014 - HIS "Drina" ver 3b, Institut za vodoprivredu "Jaroslav Černi", Beograd, 2014,
76	JCI. 2008. Korišćenje hidroenergetskog potencijala gornje Drine i Sutjeske na teritoriji Republike Srpske. Idejno rešenje i prethodna studija opravdanosti. Izveštaj o hidrološko-meteorološkimuslovima. Institut za vodoprivredu "Jaroslav Černi",
77	JRC (2008): CCM - River and Catchments Database for Europe, Version 2.1 (downoload South 2002).

Ref #	Details of Reference
	http://ccm.jrc.ec.europa.eu/php/index.php?action=view&id=24
78	Karamata, S., Olujić, J., Protić, Lj., Milovanović, D., Vujnović, L., Popević, A., Memović, E., Radovanović, Z., Resimić-Šarić K. 2000: The Western Belt of the Vardar Zone - the remnant of a marginal sea. In: Karamata, S., Janković, S. (eds.), Proc. Int. Symp. “Geology and Metallogeny of the Dinarides and the Vardar Zone”, Academy of Sciences and Arts of the Republic of Srpska, Collect. Monogr., I, Dept. Nat., Math. Tech. Sci., 1, 131-135, Banja Luka – Serbian Sarajevo.
79	Klimentov P.P., Kononov V.M. 1987 : Методика гидрогеологических исследований, 157-180, Москва
80	Kottelat, M. & Freyhof, J. (2007). Handbook of European freshwater fishes. Kottelat, Cornol, Switzerland and Freyhof, Berlin, Germany.
81	Konjuh protected area: www.zpkonjuh.ba
82	Kubat, I. 1977. SFRJ, OGK, 1:100.000. Tumač za list Ljubovija, L 34-111. Savezni geološki zavod, 1-58, Beograd 1968.
83	Kultura, 2014, Biodiversity of the SNR Gromiželj http://ekulturars.com/posebni-rezervat-prirode-%E2%80%9Egromizelj%E2%80%9C,233.html?sLang=la
84	Lakušić et al. (2005): Staništa Srbije – Priručnik sa opisima i osnovnim podacim. Institut za botaniku i Botanička bašta “Jevremovac“, Univerzitet u Beogradu - Biološki fakutet.
85	Lakušić R., Pavlović D., Redžić S. (1982): Horološko-ekološka I floristička diferencijacija šuma I šikara sa bjelograbićem (*Carpinus orientallis* Mill.) i crnim grabom (*Ostrya carpinifolia* Scop.) na prostoru Jugoslavije. Glasnik republičkog zavoda zaštite prirode - Prirodnjački muzej Titograd, 15, 103-116.
86	Lakušić R., Redžić, S. (1989): The Flora and the Vegetation of Vascular Plants in Refugial-Relict Ecosystems in the Canyon of the River Drina and its Tributaries. – In: Lakušić, R. & al. (eds), Flora and Vegetation of Vascular Plants, as well as Fauna of Symphyla, Pauropoda and Mollusca in the Refugial-Relict Ecosystems in the Canyons of Tara, Piva, Komarnica, Lim and Drina Rivers. The Montenegrin Acad. Sci. & Arts. Glasnik of the Section of Natural Sciences, 7, 107-205.
87	Langumir, D. 1971. The Geochemistry of some Carbonate Groundwater in Central Pennsylvania. Geochemica et Cosmochimica Acta, Vol. 35, 1023-1045.
88	Lelek, A. (1987). Threatened Fishes of Europe. Aula-Verlag, Wiesbaden. 118-122 pp.
89	Loi fédérale sur la protection des eaux – Article 31, Etat le 1er juin 2014, Switzerland
90	Lubarda, B. et al., 2014, *Chorological characterization and distribution of the Balkan endemic vascular flora in Bosnia and Herzegovina*, Botanica Serbica, 38 (1): (2014) 167-184UDK 581.9:497.15: http://www.academia.edu/7026653/Chorological_characterization_and_distribution_of_the_Balkan_endemic_vascular_flora_in_Bosnia_and_Herzegovina
91	Mijatović, Z.: *Srbija i evroregioni, strah od decentralizacije, (Serbia and Euroregions, Fear of Decentralization)*, pg. 2, See: http://www.emins.org/sr/press/clanci/051210-g-list-z-mijatovic.pdf, date: 14.05.2015.
92	Mikavica, D., 1987, Dužinski i maseni rast mladice (Hucho hucho L.) iz rijeke Drine, (Length and weight growth of the Danube Danube Huchen in the Drina river), Ribarstvo Jugoslavije, 43, 75-81, Zagreb: https://www.google.fr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CCMQFjAA&url=http%3A%2F%2Fhrcak.srce.hr%2Ffile%2F125725&ei=b4CIVNSqDcmwUbjeg_gE&usg=AFQjCNFgd9jN0l5VZPf8VDQx3v4vsEIbRQ&bvm=bv.81456516,d.d24
93	Ministry of Physical Planning, Civil Engineering and Ecology of Republika Srpska, Amendments to the Spatial Plan for the Republic of Srpska 2025, 2013 http://nasprostor.org/dokumenti-2/prostorni-plan-republike-srpske/ http://nasljedje.org/docs/pdf/zasticena_podrucja_1_2013.jpg
94	Mirković, M. 1980. SFRJ OGK, 1:100 000 Tumač za list Gacko 34-26. Savezni geološki zavod, 1-63, Beograd 1974.
95	Mišić V., Kojadinović R. (1985): Prilog poznavanju šumske vegetacije klisure Drine (Nacionalni Park Tara). Užički zbornik 14, 265 – 285.
96	MOFTER, State of the environment report for BiH, 2010, 2012
97	Mojsilović , S., Filipović, I. , Avramović, V., Pejović, D., Tomić, R., Baklaić, D., Đoković, I., Navala M. 1975. SFRJ OGK 1:100 000 Tumač za list Valjevo L34-136. Zavod za geol. i geof. istraž. 1965, 1-56, Beograd (autori karte: Mojsilović , S., Filipović, I. , Baklaić, D., Đoković, I., M.Navala, 1959-1966)
98	Mojsilović, S., Filipović, I., Avramović, V., Rodin, V., Navala, M., Baklaić, D., Đoković, I. 1977. SFRJ OGK 1:100 000 Tumač za list Zvornik L34-123. Savezni geološki zavod, 1-48, Beograd 1968.
99	Municipality of Bajina Bašta, Biodiversity and Ecosystem Services for Local Sustainable Development in the

Ref #	Details of Reference
	Western Balkans, Municipal profiles, Draft outline of the review report for SEE BAP,
100	Municipality of Višegrad 2013, Local action plan for the biodiversity of the municipality of Višegrad (LBAP) http://www.seebap.com/contentDocs/sr/49872_bah_visegrad.pdf
101	NP Sutjeska web site: http://www.npsutjeska.net
102	Natura 2000 u BiH. U.G.Centar za okolišno održivi razvoj Sarajevo, 2011
103	Nacrt Nacionalnog plana smanjenja emisija (National Emission Reduction Plan – NERP) za Bosnu i Hercegovinu, November 2015
104	Nurković, R., 2014: Fish ponds as a factor of development in rural areas in Bosnia and Herzegovina, Revija za geografijo 9-2, Univerza v Mariboru, Maribor http://www.ff.um.si/zalozba-in-knjigarna/ponudba/zbirke-in-revije/revija-za-geografijo/clanki/stevilka-9-2-2014/RG_18_9-2_03_Nurkovic_-_Fish_ponds_as_a_factor_of_development_in_rural__areas__of_Bosnia_and_Herzegovina.pdf
105	Obratov D. (1992): Flora and vegetation of the mountain Zlatar, PhD Thesis, University of Belgrade.
106	Olujić, J., Karović, J. 1986. SFRJ OGK 1:100 000 Tumač za list Višegrad L34-3. Savezni geološki zavod, 1-57, Beograd 1970-1980.
107	Pre-Feasibility Study and Environmental Impact Assessment Study for HPPs Brodarevo 1 and 2, Energoprojekt – Hydroinzenjering, Belgrade, 2012
108	Pre-feasibility Study and Preliminary Design for “Buk Bijela” HPP and “Foca” HPP, Stucky and “Jaroslav Černi” Institute for the Development of Water Resources, Belgrade, 2012
109	Pre-feasibility Study and Preliminary Design for “Paunci” HPP, “Energoprojekt-Hidroinzenjering” and “Jaroslav Černi” Institute for the Development of Water Resources, Belgrade, 2008
110	Pre-feasibility Study and Preliminary Design for “Sutjeska” HPP, “Energoprojekt-Hidroinzenjering” and “Jaroslav Černi” Institute for the Development of Water Resources, Belgrade, 2008
111	Pre-feasibility Study and Preliminary Design for Middle Drina, "Jaroslav Cerni" Institute for the Development of Water Resources, Belgrade, 2010
112	Pre-feasibility Study and Preliminary Design for Middle Drina, “Jaroslav Černi” Institute for the Development of Water Resources, Belgrade, 2010
113	Preliminary Design for “Mrsovo” HPP, IK Consulting Engineers, Belgrade, 2012
114	Preliminary Design for “Ustikolina” HPP, “Energooinvest”, “IPSA” Institute and "Pöyry", Sarajevo, 2013
115	Prohaska S, Simić Z, Orlić A. 2004. Osnovne hidrografsko-hidrološke karakteristike sliva Drine i hidrometeorološki podaci. Vodoprivreda. 36 (207-208): 21-38,
116	Prohaska S. 2006. Hydrology II. Faculty of Mining and Geology. University of Belgrade. Serbia
117	Protić Lj., Filipović I., Pelikán P., Jovanović D., Kovács S., Sudar M., Hips K., Less Gy., Cvijić R., 2000: Correlation of the Carboniferous, Permian and Triassic sequences of the Jadar Block, Sana-Una and “Bukkium” terranes.- In: S. Karamata & S. Janković (Eds.), Proc. Int. Symp. “Geology and Metallogeny of the Dinarides and the Vardar Zone” (Zvornik, 3-6 October, 2000), Acad. Sci. Arts Rep. Srpska, Coll. Monogr., 1, Dept. Nat., Math. Tech. Sci., 1, 61-69, 3 Figs., Banja Luka, Sarajevo.
118	Radulović S. et al. 2010. Towards candidature of the Crno Jezero (Black Lake) (Durmitor, Montenegro) as a high ecological status (HES) site of The Dinaric Western Balkan Ecoregion. Arch. Biol. Sci., Belgrade, 62 (4), 1101-1117, 2010,. DOI:10.2298/ABS1004101R.
118	Rafik Hirji and Richard Davis – “Environmental Flows in WaterResources Policies, Plans and Projects” – Environmental Department Papers, Nr 117 – April 2009
119	RANSMO Project- Evaluation of Composition of Waste and Routine Data Collection
120	Razvoj i primena hidro-informacionih sistema u cilju povećanja energetske efikasnosti u upravljanju hidropotencijalom u Republici Srbiji, Institut za vodoprivredu "Jaroslav Černi", Beograd, 2008-2010
121	REC, 2011, *Pollution in the Drina River Basin, An inventory of potential sources, 2011,* http://www.rec.org/publication.php?id=281
122	Redžić S., Barudanović S., Radević M. (2008) (Eds.): Pregled i stanje biološke i pejzažne raznolikosti Bosne i Hercegovine. Bosna i Hercegovina zemlja raznolikosti. Prvi izveštaj Bosne i Hercegovine za Konvenciju o biološkoj raznolikosti. Federalno ministarsvo okoliša i turizma.
123	Rekovici HPP – Preliminary Desing, Hidro-Tan, Belgrade, 2013
124	RTS, 2011, Proradila riblja staza (The fish ladder started to work), May 14, 2011 : http://www.rts.rs/page/stories/sr/story/57/Srbija+danas/891450/Proradila+riblja+staza.html

Ref #	Details of Reference
125	Sava RBM Plan, RS - NACRT IZVJESTAJA ZAŠTIĆENA PODRUČJA – EPTISA 2015
126	Savić, N. 2008, Akvakultura u BiH-RS
127	Schmid, S., Bernoulli, D., Fügenschuh, B., Matenco, L., Scheffer, S., Schuster, R.,Tischler, M., Ustaszewski, K. 2008: The Alpine-Carpathian-Dinaridic orogenic system: correlation and evolution of tectonic units. Swiss J. Geosci., 101, Birkhäuser Verlag, 139-183, Basel
128	Smakhtin V.U. 2001. Low flow hydrology: a review. Journal of Hydrology. 240: 147-186
129	Spatial plan of Republic of Srpska until 2025 Website: http://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mgr/Documents/)
130	Stahl K, Hisdal H, Hannaford J, Tallaksen LM, Van Lanen H.A.J, Sauquet E, Demuth S, Fendekova M, Jodar J. 2010. Streamflow trends in Europe: evidence from a dataset of near-natural catchments. Hydrology and Earth System Sciences 14(12): 2367-2382,
131	Stahl K, Tallaksen L.M, Hannaford J, Van Lanen H.A.J. 2012. Filling the white space on maps of European runoff trends: estimates from a multi-model ensemble. Hydrology and Earth System Sciences 16(7): 2035-2047,
132	State of environmental report for BiH 2010
133	State of environmental report for BiH, 2012
134	Stojković M, Ilić A, Prohaska S, Plavšić J. 2014a. Multi-Temporal Analysis of Mean Annual and Seasonal Stream Flow Trends, Including Periodicity and Multiple Non-Linear Regression, Water Resources Management, 28 (12): 4319–4335,
135	Tennant D.L. 1976. Instream flow regimens for fish, wildlife, recreation and related environmental resources. Fisheries 1(4): 6-10,
136	Todić, D. & V. Vukasović. 2002. Ekološka kriza u svetu i odgovor međunarodne zajednice – izbor najznačajnijih međunarodnih dokumenata i jugoslovenskih propisa (Environmental Crises and Responses of International Community). Beograd: Savezni sekretarijat za rad, zdravstvo i socijalno staranje, Institut za medunarodnu politiku i privredu.
137	Todić, D. 2002. Međunarodne konvencije u oblasti životne sredine i SR Jugoslavija (International Conventions in the Field of Environment and FR Yugoslavia). Belgrade: REC.
138	Todić, D. 2011. Social and Environmental Issues Related to the Security in SEE Countries, in Montini, M., Bogdanovic, S., (Ed) Environmental Security in South – Eastern Europe, Springer Science + Business Media B.V. 2011, pp. 43-58.
139	Todić, D., Janjatović T. 2014. Međunarodno vodno pravo i odgovornost za štete [International Water Law and liability for damages], *Pravni život*, 9, pp. 403-418.
140	Todić D., Ignjatić M., Vukasović V. Environmental Law – Bosnia and Herzegovina, International Encyclopaedia of Laws: Environmental Law, Kluwer Law International, Alphen aan den Rijn, NL: Kluwer Law International, 2014.
141	Travar, R. 2014, Existing threats for the Drina river, Travar d.o.o. http://www.travarfishing.com/index.php/tekstovi/predstavljamo-vam/izvestaje-sa-voda/833-1-prijeti-li-drini-katastrofa
142	Tuzla Canton, 2006, Spatial plan of the Tuzla Canton for the period 2005-2025, July 2006: http://www.vladatk.kim.ba/vlada-tk/dokumenti-tk/tk-prostorni-plan
143	UK Technical Advisory Group on the Water Framework Directive, Defining & Reporting on Groundwater Bodies.
144	UNECE – Environmental performance reviews – Bosnia Herzegovina – UN, 2004 (First Edition)
145	UNECE – Environmental performance reviews – Bosnia Herzegovina – UN, 2011 (Second Edition)
146	UNEP, 2010. Feasibility Study on Establishing a Transboundary Protected Area Durmitor – Tara Canyon – Sutjeska, UNEP Vienna ISCC, http://www.mtnforum.org/sites/default/files/publication/files/durmitor_study_25-10-210.pdf
147	UNEP Bosnia and Herzegovina, 2011, *Desk Review of the Legal and Institutional Framework of Environmental Protection in Bosnia and Herzegovina* [FINAL DRAFT], http://www.bhas.ba/dokumenti/Pregled_okvira_za_zastitu_okolisa-en.pdf
148	Vučić, M. Todić, D., Članstvo država sukcesora SFR Jugoslavije u međunarodnim ugovorima u oblasti životne sredine, [Membership of the successor states of former Yugoslavia in international treaties in the field of environment], u Dimitrijević D., Novičić Ž., Vučić M. (pr) *Regulisanje otvorenih pitanja između država*

Ref #	Details of Reference
	*sukcesora SFR Jugoslavije,*Zbornik radova sa međunarodne naučne konferencije Beograd, 29-30. Novembar 2012. Institut za međunarodnu politiku i privredu, Hans Zajedel Fondacija. str. 337-355.
149	Vucijak, B. Smolar-Zvanut N., Antonelli F., 2007. Development of environmental flow assessment procedure for Bosnia and Herzegovina.
150	Vukasović, V. 2006. Međunarodno pravno regulisanje zaštite i održivog korišćenja vodnih resursa sa posebnim osvrtom na sliv reke Save [International legal regulation of the protection and sustainable use of water resources with special emphasis on the Sava River Basin], *Međunarodni problemi*, br.1-2, 157-183.
151	Vukojičić S. (2008): Glacijalni relikti u orofitskoj flori Srbije, Crne gore i Makedonije. Biološki fakultet, Univerzitet u Beogradu. Dooktorska disertacija.
152	Waste from production activities in 2012, No.301/13, RS Institute of Statistics, 11 December 2013
153	Water Managment Strategy of the FBiH, Consortium for development of the water management strategy, Sarajevo 2012
154	WBIF-IPF4 Flood prevention and management Gap analysis and needs assessment in the context of implementing EU Floods Directive (September 2015)
155	Website: http://www.provincia.ferrara.it/download/4-LIR_BiH.pdf?server=sd2.provincia.fe.it&db=/intranet/internet.nsf&uid=0FFBD0B546482123C12574DA004F819A
156	WG (2007): Proposal for a European coding system for hydrological features. Appendix 7 of CIS Guidance No 22, Working group
157	Witkowski, A., Bajić, A., Treer, T., Hegediš., A, Marić, S., Šprem, N., Piria, M., Kapusta, A.(2013): Past and present of and perspectives for the Danube huchen, Hucho hucho (L.), in the Danube basin. Arch. Pol. Fish. 21:129-142
158	World Bank – IAWD – Danube Water Program – A State of the Sector Study for BiH – May 2015 - http://sos.danubis.org/eng/country-notes
159	World Bank 2003, Water Resources and Environment – technical Note C.1 – Environmental Flows: concepts and Methods, Richard Davis & Rafik Hirji, Washington, D.C.
160	World Bank 2015 Water and Climte Adaption Plan for the Sava River Basin for ISRBC. Main Report and five Guidance notes.
161	World Bank web sitehttp://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/01/30/000461832_20140130114213/Rendered/INDEX/E44300V60ECA0E00Box382138B00PUBLIC0.txt
162	WRMP for lower Drina, Energoprojekt – Hidroinženjering, Belgrade, 1998
163	WWF, June 2009. Assessment of Environmental flow for Trebizat and Vrbanja.
164	Zelinka, M., Marvan, P. (1961) Zur Prazisierung der biologischen Klassifikation der Reinheit flisender Gewasser. Archiv fur Hydrobiologie 57, 389-407
165	Zavod za Vodoprivredu, Jun 2014, Preliminary flood risk assessment in Republika Srpska, Bijeljina
166	Zavod za Vodoprivredu – Bijeljina and Institute of Civil Engineering – Banja Luka, January 2014, Feasibility study for the flood protection of Semberia region and Janja municipality against Drina River floods – Municipality of Bijeljina, Project for Flood Protection in Bosnia and Hercegovina, Bijeljina
167	Zavod za Vodoprivredu – Sarajevo and Zavod za Vodoprivredu – Mostar, March 2012, Water management strategy in FBiH between 2010 and 2022, Sarajevo