

# Impacts of Climate Change on Water Resources of the Republic of Srpska (Entity of Bosnia and Herzegovina)—Geopolitical Aspect



Igor Zekanović

**Abstract** The Republic of Srpska has many significant natural resources, which represent an important segment in the evaluation of its economic and geopolitical position in Europe. The most important resource is fresh water, including mountain and plain rivers, karst areas, natural and artificial lakes, and thermal and mineral springs. Considering the emerging crisis in drinking and industrial water supply, caused, among other things, by the negative effects of climate change at global and local level, the water resources of the Republic of Srpska can rightfully be considered as a key development resource, which has its own geopolitical dimension. This study is based on the analysis of the impact of climate change on water resources of the Republic of Srpska, including adaptation to climate change and optimal exploitation and preservation of freshwater resources. While respecting the criteria of sustainable development, the present situation has been examined through the prism of geopolitical aspect specific for the Southeastern Europe. Also, the research addresses national priorities, as well as the mutual connection between natural and geographical factors on one side and “the geopolitics of resources” on another. The results of this research offer both theoretical and applied value to the current situation in the country, and the Republic of Srpska could become a successful example of adaptation to climate change under specific geopolitical circumstances.

**Keywords** Water resources · Climate change · The Republic of Srpska  
Bosnia and Herzegovina · Geopolitical characteristic · Geopolitics of resources

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## 1 Introduction

Natural resources can be defined as the sum of elements of the environment related to the integral natural complex. Besides being naturally present in the specific area, natural resources have a temporal function which determines their political and geographical character for a specific country or political and territorial community. They can be conditionally divided into those which have always been essential, such as water, air and land, and those whose character is changing depending on the level of historical, geographical or economic development of a country (coal, oil, nuclear energy).

The study of mutual conditionality between “geographical” and “political” aspects, as well as the impact of geographic features on national politics, represents the basic guidelines of political geography. It can be defined as “the study of effects of political actions in the social geography, which contains a spatial analysis of political phenomena” (Grčić 1989). Therefore, “geopolitics of resources” is an indispensable element in contemporary international relations, because of the access and safe disposal of natural resources and raw material bases which determine the international status and relations between political and territorial communities at the local, regional and global level.

Global climate change and its impact on the environment and humans, as well as natural resources is the subject of interest of various international institutions, experts, public media, etc. Nowadays, one of the most important segments of the impact of climate change is the impact on the water resources. More frequent floods and droughts, and other disorders of the natural water regime, caused by the global climate change, as well as the crisis in the supply of drinking water and water quality have been registered globally. Therefore, various water management strategies have been developed in order to mitigate and adapt to these changes. This approach requires the development of strategies and plans of a unique and integrated management.

In preparing these plans and their implementation, with the aim of rational use and protection of water resources, all relevant factors must participate on local, regional and global level.

This work references to the valid literature on climate change in Southeastern Europe, of which we highlight the most relevant:

1. First National Report of Bosnia and Herzegovina in accordance with United Nations Framework Convention on Climate Change, from October 2009 (UNFCCC 2009);
2. Second National Report of Bosnia and Herzegovina in accordance with United Nations Framework Convention on Climate Change, from October (UNFCCC 2013);
3. Strategy of Adaptation to Climate Change and Low Emission Development for Bosnia and Herzegovina, from October 2013 (Council of Ministers of Bosnia and Herzegovina 2013);

4. Third National Report and Second Biennial Report on Greenhouse Gases of Bosnia and Herzegovina in accordance with United Nations Framework Convention on Climate Change, of July 2016 (UNFCCC 2016);
5. Strategy of Integral Water Management of the Republic of Srpska, until 2024 (2012);
6. Action Plan for Protection from Floods and River Management of Bosnia and Herzegovina, 2014–2017 (Council of Ministers of Bosnia and Herzegovina 2014);
7. Flood Prevention and Management. Gap analysis and needs assessment in the context of implementing the EU Floods Directive, from September 2015 (European Commission 2015).

### ***1.1 Natural and Geographical Characteristics of the Republic of Srpska***

The Republic of Srpska is an entity within Bosnia and Herzegovina, which spreads over the area of 24,641 km<sup>2</sup>. It spreads over about 48% of overall territory of B&H. Mathematically and geographically, it occupies the northern and eastern part of the geographical space of B&H, between 42°33'18" and 45°16'36" of north latitude and 16°12'18" and 19°37'44" of east longitude (Table 1). According to the results from the Census from 2013, it had 1,170,342 residents (Republic of Srpska Institute of Statistics 2017a).

Natural characteristics of the Republic of Srpska are conditioned by belonging to different natural and geographic regions. They are therefore characterized by heterogeneous geomorphological, climatological, vegetation, hydrological and pedological structure (Zekanović 2011).

Different climatic impacts on the geospace of the Republic of Srpska are the result of natural elements and the legality of general circulation of air masses over a wide area. The climate is affected by several factors: geographic latitude, relief—which predominantly has mountain character, proximity of the Adriatic Sea and continental masses—primarily Euroasian mainland. Therefore, in this region, different cli-

**Table 1** Geographical coordinates of the endpoints of the Republic of Srpska

	North latitude	East latitude	Municipality	Populated places
North	45°16'36"	16°56'08"	Kozarska Dubica	Donja Gradina
South	42°33'18"	18°26'45"	Trebinje	Podštirovnik
East	44°02'59"	19°37'44"	Bratunac	Žlijeb
West	44°56'52"	16°12'18"	Krupa na Uni	Srednji Bušević

Source Republic of Srpska Institute of Statistics (2017b)

mate types are represented: moderate-continental, continental (steppic), mountain, mountain-depression and modified-Adriatic.

In the northern and western part of the Republic of Srpska, in the areas up to 500 masl, the annual average temperature has a value from 10 to 11 °C in the central mountain area. The areas over 500 m above the sea level, is characterized by the annual average temperature in the interval from 4 to 10 °C, except for the highest mountain peaks, at which the temperature is under 4 °C. The warmest part of the Republic of Srpska is the area of low Herzegovina and southern part of Herzegovinian grasslands, where the annual average temperature has the value from 11 to 14 °C, and the area of Trebinje and Popovo experience around 14 °C (Trbić and Bajić 2011).

Thus, northern, peri-Pannonian part of the Republic of Srpska, is characterized by moderate continental climate with warm summers, moderately cold winters and average annual temperature over 10 °C (Fig. 1). Precipitations are generally equally distributed, and the greatest precipitation is in the period of May–June. The amount of precipitation decreases from the west (1500 mm) to the east (700 mm), because of the crucial impact of western air currents. The wind from the North and Northwestern direction is dominating. The duration of snow cover is 30–45 days.

The areas with higher altitude have mountain and mountain-depression variant of climate, characterized by fresh and short summers, and long, cold and snowy winters. Snowfalls are often plentiful and remain for a long time, and annual average of precipitation is over 1200 mm.

Mountain-depression variant of climate impact prevails in the hills and depression-valley areas. Average winters last longer than the winters of moderate-continental type. Snowfalls last in average 30–60 days. Precipitations are equally distributed, annual average amounts 750–1000 mm. Summers are moderately warm (from 18 to 20 °C). Average annual temperature is lower than 10 °C.

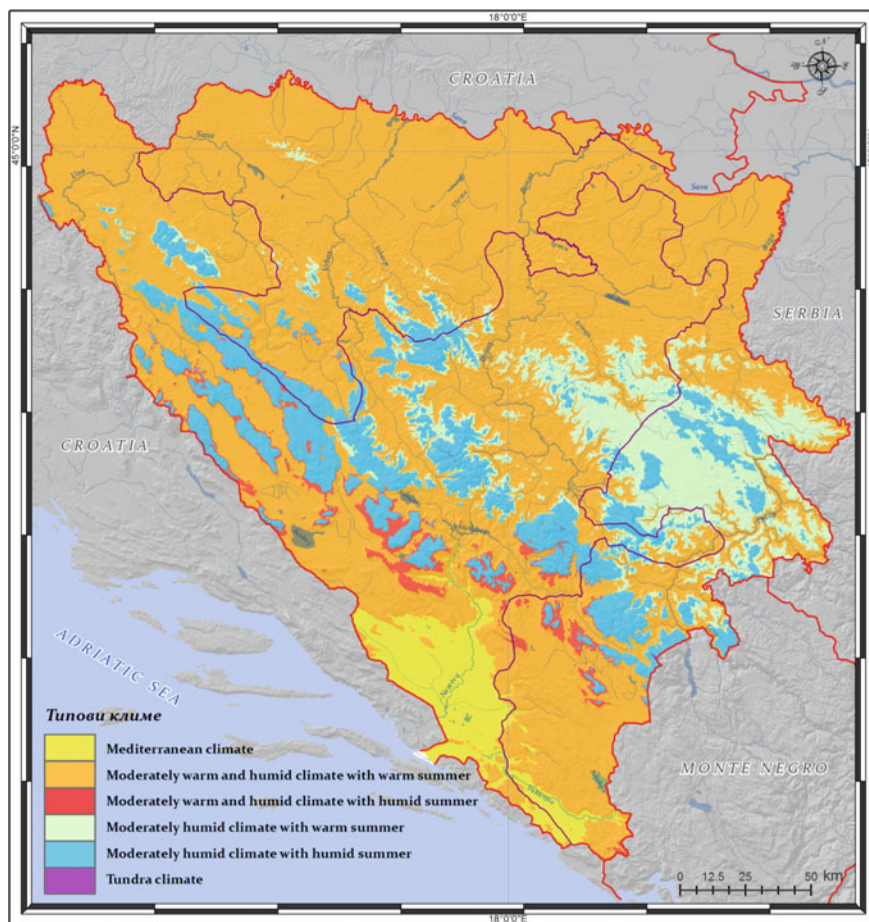
Southern part of the Republic of Srpska is characterized by altered variant of Adriatic climate. It is characterized by very warm summers and mild winters. Annual amount of precipitation is over 2000 mm.

## 2 Hydrographic Characteristics of the Republic of Srpska

From the hydrological point of view, geospace of the Republic of Srpska is characterized as rich surface and underground hydrological network. Fresh water network is represented by the main rivers: Una, Sana, Vrbas, Bosna, Sava, Drina and Trebišnjica (Table 2).

However, in addition to the main rivers listed above, various small lowland rivers, mountain rivers and rivers of karst areas contribute efficiently to the richness of the network. Additional natural and artificial lakes and thermal and mineral springs form part of overall fresh water resources of the Republic of Srpska converting it to one of the richest fresh networks of Eastern Europe (Fig. 2).

Shaft of the Black Sea is the Sava River, which runs by the northern border of the Republic of Srpska, about 200 km long, from the mouth of the Una River in the west



**Fig. 1** Types of climate of the Republic of Srpska. *Source* Author

to the Drina River in the east. The Sava River is the richest river with water power on the Balkan Peninsula.

The flow of the Sava River is low-sited and all major rivers of the Republic of Srpska flow to it (Una with Sana, Vrbas, Ukrina, Bosna and Drina). They have a composite character of river valleys with large declines, and they also have a significant waterpower potential. Rivers Una, Vrbas and Bosna contain 14.3 billion  $\text{m}^3$  per year. However, waterpower potential of these rivers cannot be compared with waterpower potential of the Drina River.

The Drina River is the largest tributary to the Sava River. The length of the flow is 341 km, and the basin area is about 19,570  $\text{km}^2$ . In the basin area of the Drina River, 9 hydro power plants were built so far, with installed capacity of 1932 MW and average annual production of 6350 GWh (Jokanović 2016).

**Table 2** Main rivers of the Republic of Srpska

Rivers <sup>a</sup>	Length, km	
	Total	In Republic of Srpska
Sava	945	204.85
Drina	341	308.52
Vrbas	249.9	131.91
Vrbanja	95.4	95.4
Sana	157.7	85
Una	212.5	91.8
Ukrina	80.9	80.9
Bosna	279.4	98.03
Gomjenica	68.5	68.5
Drinjača	91.37	61
Trebišnjica	96.5	56
Lim	234	44
Prača	62.6	42
Mušnica	41.8	41.8
Neretva	225	39
Čeotina	92.6	36.07
Spreča	147.32	72.42
Sutjeska	35.54	35.14
Rzav	54.3	28.63
Pliva	31.45	20
Usora	25.99	6.54

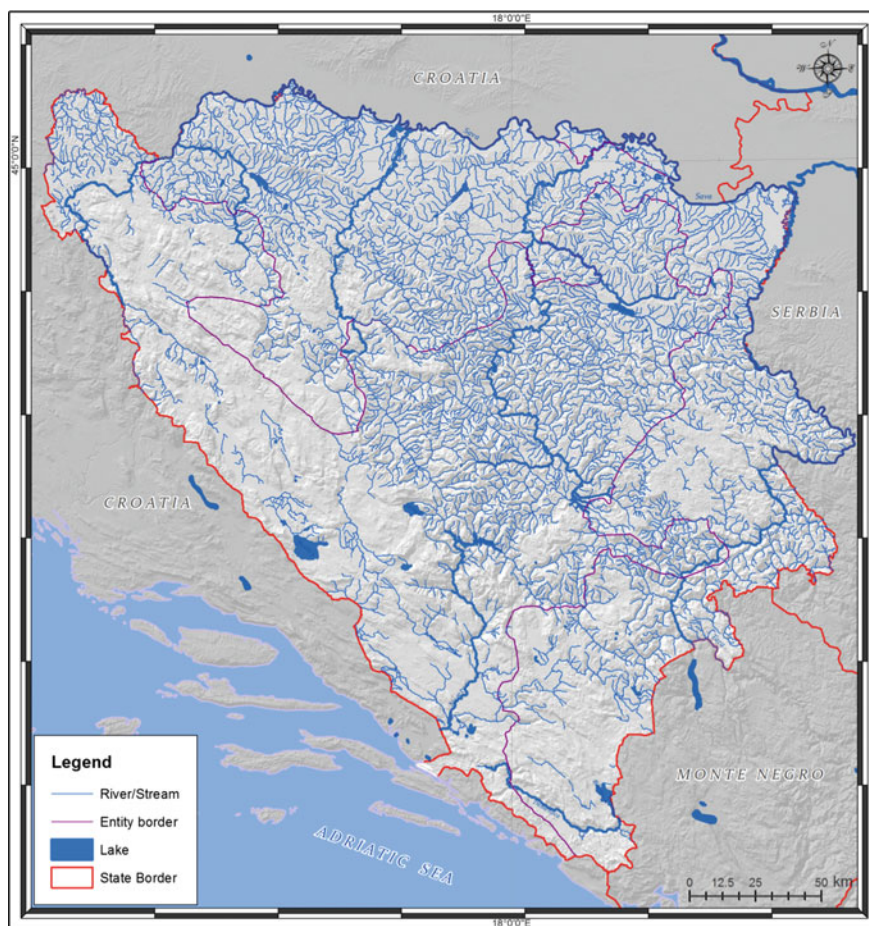
<sup>a</sup>Rivers with river basins larger than 500 km

Source Republic of Srpska Institute of Statistics (2017c)

Southeast area of the Republic of Srpska hydrographically gravitates to the Adriatic Sea (Eastern Herzegovina). In Adriatic basin, the Trebišnjica River is the main watercourse link, and historically its riverbed was regulated by anthropogenic impact and it was the largest underground river in the world.

The effect of the rivers of the Republic of Srpska has insulating and integrative role. The most significant rivers are at the same time border rivers where Una and Sava form a border with the Republic of Croatia and Drina with the Republic of Serbia. In political and geographical terms, “transit waters” are dominating at the territory of the Republic of Srpska, since it has about 10% of domicile waters. From major watercourse links, the Ukrina River, throughout its flow length of 80.9 km and Vrbanja River (99.68% at the territory of the Republic of Srpska)” belong to the Republic of Srpska (Rajčević and Crnogorac 2011).

Hydrographic potentials are based on large possibilities of exploitation and hydropower generation, because waterpower potential of the rivers with coal reserves forms the basis of electricity production. The estimated waterpower potential of



**Fig. 2** Hydrographic network of the Republic of Srpska. *Source* Second National Report of Bosnia and Herzegovina in accordance with United Nations Framework Convention on Climate Change (UNFCCC) (2013)

watercourse links in the Republic of Srpska is about 10,000 GWh per year, of which about 35% of the total waterpower potential is used through four hydropower plants: Hydropower Plant Višegrad, Hydropower Plant Trebinje 1, Hydropower Plant Trebinje 2 and Hydropower Plant Bočac, and a few smaller hydropower plants: Bogatići, Mešići, Tišća and Vlasenica. Hydropower Plant Dubrovnik is at the territory of the Republic of Croatia and uses water from the basin of Trebišnjica River. Production of this power plant is divided in the ratio of 50:50 between the Electric Company of RS and the Electric Company of Croatia. The Republic of Srpska, by production, fully meets the demands for the electricity, and owns waterpower potentials with which it can become a significant exporter of electricity (Zekanović and Živković 2015).

**Table 3** The largest lakes and ponds

	Surface area, km <sup>2</sup>	Elevation, m	Largest depth, m	Water quantity, m <sup>3</sup>
<i>Artificial lakes</i>				
Bilečko (at Trebišnjica R.)	27.064	400	104.0	1280.0
Perućačko (at Drina R.)	12.401	290	70.0	355.0
Zvorničko (at Drina R.)	8.876	140	28.0	89.0
Višegradsko (at Drina R.)	8.900	336	78.0	161.0
Bočac (at Vrbas R.)	2.330	282	62.0	52.7
<i>Natural lakes</i>				
Štitarsko (at Zelengora)	0.129	1672	4.5	0.255
Kotlinačko (at Zelengora)	0.044	1528	10.0	0.250
Uloško (at Crvnje)	0.043	1058	14.0	0.255
Donje Bare (at Zelengora)	0.021	1475	4.5	0.057
Orlovačko (at Zelengora)	0.021	1438	5.0	0.054
<i>Ponds</i>				
Saničani (at Gomjenica R.)	11.179	143	4.0	...
Bardača (at Matura R.)	7.472	90	2.2	...
Prnjavor (at Vijak R.)	6.664	134	3.5	...
Sjekovac (at Ukrina R.)	3.980	85	3.0	...

Source Republic of Srpska Institute of Statistics (2017b)

Despite being rich in running waters, the Republic of Srpska is relatively poor in standing waters, since there are no major natural lakes, but artificial hydro-reservoirs with the purpose of waterpower exploitation (the most important ones are located at the rivers: Vrbas, Drina and Trebišnjica) (Table 3).

Different geological construction and composition of geotectonic units and heterogeneous hydro-geological function of rock masses impacted the formation of a variety of ground waters. The southern part of the Pannonian Basin is quantitatively richest in ground waters.



On the territory of the Republic of Srpska, four main hydrogeological areas can be distinguished and divided into lesser or greater hydrological units:

1. North Bosnian hydrogeological area;
2. Banjaluka—Kladanj—Višegrad hydrogeological area;
3. Middle Bosnian hydrogeological area;
4. Herzegovina and Southeastern Bosnian area (Ministry of Agriculture, Forestry and Water Management of RS 2012).

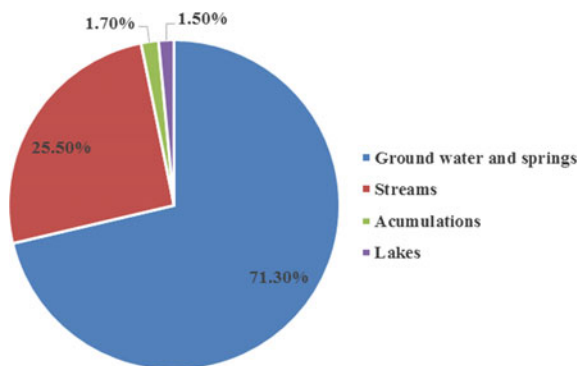
These locations represent the most important sites of groundwater for water supply of settlements in the Republic of Srpska. The quality of groundwater can be divided in four groups: (1) the first group includes the sources of groundwater from which the water can be used without previous treatment (Semberija, Posavina); (2) the second quality group includes the sources of groundwater from which water can be used after disinfection, and that is the water accumulated in the alluvium and the rocks of fracture-karst porosity; (3) the third group includes the sources from which the water has to be subjected to different treatments (filtration, softening, remove of Fe, Mn and other components); and (4) the fourth group that includes the sources whose quality of water cannot be used for water supply even after treatment (Gligorić 2008).

Thermal and thermo-mineral waters are widespread in a broad belt from the western part of the Republic of Srpska, starting from the municipalities of Krupa na Uni and Novi Grad to the eastern part and City of Bijeljina. There are more explored and potential sources in the eastern part, and the most significant are located in the area of Srebrenica and Višegrad. These waters are used mainly in balneological and recreational purposes. Based on these potentials, it has already been built and affirmed several spa and recreational centers: Mlječanica, Laktaši, Slatina, Banja Vrućica, Dvorovi, Guber and Vilina Vlas.

Therefore, distribution of different water resources in the Republic of Srpska is the following: 71.30% of available fresh water consists of ground waters and springs, 25.50% are running waters and only 2.70% are accumulations and lakes (Fig. 3).

In addition to the great possibilities of exploiting the hydropower potential, hydrographic network of the Republic of Srpska provides great opportunities in irrigation

**Fig. 3** Water sources of public supply system of the Republic of Srpska. *Source* Republic of Srpska Institute of Statistics (2017b)



of farmlands, development of fisheries, possibilities for river traffic and affirmation of fishing and spa tourism. Rivers of the Republic of Srpska, with its excellent water quality and rich fish stock (especially salmonidae fish species), provide a very good basis and important component in the development of tourism.

Therefore, the Republic of Srpska has sufficient water quantities to satisfy national needs. In addition, the water resources are not a limiting factor of economic and social development, and its elevated quantity and quality can be preserved by the corresponding protection measures. However, due to the extreme spatial and temporal unevenness of waters, as a consequence of exposure to the impact of climate change, and unregulated water regimes, a successful realization of all development goals in the area of water resources usability and environment development can be achieved only by realization of large integral systems on the level of great basins, which means mutual and coordinated action of all political-geographical entities in regions of Western Balkans and Southeastern Europe.

### **3 The Impact of Climate Change on the Geospace of the Republic of Srpska and Possibilities for Adaptation**

Global climate change represents one of the most current ecological, economic and political problems of the modern international community.

Generally, global climate change is manifested in the following ways: by increase of the air temperature, fluctuation of pluviometric regime, reduction of precipitation, increase of the intensity and frequency of periods of drought, floods and fires.

According to IPCC (Intergovernmental Panel for Climate Change) and their climate models (e.g. SRES), by the end of the year 2100, the global temperature could increase from 1.4 to 5.8 °C (IPCC 2012), which will cause a number of changes in the environment, its ecosystems and opportunities for sustainable development (Trbić and Bajić 2011).

Study of the air temperature for the period 1981–2010 showed evident increase in almost the entire territory of the Republic of Srpska. The highest increase has been recorded in the northern part of the Republic of Srpska (in the area of Posavina and Semberija) and in the southern part of Eastern Herzegovina. In the central region, the increase of temperature is insignificant, while in the high mountain area of Herzegovina, the trend of a slight decrease of temperature has been detected (Trbić and Bajić 2011).

In the period of 14–19 May of 2014, disastrous floods affected wide area of the Sava River basin in Bosnia and Herzegovina, Republic of Croatia and Republic of Serbia. The floods affected entire B&H area belonging to the River Sava basin and caused the loss of 23 lives and high material damages. In total, 70 administrative units (municipalities/cities) of B&H (the Federation of B&H, the Republic of Srpska and Brčko District of B&H) were affected by the floods (Council of Ministers of Bosnia and Herzegovina 2014).

The extent of the disaster in 2014 revealed vulnerability of Serbia and B&H, and emphasized the need to strengthen flood control management systems, forecasting and prevention, especially considering negative impact of climate change. Although meteorologists issued appropriate warnings regarding the expected weather condition, the municipalities were not able to foresee an exact height of water levels or the speed. In addition, the evacuation order was issued too late. Therefore, it could be argued that conditions were aggravated because defense system had not been upgraded in 25 years, flood ways were not adequately maintained, proper forestation of drainage canals had been ignored and therefore canals could not drain excess water (EU Commission 2015).

Due to complex geopolitical circumstances and “turbulent” geopolitical processes at the end of 20th century, which affected B&H and the Western Balkans region, B&H was included late in the possibilities of choosing an adequate method and approach for the social-economical scenarios to mitigate climate change. Because of that, the First National Report of Bosnia and Herzegovina in accordance with the UNFCCC was not enacted until October 2009 (UNFCCC 2009).

It took more than 10 years since the end of the B&H conflict to finally produce optimal political conditions for coordinated work in the field of environment and protection from climate change effects in B&H geospace. During the last 10 years, a great effort has been made in this field by initiating appropriate mitigation to climate change.

Therefore, since the end of the armed conflict and after signing the “Framework Agreement for Peace in Bosnia and Herzegovina”, all issues related to the environment and the effects of global climate change have been assigned to three entity governmental institutions: the Ministry of Environment and Tourism of the Federation of B&H, Ministry of Spatial Planning, Civil Engineering and Ecology of the Republic of Srpska, and the Department of Public Utilities of Brčko District. However, there were many difficulties in cooperation between these institutions.

Luckily, at the beginning of the 21st century the coordinated work was initiated by solving the environmental problems and passing legal acts, so that B&H would actively engage in solving the negative effects of climate change. The work of the Entity Ministries and the Department of Brčko District was primarily based on the adoption of the following laws: the Law on Environmental Protection, the Law on Air Protection, the Law on Nature Protection, the Law on Waste Management, the Law on Waters and the Law on the Environmental Protection Fund.

This group of Laws has been prepared with the financial and technical assistance of the European Commission and the PHARE Program, with the intention of developing laws that would be in line with the relevant EU directives and which would be harmonized for both Entities and the Brčko District. The Laws were adopted in RS in 2002 (Official Gazette of RS, No. 50, 51 and 53/02), FB&H in 2003 and 2006 (Official Gazette FB&H, 33/03 and 70/06) and in the Brčko District 2004 (Official Gazette of Brčko District No. 24/04). In December 2005, the Ministry of Spatial Planning, Civil Engineering and Ecology of the Republic of Srpska prepared amendments to the Law on Environmental Protection, which were published in the Official Gazette of the RS no. 109/05 (UNFCCC 2009).

By adopting a set of laws, B&H has united all legal aspects of environmental protection, and the Government of B&H is a signatory of a large number of international agreements and environmental conventions and is fully committed to meeting the conditions prescribed in these agreements. The most important ratified international agreements include the UNFCCC, the United Nations Convention on Biological Diversity, the United Nations Convention to Fight against Land Desertification, the Vienna Convention on the Protection of the Ozone Layer, the Convention on Long-Range Transboundary Air Pollution, Aarhus Convention and First National Report of Bosnia and Herzegovina in accordance with United Nations Framework Convention on Climate Change (UNFCCC 2009).

The Ministry of Spatial Planning, Civil Engineering and Ecology of the Republic of Srpska is responsible for the overall quality of environmental protection and improvements through research, planning, management and protection measures, including the protection of resources of general interest, natural resources and natural and cultural heritage. In accordance with the Law on Meteorological and Hydrological Activities of the Republic of Srpska (Official Gazette of the Republic of Srpska, 20/2000), the Republic Hydro-meteorological Institute of the Republic of Srpska is a governmental organization responsible for monitoring climate change, climate data exchange and database management, applied research and climate forecasts within various WMO (World Meteorological Organization) scientific and technical programs (UNFCCC 2009).

As a result of constant activities in addressing the problem of negative impacts of climate change and adaptation possibilities in Bosnia and Herzegovina, and in addition to the aforementioned state and entity laws, as well as ratified international agreements, special highlight should go to draft the First National Report of Bosnia and Herzegovina in accordance with the UNFCCC, Second National Report of Bosnia and Herzegovina in accordance with the United Nations Framework Convention on Climate Change, from October 2013, the Adjustment Strategy for Climate Change and Low-Emission Development for Bosnia and Herzegovina from 2013, the Third National Report and the Second Biennial Report on Greenhouse Gas Emission of Bosnia and Herzegovina in accordance with the UNFCCC from July 2016.

The First National Report of Bosnia and Herzegovina in accordance with the UNFCCC pointed to the vulnerability of B&H to climate change and significant potential exposure to threats from climate change. B&H also has a high sensitivity to these threats because the high economic role of the “climate sensitive” sectors, such as agriculture and forestry; and the role of hydroelectric power plants in the energy sector to a lesser extent. Finally, it was concluded that B&H has very limited adaptation capabilities to address climate risks.

In particular, when water resources are concerned, the First Report identifies the basic problems arising from climate change, such as: change in seasonal flows of the river, reduction in the amount of water flow in rivers and difficulties in supplying water to households and industry. Also, primary and secondary measures of adaptation to these problems are proposed: *“construction of dams and reservoirs for production of electricity in hydropower plants, agriculture, water supply, tourism, fish farming, etc., then, training on efficient water usage and reduction of losses*

*in distribution, strengthening the monitoring system and predicting the amount of water, and developing a hydrological information system”* (UNFCCC 2009).

The Second National Report of Bosnia and Herzegovina in accordance with the United Nations Framework Convention in 2013, among other things, clearly defined the sectors that are most vulnerable to climate change (agriculture, water resources, human health, forestry, biodiversity and sensitive ecosystems).

In that sense, detailed analyzes of long-term climate change in these sectors have been carried out. Estimations are based on SRES climate scenarios A1B and A2 developed for Bosnia and Herzegovina for the needs of the Second National Report (SNC). For each sector, the proposed adaptation measures have been identified on the basis of expert consensus, consultations with parties of interest and analysis of relevant research (UNFCCC 2013).

Regarding water resources, both scenarios for the periods 2001–2030 and 2071–2100 (A1B 2001–2030; A1B 2071–2100; A2 2071–2100) predict the increase in air temperature in B&H and decrease of precipitation. Changes in precipitation regime will be manifested in terms of the occurrence time, frequency and intensity of extreme events - floods and droughts. The Report concluded that *“additional and more complex research on climate change and its impact on water resources is needed, together with the development of a sector strategy of climate change adaptation and with the accompanying action plan and concrete measures”* (UNFCCC 2013).

Potential measures to protect water resources would refer to:

1. A detailed vulnerability assessment, and an assessment of the ability to adapt to climate change for water resources;
2. Creation of vulnerability maps and flood risk diagrams developed using GIS techniques;
3. Construction of several functional reservoirs and river regulations (In accordance with the strategy “Support to water policy in B&H”—project financed by EU IPA for 2007);
4. Improvement in hydrological monitoring and measurement systems, and in early warning systems for high water levels;
5. Improvement of the flood protection system;
6. Development of a sectoral plan for adapting to climate change;
7. Incorporate the impact of climate change in sectoral strategies and action plans;
8. Strengthening research activities regarding the impact of climate change on water resources and modeling of hydrological processes;
9. Developing capacity of competent institutions and local communities, raising awareness of the impact of climate change on water resources and adaptability;
10. Promoting Integrated Sustainable Development and Efficient Water Management. (UNFCCC 2013)

*“Adaptation strategy for climate change and low-emission development for Bosnia and Herzegovina (B&H)”* was prepared simultaneously with the Second National Report on Climate Change (SNC) of Bosnia and Herzegovina in accordance with the UNFCCC and in coordination with the United Nations Development Program (UNDP) in Bosnia and Herzegovina.

The strategy was developed based on the First National Report (INC) and as part of ongoing activities on the development of the Second National Report (SNC). The Strategy defines guidelines for mitigating the effects of climate change, which relate to:

1. Building the necessary capacity;
2. Determining a general policy course for low-emissions development that is resistant to climate change;
3. Integrating more specific policies, measures and projects into sectoral strategies;
4. Identifying already existing options for adapting to climate change and mitigating measures, in order to ensure their international support. (Council of Ministers of Bosnia and Herzegovina 2013)

“The Third National Report and the Second Biennial Report on the Greenhouse Gas Emissions of Bosnia and Herzegovina” by the UNDP in B&H, in accordance with the United Nations Framework Convention on Climate Change (2016), analyzed the series of annual precipitation from the previous reports, and complemented by the values for the period 2011–2014, for the Sava River basin and the Adriatic Sea basin as well. The study found that the median value did not change much.

However, the value of the range (distribution) is significantly higher for both basins. In the period of 1961–2014, annual precipitation was 44 mm higher in the Sava River basin than in the period 1961–1990, which was slightly lower increase value than in the period 1991–2010. However, the range has increased significantly (769 mm in relation to 407 mm), i.e. the minimum value is 100 mm smaller and the maximum is 262 mm higher. Accordingly, the value of the variance was significantly higher in the period 1991–2014 (UNFCCC 2016).

Water, as a resource, does not represent the limiting factor for development of Bosnia and Herzegovina, on the contrary, it represents the most important natural resource. However, its vulnerability to climate change is every day more significant. Therefore, the need for monitoring and detecting changes due to the impact of climate change is of great importance.

The Third National Report and the Second Biennial Report on Greenhouse Gas Emissions of Bosnia and Herzegovina provide clear guidelines/adaptation measures for climate change when talking about water potentials;

1. Regular maintenance of watercourse riverbeds;
2. Pre-flood warning;
3. Structural measures for flood protection (embankments);
4. Prevention of losses on pipelines;
5. Measures to reduce the specific use of water in industry, irrigation, etc.;
6. Melioration;
7. Construction of reservoirs;
8. Ensuring conditions for the sustainable use of groundwater (monitoring, estimation of available quantities, protection of sources);
9. Improving monitoring and other measures related to the fight against drought;
10. Rainwater collection. (UNFCCC 2016)

### 4 Management of Water Resources Affected by Climate Change

The water became the priority in “geopolitics of resources”. It is estimated that in the past century, the total quantity of drinking water on Earth was reduced for about 40%. If this trend continues, which is in accordance with global climate change, it can cause various forms of crises and ecological disaster.

Therefore, the impact of climate change and the possibility of adaptation has become the center of attention of international policy, as a factor in direct relation with modern political and geographical, economical, demographical and other flows. The possibilities to mitigate these impacts are minimal, but there are many possibilities to adapt, and that includes defining new models of the environment, defining sustainable development strategies and cooperation of all political and geographical units from the environment at the local, state and regional level.

Previous statements point to the necessity of developing an adaptation strategy for climate change. The importance of drafting the strategy is particularly emphasized in the field of water resources protection and water management systems, since the events of 2014 (catastrophic floods) and 2017 (wildfires) are more than enough (Fig. 4). Although total and average precipitation remains the same during the vegetation period, the more frequent variability in precipitation quantity leads to necessity and demand for solving irrigation problems.

When developing strategies, analysis and monitoring, it is necessary to engage science experts from different fields and professions, with particular emphasis on: flood risk management, drought and wildfire protection, construction of irrigation

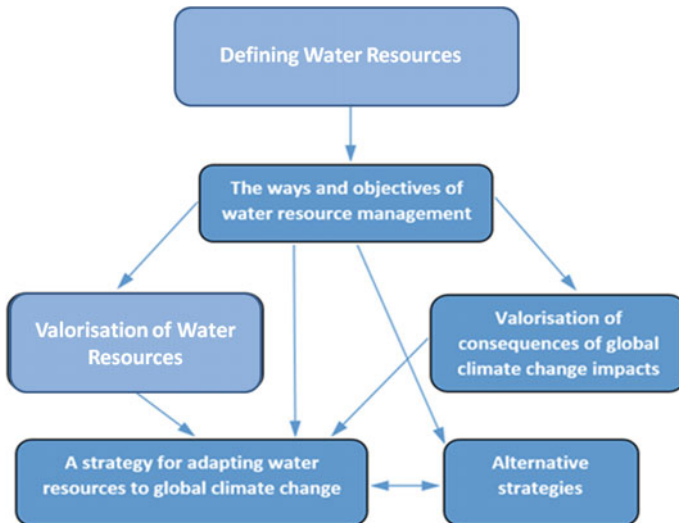


Fig. 4 Management of water resources highly affected by climate change. Source Author

systems and, in general, rational use of water resources, with the aim of making the most effective adaptation to global climate change. Among other things, strategy and continuous monitoring is necessary as a scientific basis for assessment and response to the question of whether certain changes in water potentials are caused by human activities or just a result of global climate change.

Also, the International Treaties, (in particular, the UN Framework Convention on Climate Change and the Kyoto Protocol), obligate B&H, and therefore the Republic of Srpska, to work continuously in the field of mitigation and adaptation to climate change.

The Third National Report and the Second Biennial Report on the Greenhouse Gas Emissions of Bosnia and Herzegovina in accordance with the United Nations Framework Convention on Climate Change, from July 2016, defined the limitations and pointed out future directions and prospects, regarding political and socio-economic adaptation component to climate change.

More attention should be paid to education, informing and awareness raising in the population about climate change through education systems in B&H and RS, with clearly designed goals. It is necessary to continue intensively with international cooperation in the framework of global environmental agreements and to intensify regional cooperation that takes place within the countries of Southeastern Europe and the Western Balkans, because climate change issues cannot be solved individually by states or without coordination between the countries in the region.

Also, it is necessary that the Republic of Srpska and B&H, considering the political and geographical dimension of watercourse and water resources, which are of transitional character and pass through more than one country, establish cooperation with all countries in the region, primarily on regulating the river flows, and coordination for creation of mechanisms for solving the problem of water management.

Geopolitical conditions and historical and geographical development, stemming from the disintegrative processes in the geographical space of the former SFRY, are not possible to ignore and discard, as well as negative political and geographical processes that have marked this geospace at the end of 20th century. But, cooperation and joint action, regarding the adaption to climate change, would lead, in a political and political-geographical context, to easing tensions between the countries of the former SFRY, as well as to improvement of inter-ethnic cooperation.

## 5 Conclusions

Bosnia and Herzegovina pointed its vulnerability to climate change and significant potential exposure to threats from climate change because of the high economic role of the “climate sensitive” sectors, such as agriculture and forestry; and the role of hydroelectric power plants in the energy sector to a lesser extent. Due to the fact that B&H has very limited adaptation capabilities to address climate risks more attention should be paid to education, informing and awareness rising in the population about climate change through education systems in B&H and RS, with clearly designed



goals. In addition, it is necessary to intensively continue with international cooperation in the framework of global environmental agreements and to intensify regional cooperation that takes place within the countries of Southeastern Europe and the Western Balkans.

Joint action on the issue of planned and rational exploitation of natural potentials, seen through the prism of perspective trans-border cooperation, would represent one of the guidelines not only for revitalization in the economical and geographical terms, but also the guideline of the future concept of ethnic tolerance and political and geographical stability of the Republic of Srpska, Bosnia and Herzegovina, and also the countries of former SFR Yugoslavia and the entire region.

Among other things, joint action on prevention and adaptation to climate change would become a “geopolitical connecting tissue” of all political-geographical subjects in the region and would have a huge impact—that the nations of South-eastern Europe realize that the time of conflicts and wars is past, while the time of euro integration is the future.

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