BOSNIA AND HERZEGOVINA'S NATIONAL PRIORITIES AND INSTITUTIONAL RESPONSE TO WATER-ENERGY-CLIMATE-FOOD NEXUS: THE EFFECTS ON TRANSBOUNDARY SAVA RIVER BASIN

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During the Conference on Sustainable Development in 2012, United Nations defined the ''water-food-energy nexus (WECF)'' as a key element in today's process of greening the economy or its transition towards the circular economy. The analysis of interactive linkage between these sectors is certainly new field of research (Biggs, et al, 2015). The report by the UN (Waughray and Workman, 2011), underlined the concerns in the world regarding growing water, energy and food demands under the conditions of demographic and economic growth, urbanization and climate change.

Bosnia and Herzegovina also, came to the realization that water, energy, climate and food issues are closely interconnected and that there is an urgent need for integrated policies to address this nexus on national level. The country is facing interconnected challenges such as water availability, energy access, climate change impacts and food security on both national and local levels. Currently, Bosnia and Herzegovina's response to the WECF challenges is being shaped by its own national interest and international obligations. National priorities and policy responses to mentioned challenges as well as other external factors affect the Sava River basin which is one of the most important parts the country, having high economic and social importance.

This paper evaluates Bosnia and Herzegovina's political and institutional response to the nexus and explores its implications on the Sava River basin through a comprehensive analysis of the political and institutional settings and a causal-chain analysis, identifying root causes of the problems in the basin. To achieve this objective, national and strategic documents as well as interviews with representatives from different institutions were analyzed.

Key words: Bosnia and Herzegovina, Sava River basin, water-energy-food-climate nexus, governance, political response, national priorities

INTRODUCTION

Bosnia and Herzegovina is undertaking steps in the solution of nexus issues, on national but also global level. Within the country borders, Water-Energy-Climate-Food (WECF) nexus issues are considered a question of key strategic importance, especially within the national governance and the academic community. The vision, which country follows, shows it as a sustainable and progressive ''green economy'' by the 2030s. The sole issue of water-energy-climate-food nexus was only recently brought into the spotlight, following the annual meeting of the World Economic Forum in January 2011, when a book was released (Waughray and Workman, 2011), highlighting the concerns about meeting growing water, energy and food demands under the conditions of population growth, economic growth, urbanization and climate change. Water, energy, climate and food issues are being realized to be closely interconnected and there is an urgent need for integrated policies to address this nexus on the global and national levels. Bosnia and Herzegovina, just like any other country (even more than other European countries, due to its dependence on coal) also faces these challenges and needs to provide an adequate response to them.

Bosnia and Herzegovina's answers to issues related to energy, water, climate and food are directly influenced by its own national interests and international obligations (especially EU obligations). On the other hand, national policies depend on the character of cooperation and geopolitical situation on the regional scene. In this aspect, Transboundary Rivers play big role. They connect neighboring countries in the region (Sava River as a connection with Croatia and Drina River as a connection with Serbia and Montenegro), their infrastructure and economic flows. Through these connections, Bosnia and Herzegovina is slowly building its own national policy, which also reflects its response to regional issues.

Howells et al. (2013) claim that land, energy, water and the ecosystems they support are our most precious resources, providing food, energy, clean water and other essential services. As we have mentioned before, food, energy and water demands are growing on the global level due to the constant growth of the world population. The use and production of one resource always affects the use and production of other resource. (Howells et al, 2013) Moreover, these resources are commonly managed in so-called national institutional silos (Morgan Brazilian et al., 2011), meaning that energy land management and water resources planning takes place in isolation without adequately considering the requirements of planned development or the assumptions made about other sectors, based on the implications they might have – which can be either positive or negative. Through the research, we would like to find out how the WECF nexus is institutionally taken into account and implemented at the scale of the country. We have studied this research question at the scale of BiH.

For ensuring the sustainable development, it is crucial for Bosnia and Herzegovina that all the environmental concerns are integrated into the legal, political and institutional settings of the country. It is very important that water, energy, climate and food issues are equally addressed, and that there is effective cooperation across sectors, boundaries and levels. However, there is no comprehensive analysis of these necessary conditions for securing sustainable development of the country.

According to the *National Development Strategy* of the country, Bosnia and Herzegovina has significant agricultural areas, good climate, and to a significant extent developed manufacturing industry, and agriculture can strongly service its own food market and export. But it agrees, as well, that series of the challenges are on the way. For example, irrigation system that dates back to 1995 hasn't been completely renovated, and the size of

irrigated areas is extremely small, far away the smallest in the region. The country has not yet secured access to external markets, which not only impedes domestic production, but also results in a large foreign deficit in the food department. Bosnia and Herzegovina, though, has competitive advantage in the field of energy, especially in the field of hydropower. Energy can significantly contribute to its economic development. According to its capabilities, BIH can be a regional leader in energy and a significant energy exporter. However, as the national strategic development plans appear to increase demands in water, energy and food sectors, the existing negative effects on the country and ultimately the Sava River basin, will become more urgent unless environmental concerns are introduced into the national priorities and there is an adequate response to the WECF nexus in the political institutional settings.

Why the Sava River basin is a relevant case-study?

The selection of Sava River basin was determined by a variety of criteria. First of all, this region is the main object of national agriculture, water and in most cases, energy development plans. In addition to the existing load on the basin, these programmes aim to develop new energy projects in order to solve issues related to existing old, and introduction of new irrigation areas, as well as some of the issues related to electricity deficits. Furthermore, this basin is considered to be one of the most vulnerable regions to climate change. [1] And ultimately, this basin is the most important national food provider. Meanwhile, irrigated agriculture, one of the highest water consumers in the basin, is considered to have the highest risk, which will affect the food situation, not only in the basin, but also in the country as a whole, as mentioned above.

Sl. 1. Sliv i poriječje Save na teritoriji Bosne i Hercegovine
Figure 1. Sava River basin and its area on the territory of Bosnia and Herzegovina

Izvor: UNEP / DEWA / GRID

Other than being main agricultural area for the country, the Sava River basin also represents an important source of water for settlements (the biggest regional centers directly or indirectly depend on Sava River or its tributaries), industry, energy and all the ecosystems. Due to all these reasons, Sava River basin is an integral part of the developme-nt and support for

[1] Strategija prilagodjavanja na klimatske promjene i niskoemisionog razvoja za Bosnu i Hercegovinu, dostupno na: www.undp.org (Pristupljeno 06. 05. 2019)

each and every of the sectors mentioned, and thus, a valuable target for a nexus place-based assessment.

In this paper, we present the theoretical framework of WECF nexus in the first part. The second part applies this reading grid to the case of Bosnia and Herzegovina and more specifically, the Sava River basin. We analyze the results concerning the consequences and the challenges of the application of WECF nexus in a third part. The last part will allow us to discuss and conclude on this political commitment.

NATURE OF WATER-ENERGY-CLIMATE-FOOD NEXUS

Sole subject of nexus and its nature is relatively new in the scientific and governing circles. In years before the UN Conference in 2011, nexus issues were usually explored or acknowledged separately. Some of the earlier literature investigated and discussed about the interconnections or conflicts of water and climate (Smith et al. 2009, Bates et al. 2008). Other authors discussed issue of water and energy (Marsh 2008), energy and climate (McIntrye et al. 2009), climate and food (Garnet 2011), water and food (Seckler and Amarasinghe 2004) and energy and food (Molle et al. 2008). In most of the studies about the nexus nowadays, especially ones assessing WECF nexus, water component is usually the connection between other nexus components. (Waughray and Workman, 2011). IPCC technical paper highlights strong links between water and climate (Bates et al. 2008). According to Sadoff and Muller (2009), hydrological patterns, availability and quality of water and water services are sensitive to climate change. Even though impacts of climate change on freshwater systems are projected to be different in different places, globally negative impacts seem to prevail. As Newel et al (2009) explain, the multi-scalar, institutional and governance aspects are little discussed in the WECF nexus literature, unlike the quantitative and modeling approaches. That's why in this article we try to fill this blind spot by focusing on political and socio-economic factors.

Some authors (like Bates et al, 2009) argue that large water bodies inevitably affect climate situation in certain regions. The WEF report from 2013 showed how closely energy/electricity and water sectors are interlinked, showing how significant amount of water is used in the primary energy and electricity production and, on the other hand, how large amount of energy is needed for water treatment, both including transition through states of raw materials, transformation and delivery to the final customers. This highlighted hydropower generation as the main point of direct sector integration and water use by the electricity sector. On the other hand, water and food are mainly connected through the fact that food production heavily depends on water. There are tradeoffs between all water using sectors, but agriculture, and the environment are major consumers (Rijsberman and Molden, 2001). Agriculture is responsible for 70% total withdrawal and 86% of consumption of water worldwide.[2]

According to the IAASTD report[3] climate and food are interconnected in several ways. Changes of climate patterns such as temperature and precipitation can have combined effects on agriculture as they can cause both increase and decrease in yields, depending on the geographical distribution of climate change effects, type of crop and an adaptation

[2] http://www.fao.org/3/a-i7959e.pdf, pristupljeno, 13. 05. 2019

[3] https://www.globalagriculture.org/fileadmin/files/weltagrarbericht/IAASTDBerichte/IAASTDExecutiveSummarySynthesisReport.pdf (pristupljeno 12.05.2019)

potential of the region. Energy and climate are interconnected both directly and indirectly. The direct link lies in the fact that energy sector is the largest GHG emitter. The indirect influence of climate on energy is presented through climate change mitigation policy affecting energy policy. Waughray and Workman (2011) claim that water, energy, climate and food issues will become more and more interlinked in the future and existing tradeoffs will become more acute. This is why taking WECF nexus into account is essential in the development of national cross-sector energy, food and environmental policies. In the next section, we study how Bosnia and Herzegovina includes this issue on the political agenda.

THE INCORPORATION OF THE WECF NEXUS INTO POLITICAL AND INSTITUTIONAL FRAMEWORKS IN BOSNIA AND HERZEGOVINA

After the collapse of the Yugoslavia and the devastating war that followed, Bosnia and Herzegovina has been developing its own policies in accordance to its own national and regional interests, as well in compliance with the global context. Recently, Bosnia is slowly becoming an active player on the regional and global levels in terms of the involvement into environmental governance. As a country, Bosnia and Herzegovina has a very complex administrative organization a lot of levels of government, from the State level, through the entities of FBiH and RS, Brcko District, cantonal levels, to the lowest levels of the local community. Bosnia and Herzegovina has 14 governments including the Council of Ministers of Bosnia and Herzegovina, where there are around 180 ministries competent for various areas, resulting in a huge governance challenge. Such a complicated administrative apparatus in BiH hampers many projects and is a barrier to investment, and the consent of all decision-makers is needed when issuing a concession for natural resources. Bosnia and Herzegovina is a decentralized state consisting of two entities (Republika Srpska and Federation of Bosnia and Herzegovina) and Brcko District. The character of environmental legal framework in Bosnia and Herzegovina is that the highest level of environmental governance is lowered to the level of Entity governance. However, it should be emphasized that the legislation of the Federation of Bosnia and Herzegovina and the Republic of Srpska is already largely in line with the relevant EU legislation, and the fact that both Entity legislations are identical with each other in terms of basic solutions, with certain differences in respect of secondary legislation and implementing documents.

Moreover, despite this challenging system, Bosnia and Herzegovina is a signatory of a series of international agreements and conventions related to environmental protection, climate change and renewable resources (*the South East European Energy Community Treaty, the Framework Convention on Climate Change, the Kyoto Protocol, the Espoo Convention, Paris Agreement etc*.) and the *Stabilization and Association Agreement* itself, and thus, is obliged to respect them.

Bosnia and Herzegovina ratified *The UN Framework Convention on Climate Change (UNFCCC)* on December 6, 2000. Since it is not considered as a developed country (it does not belong to Annex I), there is no strict obligation to reduce greenhouse gases, but only general obligations regarding the calculation of annual emissions of greenhouse gases, implementation of measures for regulating anthropogenic emissions and adaptation to climate change as well as acceptance and development of technologies that limit and reduce greenhouse gases. Also, the country must cooperate in the preparation of protective measures in the field of water resources and areas affected by droughts and floods. A

systematical monitoring of the climate and climate change, report on this, including these estimates in different economic and development strategies, are expected.[4]

By signing the *Stabilization and Association Agreement* with the European Union, Bosnia and Herzegovina has committed itself to implementing a number of directives related to sustainable development and environmental protection, which means, the acceptance of the EU's environmental policy[5]. *The European Partnership* document with Bosnia and Herzegovina explicitly lists all the individual obligations country has to fulfill - from the adoption of the State environmental law to the ratification and implementation of a series of international conventions related to environmental protection (*Espoo Convention, the Aarhus Convention, etc.).* Similarly, Bosnia and Herzegovina is a signatory both the *Kyoto Protocol and the UN Committee for Sustainable Energy* documents. However, the implementation of these protocols, conventions and directives encounters significant difficulties due to the lack of an adequate institutional and legislative framework.

To address transboundary water challenges, Bosnia and Herzegovina joined the *UNECE Water Convention*. In order for Bosnia and Herzegovina to meet all the obligations defined by the EU and international legislation, and provide an adequate integrated response to the challenges it is important to establish an effective policy, legal and institutional framework ensuring integration of environmental policies and equal components of WECF nexus.

The analysis of the political setting uses horizontal and vertical dimensions, suggested by Lafferty and Hovden (2003) as a framework for the analyses of Environmental Performance Index (EPI), and for the analysis of strategies, concepts, programs and plans, identification of their priorities, including those connected to water, energy, climate and food issue. We analyzed three groups of policies regarding the horizontal policy dimension. These documents are the main national cross-sectoral integration strategies, governmental policies with a cross-sectoral focus and new policies addressing broad issues of climate change and water. These are also fundamental strategic documents in Bosnia and Herzegovina that can be identified as cross-sectoral integration strategies. They are *The Development Strategy of Bosnia and Herzegovina* (2010), *The Development Strategy of Federation of Bosnia and Herzegovina 2010-2020 (2009)* and *National Environmental Action Plan BiH (2003)*. Other than these three main cross-sectorial documents, it is important to analyze *The Framework Energy Strategy of Bosnia and Herzegovina until 2023 (2010), Sava River Basin Management Plan* and *Adapting Strategy to Climate Change and Low-emission Development for Bosnia and Herzegovina* in order to assess WECF nexus issues.

The main strategic documents of Bosnia and Herzegovina are the *Development strategy of Bosnia and Herzegovina* and *The Development Strategy of Federation of Bosnia and Herzegovina 2010-2020 (2009),* presenting a vision of Bosnia and Herzegovina for the period of 10 years, as a State with developed economy, social welfare and security. All other national documents and programs were developed in compliance with the strategy and aimed to fit into this vision. Among the priorities highlighted, one of the goals is aimed at sustainable development, including agriculture, environmental protection and the

[4] INC: Prvi nacionalni izvještaj BiH u skladu sa Okvirnom konvencijom UN o klimatskim promjenama, avgust 2009. Banja Luka, p. 2.

[5] Npr. član 86. i član 108. se odnose na okolinske politike i obnovljive izvore

development of energy potentials. Within this strategic goal, Strategy highlights Bosnia and Herzegovina's bio and geo diversity as a main basis for country's sustainable development[6]. It is stated that the acquisition of *acquis communautaire* in the field of the environment should be in the function of sustainable development and not a burden to the economy, that is, it should strengthen rather than weaken its competitiveness. The area that can most contribute to sustainable development is increased efficiency of energy use. In spite of its geographical assets, Bosnia and Herzegovina is facing many challenges related to WECF issues. For example, irrigation systems are old, dating from 1995, and have yet to be completely renovated.

Bosnia and Herzegovina has a competitive advantage in the field of energy, especially in the field of hydropower. Energy can significantly contribute to its economic development. According to its potential, Bosnia and Herzegovina can be a regional leader in energy and a significant energy exporter. The State should give an example in promoting energy efficiency. As it uses a lot of energy and purchases a lot of electrical devices, the State would need its investments, purchases and current businesses to focus into energy-saving business premises, products and services.[7] Sustainable development as one of the goals of Bosnia's Development Strategy relates to the development of the environmental infrastructure, energy and renewable energy sources, transport infrastructure and telecommunications and the development of agriculture and rural areas with the goal of diversification of economic activities, and in particular, the increase in self-sufficiency of BiH with healthy food production. As we can see, the main strategy of the country emphasizes energy as a priority, whereas it refers to the environment in general and to some extent indirectly without having a special focus on water and climate.

However, the second document focusing on environment is the *National Environmental Action Plan BiH (NEAP) (2003).* The government of the Federation of Bosnia and Herzegovina and the Republika Srpska received in July 2000 the World Bank's International Development Fund (IDF) Grant for Institutional Strengthening in the Field of Environmental Protection. The goal of the NEAP is to identify short-term and long-term priority activities and to create a basis for preparing a long-term environmental protection strategy in line with the economic development of Bosnia and Herzegovina and its socio-political arrangements. The intention of the NEAP is to develop a common environmental protection policy in the context of the macroeconomic reform program, the fight against poverty and the transition process. The key element of the NEAP is a comprehensive analysis of the state of the environment. Ten thematic areas have been identified covering key environmental issues (air, water, land, forests, waste, space, economy, biodiversity, health and demography, and legal-institutional area). A common multidisciplinary approach has identified eight NEAP priority areas (water resources/wastewater, sustainable rural development, environmental management, biological and landscape diversity protection, waste/waste management, economy/sustainable economic development, public health and demining). [8]

[6] http://fmks.gov.ba/stara/kultura/legislativa/strategije/StrategijarazvojaFBiH2010-2020.pdf, pristupljeno 17.05. 2019.

[7] https://danube-inco.net/object/document/10210/attach/0_National_Background_Report_Energy_BiH_2012.pdf, pristupljeno 17. 05. 2019

[8] https://opcina.lukavac.ba/wp-content/uploads/2012/02/NEAP-BiH-1.pdf, pristupljeno 15. 05. 2019

All three mentioned documents underline high global economic instability and the need to increase the sustainability of the national economy to the global and regional crises by promotion of industrial and innovation development. Even though the NEAP document prioritizes issues of environment, water is also addressed, but climate change is, once again, excluded. Document that focuses solely on water in the basin area is *Sava River Basin Management Plan.*[9] The Sava River Basin Management Plan has been developed in accordance with the requirements of the Framework of the *EU Water Directive (WFD)*[10], which establishes a legal framework for protection and improvement of the status of all waters and protected areas, including ecosystems dependent on waters, it prevents their deterioration and ensures long-term and sustainable use of water resources.[11]

The Sava River Basin Analysis was developed and published in 2009. This analysis has addressed the requirements of *Article 5 and 6 of the EU Water Framework Directive*. Significant resources were invested in the field of water supply in the post-war period. Almost 95% of water management systems have been brought to the pre-war level. However, there are still present problems of providing sufficient quantities of drinking water and population coverage to the public water supply. As we mentioned before, water management in Bosnia and Herzegovina, institutional and technical, is done at the level of the Entity. Entity water laws define institutional governance frameworks with ways of financing the water sector. (*Law on Waters of FBiH* adopted in 2006). Shortly afterwards, the *Agency for the Water Area of the Sava River* in Sarajevo (AVP Sava) and *Agency for water area of the Adriatic Sea* in Mostar (AVP Adriatic Sea) were founded.

In addition to mentioned three underlying cross-sectoral documents there are several governmental documents that to some extent have a cross-sectoral focus. The document which addresses thoroughly energy issues is the *Framework Energy Strategy of Bosnia and Herzegovina until 2035 (2010)*. It is underlined, that, in a period of economic uncertainty, significant resources and focus should be pointed towards identifying sources and enabling sustainable growth. This is possible only with clearly defined priorities, a focus on efficiency and development and consistent implementation. The coherence of strategic goals and implementation aims to effectively use (scarce) resources, both financial, and professional (human), and natural. In accordance with the above mentioned context, the energy system of Bosnia and Herzegovina can and must play a key role in improving the overall economy. To cope with the key challenges that the sector has and expect, a focused and consistent set of structural reforms is needed, sometimes beyond the field of energy.[12]

Taking into account the specific economic situation of Bosnia and Herzegovina in its entirety, one of the main priorities embedded in the overall sector strategy must be a competitive energy sector which significantly preserves the standard of citizens and positively affects the competitiveness of other economic branches. There are two key challenges; the need to restructure key sectors as a prerequisite for creating greater value for end users, and finding new values through the development of new business models. The

[9] Dostupno kod Sava Commission

[10] Directive 2000/60 / EC of the European Parliament and of the Council of 23 October 2000 establishing Framework for Community action in the field of water policy.

[11] http://www.savacommission.org/srbmp/en/about-plan/show-3-description-of-the-plan, pristupljeno 25. 05. 2019

[12]http://www.mvteo.gov.ba/data/Home/Dokumenti/Energetika/Okvirna_energetska_strategija_Bosne_i_Hercegovine_do_2035._HR_FINALNA.PDF (pristupljeno 25.05.2019)

past period has shown that electricity generation in Bosnia and Herzegovina, as a rule, ensures the safety of supply of domestic demand, despite the fact that this balance is sensitive due to the high share and change in the energy from hydroelectric power plants. Nevertheless, when we take into account the trends of intensified integration of the European markets, we can conclude that the security of supply is not significantly impaired even in the small deficit scenario. Although aspirations for the period up to 2035 place security of supply high on the priority scale, this goal needs to be approached very carefully taking into account the negative experiences of some European countries in the scenarios of overcapacity and European energy trends. The strategic goals of maintaining a competitive energy system and supply security must be aligned with the sustainable development agenda, i.e. reducing the negative impacts on the environment, especially bearing in mind today's position of Bosnia and Herzegovina in relation to EU initiatives, energy trends and assumed future commitments to the Energy Community and other bodies, including the guidelines of the Paris Agreement.[13]

Regarding the energy priority, it was highlighted that Bosnia and Herzegovina by 2035 should depend mainly on national energy sources, that renewable energy target of 40 percent by 2020 should be accomplished, compared to 34 percent of energy in 2009. This relatively high level is accounted for mainly by hydro power and wood use in households. Also, new generation capacities will be introduced as well as old energy infrastructure modernized. (especially thermal power plants). According to the *NEAP* and *Strategy of Development for FBIH*, the water use efficiency will be increased in the agricultural sector. The irrigation system will be modernized and improved. Although the energy sector is in the Entity's ownership, by taking over international obligations, the State of Bosnia and Herzegovina has committed itself to adopting a set of umbrella, State-related laws related to energy, renewable sources and environmental protection. Although at Entity level, there are a number of laws related to the production and distribution of electricity (*FBiH Electricity Law, RS Electricity Law, RS Gas Act, etc.)* as well as laws, regulations and programs related to environmental protection (*Law on Protection environment of the FBiH, RS Environmental Protection Act)*, there is a lack of a synchronizing element among them. Inadequate regulations at Entity levels and the lack of cohesion of State laws also contribute to co-ordination in the implementation of laws and commitments. For provision of the food security, the agricultural sector will be developed, the food processing in particular. The only area of WECF nexus that none of the three mentioned documents address in depth or at least directly, is the Climate Change.

Climate Change as a nexus issue is thoroughly addressed in the *Climate Change Adaptation and Low Emission Development Strategy for Bosnia and Herzegovina, 2014*. In this document, vision of the State's development is that by 2025 Bosnia and Herzegovina will be a sustainable and progressive 'green economy'. When Bosnia and Herzegovina joins the European Union (EU), it should have low emissions as a Member State, high quality of life for all, preserved natural ecosystems, sustainable management of natural resources and a high level of resistance to climate change. Increased levels of energy efficiency, greater use of renewable energy sources and improved energy and transport infrastructure and services will result in attracting international investment, opening new jobs and business entrepreneurship in an economy based on the efficient use of resources. Negative impacts of climate change will be minimized by reducing the level of sensitivity and by exploiting

[13] Ibid.

climate-related opportunities changes. Transition to the 'green economy' will particularly benefit vulnerable groups and groups at a disadvantage position, by being socially inclusive and ensuring a positive contribution to gender equality. This will be achieved by implementing the Adaptation Strategy on Climate Change and low-emission development for Bosnia and Herzegovina, which has two main objectives in the areas of adjustment on Climate Change and Reduction of Greenhouse Gas Emissions: a) increasing resistance to climate variability and climate change, ensuring the development profits; b) achieving the highest value and stopping the growth of the level of greenhouse gas emissions roughly around 2025 at a level below the EU27 average per capita.[14]

Unlike many other environmental issues, the impact of climate change is not geographically linked to its causes. So, although Bosnia and Herzegovina belongs among countries that have the lowest greenhouse gas emissions per capita in Europe (five tons of carbon dioxide equivalent per capita per year, about half of the value of the EU average), climate change has already been observed. Bosnia and Herzegovina is particularly vulnerable on climate change due to its geographical position, the economic importance of the agricultural sector and forestry, as well as due to its limited capacity to adapt to climate change. Summer temperatures in some places increased by 1.20°C over the past decades, and rainfall regimes were changed too[15].

According to the report, climatological forecast models predict an increase in average annual temperatures for 2-40°C by the end of this Century, with an increase in summer temperatures up to 4.80°C. This situation will require fundamental changes in agriculture, forestry and approaches in processing and management of land. Predicted reduction of annual rainfall by 30% and reduction of summer precipitation in Posavina (Sava River basin) region and in the south of Bosnia and Herzegovina to 50%, will have negative implications for agriculture and forestry. These two most important industries have a 12% share in GDP of Bosnia and Herzegovina, employ 20% of the labor force and have a crucial role in rural development. Changes in the rainfall regime will also affect the area of hydropower use, and without adequate measures of adjusting to these changes, the situations where the country's needs for energy cannot be met, is more than possible.

Bosnia and Herzegovina has already begun to take measures to tackle climate-related problems. As mentioned earlier, the country has ratified the *United Nations Framework Convention on Climate Change (UNFCCC)* in 2000. *The first national report (INC)* was completed in 2009, adopted by the *Council of Ministers* and Entity governments, and was submitted to the UNFCCC Secretariat in 2010. However, the previous strategic approach did not include integrated mitigation measures and impacts of climate change, or adaptation measures to climate change. Without coordinated and planned approaches to adapting to climate change, Bosnia and Herzegovina will face economic consequences and negative impacts on the environment.

The *Climate Change Adaptation and Low Emission Development Strategy for Bosnia and Herzegovina* is the first step towards establishing a feedback management process. There is not enough data at the moment, and domestic capacities are limited so that the

[14] *Climate Change Adaptation and Low Emission Development Strategy for Bosnia and Herzegovina, 2014*

[15] A temperature change of 1.20C may seem unimportant, but a 10C drop in temperature has caused a European
Ice Age in 15-17. Century. A change of such extent can have major impacts.

Strategy is only consolidating political support for the development of low carbon emissions and climate resilience changes. As the quality of emission information and experience with the measures for mitigation of climate change improve, the Strategy will be revised and adapted in the future. Strategy will enable and coordinate enhanced sectoral strategies with detailed policies, measures, programs and projects. In addition, the Strategy identifies measures to mitigate climate change, measures to adapt to climate change, as well as capacity building needs, which will provide a strategic and programmatic basis for effective international support. [16]

The overall results of the gap-analysis, identifying water, energy, climate and food in the horizontal policies of Bosnia and Herzegovina, are presented in the Table 1. As it can be seen, Bosnia and Herzegovina's *Strategy for Development,* the main development strategy of the country, which prioritizes oil and coal use, has not been modified since 2010 in accordance with growing water, energy, climate and food challenges. It seems that all the crucial documents in Bosnia and Herzegovina still appear to fail to provide the adequate political response to WECF nexus.

Table 1. Water, energy, climate and food in the horizontal political dimension in Bosnia and Herzegovina

Strategy, concept, program, plan	***Priorities***			
	Water	***Energy***	***Climate***	***Food***
Development Strategy of Bosnia and Herzegovina (2010)	**Water use or issues related to water haven't been addressed in this strategy in depth, or directly.**	**Increase of energy efficiency; high decrease of non-renewable energy use.**	**Some solutions for climate change; Adaptations in agriculture.**	**Increasing the volume of agricultural production and unit yields;** **A higher degree of specialization and modernization of agricultural production;** **Increased consumption of food of domestic origin;** **Balancing the foreign trade balance of agricultural and food production.**
Development Strategy of Federation of Bosnia and Herzegovina 2010-2020 (2009)	**Providing sufficient quantity of drinking water and coverage of the total population**	**More efficient use and encouragement of the development of all renewable and non-renewable**	**This strategy does not address issues related to climate change and measures to fight them.**	**Establishment of institutional capacity for support and development of agriculture;**

[16] *Climate Change Adaptation and Low Emission Development Strategy for Bosnia and Herzegovina, 2014*

	public water supply; **Integrated water management, water protection, protection against harmful effects of water;** **with the land management sector, agriculture, forestry, traffic and** **communications;** **Reduction of damage caused by various harmful effects of water/**	**natural** **resources in energy production;** **Implementation of adopted development strategies and full integration of coal mines with EPBiH and EPHB;** **Continue with oil exploration in the FBiH;** **Distribution of gas throughout the FBiH region.**		**Increasing competitiveness in production, processing and trade through land management;** **and investment in agriculture;** **Harmonization of the agriculture sector with the EU.**
National Environmental Action Plan BiH (2003)	**Water quality protection; and preservation of the quality of underground and surface waters;** **Protection from floods;** **Provision of sufficient quantities of quality water for water supply and other purposes.**	**This plan does not address energy issues directly. Only mention of a program of stabilization and gradual reduction of acid and greenhouse gas emissions by increasing energy efficiency, technological restructuring, greater use of renewable energy sources.**	**Establishment of a register and database on the emission of acid and greenhouse gases, including information on trends in local emissions and quantities of greenhouse gases removed from the atmosphere by local absorbers;** **Research into the impact of changed air quality and climate change on the health of the population, water resources, agriculture, forest ecosystems and biodiversity, energy, transport, tourism and other economic activities that are directly dependent on climatic conditions;**	**This plan does not address issues related to food production or agriculture in general.**

			Research of the sensitivity of certain economic activities to acid deposits of climate change and options for adaptation to changed climatic conditions on the territory of BiH.	
Energy Strategy of Bosnia and Herzegovina Until 2023 (2010)	**Addressed use of water for electricity generation.**	**Oil and coal use;** **Energy efficiency;** **Introduction of generation capacities;** **Modernization of energy infrastructure;** **Focus on renewable energy sources;** **Large-scale development and modernization of energy infrastructure for domestic energy supply.**	**This strategy does not address issues related to climate change directly. There is only slight environmental impact in its version from 2014.**	**This strategy does not address issues related to food production or agriculture in general.**
Sava River Basin Management Plan	**Water use efficiency in agriculture and households;** **Water access;** **Solution of transboundary water problems;** **Prevention of depletion and pollution of water resources;** **Water quality;** **Integrated water resources management for solution of internal and transboundary water problems;**	**This Plan focuses on water issues and as such it only mentions indirectly other nexus issues, or, in food and climate change case, it fails to address these components completely.**		

The Climate Change Adaptation and Low Emission Development Strategy for Bosnia and Herzegovina	**Water use or issues related to water haven't been addressed in this strategy in depth, or directly.**	**Energy component of the nexus hasn't been addressed in this strategy.**	**Reduction of GHG and ozone depleting gases emissions;** **Reduction of anthropogenic pressure, leading to climate change;** **Monitoring of climate change;**	**Efficiency us of lad resources;**
Directions shaped by the global challenges ***Directions, satisfying both ''economy driven'' and ''environment driven'' policies: climate change mitigation and energy efficiency as well as increased use of renewable energy sources.***				

Despite the fact NEAP has priorities in all nexus areas and incorporates principles of sustainable development, the table 1 shows that, while the national priority is given not only to the sectors directly contributing to the economic development but also to the environmental and social components, ultimately only the economic direction of the policy seems to be, in fact, prioritized.

The existence of the concept of the transition to sustainable development is a crucial component for horizontal EPI and for addressing WECF nexus in Bosnia and Herzegovina, as it assures that environment is taken into consideration on the highest level of the strategic planning and promotes finding a balance between various existing tradeoffs taking place around and within the nexus. However, the concept is ineffective without ensured integration and implementation into the political and institutional settings of Bosnia and Herzegovina.

As it was mentioned previously, there are problems connected with implementation of the concept of transition to sustainable development due to lack of implementation within different sectors, within Entities and ultimately Cantons. The existing sectorial and Entity strategies are mainly aiming to reach economic goals and the environmental impact of their implementation is not evaluated thoroughly, if evaluated at all. Meanwhile, all sectors and ministries (within Federation or Republika Srpska) have their own strategic plans. Even all the Cantons within Federation of Bosnia and Herzegovina have their own strategic plans. However, as we mentioned before, there is an ongoing issue with coordination of these plans between entities, which obstructs overall development of the country.

The main two Entities and Brčko District manage issues of protecting the environment by applying laws, regulations and standards. *Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina* is responsible for coordination of activities and harmonization of the plans of the bodies and institutions of Entity governments at the international level, among others in the areas of energy, environmental protection, development and exploitation of natural resources. Named Contact Institution according to the UNFCCC and the Authorized State Body (DNA) for the Clean Development Mechanism (CDM) is the *Ministry of Physical Planning, Construction and Ecology* of the Republic of Srpska. Within Federation of Bosnia and Herzegovina, the main ministries in charge of water, energy, climate and food are *Ministry of Energy, Mining and Industry*

(MEMI), Ministry of Agriculture, Water-Management and Forestry (MAWF) and *Ministry of Environment and Tourism. (MET*) Within RS there is *Ministry of Energy and Mining (MEM)*. (See Table 2.) Interestingly, the MAWF on Federal level represents both food and water issues, climate is limited to the competency of MET and energy issues of domestic energy issues are divided within two ministries, MEMI at the Federal level and MEM in Republika Srpska. However, above all these ministries is the State *Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina.* Bosnia and Herzegovina's complex governance comes into the focus once again.

Table 2. Ministries responsible for water, energy, climate and food

Ministry of Foreign Trade and economic relations of Bosnia and Herzegovina (State level)			
Ministry of Energy, Mining and Industry (FBIH)	Ministry of Agriculture, Water-Management and Forestry	Ministry of Environment and Tourism	Ministry of Energy and Mining (RS)
ENERGY	**FOOD, WATER**	**CLIMATE**	**ENERGY**

The main documents of the ministries, the strategic plans, are developed by the currently introduced departments of the strategic planning within each ministry to reach the targets set within the State or Entity development programmers. A strong institutional setting, with effective cooperation within, is important for implementation of the numerous policies we discussed previously. However, Bosnia, as a country has a problem when it comes to cooperation segment between some of the Ministries or between two Entities, which results in ultimate halt for the implementation of many policies (especially international ones). As the political framework, however, the institutional setting in Bosnia and Herzegovina has been changing. Some of the changes that occurred recently (sometimes under the pressure of EU) reflect the development of national priorities, including those connected to water, energy, climate and food. To ensure an adequate response to WECF nexus, ideally, Bosnia and Herzegovina's institutional framework also needs to present a network of equally significant and interconnected water, energy, climate and food institutional bodies.

At the international and regional level, the country has engaged in various mechanisms aimed at implementing important and relevant global standards, starting with *the concept of sustainable development* as outlined in the *declarations and action plans adopted at global conferences in Rio* (1992), *Johannesburg* (2002) and *Rio* (2012). Other relevant regional regimes include *Espoo Convention on Transboundary EIA* and the *SEA Protocol*, where Bosnia and Herzegovina is a signatory. Also, the membership in the regional cooperation mechanisms related to river basins, such as the *UNECE Water Convention*, its *Water and Health Protocol*, and the *International Convention on the Protection of the Danube River (ICPDR)*, provides a relevant context. Under the *Water and Health Protocol*, for example, relevant standards include equitable access, sustainability, water related diseases, fixing vulnerable resources, water safety planning, improving water quality, small scale systems, and information and involvement of the public.

At the Sava River basin level, the legal and institutional framework for cooperation is established by the *Framework Agreement on the Basin of the River Basin (FASRB)*, under which the *International Basin Commission of the River Basin (ISRBC)* acts as its implementing body. The ISRBC also participates actively in projects and initiatives across the Danube River Basin. For example, the ISRBC supported the work of the COWANDA project funded by the EU, in order to develop a new legal and financial framework for the management of ship-based waste in the Basin of the Danube River. The Sava River Basin Management Plan provides an example of how the ISRBC facilitates a common and comparable approach among the states by providing a framework for the establishment of common objectives that can be implemented by States in different stages of development. In general, EIA and SEA, in particular in a transboundary context, could be effective tools for assessing the impact of energy, water management and agricultural projects on the ecosystems and to synchronize competitive goals, as well as ensuring proper public participation. The tools could support, for example, consideration of different alternatives for e.g. Hydropower development projects, as the concentration in most perspective areas and outside zones of high conservation value. Successful development of multi-sector flow regulation projects requires sufficient early consideration of different users' needs, so that they can be taken into account in designs and budgets. Only 70 EIAs were conducted in Republika Srpska by 2010, for example, mostly related to extractive industries and energy production. [17]

In Bosnia and Herzegovina, constitutional complexity presents specific challenges. The 2011 RENA report on Bosnia and Herzegovina noted that "*institutional arrangements are not in place at the level of FBiH for urban wastewater treatment. The FBiH projected that the competent authorities would be identified by 2011''.* (There is no system in place yet for the regulation and control of the quality of discharges from industrial plants into collection systems. Full implementation of the Directive is not foreseen until 2020. In the Republic of Srpska, the date for full implementation of the water directive is envisaged in 2021, with the exception of the Urban Waste Water Directive, where full implementation is expected for 2033. [18]

This brings attention to the fact that local and national authorities sometimes have different priorities (e.g., local tourism vs. national energy strategy, or local agricultural interests vs. national biodiversity strategy). This is nowhere more apparent than in Bosnia and Herzegovina where good cooperation across Entity lines in the field of monitoring may be contrasted with lack of inter-Entity cooperation on permitting. A lack of cooperation in permitting has been described in case of large hydropower facilities, in which Republika Srpska unilaterally changed permit conditions regarding return of flow to the main channel that was agreed with the Federation of Bosnia and Herzegovina. This resulted in a situation where minimum flow was not guaranteed to downstream users of Federation of Bosnia and Herzegovina. [19]

[17] RENA report Bosnia and Herzegovina

[18] RENA report Bosnia and Herzegovina

[19] Ibid.

IDENTIFICATION OF THE WECF NEXUS CHALLENGES IN THE SAVA RIVER BASIN AND THE CAUSES AND FACTORS AFFECTING THEM

This part of paper is a result of analysis of official strategic documentation, as well as interview analysis with a special focus on the local level. It presents problems related to water, energy, climate and food in The Sava River basin and their causes. Within the period from 3 May 2019 and 15 June 2019, we conducted semi-structured interviews with officials from various institutions within Bosnia and Herzegovina's political and academic circles. Interviews were conducted by the phone. Respondents were chosen based on their importance when it comes to WECF issues within the country. They were either heads of prominent institutes, university departments or agencies or political figures employed within specific ministries on the Federal and Sate levels. We asked all the interviewee same semi-structured questions, which are listed in the appendices at the end. Problems and causes were explored on the basis of the opinions of the interviewees. The identification of the local problems and understanding of the causes is crucial for provision of the national address to the challenges. It is important that the interconnections between the local problems and the causes on the national level are shown. The list of interviewees and their belonging IDs is given in the appendices at the end.

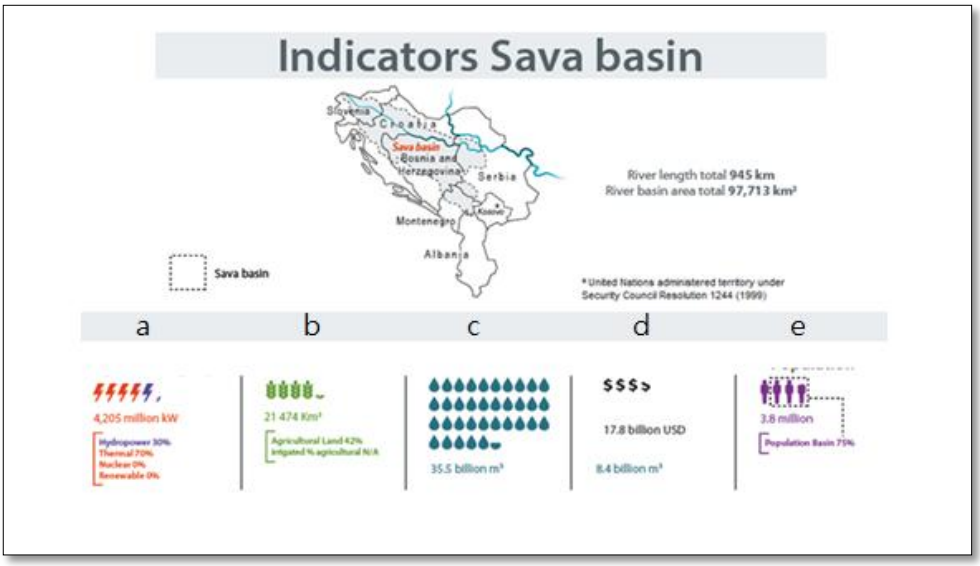

Figure 2. Indicators for Bosnia and Herzegovina within Sava river basin (source World Bank, FAO, World Energy Trilemma, 2014) ***Legend: a) electricity – installed generating capacity and hydropower, b) area used for agriculture, c) internal renewable freshwater resources, d) GDP, e) Population***

Water challenges in the basin

Water is an irreplaceable good of general interest, which, because of its importance for life, economy and development requires a unique and comprehensive approach, which is not the case with other natural resources. Water is an increasing economic category, or

commodity, and not a gift of nature anymore. As the need for water grows, so the available and usable quantities become more limited. Considering the water as inexpensive, in its development so far, it was treated with wasting intent, in the non-saving and non-economic way i.e. it was wasted irrationally and polluted without limits. By not giving enough attention to securing and protecting potential water resources, it will make water more expensive in the future. In addition, the development of the economy and the growth of individual standards cause an increase in water consumption, and this entails an increasing investment in water quality and quantity protection. On the other hand, agricultural resources, economic and other important facilities and significant infrastructure represent areas requiring a higher level of water protection. In the process of development of the economy, water wealth is one of the basic elements whose availability is limited and for which there is no substitution in the development of life processes.[20]s

Analyzing the responses from majority of interviewees, we noticed that there is mention of many water problems in the basin. However all of them can be organized into three main categories such as degradation of water quality, instability and possible reduction of the flow and change of the hydrogeological regime of the Sava River, the main river of the basin. The internal reasons of water problems of the Sava River basin, according to the official from *Federal Hydro-meteorological Institute of Bosnia and Herzegovina* (ID 3) were seen as both general causes of water problems on the national level and some causes specific to the Sava river basin. Inter-sectoral conflicts, especially between energy and irrational water use for agriculture and municipal utilities and interdepartmental disunity were referred to as reasons of water problems not only for Sava River basin, but for Bosnia and Herzegovina in general.

According to the official from the *Department of Hydrology at the Faculty of Mathematics and Science*, "*the difference of the interests of the energy sector and the irrigation sector is evident not only in the Sava river basin*" (ID 2 pers.comm.). Inter-sectoral conflicts, mainly conflicts between the energy sector and irrigation, were called '*'the main reason for water problems both in the Sava River basin and some of its sub basins like Drina River basin*.'' (ID 4 pers.comm.) Hydropower was given as an obvious example. As the maximum electricity consumption is during the winter, an energy sector is interested in using winter resources in winter and collecting these resources during the summer. It does not satisfy irrigation because they need water during hot season. It was noted by ID 4 that the inter-sectoral conflict in the Drina River basin transformed even into an interstate conflict within boundary States as the countries are interested in different regimes of water use (even inter-Entity conflict within BIH). In addition, according to ID 2, the conflict in the Sava River basin is not only between the water use for energy and the needs of other sectors, but also the needs of the eco-system itself.

Irrational water use, especially for agriculture and municipal utilities due to generally high water consumption in Bosnia and Herzegovina, water losses and inefficient irrigation technology was also highlighted by ID 1, ID 3 and ID 5. The official from *Hydro-Engineering Institute Sarajevo* (ID 4) argued that we use three times more water than in developed countries and at the same time the effectiveness of water use is very low. However, official from the *Ministry of Environment and Tourism* (ID 5) argues that even

[20] http://fmks.gov.ba/stara/kultura/legislativa/strategije/StrategijarazvojaFBiH2010-2020.pdf, pristupljeno 27.05.2019

given the situation that the Sava River basin gets only the runoff on the side of Bosnia and Herzegovina and there is a significant water intake in other countries belonging to this basin, this water could be enough for current needs in water resources under conditions of rational water use in agriculture and municipal utilities, as well for hydropower.

Another official from the *Agency for the Water Area of the Sava River* (ID 6) identified cause of inter-departmental disunity as a general institutional problem and it appears as a cause of water problems in the Sava River basin. According to this interviewee, the conflicts do not appear only between different sectors but also within the water sector itself. Comments such as "*different departments have different interests*" (ID 4 pers.comm.) show clear clashes in interest between different departments of same sector.

One of the issues everyone agreed upon was about the issues related to floods within Sava River basin. Not so long ago, the Sava River experienced one of its most severe floods (UNISDR, 2014). [21] In Bosnia and Herzegovina, flood events between April and May 2014, caused irreparable damages for many facilities and of course, for population. Occurrence of extreme hydrological events such as flooding is expected to increase. Even in that case, there will be trade-offs between sectors. Again, pointing to energy, there will be inter-sector tensions, as described in UNISDR (2014), BBC (2014) and TENT (2014).[22] According to ISRBC, (2014), floods in May 2014 were direct result of the heaviest rainfall since records began 120 years ago. They caused an extreme increase of water levels in the rivers, some exceeding over recorded maximum. Tributaries of the Sava River within the basin, the Bosna, Vrbas, Una and Drina Rivers caused flooding and landslides and great loss in the area. Floods had particular devastating impact in the towns and villages along the Bosna River (Zavidovici, Maglaj, Doboj, etc.). According to the ID 6 and ID 4, an approach to buy time or help adapt to a small flooding incidence by lowering reservoir levels during normal operation may be helpful. Tension between optimization of hydropower generation will occur if lower reservoir operating levels in reservoirs are adopted. Low reservoir levels can limit hydro potential. Also, low reservoir levels will affect the ability to cope with the drought and affect the scheduling potential of power plants, irrigation and maintaining proper flow regimes.

According to the Draft Report on the Water-Food-Energy-Ecosystems Nexus in the Sava River Basin, the flood reaches its 100-year return period at about 6000 m^3/s to the Sava River Basin (2010 Floods in the Danube River Basin). The reservoir capacities reach 1,752 km^3 in the basin. Assuming that the storage facilities are half full, the centennial flood could be reduced by at least four hours. Further lower impacts, which often last for up to four days (Komatina, 2014) may be better contained in instances where natural floodplains are complemented by spare reservoir capacity. However, according to the ID 6, water in the system has a value as a function of which sector it will be used in. Let's consider for example the removal of $1m^3/s$ of water throughout the year in the entire chain of all hydropower plants. This may be due to extraction, due to irrigation requirements, or the result of pressure placed on regulating flows for ecosystems, or maintaining water levels. In doing so, it is estimated that approximately 114 GWh less electricity will be generated from

[21] ISRBC has collected information on recent floods and the report is under development (discussed within the ISRBC expert groups).
[22] Sava Draft Nexus Report 2015

hydropower in the basin (KTH calculations[23]). This will require extra generation from other sources to cover the demand in the basin, coming from coal, natural gas and oil. It is expected that such a decrease in water availability would result in extra $ 0.9 million per year for the Sava region to generate electricity from other sources and 90,000 extra tons of GHG emissions released into the atmosphere.

Some of other key water issues and challenges in the Sava River basin are: sedimentation and erosion, groundwater pressures, and point-source pollution. There are economic pressures to exploit the Sava further. Human activities will affect river flow patterns. This will in turn affect the historical flow patterns in the river system and the dependence on it (and their services), and these will need to be assessed. Similarly, this will affect sedimentation. Sediments that are withdrawn upstream (for use in construction sector) can create a lack of sediments downstream influencing the hydro morphology of the river bed. It would be bad for the natural functioning of river ecosystems. However, slowing flows, especially in reservoirs or slower stretches of the river can increase. Sedimentation can affect the navigation of the river. As sediment transport affects the infrastructure of different sectors, reducing and controlling erosion is a shared interest, and would benefit from the efforts of different sectors. Information on effective measures, for example land use and farming practices that reduce erosion, would be valuable.

In the Sava River basin, groundwater is important as a source of public water supply of population and industry, but also as a support for ecosystems. Pressure on groundwater bodies (mainly around cities and agricultural areas) is likely to increase as more water is expected to be withdrawn from them. (ISRBC, 2013) An assessment of the quality and quantity status of groundwater bodies in the Sava River basin concluded (SRBMP Background paper 2, 2013) that regarding chemical status, 11 groundwater bodies (or nearly 30%) are possibly "at risk" or have poor status and 30 GWBs are in good status (or not "at risk'') and based on a quantitative status (or risk) assessment, only three GWBs are possibly "at risk'' not achieving a good quantitative status, 38 groundwater bodies are in good status or not "at risk''.[24] Some 19 transboundary aquifers have been identified in the Sava basin (UNECE 2011). Some pressure factors have been identified - depending on the transboundary aquifer - namely hydropower schemes and flow regulation, transport, agriculture, groundwater abstraction, communities, industry, wastewater (septic pits), solid waste disposal, gravel extraction, tourism and mining. It is clear however, that groundwater withdrawals will have trans-sector implications. Energy consumption (and therefore price) can be significant as a function of depth.

Even though a number of new treatment plants were foreseen to be put into operation, the share of wastewater discharged to the Sava and its tributaries that either is untreated or has gone through only primary treatment is still significant. Urban waste water is also an important source of nutrient pollution, and other important contributors are from industrial facilities and chemical production and intensive livestock production.

One of the main issues within the Sava River basin related to water is increased demand for energy. Increased demand for energy increases the importance of the Sava River

[23] Draft report on the water-food-energy-ecosystems nexus in the Sava River basin. For comments by national authorities and other stakeholders, version 8 April 2015

[24] Sava River Basin Management Plan, accessible at: http://www.savacommission.org/dms/docs/dokumenti/srbmp_micro_web/srbmp/sava_rbmp_draft_full_version.pdf (pristupljeno 28. 05. 2019)

basin on which the energy system relies. The low level of wastewater treatment results in negative effects of direct uses, harming ecosystems, aquaculture and other uses. As there is still a lot of need to put in place wastewater treatment, these investments to be made are a chance to select technologies that are energy efficient. This would include measures in e.g. households to be more water efficient, such as implementing low flow devices (toilets, showerheads, washing machines etc.). These then result in indirect energy savings, as less water is used and processed. In the treatment centers themselves there is scope to use state of the art high efficiency pumps etc. As we have seen, issues and challenges related to water in the basin are various and they need to be addressed adequately, starting from the highest levels of the country.

Energy challenges in the basin

All respondents acknowledged that there are energy problems in the region. However, they did not specify which part of the Sava river basin is the most affected but rather referred to the general area of the basin with its sub-basins. Interestingly, the official from the *Ministry of Energy, Mining and Industry* avoided answering the questions about energy problems in the basin and, instead, insisted how the energy sector within the basin is expected to expand and transform (ID 7). It is expected to expand to meet new economic growth targets. It has also been argued that the basin may be an important exporter of renewable electricity (ID 4, 7). The structure of the sector is likely to transform, increasing the amount of renewable energy. Since the highest percentage of renewable energy comes from hydropower, this will put additional stress on the rivers in the basin, especially the ones that are already overloaded with the construction of small hydro power plants. Increase in energy demand, as reported by national projections, for Bosnia and Herzegovina by 2020, is 15%. [25] As mentioned, for Bosnia and Herzegovina, renewable energy sources target in gross final energy consumption for 2020 is 40%. [26]

At the same time, growth is expected in the electricity generation from new fossil fuel plants - which isn't surprising for Bosnia and Herzegovina. The exploitation of fossil and hydro-based electricity faces opposition from conservation groups and reservations from environmental authorities. According to national estimates, for five Sava River Basin countries, energy demand is expected to increase by 8% by 2020 compared to 2012. However, when analyzing the countries individually, the projected demand does not always correspond to an increase (Serbia case). Bosnia and Herzegovina is the country where the demand is expected to experience a higher increase, 27% in 2020.[27]

Such a heterogeneous - but upward - trend implies the need to invest in new electricity generation options. In the case of Bosnia, the increase in energy demand will be supported by a 3.8 GW expansion of thermal capacities of coal and natural gas. According to the National Renewable Action Plan of Bosnia and Herzegovina, the RES capacity increase in 2020, in relation to 2012, is projected to be of 426 MW.

Within Bosnia and Herzegovina, 88% of its population lives in the Sava river basin. One of the key pressures on the Sava River basin environment is related to the impact of

[25] Historical demand is taken from SORS, 2013, CBS, 203, 2014, FHBOS, n.d; RSRSO, 2013, 2012, 2011, 2010, 2008, n.d) and projections from BFME, 2014, SMEEP, 2013, NREP, 2009
[26] Energy Community Secretariat (2012)
[27] Sava Draft Nexus Report 2015

settlements on the quality of water. Table 3 indicates (for settlements of over 10 000 people) incidence of treatment facilities. [28]

Table 3. Incidence of treatment facilities in the Sava River Basin (ISRBC, 2013).

	Primary treatment	Secondary treatment	Tertiary treatment	With treatment (total)	No treatment
Bosnia and Herzegovina	**0**	**5**	**0**	**5**	**243 (98%)**
Sava River basin total (including other belonging countries) > 10 000	**7**	**19**	**3**	**29**	**87 (87%)**

In total, about 43% of the total pollution load, or about 3 million person equivalents is not treated (SRBMP, 2014). Other users and polluters include intensive agriculture. Sava river basin plays a dominant role in the energy system of Bosnia and Herzegovina. Also, majority of country's thermal power plants derive their cooling water from this basin. Every interviewee agreed that the Sava River and its tributaries are of extreme importance, from an energy security point of view. If water levels drop or flood events compromise the generation or cooling of hydroelectric power, approximately 53% of the entire generation's electricity generation will be affected by high economic, social and security costs.[29]

Importantly, the hydropower potential can play a special role for enabling the region to introduce larger volumes of intermittent variables such as solar and wind. Solar power is available only during the day and wind power is produced only when the wind blows. In order to balance the disparity between supply and demand, storage and scheduling is required. Provided by hydro, including pumped storage systems. All this mentioned above is important for the nexus in the Sava River basin.

Climate change challenges in the basin

Almost every interviewee considers climate change as a future serious problem for agriculture in the basin and in their opinion, climate change adaptation, in particular risk management, should be one of the priorities of the country. In addition, it was noted by ID 3 that the monitoring capacity of Sava River should be increased. Climate change is considered one of the causes of possible water issues in the basin by ID 2, ID 3 and ID 4. According to the Official from the *Hydro-Engineering Institute Sarajevo,* climate change is one of the main factors, which is likely to influence overall water situation of the basin in

[28] Sava River Basin Management Plan, accessible at: http://www.savacommission.org/dms/docs/dokumenti/srbmp_micro_web/srbmp/sava_rbmp_draft_full_version.pdf (pristupljeno 28. 05. 2019)

[29] Ibid.

the future. It was underlined that the climate projections vary, but the main conclusion of ID 4 was that “it will be even more water in wet places and more water deficit in dry places”.

According to the Official from the UNDP project "Climate risk management in Bosnia and Herzegovina", Sava River basin was identified as one of the most vulnerable to climate risks by preliminary expert assessment of the vulnerability of Bosnia and Herzegovina regions to climate risks within the UNDP project. It was suggested that extreme hydro meteorological events such as floods and temperature increase will exacerbate the existing water problem in the basin and increase the risk of sills. All these events and changes in the water runoff will lead to unavoidable socio-economic consequences. As greenhouse gas (GHG) emissions contribute to climate change, each country in the region is expected to meet targets to reduce (or mitigate) its greenhouse gas (GHG) emissions. All countries and (once accepted) candidates will be expected to contribute to the EU's target of a 40% reduction in emissions by 2030 over 1990 levels (EC, 2014). It is likely that the targets will be adjusted to be country specific.

In order to reduce emissions, key sectors must be targeted. The highest emitting sectors are energy (81%) followed by agriculture (10%), with smaller contributions from industry (5%) and waste (4%).

Table 4: GHG emission by sector in the Sava River basin in BIH in 2011. Source: WRI, n.d.

National contribution of GHG emissions	Contribution of each sector to national emissions			
	Agriculture	Energy	Industry	Waste
33%	8%	84%	4%	4%

A changing climate is a cause for concern. There are two key issues: increase in the occurrence of extreme events, such as flooding and lower rainfall. (WMO & GWP, 2014) According to the IPCC, South Eastern Europe is expected to be strongly affected by climate change. Water flows in summer can be reduced by 10% over historical levels, while the flows in winter are expected to increase for the same amount, resulting in overall reduction of mean water flows. It is also important to consider here economic implications for agriculture, energy (e.g., the implications of changes in hydro-production) and water supply schemes. This will point to the need for increased resilience of the agricultural sector to climate change (floods and droughts, rainfall and river flow reduction).

Figure 3. shows the generation of electricity from hydro power plants and thermal power plants from the OSeMOSYS model. It is interesting to note that the use of fossil fuels reduces steeply from 2019. This mirrors the increase in the deployment of large amounts of hydropower. This trend is followed by a continuous reduction in CO_2 emissions, reflecting the overall decrease in the use of coal for the generation of electricity. From a GHG mitigation perspective, the increase in hydro-power capacity, in combination with other

RES, allows the reduction of CO_2 emissions by 50% in 2030 in the basin, when compared to 2015. Such emission reduction potential can become a significant driver in the future.[30]

Bosnia and Herzegovina maintains its status as a region's net exporter, with hydro-power plants replacing coal-fired technologies for the production of electricity for exports.

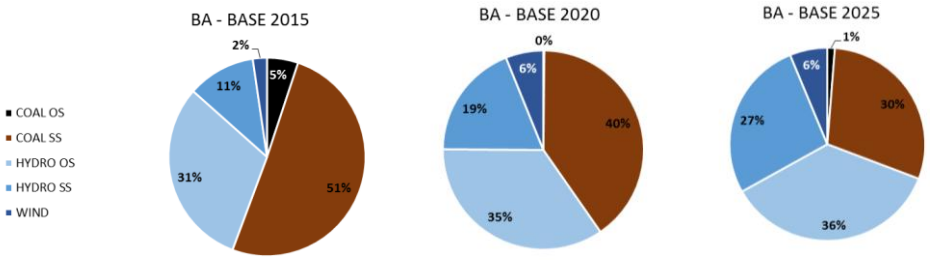

Figure 3. Baseline Scenario projections of electricity generation in Bosnia and Herzegovina for the years 2015, 2020 and 2025. The denominations OS and SS used for some technologies, respectively, mean "Outside Sava River basin" (OS) and "In Sava River basin" (SS) (source: Energy Strategy for BIH until 2035)

The amount of energy traded within the Sava river basin is very dependent on low cost electricity surplus produced in Bosnia and Herzegovina. From 2020, Montenegro, due to the expansion of hydropower and to the lowest demand in the region, starts exporting electricity to neighboring countries, as a result of the decrease in exports from Bosnia and Herzegovina.[31]

Agriculture/Food challenges in the basin

For the region of Sava River basin, there is a goal of expanding and increasing the area under cultivation. The region is expecting a twofold increase in the share of irrigated agricultural land by 2020 (SEE 2020, 2012). Agricultural irrigated land is fragmented, mainly used by small agricultural producers as landowners. Locations of available water for irrigation are often inconvenient and agricultural producers are not trained to use modern irrigation systems. Along with the necessary investments, these are the main reasons why only a limited area of agricultural land is irrigated. Irrigation is important not only to increase yield but also to improve the quality of agricultural products, increase employment and income through export as well as to strengthen the security of food supply.[32]

The majority of the region's agriculture is located in the region of the river basin of the Sava River. While the share of GDP is relatively limited, its impact on national employment is very significant. Employment is essential for establishing stability. Given the historical volatility as well as recent economic crises, the management of agriculture in the region, and its inputs: land and water, will be crucial.

[30] *Climate Change Adaptation and Low Emission Development Strategy for Bosnia and Herzegovina, 2014*

[31] Ibid.

[32] Draft report on the water-food-energy-ecosystems nexus in the Sava River basin. For comments by national authorities and other stakeholders, version 8 April 2015

Table 5. Employment statistics for agriculture in BiH, source: SRBMP (2014)

	Employment in agriculture	% in the SAVA region	% national direct jobs
Bosnia and Herzegovina	**20.60%**	**75.80%**	**15.61%**

According to the NEAP, the most important agricultural activities are in order of importance: corn and wheat production, oil plant production (soy and sunflower), orchards and vineyards. Another major agricultural activity is livestock production, where small production units dominate, especially for cattle, pigs, sheep, goats and horses. Poultry production on the other hand is characterized by large-scale production units. The Gross Value Added (GDP) of agriculture in the total GDP of the Sava countries is around 10% for Bosnia and Herzegovina. A number of policies to support agricultural activity by country were collected by IAMO (Volk, 2010). While outdated and published only in 2007, insights were instructive. This is especially with respect to the types of policy support by the country in the region.

According to the official from the *Ministry of Agriculture, Water-Management and Forestry* (ID 8), soil degradation is one of the main problems affecting agriculture in the basin. According to ID 4, there is still high underinvestment in the irrigation systems, since the majority of the systems were built back in 1995. In addition, due to poor drainage, water logging of irrigated lands takes place, which results in deterioration of the quality of drinking water. Regarding soil degradation, according to ID 8, it is mainly related to poor agricultural practices.

In addition, some of the interviewee claimed that despite the construction of some of the HPP in the basin area and the boost of economic development, the construction was only beneficial for some people, and the local people who were living on agriculture were severely affected. ID 7 argues that the existing and planned hydropower plants in the basin area not only play essential role to address peak loads in the region, but also promote development. However, ID 6 argues that large area of fertile agricultural lands was flooded and directly affected the local agricultural sector. From the other side, increased agricultural expansion will result in evaporation and evapotranspiration losses. Less water will be available for hydro generation. Less hydro generation will result in increased generation from other sources, including fossil fuels. Increased fossil fuel use will increase GHG emissions.

The most important nexus challenges are summarized in the table 6.

Table 6. The most important nexus challenges in the Sava River basin (according to official documents and the interviewees)

	Water challenges	Energy challenges	Climate Challenges	Agriculture/Food challenges
Links to Water	**Degradation of water quality, irrational water use and water losses.**	**Additional stress on all rivers in the basin by constructing new**	**Reduction in water flows in summer.**	**Sustainability of corn and wheat production.**

		HPP.		
Links to Energy	**Instability and possible reduction of flow which affects HPP production.**	**Underinvestment in the renewable energy technologies and need for renovation of old energy networks.**	**Reducing in water flows, affects energy production from HPP.**	**Underinvestment in the irrigation system and poor drainage;** **Flooding of fertile land due to overload in hydro-power plant construction.**
Links to Climate	**Change of hydrogeological regime of Sava river and its tributaries.**	**Reduction of fossil-fuel based plants, which are the biggest polluters.**	**Occurrence of extreme climate events, such as flooding and lower rainfall;** **CO2 decrease due to increase in the deployment of HPP.**	
Links to Food	**Irrational water use for agriculture;** **Majority of the water is used for energy, especially in summer, making deficit in water needed for agriculture;** **Inefficient irrigation.**	**More energy is needed in food production and treatment of waste.**	**Need for increased resilience of the agricultural sector (floods and droughts, rainfall, river flow reduction).**	**Flooding of the fertile agricultural lands;** **Soil degradation.**

DISCUSSION AND CONCLUSION

Bosnia and Herzegovina is paving its own development pathway. However, the country and the challenges it faces cannot be viewed out of the regional and global context. Bosnia and Herzegovina is a part of the global political playground as well as national water, energy, climate and food challenges are implications of regional and global WECF nexus. The country is already becoming more involved in international environmental governance. Its policy responses are shaped to some extent by international obligations and facilitated by international actors. They actively promote existing integrated policy frameworks such as climate change policy. As the global links between WECF intensify and countries become more dependent on each other, Bosnia and Herzegovina will have to make important choices to face the challenges.

Meanwhile, a pro-active focus on all components of the nexus is crucial to adequately address the WECF nexus and face the challenges. In fact, all the challenges of water availability, energy access, climate change impacts and food security are not properly addressed in the political setting. Despite the fact that programs are developed on improving

integrated water management and water efficiency, climate change adaptation, they do not receive significant attention from the central Government, and again are mainly addressed within the Ministry of Environment and Tourism. However climate change has recently received more attention (mainly thanks to the international pressures). Since Bosnia and Herzegovina is among the countries aspiring for membership within EU, it has to oblige to EU's environmental policies. Because of this, the promotion of renewable energy and energy efficiency is on increase lately. In addition, the low-carbon development concept promotes GHG emissions trading. On the other hand, compared to other policy directions identified to address the WECF nexus on a global scale, the policy on climate change mitigation is most actively developing.

Within this paper, we concluded that water, energy, climate and food were not given a pro-active attention in the political setting. The national and local priorities in the country are different. For instance, according to the energy experts, the policy of climate change mitigation can be very problematic for Bosnia and Herzegovina. The development of renewable energy sources faces serious obstacles starting with the inapplicability of RES to solve problems of large energy in industrial-developed regions with deficits of electricity and ending with the lack of willingness of the population to pay high electricity tariffs. The biggest obstacle in implementation of any policy is the complex political situation in Bosnia and Herzegovina. Among some of the levels, there is almost no cooperation within the sectors. Also, in the context of Bosnia and Herzegovina, it seems unreal to meet international obligations to reduce GHG emissions, given the initial high dependence on coal and plans to introduce new coal-generating capacities according to the industrialization program. Finally, the introduction of emissions trading will probably face a serious protest of large energy and industrial players.

The analysis of the institutional setting revealed that national ministerial level clearly reflects the political priorities of the country. The Ministry of Energy, Mining and Industry on the Federal level was created to implement the program of industrialization and deals with the provision of internal energy supply, mainly by increasing coal production. Meanwhile, the Ministry of Environment and Tourism, the main body responsible for climate, has a low potential. Through the analysis of both political and institutional settings, we came to the conclusion that the response to the WECF nexus is inadequate, since the components of the nexus are not equally addressed and there is a lack of cross-sectoral cooperation. Water, the center of the nexus, is not given enough attention in Bosnia and Herzegovina. This can have serious implications on the water situation on both national and local levels. The biggest issue in addressing WECF nexus at the State level is the complexity of cross-cutting for government in general, limited by the sectoral prerogatives.

Meanwhile, these inter-sectoral conflicts together with other political and institutional decisions have serious implications and are the root causes of existing problems on the local level in the Sava River basin. The complex of political, economic, institutional, socio-economic factors and problems of inadequate maintenance and knowledge caused such problems in the basin as degradation of water quality, change of hydrological regime of Sava River and its tributaries, instability and possible reduction of hydrological flow, soil degradation and the instability of the energy access. Although the immediate and root causes of these problems are, for example, irrational water use for agriculture and utilities or pollution, the underlying and root cause are connected with the inadequate political and institutional response to WECF nexus, preponderance of economic priorities, predominance

of more export-oriented than internal supply-oriented priorities, lack of investment in water, irrigation and energy internal infrastructure and other factors.

From the scientific point of view, the study of the integration of WECF nexus shows us the importance of crossing several methodological approaches as indicated by the Newell review (2019). Indeed, the purely modeling approach is essential to measure the socio-economic metabolism of the territories (Barles, Krausman, 2009) and to understand the evolution of the indicators of consumption and demands for water, energy and food. These flows are interdependent and require a complex analysis of their dynamics. However, we cannot do without a socio-political approach to the integration of these concepts among institutional actors. In order to tackle complex resource and development challenges, Albrecht et al (2018) show that mixed and transdisciplinary methods must be adopted that integrate the social and political dimensions of water, energy and food and involve stakeholders and decision-makers. We have therefore been able to reveal with the interviews the consequences and the indirect effects of not taking into account nexus in economic and industrial development policies, at several geographic levels. In this, the administrative boundaries is a first strong constraint, because it is necessary to be able to establish a multilevel governance (Geels, Schot 2007) to produce scenarios compatible with approach by nexus.

Scientific prospects for deepening are opening up as a result of this work. On the one hand, a spatial analysis of flows based on GIS would be very relevant in order to have precise elements of the interrelationships between nexus in a territorial approach. On the other hand, a comparative analysis with case studies would be timely in order to capture convergence and divergence factors in territorial metabolism governance regimes (Bahers, Haberl, Kowalski, 2018).

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APPENDICES

Appendix 1. List of people contacted during the research period and their IDs

1. Official from Ministry of Foreign Trade and economic relations of Bosnia and Herzegovina – ID1
2. Official from Department of Hydrology at the Faculty of Mathematics and Science – ID2
3. Official from Federal Hydro-meteorological Institute of Bosnia and Herzegovina – ID3
4. Official from Hydro-Engineering Institute Sarajevo – ID4
5. Official from Ministry of Environment and Tourism – ID5
6. Official from Agency for the Water Area of the Sava River – ID6
7. Official from Ministry of Energy, Mining and Industry – ID7
8. Official from Ministry of Agriculture, Water-Management and Forestry ID8

List of officials who could not give interview:

Official from EP BiH
Official from EKO Energetika
Official from Institut za Vode doo Bijeljina

Appendix 2. List of semi-structured questions

Please tell me about your institution and its influence on the Sava River basin.

In your opinion:

1. What are the main water, energy, climate and food problems and challenges in the Sava River basin? Are they interconnected?
2. What are the causes for these problems?
3. What is your attitude towards construction on new hydropower plants in the basin?
4. What is your attitude towards the new energy projects especially construction and modernization of thermal power plants?
5. Can new energy projects drastically influence water situation in the basin>
6. Can their effectiveness be affected by climate change or by the transboundary aspect?
7. What are the main actors in the field of water, energy, climate and food?
8. What is the level of cooperation between these authorities?
9. How problems in the basin differ from those on the national level? Ar e they the same?
10. What are your recommendations for solution of mentioned WECF issues in the basin?

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