GEOGRAPHICAL ASPECTS OF RIVER FLOWS IN THE REGION OF NORTHEAST BOSNIA

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ABSTRACT. - Geographical aspects of river flows in the region of northeast Bosnia. All streams in the region of north-eastern Bosnia belong to the Black Sea basin, and consist of flows with small waterfalls, cascades, streams and the larger rivers Sava, Drina and Spreča. By field trips to natural watercourses, reviews and analysis of the current situation the following can be concluded: pollution of water courses in the area of the region of north-eastern Bosnia are different, surface water quality has largely been compromised and in some waterways dangerously disturbed, riverbeds serve as garbage dumps, while the river banks are covered in different types of vegetation. The most common pollutants are municipal wastewater, which occur as a result of the activities of the population. A particular problem is the waste water of some industrial plants. The lack of enough protection from flood waters makes it even worse. Flooding is a serious distortion factor of the environment and it causes property damage. The negative influence of surface water pollution is reflected in the quality of drinking water, water for irrigation, recreation, etc. Conducted research points to the problems in this area that we encounter daily, it provides valuable guidelines to protect river flows and improve the environment in the region of north-eastern Bosnia.

Keywords: rivers, protection, region of north-eastern Bosnia.

1. INTRODUCTION

According to regional geographical position, the region of northeast Bosnia belongs to the northeastern part of North Bosnia with 24 municipalities in two entities: the Federation of Bosnia and Herzegovina - 13 municipalities, (The Spatial Plan for the area of TK 2005-2015), and Serb Republic -10 municipalities, (The Spatial Plan of the Serb Republic until 2015) and the Brčko District of Bosnia and Herzegovina (The Government of the Brčko District of BiH). The territory of the region of northeast Bosnia is located within the geographic coordinates between 43° 56' and 44° 58' north latitude, 18° 08' and 19° 38' east longitude.

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Area of the region of north-eastern Bosnia is 6.628 km², accounting for 12% of the territory of Bosnia and Herzegovina. (Hereinafter referred to as the region). According to estimates, this area has 1.041.043 inhabitants, or 20% of the population of Bosnia and Herzegovina. The average population density is 157 inhabitants per 1km^2. (Hodžić and Kofrc 2006) The region borders in the east with the Republic of Serbia, in the north with the Republic of Croatia, border lines with the Republic of Serbia goes along Drina river, and with the Republic of Croatia along Sava river.

2. RIVER BASINS AND MAJOR RIVER SYSTEMS IN THE REGION OF NORTHEAST BOSNIA

All streams in northeast Bosnia belong to the Black Sea basin, and consist of flows with small waterfalls, cascades, streams and larger rivers Sava, Drina and Spreča.(Group of Authors: 1977) (Fig.1.) The main river in the north, towards which flow the courses of larger river systems is ***Sava***. The larger tributaries of the Sava River in the territory of north-eastern Bosnia are Brka and Tinja.

The river Drina emerges by joining the Piva and Tara at Šćepan field (433m/asl.) on the border between Bosnia and Herzegovina and Montenegro. It flows in meridian direction from south to north, along the distance of 346 km. The catchment area of the river Drina belongs to the territory of Bosnia and Herzegovina, Serbia and Montenegro. The larger tributaries of the Drina River in the territory of north-eastern Bosnia are: *Križevica, Drinjača and Janja.*

The Drina River has a large hydroenergetic power. By raising hydroplants: Zvornik in 1955, *Zvornik Lake* was accumulated, 25 km long, 200 m-2 km wide and 39 m deep, it extends through the territory of Zvornik to the mouth of the Great river (Velika rijeka) into the Drina (Bratunac municipality), and Bajna Bašta hydroelectric power station in 1961. *Peručac lake* was accumulated, long 54 km, wide from 100 m to 1,1 km, and deep 80 m. (Strategy development based on respect for human rights, Zvornik, 2005).

The Spreča River emerges in the settlement Paprača, municipality Šekovići. It is 137,5 km long, it flows through the central and western part of Tuzla Canton, through municipalities of Kalesija, Živinice, Lukavac, Gračanica and Doboj Istok. It is a right tributary of the river Bosna into which it flows near Doboj. According to macrorelief characteristics, Spreča river valley is characterized by narrowing and expansion, which are manifested in the two larger parts, Gornja and Donja Spreča, separated by Modrac lake.

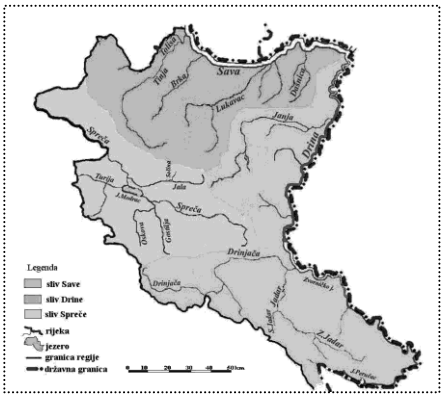

Fig.1. ***River basins and river systems in the region***

The construction of HPP on the river Spreča in 1964 *Modrac lake* was accumulated, 11 km long, 1.600 m wide, and 17 m deep. (http://www.bistro.BiH.ba) Tributaries of the Spreča are *Oskova, Turija and Jala*.

3. WATER QUALITY CONDITION IN THE RIVERS OF THE NORTHEAST BOSNIA REGION

In the protection of the environment in this region, especially the area of water resources, a major problem is the quality of surface fresh water. Due to unresolved sewage systems network, and a large-scale water supply, large quantities of water are without previous treatment directly discharged into watercourses, often in the vicinity of the settlements, or in the settlements, so that most of the water flows represent *sewers collectors*. According to the analysis of water quality, it is usually talked about the four types of wastewater: I Domestic wastewater, II Industrial effluents, III Agricultural waste water, IV Town (municipal) wastewater composed of domestic sewage and various industrial wastewater.

The Sava River Water Quality -The influx of large amounts of organic matter and different nutrients during years lead to changes in water quality in rivers. According to the degree of pollution, ***the river Sava water*** quality belongs to class IV, because itreceives polluted water from industrial plants and urban settlements in particular from the area of Tuzla basin. By the analysis of water in the basin of the river Sava, it was found that its tributary Bosnia brings more contaminated water in relation to the river Tinja, Brka and Drina. The largest sources of pollution in the catchment area of the river Bosna are municipal wastewater from urban centers: Sarajevo, Visoko, Zenica and Tuzla Basin.

Water quality of the Drina River -Drina is a fast and impetuous river with the water of greenish colour, it is the main watercourse in the eastern part of the region and the largest tributary of the Sava river into which it delivers 11,7 billion m³ of water. (Maric, 2002) The water of the river Drina belongs to I (first) class (water that in its natural state or after disinfection can be used for drinking) and II (second) class (after purification it can be used for water supply, the food industry or for rearing cyprinid fish species), which makes them high-quality streams. In its upstream flow, the landscape value is visible and it is rich in fish of different species, such as brook trout, grayling, chub, sneep, pomfret, barbel (lat. Barbus barbus), barbel (Southern Barbel, Mediterranean barbel), Marble trout.

The ecological balance of the watercourses in the last decade disturbs the accumulation of large amounts of municipal solid waste being uncontrollably thrown into the Drina River. Raising the level of the Drina River, plastic bottles, cups, styrofoam, etc. rise to the surface, carried by water it finishes in the accumulation Peručac near hydroplant Bajna Bašta. Municipal solid waste is an environmental problem, which is becoming increasingly evident, aestheticly spoils the appearance of the lake, thus may cause a degradation of species, making the interstate cooperation of Bosnia and Herzegovina and the Republic of Serbia necessary in building a common landfill within the Drina river basin.

Water quality of the Spreča river **-** When it comes to running waters in the region, the most difficult situation is in *the Spreča river*, where nutrients influence the development of different organisms, especially plankton algae, leading to eutrophication and deterioration of water quality. Especially endangered part is from Coke and Chemical Combine (CCC) Lukavac, downstream the situation somewhat improved due to the process of autopurification, so that the linewater takes on the characteristics of water of II (the second) and III (the third) class quality (after purification of water that can be used for irrigation). (Adrović, 2010) Of special mention is the impact of coal mining. Separations of coal in Đurđevik and Banovići daily emit huge amounts of coal dust into the tributaries of the Spreča river. (Strategy of reconstruction and development of TK) Into the Spreča river, people daily bring a large amount of fertilizers from Spreča agricultural goods and other arable land in the villages near the watercourse. Research of ichtyofauna of the Spreča river indicate the presence of ten species of fish families cyprinids. The finding of a small number of fish species is a reflection of the presence of unfavorable environmental conditions in this river. Waste water from the settlements around the reservoir as well as other forms of pollution are also present and represent a serious problem for water and environmental community in it. In the wider catchment area of *Modrac lake*, live about 135.000 inhabitants, of which 25.000 live directly on the basin reservoirs. It follows one more important function. Water from Modrac lake is used for the supply of industry and the population in the municipalities of Tuzla, Lukavac, Živinice, Kalesija and Banovići. (Nurković, 2008) Starting from these facts, it is necessary to urgently take all necessary measures to protect the watercourse of the river Spreča.

4. FLOODED AREAS

The occurrence of floods is also caused by uncontrolled deforestation in the catchment area of watercourses, which affects the erosion of topsoil and reduces its power to absorb large quantities of water. This leads to faster water run off into watercourses, which affects the occurrence of floods.(Risk assessment of natural and other disaster in Tuzla Canton) *In the immediate Sava River Basin*: pouring from its riverbeds, the Tinja and Sava in the area of Srebrenik and the Brčko District, threaten by floods about 10.000 ha of land. The Sava River and its smaller tributaries Lukovac and Gnjica pouring from the bed, in the area of Semberija threaten and flood around 21.820 ha of land. (Capabilities and strategies of development of the water sector) On the basis of the existing planning documents, the regulation of the Tinja river bed is going to be provided in the area of Srebrenik in a length of 26 km. Documentation and plans for protection of water in the area of Brčko District are in the development stage, so that in this paper there are not presented the planned features and regulation of beds of the mentioned watersteams.

In the immediate Drina River Basin: pouring from their banks, the river Drina and Janja threaten to agricultural land in Semberija, Janja and Bratunac.

(Republican Institute of Statistics) In the valley of the Drina River, surfaces in Sembrija (20.800 ha) and Bratunac (300 ha) are exposed to floods. A particular problem is an unprotected area upstream of the confluence of the Drina River to the Janja river of about 18 km, as well as the area along the lower course of the Janja river. Pouring water courses of the Janja river in Suho Polje, Modran, it is threatened around 1500 ha of land. (The Spatial Plan of the Serb Republic until 2015)

In the immediate Bosnia River Basin: during heavy rainfall especially in the spring and fall, pouring from their banks, the river Oskova, Gostelja and Spreča, endanger about 7.000 ha of land in Spreča valley, in the Kalesija, Živinice, Gračanica and Lukavac municipalities. The causes of flooding are unregulated and unorganized channels for drainage of surface water, poor drainage networks in these areas, undeveloped main and sub defensive levees along larger streams in the lowlands as well as flood and mountain water, of great destructive power, which occur after heavy local showers. Flooding also occures downstream of hydro reservoir Modrac, in the municipalities of Lukavac, Gračanica and Doboj Istok. During prolonged and heavy rainfall or due to rapid snow melt, there is an influx of water (several hundred m^3/s) into the reservoir which results in leakage of water over the spillway at the dam Modrac. Floods are a serious factor of disrupting the environment, and they are a major cause of damage and the cause of the inadequate use of important agricultural areas of the region. (Group of authors, 1977)

Floods, however, occur by the regulated watercourses as well because of deposing of large amounts of various waste materials, and along watercourses, as well as over them, various buildings are illegally built, all of which has an impact on reducing the water flow and water courses leading to floods. After field tour of natural watercourses, reviews and analysis of the current situation, it may be stated as follows: in northeast Bosnia in almost all watercourses, in the river beds are disposed different kinds of waste, which results in a blockage of the water flow, which leads to major spills of water to the surrounding areas.

Acording to the General project of ***flood protection*** and regulation of the river bed - Energoproject,1998, *the regulation of the Drina River was proposed*, from the standpoint of stabilizing the river bed and coastal development in the area downstream from Zvornik to the confluence into the *Sava river* and *the regulation of the riverbed* and protection from the spills of *the Janja watercourses* in the area of Suho Polje, Modran to the mouth of the River Drina. "Barrier troughs" the so-called river variant were proposed, with a cascade of small steps in the riverbed of the Drina from Zvornik to the confluence with the four steps "Kozluk", "Drina I, II and III".

System of coastal protection would arrange the groundwater regime in the wider area ofthe coast, which would create opportunities for even complex hydroamelioration of valley parts of the Drina valley and Semberija. By stabilizing the bed of the disadvantaged sections: Adica, Kutovića Ada, Ada Škuljević, Purevine and Popovi, damming of the secondary flows (pins, elderly, etc.), to have the concentrated flow in the main channel, it would stop the so-called "wandering riverbed" and shortening some sharp bends, punching (flood relief channels) of very developed meanders. The situation with the Drina river upstream is more

favorable in comparison to the natural state because of the Peručac hydro accumulation. It must be stated that in natural conditions, in 1896, the entire Drina valley was flooded. (Capabilities and strategies of development of the water sector)

This extreme hydrological event eloquently demonstrates what an unfavorable coincidence of hydrological and meteorological phenomena can occur, and cause catastrophic floods, which is the reason why the bed of the impetuous river should be regulated in time. Preventive flood protection primarily means taking the necessary actions on the regulation of the river beds of the Spreča and major tributaries that threaten to flood the area of Spreča valley. All planned measures are necessary by the inspection and other competent authorities in order to prevent desposal of various waste materials in river beds, as well as measures to prevent illegal construction of various buildings over and along the river channels, which can decrease the water flow of watercourses.

It is necessary to regularly maintain waterbeds, which involves the removal of various plants and waste materials from the water stream. For protection from flood waters of *Spreča river valley*, it is necessary to create dikes upstream from the reservoir Modrac, the length of about 36 km, and downstream of the reservoir Modrac, the length of about 65 km. Two variants have been discussed. Making embankments in the length of the entire flow and regulation of the riverbed by stones lining in the length of 47.774 m. (Department of Social Services)

Preparations of the documentation and phase implementation of regulation works of the Jala watercourses in Slavinovići, Gornja Tuzla, and Lukavac settlements, the Solina watercourses in Solina settlement are in progress as well as of a part of the Spreča watercourses in Maline (Živinice) and in the Sokoluša watercourse in Gračanica. (The Spatial Plan for the area of TK 2005-2015) Preventive flood protection includes also *the construction and maintenance of embankments* along rivers, construction and maintenance of adequate water facilities and an exhaust system, the acceptance of surface and ground water, construction, maintenance of culverts, channels below and along the roads.

5. CONCLUSION

The main goal of each society and each of its segments is development, what is also meant in the case of the entire water sector. In particular, a long-term goal of BH is accession to the European Union. As a condition of this it becomes important to harmonize the overall development, including the water sector, with relevant European Union directives. In this case, it involves the consistent application of the Water Framework Directive of the EU, which is primarily related to the quality of water and the collection and treatment of wastewater. This implies that the quality of service in these areas should be as soon as possible brought closer and eventually led to the level of member states. Also, in other documents and conventions, signed by BH, there is this same obligation (Barcelona Convention, Danube Convention, the Basel Conference). (Development Strategy of Serb Republic)

In order to improve the water quality of rivers in the whole area of northeast Bosnia, in perspective, it is necessary to consider the long-term systemic problem solving and access it with a certain seriousness that will guarantee success. In this process it is important to make an analysis of the problem, establish goals, define the criteria and compile a list of priorities for action. A key attribute of integrity of water infrastructure is its harmonious integration into the environment, in particular, complying with all other users of the space.

Positive impacts on the environment are very numerous, for the purpose of economic development, especially tourism, here are systematized those most important ones: safe drinking water has a very significant, positive impact on the ecological environment, a condition is also potential for development of fisheries, water use for recreation and tourism. The waters are a tourist attraction of places or regions. It is an integral part of the area for a variety of activities: swimming, sailing, boating, water skiing. In the area of north-east Bosnia, a cult of water has been traditionally nurtured and waterways have been extensively used in recreational purposes, swimming and water sports, for sightseeing tourism like traditional "teferič" next to the river, boat rides, etc. In recent decades, with the development of water infrastructure, conditions for such activities on water instead of improving – are constantly worsened, requiring serious examination of the causes, because it becomes one of the causes of more and more organized opposition of the public to the implementation of water facilities. (Development Strategy of Serb Republic). Near the larger settlements, in the zones of preserved watercourses, one should evaluate recreational bodies of water in order for recreational purposes, trips, fairs or barbecues. That is why it is justified to say that the investments in water management infrastructure of locomotives for running the development of all other economic sectors.

As purity water is significant for tourism, tourism workers must activate themseves in the fight against water pollution and actively involve in politics of tourist destinations. Necessary technical measures today are all known to everyone and economically affordable. Based on the above it can be concluded that the constant and systematic control of all existing and potential sources of pollution is necessary in order to take adequate measures to reduce their harmful impact on the final recipient the Sava River.

REFERENCES

1. Adrović (2010); *Water quality in rivers and reservoirs in northeast Bosnia*, Centre for Ecology and Energy, Tuzla
2. Group of Authors (1977); *A study on the program and the spatial plan for tourism development in northeast Bosnia, Department of economics*, Tuzla.
3. Hodzic and Kofrc (2006); *Tourism in function of development of the northeast Bosnia region, Proceedings*, Tuzla, pg 85-99.

4. Maric (2002); *Geodiversity of the Drina River Basin*, Proceedings, Faculty of Geography, University of Belgrade, Belgrade, pg 59 - 70
5. Nezirović (2008); *Tourism potential of Srebrenica, Srebrenica, monographs* pg. 30.
6. Nurković (2008); *The influence of lake tourism in economic development of Tuzla region*, The Department of Geography, Proceedings, Tuzla 2008.
7. *** (2008), *The Spatial Plan for the area of TK 2005-2015*,Official Gazette TK 9/06, Tuzla
8. *** (2008), *The Spatial Plan of the Serb Republic until 2015*, Urbanity Institute of RS,B.Luka
9. *** (2007), *The Government of the Brčko District of BiH*, Strategy for the Development of the Brčko District of BH for the period 2008-2013
10. *** (2010), *Capabilities and strategies of development of the water sector*, Draft Development Plan of RS, Banja Luka, pg.100.
11. *** (2010), *Department of Social Services*, The Government of Brčko District.
12. *** (2006), *Development Strategy of Serb Republic*, Directorate for Water Bijeljina,The Ministry of Agriculture, Forestry and Water Management, Bijeljina,
13. *** (2005), *Evaluation of the threats of natural and other disasters in Tuzla Canton*, Cantonal management of civil protection, Tuzla, pg. 20-25.
14. *** (1991), *Hydrological yearbooks 1971.–1991.*, Federal Hydrometeorological Institute, Yugoslavia, Belgrade
15. *** (2010), *Opportunities and strategies of development of the water sector*, Draft Development Plan of RS, Banja Luka, pg. 51
16. *** (1981), *Regional Plan, Srebrenica*,Srebrenica Municipality Official Gazette, SO 4/81, pg. 1-26
17. *** (2012), *Review of the environmental situation in northeast Bosnia and Herzegovina* Centre for Sustainable Development, Bijeljina-Brčko-Tuzla, 2012
18. *** (2005), *Risk assessment of natural and other disaster in Tuzla Canton*, Cantonal management of civil protection, Tuzla
19. *** (1991), *Statistical Yearbook of Bosnia and Herzegovina*, Republican Institute of Statistics,Sarajevo.
20. *** (2009), *Strategy of reconstruction and development of TK, state and possibilities* The Government of Tuzla Canton,
21. *** (2005) *Strategy of development based on respect for human rights*, Zvornik Municipality, Zvornik.
22. http://www.bistro.BiH.ba, accessed on, October,10, 2014.