DANUBE POLLUTION REDUCTION PROGRAMME

NATIONAL REVIEWS 1998
BOSNIA AND HERZEGOVINA

EXECUTIVE SUMMARY

Ministry of Agriculture,
Water Management and Forestry

in cooperation with the

Programme Coordination Unit
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Preface

The National Reviews were designed to produce basic data and information for the elaboration of the Pollution Reduction Programme (PRP), the Transboundary Analysis and the revision of the Strategic Action Plan of the International Commission for the Protection of the Danube River (ICPDR). Particular attention was also given to collect data and information for specific purposes concerning the development of the Danube Water Quality Model, the identification and evaluation of hot spots, the analysis of social and economic factors, the preparation of an investment portfolio and the development of financing mechanisms for the implementation of the ICPDR Action Plan.

For the elaboration of the National Reviews, a team of national experts was recruited in each of the participating countries for a period of one to four months covering the following positions:

- Socio-economist with knowledge in population studies,
- Financial expert (preferably from the Ministry of Finance),
- Water Quality Data expert/information specialist,
- Water Engineering expert with knowledge in project development.

Each of the experts had to organize his or her work under the supervision of the respective Country Programme Coordinator and with the guidance of a team of International Consultants. The tasks were laid out in specific Terms of Reference.

At a Regional Workshop in Budapest from 27 to 29 January 1998, the national teams and the group of international consultants discussed in detail the methodological approach and the content of the National Reviews to assure coherence of results. Practical work at the national level started in March/April 1998 and results were submitted between May and October 1998. After revision by the international expert team, the different reports have been finalized and are now presented in the following volumes:

Volume 1:	Summary Report
Volume 2:	Project Files
Volume 3 and 4:	Technical reports containing:
	- Part A : Social and Economic Analysis
	- Part B : Financing Mechanisms
	- Part C : Water Quality
	- Part D : Water Environmental Engineering

In the frame of national planning activities of the Pollution Reduction Programme, the results of the National Reviews provided adequate documentation for the conducting of National Planning Workshops and actually constitute a base of information for the national planning and decision making process.

Further, the basic data, as collected and analyzed in the frame of the National Reviews, will be compiled and integrated into the ICPDR Information System, which should be operational by the end of 1999. This will improve the ability to further update and access National Reviews data which are expected to be collected periodically by the participating countries, thereby constituting a consistently updated planning and decision making tool for the ICPDR.

UNDP/GEF provided technical and financial support to elaborate the National Reviews. Governments of participating Countries in the Danube River basin have actively participated with professional expertise, compiling and analyzing essential data and information, and by providing financial contributions to reach the achieved results.

The National Reviews Reports were prepared under the guidance of the UNDP/GEF team of experts and consultants of the Danube Programme Coordination Unit (DPCU) in Vienna, Austria. The conceptual preparation and organization of activities was carried out by **Mr. Joachim Bendow**, UNDP/GEF Project Manager, and special tasks were assigned to the following staff members:

- Social and Economic Analysis and Financing Mechanisms: **Reinhard Wanninger**, Consultant
- Water Quality Data: **Donald Graybill**, Consultant,
- Water Engineering and Project Files: **Rolf Niemeyer**, Consultant
- Coordination and follow up: **Andy Garner**, UNDP/GEF Environmental Specialist

The **Bosnian National Reviews** were prepared under the supervision of the Country Programme Coordinator, **Mr. Mehmed Saric**. The authors of the respective parts of the report are:

- Part A: Social and Economic Analysis: **Mr. Osman Slipicevic**
- Part B: Financing Mechanisms: **Mr. I. Sofovic**
- Part C: Water Quality: **Mr. M. Bezdrob**
- Part D: Water Environmental Engineering: **Mr. A. Novalija**

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1. Description of the State of Danube Environment

Water Resources

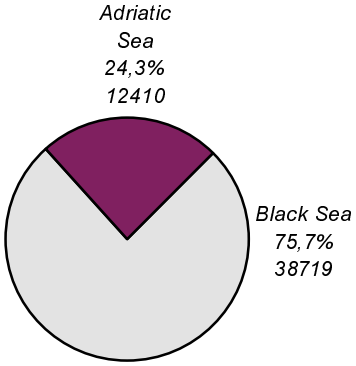
Territory of Bosnia and Herzegovina is placed between $42^0$26' and $45^0$15' of northern latitude and $15^0$45' and $19^0$41' of eastern longitude. Rivers of Bosnia and Herzegovina belong to the river basins of Black Sea and Adriatic Sea. Total river surface in Bosnia and Herzegovina is 51.129 km^2. To Black Sea basin, i.e. river Sava and its tributaries, belongs 38.719 km^2 or 75,7%. To Adriatic Sea river basin belongs 12.410 km^2, i.e. 24,3% (see Figure 1).

All rivers in Bosnia and Herzegovina, beside the river Neretva, belong to the Danube River basin. Their joint characteristic is great height difference between source and estuary (slope) and large water quantities, what makes them fast and strong. The biggest rivers are Una, Vrbas, Drina, and Sava. All these rivers in their upper flow are passing through mountains, while their estuaries are in valleys. Their estuaries are wide, still and rivers are often flooding surrounding areas. Importance of these rivers is many-sided, and mostly they are used for irrigation, hydro power plants, fishery, ware supply, tourists activities, etc.

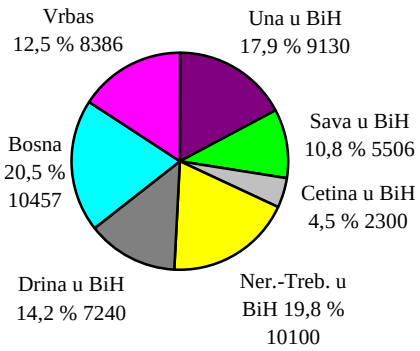
Surface of each river with its tributaries compared to total river surface in Bosnia and Herzegovina is shown in the following Figure.

BOSNIA AND HERZEGOVINA
(Main catchment areas - km^2)

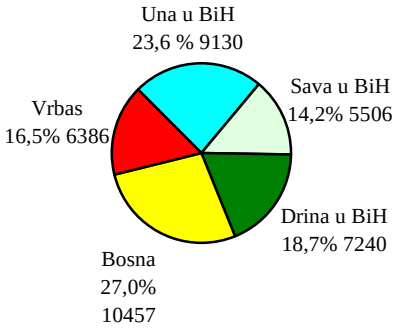
AREA OF BIH
51129 km^2



BOSNIA AND HERZEGOVINA
(River basins - km^2)



BLACK SEA CATCHMENT AREA
(River basins - km^2)



Significant water resources in Bosnia and Herzegovina are also lakes, especially mountain lakes which are rich with water of high quality that also can be used in many ways. Boračko Lake, lakes on mountain Zelengora and Šator, Big and Small Plivsko Lakes are only some of many such lakes. By construction of hydro power plants on rivers in Bosnia and Herzegovina, many artificial lakes have been made. The most famous of such lakes are Zvorničko Lake, lakes made by construction of hydro power plants Jajce, Modrac Lake on the river Spreča near the city of Tuzla, etc. Main activities on these lakes are tourism, fishery and water supply.

Another water resource in Bosnia and Herzegovina is 24 kilometers long coast, which recently has become a significant tourist's resource.

Biological Resources and Ecological Systems

New knowledge about natural phenomena in Bosnia and Herzegovina and scientific and modern approach to planning led to the creation of Space Arrangement for Bosnia and Herzegovina in 1980 that insisted that between 16 and 24% of entire Bosnia and Herzegovina territory should be put under some kind of protection. Unfortunately, because of slow implementation, that plan was prolonged from 2000 until 2025 year. Although the implementation process was going slow, 253 areas and natural monuments were protected by that plan up to now, with total surface of 28.127 hectares (0,55% of the entire Bosnia and Herzegovina territory). That minimal protected surface includes areas with Pančićeva pine-tree, the primeval forest Peručica, primeval area on the mountain Klekovača (from total surface of 7000 hectares, covered with fir-tree, beech-tree and spruce this area is reduced on 295 hectares of so called "forest stock"), areas covered with white pine, glacier lakes on the mountains Treskavica and Vranica, water-falls on the rivers Una and Trebižat, etc.

Unfortunately, Space Arrangement Plan also failed because of old-fashioned way of thinking, which put Bosnia and Herzegovina in the position of the most misused republic in former Yugoslavia, because it was used as raw materials storage.

Recently, two activities for space arrangement and nature protection were initiated in Bosnia and Herzegovina. City Planning Institute of the city of Sarajevo initiated creation of the National Park in the area of the mountains Treskavica, Igman and Bjelašnica. That would make a rich and attractive environment around the capitol, and later on other areas (the mountains Jahorina, Trebević, Crepoljsko and Crnoriječki Plato - foreseen to be the natural parks) would be involved.

Special place in Space Arrangement Plan is foreseen for water resources, because they have top priority due to richness of phenomena and sensitivity of their ecological systems. These resources are the rivers Una, Sana, Trebižat, Drina, Neretva, Pliva that have phenomena, which are result of millennium years old bio-dynamic process, and which can be ruined and destroyed by natural misbalance caused by hydro power plants. Terrifying example is coving in of barrier on the waterfall on the river Pliva near the town Jajce.

Human Effects and Key Issues of Deterioration of Environment Protection

Even in the B&H pre-war period, pollution and unhealthy environment were great social, economic and health problem. Unfortunately, it can be said that B&H in the former Yugoslavia was some kind of colony, with all greater polluters and environment consumers placed in it, receiving yearly even 10 million tons of waste materials. In the recently ended war, beside other problems, B&H also have experienced framed ecological apocalypse. For that reason it is very important, for this country that just enters to period of reconstruction and long-term development, to start to develop more responsible relation of population to nature and environment.

There are numerous and close dangers, which are mostly result of human activities, and those are: loss of cultivable areas, toxically agricultural technologies, unrecoverable loss of rare plant and animal species and ecological phenomena, limited water quantities, wide spectrum of air, water and food contaminants, dependence on damaging and unrecoverable energy resources, forest destruction, etc.

These human effects are supported by the war effects, e.g. presence of 16.000 minefields that cover 18% of the entire B&H territory, with more than 6.000.000 unexploded mines. Also there are more than 36.000 of SFOR soldiers that discharge different kinds of waste materials without any control from B&H or Entities Authorities. There is also problem of adequate storage or destruction of 500 tons medical drugs, which date of usage is expired.

In spite of improvement in some water systems in the country, as direct consequence of cease of production in industrial plants during the war, now again water quality deteriorate as consequence of industrial and agricultural plants restart and reconstruction. Many of industrial and agricultural facilities, beside air pollution, also are polluting environment with discharge of waste materials. Secret and covered discharge of waste materials in rivers and public communal areas is still present. In 90% of total cases, the Authorities know neither kind, nor location of these waste materials.

Before the war, there was no radioactive contamination in B&H. There was more than 500 installed lightning conductors and around 30.000 ionic fire alarms, but they all were under control and permanent monitoring. It is estimated that 10-12 lightning conductors are crushed down, and 5.000 - 8.000 fire alarms are damaged or stolen. There are potential danger for contamination of environment and persons, who enter to such facilities.

2. Population Development and Water Sector Relevant Characteristics

Analysis of Demographic Data and Projection of Urban and Rural Population

According to the estimates of State Institute for Statistic and Health Protection of B&H, on the B&H territory there is at present 3.798.333 inhabitants. Compared to 1991 it is 9,8% reduction. Population in B&H consisted of 62% of city and 38% of rural population, placed in 109 basic social-political communities, i.e. the municipalities.

Ratio of city and rural population was also changed as a result of the war activities. That ratio is, according to estimate of Institute for Statistic and Institute for Health Protection of B&H, 80:20 in favor of city population. This ratio is multicausal and forced war migrations have determining part. Also, consequences are numerous and full of psychosocial, cultural, health and other phenomena, and have influence on subject of this report, i.e. water in widest range of meaning of this word.

Most of the B&H inhabitants are living near rich soil area by river basins which all, beside Neretva River, belong to the Danube River basin. Total number of inhabitants of certain areas (by rivers) consists of population concentrated mostly in bigger settlements and cities. On that way we can estimate that total number of inhabitants who live in these areas is 2.945.770, i.e. 73.7% of the total population of B&H. If we discount the number of rural population out of this number, we will get evaluation that in areas located directly by rivers (larger settlements and cities), at present live around 2.356.300 inhabitants.

Estimation of Actual and Future Demand for Water

Revision of total conditions of water supply system in B&H during 1996/1997 shows that: 45% water supply system is damaged, 20% is partially damaged, 5% is worn out, 20% is undamaged, and 15% is under reconstruction. Losses in the water supply systems are large and they varied from 30 to 70%. It is estimated that only 50% of the population is supplied with water from water supply systems, while the rest of the population uses water from alternative water sources.

In respect to the above mentioned facts we can deduce some new estimates related to the population water needs and demands. If we consider regulated hygiene standards of daily water consumption per capita, we need to provide following water quantities (also including all categories except industrial consumption):

- in the settlements without water systems (dug well, rain water tanks) - 20 to 60 liters per capita
- in the settlements with water supply system, but without house tapping - 100 liters
- in the settlements with water supply system and with house tapping - 250-500 liters

If we take into consideration the lowest quantities, we will get a figure of 235 million m^3/year that should be provided to the population of B&H. 203,5 million m^3 of that quantity belongs to the urban population.

In 2010 we can expect fulfilling of present water needs, which were foreseen by development plan until 2000. Here we must take into consideration needs created by increased number of population and foreseen dynamic of repatriation. In urban areas water supply should cover 100% and in rural areas 60% of population. Water losses should be reduced to 30% in the most critical areas. In urban areas 250 liter per capita per day should be provided and in rural areas – 60 liters per capita per day. In 2020 population growth should be continued and water consumption is expected to be increased to 350 liters per capita per day in urban areas and to 100 liters per capita per day in rural areas. Connection to central water supply system in rural areas should be also increased to 90%, and water losses should be reduced below 20%.

Estimation of Actual and Future Production of Wastewater

Problem of waste material disposal, which was present even before the aggression on B&H and was intensifying during the aggression, remains unsolved after the peace was established. Secret and hidden disposal of waste material in rivers and on public properties is still present in 90% cases, and authorities yet do not know nature or location of these waste materials. Wastewater, both industrial and communal origin, is being discharged to recipients without previous interception, collection and purification (only 15% percent of total wastewater is being purified before discharging). There is no list of industrial polluters, and none of the pollution measuring was performed during the war.

River basins of some water sources are continuously deteriorating, because of forest hewing down, soil erosion, development of settlements, construction of industrial utilities and infrastructure, waste material disposals, etc.

It is hard to make estimation about quantities of wastewater coming from households. On the basis of quantities of consumed water per capita per day in some municipalities (Tuzla 80-150 liters, Lukavac 250, Gračanica 200, Sarajevo 200, Banovići 50…), it can be estimated that population of the B&H Federation is supplied with 150 liters per capita per day. If 80-90% of that quantity becomes wastewater, that means that each inhabitant in average produce from 120 to 135 liters of wastewater per day. For entire B&H Federation territory that means between 28.640 m^3 and 316.845 m^3 of wastewater per day.

Analysis of Health Hazard through Water Pollution and Unsanitary Condition

Estimates show that 57% of city population is connected on sewerage systems, while rural population uses permeable septic tanks. Where city sewerage networks already exist, they are mostly worn out. Consequence is breaking and cracking of sewerage pipes, which is followed by pour out of wastewater and potential danger of infectious increase.

Proves about harmful effects of polluted waters on human health are quite poor, mainly because there were not many research project with this specific goal, but not because that effects are unknown. Public companies are in charge for water supply systems, but they do not have any card-file of water facilities. They are expected to provide water quality in accordance to the defined standards, but water quality is still bad and does not comply with demanded standards. Joint characteristic of almost all water facilities is badly arranged area of pollution protection.

Regarding chemical control, we can say that 55% of B&H Federation population is supplied with water that is continuously and regularly controlled in laboratories. 32% of urban population is supplied with hygienically correct potable water, while the rest is supplied with hygienically incorrect water. 42% of total laboratory checked water samples is chemically incorrect. Regarding water biological contains, 32.5 of total laboratory tested water samples is incorrect.

It is estimated that percentage of rural population supplied with hygienically incorrect water is lower than 32 percent. Such situation puts B&H on high place among the countries with large percentage of water-born stomach contagious decease, e.g. enterocolitis and hepatitis A. Because of bad life conditions parasitological deceases, especially scabies, are increased.

3. Analysis of Actual and Expected Impact of Economic Activities on Water Demand and Potential Pollution of Aquatic Systems

Industrial Activities

Intensive increase of industry, agriculture, traffic and other activities also increased water consumption, whether it is being used directly or being polluted and discharged into environment without pervious purification. Consequence of such usage is that some rivers, like Bosna, Vrbas, Sana, Jala, etc., practically become wastewater channels almost along their full length.

Most of the industrial plants had poor or no purification system at all even before the war, so this is a good opportunity not to forget that problem in reconstruction process. Covered and secret waste discharge is still present, and authorities do not know about 90% of the deposits.

In some regions, especially those where intensive economy development damages environment, care about environment protection was neglected. Those regions are mostly placed in Canton Tuzla-Podrinje. Main sources of pollution are bigger settlements, industrial centers, enterprises, power plants and coalmines. Investigation carried out in 1992 registered 48 polluters who discharged their wastewater directly into the rivers without any kind of purification. Most of the wastewater contained toxic things, which are very dangerous for water environment even in very small quantities. Water was purified only in municipality Gradačac, where both communal and industrial wastewater was purified in the same plant. In chemical plant in Lukavac part of the wastewater was purified in purification plant in Banovići, sludge water was purified in Đurđevik, and pretreatment plants in Polihem.

Project of revival of industry must in its reconstruction program contain project of waste materials treatment, which will go into water recipients. It is hard to discuss now how large quantity will be, because the reconstruction process of entire economy system on new conception is still being expected. We can assume that there will be certain deviation from pre-war basic kind of industry, and that new industry will have ecologically safe, profitable and effective equipment.

Municipal Discharges

Sewerage systems exist in most big cities (about 57% of population is connected to them), but wastewater is usually discharged directly in rivers (90%) without previous treatment. Some wastewater treatment plants that existed before the war are now out of operation due to war destruction (plant for the city of Sarajevo in Butile). Village population discharges their waste mostly to septic tanks with permeable bottoms.

Agricultural Activities

Agricultural facilities are big consumers of water, but they are also contaminant of water, especially aquifer. While great care was given to protection from water, nobody took care about protection of water itself. It was especially expressed during uncontrolled and massive using of different chemicals (fertilizers, plant protection means, herbicides), which were drained into rivers and aquifer by rains. Dewatering of cultivable areas with polluters is present in some areas (Gornja Spreča, Brčanska Posavina, etc.).

Even before the war, pesticides were great problem, because uncontrolled and excessive usage (even as high as 1 kg of pesticide per hectare of cultivable area). During the war agricultural activities were drastically reduced, around 0,25 hectare per person. That way cultivable land was

recovered from overuse of pesticides, but redevelopment of agriculture will bring same risk again. At the same time, possibilities for controlling of pesticides are reduced. Special danger is presence of such means in aquifer, because they are being used for supply of potable water. Water with bad quality (which contains industrial material, acid rains and colored rains) can have back influence on agriculture, what can be seen by reduced production, inequality products and sometimes even by destruction of some crops.

Solid Waste Disposal and Possible Soil and Groundwater Contamination

There is only one city deposit, and that is Uborak in Mostar (built in 1997), which is in accordance with sanitary rules and norms. City deposits are mostly not properly built, and waste material is mostly being left on riverbanks, free land areas, market places and between buildings. Only 15% of urban and industrial wastewater is being purified before discharge to recipients, because purification collectors do not exist or are out of order.

Garbage quantities in larger cities (ash, glass, metals, tires, broken dishes, plastic materials, food residual and other waste materials) are between 300-500 kg per capita per year. Such large quantities should be collected, transported and destroyed according to hygiene conditions. At present, in B&H is impossible to perform any of mentioned phases.

B&H have great raw-goods capacity, especially coal, iron, bauxite. Exploitation of so many raw-goods will cause multiply negative effects to soil quality. Exploitation process consists of removing of large soil layers in order to access to raw-good. Removed layers are being displaced on another land surface, which destroys vegetation in those parts. Afterwards, raw-goods are being used through different technology processes, creating on that way many kinds of industrial and mine waste.

Depth of excavated soil can be even 300 m. The biggest excavations of that type is in region of Banovići and Zenica (e.g. led, cadmium). Total surface of soil occupied by waste deposits in B&H is about 1.200 hectares. In municipality of Lukavac 25 hectares of soil was damaged because of SFOR activities (presence of heavy armament, parking of vehicle, performing of military exercises).

Excavated soil is being displaced on other location, what causes additional damage to the land. Surface damaged by this additional way is half of the surface directly damaged by excavations, i.e. 6.420 hectares.

Work of thermal power supply facilities (Lukavac, Ugljevik, Kakanj, Tuzla, Gacko) causes making of large quantities of ash and slag which are deposed on land again. Areas covered by ashes in B&H have 600-800 hectares of surface.

Development of technology and industry caused economy progress, which will continue to develop in the post-war period. Consequence of that will be usage of new areas and soil for industrial and water facilities, deposit of waste from raw-goods mines, deposits of industrial and communal waste, construction of traffic facilities, etc.

Such construction will have following influence on soil:

- destruction of green areas,
- presence of some geological and petrography means,
- presence of damaging means which contaminate soil and aquifer (e.g. heavy metals)
- impossibility of reuse without previous soil treatment.

4. Analysis of Water Quality Data and Description of Environmental Impact on Ecosystem and Human Quality of Live

Water Quality Data Critical to the Transboundary Analysis (Danube Water Quality Model)

War activities, started in 1991, constrained monitoring of the water quality in Bosnia and Herzegovina, and stopped it completely in 1992.

In the war condition, where factories are not working or work with reduced capacity, it can be assumed that quality of the surface waters is much better.

Standard physical and chemical parameters, which are constantly being measured are: temperature, appearance, pH, alkaline, dissolved oxygen and percentage of saturation, hardness, total quantity of hard and suspended particles, consumption of $KMnO_4$, BOD, ortho-phosphates, total iron. Nitrogen compounds (ammonia, nitrites nitrogen and nitrates nitrogen) are being regularly controlled only at 10 points.

For presentation of water quality state in Bosnia and Herzegovina in the normal conditions, available data bank of Republic Hydro-Meteorological Institute for the last pre-war five years period (1985-1989) was used.

Concentration and loads of nutrients and other pollutants in the Danube River and its tributaries

Available water quality data for the Danube tributaries are shown in Table 4.

For further analyses of the surface water quality, there are individual data for some general parameters (dissolved oxygen, suspended particles, consumption $KMnO_4$, BOD, iron and the most probable number of total coliforms - PNC). Beside middle values, on every point number of samples is shown, where value of mentioned parameters in given hydrological conditions exceeds allowed value for adequate class. Beside few exceptions, all data comprise 15 samples (3 times per year). Number of samples for bacteriological analyses is not higher then 10 (2 times per year).

On the most of the points, concentration of dissolved oxygen persistently satisfies values foreseen by class. Only on 13 points (22,4%), temporarily problems with dissolved oxygen occur. The most critical situations are in the estuary of the river Sana, in the river Una after inflow of the river Sana, in the river Vrbas after Banja Luka in the river Bosna by Reljevo, and in estuaries of some tributaries of the river Bosna (Zujevina, Miljacka, Spreča).

Concentrations of suspended particles sometimes exceed value of maximum allowed concentration (MAC) for given class of river in 46 points (79,3%). If we exclude rare exceeding of MAC, which are probably consequence of soil erosion, mentioned number of points with concentration of suspended particles above allowed concentration decreases to 25, i.e. 43,1%. Water in the rivers Una and Drina contains very little suspended particles. As opposite case, water in the river Bosna and its tributaries mostly has large concentrations of suspended particles, which even in the middle value exceed high allowed concentration for III class, which is 80 $g.m^{-3}$. Especially high concentrations were found in the rivers Jošanica, Stavnja, Lašva, Spreča, Bosna downstream from Zenica, and the river Vrbas downstream Jajce.

Values BPK_5 are sometimes above the standard for given class at 41 points (70,7%). Especially high are values in the tributaries of the river Bosna and at points that are under influence of cellulose factory (the river Sana downstream of Prijedor, the river Vrbas downstream of Banja Luka, and the river Bosna downstream of Maglaj).

Consumption of oxygen from $KMnO_4$ is also sensitive parameter for quality measuring, because at 38 points (65,5%) quality that do not comply with requested class was found.

Number of points where the biological pollution is above standard is very high (46), i.e. 79,3% of total controlled points. Bacteriological pollution can not be found only in part of the river Una up to Bosanski Novi and part of the river Drina up to Foča.

Iron concentration in pure parts of flows (the river Una up to Dubica, the river Drina up to Foča) are not high and only sporadic, and because of erosion, can be little bit bigger. But in the river Vrbas and especially in the river Bosna, those concentrations are very high. In the river Bosna, except in the part from its source up to the estuary of the river Zujina, even middle values are 2 to 3 times bigger then allowed value for the III class. The biggest contribution for increase of iron level in further flow of the river Bosna is given by its tributaries Miljacka and Jošanica, and iron factories in Ilijaš and Stavnja. Next large source of pollution is Mine and Metallurgy Plant Zenica. In further flow, because of sedimentation, concentration of iron is lower.

All rivers in Bosnia and Herzegovina belong to the types of hard or very hard waters. The river Una has the biggest hardness and alkaline, but this is not related to total contains of solid matters. Concentration of all three mentioned parameters in the river Vrbas are in increase from point V-1 up to the point V-3, then in decrease, especially after the artificial lakes Jajce and Bočac. After Banja Luka, their concentration increases again because large quantities of industrial and community wastewater pollution. Compared to the other rivers, Drina has the lowest levels of mineral contains, hardness and alkaline in the controlled part of its flow. Because the river Bosna is heavily polluted along entire length, situation is changing along its flow: from middle value of hardness of 160 (Roman bridge) up to 283 (Modriča).

Contains of total solid matters varies even more: from 155 (Roman bridge) up to 444 (downstream from Zenica), or 458 (downstream from estuary of the river Spreča). Concentration of chlorides and sulfur compounds in every river are small, except in the river Spreča and the river Bosna after inflow of Spreča, where concentrations of chlorides are several thousand milligrams, and concentration of sulphates is several hundreds per liter. Such high values of hardness, alkaline and total solid matters rise costs of preparing of water which is used for different purposes in thermal power supply plants and other industrial plants.

Republic Hydro-Meteorological Institute performed measuring under different hydrological conditions, but very small number of samples belongs to flows that are similar to monthly small waters with 95% security (Q_{MP}). Law regulations defined that MDK is related to flows “which are equal or higher than monthly small water with 95% of security”. According to aforementioned law, the most severe criteria are concentration of standardized quality during Q_{MP}.

Average flows for observed five-year period are much higher then flow relevant for calculation of pollution effects. Number of samples taken in period of low water level is very small and it is around 5% of total number of taken samples. Beside this, mentioned samples are taken mostly from tributaries or points in upper flows of main rivers. If we consider samples within QMP + 30% as relevant for analyses of concentration in case of low water, we can say that 10,2% of samples satisfy conditions. But if we exclude tributaries and upper flow of main rivers, then we have only 2,8% of samples that satisfy given conditions. Those samples are taken on random basis in different streams, so it is practically impossible to make analyses about state during low waters. But we can assume that values of quality at the points, which are under direct influence of strong source of anthropological pollution, are much higher during low waters than it is established by experiments.

Results of monitoring of the surface waters do not give all elements necessary for estimation of macronutrients and estimation of potential productivity of the system (which is based on total contains of phosphor and nitrogen). Water testing of Republic Hydro-Meteorological Institute

includes only fragment of total phosphor (dissolved ortho-phosphate) and parts of total nitrogen (ammonia nitrogen, nitrite and nitrate nitrogen). Concentrations of both nutrients at all testing points were above the level that limits algae overgrowth (eutrofication) in all built or planned artificial lakes. Relatively, lower concentrations of nutrients have river basins of Una, Drina and Vrbas. High concentrations of phosphor and nitrogen were found in the Ukrina, the river Bosna and most of its tributaries. Because of toxic and other negative effects, in our country, law regulates maximal allowed concentrations of ammonia nitrogen, nitrite and nitrate nitrogen. According to available data (only 15 samples was taken), the most jeopardized points are part of the river Vrbas below the city Banja Luka (points V-6, V-7 where 25% of tested samples contains ammonia above the allowed level, and 12,5% of tested samples contains nitrites). At all tested points of the river Bosna average values of tested nitrogen compounds, although they are higher than in the other rivers, are below allowed concentration because of the water class (III class). At downstream points of the river Bosna (B-8, B-11, B-13) in 18,6% of tested samples nitrite nitrogen was above the allowed limit for III class.

Table 4. Middle values of parameters and percentages of exceeding of MAC (in brackets) according to research of Republic Hydro-Meteorological Institute

Points	Dissolved O_2		Suspended solids		O_2 from $KMnO_4$		BOD		Total Fe		PNC	
1	2		3		4		5		6		7	
U-1	11.3	(0)	11	(6.7)	0.85	(0)	2.4	(6.7)	0.15	(13.3)	4120	(0)
Un	11.5	(0)	6	(6.7)	0.97	(0)	2.4	(0)	0.06	(0)	592	(0)
U-2	12.2	(0)	6	(6.7)	0.95	(0)	2.5	(0)	0.06	(0)	1470	(0)
U-3	11.3	(0)	14	(13.3)	0.91	(0)	2.6	(0)	0.07	(0)	4360	(0)
U-4	11.2	(0)	12	(6.7)	1.08	(0)	2.4	(6.7)	0.08	(0)	13500	(0)
U-5	10.8	(0)	11	(6.7)	1.12	(0)	2.4	(6.7)	0.10	(0)	6070	(22.2)
S-2	6.1	(40)	12	(6.7)	21.2	(100)	3.9	(33.3)	0.26	(13.3)	217000	(77.8)
U-6	8.3	(26.7)	16	(6.7)	9.2	(86.7)	3.3	(20.0)	0.15	(0)	11100	(33.3)
U-7	8.8	(6.7)	21	(20.0)	10.3	(93.3)	3.2	(26.7)	0.28	(20)	25700	(62.5)
V-1	11.3	(0)	18	(22.2)	1.6	(11.1)	3.0	(22.2)	0.33	(22.2)	16600	(40.0)
V-2	11.2	(0)	21	(26.7)	2.1	(13.3)	3.7	(40.0)	0.35	(26.7)	19700	(11.1)
V-3	11.8	(0)	31	(40.0)	2.43	(13.3)	3.1	(20.0)	0.39	(33.3)	14300	(11.1)
V-4	11.1	(0)	44	(53.3)	2.37	(26.7)	3.3	(40.0)	0.49	(60.0)	31600	(22.2)
V-5	11.5	(0)	11	(0)	1.08	(0)	2.8	(20.0)	0.14	(13.3)	15100	(10.0)
V-6	5.9	(26.7)	33	(6.7)	37.5	(93.3)	9.5	(66.7)	0.24	(0)	85100	(40.0)
V-7	5.5	(33.3)	46	(6.7)	26.5	(80)	7.0	(26.7)	0.71	(13.3)	97500	(40.0)
B-0	12.3	(0)	9	(40.0)	0.96	(0)	2.3	(66.7)	0.12	(6.7)	1770	(50.0)
Z-1	11.1	(0)	14	(13.3)	1.58	(0)	3.4	(33.3)	0.27	(20.0)	253000	(80.0)
Zu	8.4	(20)	33	(33.3)	22.2	(80)	8.1	(92.9)	0.66	(60.0)	180000	(70.0)
B-1	9.8	(6.7)	27	(20.0)	4.09	(60)	3.9	(33.3)	0.40	(33.3)	67900	(30.0)
M-1	7.1	(20)	30	(0)	7.71	(80)	6.0	(28.6)	4.67	(86.7)	566000	(70.0)
B-2	7.2	(26.7)	21	(0)	4.40	(33.3)	4.5	(6.7)	1.31	(53.3)	232000	(60.0)
J-1	9.8	(0)	148	(73.3)	9.40	(93.3)	10.3	(100)	7.04	(66.7)	770000	(90.0)
B-3	8.7	(0)	34	(13.3)	4.40	(26.7)	4.5	(6.7)	2.43	(73.3)	116000	(50.0)
St-1	9.7	(0)	203	(80.0)	12.40	(80)	5.6	(40.0)	6.39	(93.3)	182000	(50.0)

1	2		3		4		5		6		7	
B-4	8.8	(0)	47	(13.3)	4.50	(33.3)	4.7	(13.3)	2.32	(100)	164000	(50.0)
F-1	12.3	(0)	13	(0)	1.12	(0)	3.9	(33.3)	0.21	(33.3)	20600	(25.0)
B-5	8.2	(0)	55	(20.0)	4.64	(20)	6.3	(26.7)	1.76	(60.0)	68200	(50.0)
Zg	10.3	(0)	28	(40.0)	5.30	(73.3)	7.4	(80.0)	0.60	(66.7)	308000	(66.7)
B-6	9.3	(0)	45	(20.0)	3.65	(13.3)	4.1	(6.7)	1.19	(40.0)	92700	(50.0)
Ls-1	11.0	(0)	53	(40.0)	2.56	(20)	3.5	(40.0)	0.90	(66.7)	101000	(60.0)
B-7	9.8	(0)	58	(26.7)	3.59	(13.3)	3.5	(0)	1.30	(40.0)	137000	(50.0)
B-8	8.5	(0)	97	(53.3)	5.50	(53.3)	4.6	(0)	3.09	(86.7)	225000	(70.0)
K-1	10.3	(0)	19	(6.7)	3.04	(46.7)	2.0	(0)	0.61	(53.3)	168000	(60.0)
B-9	9.3	(0)	62	(33.3)	5.10	(20)	3.6	(6.7)	2.06	(66.7)	578000	(80.0)
B-10	9.6	(0)	34	(6.7)	4.00	(13.3)	4.2	(6.7)	1.01	(40.0)	492000	(80.0)
B-11	7.7	(6.7)	45	(6.7)	8.40	(73.3)	6.0	(20.0)	1.20	(46.7)	655000	(80.0)
Us-1	9.9	(0)	14	(6.7)	3.16	(60)	3.3	(20.0)	0.37	(53.3)	107000	(50.0)
B-12	8.4	(0)	55	(13.1)	4.51	(26.7)	3.6	(0)	1.03	(40.0)	688000	(80.0)
Sp-2	5.4	(26.7)	118	(40.0)	12.50	(100)	5.5	(35.7)	0.60	(20.0)	529000	(80.0)
B-13	8.1	(6.7)	26	(0)	5.20	(40)	4.2	(13.3)	0.83	(40.0)	479000	(70.0)
B-14	9.5	(0)	20	(0)	5.10	(40)	3.7	(0)	0.49	(13.3)	549000	(90.0)
D-1	11.5	(0)	12	(6.7)	0.78	(0)	2.3	(0)	0.26	(6.7)	280	(0)
Ce-1	11.1	(0)	4	(0)	1.00	(0)	2.7	(0)	1.10	(0)	240000	(100)
D-2	11.3	(0)	22	(6.7)	1.92	(13.3)	2.8	(6.7)	0.48	(13.3)	63100	(50.0)
D-3	11.1	(0)	28	(13.3)	1.28	(0)	2.7	(13.3)	0.60	(20.0)	168000	(60.0)
L-1	11.2	(0)	27	(13.3)	1.61	(6.7)	2.5	(13.3)	0.71	(46.7)	56400	(33.3)
D-4	10.9	(0)	34	(13.3)	1.42	(0)	2.3	(13.3)	0.93	(33.3)	17200	(16.7)
Uk-1	9.4	(0)	22	(20.0)	5.20	(73.3)	2.8	(13.3)	0.62	(66.7)	24000	(10.0)
Uk-2	8.8	(6.7)	29	(33.3)	4.96	(86.7)	3.8	(46.7)	0.43	(33.3)	39500	(33.3)

(Remark for the Table 4. - Numbers in front of the brackets present middle value, and numbers in the brackets percentage of the samples where values are higher then MAC)

Transboundary effects of pollution

Main problem in normal pre-war conditions was industrial pollution. In current conditions, municipal pollution is dominant, especially along river Bosna, although there are no exact indicators. For detailed analysis larger scope of research than the one that is present now is needed.

5. Identification, Description and Ranking of Hot-Spots

During 1991 and in the beginning of 1992, because of the war, import of raw goods and accessories for Bosnia and Herzegovina industry was difficult, and sometimes stopped completely. For that reason, characteristic of that period is extremely low level of means for production. Basic problem during consideration of possible occurrence of industrial pollution and its consequences in the war conditions, is lack of information about factories in the moment of the war start (quantities of stored harmful and toxic raw goods, half-products and final products).

Although the biggest part of the organic pollution, in normal conditions, comes from the industry plants, main source of the present pollution, especially biological pollution comes from community wastewater. Lack of higher density network of measuring points where Republic Hydro-Meteorological Institute is monitoring quality of surface waters causing the inability to arrange more accurate evaluation of quality directly below the pollution source. That is especially related to tributaries, where the water quality is being judged only in estuary, so there is no information about pollution along entire flow. Special attention must be paid to the negative effects of untreated community wastewater on small rivers and small settlements located downstream from bigger communities, which must use this water for many different purposes. How serious is situation related to bacteriological pollution we can see from the fact that in large number of settlements quantity of wastewater is larger than monthly small water of 95% security. This is especially emphasized because of hygiene and sanitary demands, and possibility of occurrence of water-born decease epidemics.

In the post-war conditions, especially in the period of reconstruction, it cannot be expected that water quality will maintain its improvement. Because of restart of production, pollution can be increased, if adequate measures are not taken. Beside that, in city and industry sewerage systems, many different materials are accumulated. Those materials will be gradually washed out, what can cause significant shock-loads in rivers.

Municipal Hot Spots

Table 5.1. Emission of pollution in Bosnia and Herzegovina according to rivers for community centers

Rivers	Q m^3/s	SS kg/d	COD kg/d	BOD kg/d	total N kg/d	total P kg/d	PE
Glina and Kupa	0,040	917	1944	1076			17917
Una	0,588	13493	27153	14831			247183
Vrbas	0,801	19104	38271	21519			358650
Ukrina	0,117	2739	5612	3298			54967
Bosna	2,953	70414	144769	79835			1330583
Drina	0,325	7871	15800	8668			144467
Sava	0,591	13664	27800	15329			255483
TOTAL	5,387	128148	261349	144555	20008	8392	2409250

Table 5.2. Emission from pollution from community sources included in protection program (settlements above 5000 inhabitants and municipality centers)

River basin	Recipient	Settlement	Community
1	2	3	4
Glina i Kupa		Cazin	3.283
		Velika Kladuša	9.917
	TOTAL FOR THE RIVER BASIN		13.200
Una	Unac	Drvar	10.400
	Unac	Bosanski Petrovac	6.550
	Una	Bihać	42.517
	Una	Bosanska Krupa	16.917
	Una	Bosanski Novi	17.083
	Sana	Ključ	6.983
	Sana	Sanski Most	20.983
	Sana	Prijedor	46.567
	Una	Bosanska Dubica	16.750
	Una	Bosanska Kostajnica	4.433
	TOTAL FOR THE RIVER BASIN		189.183
Vrbas	Vrbas	Gornji Vakuf	5.667
	Vrbas	Bugojno	30.167
	Vrbas	Donji Vakuf	11.367
	Pliva	[ipovo	6.500
	Vrbas	Jajce	20.483
	Vrbas	Skender Vakuf	4.033
	Crna Rijeka	Mrkonjić Grad	11.883
	Vrbanja	Kotor Varoš	9.467
	Vrbanja	Čelinac	6.450
	Vrbas	Banja Luka	203.117
	Vrbas	Laktaši	3.883
	Vrbas	Srbac	12.917
	TOTAL FOR THE RIVER BASIN		325.934
Ukrina	Vijaka	Prnjavor	11.950
	Ukrina	Derventa	33.750
	TOTAL FOR THE RIVER BASIN		45.700
Bosna	Bosna	Sarajevo (++)	484.467
	Palj. Miljacka	Pale	6.483
	Željeznica	Trnovo	3.933
	Jošanica	Vogošća	12.533
	Bosna	Ilijaš	13.017
	Stavnja	Breza	5.033
	Stavnja	Vareš	12.550
	Lepenica	Kiseljak	11.450
	Fojnica	Fojnica	7.883
	Kreševica	Kreševo	5.050
	Bosna	Visoko	20.167

1	2	3	4
	Bosna	Kakanj	19.383
	Lašva	Travnik	27.817
	Grlovnica	Novi Travnik	13.450
	Lašva	Vitez	11.767
	Kozica	Busovača	5.333
	Bosna	Zenica	130.483
	Bosna	Klopče	5.833
	Bioštica	Olovo	5.733
	Bosna	Zavidovići	26.483
	Bosna	Žepče	8.017
	Bosna	Maglaj	15.417
	Spreča	Kalesija	5.917
	Jala	Tuzla	110.017
	Spreča	Lukavac	19.217
	Oskova	Živinice	14.817
	Litva	Banovići	15.867
	Sokoluša	Gračanica	20.550
	Bosna	Doboj	37.467
	Vel. Usora	Teslić	18.150
	Tešanjka	Tešanj	12.667
	Gostelja	Đurđevik	6.117
	Bosna	Modriča	20.650
	Bosna	Odžak	20.383
	Stupčanica	Han Pijesak (+)	4.650
	TOTAL FOR THE RIVER BASIN		1,158.751
Drina	Drina	Foča	14.283
	Drina	Goražde	18.533
	Rešetnica	Sokolac	6.183
	Rakitnica	Rogatica	10.917
	Drina	Višegrad	8.000
	Potranjski potok	Srebrenica	9.300
	Sušica	Bratunac	9.033
	Drinjača	Kladanj	6.500
	Tabhana	Vlasenica	7.950
	Drina	Zvornik	21.700
	Drina	Janja	10.333
	Janjina	Čajniče	3.317
	Lim	Rudo (+)	2.230
	Drinjača	Šekovići	1.817
	Mezgraja	Ugljevik	3.200
	TOTAL FOR THE RIVER BASIN		133.296
Sava	Sava	B. Gradiška	23.917
	Sava	Nova Topola	2.066
	Sava	B. Brod	17.650
	Sava	B. Šamac	10.733

1	2	3	4
	Bagdalski potok	Gradačac	15.617
	Brješnica	Mionica	5.200
	Sava	Orašje	10.417
	Tinja	Srebrenik	5.850
	Sava	Brčko	48.650
	Gnjica	Lopare	1.917
	Dašnički kanal	Bijeljina	47.183
	TOTAL FOR THE RIVER BASIN		189.200
TOTAL FOR THE BLACK SEA GATHERING AREA IN B&H			**2,055.264**

(+) - *Municipality point*
(++) - *Municipalities, i.e. settlements and belonging industry foreseen for treatment through city purification plant*

Industrial Hot Spots

Table 5.3. Emission of pollution in Bosnia and Herzegovina in the river basins, for industrial wastewater

Rivers	Q M^3/s	SS kg/d	COD kg/d	BOD kg/d	total N kg/d	total P kg/d	PE
Glina and Kupa	0,163	533	1711	536			13400
Una	1,122	201625	139282	56377			1409425
Vrbas	2,587	27481	174852	89843			2246075
Ukrina	0,036	2425	1558	651			16300
Bosna	17,576	392139	216737	80994			2024850
Drina	1,176	4896	18908	10579			264475
Sava	0,483	16242	30856	28702			717550
TOTAL	23,142	645341	583904	267693	2995*	250*	6692075

** Data about many industries are missing*

Total production of industrial wastewater in Bosnia and Herzegovina is 23.142 m^3/s (Table 5.3.). The biggest quantities occur in the river basin of Bosna (17.676m^3s^{-1}), Vrbas (2.587), Drina (1.176) and Una (1.122), which is 94,4% of total quantity of the industrial wastewater. In the river basin of Bosna (74,3% of total production of industrial wastewater in Bosnia and Herzegovina) significant part of the cooling water (12,1 m^3/s) is being discharged together with other industrial effluents from thermal power plants (TE Kakanj, TE Tuzla), from iron factories (Zenica, Vareš, Ilijaš) and chemical industry in Lukavac. Hence, percentage of the cooling water in total quantity of industrial wastewater in the river basin is 68,8%. Production of the wastewater in the river basin Vrbas is 11% of the total industrial effluent in Bosnia and Herzegovina. Most of that wastewater is coming from cellulose and viscose factory (83,1%), which use around 37% of cooling water. In the other river basins, the cooling water is not being used and is not in recirculation.

Regarding the number of the mines in Bosnia and Herzegovina, larger percentage of mines wastewater should be expected. But their total quantity cannot be estimated because, up to now, only small number of such pollution sources was included in measuring.

Daily discharge of suspended particles from industrial plants in Bosnia and Herzegovina is 674,5 tones, mostly in the river basin Bosna (58,1%) and Una (29,9%). Main sources of pollution are mines, metal factories and thermal power plant.

Total daily emission of organic pollution from the industry in Bosnia and Herzegovina is 275 tones BOD or 6.873.100 ES. The largest part is coming from industry of cellulose, paper and viscose (51,3%), which also has significant percentage in emission of organic pollution (36,8%). Second largest part organic pollution emission is coming from food industry (19,2%). Industry with the largest organic pollution load is placed along Vrbas (32,2%), Bosna (29,5%), Una (20,5%) and Sava (10,4%).

List of the biggest industrial polluters and their location in the river basin is given in the Table 5.4.

Table 5.4. Big sources of the organic pollution in Bosnia and Herzegovina per river basins

River Basin	Emission on river	Location	Pollution		Industry	Pollution	
	(PE)		(PE)	% for river		(PE)	% for river
Vrbas	2,246.075	B. Luka	2,162.248	96,3	Incel	1,922.584	85,6
					Pivara	185.958	8,3
					Vitaminka	19.173	0,9
		K. Varoš	56.701	2,5	Kozara	56.701	2,5
Bosna	2,024.850	Sarajevo	248.076	12,3	Bosanka-Blažuj	106.204	5,2
					Pivara	72.573	3,6
					Zora	18.255	0,9
					Mljekara	10.981	0,5
		Visoko	114.325	5,7	Viteks	56.482	2,8
					Kožara	34.620	1,7
		Zenica	233.456	11,5	RMK	176.947	8,7
		Maglaj	400.920	19,8	Natron	400.920	19,8
		Tuzla	476.756	23,5	Poliuretan. hemija	422.292	20,9
		Lukavac	221.675	10,9	Koksara	214.093	10,6
		Teslić	58.480	2,9	Destilacija	50.263	2,5
Una	1,409.425	Prijedor	1,207.963	85,7	Celpak	1,199.175	85,1
		Bihać	26.150	1,8	Klaonica	21.750	1,5
		B.Dubica	18.140	1,3	Knežopoljka	14.623	1,0
Sava	717.550	Brčko	468.822	65,3	Spiritana	392.991	54,1
					Uljara	28.822	4,0
					Far. svinja	18.164	2,5
		Bijeljina	111.728	15,6	Šećerana	106.207	14,8
		N.Topola	53.500	7,5	Farma	53.500	7,5
		Bosanska Gradiška	49.770	6,9	Tvornica protena	49.363	6,9
Drina	264.475	Foča	208.165	78,7	Maglić	208.165	78,7
		Goražde	36.743	13,9	Azotara	36.743	13,9
		Bileća	12.470	8,4	Fabrika tepiha	12.470	8,4

Toxicity

Many industrial wastewater in Bosnia and Herzegovina contains toxic substances, mostly heavy metals, cyanide, phenols, mineral oils, emulsions, organic solutions (complex of metal industry), as well as other different organic substances (basic organic chemistry, viscose industry, linen and leather industry). Analysis of quality state of the surface water shows consequence of the toxic influence, which is manifested in creation of zones with different grade of water degradation, from impoverishing of flora and fauna up to complete devastation or destruction.

Estimate of emission of toxic wastewater was made on the basis of data of water quantities in the rivers, necessary to eliminate toxic effect by softening (Table 5.5.). Total quantity of water needed for softening of all toxic wastewater in Bosnia and Herzegovina is about 700 m^3s^{-1}, which is much higher than total flow quantity of all rivers in Bosnia and Herzegovina during small water levels with 95% of security.

Table 5.5. Big sources of toxic pollution in Bosnia and Herzegovina

River basin	Emission on river (m^3/s of water for softening)	Location	Industry	Toxicity (m^3/s of water for softening)	% according to river basin
Bosna	539,8	Sarajevo	RMK Žica	8,0	1,5
		Visoko	Kožara	17,0	3,1
			Viteks	14,3	2,6
		Zenica	RMK	193,1	35,8
		Teslić	Destil. drveta	2,0	0,4
		Tuzla	Termoelektrana	35,4	6,6
			Fabrika sode	80,4	14,9
			Poliuret. hemija	64,9	12,0
		Lukavac	Koksara	115,5	21,4
Total for river basin				**530,6**	**98,3**
Una	44,9	Bihać	Površinska zaštita metala	1,2	2,7
		Ljubija	Rudnik	1,1	2,4
		Prijedor	Celpak	41,7	92,9
Total for river basin				**44,0**	**98,0**
Vrbas	65,0	Jajce	Elektrobosna	15,7	24,1
		Banja Luka	INCEL	43,4	66,8
Total for river basin				**59,1**	**90,9**
Ukrina	1,67	Prnjavor	Kožara	1,5	89,8
Drina	22,0	Goražde	Pobjeda	3,7	16,8
			FAJ	9,7	44,1
		Šekovići	Fabrika okova	2,4	10,9
		Zvornik	Glinica	3,4	15,5
Total for river basin				**19,2**	**87,3**

Distribution of emission of the toxic wastewater is extremely non-homogenate. The most toxic water is being discharged in the river Bosna and its tributaries (78,0%), then in the river Vrbas (9,4%) and the river Una (6,5%). The biggest emission of toxic substances is coming from Tuzla region (polyurethane chemistry, chemical industry, cookery), and then from Mines and Metallurgy Plant Zenica. Wastewater from these two locations on the river Bosna would demand 71,3% of total necessary water for softening in Bosnia and Herzegovina.

On many locations (Sana-Prijedor, Vrbas-Jajce and Banja Luka, Bosna-Sarajevo and Visoko, Usora-Teslić, Drinjača-Šekovići), quantity of the water needed for softening is bigger than value of monthly small flows (Q_{MP}), and in some cases, (Crna Rijeka-Mrkonjić Grad, Stavnja-Vareš and Breza, Bosna-Zenica, Spreča-Tuzla and Lukavac, Srebrenički Potok and Srebrenica) is even bigger then average year flow. Consequences of such high emission of toxic wastewater are especially drastic in second mentioned case, where even middle flows do not soften level of toxicity to the so called "no effect" level. Situation is better in the river basin of Drina and upper flows of the river Vrbas and Sana, where the flows are, even in case of small waters, larger then it is necessary for the softening of toxic wastewater.

In the river basins of Bosna, Drina and Una there is larger number of mine dumps, power supply plants dumps, wet quarries with different, mostly inadequately solved retention, which presents points of high pollution risk as consequence of failures.

Agricultural Hot Spots

Emission of pollution from dispersed (agricultural) sources, its type and partition per river basins, are shown in table 5.6.

Table 5.6. Emission of pollution from dispersed sources per elements of river basins

River	Profile	Input for dry year (kg/d)			Input for medium year (kg/d)			Input for rainy year (kg/d)		
		COD	N	P	COD	N	P	COD	N	P
1	2	3	4	5	6	7	8	9	10	11
Una	U-2	414	624	32	2484	1714	113	8279	9063	322
	U-3	812	512	30	4873	1580	123	16246	7033	362
	U-4	982	458	27	5890	1536	123	19632	9575	427
	U-6	2640	1456	95	15841	4771	430	52805	27713	1439
	U-7	1806	782	60	10838	2815	300	36126	18131	1067
TOTAL		6654	3832	244	39926	12416	1089	133088	71515	3617
Vrbas	V-2	150	232	12	900	673	47	3000	3584	142
	V-3	498	808	42	2988	2288	154	9961	12309	456
	V-6	1231	1361	80	7386	4235	343	24620	24211	1117
	V-7	665	525	37	3991	1843	181	13302	12078	645
TOTAL		2544	2926	171	15265	9039	725	50883	52182	2360
Ukrina	Uk-1	2049	782	69	12294	2909	359	40979	18438	1270
	Uk-2	383	157	14	2298	593	74	7659	3984	266
TOTAL		2432	939	83	14592	3502	433	48638	22422	1536
Sava	S-1	1217	521	46	7304	1932	238	24346	12867	851
	S-2	609	249	22	3654	904	112	12180	5908	398
	S-3	812	328	33	4871	1252	190	16236	8311	674
	S-4	3745	1539	142	22471	5819	745	74904	38811	2672
TOTAL		6383	2637	243	38300	9907	1285	127666	65897	4595

1	2	3	4	5	6	7	8	9	10	11
Bosna	B-5	1340	1156	70	8039	3501	292	26797	18256	908
	B-7	833	624	39	5000	1908	169	16667	23941	522
	B-11	1197	1056	64	7182	3200	272	23941	16095	839
	B-13	2519	1446	99	15116	4957	467	50387	29782	1610
	B-14	838	466	39	5026	1727	199	16754	11216	710
TOTAL		6727	4748	311	40363	15293	1399	134546	99290	4589
Drina	D-2	338	476	25	2030	1410	98	6768	7357	296
	D-3	280	256	15	1680	768	60	5601	3847	184
	D-4	540	612	34	3241	1748	132	10802	8667	385
	D-5	2397	1868	123	14384	6050	562	47947	34907	1873
TOTAL		3555	3212	197	21335	9976	852	71118	54778	2738
Glina		1563	398	25	9377	1423	120	31255	9228	432

U-2	*from border up to point behind M. Brod*	*S-2*	*from Srbac up to B. Brod*
U-3	*from M. Brod up to point in front of Bihać*	*S-3*	*from B. Brod up to B. Šamac*
U-4	*from point in front of Bihać up to point behind Bihać*	*S-4*	*from B. Šamac up to border*
U-6	*from Bihać up to point behind B. Novi*	*B-5*	*from source up to point behind Visoko*
U-7	*from B. Novi up to estuary*	*B-7*	*from Visoko up to Zenica*
V-2	*from source up to point behind Bugojno*	*B-11*	*from Zenica up to point behind Maglaj*
V-3	*from Bugojno up to point behind Jajce*	*B-13*	*from Maglaj up to point behind Doboj*
V-6	*from Jajce up to point behind Banja Luka*	*B-14*	*from Doboj up to estuary*
V-7	*from Banja Luka up to estuary*	*D-2*	*from border up to point behind Foča*
Uk-1	*from source up to point behind Derventa*	*D-3*	*from Foča up to point behind Goražde*
Uk-2	*from Derventa up to estuary*	*D-4*	*from Goražde up to Višegrad*
S-1	*from border up to Srbac*	*D-5*	*from Višegrad up to estuary*

Total emission of organic pollution, nitrogen and phosphor from dispersed sources in Bosnia and Herzegovina during dry year is 5,6 tones BOD per day, 25,2 tones of nitrogen per day and 1,6 tones of phosphor. Pollution in medium rain years and in heavy rain years is much bigger. The biggest emission from this source is from the Bosna River basin (around 20%). Next one is Una (15%), then Sava (13%), Drina (12,5%) and Vrbas (around 10%).

Spatial distribution of emission is in accordance with size of river basin, and size of river basin is in accordance with other parameters (population, agricultural activities, cattle breeding). Exceptions are the river basins of Sava and Ukrina with bigger concentration of population and more intensive agricultural activities (e.g. in these river basins we have 40% pig-breeding and 20% cattle-breeding of total Bosnia and Herzegovina production).

Dispersed pollution on individual section of different river basins, although the real comparison is not possible because those are different areas, is larger on the lower flows. Exceptionally, on the river Bosna, maximal emission of dispersed pollution occurs in the middle flow (the tributaries Spreča and Usora and the river Bosna itself on section between Maglaj and Doboj) and in upper flow, on the first section from Sarajevo up to Visoko.

Increase of the organic matter from dispersed pollution sources in water, in all hydrologic conditions, is low and it varies, in average, from 0,1 to 0,2 grams of BOD per m^3. If we use as criteria limit concentration for macronutrients, contribution of nitrogen and phosphor is high (0,5-0,8 g/m^3 of nitrogen and 0,03-0,05 g/m^3 of phosphor).

Ranking Criteria under Considerations of Transboundary Effects

Ranking criteria for hot spots are based on detailed analysis, which are not in use at the moment, so the following proposals are hypotetic. Correct determination should be the result of much more information and discussion on higher level.

In the country in which the war ended just recently, priority is renewal and reconstruction of economy and through it the urgent water supply of population. Afterwards comes rehabilitation of other water management facilities (sewerage systems, wastewater treatment plants, flood control dykes etc.)

Considering complete post-war situation, hot spots related to water pollution, which need to be resolved in future, could be expected in the following areas:

Municipal Hot Spots

High priority:	SARAJEVO, TUZLA, BANJA LUKA
Medium priority:	GORNJI VAKUF, BUGUJNO, DONJI VAKUF, VISOKO, FOJNICA, KISELJAK, ILIJAŠ, VOGOŠĆA
Low priority:	TRAVNIK, VITEZ, JAJCE

Industrial Hot Spots

High priority:	TUZLA, LUKAVAC, BANJA LUKA, MAGLAJ, PRIJEDOR
Medium priority:	ZENICA
Low priority:	TESLIĆ, FOČA

Agricultural Hot Spots

High priority:	NOVA TOPOLA
Medium priority:	TUZLA, BRČKO
Low priority:	BIJELJINA, SARAJEVO

6. Identification and Evaluation of Pollution Reduction Measures

6.1. National Targets and Instruments for Reduction of Water Pollution

General strategy and guidelines for improvement of the surface waters quality in B&H, and subsequently reduction of water pollution is based on the emission pollution decrease of toxic, organic and mechanical nature.

Targets of program for water pollution protection in B&H are built on the actual policy with tendency for gradual development.

Main guidelines of this strategy are:

- Option for technological development of the country is to be set on transferring from "dirty" to "clean" technologies.
- To establish minimum criteria for effluent quality of municipal and industrial pollution sources, which are discharged into municipal sewerage or are discharged into natural recipient after being treated.
- According to the relevant indicators which realistically demonstrate the actual
- situation in B&H, the least urban unit, when wastewater is to be treated, is over 5.000 inhabitants. European quota is considerably lower and it ranges over 2.000 inhabitants.
- Regardless the variety of selection, toxic industrial wastewater has to be pre-treated before discharging into municipal sewerage system or is to be treated if discharged into natural recipient.
- Direct efforts, where possible, to treat industrial wastewater, with or without pre-treatment, subsequently at the municipal wastewater treatment plant. One has to bear in mind to decrease the hydraulic load, to perform pretreatment of toxic wastewater before mixing with the other effluents of respective factory and to meet standards or criteria for discharge of industrial waters into municipal sewerage systems.
- Benefit should be given to construction of the municipal plants for common treatment of public utility and industrial wastewater. It implies that solution for sewerage systems of good quality has to be found out.
- Large industrial pollutants, where complete effluent treatment is anticipated, have to use all possibilities for emission relief such as applying of new procedures, recirculation of water, orientation to the "clean " technologies and the like. This option will prove efficient if legal and economic tools have influence on industry to abandon technologies causing large source pollution.
- Establishing of a new system and activities schedule for control of pollution and degree of pollution taking precautions, rehabilitation of the existing condition, establishing of database, passing a new European standards, convention rules, etc.
- The following criteria are used in selection of the priority for construction of water treatment plant: location of pollution source, toxicity of pollution source (quality and quantity), vicinity of the portable water source and zones and sewerage system pollution, existing of the industrial wastewater pre-treatment, impact of pollution on water quality in recipient and in the water basins.
- During the construction of the wastewater treatment plant it is necessary to take into consideration the disposition of the sludge occurred in the wastewater treatment process.

- Rehabilitation and reconstruction of the existing waste water treatment plant with aim to increase efficient of operation and capacity of treatment. It inevitably includes staff training from this field of work.
- Permanent measure in program for water quality protection is increase of water course recipient capacity by making up fresh water quantities from the same or other river basin. It is accomplished by planned and rational water managing within the water management master plans of river basins.
- Planning, designing or reconstruction of industrial and other structures require legal basis for establishing of required measures for water protection.
- Legal provisions have to provide water quality protection at the sources and protection for water supply of settlements of importance against disruption of natural ecological system. It implies prohibition of industrial plants construction, closing or dislocation of the existing plants.
- Control of water from wastewater treatment plant requires engagement of water management inspection to check effects of operation and maintenance of plants and staff skill.
- It is necessary to establish by law a certain testing of quality and quantity of discharged wastewater from industry and cities as the basic measures in monitoring of water courses pollution. Water management inspection and competent water management laboratory are given prominent place in organization schedule of control and supervision.
- Monitoring, database and data processing systems are to be fit in with water protection program. It is absolutely required to reconstruct the old (destroyed) and establish a new cadaster system which will have: cadaster of industrial pollutants, cadaster for water treatment plants, cadaster of settlements in a view of source pollution and cadaster of surface water quality.

6.2. Actual and Planned Projects and Policy Measures

Projects and programs, which define water pollution problem and its solution, can be presented through certain segments:

- reduction of pollution at the very source by improvement in reconstruction,
- reduction of pollution in the process of transferring form dirty and unprofitable technology to clean technology,
- reduction of pollution through construction of a sewerage network in the towns and by construction of water treatment plant,
- decrease of water pollution by expert's and efficient selection of the most important industries where system for waste water treatment is to be constructed,
- decrease of water pollution coming from agriculture activities will be solved through integral agriculture production and construction of treatment plants in combination with other harmful effluents.

The main task in discharging of wastewater from urban areas is a proper selection of sewerage systems. The selection is constrained by a series of technical-economic factors, which relate to the construction and exploitation of sewerage systems and plants for wastewater treatment.

We are familiar with the fact that in B&H there is a low degree of sewerage systems development, what will require large funds for their construction. Hence separate sewerage systems are planned to be constructed due to their gradual constructional phases and consequently lower initial funds. In this case investment and exploitation costs for construction, operation and maintenance are less.

On the other hand, mixed sewerage system requires larger hydraulic load, which has surge on treatment process and its effects are weaken. Separate sewerage systems are used worldwide, where common treatment of municipal and industrial wastewater is performed. Industrial wastewater, which is discharged into sewerage systems, has to be previously treated to meet the standards applied in the respective country.

Construction of the sewerage systems in B&H as a first phase of final solution for discharge, treatment of sludge and discharge of wastewater into water courses, is to be solved according to the following priorities:

1. Reconstruction, rehabilitation and enlargement of existing sewerage systems where it is technically and economically justified.
2. Urgent construction of sewerage systems, whose wastewater affects existing portable water sources.
3. Construction of regional and municipal sewerage systems for settlements, whose wastewater affects quality of open courses waters and influences river basin quality.
4. Development of sewerage system in the settlements, where there is imbalance of water supply systems and discharge of wastewater.
5. Construction of sewerage systems for settlements of over 5.000 inhabitants.

Some plants for municipal wastewater were constructed in B&H. Only plants in Sarajevo and Trebnje have significant importance in a view of water protection, whilst other constructed plants are of less importance and have small contribution in a protection at the local level.

Construction of new plants is necessity in the forthcoming period, where everyone will take part in water protection activities. It is necessary to take into account the standards in planning and construction of main municipal plants, such as:

- to construct main plants with more connected industrial waters from the wider area. The obligation of the industry to perform pretreatment of their waters before treatment at the main plant,
- enable by special measures construction of plants, which have wider importance in a field of water and environmental protection,
- planned construction of the plant has an aim to make optimization of treatment process and to meet international standards,
- if specific cases do not require specific conditions, then it is necessary to adopt the process depending on capacity as per plant design:
  - for capacity up to 10.000 ES, extended aeration with simultaneous sludge stabilization,
  - for capacity 10.000 - 50.000 ES, aeration with separate sludge stabilization,
  - for capacity over 50.000 ES, aeration with methane sludge processing,
- Planning for plant construction with applied priorities is to be harmonized with the Plan for water protection and other plans, which provide:
  - protection of water source for water supply,
  - protection of impounding reservoirs,
  - protection of river basins or longer water courses sections,
  - protection of ground waters .

Chronicle problems could be solved by planned construction of the relatively few main municipal treatment plants for larger towns and industry.

Municipal areas, where construction of the wastewater treatment plants are planned to be constructed as the first priority and whereas treatment of wastewater will be provided for more of 80% of total pollution produced in B&H, are listed below.

Table 6.1. Towns where construction of treatment plant is planned as first priority

River basin	Town	Required capacity of plant(PE)	Pollution in river basin (%)
DRINA	Goražde	80.000	90%
	Foča	250.000 / 25.000[1)]	
UNA	Prijedor	1.300.000 / 400.000[2)]	
	Bihać	80.000	90%
	Bosanska Dubica	40.000	
VRBAS	Reg. "Gornji Vrbas"	100.000	
	Banja Luka	2.500.000	95%
	Jajce	30.000	
	Kotor Varoš	75.000	
UKRINA	Prnjavor	25.000	95%
	Derventa	60.000	
Direct SAVA	Bos. Gradiška N. Topola	120.000	
	Brčko	500.000	80%
	Bijeljina	100.000	
BOSNA	Vogošća	30.000	
	Ilijaš	60.000	
	Vareš	20.000	
	Visoko	150.000	
	Kakanj	150.000/25.000[3)]	
	Travnik	40.000	90%
	Zenica	400.000/150.000[4)]	
	Maglaj	450.000/25.000[5)]	
	Tuzla	600.000	
	Lukavac	250.000/25.000[6)]	
	Doboj	75.000	
	Teslić	85.000	
	Modriča	50.000	
	Odžak	25.000	

1) Capacity when Fiberboard factory build plant for recirculation of wastewater
2) Capacity when Factory for pulp wood performs reconstruction and enlargement
3) Load by Kakanj wastewater, and bigger figure is by TE "Kakanj"
4) Estimated capacity and actual one will be estimated lately
5) Capacity of settlement, and large pollution comes from "white waters" by Natron factory
6) Capacity of settlements, and the rest comes from Cokery chemical combine

The high participation of industrial effluent presents the common characteristic in above table, which indicates impact of industrial wastewater in relation to the pollution produced by cities. When type of industry in B&H, purpose, level of technical-technological contemporary, profitability of industry and etc. are perceived, than many reasons could be found out for creating increase in pollution at the river basins.

Most industrial capacities are operated by outdated technology and equipment, what results in low production and poor economy. Low rentability limited any attempts for improvement of technology process, and especially solving the problem of pollution in watercourse by industrial waters.

It is required to provide funds for reconstruction and transformation to the better technologies in industrial production according to experts' opinions.

Industrial plants, which created enormous pollution in terms of quality and quantity and cannot solve this problem of pollution in economic term, have to be closed.

As it had been anticipated by the Long-Term Water Pollution Protection Program in Bosnia and Herzegovina, the implementation would have lasted from January 1, 1992 till December 1, 2010 in stages. However, due to the war in Bosnia and Herzegovina, this implementation schedule could not have its progress time schedule, but the global accomplishment targets remained.

Firstly, water protection implementation program included three stages with time schedules.

I stage from 1992 – 1995, it foresees implementation of indispensable and preliminary works, rehabilitation of the existing wastewater treatment plants and construction of some minor ones, which are in function of potable water source protection.

II stage is foreseen to be implemented within two middle-term periods, I phase from 1995 – 2000 and II phase from 2000 – 2005.

III stage is foreseen for the period 2005 – 2010.

Preliminary works will be accomplished in the I stage within the special part of program and financial plans relate to the organizational-legal tasks and targets traced by Long-Term Water Pollution Protection Program.

The following table can be used for the rehabilitation of the existing water treatment plants and construction of several wastewater treatment plants within the planned time period:

Table 6.2.: Recapitulation of required investment estimation for the rehabilitation of the existing and construction of planned main sewers and wastewater treatment plants in the area that belongs to the Black Sea basin

Realization in US mill $						
River basin	I stage 1992-1995	II Stage		III stage 2005-2010	Total for river basin	Percentage participation in price
		I phase 1995-2000	II phase 2000-2005			
	Rehabilitation of existing plants(1)	Construction of new plants 2000-2010				
Glina & Kupa			15.94(3)		15.94	1.324
UNA		46.634(3)	136.323 (9)		182.957	15.196
VRBAS	0.596	199.156(4)	195.667(10)		396.435	32.933
UKRINA		16.25(5)			16.250	1.350
BOSNA	7.075	11.065(2)	3.208(11)	393.977(16)	415.326	34.500
DRINA		48.826(6)	13.473(12)	36.253(17)	98.553	8.186
SAVA	3.758	-	44.215(13)	30.560(18)	78.533	6.523
TOTAL	12.510	321.927	408.828	460.791	1203.943	100
Percentage participation	1.039	26.74	33.96	38.27	100	

Valid exchange rate on May 8, 1998 – 1 US$ = 1,78305 kDEM

The price includes central municipal plants and industrial wastewater that is specially treated (prices are based on values dated January 1991)

Explanation of asterisk meanings:

(1) The price includes only rehabilitation of the existing municipal plants
(2) Kiseljak, Kresevo, Fojnica, Pale
(3) Drvar, Bosanski Petrovac, BihaĆ, Bosanska Krupa, Bosanski Novi
(4) All municipal plants without industrial wastewater "INCEL" Banja Luka
(5) Prnjavor and Derventa
(6) Goražde and Foča
(8) Cazin and Velika Kladuša
(9) Ključ, Sanski Most, Prijedor, Bosanska Kostajnica and Bosanski Brod
(10) Industrial wastewater "INCEL" Banja Luka
(11) Olovo
(12) Rogatica, Srebrenica and Skolac
(13) Bijeljina, Brčko, Bosanski Brod
(16) Tuzla, Zenica, Lukavac, Visoko, Teslić, Vareš, Banovići, Maglaj, Doboj, Vogošća, Ilijaš, Travnik, Kakanj, Novi Trvnik, Kalesija, Živinice, Tešanj, Han Pijesak, Modriča, Odžak, Đurđevik, Gračanica, Zavidovići, Žepce, Breza, Vitez, Busovača, Klopče
(17) Janja, Čajniče, Kladanj, Vlasenica, Višegrad, Ugljevik, Rudo, Šehovići, Zvornik, Bratunac
(18) Bosanska Gradiška, Lopare, Orašje, Bosanski Šamac, Srebrenik, Mionica

Total costs and expenses of the municipal wastewater treatment plant with pre-treatment of industrial wastewater, as well as complete industrial wastewater treatment costs are given in the table.

6.3. Expected Results of Planned Measures and Projects with Particular Attention to Transboundary Effects

Once the measures and the existing situation in water pollution protection field are recognized, it can be noticed that Bosnia and Herzegovina needs enormous funds for the implementation of projects related to water pollution protection and control. In the present situation, it is not possible to provide those funds and, therefore, gradual progress in solving actual sources of pollution will be needed. At the moment when the industrial capacities in the country are not fully operated, the country is not financially sufficiently stable and firm, major investments in water protection can not be expected.

At this moment the duration of such a situation in the country also cannot be anticipated taking into consideration that improvements, which are evident but very slow.

Reduction of Nutrient Emission

Considerable decrease of nutrient in wastewater which are discharged into water streams, would be done by implementing the planned projects that include sewage systems in municipalities with more than 5.000 inhabitants and construction of central municipal plants for the municipal and industrial wastewater treatment.

The largest concentration of nutrient is contained in wastewater discharged from the sewage systems of the residential areas. Those waters will be treated in the wastewater treatment plant, in which the largest part of those pollutants will be eliminated in terms of quality.

Toxic substances

Great many toxic substances are originated in industry during the production in the technological process. According to the current and planned projects, wastewater will be pre-treated in the own pre-treatment plant and, then during the final treatment in the central plant for municipal and industrial wastewater treatment. If the long-term programs for water protection in Bosnia and Herzegovina up to the year 2020 were implemented, more than 80% of wastewater pollution decrease would be expected.

Micro-biological contamination

Micro-biological contamination reduction of river courses can be expected within the implementation of the planned projects anticipating municipal wastewater treatment in plants for wastewater treatment collected in settlement with population of more than 5.000.

Biological contamination most frequently originates from direct discharge of municipal sewage system into open watercourses. With the construction of sanitary landfill sites, which are also planned for the forthcoming period, contamination risk by bacteriological effluent will be decreased.

7. Analysis of National Financing Mechanisms

7.1. Policies for Funding of Water Sector Programs and Projects

Even though there are no officially confirmed State Development Plans, or the Federation of Bosnia and Herzegovina plans, Water sector has defined its priorities that can be divided into three phases:

Phase I - Presents urgent activities of the restoration of the basic services for the inhabitants to alleviate the suffering and the time period for this would be about 2- 3 years. This phase includes:

- Implementation of urgent works on reconstruction and construction of water economy systems.
- Preparation and adoption of Statute about Waters and legal acts for establishment of financial and organizational base.
- Improvement of staff capacity
- Gathering of available documents and texts from the water sector
- Restoring of the register system for the quality and quantity of waters
- Reinforcement of supervision of the quality and quantity of waters
- Supervision of industry connected with waters
- Preparation of strategy including finances for Phase II

Phase II (ongoing activities) includes:

- Reconstruction of system of agricultural drainage
- Continuation of attempts to bring services up to the pre war levels.
- Actualization of the Long - term Programme from 1989 for supplying of water
- Defining of the criteria for consumption of water
- Actualization of water economy foundations
- Establishment of legislature between the State and European Community
- Improvement of personnel capacity
- Preparation of documentation for financing of Phase III

Phase III (ongoing activities) includes:

- Continuation of protection against floods and drainage of soil
- Realization of Long- Term Program of Water Supply
- Realization of drainage, purification of waste waters and program for disposition of solid waste
- Realization of Strategy for consumption of waters, that is water power, irrigation, navigation, fishing and other.
- Control of erosion and torrents
- Establishment of criteria for gravel excavation from the water current.

At the moment none of the detailed programs exist which have developed measures, activities and tasks necessary for every phase. Financial resources needed do not exist either, but above mentioned represents significant document for the future planing.

7.2. Funding Mechanisms for Water Sector Programs and Projects

7.2.1. Public Funding Sources and Water Sector Development Institutions

Entity Statutes about Waters regulate, among other things, financing of water sector and institutions responsible for sector policy implementation. Statutes define wider scale of financing sources and they are, more or less, identical in both entities:

- Water compensation
- Concession compensation
- Compensation from the use of irrigation systems
- Income achieved by offering of services to users of water use and protection facilities
- Federation and canton budgets
- Restricted loans
- Public loans
- Funds secured by specific law
- Donations and others.

In the Statutes about Waters a chapter for financing of water economy activities from the water economy compensations is especially formulated. The types of water economy compensations, which are obligatory for payment, the base for an account and payment, as well as distribution of collected funds are defined.

Water economy compensations present own financing source of the water sector:

1. General water economy compensations
2. Specific water economy compensations
   - for use of waters
   - for protection of waters
   - for excavated material from water course
   - for the change in regime of waters

Other financing sources have not been worked out in detail and they represent wide - ranging possibility for securing resources for these sector activities.

According to newly- adopted Statute about Waters in the Federation of Bosnia and Herzegovina, two public firms were established, one with the headquarters in Sarajevo that is responsible for the Sava watershed, and the other, with headquarters in Mostar, which covers the Adriatic Sea catchment area.

In Republic of Srpska Water Board within Ministry of Agriculture, Forestry and Water Economy is in charge for water sector development policy.

However, situation with collection of water compensations is still different on the territory of whole Bosnia and Herzegovina. The system of water compensations collection is established in Republic of Srpska and in the part of the Federation with Croat majority, while this system does not exist yet in the part of the Federation with Bosniac majority.

7.2.2. Banking Institutions

Banking system in Bosnia and Herzegovina today is made out of the Central Bank of Bosnia and Herzegovina - which plays the role of central bank, and business banks - some banks have continued the business from the pre- war times and today they are treated as State’s banks, and

more banks have been established during and after the war. The latter ones are mainly with the private capital, the rest of capital comes from State's or joint firms. Some of them operate in a way that is not much different from the pre - war practice. This is because of the influence of their joint owners, stockholders in control and management bodies.

Existing banking system in the Federation of Bosnia and Herzegovina has different limits in business world. Those are usually inherited from pre-war period: high foreign encumbrances; encumbrance of banks with foreign creditors on financing of credits; unresolved questions with creditors and others; high internal encumbrances; foreign currency savings of citizens, with the guarantee of the State; partly heritage from the pre - war period in the sense of shortage of modern trained staff, effective information system, undeveloped system of evaluation of firms and their management personnel - in one word the shortage of suitable market conception and organization.

Deposits in the banks are short - term, unstable and expensive. Public and private sector do not possess enough resources which they can deposit in banks, and those that they have are on short-term basis.

The liquidity of banks is poor. The only larger amounts of resources for credit come from different credit lines from the foreign countries, World Bank, USAID, EU and others. The result of this is that the bank loans from their own potential are mostly short term (30 to 90 days) and with high interest rates.

In October 1997 the Government of the Federation of Bosnia and Herzegovina established new bank, with mainly State's capital named Investment Bank of the Federation of Bosnia and Herzegovina. The basic purpose of existence of this bank is for performance of banking jobs on basis of investment, development programmes and projects in the Federation of Bosnia and Herzegovina and projects of restoration and reconstruction, invested by foreign donators.

7.2.3. International Help in Financing of Programmes and Projects within the Water Sector

To the country, which has come out of a difficult war, with all conditions of economy ruined, and came to zero, the international help was absolutely necessary. On donator conferences the list of priority projects from the water sector was present. Donator and creditor funds of international community were the only funds that were invested in the restoration of the water economy sector. There were no domestic sources.

The following text gives a review of basic information about projects, amounts and donators and creditors, who invested in water sector rehabilitation.

The World Bank

The World Bank has the leading role in restoration and reconstruction of Bosnia and Herzegovina. In the water sector the World Bank is financing the project of urgent work on the rebuilding of Water supply, sewerage and hard waste material in Federation of Bosnia and Herzegovina, whose realization is near the end. This project presents inclusive frame for the rehabilitation of the water sector of Bosnia and Herzegovina and at the beginning of this year a similar project begun in the Republic of Srpska.

Apart from the investment into the physical restoration of the objects of water sector that have highest priority, the project foresees other measures and activities for the rehabilitation of the sector as well.

The World Bank has apart from investing their own creditor resources, also with their own activities supported other creditors and donators for restoration of the water sector for those projects and activity which it considered most necessary, such as: institutional strengthening of the

sector, creation of conditions for introduction of economical prices in sector, professional improvement of the personnel, technical preparing of the institutions, introduction of private sector into this field and other, in hope of creating the independent future functioning that will stay that way.

The World Bank approved credit of 20 million dollars, with exceptionally suitable conditions, for the water sector: repayment period is 30 years, grace period of 7 years, interest rate of 0,75% per year for servicing of credits. The implementation of projects financed by the credit is in the phase of completion.

European Union

European Union is the largest of the active donators engaged in restoration and rebuilding of Bosnia and Herzegovina. In period from 1996 to 1999 European Union will finance two projects: Project for Restoration and PHARE Program. The whole package of help given by the European Union is a grant. In 1996 more than 9 million ECU was donated (emergency program – as first phase of PHARE Program) for 62 municipalities in the Federation of Bosnia and Herzegovina. The same year in the framework of the project "Europe for Sarajevo ", 9,3 million ECU was donated to the water sector. In this project 1,2 million ECU is planned for the elaboration of a Plan for management of waste material.

In 1997, mainly from the PHARE Program, a donation of 16,7 million ECU was approved for insuring and modernization of the water supply. The realization of these projects has begun in year 1998. The projects of water supply in the Municipalities of Una - Sana Canton, Bihać, Bosanska Krupa, Velika Kladuša, Sanski Most and Bosanski Petrovac are financed by the approved resources.

European Union, in co-operation with the World Bank, undertakes series of other activities so that institutions and organizations in the water sector of Bosnia and Herzegovina are prepared for independent functioning of the sector. Apart from this, European Union urges other member states to invest in the restoration of Bosnia and Herzegovina, and therefore the water sector.

United States of America

United States of America are one of the greater donators for the restoration of Bosnia and Herzegovina. Up to now in the water sector, the USAID agency donated 19,16 million dollars, out of that 1,9 million went to Republic of Srpska, and the rest to the Federation of Bosnia and Herzegovina.

USA by means of their own agencies for implementation, similar to the World Bank and European Union, take upon themselves series of activities, apart from investment, for long term strengthening of the water sector. Donated funds are directed to all parts of the Fe million USD deration of Bosnia and Herzegovina (Donji Vakuf, Zenica, Vogošća, Brčko Ravne, Maglaj Odžak, Orašje Tuzla Usora, Zavidovići, Čelić and Goražde).

Other Creditors and Donators

a.	Republic of Italy	5,30 million USD
b.	Republic of Austria	6,14 million USD
c.	Kingdom of Netherlands	4,24 million USD
d.	Saudi Fund for Arabic Development	6,00 million USD
e.	Kingdom of Spain	4,34 million USD
f.	Republic of Finland	5,72 million USD
g.	Kingdom of Sweden	1,59 million USD

h.	Norway	1,39 million USD
i.	France	0,75 million USD
j.	Switzerland	1,59 million USD
k.	UNICEF	1,50 million USD

It is estimated that over 100 million dollars from international resources was directed towards reconstruction and rebuilding of the water sector in post - war period. Mainly these are projects of water supply. Lesser part is directed towards the protection of water from pollution, and development and rebuilding of sewerage systems.

7.3. Actual Cost and Price Policy

The war has brought great difficulties to the functioning of municipal communal systems. They suffered great damages. In many cases the system's facilities were direct targets of destruction. The underground parts of a system, due to the lack of maintenance for more than seven years, are neglected and require significant resources for rebuilding and rehabilitation. All this has resulted in enormous losses in the water supply systems, even up to 70% (for example the water supply system in Sarajevo).

Only in the second half of 1997 all municipalities begun with charging of communal services which stopped during the war. In some places the charges for water were lump sums and not based on water consumption, which creates inefficient and extravagant consumption. Present prices, depending on municipalities, size and on how complicated the system is, provide cost covering from 20 to 40%. Great part of the costs is covered by the municipal budgets, and in Sarajevo, Canton provides this.

The field of wastewater in the Federation of Bosnia and Herzegovina is in exceptionally poor condition. Only few wastewater treatment plants are partially in use. The only benefit of the inactivity of the industrial capacity in Bosnia and Herzegovina is that the quality of water is less threatened by the industrial wastewater. The above mentioned shows a very bad situation in the field of communal infrastructure and the offering of services in this field. Even before the war, and today as well, the chronic shortage of funds is the main cause of bad situation. The prices of water supply and wastewater disposal services were inadmissible low, which is the case today as well.

Public utility companies send bills to the users and in that way charge their services. In places, where the water meters exist, the meter reading is done and consumed quantities are invoiced. Tariff - prices for services are usually different for households and firms. Somewhere the tariffs are different for particular activities - health service, education and others, which usually have to pay less for the communal services.

In case there are no water meters the prices are calculated as lump sums per person in the household or per household a month. The price of wastewater is calculated according to the quantity of consumed water. In some municipalities the price is united for water and public utilities, and in others it is calculated and paid separately. In municipalities where there is no sewerage system, the payment of services is only for the delivered water.

Regarding the World Water Day, in 1997 and 1998 two conferences were held on the theme of the functioning of communal water supply systems, with participation of water sector representatives of all levels. Among other thing, the conclusions showed the need for the introduction of economic prices in this field.

Many of the problems in the water sector originate directly from poor financial conditions on all levels, particularly in the organizations responsible for the water sector, which means that money is not available not even for carrying out basic functions. It is important to immediately establish system of financing of this sector with secure and continual funds resources.

Also, it is important to define planing documents with all necessary details, measures and activities.

Table 7 Tariffs, collection and cost recovery of public utility companies in 1997 (in US Dollars)

No.	Municipality	Water Tariff(m3)		Sewerage Tariff(m3)		Collection %	Income Expenses	Profit/loss	Cost Recovery %	Subvention
		Households	Industry	Households	Industry					
1.	Cazin	0,59	1,23	0,07	0,14	50	984.956 982.608	2.348	30	-
2.	Srebrenik	0,27-0,57*	1,72	-	-	66,7	638.392 638.392	0,00	45	-
3.	Sarajevo	0,57*	1,47*			40	17.363.305 30.016.856	-12.653.551	29	7.133.512
4.	Fojnica	2,26/house/ month				45	70.584 120.812	-50.228	35	
5.	Hadžići	0,57*	1,47*			26,4	731.939 726.046	5.893	33	338.983
6.	Jablanica	0,57/house/ month	1,42*			61,3	504.727 544.593	-39.866		
7	Goražde	2,82/house/ month	16,95/ toilette	30% of water tariff	30% of water tariff	27,8	455.340 411.418	43.922	20	79.096
8.	Sanski Most	0.28* or 2,82/h./mon	0,40-0,68*				2.018.806 2.016.584	2.222	19	13.889
9.	Gradačac	0,57	1,13	0,14	0,28	27	744.025 743.859	166	21	
10.	Ključ	0,23	0,57			50	375.566 387.859	-12.293	31	
11.	Gračanica	0,23*	1,13*				416.137 416.018	119		
12.	Konjic	Lump sum				47	181.642 385.000	203.358		

No.	Municipality	Water Tariff		Sewerage Tariff		Collection %	Income	Profit/loss	Cost Recovery %	Subvention
		Households	Industry	Households	Industry		Expenses			
13.	Bugojno	0,17	0,40 or			62,7	462.301			
		Lump sum 2,82/house					688.029	225.728		
14.	Kakanj						492.035			
							479.613	12.422		
15.	Bos.Petrovac	0,71	0,71	0,19	0,19		386.960			
							434.958	-47.998		
16.	Kladanj	0,07	0,59	0,03	0,18	60	204.232			
							207.479	-3.247		
17.	Banovići	0,57/cap/	0,24	0,28/cap/	0,12		383.155			
		Month		month			453.539	-70.384	19,6	

1 USD = 1,775 KM

**Total price of potable and wastewater cap/month - price per household member per month house/month - price per household per month toilette - price per toilette per month*

8. Development of National Pollution Reduction Program

Since, after the war, only 20% of the economy capacities are in operation, the planned time schedule for the accomplishment of the traced objectives in the "Long-term Program on Water Pollution Protection in Bosnia and Herzegovina" could not be achieved. Therefore, emergency measures with relatively small investments were approached. They solved crucial problems in water supply, sewerage and solid waste disposal.

Assistance in implementation of these very important and crucial issues for Bosnia and Herzegovina was given by EU, WB, many countries and institutions, through donor funds, loans, donations in equipment and material and the like.

All the projects related to water protection, which are implemented after the war, had to pass through technical and economic procedures to reach the validity stage for application and acceptance by the financiers' banks. So, domicile designing companies for draw up of design documentation in the field of water protection are capable for such kind of work. Of course, foreign companies, consultants and experts in designing work can be engaged, too.

Since the end of the war in 1996 up to the present, minor operations on sewerage systems have been done, as well as rehabilitation of the existing plants for wastewater treatment and solid waste landfill sites. Those works are so small that they cannot resolve water pollution reduction. Focuses of the problems should be approached and accomplished to reduce water pollution in a considerable extent and significantly larger investments are needed for that.

The society in Bosnia and Herzegovina is going from socialistic and planned production to market economy and capitalistic approach. Consequences of month spent under the war are numerous and have left the country faced with heavy problems. Regarding water sector, we inherited earlier Law on Waters, books of rules, and Law annexes and sub-regulations, with remark that it was intensively worked on rearrangement to new Law on Waters and other law regulations. This resulted in establishing of new Law on Waters for the Federation of Bosnia and Herzegovina, which became effective on May 19, 1998. Simultaneously with state activities on finding of new law regulations, in accordance with European standards, the work has been done together with foreign experts on searching for fundamental organizational, economic, legal and technical methods and systems, and finding of best solutions of institutional strengthening of water sector in the Federation of Bosnia and Herzegovina and Republic of Srpska.

This project of institutional strengthening is financed through European Commission and foreign consulting company PLANCENTER from Finland leads it together with local subconsultant.

This project will give basic directions of development and guidance for water sector through law regulations and organization of entire water resources management system, financing and finance mechanisms, training of staff and protection of water quality.

Annexes

1. **Summary of recommended projects for municipal hot spots**
2. **Summary of recommended projects for agricultural hot spots**
3. **Summary of recommended projects for industrial hot spots**

Annex 1 Summary of Recommended Projects for Municipal Hot Spots

Name Hot Spots River+Location	Parameters and values which define problem	Ranking of problem	Name and type of project structural and non-structural	Strategy of project and aims	Parameters and values defining project benefits	Project Beneficiaries
1	2	3	4	5	6	7
1. Municipal sewerage system-treatment of wastewater of r.Miljacke,Butile Sarajevo city	Large concentration of pollution by large town Total PE=741.967 Upper water stream of r.Bosne	High	Rehabilitation and reconstruction of municipal plant for complete wastewater treatment in town and for industry	Uniform treatment of municipal and industrial wastewater .Reduction of pollution in upper stream of r.Bosne	Improvement of total water pollution, control of bioenergetic process. Disposition of sludge from wastewater. Improvement of ecology water system	Municipality and Canton Sarajevo
2. Regional sewer systems Tuzla-Lukavac with main plant for treatment of Jala and Sprecč wastewater	Large pollution combined by municipal wastewater and high percentage of pollution by “dirty” industry at low flow of r.Jala i Spreca. Tuzla Es_{uk}=586.767 Lukavac Es_{uk}=240.892	High	Regional sewerage system Tuzla-Lukavac Structural	Cover much polluted waters from Tuzla basin which has great impact on ecology especially during low flow of r.Jala and r.Spreča	Reduction of pollution of r.Jala and r.Spreča. Uniform discharge in recipient, protection of river beds. Disposition of sludge.	Municipalities Lukavac and Tuzla
3. Regional sewerage systems of Banja Luka with main plant for treatment of wastewater of r. Vrbas	There is no municipal system for wastewater treatment. Large load of wastewater Es_{uk}=2.365.367	High	Regional sewerage system Banja Luka Novoselija-Klašnice L=21 km ϕ=400-1000 mm structural	Solving the problem of wastewater treatment in town of 200000 population and for industry with high organic load . protection of surface waters at Lijevče polje	Reduction of total pollution of r.Vrbas common treatment and uniform discharge into recipient	Municipality Banja Luka

Name Hot Spots River+Location	Parameters and values which define problem	Ranking of problem	Name and type of project structural and non-structural	Strategy of project and aims	Parameters and values defining project benefits	Project Beneficiaries
1	2	3	4	5	6	7
4. Regional sewerage system at r.Vrbas G.Vakuf-Bugojno-D.Vakuf	Pollution by upper water course of r.Vrbas G.Vakuf Es_{uk}=5717 Bugojno Es_{uk}=45292 D.Vakuf Es_{uk}=19742	Medium	Sewerage systems of G.Vakuf-Bugojno-D.Vakuf L=30 km ϕ=400-700 mm	Long-term strategy for protection of upper waters of r. Vrbas	Protection of natural eco system, reduction of pollution, common treatment	Municipalities Gornji Vakuf, Bugojno and Donji Vakuf
5. Regional sewerage system Sarajevo-Visoko	Connection of more towns and industrial centres Vogošća, Ilijaš,Visoko and connection to KS Fojnica-Kiseljak-Visoko L=32 km ϕ=400-700 mm	Medium	Sewerage system Sarajevo-Visoko L=21K ϕ=400-1000 mm Structural	Connection of the sewerage systems network of more Long term program for protection of r.Bosna water	Reduction of discharge into recipient, common treatment of wastewater. Reduction of water source pollution	More municipalities in upper water stream of r.Bosne
6. Main sewer Travnik-Vitez along r. Lašva	Deterioration of II category of r.Lašva by increased pollution Es_{uk}=55.209	low	Main sewer Travnik-Vitez L=17 km ϕ=600-800 mm Structural	Protection of r.Lašva and valleys along river and collection of wastewater of Travnika, N.Travnika and Vitez into one system	Long -term solution for protection of r.Lašva water and reduction of pollution	Municipalies Travnik and Vitez
7. Main sewer along r. Pliva and Plivsko jezero near Jajce	Endanger of Plivskog jezera and r.Pliva as water systems of I category	low	Main sewer Pliva-Jajce L=23 km ϕ=300-600 mm	Long-term plan for protection of natural systems, solving the problem of sewerage systems of settlements	Protection against pollution of Pliva and Jezero	Municipality Jajce

Annex 2 Summary of Recommended Projects for Agricultural Hot Spots

Name Hot Spots River+Location	Parameters and values which define problem	Ranking of problem	Name and type of project structural and non-structural	Strategy of project and aims	Parameters and values defining project benefits	Project Beneficiaries
1	2	3	4	5	6	7
1. Farm, "Nova Topola" direct river basin of the Sava river Bos. Gradiška	Farms with 2,000 milk cows, 1,000 heifers and 62,000 pigs, production of animal feeds and silage G.Gradiška Es_{uk} =73692 N.Topola Es_{uk} =55566	high	Treatment of wastewater from the main sewer L=15 km ø 400-6-mm structural	Long-term ground waters pollution protection of Lijevče polje, the Sava river protection from direct pollution	Protection of potable water source from pollution of organic origin, bio-energy generating	Municipalities Nova Topola and Gradiška
2. Farm "Spreča", the Spreča river Tuzla	Farm with 800 cows	medium	Wastewater treatment from the "Spreča" farm-structural	The Modrac lake protection from organic waste	Pollu. reduction of the r.Spreča and Modrac lake from organic pollution	Municipalities Tuzla, Zivinice, Lukavac
3. Agricultural estate "Butmir" The Bosna river – Sarajevo	Potable water source endangered, farm with 600 cows	low	Wastewater treatment from "Butmir" farm structural	Potable water source protection of the city of Sarajevo	Reduction of infiltration into ground waters – organic pollution	Sarajevo municipality
4. Farm in Brcko, direct river Sava basin	Slaughter house, pig farm knacker's yard Es_{uk}=517,450	medium	Wastewater treatment from farms – structural	Pollution from farms-problem solving	Pollution reduction of waters discharged into the Sava river	Municipalities Brcko
5. Farm in Bijeljina, direct Sava river basin	Farm Es_{uk}=158908	low	Wastewater treatment from farms - structural	Direct Sava river basin protection. pollution reduction	Reduction and control of pollution from agriculture	Municipality Bijeljina

Annex 3 Summary of Recommended Projects for Industrial Hot Spots

Name Hot Spots River+Location	Parameters and values which define problem	Ranking of problem	Name and type of project structural and non-structural	Strategy of project and aims	Parameters and values defining project benefits	Project beneficiaries
1	2	3	4	5	6	7
1. Chlorine alkaline complex, the Jala river	High content of toxic matters, existing pre-treatments do not meet the requirements	high	Reconstruction of wastewater pre-treatment – structural	Effluent toxicity reduction, long-term solution for industry	Pollution reduction of r. Jala and possibility of treatment with municipal wastewater	HAK – Tuzla and Canton
2. Coke chemical combine, Lukavac, the Spreča river	Wastewater toxicity in high 115 m^3/s – dilution	high	Wastewater treatment reconstruction	Long-term solution for toxicity	The Spreca river pollution reduction	HAK-Lukavac and Lukavac municipality
3. Pulp wood and viscose factory, Banja Luka, the Vrbas river	High pollution in organic component EBS^{uk}=1922584	high	Existing "Incel" wastewater treatment – reconstruction structural	Pollut. reduc. & systematic w.w. problem solving for town & industry	The Vrbas river pollution reduction	Incel – Banja Luka and municipality
4. Pulp wood and paper industry-Maglaj the Bosna river	High organic pollution Es^{uk}=400,025	high	Reconstruction & enlargement of "Natron" w.w treat.-structural	Common treatment of all waters, "black" and "white"	pollution reduc. of the Bosna river near near Maglaj	"Natron" Maglaj and municipalities
5. Pulp wood & paper factory, Prijedor, the Sana river	High organic pollution Es_{uk}=1207963	high	W.W.treatment plant of "Celpak" Prijedor– struct.	Reduction of pollution in the Sana river	Red. of organic pollution & brown color of the Sana river	"Celpak" Prijedor and municipality
6. The Zenica Mining and Metallurgical Combine, the Bosna river	High toxicity 193.1 m^3 /s Es_{uk}=176947	medium	Reconstruction of wastewater treatment plant - structural	Reduction of toxicity & water pollution from suspended substances	Overall pollution reduction of the Bosna river	Iron works – Zenica and municipalities

Name Hot Spots River+Location	Parameters and values which define problem	Ranking of problem	Name and type of project structural and non-structural	Strategy of project and aims	Parameters and values defining project benefits	Project beneficiaries
1	2	3	4	5	6	7
7. Sodium factory – Lukavac, the Spreča river	Increased pH & content of suspended matters	medium	Construction of a plant for pre-treatment of wastewater	The Sana & Una rivers protection from pollution	Red.of organic & susp. subst. pollution of wastewater	"Celpak" and municipality
8. Wood distillation – Teslić, r. Usora	High concentr. of pollution ES=58400 & toxicity 2 m^3/s	low	Construction of devices for pre-treatment of wastewater	The Usora river pollution protection	Wastewater toxicity and pollution reduction	Wood distillation and municipality
9. Plywood sheet factory "Maglić" Foča the Drina river	High content of water pollution ES=208175	low	Construction of wastewater pre-treatment plant	The Drina river pollution protection	reduction of overall pollution of wastewater	"Maglić" Municipalities