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ASSESSMENT OF THE STATUS OF TRANSBOUNDARY RIVERS, LAKES AND GROUNDWATERS

ASSESSMENT OF TRANSBOUNDARY RIVERS, LAKES AND GROUNDWATERS IN SOUTH-EASTERN EUROPE DISCHARGING IN THE ADRIATIC SEA

Note by the secretariat

Summary

This document was prepared pursuant to decisions taken by the Working Group on Monitoring and Assessment at its tenth meeting (Bratislava, 10–11 June 2009, ECE/MP.WAT/WG.2/2009/2, paras. 8–44) and by the Working Group on Integrated Water Resource Management at its fourth meeting (Geneva, 8–9 July 2009; ECE/MP.WAT/WG.1/2009/2, paras. 44–48). This document contains the draft assessment of the different transboundary rivers, lakes and groundwaters in South-Eastern Europe (SEE) that are located within the Adriatic Sea drainage basin by transboundary basin and aquifer.

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CONTENTS

I. INTRODUCTION

1. The present document contains the assessments of the different transboundary rivers, lakes and groundwaters in South-Eastern Europe (SEE) which are located within the Adriatic Sea drainage basin. The river basins which assessments are presented in this document are sub-basins of the Danube. The document has been prepared by the secretariat with the assistance of Global Water Partnership Mediterranean (GWP-Med) on the basis of information provided by SEE countries.

2. The present document contains several references to figures, which are not presented here but will be included in the final assessment publication as edited or redrawn, as needed. It should be noted that maps of the basins and maps showing locations of the transboundary aquifers are not referred to here but will be developed for the final assessment, consulting the riparian countries when necessary. For ease of reference, in most cases the numbers in front of the names of the aquifers and groundwater bodies in the tables containing related information refer to the numbering used in the list of transboundary groundwaters in South-Eastern Europe in the First Assessment of Transboundary Rivers, Lakes and Groundwaters. For descriptions of the transboundary aquifer types and related illustrations, Annex V of document ECE/MP.WAT/2009/8 should be referred to.

II. KRKA RIVER BASIN[1]

Table 1. Basin of the Krka River

Area	**Country**	**Country's share**		**Number of inhabitants**	**Population density (persons/km^2)**
5,613 km^2	Bosnia and Herzegovina	300 km²	12%	N/A	34 persons/km^2
	Croatia	2,200 km²	88%	N/A	N/A

3. The river has its source in Croatia and ends up in the Adriatic Sea in Croatia. The basin has a pronounced mountainous character with an average elevation of about 100 m a.s.l. The National Park "Krka" covers 4.5% of the basin area.

Hydrology and hydrogeology

3. A major transboundary tributary is the river Butišnica. Major lakes are Lake Brljan (man-made), Lake Golubić (man-made), Lake Visovac (natural) and Lake Prokljan (natural).

4. There are three hydropower stations located on Krka, and two located on the tributaries Butišnica and Krčić.

5. Hydrogeologically, the basin of the upper course of the Krka River around the town of Knin and the Kosovo polje valley is made mostly from impermeable and poorly permeable

[1] Based on information from Croatia and the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Croatian Waters/Water Management Department (Split, Croatia) on behalf of both Croatia and Bosnia and Herzegovina

deposits, that is, less vulnerable to pollution transport. Transboundary Krka aquifer (no. 19) is described in the table below.

Table 2. Discharge characteristics of the Krka River at the gauging station Marjanovići (Croatia)

Discharge characteristics	Discharge	Period of time or date
Q_{av}	21.2 m^3/s	1963-1990
Q_{av}	18.4 m^3/s	1979-1991
Q_{max}	125 m^3/s	1961-1990
Q_{min}	3.3 m^3/s	1961-1990
Mean monthly values		
October: 11.8 m^3/s	November: 17.9 m^3/s	December: 24.3 m^3/s
January: 22.0 m^3/s	February: 23.8 m^3/s	March: 25.0 m^3/s
April: 28.2 m^3/s	May: 24.6 m^3/s	June: 17.6 m^3/s
July: 11.7 m^3/s	August: 8.06 m^3/s	September: 8.67 m^3/s

Table 3. Krka aquifer

No. 19 Krka [2]		**Shared by Bosnia and Herzegovina and Croatia**
According to the riparian countries represents none of the illustrated transboundary aquifer types; Cretaceous karstic limestone, strong links to surface water system, groundwater flow from Bosnia and Herzegovina to Croatia		**Mediterranean Sea Basin** Border length (km): 42
	Bosnia and Herzegovina	**Croatia**
Area (km^2)	85	414
Water uses and functions	>95% to support ecosystems, <5% of abstraction is for drinking water	Drinking water supply
Notes		Transboundary aquifer under consideration, but not approved

Status, pressures and transboundary impacts

6. The main forms of land use include grasslands (44%), forests (30%) and cropland (15%). In the Croatian part of the basin, forests occupy approximately 32% of the land area, cropland 35%, grassland 24% and urban areas 3%. Some 6% of the area is under protection.

[2] Based on information from the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Public Enterprise for the Sava Catchment Area, Bosnia and Herzegovina, and Croatian Waters.

Industry uses 27% of the water from the public water supply systems, and the urban sector, 73%.

7. The pressure from agriculture is insignificant due to the still low agricultural production of fruits, vegetables and olives as well as a very low animal production (sheep, pigs, poultry). However, the production is slowly increasing, which in turn may lead to increasing pressure and transboundary impact. Sustainable agriculture and technological development are necessary.

8. There are 18 small sites for stone and alabaster excavations. The intensity of exploitation and the number of sites are slowly increasing.

9. Industry is a pressure factor for the Krka aquifer in Croatia. Intensive aluminium production and shipyards are located in the coastal area. Other industry sectors are less intensive and not recovered after the war. They are mostly connected to the sewer systems. The number of industrial zones is rapidly increasing, but they are all required by law to have adequate wastewater treatment or to be connected to municipal wastewater treatment plants.

10. There are still unfinished sewerage systems and untreated urban wastewaters from the towns Knin (40,000 p.e.) and Drniš (10,000 p.e.[3]). The three controlled dumping sites do not cause significant impact; however, there are also several small illegal dumpsites. Solid waste disposal exert pressure to the Krka aquifer in Bosnia and Herzegovina; polluted water locally drawn in the aquifer has impacts to the groundwater quality. Generally good chemical status of groundwater in the Krka River basin indicates insignificant salinization and seawater intrusion.

11. Storm waters from highways are treated by oil-separators and disposed into underground or discharged into the rivers. However, the treated waters cannot be disposed of into the underground in the vicinity of water abstraction sites (sanitary protection zones).

12. The water bodies have mostly a “good ecological status”. The surface waters in the National Park “Krka” have a “moderate status” because of the ecological requirements of the National Park for high water quality and the untreated urban wastewater discharges from the towns Drniš and Knin, which are located upstream. Phosphorus concentrations have increased in some areas, but not significantly. There are increased concentrations of Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), particularly in the vicinity of Knin. The area of the port of Šibenik is extremely eutrophic.

13. Reduced springflow in Bosnia and Herzegovina results in ecosystem degradation; nevertheless the Krka aquifer is not at risk.

Responses

14. Groundwater quantity and quality monitoring need to be improved, as do abstraction control, protection zones and wastewater treatment with regard to the Krka aquifer in Bosnia

[3] The abbreviation “p.e.” means population equivalent.

and Herzegovina. In Croatia there is a need to establish protection zones. Croatia suggests that the two countries should cooperate for the delineation of transboundary groundwaters, and in the field of monitoring.

15. Croatia has initiated the transposition of the European Union's (EU) Water Framework Directive (WFD) in its legal framework. A river basin management plan (in accordance to EU WFD) has been developed for the Krka river basin, being a pilot for the country.

Trends

16. Oil spilled into the Orašnica River in Knin in 2007. A pollution risk is posed by a petrol station constructed on a flood plain in the vicinity of Knin. Croatia reported that investments in flood protection facilities and hydro-amelioration systems in general are required.

17. Increase in capacity to receive tourists is planned, because this sector has developed favorably in the past several years.

III. NERETVA BASIN[4]

18. The Neretva River basin is shared by Bosnia and Herzegovina and Croatia, and through Trebišnjica River, also by Montenegro.

Table 4. Basin of the Neretva River*

Area	Country	Country's share		Number of inhabitants	Population density (persons/km^2)
XX	**Bosnia and Herzegovina**	10,100 km^2	XX	436,271	42.87
	Croatia	280 km^2	XX	N/A	N/A
	Montenegro	N/A		N/A	N/A

*Also including the Basin of Trebišnjica River

19. The 220 km long Neretva River has its source in the Jabuka Mountains in Bosnia and Herzegovina, and it flows for 20 km through Croatia before reaching the Adriatic Sea. The upper Neretva River flows through a mountainous landscape; the last 30 km, from Mostar (Bosnia and Herzegovina) to its mouth, spreads into an alluvial delta covering 200 km^2. The average annual flow of Neretva is 11.9×10^9 m^3.

20. The Lower Neretva valley contains the largest and the most valuable remnants of the Mediterranean wetlands on the eastern Adriatic coast and one of the few areas of this kind

[4] Based on information from Bosnia and Herzegovina, Croatia the Environmental Performance Review of Bosnia and Herzegovina (UNECE 2004), and the Neretva and Trebišnjica Management Project, Appraisal Document, The World Bank/GEF.

remaining in Europe. The area is a significant European resting and wintering place for migratory species. The wetlands are also valuable for the ecological services they provide as well as for their support to local economic activities. The part of the delta area extending in Bosnia and Herzegovina is under protection status (Hutovo Blato Nature Park). The Hutovo Blato (74.11 km^2) has been designated as Ramsar site (2001) and so is the delta area extending in Croatia (1993). Five protected areas exist in the Croatian part of the delta covering a total area of 16.2 km^2; two sites (total of 7.77 km^2) have been proposed for designation as well. Protection of the sensitive areas needs to be improved at national level. Moreover, since the delta is a geographical and ecological entity, the two countries should use similar protection requirements and measures to manage it. Besides the wetlands the basin includes also Dinaric karst water ecosystems.

Hydrology and hydrogeology

21. Major transboundary tributaries include the rivers Ljuta, Rakitnica, Bijela, Trešanica, Kraljušnica, Neretvica, Rama, Doljanka, Drežanka, Radobolja, Jasenica, Trebižat (right tributaries) and Šištica, Baščica, Prenjska river, Šanica, Bijela, Buna, Bregava, Krupa (left tributaries).

Table 5. Discharge characteristics for the Neretva River at different gauging stations

Gauging station: Mostar (Bosnia and Herzegovina)		
Discharge characteristics	**Discharge**	**Period of time or date**
Q_{av}	180 m^3/s	1995 – 2007
Q_{max}	2,600 m^3/s	1999
Q_{min}	50 m^3/s	N/A

Gauging station Žitomislići (Bosnia and Herzegovina)		
Q_{av}	231 m^3/s	1995 – 2007
Mean monthly values:		
October: 128 m^3/s	November: 238 m^3/s	December: 155 m^3/s
January: 504 m^3/s	February: 336 m^3/s	March: 416 m^3/s
April: 367 m^3/s	May: 197 m^3/s	June: 105 m^3/s
July: 74.1 m^3/s	August: 74.7 m^3/s	September: 181 m^3/s

Gauging station Metković (Croatia)		
Discharge characteristics	**Discharge**	**Period of time or date**
Q_{av}	342 m^3/s	1961–1990
Q_{max}	N/A	N/A
Q_{min}	N/A	N/A

22. Croatia reports that water scarcity and droughts are observed during the summer period.

23. The karst geology of the area results in high interaction between the surface waters and groundwater. The Trebišnjica and Trebižat Rivers are characteristic examples. The Trebišnjica River emerges near Bileća town (Bosnia and Herzegovina). Trebišnjica is a characteristic example of a “sinking river” (drains into the underground and reappears); its total length is 187 km above and under the ground. Its average annual flow is 2.5×10^9 m^3. Part of the river’s water drains directly across the borders with Croatia to the Adriatic Sea. Trebišnjica is hydraulically partially linked to the Neretva River, being part of the same karstic hydrogeological basin. The Trebišnjica sub-basin is shared between Bosnia and Herzegovina – where the major part of the sub-basin extends - Croatia and Montenegro (almost the total of the western bank of the Bileća Reservoir belongs to Montenegro). The 51 km long Trebižat River (also known as Tihaljina and Mlade) is also a “sinking river”; the Vrljika River (Croatia) drains into the underground and takes rise at the spring Tihaljina (Bosnia and Herzegovina) then flowing as Tihaljina-Mlade-Trebižat River.

24. Transboundary aquifers in the basin include the: (i) Neretva Right coast; (ii) Trebišnjica/Neretva Left coast; and (iii) Bileko Lake.

Table 6. Neretva Right coast aquifer

No. 21 Neretva Right coast [5]		**Shared by: Bosnia and Herzegovina, and Croatia**
According to the riparian countries represents none of the illustrated transboundary aquifer types; Cretaceous limestones and dolomites and Eocene flysch; average thickness 250-600 m and up to 600-1,000 m, medium to strong link to surface waters, groundwater flow from Bosnia and Herzegovina to Croatia. Groundwater is 100% of total water use both in Bosnia and Herzegovina and Croatia.		**Mediterranean Sea Basin** Border length (km):
	Bosnia and Herzegovina	**Croatia**
Area (km²)	>1,600	862
Water uses and functions	Dominantly drinking water supply and hydroelectric power, some irrigation	Drinking water supply
Notes		-Transboundary aquifer under consideration, but not approved -Agreed delineation of transboundary groundwater is needed

[Figure 1. Conceptual sketch of the Trebišnjica/Neretva Left groundwater body (provided by Bosnia and Herzegovina)]

[5] Based on information from Bosnia and Herzegovina, Croatia and the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Public Enterprise for the Adriatic Sea Catchment Area of Bosnia and Herzegovina and Croatian Waters.

Table 7. Trebišnjica/Neretva Left coast aquifer

No. 22 Trebišnjica/Neretva Left coast [6]		**Shared by: Bosnia and Herzegovina, and Croatia**
According to the riparian countries represents none of the illustrated transboundary aquifer types; Triassic, Jurassic, Cretaceous layered and massive limestones, with local Eocene flysch, total average thickness 1,000 m and maximum 2,500 to 3,000 m, groundwater flow from Bosnia and Herzegovina to Croatia, medium to strong links to surface water systems. Groundwater is 100% of total water use in both Bosnia and Herzegovina and Croatia.		**Mediterranean Sea Basin** Border length (km): 124
	Bosnia and Herzegovina	**Croatia**
Area (km^2)	>2,000	242
Water uses and functions	50-75% for hydroelectric power, <25% for drinking water supply and irrigation, also to support ecosystems	Dominantly drinking water supply (Slamo and Ombla springs) – it supplies Dubrovnic
Notes		-Transboundary aquifer under consideration, but not approved -Agreed delineation of transboundary groundwater is needed

Table 8. Bileko Lake aquifer

No. 23 Bileko Lake [7]		**Shared by: Bosnia and Herzegovina and Montenegro**
According to the riparian countries represents none of the illustrated transboundary aquifer types. Triassic, Jurassic and Cretaceous limestones and dolomites up to 3,000 m thick, weakly linked to surface waters, groundwater flow from Montenegro to Bosnia and Herzegovina. Groundwater provides 100% of total water use in Bosnia and Herzegovina		**Mediterranean Sea Basin** Border length (km): 90
	Bosnia and Herzegovina	**Montenegro**
Area (km^2)	>1,000	N/A
Water uses and functions	>75% for hydroelectric power, small amounts for drinking water and irrigation	N/A

[6] Based on information from Bosnia and Herzegovina, Croatia and the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Public Enterprise for the Adriatic Sea Catchment Area of Bosnia and Herzegovina, the Directorate of Water and Institute of Geological Research, Republic Srpska, Bosnia and Herzegovina, and Croatian Waters.
[7] Based on information from the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Directorate of Water and the Institute of Geological Research, Republic Srpska, Bosnia and Herzegovina, and Croatian Waters. There was no information included for Montenegro.

Notes	There is no pressure exerted to the aquifer which is considered to be in good status both in terms of quantity and quality; nevertheless, there is local moderate degradation of ecosystems	

Pressures and transboundary impacts

Table 9. Land cover/use (% of the part of the basin extending in each county)

	Lakes / reservoirs	Forests	Cropland	Grassland	Urban / industrial areas	Protected areas	Other forms of land use
Bosnia and Herzegovina	20	30	30	5	3	12	-
Croatia	2.96	46.15	31.22	7.48	1.14	11.05	-

24. The water resources in the Neretva and Trebišnjica basins are important for the economies of both countries. The rivers are crucial for transport, recreation, fisheries, and fishing. They are used also for drinking water, irrigation, gravel and sand extraction.

25. Both Neretva and Trebišnjica are particularly important in terms of energy production. In the Bosnia and Herzegovina’s part of the Neretva and Trebišnjica basins, there are 13 artificial reservoirs. Dams with accompanying reservoirs on Neretva include those of Jablanica, Grabovica, Salakovac and Mostar. A hydroelectric production system has been constructed on Trebišnjica River. This includes two dams on the river (Trebinje I or Grančarevo and Ttrebinje II, in the Srpska Republic/Bosnia and Herzegovina) and two channels: a channel through Popovo polje (Popovo field) towards Čapljina plant (Federation of Bosnia and Herzegovina/Bosnia and Herzegovina) and a second one across the borders towards Dubrovnik plant (Croatia). Additional infrastructure is planned to be constructed within the “Upper horizons” project – includes regulation of Gatačko, Nevesinjsko, Dabarsko and Fatničko fields (see figure 2 below; the blue circles represent available infrastructure in the Trebišnjica hydroelectric production system (Čapljina, Trebinje I, Trebinje II and Dubrovnik I) while the red circles represent planned infrastructure).

[Figure 2. Available and planned infrastructure in Trebišnjica hydroelectric production system (provided by Bosnia and Herzegovina)]

26. A hydropower plant exists also in Rama River. The operation of the infrastructure available on the rivers should be coordinated taking into account the upstream-downstream needs and considerations as well as the evolving climatic conditions and prevent potential negative effects on the ecosystems and economic activities. Plans for hydropower generation development in both countries should also take into account these factors.

27. Alteration of the hydrological regime as a consequence of water use for agricultural, municipal, industrial, and hydropower generation purposes, reclamation of wetlands, uncontrolled urbanization and excessive illegal hunting and fishing in the wetlands are pressure factors. Erosion of riverbeds and land as well as decline of groundwater levels in the

Trebišnjica/Neretva Left coast aquifer and reduced springflow linked to both Neretva Right coast and Trebišnjica/Neretva Left coast aquifers in Bosnia and Herzegovina have been observed.

28. Point-source pollution (aluminium production, untreated municipal and industrial wastewaters and uncontrolled dumpsites, both for municipal and industrial wastes) and non point pollution due to unsustainable agricultural practices exert pressure both on surface waters and on aquifers. Widespread but moderate drawing of polluted water in the Neretva Right coast and Trebišnjica/Neretva Left coast aquifers exacerbates the situation. Bosnia and Herzegovina reported that water pollution by nutrients, pesticides, heavy metals and organic compounds are issues of concern. Access of population to sewerage systems has been low in Bosnia and Herzegovina and there is room for improvement in treatment facilities for municipal wastewater. There are water losses due to degraded water supply and distribution systems, and the efficiency of agricultural water use is limited. There is pollution from municipal wastewater in the areas of Metković, Rogotin and Opuzen in Croatia. Occasional microbiological pollution in Neretva Right coast and Trebišnjica/Neretva Left coast aquifers in Croatia as well as moderate nitrogen, pathogens and organic compounds pollution in the Neretva Right coast aquifer and wide but moderate nitrogen, pathogens and heavy metals and some local, moderate pesticides pollution in Trebišnjica /Neretva Left coast aquifer in Bosnia and Herzegovina, was also reported; groundwater pollution has effects at the transboundary level.

29. The cumulative impacts of these pressures have led to degradation, in terms of quality and quantity, of surface waters and groundwater and subsequently to associated ecosystems.

30. Pressures and impacts have in many cases an upstream – downstream character; for instance the regulation of the flow of the river has led to salt water intrusion in the Neretva delta as well as the reduction of sediment deposition in the alluvium affecting the natural system, its functions and services, as well as economic activities downstream. This is not applicable everywhere throughout the area, since the existence of karstic geological formations creates also a favorable environment for the diffusion of impacts of pressure factors such as point pollution, that occur downstream, to other parts of the basin.

Response measures

31. A number of water resources management plans and measures are implemented in Croatia which has initiated the transposition of the EU WFD in its legal framework; legal acts that will fully transpose the EU WFD in the legal framework of the country will be adopted soon (within 2009). The preparation of a River Basin Management Plan in accordance to the EU WFD (Croatian Waters in cooperation with the Ministry of Regional Development, Forestry and Water Management) is underway.

32. Bosnia and Herzegovina has established protection zones for drinking water supply for the Neretva Right coast aquifer; wastewater treatment plants exist in the area but improvements are needed. Vulnerability mapping is planned for Neretva Right coast and Trebišnjica/Neretva Left coast aquifers in Bosnia and Herzegovina. Groundwater quantity is being monitored in the Neretva Right coast aquifer in Bosnia and Herzegovina while

groundwater quality is being monitored in Bileko Lake aquifer; improvements are necessary though in both cases. Data on Trebišnjica/Neretva Left coast has been exchanged between the two countries, but improvement is needed in this regard; monitoring is needed in both countries.

33. The process for the improvement of the water flow and quality monitoring is on-going; more effort is needed in the area of bio-monitoring. This will eventually allow the assessment of the evolving status with regard to water supply, demand and quality, in a basin with a rather complex hydrogeology, providing the basis for adequate planning and regulation on a river basin level. The essential balancing of competing water demands taking into account social, economic and environmental considerations through a comprehensive and coordinated strategy agreed by the two countries may follow. Enhancement of overall institutional capacity, at national level, to plan, implement and enforce management of demand and use measures is indispensable.

34. Croatia reports that investments on flood protection and hydro-amelioration are necessary.

Trends

35. There is an accidental pollution risk due to the storage of large quantities of dangerous substances in the port of Ploce in Croatia and their transport along the Neretva.

36. Rural tourism is under development in Croatia; it may assist in the decreasing of pressures in the delta area of Neretva.

Transboundary cooperation

37. An agreement between the Croatia and Bosnia and Herzegovina on Water Management Relations was signed on 11 July 1996, to regulate transboundary cooperation (more information can be found in Annex III of document ECE/MP.WAT/2009/8). A joint Interstate Water Commission (ISWC) has been established, having two main sub-commissions, one for the Black Sea and one for the Adriatic basin. The ISWC is the key bilateral mechanism for transboundary cooperation in the Neretva and Trebišnjica basins.

38. A Memorandum on Cooperation on Neretva River was signed among Croatia, Bosnia and Herzegovina, Principality of Monaco and the Coordination unit of the Mediterranean Initiative of the Ramsar Convention on Wetlands (MedWet) in 2003. Pollution in the delta of Neretva River, hydropower utilization and water supply were among the themes of focus.

39. In Bosnia and Herzegovina, the multiple levels of administration involved make coordination of international and bilateral cooperation challenging. This results in considerable delays in coordination and difficulties in entering international agreements.

40. A Global Environment Facility (GEF)/World Bank project has been initiated with the objective to support integrated water resources management in the basin, by harmonizing the management approach and legal frameworks across the two countries and ensuring improved

stakeholder participation at all levels. The EU WFD principles and guidelines are used for what concerns the preparation of the river basin management plan. ISWC has been involved in the project preparation and will oversee its implementation.

IV. DRIN RIVER BASIN[8]

41. The Drin River starts at the confluence of its two headwaters, the transboundary rivers Black Drin[9] and White Drin[10] at Kukës in Albania. The interconnected hydrological system of the Drin River basin comprises the transboundary sub-basins of the Black Drin, White Drin, Buna/Bojana[11] (outflow of Skadar/Shkoder Lake in the Adriatic Sea) Rivers and the sub-basins of Prespa, Ohrid and Skadar/Shkoder[12] Lakes.

42. Albania, Greece, the former Yugoslav Republic of Macedonia, Kosovo (UN administered territory under UN Security Council resolution 1244) and Montenegro share the Drin basin.

A. PRESPA LAKES

43. Prespa comprises of two Lakes separated by a naturally formulated narrow strip of land: Micro (Small) Prespa and Macro (Big) Prespa. Micro Prespa sits 8 m higher than Macro Prespa. An artificial canal connects the two Lakes. Micro Prespa is shared by Albania and Greece while Macro Prespa is shared by Albania, Greece and the former Yugoslav Republic of Macedonia.

Hydrology and Hydrogeology[13]

44. The Prespa Lakes basin, situated at a mean 850 m a.s.l., has no surface outflow; its waters drain into Lake Ohrid, which sits at 150 m lower level, through the Mali Thate-Galicica karst massive. Lakes Prespa and Ohrid are part of the same hydrogeological basin; the Prespa and Ohrid Lakes Aquifer is the connecting agent.

[8] Based on information from Montenegro; and on Faloutsos D., Constantianos V. and Scoullos M., “Status Paper - Management of the extended Transboundary Drin Basin”. GWP-Med, Athens, 2008, as well as the First Assessment of Transboundary Rivers, Lakes and Groundwaters. Some information was also provided by the former Yugoslav Republic of Macedonia and Albania.
[9] The River is called Drin i Zi in Albania and Crn Drim in the former Yugoslav Republic of Macedonia.
[10] River is called Drin i Bardhë in Albania and Beli Drin in Kosovo (UN administered territory under UN Security Council resolution 1244).
[11] The River is called Buna in Albania and Bojana in Montenegro.
[12] The Lake is called Skadar in Montenegro and Shkoder in Albania.
[13] See also the respective part in the assessment for Lake Ohrid; some additional hydrological information is given in Table 12. Characteristics of the shared water bodies.

Table 10. Prespa and Ohrid Lakes aquifer

No. 39 Prespa and Ohrid Lakes [14]		**Shared by: Albania, the former Yugoslav Republic of Macedonia and Greece**	
		Border length (km): 40 (Greece/Albania), 20 (Greece/the former Yugoslav Republic of Macedonia)	
Mainly Triassic and Jurassic and up to Middle Eocene massive limestones and lesser dolomites, mean thickness 200 m in the Greek part and 400 m in the Albanian, and up to a maximum of 330 m (Greece) and 550 m (Albania), including Galicica mountain between the lakes, medium to strong links to surface water systems, groundwater flow dominantly from the basin of Micro (Small) Prespa Lake to that of Macro (Big) Lake and from there to the Ohrid Lake basin. Groundwater movement is interconnected between all three countries.			**Mediterranean Sea Basin**
	Albania	**the former Yugoslav Republic of Macedonia**	**Greece**
Area (km^2)	277	758	327

Assessment of Ramsar sites in the basin: Prespa Park Wetlands (Albania, Greece, the former Yugoslav Republic of Macedonia)[15]

General description of the wetland

The Prespa lakes and their basin hold important freshwater and shoreline ecosystems including riverine forests and shrub formations that gradually lead up to mountain oak, beech and beech-fir forests, as well as pseudo-alpine meadows located above the forest limit.

Main wetland ecosystem services

The lakes perform important water storage, flood control and storm protection functions and serve as retention basin for sediments and nutrients that are utilized by wetland vegetation which is major food for domestic animals and fish. Being part of a complex karst system, the lakes provide ground water recharge and make the local climate milder.

Supporting socio-economic services

The lakes and their aquifers provide drinking and irrigation water. The lakes are important for fishing and cattle grazing. The area is a well known cultural tourism destination, while nature tourism is

[14] Based on the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by ITA Consult, Albania, the Institute of Geology and Mineral Exploration and Central Water Agency, Greece, and the Ministry of Environment and Physical Planning, the former Yugoslav Republic of Macedonia.

[15] *Sources*: (1) Prespa Park Coordination Committee (www.prespapark.org). (2) United Nations Development Programme (UNDP) GEF Prespa Regional Project - “Integrated ecosystem management in the Prespa Lakes Basin in Albania, the FYR of Macedonia and Greece” (http://prespa.iwlearn.org). (3) Strategic Action Plan for the Sustainable Development of the Prespa Park, Aghios Germanos. Society for the Protection of Prespa (SPP), World Wildlife Fund WWF-Greece, Protection and Preservation of Natural Environment in Albania (PPNEA), Macedonian Alliance for Prespa (MAP). 2006.

developing. The basin is recognized as an important area for environmental education and ecological, hydrological and geological research.

Cultural values

Besides pre-historic caves and fortifications as well as monuments and artwork from the Classical, Hellenistic, Roman, and Byzantine periods, the region keeps a wealth of local traditions, many of which are connected with nature.

Biodiversity values

Relatively uninterrupted lakes ecosystem and surrounding area support exceptionally rich biodiversity with a large number of endemic and threatened species as well as natural habitats of European Union interest.

The isolation of the basin for millions of years has resulted in high level of endemism; more than forty five invertebrate species and nine fish species are endemic for Prespa lakes and their basin.

Large numbers of waterbirds use Prespa lakes for breeding, feeding, wintering and as stop-over site during migration. It is the most important breeding site for Dalmatian Pelican (*Pelecanus crispus*), with more than 1,100 pairs which is about 18% of the world population of this vulnerable species included in the International Union for Conservation of Nature (IUCN) Red List.

Periodically flooded meadows, rocky and gravel shores, river banks and permanent springs provide important spawning grounds for fish.

Pressure factors and transboundary impacts

The steady decrease of the water level of Macro Prespa occurred since the late 1980s, but has not yet been fully explained. It is assumed that the dry period after 1987, in combination with the underground outflow to lake Ohrid and the increased water abstraction resulted in this phenomenon. This affected natural ecosystems and made shoreline areas less attractive for tourists; combined with increased nutrients input, this has led to eutrophication. Construction of irrigation systems resulted in drainage of a number of wet areas, mainly near Micro Prespa, and at present abstraction of water puts a pressure on natural ecosystems. Illegal sand and gravel extraction also can affect hydrological regime of the wetland.

Tourism and recreation need to be developed in a sustainable way minimizing direct disturbance of natural ecosystems and pressures through water abstraction and wastewater discharges. Other disturbing activities are non-sustainable (including illegal) hunting and fishing, and introduction of alien fish species (e.g. *Carassius gibelio, Ctenopharyngo idella, Hypopihalmichtius molitrix, Aristichthus nobilis*, *Tinca tinca, Parabramis pekinensis, Pseurasbora parva*) that affect native fish and invertebrate populations.

Abandonment of cattle grazing on littoral meadows has led to the loss of these important habitats and expansion of reed beds in Micro Prespa. Attempts to solve the problem by reed burning led to additional disturbance of wetland ecosystems and carbon release into the atmosphere, but during the last decade an effective restoration and management programme has been implemented by the Society for the Protection of Prespa.

Transboundary wetland management

In 2000, the Prime Ministers of Albania, Greece, and the former Yugoslav Republic of Macedonia declared creation of the Prespa Park, under the auspices of the Ramsar Convention, upon a proposal by the Society for the Protection of Prespa and WWF Greece. This decision was followed by establishment of the trilateral Prespa Park Coordination Committee. Since 2006, transboundary cooperation is enhanced within the project "Integrated ecosystem management in the Prespa Lakes Basin in Albania, the former Yugoslav Republic of Macedonia and Greece" financially supported by the Global Environment Facility. A number of parallel projects are supported by UNDP, German Development Bank (KfW), Swiss Development and Cooperation Agency (SDC), Swedish International Development Cooperation Agency (SIDA), NGOs and the three national Governments.

The priority issue for transboundary cooperation is water resources management at basin level in accordance with the EU WFD and with the aim of maintaining water dependent ecosystem values and satisfying needs for drinking and irrigation water. A transboundary monitoring system in the Prespa basin is under development; sustainable fishery and tourism, biodiversity and hydrogeology studies, management of protected areas, education and public awareness on the Prespa Lakes wetlands are also addressed on transboundary and national level.

In all three countries lake and shoreline areas have the status of nationally protected areas. In Albania the **Prespa National Park** (27,750 ha) covers the whole Albanian catchment. Two park information centers are located in the villages of Gorice e Vogel and Zagradec. In Greece the **Prespa National Park** (32,700 ha) has been designated in July 2009, replacing the older regime and including Ramsar site **Lake Micro Prespa** (N° 60, 5,078 ha) and NATURA 2000 site. Three information centers operate in the area. In the former Yugoslav Republic of Macedonia **Lake Prespa** is designated as natural monument and Ramsar Site (N° 726, 18,920 ha), which include Strict Nature Reserve Ezerani (2,080 ha).

Table 11. Water quality determinands

Parameter	Unit	Lake Prespa[16]	Lake Ohrid[17]	Lake Skadar[18]
Temperature	^{o}C	4-24.6	6-21.8	16-30
Transparency (Secchi disc)	M	2.5-5	10-20.5	-
Dissolved Oxygen	mg/l	0-14	6.92-15.74	5.2-9.2
Oxygen saturation	%	0-131.03	62.71-166.57	60-120
BOD_5	mg/l	0.15-3.3	0.09-2.65	2-4
CO_2	mg/l	0-2.26	0-4.22	-
$KMnO_4$ Consumption	mg/l	7.77-10.84	1.14-7.11	2.5-3.2
TP (total phosphorus)	µg/l	0-66	0-36	>0.10

[16] Information by the Ministry of Environment and Physical Planning, the former Yugoslav Republic of Macedonia.
[17] Information by the Ministry of Environment and Physical Planning, the former Yugoslav Republic of Macedonia.
[18] Data collected by the Hydrometeorological Institute of Montenegro, at 9 sampling points (2008); information provided by the Ministry of Spatial Planning and Environment, Montenegro.

Parameter	Unit	Lake Prespa[16]	Lake Ohrid[17]	Lake Skadar[18]
TN (total nitrogen)	µg/l	210-792	100-551.4	-
Chlorophyll *a*	µg/l	0.49-15	0.39-5.55	-
Saprophytic bacteria	Bact/ml	200-158,720	100-10,000	90-400
Total coliform bacteria	Bact/100ml	2-1.504	0-0	734-4,460
Escherichia coli	Bact/100ml	0-17	0-0	-
Trophic State Index (OECD criteria)		Mesotrophic	Oligotrophic	Oligotrophic

Table 12. Characteristics of the shared water bodies[19]

	Lake Prespa	Lake Ohrid	Drin River	Lake Skadar/ Shkoder	Buna/Bojana River
Sub-basin shared by	Albania, Greece, the former Yugoslav Republic of Macedonia	Albania, the former Yugoslav Republic of Macedonia	Albania, Kosovo[20], the former Yugoslav Republic of Macedonia,	Albania, Montenegro	Albania, Montenegro
Origin	Tectonic	Tectonic	-	Tectonic-Karstic	-
Catchment area (km²)	2,519.1	1,432 the former Yugoslav Republic of Macedonia: 62 % Albania: 38 %	14,173 (including the catchments of White and Black Drin Rivers and Ohrid and Prespa Lakes) Albania: 5,973 km²	5,409 Montenegro: 80% Albania: 20%	19,582 (including the catchments of Drin River and Skadar/Shkoder Lake)
Lake's surface area (km²)	Macro Prespa: 253.6 – 259.4 (282)[a] Micro Prespa: 47.4 Albania: 16% Greece: 25% the former Yugoslav Republic of Macedonia: 59%	359 Albania: 35 % the former Yugoslav Republic of Macedonia: 65 %	-	475 Min: 320 Max: 510 Albania: 35% Montenegro: 65%	-

[19] Source: Faloutsos D., Constantianos V. and Scoullos M., "Status Paper - Management of the extended Transboundary Drin Basin". GWP-Med, Athens, 2008.
[20] UN administered territory under UN Security Council resolution 1244.

	Lake Prespa	Lake Ohrid	Drin River	Lake Skadar/ Shkoder	Buna/Bojana River
Lake's volume (km^3)	3.6 (4.8)[a]	55.4	-	1.7 – 4	-
Lake's mean depth (m)	14 (19)[a]	163.7	-	5	-
Lake's maximal depth (m)	Macro Prespa: 48 (54)[a] Micro Prespa: 8.4	288.7	-	8.3 (more than 80 in lake springs)	-
Lake's maximal length (km)	N/A	30.8	285	44	44
Lake's maximal width (km)	N/A	11.2 - 14.8	-	14	-
Shore line (km)	N/A	87.5 Albania: 31.5 the former Yugoslav Republic of Macedonia: 56	-	168 Albania: 57.5 Montenegro: 110.5	-
Natural trophic state	Macro Prespa: Oligotrophic Micro Prespa: Mesotrophic	Oligotrophic	-	Oligotrophic - Mesotrophic	-
Total water volume exchange rate (years)	10-12 (17)[a]	70 - 85	-	2 – 3 times per year	-
Discharge (average)	There is no surface discharge; there is no information available about groundwater discharge	22 m^3/s (lake outlet - average)	350 m^3/s (at its estuary) Black Drin: 116 m^3/s White Drin: 66.4 m^3/s	320 m^3/s (lake outlet - average)	682 m^3/s

[a]Value in parentheses: in the 1980s before recent water level decline of Lake Prespa

B. LAKE OHRID

45. Ohrid is the largest lake in volume in South-Eastern Europe and one of the oldest in the world; it was formed 2 to 3 million years ago. It sits at 695 m a.s.l.

Hydrology and hydrogeology[21]

Table 13. Water balance for Lake Ohrid (× 10^6 m^3/year)[22]

	Inflow	Outflow
Surface water:		
Rivers	380.6	693.8
Rest of catchment area	75.7	
Groundwater:		
Known springs	323.6	
Unknown springs	-	
Precipitation	276.6	
Evaporation		408.0
TOTAL*	1056.5	1101.8

*The difference between outflow and inflow – 45.3 10^6 m^3 or 1.4 m^3/s – may be considered as the contribution of unknown springs (underwater springs)

Status

46. Because the lake has been isolated by surrounding mountains, a unique collection of plants and animals have evolved; some of these are now considered relics or "living fossils" and can be found only in Lake Ohrid. The Lake Ohrid area has been a UNESCO World Natural Heritage Site since 1980. The lakeshore reed beds and wetlands provide critical habitat for high number of wintering water birds, including rare and threatened species.

47. Water from the lake and its tributaries is used for irrigation and drinking water supply.

48. Human interventions have altered the hydrological regime of the lake. The diversion of the Sateska River in the former Yugoslav Republic of Macedonia into the lake increased its watershed area hence the agricultural runoff and sediment input. Sediment loads have increased also due to unsustainable forest management and subsequent erosion causing destruction of wetlands in parts of the lake in both countries. Reforestation activities in the former Yugoslav Republic of Macedonia have resulted in improved situation in this regard.

Pressures, transboundary impacts and response measures

49. Unsustainable agricultural practices exert pressure leading to pesticides and nutrient pollution. Lack of, or inadequate municipal waste water management and sewerage leakages have an equally important share with regard to nutrient loading in the lake and exert minor pressure on the underlying Prespa and Ohrid Lakes karst aquifer. Sewage from Pogradec (Albania) has been a major contributor of phosphorus and organic load. The newly built collection and treatment facilities (allow treatment of wastewaters of some 25,000 inhabitants and further stages have been planned) are expected to improve the situation. They will also

[21] See also the respective part in the assessment for Lake Prespa. Some additional hydrological information is given in Table12. Characteristics of the shared water bodies.
[22] *Source*: Faloutsos D., Constantianos V. and Scoullos M., "Status Paper -Management of the extended Transboundary Drin Basin". GWP-Med, Athens, 2008.

reduce the levels of faecal pathogens as was already done in the former Yugoslav Republic of Macedonia side of the lake, by the construction of a sewerage system that collects wastewater from shoreline communities; about 65% of wastewater (as for 2006) of the Ohrid – Struga region (in the Black Drin catchment) are treated (in a 120,000 p.e. capacity plant) and discharged in the Black Drin. There are plans for the construction of additional systems in the area.

50. Untreated wastewater discharges from industrial activities in Pogradec (food processing, textile, metal and wood processing and other light industries) are considered to be a significant source of pollution.

51. Uncontrolled waste disposal in the watershed might be a cause of groundwater, hence lake, pollution. Both countries are planning to take necessary action to address the problem. The National Strategy for Waste Management in the former Yugoslav Republic of Macedonia provides for a regional landfill that will cover the needs of the Prespa and Ohrid areas; this will be constructed outside the boundaries of the respective sub-basins.

52. The commercially important fish species in Lake Ohrid, including the famous Lake Ohrid trout, have been over-harvested in recent years and are in immediate danger of collapse. Fish in the lake must be managed collectively, with similar requirements in the riparian countries. Fish hatcheries have been set up by both countries. Albania has also taken some measures to limit illegal fishing. Alteration of the reed zones, have caused deterioration of habitats, also threatening the spawning and wintering grounds of fish species.

53. A spatial plan for the areas of Ohrid and Prespa has been prepared in the former Yugoslav Republic of Macedonia.

Transboundary cooperation

54. The two countries have harmonized procedures for water quality monitoring in the Lake and its tributaries (Joint Protocols for sampling, analyzing and quality assurance) within the GEF Lake Ohrid Conservation Project (ended in 2004). Three hydrological stations exist in the former Yugoslav Republic of Macedonian part, while the Hydrobiological Institute monitors the lake’s system for biological and chemical quality.

55. The development of a “Transboundary Watershed Management Plan” had been prepared under the GEF project and endorsed in October 2003; restricted resources have had an impact on its implementation.

56. The 2004 Agreement for Lake Ohrid and its Watershed between the two countries was a major step towards the sustainable management of the lake and its basin (see also Annex III in document ECE/MP.WAT/2009/8). The Lake Ohrid Watershed Committee (LOWC) was created and empowered with legal authority in both countries. Three Working Groups of experts, on Legal framework, Fisheries and Management plan preparation were established in September 2008 under the LOWC, having as main duty to assist in the harmonization of related pieces of legislation in the two countries. Project support from UNDP to the secretariat structure continued in 2009.

C. DRIN RIVER

Hydrology and hydrogeology[23]

57. Water flows out of Lake Ohrid (average discharge: 22 m^3/s) into the Black Drin River near Struga (the former Yugoslav Republic of Macedonia). The Radika River is a major transboundary tributary of Black Drin. The river runs 149 km (as Drin i Zi) until Kukes, Albania where it joins the White Drin River (136 km long). Their confluence, the Drin, flows further westward and discharges into the Adriatic Sea. The old Drin channel discharges into the Adriatic south of the Buna/Bojana River near the city of Lezhe, but the Drin's major channel is the 11-km Drinasa which joins the Buna/Bojana just 1 km beyond the latter's outlet from Skadar/Shkoder Lake near the city of Shkodra. The Drin delta is located 20 km south of the Buna/Bojana Delta.

58. The topography of the watershed of the Drin River is characterized by mountainous relief, with mean average height of 971 m a.s.l. (the highest peaks are over 2,500 m), and flat land in the coastal area.

59. The White Drin is hydraulically connected with the shared karstic Beli Drim/Drini Bardhe aquifer.

Table 14. Beli Drim/Drini Bardhe aquifer

No. 26 Beli Drim/Drini Bardhe [24]		**Shared by Kosovo (UN administered territory under UN Security Council resolution 1244) and Albania** Border length (km): 30
Type 3, Lower and Upper Cretaceous karstic and dolomitised limestone, Miocene to Quaternary multilayer sequence 100 to 200 m thick, medium to strong links to surface waters, groundwater flow from Kosovo (UN administered territory under UN Security Council resolution 1244) to Albania		**Mediterranean Sea Basin**
	Kosovo (UN administered territory under UN Security Council resolution 1244)	**Albania**
Area (km^2)	1,000	170
Water uses and functions	Groundwater is 30 % of total water use. 25-50% of groundwater is used for irrigation, <25% for drinking water and industry; it also maintains baseflow	Groundwater is 60-70% of total water use. 75% of groundwater is used for irrigation, <25% for drinking water and livestock; it also maintains baseflow

[23] Some additional hydrological information is given in Table 12: Characteristics of the shared water bodies.
[24] Based on information from the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Directorate of Water and the Jaroslav Cerni Institute, Serbia, and National Committee of the International Association of Hydrogeologists of Serbia and Montenegro, and ITA Consult, Albania.

Status, pressures and transboundary impacts

60. The Black Drin sub-basin in the former Yugoslav Republic of Macedonia is mainly covered by forests (52%) and agricultural land (16%).

61. The significance of the Drin River and its main tributaries in terms of hydropower production is major, especially for Albania where plants installed produce 85% of hydropower and represent 70% of the total hydro and thermal installed capacity in the country. In Albania, there are 44 dams (4 for energy production and 40 for irrigation purposes). The construction of the Ashta hydropower plant started in 2009 near Skadar/Shkoder, with capacity downscaled to 40 megawatts (MW) from original 80 MW after consultations with Montenegro. There are plans for the construction of an additional plant (Skavica - planned installed power of 350 MW) – the process for the expression of interest was initiated in 2008. Two major dams (Globochica and Spilja) exist in the Black Drin in the former Yugoslav Republic of Macedonia with the main purpose of hydropower production. The alteration of the hydrological characteristics of Drin due to dam construction has had an impact in the distribution of sediments and caused disturbances to the ecosystems supported. Biological corridors that facilitate migration have been interrupted exerting major pressure to biodiversity.

62. Open-cast metal (iron and nickel) mines in Albania have been closed long time ago, but the sites have not been landscaped and tailings continue causing heavy metal pollution (iron, copper etc.); there are no available data regarding the level of pollution.

63. Abstraction of groundwater in Kosovo (UN administered territory under UN Security Council resolution 1244) and waste disposal, sanitation and sewer leakage in Albania are the main pressure factors as far as Beli Drim/Drini Bardhe aquifer is concerned. Nitrogen, pesticides and pathogens (only locally in Albania) have been observed.

64. In the Black Drin, in the former Yugoslav Republic of Macedonia, there is extensive cattle production. The intensive tourism around lakes Ohrid and Prespa and in the National Park Mavrovo is another pressure factor. The expected increase of water demand in the Black Drin catchment area[25] for drinking water, irrigation and fisheries will result in increasing the pressure on the system.

Table 15. Water demands (× 10^3 m^3/year) in the Black Drin Basin District in the former Yugoslav Republic of Macedonia (for 2008 and projection for 2020)[*]

		Population and tourists	Industry	Irrigation	Fisheries	Minimum accepted flow	Total water demands
Black Drin	**2008**	21,150.0	8,224.3	49,662.0	31,300.0	164,000.0	274,336.3
	2020	36,814.4	8,610.5	98,614.0	138,700.0	164,000.0	446,738.9

[25] In the former Yugoslav Republic of Macedonia, the catchment area of the Crn Drim River constitutes one of the four Basin Districts and includes in addition to the Crin Drim also the Ohrid and Prespa sub-basins. The Crn Drim catchment area in the former Yugoslav Republic of Macedonia, covers an area of 3,359 km^2, or 13.1 % of the total territory of the country. The average annual volume of discharged water is approximately 1.64×10^9 m^3.

River Basin district							
Total in the country	**2008**	218,269.1	274,147.0	899,335.0	202,140.0	635,000.0	2,227,891.1
	2020	348,261.3	287,014.0	1,806,711.0	414,300.0	635,000.0	3,491,286.3

[*] Second National Communication on Climate Change. Ministry of Environment and Physical Planning, the former Yugoslav Republic of Macedonia, 2008

65. Considerable nutrient loads get transported into the Adriatic Sea via the Drin[26] and Buna/Bojana Rivers. Whereas agriculture is the main source of nitrogen and phosphorus in the river system as a whole, the source distribution varies geographically. Whereas in the lower parts of the drainage system, in the Buna river, most of the phosphorus load derives from agriculture, sewage is more important in the upper parts.

66. The great number of illegal dumpsites is of particular concern in Albania and the former Yugoslav Republic of Macedonia.

67. *Response measures*[27]

68. Discharge and water level are being monitored at nine gauging stations in the Black Drin catchment area in the former Yugoslav Republic of Macedonia; quantity and quality monitoring of the groundwater in the country needs to be improved.[28]

69. Numerous measures are needed with regard to Beli Drim/Drini Bardhe aquifer; priority should be given to monitoring of groundwater quantity and quality, detailed hydrogeological and vulnerability mapping, delineation of protection zones, construction of wastewater treatment facilities as well as to public awareness campaigns.

D. LAKE SKADAR/SHKODER

70. Lake Skadar/Shkoder is the largest lake by surface in the Balkan Peninsula and it sits 6 m a.s.l. in the karst terrain of the south-eastern Dinaric Alps.

[26] With regard to nitrogen the total load for the entire Drin catchment was estimated at 31,580 tonnes, of which more than 30,000 tonnes, or about 95%, derived from anthropogenic sources. This total load corresponds to an area-specific load of about 17 kg/ha. As a comparison, the corresponding figure for the Danube basin is only 7.5 kg/ha (Screiber et al. 2003). As far as phosphorus is concerned, the total load for the basin was estimated at 2,020 tonnes, of which 1,970 tonnes, or 98 %, derived from anthropogenic sources. This corresponds to an area-specific load of 1.1 kg/ha. This is somewhat higher than the corresponding figure for the Danube basin (0.7 kg/ha; Schreiber et al. 2003). Source: *Borgvang A. et al.,* "Bridging the gap between water managers and research communities in a transboundary river: Nutrient transport and monitoring regimes in the Drim/Drini Catchment". Presented at the Conference on Water Observation and Information System For Decision Support, organized by BALWOIS, 23-26 May 2006 - Ohrid, the former Yugoslav Republic of Macedonia.

[27] Additional information about response measures taken or planned can be found in the text referred to the sub-basins of Drin Basin. For information regarding water resources management in the riparian countries see also Annex I in document ECE/MP.WAT/2009/8.

[28] Second National Communication on Climate Change. Ministry of Environment and Physical Planning, former Yugoslav Republic of Macedonia, 2008.

Hydrology and hydrogeology

71. The lake discharges through the 44 km long Buna/Bojana River (shared by Albania and Montenegro) into the Adriatic Sea. The connection between Drin River - Buna/Bojana River - Skadar/Shkoder Lake determines the seasonal variations in the state and characteristics of the Lake as well as Buna/Bojana and the tributaries in their catchment area, and has an important impact on the morphology of Buna/Bojana delta. The hydrologic regime is conditioned, among others, by water releases from big hydro-power dams in the Drin River in Albania.

72. The Buna/Bojana bed is lower than the sea level ("crypto depression") resulting into salt water intrusion to the Lake's outlet.

Table 16. Skadar/Shkoder Lake, Dinaric east coast aquifer

No. 25 Skadar/Shkoder Lake, Dinaric east coast aquifer [29]		**Shared by: Albania and Montenegro**
		Border length (km): 35 (excluding the lake border)
Type 2, Jurassic, Cretaceous and lesser Palaeogene massive and stratified limestones and dolomites, average thickness of 150 to 500 m and maximum 300 - 1,000 m, alluvial fans along the lake up to 80-100 m thick, strong links to surface water systems, groundwater flow in both directions. Groundwater covers 100% of total water use in Montenegro, and 80-90% in Albania		**Mediterranean drainage basin**
	Montenegro	**Albania**
Area (km^2)	~ 460 (karstic aquifer) ~ 200 (shallow aquifer in Zeta Plain)	~ 450
Water uses and functions	25-50% for drinking water supply, <25% for irrigation, industry and livestock	50-75% for irrigation, <25% for drinking water supply, industry and livestock, also maintaining baseflow and support for ecosystems

Status, pressures, transboundary impacts and responses

73. In general, the quality of the lake's water is considered to be reasonably good due to the high refreshment rate (2-3 times per year), the inaccessibility of the higher parts of the catchments and the sharp reduction in inflowing industrial effluents and agricultural run-off. Buna/Bojana's water quality also seams to be in the same generally good condition.

74. Total biodiversity is high, and the region is considered to be a biogenetic reserve of European importance. The large, geographically and ecologically connected complex system

[29] Based on information from Montenegro and the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the National Committee of the International Association of Hydrogeologists of Serbia and Montenegro and by ITA Consult, Albania.

of wetlands of Skadar/Shkoder Lake and Buna/Bojana River has been identified as one of the 24 transboundary wetland sites of international importance known as “Ecological Bricks Sites”.

Assessment of Ramsar sites in the basin: Lake Skadar/Shkoder and River Buna/Bojana (Albania, Montenegro)[30]

General description of the wetland

The system of lake Skadar/Shkoder and river Buna/Bojana with its delta area on the Adriatic Sea contains important ecosystems with fresh and brackish water and a variety of natural and human-made coastal habitats, including floodplain forests, freshwater marshes, extensive reed beds, sand dunes, karst formations, calcareous rocks, wet pastures, ponds and irrigated lands. The Buna/Bojana River mouth represents a rare example of a natural delta on the East Adriatic coast.

Main wetland ecosystem services

The wetland is important for water retention and flood control in a wide area around lake Skadar/Shkoder and along the Buna/Bojana and lower Drin Rivers floodplains. The presence of large water bodies and vast floodplain forest significantly humidifies the regional climate, thus mitigating Mediterranean summer droughts. The large amounts of sediments carried by Drin and Buna Rivers support the stabilization of the Adriatic shoreline and prevent the salinization of the coastal aquifers and agricultural lands, provided that human interventions allow the continued functioning of these natural dynamics.

Supporting socio-economic services

The wetland is used for fishing and to some extent for hunting and provides essential support for agriculture and livestock rearing on temporarily flooded grasslands. Peat, sand and gravel are exploited along the lake and river shores. Leisure activities for urban dwellers from Podgorica (the capital of Montenegro) and Shkodra (Albania), as well as beach, natural, village and cultural tourism are developing rapidly in the area.

Biodiversity values

Especially the temporally inundated floodplains and the shallow water zones of lake Skadar/Shkoder and along the lower part of Buna/Bojana River provide unique habitats for a rich biodiversity in the near Adriatic part of South-Eastern Europe. A significant number of threatened species at national, European and global level depend on this wetland ecosystem.

Important migration routes, especially of fish and birds, pass through the wetland area. For waterbirds the wetland area is also important as a breeding and wintering site. Floating islands with colonies of cormorants, herons and pelicans are unique in Europe. A breeding colony of Dalmatian Pelican

[30] *Sources:* (1) Latest Information Sheet on Ramsar Wetlands (RIS): **Lake Shkodra and River Buna Ramsar site;** Albania (RIS updated in 2005); **Skadarsko Jezero Ramsar site;** Montenegro (RIS updated in 1995) - available at the Ramsar Sites Information Service (http://ramsar.wetlands.org/Database/Searchforsites/tabid/765/language/en-US/Default.aspx). (2) Skadar Lake Concept on Cross-Border Development – a spatial perspective; prepared by GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit GmbH, project offices in Albania and Montenegro). Podgorica 2007.

(*Pelecanus crispus*), a globally threatened species, exists on lake Skadar/Shkoder, one of only a handful such colonies in South-Eastern Europe. Other important numbers of wetland birds include ducks, geese, waders, gulls, birds of prey, owls and passerines. The number of wintering waterbirds on the Albanian side only reaches 24,000 – 30,000 individuals.

The globally threatened Common Sturgeon (*Acipenser sturio*), Stellate Sturgeon (*Acipenser stellatus*) and Adriatic Sturgeon (*Acipenser naccarii*), as well as other migratory fish use the Buna/Bojana River to forage and spawn upstream. Coastal bays and lagoons, notably the largest near Velipoja in Albania, are crucial as spawning and nursery areas for a number of commercially important fish species.

Pressure factors and transboundary impacts

The most significant pressures on the wetland ecosystems are listed in the main text.

Expansion of agricultural lands at the expense of natural wetland and forest habitats took place mainly in 1950-1960 that has led to loss, degradation and fragmentation of habitats and decrease of biodiversity. Nowadays expansion of tourism areas and related infrastructure combined with significantly increasing disturbance from visitors, boat and car traffic (including off-road) represent a threat especially for attractive and at the same time sensitive coastal habitats. Development of urban settlements, roads, agriculture, tourism and industry in the catchment basin with the associated increased abstraction of water provides additional pressures on the downstream wetland ecosystems.

Several hydroelectric plants built on the River Drin during the last 30-40 years have reduced the sediment flow to Buna/Bojana River. This has led to increased coastal erosion and the continuous loss of coastal land areas. A plan to construct dams on the Moraca river – the main tributary of the Skadar/Shkoder Lake, flowing in Montenegro **-** is likely also to have significant impacts on the water level of Skadar/Shkoder Lake.

In addition to non sustainable levels and means (explosive) of fishing, populations of some introduced non-native fish like Goldfish (*Carassius auratus gibelio*), European perch (*Perca fluviatilis*) and Topmouth Gudgeon (*Pseudorasbora parva*) had negative impacts on the population of the native fish species, such as cyprinids, and especially the commercially important wild Carp (*Cyprinus carpio*). Wood harvesting and the expansion of pastures contribute to continued deforestation.

The low level of public awareness about environmental issues is a specific problem resulting in the lack of appreciation of the ecosystem services and natural values.

Transboundary wetland management

The lake including a narrow stripe of its shoreline has a specific legal protection status in both countries and was designated for inclusion to the Ramsar List of Wetlands of International Importance. On the Albanian side also the outflowing river Buna/Bojana (forming the border with Montenegro in its lower course), its delta and coastal areas as well as the adjacent part of the Adriatic coast have national protection status and are included in the Ramsar List.

The Albanian Ramsar site **Lake Shkodra and River Buna** (N°1598, 49,562 ha) includes a number of nationally protected areas beyond Shkoder lake and Buna river and its delta, notably Velipoja beach, Domni marsh, Viluni lagoon, Rrenci mountain and Velipoja forest. The Montenegrin Ramsar site (N°784, 20,000 ha) coincides with the **National Park Skadarsko Jezero**, including some strictly protected areas (permanent ornithological reserves of scientific importance). The National Park has three visitor centers in the villages of Vranjina, Mirići and Rijeka Crnojevića. The first is located along the main road between the capital Podgorica and the tourist resorts along the Adriatic coast and attracts a high number of visitors.

Environment protection and sustainable development issues are included in a number of on-going transboundary Albanian-Montenegrin initiatives on Skadar/Shkoder Lake, including e.g. the Lake Skadar/Shkodra Integrated Ecosystem Management Project financially supported by the Global Environment Facility. The Concept on Cross-Border Development of the lake Skadar/Shkoder area has been prepared by GTZ Albania and Montenegro within the GTZ project "Cross-boundary spatial planning Lake Skadar/Shkoder region, Albania and Montenegro" which has been implemented since 2006.

75. In the Montenegrin part, arable land equals to 40% and pastures to 10% of the basin. In the Albanian part, 13% of the land is used for agricultural activities while 64 % is forests, pastures and abandoned land.

76. Agricultural as well as industrial pollution (heavy industries in the Montenegrin side are also significant water consumers) and pollution from municipal wastewater "enter" the lake both through surface and groundwater (due to the karstic geology). Due to the nutrient loading, the lake has eutrophied slightly. Inadequate solid waste management in both countries and illegal disposal of wastes directly to the water bodies has exerted pressure to the lake's system. Wastewater collection and treatment facilities that are currently constructed in the Albanian side, reconstruction of existing facilities in Montenegro (in Podgorica), as well as the construction of solid waste management facilities in both countries are expected to improve the situation. Heavy metal pollution, especially in lake sediments, and moderate pathogen loads have been observed locally in the aquifer. Drin contributes to some extent with trace metals originating from the disposal of by-products from iron and copper mines located up-stream.

77. Unsustainable forest management in the Albanian side and subsequent erosion as well as illegal construction has led to the deterioration of shoreline habitats.

78. Lake Skadar/Shkoder and Buna/Bojana basin still need attention and measures to protect the state of this unique ecosystem. The two countries are taking action in this regard. Almost the total of the Lake Skadar/Shkoder and Buna/Bojana river area is under national protection status. Consolidation and harmonization of the management of the protected areas, Montenegro is much ahead in this regard, including harmonization of measures across borders would be beneficial.

Transboundary cooperation

79. The Agreement between Montenegro and Albania for the Protection and Sustainable Development of the Skadar/Shkoder Lake, signed in 2008, was the latest legal document on cooperation on environment management issues. This Agreement serves among others as the legal instrument for the implementation of the joint Strategic Action Plan for the lake agreed between the two Governments. The Skadar/Shkoder Lake Commission has been established under the Agreement and commenced work in 2009. A Joint Secretariat is based in Shkodra, Albania and four Working Groups (Planning and Legal; Monitoring and Research;

Communication / Outreach and Sustainable Tourism; and Water Management) provide support.

80. Action and coordination at national level need to accompany transboundary cooperation which is mostly supported by the GEF project (main activities initiated in 2008). Harmonization of the management approaches and instruments is an imperative in the long term. The establishment of a sustainable fishery strategy and further action for pollution reduction and prevention are among the priorities. Detailed hydrogeological mapping and investigation of the relationships between karst groundwater and groundwater of the alluvial deposits with Skadar/Shkoder Lake (through the development of the Lake watershed area hydrological model), monitoring of surface and groundwater, water demand management measures, groundwater abstraction control, vulnerability mapping for land use planning, protection zones for drinking water supply, also need to be applied/established or improved.

Trends

81. A well-defined pollution trend has not been established for the lake due to the lack of continuous data; water quality seems to have been varying in space and time.

Tourism is considered to be a major economic driver in both parts of the basin. Moreover, four dams are planned to be constructed in Moraca – the main tributary of Skadar/Shkoder Lake, flowing in Montenegro. The project has been anticipated in the Spatial Plan of Montenegro.

82. The impacts on the lakes-rivers-wetlands-groundwater system of the current economic development proposals and plans in both countries that involve alternative uses of water and the water bodies, need to be clearly understood before any decision is taken.

Transboundary cooperation in the "extended" Drin Basin level

83. The Drin Basin needs to be managed as an entity to ensure effective and sustainable management of water and ecosystems. Although there is an established cooperation between the riparian countries in the sub-basins of Prespa, Ohrid and Skadar/Shkoder Lakes there is no such cooperation at the "extended" Drin Basin level. The Petersberg Phase II / Athens Declaration Process (coordinated by Germany, Greece and the World Bank, supported technically and administratively by GWP-Med) acting in cooperation with UNECE, GEF and UNDP facilitate the initiation of a regional multi-stakeholder dialogue process aiming to explore possibilities to move the level of cooperation from the sub-basin to the Drin Basin level[31].

[31] Relevant activities have been financially supported by the Swedish Environmental Protection Agency and the German Ministry of Environment, Nature Conservation and Nuclear Safety.

V. AOOS/VJOSA RIVER BASIN[32]

Table 17. Basin of the Aoos/Vjosa River

Area	Country	Country's share		Number of inhabitants	Population density (persons/km^2)
5,613 km^2	Albania	4,365 km^2	67%	328,000	N/A
	Greece	2,154 km^2	33%	20,000	N/A

84. The Aoos/Vjosa River[33] basin is shared by Greece (upstream country) and Albania (downstream country).

Hydrology and hydrogeology

85. The 260-km-long river (70 km in Greece) has its source in Northern Pindos Mountains and ends up in the Adriatic Sea. The basin has a pronounced mountainous character with an average elevation of about 885 m a.s.l.

86. Major transboundary tributaries include the rivers Sarantaporos (870 km^2) and Voidomatis (384 km^2).

Table 18. Discharge characteristics of the Aoos/Vjosa River upstream of the Greek-Albanian border

Discharge characteristics	Discharge	Period of time or date
Q_{av}	52 m^3/s	1951-1988
Q_{max}	125.5 m^3/s	N/A
Q_{min}	15.5 m^3/s	N/A
Mean monthly values		
October: 25.8 m^3/s	November: 69.2 m^3/s	December: 100.7 m^3/s
January: 105.7 m^3/s	February: 125.5 m^3/s	March: 120 m^3/s
April: 116.2 m^3/s	May: 74.7 m^3/s	June: 44.6 m^3/s
July: 26.8 m^3/s	August: 20.6 m^3/s	September: 15.5 m^3/s

87. In Greece, the Aoos Springs Hydroelectric Dam was built on the river. The Nemechka/Vjosa-Pogoni is an aquifer that is hydraulically linked to the surface water system of the Aoos/Vjosa River Basin.

[32] Based on information from First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.
[33] The river is known as Aoos in Greece and Vjosa in Albania.

Table 19. Nemechka/Vjosa-Pogoni aquifer

No. 38 Nemechka/Vjosa-Pogoni [34]		**Shared by: Albania and Greece**
Type 1, Succession of large anticlines containing karstic limestones of mainly Jurassic and Cretaceous age and synclines with formations of Palaeocene and Eocene flysch; average thickness about 2,500 m, maximum more than 4,000 m (Albania), 100 to 150 m (Greece). The complicated geological structures and hydrogeological conditions which bring these formations together produce large karst springs; groundwater discharges towards both countries. There are weak links to surface waters. Groundwater provides about 70% of total water use in the Greek part and up to 90% in the Albanian part.		**Mediterranean Sea Basin** Border length (km): 37
	Greece	**Albania**
Area (km^2)	370	550
Water uses and functions	25-50% irrigation, <25% each for drinking water supply and livestock, maintaining baseflow and springs and supporting ecosystems	25-50% irrigation, <25% each for drinking water, livestock and industry, maintaining baseflow and springs and supporting ecosystems
Notes	Large spring discharges of Kalama, Gormou and Drinou	Large karst groundwater quantities (average about 8 m^3/s) discharge in the Vjosa River gorge in Albanian territory. There are also other large karst springs; the Glina sulphate spring is a well known bottled karst spring

Pressures

88. Of the basin, 47% is covered with forests. Other forms of land use include: cropland (3.5%), grassland (13.6%), barren (6.4%) and shrubs (29.5%). In Greece, the Aoos is part of the Vikos-Aoos National Park, a NATURA 2000 site.

89. The main pressures result from agricultural activities, animal production and aquaculture.

90. Pumping lifts have been increased locally in Greece where agricultural activities exert pressure to the Nemechka/Vjosa-Pogoni aquifer. There have been sulphate concentrations of 300-800 mg/l observed in many of the springs. In Albania minor waste disposal and sewer leakage result in local and moderate pathogen occurrence in the aquifer.

[34] Based on information from First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Institute of Geology and Mineral Exploration and the Central Water Agency, Greece, and ITA Consult, Albania.

Transboundary cooperation

91. An agreement has been concluded between Albania and Greece and entered into force on 21 November 2005. This agreement provides for the establishment of a Permanent Greek-Albanian Commission on transboundary freshwater issues with such specific tasks as the setting of joint water-quality objectives and criteria, the drafting of proposals for relevant measures to achieve the water-quality objectives, and the organization and promotion of national networks for water-quality monitoring.

Response measures

92. In Greece, implementation of the EU WFD is in progress. Existing awareness and monitoring need improvement with regard to the aquifer; other measures need to be applied or are planned according to EU WFD requirements. No management measures are yet used in Albania for the aquifer; a range of measures need to be applied though, such as detailed hydrogeological and vulnerability mapping, groundwater monitoring, public awareness, delineation of protection zones and wastewater treatment.

Trends

93. The river has a "very good water quality", which is appropriate for all uses in the basin. Despite the very good status, an integrated approach of all environmental, social, economic and technical aspects of water resources management is needed in order to ensure water preservation and environmental integrity in the region.

94. Local and moderate degradation of ecosystems supported by the Nemechka/Vjosa-Pogoni aquifer has been observed in Albania and related to issues linked to groundwater quantity. The aquifer though is not at risk since population is small and industry is not developed.

VI. TRANSBOUNDARY AQUIFERS WHICH ARE NOT CONNECTED TO SURFACE WATERS ASSESSED IN THE SEE ASSESSMENT (OR INFORMATION CONFIRMING A CONNECTION HAS NOT BEEN BY PROVIDED BY THE COUNTRIES CONCERNED)

A. AQUIFER SYSTEM OF ISTRA AND KVARNER[35]

95. The Aquifer system of Istra and Kvarner is divided in the following transboundary aquifers/groundwater bodies[36]:

(a) Sečovlje-Dragonja/Istra;

(b) Mirna/Istra which on the Slovenian side is further divided in Mirna and Območje izvira Rižane groundwater bodies;

[35] It should be noted that transboundary aquifers including Italy as a riparian country, for example Brestovica aquifer system, are not presented in this document. The information on those will we completed when the sub-region Western Europe will be assessed.

[36] Based on information from Slovenia.

(c) Opatija/Istra;
(d) Rijeka/Istra which is further divided on the Slovenian side in Riječina – Zvir, Notranjska Reka (part of Bistrica-Snežnik in Slovenia) and Novokračine groundwater bodies/aquifers.

Table 20. Secovlje-Dragonja/Istra aquifer

No. 1 Secovlje-Dragonja/Istra [37]		**Shared by: Slovenia and Croatia**
According to Slovenia: Type 2, Kenozoic carbonate limestones / silicate-carbonate flysch, weak to medium links to surface waters. Groundwater flows from Slovenia to Croatia. Pressure condition: unconfined According to Croatia: represents none of the illustrated transboundary aquifer types, Cretaceous predominantly limestones, groundwater flow from both Slovenia to Croatia and Slovenia to Croatia		Mediterranean Sea Basin Border length (km): 21?
	Slovenia	**Croatia**
Area (km^2)	95.74	99
Altitude fluctuation (m)	0 - 479	N/A
Number of inhabitants	6,451	N/A
Population density (persons/km^2)	67.38	N/A
Water uses and functions	Local drinking water supply	Drinking water supply
Pressure factors	Tourism and transport	Communities
Problems related to groundwater quantity	None	None
Problems related to groundwater quality	Pollution from urbanisation and traffic	Local bacteriological pollution
Transboundary impacts	None	None
Groundwater management measures	Pumping station has been disconnected from water supply system	There are no protection zones
Trends and future prospects	Development of transboundary water protection areas	Agreed delineation of transboundary groundwater systems and development of monitoring programmes
Notes		- Transboundary groundwater under consideration but not approved - The issue of groundwater use has not been resolved with Slovenia
	In the valley of the Dragonja River	

[37] Based on information from. Slovenia, Croatia and the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Environment Agency of Slovenia and Croatian Waters. In Slovenia the name of the aquifer is Območje Marezige – Dragonja.

96. In the area of Območje Marezige - Dragonja aquifer/groundwater body on the Slovenian side, 57.2% of the land is forest, 39.6% is cropland, 1.1% urban or industrial area and 2.1% is in other land use.

Table 21. Mirna/Istra aquifer

No. 2 Mirna/Istra [38]		**Shared by: Slovenia and Croatia**
According to the riparian countries represents none of the illustrated transboundary aquifer types;, Cretaceous limestones, weak to medium links to surface water systems, groundwater flow from Slovenia to Croatia. Groundwater is 100% of the water used in the Croatian part. Part of the Istra system		**Mediterranean Sea basin** Border length (km):10
	Slovenia	**Croatia**
Area (km^2)	N/A	198
Water uses and functions	Provides part of regional drinking water supply for the town of Piran	Drinking water supply; supports ecosystems
Altitude fluctuation (m)	N/A	N/A
Number of inhabitants	N/A	N/A
Population density (persons/km^2)	N/A	N/A
Pressure factors	Tourism and transport	N/A
Problems related to groundwater quantity	None	None
Problems related to groundwater quality	Pollution from urbanisation and traffic	N/A
Transboundary impacts	None	N/A
Groundwater management measures	Pumping station has been disconnected from water supply system	Existing protection zones
Trends and future prospects	Delineation and enforcement of drinking water protection zones	Agreed delineation of transboundary groundwater systems and development of monitoring programmes
Notes		Transboundary groundwater under consideration, but not approved

[38] Based on information from Croatia and the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Environment Agency of Slovenia and Croatian Waters.

Table 22. Mirna aquifer

No. 2.1 Mirna [39]		**Shared by: Slovenia and Croatia**
Type 2, Kenozoic carbonate limestones / silicate-carbonate flysch. Pressure condition: unconfined		**Mediterranean Sea basin** Border length (km):
	Slovenia	**Croatia**
Area (km^2)	44,00	
Altitude fluctuation (m)	108 - 860	
Number of inhabitants	604	
Population density (persons/km^2)	13.73	

97. In the area of Mirna aquifer/groundwater body in the Slovenian territory, 62.5% of the land is forest, 26.6% is cropland and other land uses make up the remaining 10.9%.

Table 23. Območje izvira Rižane aquifer

No. 2.2 Območje izvira Rižane [40]		**Shared by: Slovenia and Croatia**
Type 2, Mesozoic carbonate karstic limestones. Pressure condition: unconfined		**Mediterranean Sea basin** Border length (km):
	Slovenia	**Croatia**
Area (km^2)	227.34	
Altitude fluctuation (m)	69 – 1,015	
Number of inhabitants	5,070	
Population density (persons/km^2)	22.30	

98. In the area of Območje izvira Rižane aquifer/groundwater body in Slovenia, 69.3% of the land is forest, 24.1% is cropland and 1.1% urban or industrial area.

Table 24. Opatija/Istra aquifer

No. 3 Opatija/Istra [41]		**Shared by: Slovenia and Croatia**
Type 2, Mesozoic dominantly carbonate, karstic limestones. Pressure condition: unconfined.		**Mediterranean Sea basin** Border length (km):
	Slovenia	**Croatia**
Area (km^2)	66.61	
Altitude fluctuation (m)	476 – 1,065	
Number of inhabitants	1,002	
Population density (persons/km^2)	15.04	

[39] Based on information from Slovenia.
[40] Based on information from Slovenia.
[41] Based on information from Slovenia. The aquifer is called Podgrad–Opatija in Slovenia.

99. In the area of Opatija/Istra aquifer/groundwater body in the Slovenian territory, 83.1% of the land is forested, 13.0% is cropland and 0.5% urban or industrial area.

Table 25. Riječina – Zvir aquifer

No. 4.1 Riječina – Zvir [42]		**Shared by: Slovenia and Croatia**
Mesozoic carbonates, dominantly karstic limestones. The dominant groundwater flow direction is from Slovenia to Croatia.		**Mediterranean Sea basin** Border length (km):
	Slovenia	**Croatia**
Area (km^2)	69.95	
Altitude fluctuation (m)	785 – 1,786	
Number of inhabitants	0	

100. Of the area of Riječina – Zvir aquifer on the Slovenian side, forest makes up 97.3%, cropland 0.1% and other land uses 2.6%. Development of transboundary groundwater protection areas is suggested.

Table 26. Notranjska Reka aquifer

No. 4.2 Notranjska Reka (part of Bistrica-Snežnik in Slovenia) [43]		**Shared by: Slovenia and Croatia**
Type 2, Kenozoic carbonate limestones / silicate-carbonate flysch. Pressure condition: unconfined.		**Mediterranean Sea basin** Border length (km):
	Slovenia	**Croatia**
Area (km^2)	315.42	
Altitude fluctuation (m)	334 – 1,606	
Number of inhabitants	11,330	
Population density (persons/km^2)	35.92	

101. From 67.1 to 77.4% of the land in the area of Notranjska Reka aquifer on the Slovenian side is forest, from 1.7 to 31.4% cropland, from 0.3 to 1.1% urban/industrial areas and 0.4 to 20.6% other forms of land use.

Table 27. Novokračine aquifer

No. 4.3 Novokračine[44]	**Shared by: Slovenia and Croatia**
Type 2, Kenozoic carbonate limestones / silicate-carbonate flysch. Pressure condition: unconfined	**Mediterranean Sea basin** Border length (km):

[42] Based on information from Slovenia.
[43] Based on information from Slovenia.
[44] Based on information from Slovenia.

	Slovenia	Croatia
Area (km^2)	21.30	
Altitude fluctuation (m)	428 - 759	
Number of inhabitants	856	
Population density (persons/km^2)	40.19	

102. Some 81.0% of the land area of Novokračine aquifer on the Slovenian territory is occupied by forest, 17.8% by cropland while 1.2% is urban or industrial area.

103. In Slovenia, groundwater from the aquifers/groundwater bodies listed above is used for local drinking water supply.

104. With what concerns enhancement of transboundary cooperation on Mirna, Območje izvira Rižane and Riječina – Zvir aquifers/groundwater bodies, Slovenia reported that development of transboundary water protection areas is an issue in which international cooperation / organizations can be of support.

B. CETINA AQUIFER[45]

Table 28. Cetina aquifer

No. 20 Cetina		**Shared by: Bosnia and Herzegovina and Croatia**
According to the riparian countries represents none of the illustrated transboundary aquifer types; Palaeozoic, Mesozoic and Cenozoic karstic limestones of average thickness 500 m and maximum 1,000 m, in hydraulic connection with recent sediments, groundwater flow from Bosnia and Herzegovina to Croatia, strong links to surface water system. Groundwater covers 5% of the water used in the Croatian part.		**Mediterranean Sea Basin** Border length (km): 70
	Bosnia and Herzegovina	**Croatia**
Area (km^2)	2,650	587
Water uses and functions	Up to 50% for hydroelectric power, smaller amounts for drinking water, irrigation, industry, mining and livestock; also support of ecosystems and maintaining baseflow and springs	Drinking water supply; 95% of groundwater is used for hydropower production.
Notes:		-Transboundary aquifer under consideration, but not approved -Includes the Glamo_ko-Kupreško and other Poljes with very large springs

[45] Based on information from Croatia and the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Public Enterprise for the Adriatic Sea Catchment Area of Bosnia and Herzegovina and Croatian Waters.

105. Crop and animal production exert pressure to the aquifer in Croatia.

106. Solid waste disposal, wastewater, agriculture and industry are the pressure factors in Bosnia and Herzegovina; local and moderate nitrogen, pesticide, heavy metal, pathogen, organic and hydrocarbon pollution have been detected. Issues related to water quantity have resulted to widespread but moderate degradation of ecosystems; polluted water is drawn into the aquifer.

107. There are sinkholes in Bosnia and Herzegovina with transboundary effects in Croatia.

108. According to Bosnia and Herzegovina quantity and quality monitoring need to be improved, and so do abstraction control and protection zone systems. It is also necessary to improve protection of the upper catchment; while vulnerability mapping is planned, improved wastewater treatment is needed.

109. There are groundwater protection zones in Croatia; it is necessary to establish such at Vukovi_a Vrelo as well. The country reported that agreed delineation of transboundary groundwaters, and development of monitoring programmes are needed.

C. DINARIC LITTORAL (WEST COAST) AQUIFER

Table 29. Dinaric Littoral (west coast) aquifer [46]

No. 24 Dinaric Littoral (west coast)		**Shared by: Montenegro and Croatia**
Type 2, Jurassic and Cretaceous karstic limestones, average thickness 500 m and maximum greater than 1,000 m, weakly connected to surface water systems. Groundwater provides 100% of total water use in the Montenegrin part		**Mediterranean Sea basin**
		Border length (km):
	Montenegro	**Croatia**
Area (km^2)	200	-
Water uses and functions	25-50% each for drinking water supply and industry, <25% each for irrigation and livestock	-
Notes		According to existing data, no transboundary groundwater is recognised

110. Abstraction of groundwater is a pressure factor in Montenegro. Widespread and severe saline water intrusion at the coastal area has resulted in high salinity of groundwater. Existing control of abstraction, efficiency of water use, protection zones, agricultural

[46] Based on information from Croatia and the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the National Committee of the International Association of Hydrogeologists of Serbia and Montenegro and Croatian Waters.

practices, groundwater monitoring and public awareness need to be improved; other measures need to be introduced as well.

D. METOHIJA AQUIFER[47]

Table 30. Metohija aquifer

No. 27 Metohija		**Shared by: Kosovo (UN administered territory under UN Security Council resolution 1244) and Montenegro**
Type 4, Tertiary (Miocene) alluvial sediments, average thickness 100 m and maximum 200 m, weak links to surface water systems. In Montenegro, Type 1, Triassic karstic limestones with thickness 300 to 800 m, weak links to surface water systems. Groundwater is 20% of total water use		Basin:[48]
		Border length (km):
	Kosovo (UN administered territory under UN Security Council resolution 1244)	**Montenegro**
Area (km^2)	1,000	300-400
Water uses and functions	25-50% for irrigation, <25% each for drinking water, industry and livestock, maintaining baseflow and spring flow	>25% for drinking water, <25% each for irrigation, mining and industry

111. There are no pressures exerted to the aquifer in Montenegro.

112. Agriculture and local small industries are the pressure factors in Kosovo (UN administered territory under UN Security Council resolution 1244) leading in pesticides and industrial organic compounds in the groundwater. There is no assessment regarding the status of the aquifer.

113. There are no transboundary impacts. Several management measures are needed.

[47] Based on information from the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Directorate of Water, and the Jaroslav Cerni Institute, Serbia, and the National Committee of the International As¬sociation of Hydrogeologists of Serbia and Montenegro.
[48] The uncertainty about which drainage basin, Adriatic or Black Sea, this aquifer belongs to still persists since. the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

E. PESTER AQUIFER[49]

Table 31. Pester aquifer

No. 28 Pester		**Shared by: Serbia and Montenegro**
Type 2, Middle Triassic karstic limestones, mean thickness 350 m and up to 1,000 m thick, weak links to surface water systems, dominant groundwater flow is towards the south west from Serbia to Montenegro		**Mediterranean Sea Basin** Border length (km):
	Serbia	**Montenegro**
Area (km^2)	317.36	>150
Number of inhabitants	1,742 inhabitants	
Population density (persons/km^2)	6	

Table 32. Land cover/use in the Pester aquifer area (% of the part of the basin extending in each country)

	Lakes / reservoirs	Forests	Cropland	Grassland	Urban / industrial areas	Protected areas	Other forms of land use
Serbia		23.06	1.69	75.06	0.12		0.07*
Montenegro							

* Bare rocks

114. Pester area in Serbia, is inaccessible and sparsely populated[50]. Animal husbandry is the main economic activity.

115. In Montenegro less than 25% of groundwater is used for drinking water supply; groundwater is also used for livestock as well as in mining activities.

116. The major part (75%) of the groundwater being utilized in Serbia is used for drinking water supply, while less than 25% is used for industry and livestock. Groundwater also supports ecosystems and maintains baseflow and springs. Pressures exerted to the aquifer in terms of quantity are insignificant. Naturally discharging water from springs is used for drinking water supply; the volume of water used is less than the natural discharge.

117. In Serbia, periodical chemical analysis of groundwater used for water supply purposes has shown that it is of good quality. Dewatering of a coal mine in the area (approximately 50 l/s) is the major pressure, of local importance though. Lack of wastewater collection and treatment facilities at rural settlements is a potential threat. Present good

[49] Based on information from Serbia and the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Directorate of Water, Serbia and the National Committee of the International Association of Hydrogeologists of Serbia, and Montenegro.
[50] There is no related information available for Montenegro.

quality status could be endangered through sinkholes in Pester polje. In Montenegro domestic wastewater is a pressure factor.

118. Systematic quantity and quality monitoring need to be established in both countries and so does vulnerability mapping for land use planning in Montenegro. According to Montenegro exchange of data between the two countries is needed.

119. Serbia reports that there is no need for intensive bilateral cooperation for the management of the transboundary aquifer.

F. KORAB/BISTRA – STOGOVO AQUIFER[51]

Table 33. Korab/Bistra – Stogovo aquifer

No. 35 Korab/Bistra – Stogovo		**Shared by: The former Yugoslav Republic of Macedonia and Albania**
Type 1, Mesozoic and Paleozoic schists and flysch sediments, containing Triassic evaporites (anhydrite and gypsum) and Triassic and Jurassic karstic limestones. Minor alluvial sediments with free (unconfined) groundwater, mean aquifer thickness from 500 to 700 m, maximum more than 2,000 m, weak links to surface waters, groundwater flow occurs in both directions, but more from the former Yugoslav Republic of Macedonia to Albania. Groundwater provides >90% of total supply in Albania and the former Yugoslav Republic of Macedonia.		**Mediterranean Sea basin** Border length (km): 25
	The former Yugoslav Republic of Macedonia	**Albania**
Area (km^2)	N/A	About 140
Water uses and functions	Drinking water, irrigation, mining	25-50% for thermal spa, < 25% each for drinking, irrigation and livestock
Notes		Comparative study of the thermo-mineral springs of Albania and the former Yugoslav Republic of Macedonia is needed. There are large fresh water karst springs issuing at high elevations

120. Waste disposal, sanitation and sewer leakage are pressure factors on the Albanian side resulting in moderate pathogens occurrence locally; polluted water is drawn into the aquifer. Local and moderate degradation of ecosystems is an issue related to the quantity of groundwater.

[51] Based on information from the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by ITA Consult, Albania, and the Ministry of Environment and Physical Planning, the former Yugoslav Republic of Macedonia.

121. In the former Yugoslav Republic of Macedonia groundwater abstraction and agriculture exert pressure to the aquifer; the discharge of the springs has been reduced locally. There are transboundary impacts related to groundwater quantity.

122. Measures needed in Albania include detailed hydrogeological and vulnerability mapping, delineation of protection zones, wastewater treatment and public awareness campaigns. Improvements are needed with regard to the monitoring of the aquifer and the protection zones system in place in the former Yugoslav Republic of Macedonia.

123. There are transboundary agreements covering also this aquifer and data are exchanged between the two countries; there is room for improvement though. Albania calls for enhanced cooperation and setting up of transboundary institutions as well as for the creation of a joint programme for quantity and quality monitoring of the sulphur thermo-mineral springs issuing in both countries.

G. JABLANICA/GOLOBORDO AQUIFER[52]

Table 34. Jablanica/Golobordo aquifer

No. 36 Jablanica/Golobordo		**Shared by: Albania and the former Yugoslav Republic of Macedonia**
Type 2, Triassic and Jurassic karstic limestones of average thickness 700 m and maximum 1,500 m, weak links to surface waters, groundwater flow occurs in both directions. Groundwater is 70-80% of total water use in Albania		**Mediterranean Sea basin** Border length (km): 50
	Albania	**The former Yugoslav Republic of Macedonia**
Area (km^2)	250	N/A
Water uses and functions	25-50% for irrigation, <25% each for drinking water and industry, also for maintaining baseflow and springs	Drinking water supply, thermal water and industry, also hydroelectric power
Notes	Surface karst phenomena are very well developed on Klenja plateau	

124. Sanitation and sewer leakage exert pressure on the aquifer in both countries. This is reported to be modest in the Albanian side and so is pressure exerted from waste disposal; nevertheless, these pressures result in moderate pathogens being present in the groundwater locally. In Albania there is polluted water drawn into the aquifer.

125. In the former Yugoslav Republic of Macedonia reduction of groundwater yields from wells and discharges from springs have been observed locally.

126. There are no impacts reported at transboundary level.

[52] Based on information from the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by ITA Consult, Albania, and the Ministry of Environment and Physical Planning, the former Yugoslav Republic of Macedonia.

127. With regard to management measures there are no such in place in Albania; those that need to be introduced include detailed vulnerability and hydrogeological mapping, groundwater monitoring, protection zones, wastewater treatment and public awareness. Monitoring of quantity and quality, protection zones, hydrogeological mapping and good agricultural practices are needed in the former Yugoslav Republic of Macedonia. Both countries agree that data should be exchanged.

128. According to Albania the aquifer is not at risk since population is small and industry is not developed. There are plans in the country for the use of a large karst spring for hydropower production.

H. MOURGANA MOUNTAIN/ MALI GJERE AQUIFER[53]

Table 35. Mourgana Mountain/Mali Gjere aquifer

No. 37 Mourgana Mountain/Mali Gjere		**Shared by: Greece and Albania**
Type 1 or 2, karstic aquifer developed in Triassic, Jurassic and Cretaceous limestones in large anticlines with flysch in synclines. Average thickness about 100 m and maximum about 150 m. Thickness of alluvium of the Drinos River is 20-80 m. Strong links with surface water systems. Little groundwater flow across the border. The Drinos River flowing from Greece to Albania recharges the alluvial aquifer which contributes to the Bistritsa (Blue Eye) Spring (average discharge 18.5 m^3/s) in Albania. The Lista Spring (average 1.5 m^3/s) issues in Greece. Groundwater provides about 70% of total water use		**Mediterranean Sea basin** Border length (km): 20
	Greece	**Albania**
Area (km^2)	90	440
Water uses and functions	50-75% for irrigation, 25-50% for drinking water supply, <25% for livestock, also support of ecosystems and maintains baseflow and springs	Provides 100% of drinking water supply and spa use, and >75% for irrigation, industry and livestock
Notes		There has been a proposal to export about 4.5 m^3/s of water from Blue Eye spring to Puglia - Italy through an undersea water supply pipeline

129. Waste disposal and sewer leakage on the Albanian side as well as agriculture on the Greek side (population in the mountainous area is low) exert minor pressure on the aquifer. Increased pumping lifts in the Greek side have resulted in moderate problems related to groundwater quantity locally; there is no decline of the groundwater level in the Albanian side. There are no transboundary impacts reported.

[53] Based on information from the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Institute of Geology and Mineral Exploration and the Central Water Agency, Greece, and ITA Consult, Albania.

130. While there are no problems related to groundwater quality in Greece, in Albania there is widespread but moderate salinisation observed; concentrations of sulphate in alluvial groundwater are high (300 -750 mg/l) and this contributes to increased average sulphate (135 mg/l) in Blue Eye Spring's water.

131. The implementation of the EU WFD is in progress in Greece; existing monitoring should be improved. In Albania there are no measures employed; among those needed are detailed hydrogeological and groundwater vulnerability mapping, delineation of protection zones, wastewater treatment and public awareness. According to Albania increased collaboration is needed with the aim of setting up transboundary institutions and create a joint basin wide programme for quantity and quality monitoring.

132. When last reported, the aquifer at the Albanian side was under low risk; it was mentioned though that this could change since the agricultural and industrial activities in the area were developing rapidly. There are plans for increased use of groundwater in alluvial deposits and export of karst water to Italy.
