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Working Group on Monitoring and Assessment

Twelth meeting
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Items 5 (a) and 5 (e) of the provisional agenda
Assessment of the status of transboundary waters in the UNECE[1] region: assessment of transboundary rivers, lakes and groundwaters in Western and Central Europe

Assessment of the status of transboundary waters in the UNECE region: assessment of transboundary rivers, lakes and groundwaters in.South-Eastern Europe.

Assessment of transboundary rivers, lakes and groundwaters discharging into the Mediterranean Sea[2]

Note prepared by the secretariat*

Summary

This document was prepared pursuant to decisions taken by the Meeting of the Parties to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes at its fifth session (Geneva, 10–12 November 2009) (ECE/MP.WAT/29, para. 81 (e)), and by the Working Group on Monitoring and Assessment at its eleventh meeting (Geneva, 8–9 July 2009; ECE/MP.WAT/WG.1/2009/2, paras. 44–48), requesting the secretariat to finalize the South-Eastern Europe and Western and Central Europe assessments for the second

[1] United Nations Economic Commission for Europe.
[2] This document was submitted for publication without formal editing.
* The present document has been submitted on the present date due to resource constraints in the secretariat.

Assessment of Transboundary Rivers, Lakes and Groundwaters in time for its submission to the Seventh “Environment for Europe” Ministerial Conference (Astana, 21–23 September 2011). This document contains the draft assessment of the different transboundary rivers, lakes and groundwaters in South-Eastern Europe (SEE) that are located within the Mediterranean basin by transboundary basin and aquifer.

This document contains the draft assessments of the different transboundary rivers, lakes and groundwaters which are located in the Mediterranean Basin.

For background information and for the decisions that the Working Group on Monitoring and Assessment may wish to take, please refer to document ECE/MP.WAT/WG.2/2011/4−ECE/MP.WAT/WG1/2011/4.

Contents

I. Introduction

1. The present document contains the assessments of the different transboundary rivers, lakes and groundwaters which are located in the Mediterranean Sea Basin. They include the basins of the rivers discharging to the Adriatic Sea or the Aegean Sea assessed as part of the South-Eastern Europe sub-region as well as of those rivers of Western and Central Europe sub-region that discharge to the Mediterranean Sea. The document has been prepared by the secretariat on the basis of information provided by the countries in the above-mentioned sub-regions.

2. For descriptions of the transboundary aquifer types and related illustrations, Annex V of document ECE/MP.WAT/2009/8 should be referred to.

3. For background information and for the decisions that the Working Group on Monitoring and Assessment may wish to take, please refer to documents ECE/MP.WAT/WG.2/2011/7−ECE/MP.WAT/WG1/2011/7 and ECE/MP.WAT/WG.2/2011/8–ECE/MP.WAT/WG1/2011/8.

II. Rhone River Basin[3]

4. The Rhone River basin is shared by France, Switzerland and Italy; the Italian part is negligible. The 750 km long river originates from the Rhone glacier in Switzerland, at an altitude of 1,765 m flowing through France to the Mediterranean Sea. Before entering the Mediterranean Sea the Rhone divides in to two branches which form the Camargue delta; one of the major wildlife areas of Europe.

5. Lake Geneva and Lake Emosson are transboundary lakes in the basin, and the Arve and the Doubs (transboundary tributary of the Saône) are major transboundary tributaries of the Rhone. There is also a number of small transboundary rivers discharging to Lake Geneva. In addition to four Ramsar sites related to Lake Geneva (see the separate box), there are several other protected sites.

6. The Alpine part of the Rhone Basin (upstream from Lake Geneva) ranges from high-altitude mountain peaks and the higher valley to the main Rhone valley where the river is more influenced more by canalizations. The average elevation of the catchment area of the Rhone River at its outflow from Switzerland is 1,580 m a.s.l.

Table 1
Area and population in the Rhone Basin.

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
France	90 000	92	14 000 000[a]	156
Switzerland	7 739	8	1 228 857[b]	159
Italy	50			
Total	**98 000**			

[3] Based on information provide by Switzerland and the first Assessment of transboundary Rivers, Lakes and Groundwaters and Mediterranean Case Study (Y. Souchon, Cemagref) http://cmsdata.iucn.org/downloads/france.pdf, http://www.rhone-mediterranee.eaufrance.fr/, http://www.eaurmc.fr/.

Sources: Freshwater in Europe – Facts, Figures and Maps. UNEP/DEWA-Europe, 2004. OECD-EUROSTAT reporting for Switzerland in 2010.

[a] Figure for Rhone-Mediterranean basin, source: eaurmc.fr.

[b] Figure for 2005

Hydrology and hydrogeology

7. The Rhone typically develops floods in spring and autumn. In autumn of 2003, flood peaks of 13,000 m^3/s were recorded. Due to the flooding and the steep gradient, the Rhone has been known for its poor navigability, but good hydroelectric potential.

8. In the Alpine Rhone in Switzerland, precipitation are amounts to approximately 7.26 km^3/year and surface water resources generated upstream from Lake Geneva (inflow point at Porte du Scex) are estimated at 5.71 km^3/year. The outflow of the Rhone below Lake Geneva is regulated, and overall the the total water storage in the basin is 7 km^3, representing about 7.3 % of the annual runoff of 96 km^3. Nearly 80% of this storage capacity is located downstream of Geneva and is provided by such dams as the Vouglans dam on the Upper Ain River, several dams on Isère River (which together account for 30% of total storage capacity) and the Serre-Ponçon dam on the Durance River. The Serre-Ponçon dam provides 43% of the basin's storage capacity and is one of the largest dams in Europe.

9. Natural groundwater flow from the Geneva aquifer — the main transboundary aquifer in the basin — to the Lake Geneva is about 789,000 m^3/year and to River Rhone is about 1.9×10^6 m^3/year.

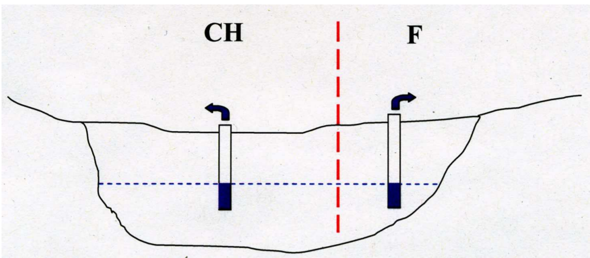
Table 2

Genevese aquifer: (see the conceptual sketch), silty-sandy gravel of glacial and glacio-fluvial origin (glacial period Wurm), lying directly on a molasse formation. Groundwater flow directions are 1) from the Arve to the lake; and 2) from the Arve to the west part of the canton of Geneva; the flow is roughly parallel to the border.. Strong links with surface waters (River Arve)

	France	*Switzerland*
Border length (km)	Partly on the French border	
Area (km^2):		30 in total for both countries
Renewable groundwater resource (m^3/d)		On average, natural annual recharge of is 7×10^6 m^3 and artificial recharge is 8×10^6 m^3 (1980 - 2010).
Thickness in m (mean, max)	25, 60	25, 60
Groundwater uses and functions	Drinking water	Drinking water (source of some 20% of Geneva's water supply), 0.2 % for agriculture; Availability has an impact on costs, social development and key sectors of economy
Pressures	Annual average withdrawal from wells, five in France and ten in Switzerland, is	Local and moderate pressure from natural/background pollution, pollution from

	15.6×10^6 m^3 (1980 - 2010).	municipal and industrial wastewaters, agriculture, flooding and groundwater pollution. Local but severe pressure from suspended sediments and mud flow. Heat waves, turbidity and surges affect the artificial recharge. Low water levels at times. Flow variations. Flow surges are likely to occur at all seasons
Groundwater management measures	Groundwater monitoring is managed by the geological survey of Geneva. Implemented measures: vulnerability mapping, protection zones for drinking water supply, water safety plans.	Groundwater monitoring is managed by the geological survey of Geneva. Implemented measures: vulnerability mapping, protection zones for drinking water supply, water safety plans.
Other information	A joint commission in place for the protection and management of the joint resource.	Private drilling and individual geothermal boreholes are an issue to groundwater protection: an attempt made at getting the same level of legislation between Switzerland and France. .

Figure 1. **Conceptual sketch of the Genevese aquifer (provided by the State of Geneva, Switzerland)**



Pressures

Table 3
Total withdrawal and withdrawals by sectors.

Country	*Year*	*Total withdrawal ×10^6 m^3/year*	*Agricultural %*	*Domestic %*	*Industry %*	*Energy %*	*Other %*
Switzerland		N/A	N/A	N/A	N/A	N/A	N/A
France, surface water			70	15	15		
France, groundwater			10	65	25		

Note: The figures for France should be considered as indicative only since they are for the whole Rhone-Mediterranean basin; source: www.eaurmc.fr

10. There are intensive tourism and recreation activities in Alpine Rhone section as well as hydropower production.

11. The main Rhone valley under pressure from river corrections (can alization) and flood control measures, settlements, traffic routes and industrial areas. The Rhone basin is densely populated, and most of the pollution in the basin originates from agriculture, industry and transport. In Switzerland pressure from agricultural pollution is assessed as local but severe to widespread but moderate, pressure from pollution from municipal wastewaters is assessed as local and moderate and pollution from industrial wastewaters as local but severe. Plant protection products, medicines and synthetic organic compounds from consumer products (on the increase) can pollute the surface waters and also infiltrate to groundwaters. On the valley bottoms and agglomeration areas there is a pressure from motorway traffic.

12. The damage potential of flooding is high in densely populated areas and in valley bottoms, and is evaluated as periodical (depending on climatic/weather conditions e.g. extreme events) local but severe in Switzerland. Flooding can have an effect on the physical infrastructures and also on the hydrotechnical constructions. In the lower part of the Rhone (the French part), the flow regulation and hydropower production has been developed (as described above).

13. The importance of scarcity and drought, as well as thermal pollution as a pressure factor is ranked as local and moderate. Also pressure from suspended sediments and mud flows are assessed as local but severe in Switzerland.

Status and transboundary impacts

14. The overall reduction of biodiversity of the river is evaluated as widespread but moderate in Switzerland; there is scarcity of species whose life histories are linked to a dynamic fluvial system. Rheophilic species have declined and communities shifted to more limnophilic habitat species. The impacts of change in physical habitat have been remarkably considerable in ecological terms. The morphology of the river channel has

changed to straight and canalized, often eroded and incised (local but severe pressure in Switzerland); the level of the groundwater has been lowered; several natural biotopes disappeared; due to groundwater depletion, the riparian forest evolved to hardwood forest; and dams block the migration of amphibiotic fish (shads, eel, lampreys), where numerous lateral communications with tributaries or side channels have been modified, and sometimes cut off.

Response measures

15. Water protection in Switzerland has a firm legal basis and several guidelines concerning the state, management and protection of waters have been produced (e.g. Water Protection Act and Ordinance, Water Engineering Act and Ordinance, Watershed Management – Guiding Principles for Integrated Management of Water in Switzerland).

16. In response to the hydromorphological pressures due to river corrections, flood control measures and hydropower production, an amendment of the Swiss Water Protection legislation (Act and Ordinance) has entered into force in 2011. The amended regulations demand the revitalisation of waters to restore their natural functions and strengthen their social benefit, along with more stringent measures to eliminate the major negative environmental effects arising from hydroelectric power generation (hydropeaking, inadequate connectivity and disrupted bed-load balance). The regulations also include a planning and financing scheme for the implementation of required measures.

17. In addition, parks of national importance have been created to help the protection and enhance exceptional natural habitats or landscapes of outstanding beauty.

18. Flood risk prevention includes a preliminary flood risk assessment and hazard mapping by 2011, along with the promotion of a modern flood protection policy with the following aims: ensuring adequate protection of areas vital to human livelihoods and economic development, limiting economic damage by means of a comprehensive prevention strategy, improving the handling of uncertainties and residual or remaining risks, and finally understanding rivers and streams as essential linking elements in landscapes and nature[4].

19. In the framework of the International Commission for the Protection of Lake Geneva (CIPEL), the focus of the river management of the Rhone is in rehabilitation or re-naturalisation, in addition to flood defence, water quality management and water resource protection.

20. A new agreement (the previous one from 1978) relating to the use, recharge and monitoring of Franco-Swiss Genevese groundwater signed between, on the one hand, the communes of the greater Annemasse region (France), the Genevese communes and the commune of Viry and, on the other hand, the State Council of the Republic and the canton of Geneva (Switzerland), is in force since January 2008. Setting up of a cross-border commission allowed for the identification of the roles and responsibilities of each side and determined the financial modalities governing the use of the resource. The cooperation evolved initially from looking into managed aquifer as a solution to the groundwater depletion resulting from heavy abstraction. The agreement is a rare example of an aquifer management transboundary agreement between a Swiss canton and European Union communities.

[4] Flood control at rivers and streams, Federal Office for the Environment, Switzerland, 2001

Future trends

21. According to the climate scenarios available for the alpine space, precipitation during winters is predicted to increase and decrease during summer. The overall annual precipitation is predicted to decrease by 5-10%. Intensive rain and the number of rainless days in summertime could increase. Temperature measurements indicate an increase of the annual mean in the last century twice as high as the global average, with a projected further increase to +2.7°C by 2100.

22. The temperature rise and the significant change in the extent and volume of the snow cover will lead to changes in the hydrological runoff regime: stronger and longer lasting low flow conditions in the summertime, higher runoff in the winter season and more frequent high floods in the lower part of Switzerland. Due to climate change the hydrology and the water balance of the alpine region is predicted to be substantially affected and extreme weather events are likely to occur more frequently. The spatial resolution of the current regional climate models does not allow more accurate quantitative predictions for the Alps and consequently these assessments have to be based on expert judgement.[5]

23. Climate change may cause more frequent water shortages and possibly problems with managed aquifer recharge (“artificial recharge”; used to charge Geneva aquifer) through, for example, increased turbidity in river water.

24. Switzerland abstracts about 5% of its precipitation for all water use purposes; due to this water quantity is not the limiting factor for a climate change adaptation strategy. [6]

25. Economical attractiveness, safety of hydropower and the trend to migrate towards CO_2-free energy are leading to increased hydropower production. This might lead to changes in run-off conditions (residual flow, hydropeaking), cause general depletion in habitats in and around the water bodies and also cause structural changes to surface waters.

26. Growth in the demand for hydropower together with climate change are predicted to create temporal and spatial changes in water availability as well as leading to an intensification of water use. These factors combined with increasing water protection concerns will aggravate conflicts of interest concerning water.[7]

III. Lake Geneva/ Lac Léman[8]

27. Lake Geneva/Lac Léman, being one of the largest lakes in Western Europe, covers an area of ca. 580 km^2 and has a volume of 89 km^3. Approximately 60% of the lake surface area belongs to Switzerland, while the remaining parts are under the jurisdiction of France. The lake forms part of the course of the river Rhône. The lake has a glacial origin with an average depth of 153 m and a maximum depth of 310 m.

28. The catchment area of the Lake of Geneva has a mountainous character with an average elevation of about 1,670 m a.s.l.

29. Lake Geneva is important as source of drinking water as well as from ecosystem/biodiversity point of view (for details, see the assessment of the related wetland area).

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[5] Source: Aschwanden, H. & Schädler, B. 2011 (in preparation)

[6] Source: Aschwanden, H. & Schädler, B. 2011 (in preparation)

[7] Core indicator Production of hydroelectric power, Federal Office for the Environment (http://www.bafu.admin.ch/umwelt/indikatoren/)

[8] Based on the first Assessment of Transboundary Rivers, Lakes and Groundwaters

IV. Lake Geneva/ Lac Léman wetland area[9]

General description of the wetland area

30. There are four Ramsar Sites in the area of Lake Geneva/ Lac Léman. Two of them were designated by France: The Ramsar Site « Rives du Lac Léman » comprises of several physically separate zones of ecological interest on the shores of the lake such as alluvial terraces, gravel islands, lacustrine dunes, extensive reedbeds and parts of the Dranse, Redon, Foron and Vion rivers. The second Ramsar Site “Impluvium d’Evian » is located in the heart of the plateau where the mineral waters of Evian have their origin. The site is composed of seasonal and permanent freshwater marshes, forested and non-forested peatlands, rivers and streams. The two Ramsar Sites designated by Switzerland both cover parts of the Rhone River. While the Ramsar Site “Les Grangettes” comprises parts of the Rhone delta flowing into the lake and includes open water, reedbeds, marshes, and riparian woodland, the Ramsar Site “Le Rhône genevois – Vallons de l’Allondon et de La Laire” covers a section of the Rhône River in and downstream from the city of Geneva, including the shores of the lake, riverbanks within the city and along two small tributaries, the Allondon and La Laire, extending from the lake southwestward to the French frontier. While habitats include reedbeds, grasslands subject to seasonal inundation, scrub and alluvial woodland, the key value of this site is that it includes some of the last remaining relatively unmodified stretches of the Rhône in Switzerland.

Main wetland ecosystem services

31. Lake Geneva is a major drinking water reservoir. The surrounding areas of the lake are mostly agricultural, urban or industrial with a few natural stretches such as the area of the Ramsar Site “Les Grangettes”. The area is important in terms of commercial (146 professionals) as well as recreational fishing (7,800 amateurs) and fish farming resulting in a production of 600-1100 t/year. Further uses include agriculture, forestry, livestock rearing and viticulture. Additionally, the lake’s tributaries are used for power generation: In addition to numerous hydro-electric power plants situated in the upper part of the Rhône, there are also two plants in operation at Verbois and Chancy-Pougny in the lower parts of the Rhône. The area of the Ramsar Site “Impluvium d’Evian” in particular is of importance for the production of the “Evian” mineral water. Additionally, the area of the lake and its surroundings are very important in terms of recreation and tourism. Activities include walking, cycling, canoeing, rafting, swimming and camping.

Cultural values of the wetland area

32. The area has some archaeological importance as prehistoric vestiges, such as mammoth tusks and bones, have been found on the left bank of the Rhone, in the valley of the Allondon and near Russin. Furthermore, its landscape and its climate give the area a special aesthetic value that is being complemented by the multitude of historical monuments along the shore of the lake such as castles and churches from the 11th to the 15th century.

Biodiversity values of the wetland area

33. Lake Geneva is the second most important wintering area for water birds in France. Parts of the lake (including parts of the Swiss side) are used as breeding and staging sites.

[9] *Sources:* RIS Les Grangettes, RIS Le Rhone Genevois, RIS Rives du Lac Leman, RIS Impluvium d’Evian, CIPEL, Plan d’action 2011-2020, “Préserver le Léman, ses rives et ses rivières aujourd’hui et demain” .

Species include the Great Crested Grebe (*Podiceps cristatus*) and the Black Kite (*Milvus migrans*) as well as large numbers of wintering ducks such as the Tufted Duck (*Aythya fuligula*). Particularly the Ramsar Site of "Les Grangettes" also harbours small flocks of non-breeding Common Eider (*Somateria mollissima*), an unusual range extension for this generally marine duck. Within Switzerland, the Rhone genevois offers one of the most important wintering sites for Goosander (*Mergus merganser*) as well as the Little Grebe (*Tachybaptus ruficollis*).

34. In addition to various mammals in the surroundings, the lake supports over 60 fish species including the spirlin (*Alburnoides bipunctatus*) and the Perch (*Perca fluviatilis*). The area of the Ramsar Site "Impluvium d'Evian" in France provides an important habitat for invertebrates, in particular for two butterfly species, the Large Heath Butterfly (*Coenonympha tullia*) and the Cranberry Fritillary (*Boloria aquilonaris*) whose populations are in decline everywhere else in the region.

35. The Lake Geneva area also offers a rich flora. Different species of orchids such as the Fen Orchid (*Liparis loeselii*) can be found.

Pressure factors and transboundary impacts

36. In general the lake and its surrounding area have been affected by urban developments such as shoreline modifications which have in the past caused a decline in nesting birds. Water abstraction is another possible threat for the maintenance of the hydrological balance as well as the biodiversity. The latter is also threatened by the increase in the abundance of invasive species such as the Japanese Knotweed (*Polygonum cuspidatum*). Despite the great reduction in pollution, there is still need for reduction of the amounts of agricultural fertilizer as well as micropollutants from industry. Further threats include erosion as well as pressures from navigation and tourism activities.

Transboundary wetland management

37. While only parts of the shores, areas surrounding the lake or parts of its tributaries are under national, European (Natura 2000) or international (Ramsar) protection, there is no protection of the lake as a whole. The International Commission for the Protection of Lake Geneva (CIPEL), founded by an agreement between the governments of France and Switzerland in 1962, focused mainly on the improvement of the water quality earlier, it is now also involved in restoration projects within the catchment area in order to preserve the biodiversity of the area. CIPEL fulfills an important role as a government advisory body. Its policy recommendations are based on an annual monitoring of the lake and help to coordinate the water policy for the Lake Geneva catchment area between the two countries. The Commission's current action plan covers the period from 2011 to 2020 and comprises of 17 objectives such as the reduction of micro pollutants and the limitation of phosphorus levels, the preservation and improvement of natural conditions of wetlands in the basin, as well as ensuring the migration of fish species and the sustainable use of the ecosystem in terms of swimming, boating, tourism, etc.

V. Lake Emosson[10]

38. Lake Emosson is located in the Swiss part of the Rhone basin and it is formed by a dam, which is jointly operated by France and Switzerland (Electricité d'Emosson SA) for hydropower generation. The water collected from the Mont Blanc Massif is channeled into the reservoir located at an altitude of 1930 meters. The water comes from the high valleys

[10] Sources: Based on information by Electricité d'Emosson SA.

of the river Arve and Eau Noire (France) and from the Ferret and Trient valleys (Switzerland). Through collectors located on the French side, the water is routed to the reservoir by gravity. The water from the Swiss side must be pumped into the reservoir. The two stations of the scheme - Châtelard-Vallorcine (France, 189 MW) and La Bâtiaz (Martigny, Switzerland, 162 MW) - annually generate 612 GWh of energy, of which 94 % in the winter. The energy used for pumping represents 110 GWh per year.

VI. Po River Basin[11]

39. The Po River basin is shared by France, Italy and Switzerland. The 652-km long Po River has its source at Mount Monviso (2,022 m a.s.l.) and it flows through Northern Italy discharging to the Adriatic Sea. The average altitude of the basin area is 740 m a.s.l.

40. Near its end, the river forms a wide delta area, which presents a habitat of precious environmental and landscape value. Protected area Bolle di Magadino is located in the Swiss part of the basin.

Table 4
Area and population in the Po River Basin

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
France	230	0.4		
Italy	70 000	94.4		
Switzerland	4 118	5.2	315 626	
Total	**74 348**		**17 000 000[a]**	

[a] Source: Po river basin Authority (http://www.adbpo.it).

Hydrology and hydrogeology

41. Typically of the glacial regime of the Alpine rivers, maximum flows occur from late spring to early autumn and low flows in winter.

The big alpine lakes such as the transboundary Lake Lugano and Lake Maggiore shared by Italy and Switzerland are a characteristic feature of the basin. Most significant transboundary river is the Ticino River, also shared by Italy and Switzerland.

42. In the Italian part, the average annual precipitation amounts to approximately 78 × 10^9 m^3/year and the average annual surface flow is some 47 × 10^9 m^3/year. Groundwater recharge is some 9 × 10^9 m^3/year.

43. In the Swiss part of the basin precipitation is 4.161 × 10^9 m^3/year, runoff is × 10^9 m^3/year and external inflow from adjacent basins/countries is reported to be 0.019 × 10^9 m^3/year.

[11] Based on information provided by Italy (the Po River Basin Authority), Switzerland and on the first Assessment of Transboundary Rivers, Lakes and Groundwaters.

Pressures and status

Table 5
Total withdrawal and withdrawals by sectors

Country	*Total withdrawal* $\times 10^6$ *m³/year*	*Agricultural* %	*Domestic* %	*Industry* %	*Energy* %	*Other* %
Total	20 537	80[a]	12[b]	7[c]		

Source: Regional water resources protection plan, Po River Basin Authority (http://www.adbpo.it).
[a] 83 % deriving from surface waters (SW), 17 % from groundwaters (GW)
[b] 20 % from SW, 80 % from GW
[c] 20 % from SW, 80 % from GW. From total 63 % from SW, 37 % from GW.

The Po River and its tributaries flow through several cities in Northern Italy. Pressures arise from agriculture, industry and the urban areas. Some 37% of the industry in Italy is in the Po Basin. Even though the Po Basin's share by agricultural land surface area is smaller (24%), some 38% of the livestock and 36% of the agricultural production in Italy is located in the Po Basin.

44. Main concerns related to water resources of the basin include: surface and groundwater pollution, drinking water contamination, aquatic ecosystems quality, hydromorphological changes, overexploitation of water for agriculture and hydropower, changes in land use coupled with climate change effects (floods, land slides) and environmental conservation and restoration. Also organizational side of managing the water resources is a concern.

45. Hydropower generation and the trend to increase hydropower production create pressures and also arouse an interest conflict between protection of ecosystems and production of electricity by hydropower. Issues related to the impacts of residual flow and hydro-peaking are assessed as moderate.

46. On the organizational side, financial tensions and overcoming the fragmentation of administrative functions are challenges.

Pressures, status and response

47. Response measures (implemented and planned) in the Po RBMP include, for example, policy integration, preservation of mountain basins; reduction of nutrient, organic compound and pesticide pollution as well as improvement of land use in order to mitigate hydrogeological risk and to improve environmental status of water bodies. The current actions include also saving and using water resources sustainably, especially in agriculture. For flood control measures in the Swiss part, please refer to the assessment of the Rhone.

48. Impacts of climate change and related pressures in the alpine part of the Po Basin are overall principally the same as described in the assessment of the Rhone Basin (Swiss part). A decrease of 5–10% in precipitation is predicted — mainly in the summer — and snowcover is predicted to be affected by the higher temperatures with changes to the runoff regime. Current actions related climate change in the Italian part include the preparation of a Hydric Balance Plan.

VII. Lake Lugano[12]

49. The transboundary Lake Lugano is shared by Italy and Switzerland and it is part of the Po River basin. It is situated in the south-east of Switzerland, at the border of Italy. The lake is popular location for recreation. Being well-managed, recreation and tourism activities only have a moderate impact.

50. Lake Lugano has a surface area of 48.9 km^2 with a volume of 6.5 km^3, and basin area of 565 km^2. Northern part of the lake is deep and the southern part relatively shallow.

51. In 1972, the International Commission for the protection of Italian Swiss Waters (CIPAIS), was created with the aim to study the increasing water eutrophication (in the 1960s the lake was heavily polluted), locating the main sources of algal nutrients and proposing possible remediation actions. During the last 20 years, recovery measures like initiation of eliminating the phosphorus in detergents and cleaning products both in Italy and in Switzerland (1986) and improvement of treatment efficiency at the main sewage treatment plants (since 1995) have reduced the external phosphorus load from about 250 to 70-80 tons/year, with visible improvements in the water status. At the present time, the external nutrient load derives from anthropogenic (85%), industrial (10%) and agricultural (5%) sources. The ecological status of Lake Lugano is poor.

52. The catchment areas of the Lago Maggiore and the Lake of Lugano are managed in an integrated way — with a focus on water quality issues — by the CIPAIS. The CIPAIS has among its responsibilities collecting and managing data, including joint programmes and projects.

53. Regulation of the outflow of Lake of Lugano (River Tresa) is ensured by a transboundary agreement between Italy and Switzerland (independent commission, separate of the CIPAIS).

VIII. Lake Maggiore[13]

54. Lake Maggiore[14] belongs to the sub-basin of the Ticino River which is a tributary of the Po River. It is a large pre-Alpine lake situated west of Lake Lugano on the border between Italy and Switzerland.

55. The 6,600 km^2-drainage basin of Lake Maggiore is covered by woody vegetation (20%), rocky outcrops and debris (20%), permanent snow, and glaciers and lakes. The lake is 65 km long and 2–4.5 km wide with a surface area of 213 km^2 and a total volume of 37.5 km^3.

56. The lake is popular for recreation, such as swimming, sport fishing and yachting and it is also a significant tourist attraction.

57. During 1960s and 1970s the lake became eutrophic; the status changed from oligotrophic to meso-eutrophic, due to phosphorus inputs from municipal sewage. As described in the assessment of Lake Lugano, CIPAIS was created in 1972 to study the eutrophication and help to identify remediation measures. From the late 1970s, the phosphorus load has been decreasing due to wastewater treatment plants and elimination of phosphorus in detergents and cleaning products. The total phosphorus in-lake

[12] Based on the first Assessment of Transboundary Rivers, Lakes and Groundwaters.

[13] Based on the first Assessment of Transboundary Rivers, Lakes and Groundwaters and on information posted in http://www.cipais.org.

[14] The lake is also known as Lago Maggiore.

concentration is currently below 10 µg/l (at winter mixing), compared to a maximum value of 30 µg/l in 1978. According to the EU WFD classification, the ecological status of Lake Maggiore is poor.

IX. Isonzo River Basin[15]

58. The 140-km long Isonzo River[16] is situated in the Eastern Alps district and it flows through western Slovenia and northeastern Italy. It has its source in Trenta Valley in Slovenia (955 m a. s. l.), and it discharges to the Panzano Gulf in the North Adriatic Sea (Mediterranean Sea) near Monfalcone in Italy.

59. The basin has a pronounced mountainous character with an average elevation of about 600 m a.s.l.

60. The main tributaries of Isonzo are the transboundary Torre River sub-basin with the Natisone and Iudrio Rivers, and nearly entirely in the Slovenian territory the Idrijca and Vipacco Rivers. The Doberdò and Pietrarossa are lakes in the Italian part of the basin.

Table 6
Area and population in the Isonzo River Basin

Country	*Country's share km^2*	*Country's share %*	*Number of inhabitants*	*Population density (persons/km^2)*
Italia	1 150	34		
Slovenia	2 250	66		
Total	**3 400**			

Hydrology and hydrogeology

61. Precipitation in the basin area varies significantly, ranging from 1,000 mm/year in the plain area up to 3100 mm/year in the alpine area.

Table 7
Discharge characteristics of the Isonzo at the gauging station Pieris in Italy

Discharge characteristics	*Discharge (m^3/s)*	*Period of time or date*
Q_{av}	173	-
Q_{max}	4 400	1925-1953
Q_{min}	12.1	1904

62. The basin area is characterized by the presence of groundwater bodies related to different transboundary aquifers, which are hydrogeologically different even if hydraulically connected. In the Isonzo river's clastic alluvials (mainly gravel and sands of Quaternary Age) form a porous aquifer system and in the Timavo River bedrock (mainly Cretaceous carbonatic sequences) is a Karst and fractured aquifer.

[15] Based on information provided by Italy (North Adriatic Sea Basin Authority) and Slovenia and on the first Assessment of Transboundary Rivers, Lakes and Groundwaters.

[16] The river is also known as the Soča in Slovenia.

63. In the south course of the basin, part of the river discharge recharges the groundwater bodies through the permeable alluvial deposits.

64. Aquifer system of Soča (fissured, dominantly dolomite and limestone aquifers of western catchment area of Isonzo/Soča river)[17] is divided in to Rabeljski rudnik and Kobariški stol transboundary groundwater bodies.

Table 8

Rabeljski rudnik aquifer: type 2, Triassic carbonates, karstic limestones and dolomites, marlstones. Unconfined aquifer. Dominant groundwater flow from Italy to Slovenia.

	Italy	*Slovenia*
Border length (km)		
Area (km^2):		66.2
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)		>1 000 m, -
Number of inhabitants		167
Population density		2.52
Groundwater uses and functions		
Pressures		Possible local leaching of minerals from abandoned mine works is an issue of low concern. The dewatering tunnel of the mine is poorly maintained. Background concentration of sulphates, Mo, U, Pb, Zn are elevated, but bellow risk limits for human health. Special threshold values have not been defined.
Groundwater management measures		The condition and stability of the mine's dewatering tunnel need to be thoroughly investigated and protective measures should be taken and applied to decrease the risk of having an accident
Other information		Transboundary flow is artificial; water discharges through a dewatering tunnel of the abandoned Radelj lead and zinc mine at 380 – 510 l/s, in Koritnica river; groundwater flows from the Black Sea Basin to the Mediterranean Sea Basin. A small hydropower plant at the end of the dewatering tunnel is used for energy production.

[17] Based on information provided by Slovenia.

Table 9

Kobariški stol aquifer: type 3, Triassic and Jurassic limestones, carbonates, karstic limestones. Dominant groundwater flow from Italy to Slovenia. Recharge and discharge are both in Slovenia and Italy. Possible drainage to surface water systems; from karstic area near Kobarid into the gravel fill of Soča valley and reverse. Pressure condition: unconfined level.

	Italy	*Slovenia*
Border length (km)		
Area (km^2):		37
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)		>300, -
Number of inhabitants		480
Population density		13
Groundwater uses and functions		Groundwater is not currently used but is considered to be a strategic reserve for drinking water supply.
Pressures		Microbial pollution and turbidity are the main problems observed during rain events.
Groundwater management measures		The groundwater body is not being managed in Slovenia. A pre-feasibility study on capturing groundwater has been conducted. Slovenia reports that joint identification of the transboundary groundwater body should be carried out. In addition the issue of joint management should be considered with the main question of using this groundwater body as regional drinking water source. International cooperation / organizations can be of support on both issues.
Other information		.

65. Aquifer system of Brestovica (highly karstified aquifers of Adriatic coast and Timavo river)[18] is divided in Osp-Boljunec and Brestovica transboundary groundwater bodies.

[18] Based on information provided by Slovenia.

Table 10

Osp-Boljunec groundwater body: type 2, Kenozoic / Quaternary dominantly carbonates, karstic limestones / partly carbonate-silicate alluvial. Pressure condition: unconfined. The dominant groundwater flow direction is from Slovenia to Italy.

	Italy	*Slovenia*
Border length (km)		
Area (km^2):		36
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)		
Number of inhabitants		769
Population density		21
Groundwater uses and functions		Local drinking water supply.
Pressures		
Groundwater management measures		
Other information		Makes a part of the Brestovica aquifer system.

Table 11

Brestovica groundwater body: type 2, Dominantly Cretaceous / partly Tertiary carbonates karstic limestones. Pressure condition: unconfined. The dominant groundwater flow direction is from Slovenia to Italy but partly from Italy to Slovenia.

	Italy	*Slovenia*
Border length (km)		
Area (km^2):		499
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)		
Number of inhabitants		20 672
Population density		41
Groundwater uses and functions		Local and regional drinking water supply, maintains baseflow and springs. The aquifer is of major importance for the whole Slovenian karst area -it is the only drinking water source- as well as for the whole region of south-west

	Slovenia since quite a large volume of groundwater is transferred to the coastal zone during drought events. Groundwater covers 90% of the water used.
Pressures	Waste disposal (landfill near Sezana), agricultural activities (extensive vineyards), transportation (important roads and railroads) and groundwater abstraction (drinking water supply) are important pressure factors; urban wastewater very important. Groundwater is of good quality for water supply; turbidity and bacteria occurrence during intensive precipitation events is an issue of concern though.
Groundwater management measures	Since the aquifer is highly vulnerable, urbanization in the aquifer recharge area has to be strictly controlled in order to avoid related pressures that may lead to the deterioration of groundwater quality. A water protection area for the Brestovica – Klariči groundwater source has been established.
Other information	Slovenia reported the following areas in which international cooperation/ organizations can be of support: (i) development of transboundary drinking water protection areas; (ii) development of groundwater resources potential for water supply of coastal area; (iii) development of regional waterworks systems; (iv) preparation of a strategic plan for the development of settlements; and (v) detailed research of fresh water/salt water interface. Makes a part of the Brestovica aquifer system.

Table 12

Vrtojbensko polje aquifer (Aquifer system of Gorica-Vipava valley, Alluvial gravel aquifer of Vipava and Soča rivers)[19]: type 2, Quaternary carbonate-silicate alluvial. Pressure condition: unconfined.

	Italy	*Slovenia*
Border length (km)		
Area (km^2):		9
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)		
Number of inhabitants		4 968
Population density		531
Groundwater uses and functions		Local drinking water supply
Pressures		
Groundwater management measures		
Other information		Land is mainly used for agricultural activities (67% of land area); 29.4% is covered by urban and industrial areas and 3% by forests. Altitude fluctuation 35-111 m.

Pressures, status and transboundary impacts

Table 13

Total withdrawal and withdrawals by sectors

Country	*Total withdrawal* $\times 10^6$ *m*^{3}*/year*	*Agricultural %*	*Domestic %*	*Industry %*	*Energy %*	*Other %*
Italy		64	5	4	*27*	
Slovenia						

66. Water from the river is withdrawn for hydroelectric, industrial and agricultural uses, creating pressure especially during drought period.

67. In both countries dams exist along the river and they can create artificial pressure on natural river discharges. Salcano, Sottosella and Canale Dams are situated in Slovenia and Crosis Dam in Italy. Salcano dam is used for regulation of floods; the reservoir operations

19 Based on information provided by Slovenia.

have a direct influence on the downstream discharge creating conflicts mainly with Italian agricultural uses (other than possible impacts on ecosystems due to hydro-peaking).

68. Pressures arise from both anthropogenic and natural sources. Dumped mining residues of Idrija mercury mine in Slovenia cause quicksilver contamination in marine sediments. Wastewater discharges from Nova Gorica in Slovenia are flushed into the Corno River causing organic contamination in the Italian side of the Isonzo basin. In general organic matter from wastewater discharges and heavy metals cause a transboundary impact and affect the water quality in the Adriatic Sea.

69. Between Italy and Slovenia there is a difference in the local water resource uses and quantity and quality status of waters, which creates a possibility of conflicts.

70. According to recent Italian data[20] eight monitoring stations show a “good status” of surface waters, and one station an “elevated status”.

Response

71. Eastern Alps Hydrographic District Management Plan has individuated the Permanent Italian Slovenian Commission for Hydro-economy as an official public organism to discuss transboundary water problems. The first step of the commission was to define an expert group to prepare a road map for implementation of “First Italian Slovenian Isonzo-Soča Common Management Plan”.

72. A wide monitoring network has been set up in order to define the quality and quantity of water bodies in accordance with the Water Framework Directive and it has been decided that a transboundary monitoring network will be planned and it should be operating from 2015.

X. Krka River Basin[21]

Table 14
Area and population in the Krka River Basin

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Bosnia and Herzegovina	300	12	N/A	34
Croatia	2200	88	N/A	N/A
Total	**5 613**			

73. 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.

[20] Source: Ministry of the Environment, Land and Sea, Italy. Database “Quality Data D.Lgs. 152/99”

[21] 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

Hydrology and hydrogeology

74. 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).

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

76. 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 deposits, that is, less vulnerable to pollution transport. Transboundary Krka aquifer is described in the table below.

Table 15

Krka aquifer[22]: 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.

	Bosnia and Herzegovina	*Croatia*
Border length (km)	42	42
Groundwater uses and functions	>95% to support ecosystems, <5% of abstraction is for drinking water	Drinking water supply
Other information		Transboundary aquifer under consideration, but not approved

Status, pressures and transboundary impacts

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

78. 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.

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

80. 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

[22] 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.

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.

81. There are still unfinished sewerage systems and untreated urban wastewaters from the towns Knin (40,000 p.e.) and Drniš (10,000 p.e.[23]). 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.

82. 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).

83. 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.

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

Responses

85. 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 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.

86. 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

87. 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.

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

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

XI. Neretva River Basin[24]

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

Table 16
Area and population in the Neretva River Basin[25]

Country	*Area in the country (km^2)*	***Country's share %***	***Population***	***Population density (persons/km^2)***
Bosnia and Herzegovina	10 100		436 271	42.87
Croatia	280		N/A	N/A
Montenegro	N/A		N/A	N/A
Total				

90. 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.

91. 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 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

92. 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).

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

[24] 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.

[25] Also including the Basin of Trebišnjica River

94. 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.

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

Table 17

Neretva Right coast aquifer[26]: 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.

	Bosnia and Herzegovina	*Croatia*
Area (km^2):	> 1 600	862
Groundwater uses and functions	Dominantly drinking water supply and hydroelectric power, some irrigation. Groundwater is 100% of total water use.	Drinking water supply. Groundwater is 100% of total water use.
Other information		Transboundary aquifer under consideration, but not approved. Agreed delineation of transboundary groundwater is needed

[26] 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.

Figure 2 **Conceptual sketch of the Trebišnjica/Neretva Left groundwater body (provided by Bosnia and Herzegovina**

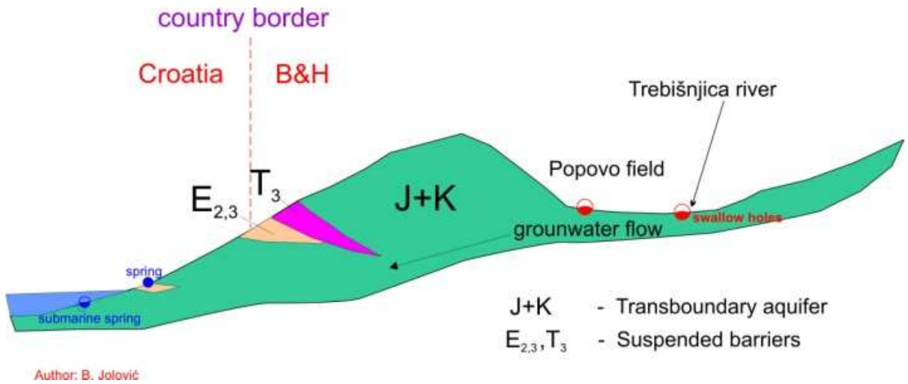


Table 18

Trebišnjica/Neretva Left coast aquifer[27]: 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.

	Bosnia and Herzegovina	*Croatia*
Border length (km)	124	124
Area (km^2):	>2 000	242
Groundwater uses and functions	50-75% for hydroelectric power, <25% for drinking water supply and irrigation, also to support ecosystems. Groundwater is 100% of total water use.	Dominantly drinking water supply (Slamo and Ombla springs) – it supplies Dubrovnic. Groundwater is 100% of total water use.

[27] 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.

Table 19

Bileko Lake aquifer[28]: 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.

	Bosnia and Herzegovina	*Montenegro*
Area (km^2):	>1 000	N/A
Groundwater uses and functions	>75% for hydroelectric power, small amounts for drinking water and irrigation. Groundwater provides 100% of total water use	N/A, Groundwater provides 100% of total water use.
Other information	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	

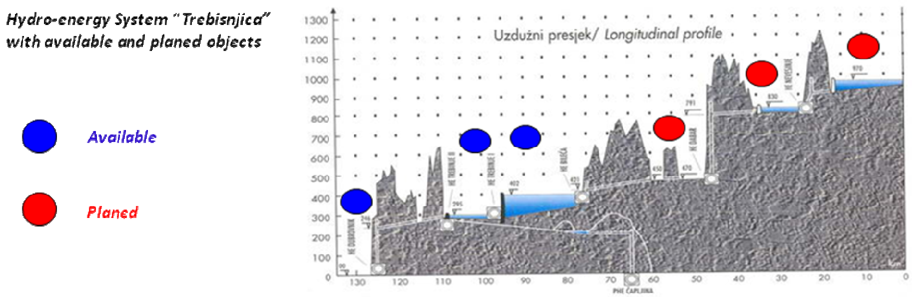
Pressures and transboundary impacts

96. 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.

97. 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 3 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).

[28] 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.

Figure 3 **Available and planned infrastructure in Trebišnjica hydroelectric production system (provided by Bosnia and Herzegovina)**



98. 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.

99. 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.

100. 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.

101. 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.

102. 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

103. 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.

104. 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.

105. 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.

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

Trends

107. 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.

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

Transboundary cooperation

109. 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 II of document ECE/MP.WAT/WG.2/2011/7–ECE/MP.WAT/WG1/2011/7). 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.

110. 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.

111. 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.

112. 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.

XII. Bileća Reservoir/ Bilećko Lake[29]

113. Bileća Reservoir is located in the territory of two neighboring countries - Bosnia and Herzegovina and Montenegro. It was formed when the concrete arch dam of Grančarevo (height 123 m, the length of the crown 439 m) was constructed with a goal to exploit the hydro-energy power of river Trebišnjica. River Trebišnjica belongs to river basin of Neretva.

114. The length of the reservoir is about 17 km, and width ranges between 250 and 5400 m. Maximal surface of the lake is about 27.8 km^2 with a volume of about $1{,}278 \times 10^6$ m^3. Average discharge of the river Trebišnjica in the profile of the dam was 67 m^3/s during the monitoring period from 1956 to 2005.

115. Water from the lake is used for hydropower generation at hydro-power plants (HPP) Trebinje in Bosnia and Herzegovina and HPP Dubrovnik which is located in Croatia.

XIII. Drin River Basin[30]

116. The Drin River starts at the confluence of its two headwaters, the transboundary rivers Black Drin[31] and White Drin[32] 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[33] (outflow of Skadar/Shkoder Lake in the Adriatic Sea) Rivers and the sub-basins of Prespa, Ohrid and Skadar/Shkoder[34] Lakes.

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[29] Based on information provided by Bosnia and Herzegovina

[30] 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.

[31] The River is called Drin i Zi in Albania and Crn Drim in the former Yugoslav Republic of Macedonia

[32] River is called Drin i Bardhë in Albania and Beli Drin in Kosovo (UN administered territory under UN Security Council resolution 1244).

[33] The River is called Buna in Albania and Bojana in Montenegro.

[34] The Lake is called Skadar in Montenegro and Shkoder in Albania.

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

Hydrology and hydrogeology[35]

118. 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.

119. 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.

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

Table 20

Beli Drim/Drini Bardhe aquifer[36]: type 3, Lower and Upper Cretaceous karstic and dolomitised limestone, Miocene to Quaternary multilayer sequence 100 to 200 m thick, groundwater flow from Kosovo (UN administered territory under UN Security Council resolution 1244) to Albania, medium to strong links with surface waters

	Albania	*Kosovo (UN administered territory under UN Security Council resolution 1244)*
Border length (km)	30	30
Area (km^2):	170	1 000
Groundwater uses and functions	Groundwater is 60-70% of total water use. 75% for irrigation, <25% for drinking water and livestock; it also maintains baseflow.	Groundwater is 30 % of total water use. 25-50% for irrigation, <25% for drinking water and industry; it also maintains baseflow.

Status, pressures and transboundary impacts

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

[35] Some additional hydrological information is given in Table 12: Characteristics of the shared water bodies.

[36] 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.

122. 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.

123. 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.

124. 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.

125. 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[37] for drinking water, irrigation and fisheries will result in increasing the pressure on the system.

Table 21

Water demands in the Black Drin Basin District in the former Yugoslav Republic of Macedonia (for 2008 and projection for 2020)[38]

		Total demands ×10^6 m^3/year	*Population and tourists ×10^6 m^3/year*	*Industry ×10^6 m^3/year*	*Irrigation ×10^6 m^3/year*	*Fisheries ×10^6 m^3/year*	*Minimum accepted flow ×10^6 m^3/year*
Black Drin River Basin district	2008	274.3363	21.15	8.2243	49.662	31.3	164
	2020	446.7389	36.8144	8.6105	98.614	138.7	164
Total in the country	**2008**	**2 227.8911**	**218.2691**	**274.1470**	**899.335**	**202.14**	**635**
	2020	**3 491.2863**	**348.2613**	**287.0140**	**1 806.711**	**414.3**	**635**

[37] 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.

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

126. Considerable nutrient loads get transported into the Adriatic Sea via the Drin[39] 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.
The great number of illegal dumpsites is of particular concern in Albania and the former Yugoslav Republic of Macedonia.

Response measures[40]

127. 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.[41]

128. 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.

XIV. Lake Ohrid

129. 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.

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[39] 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.

[40] 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/WG.2/2011/7–ECE/MP.WAT/WG1/2011/7.

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

Hydrology and hydrogeology[42]

Table 22
Water balance for Lake Ohrid[43]

	Inflow *(× 10⁶ m³/year)*	***Outflow*** *(× 10⁶ m³/year)*
Surface water:	380.6	
Rivers		693.8
Rest of catchment area	75.7	
Groundwater:		
Known springs	323.6	
Unknown springs	-	
Precipitation	276.6	
Evaporation		408.0
Total[a]	**1 056.5**	**1 101.8**

[a] 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

130. 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.

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

132. 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

133. 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

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[42] 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.

[43] *Source*: Faloutsos D., Constantianos V. and Scoullos M., "Status Paper -Management of the extended Transboundary Drin Basin". GWP-Med, Athens, 2008.

25,000 inhabitants and further stages have been planned) are expected to improve the situation. They will also 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.

134. 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.

135. 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.

136. 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.

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

Transboundary cooperation

138. 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.

139. 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.

140. 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 II in document ECE/MP.WAT/WG.2/2011/7–ECE/MP.WAT/WG1/2011/7). 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.

XV. Prespa Lakes

141. Prespa comprises 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. A natural canal with sluice gates (re-constructed in 2004) 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[44]

142. 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.

Table 23

Prespa and Ohrid Lake aquifer[45]: Mainly Triassic and Jurassic and up to Middle Eocene massive limestones and lesser dolomites, 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.

	Albania	*Former Yugoslav Republic of Macedonia*	*Greece*
Border length (km)	40 with Greece	20 with Greece	40 with Albania, 20 with Former Yugoslav Republic of Macedonia
Area (km^2):	262	972	291
Renewable groundwater resource (m^3/d)			
Thickness in m (mean, max)	400, 550		200, 330

Table 24

Water quality determinants

Parameter	*Unit*	*Lake Prespa[a]*	*Lake Ohrid[b]*	*Lake Skadar[c]*
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	%	0-131.03	62.71-166.57	60-120

[44] 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.

[45] 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. All the data in the table refers only to Prespa basin and not to Ohrid basin.

saturation				
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
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

[a] Information by the Ministry of Environment and Physical Planning, the former Yugoslav Republic of Macedonia referring to Macro Prespa Lake.
[b] Information by the Ministry of Environment and Physical Planning, the former Yugoslav Republic of Macedonia.
[c] Data collected by the Hydrometeorological Institute of Montenegro, at 9 sampling points (2008); information provided by the Ministry of Spatial Planning and Environment, Montenegro.

Table 25
Characteristics of the shared water bodies[46]

	Prespa Lakes	*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[47], the former Yugoslav Republic of Macedonia,	Albania, Montenegro	Albania, Montenegro
Origin	Tectonic	Tectonic	-	Tectonic-Karstic	-
Catchment area (km^2)	1 524.9[a] Albania: 17.2% Greece: 19% the former Yugoslav Republic of Macedonia: 63.7%	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 km^2	5,409 Montenegro: 80% Albania: 20%	19,582 (including the catchments of Drin River and Skadar/Shkoder Lake)

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

	Prespa Lakes	*Lake Ohrid*	*Drin River*	*Lake Skadar/Shkoder*	*Buna/Bojana River*
Lake's surface area (km^2)	Macro Prespa: 253.6 – 259.4 (282)[b] 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%	-
Lake's volume (km^3)	Macro Prespa 3.6 (4.8)[b]	55.4	-	1.7 – 4	-
Lake's mean depth (m)	Macro Prespa: 18[a] Micro Prespa: 4.1[a]	163.7	-	5	-
Lake's maximal depth (m)	Macro Prespa: 48 (54)[b] Micro Prespa: 8.4	288.7	-	8.3 (more than 80 in lake springs)	-
Lake's maximal length (km)	Macro Prespa: 28[a] Micro Prespa: 13.6[a]	30.8	285	44	44
Lake's maximal width (km)	Macro Prespa: 17[a] Micro Prespa: 6.1[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 to Mesotrophic Micro Prespa: Mesotrophic	Oligotrophic	-	Oligotrophic - Mesotrophic	-
Total water volume exchange rate (years)	10-12 a(7)[b]	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] Source of the values marked with an asterisk: C. Perennou, M. Gletsos, P. Chauvelon, A. Crivelli, M. DeCoursey, M. Dokulil, P. Grillas, R. Grovel, & A. Sandoz, A. Development of a Transboundary Monitoring System for the Prespa Park Area. Aghios Germanos, Greece. November 2009.

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

XVI. Prespa Park Wetlands Ramsar site (Albania, Greece, the former Yugoslav Republic of Macedonia)[48]

General description of the wetland

143. 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

144. 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

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

Cultural values

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

Biodiversity values

147. 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.

148. 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.

149. 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.

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

[48] *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), WWF-Greece, Protection and Preservation of Natural Environment in Albania (PPNEA), Macedonian Alliance for Prespa (MAP).

151. Pressure factors and transboundary impacts

152. 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 increased eutrophication. Construction of irrigation systems resulted in drainage of a number of wet areas in the 1960s, mainly near Micro Prespa, and in extensive sedimentation of the lake from the 1970s onwards due to the Devolli River diversion in the Albanian part of Micro Prespa. At present, abstraction of water throughout the basin puts a pressure on natural ecosystems. Illegal sand and gravel extraction also can affect the hydrological regime of the wetland.

153. 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, among others. Other disturbing activities are non-sustainable (including illegal) hunting and fishing, and introduction of alien fish species[49] (e.g. *Carassius gibelio, Ctenopharyngodon idella, Gambusia holbrooki, Hypopihalmichtius molitrix, Tinca tinca, Parabramis pekinensis, Pseurasbora parva, Lepomis gibbosus, Oncorhynchus mykiss, Rhodeus amarus, Silurus glanis and Salmo letnica*) that affect native fish and invertebrate populations.

154. 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 partially 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 by grazing and summer cutting of the reed bed vegetation coupled with management of the water level has been implemented by the Society for the Protection of Prespa.

Transboundary wetland management

155. In 2000, the Prime Ministers of Albania, Greece, and the former Yugoslav Republic of Macedonia declared the creation of the Prespa Park, under the auspices of the Ramsar Convention, upon a proposal by the Society for the Protection of Prespa,WWF Greece and the Mediterranean Wetlands Initiative (MedWet). 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.

156. In 2010, the Environment Ministers of the three countries and the EU Environment Commissioner signed an Agreement on the Protection and Sustainable Development of the Prespa Park Area that sets out detailed principles and mechanisms of transboundary cooperation. The priority issue for transboundary cooperation is water resources

[49] *Sources:* (1) A. J. Crivelli, G. Catsadorakis, M. Malakou & E. Rosecchi. Fish and fisheries of the Prespa lakes. In A. J. Crivelli & G. Catsadorakis (eds), “Lake Prespa, Northwestern Greece: A unique Balkan wetland”, Hydrobiologia 351, 107-125. 1997.
(2) A. J. Crivelli unpublished data – report included in the ongoing (December 2009) programme “Design and organization of a Transboundary Monitoring System (TMS) for the Prespa Park”

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.

157. In all three countries, lake, shoreline and forest 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 sites. 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 includes Strict Nature Reserve Ezerani (2,080 ha). Additionally, large parts of Galicica National Park and Pelister National Park are found within the Prespa basin.

XVII. Lake Skadar/Shkoder

158. 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.

Hydrology and hydrogeology

159. 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.

160. The Buna/Bojana bed is lower than the sea level (“crypto depression”) resulting into salt water intrusion to the Lake’s outlet.

Table 26

Skadar/Shkoder Lake, Dinaric east coast aquifer[50]: Type 2, Jurassic, Cretaceous and lesser Palaeogene massive and stratified limestones and dolomites, groundwater flow in both directions, strong links to surface water systems

	Albania	*Montenegro*
Border length (km)	35 (excluding the lake border)	35 (excluding the lake border)
Area (km^2):	~ 450	~ 460 (karstic aquifer)
		~ 200 (shallow aquifer in Zeta Plain)

[50] 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.

Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)	150-500, 300-1 000, alluvial fans along the lake up to 80-100 m thick	150-500, 300-1 000, alluvial fans along the lake up to 80-100 m thick
Groundwater uses and functions	50-75% for irrigation, <25% for drinking water supply, industry and livestock, also maintaining baseflow and support for ecosystems. Groundwater covers 80-90% of total water use.	25-50% for drinking water supply, <25% for irrigation, industry and livestock. Groundwater covers 100% of total water use.

Status, pressures, transboundary impacts and responses

161. 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.

162. 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 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".

163. 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.

164. 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.

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

166. 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

167. 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.

168. 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

169. 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.

170. 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.

171. 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

172. 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. Albania, the former Yugoslav Republic of Macedonia and Greece and the European Commission signed an agreement on the protection and sustainable development of the Prespa Park Area on 2 February 2010. 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[51].

XVIII. Lake Skadar/Shkoder and River Buna/Bojana Ramsar sites (Albania, Montenegro)[52]

General description of the wetland

173. 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

174. 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

175. 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

176. 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.

177. 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.

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

[52] *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.

Floating islands with colonies of cormorants, herons and pelicans are unique in Europe. A breeding colony of Dalmatian Pelican (*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.

178. 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.

179. 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.

180. 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.

181. 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.

182. 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

183. 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

184. 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.

185. 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.

186. 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.

XIX. Aoos/Vjosa River Basin[53]

Table 27
Area and population in the Aoos/Vjosa Basin

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Albania	4 365	67	328 000	N/A
Greece	2 154	33	20 000	N/A
Total	**5 613**			

187. The Aoos/Vjosa River[54] basin is shared by Greece (upstream country) and Albania (downstream country).

Hydrology and hydrogeology

188. 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.

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

190. 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.

[53] 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.

[54] The river is known as Aoos in Greece and Vjosa in Albania.

Table 28

Nemechka/Vjosa-Pogoni aquifer[55]: type 1, succession of large anticlines containing karstic limestones of mainly Jurassic and Cretaceous age and synclines with formations of Palaeocene and Eocene flysch. 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.

	Albania	*Greece*
Border length (km)	37	37
Area (km^2):	550	370
Thickness in m (mean, max)	2 500, 4 000	100, 150
Groundwater uses and functions	25-50% irrigation, <25% each for drinking water, livestock and industry, maintaining baseflow and springs and supporting ecosystems	25-50% irrigation, <25% each for drinking water supply and livestock, maintaining baseflow and springs and supporting ecosystems
Other information	Large karst groundwater quantities (average about 8 m3/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	Large spring discharges of Kalama, Gormou and Drinou

Pressures

191. 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.

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

193. 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.

Transboundary cooperation

194. 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

[55] 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.

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

195. 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

196. 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.

197. 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.

XX. Vardar/ Axios River Basin[56]

Table 29
Area and population in the Vardar/ Axios River Basin

Country	*Area in the country (km^2)*	*Country’s share %*	*Population*	*Population density (persons/km^2)*
The former Yugoslav Republic of Macedonia	19 737	88.7	1 800 000	91
Greece	2 513	11.3	1 600 000	637
Total	**23 750**		**3 400 000**	

198. The former Yugoslav Republic of Macedonia and Greece share the basin of the Vardar/Axios River[57]. The transboundary Lake Dojran/Doirani[58] is located in this basin.

[56] Based on information mainly from the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Ministry of Environment, Physical Planning and Public Works/Central Water Agency, Greece and the Ministry of Urban Planning, Construction and Environment, the former Yugoslav Republic of Macedonia; some additional information was provided by the former Yugoslav Republic of Macedonia.

[57] The river is known as Vardar in the former Yugoslav Republic of Macedonia and Axios in Greece.

[58] The lake is known as Dojran in the former Yugoslav Republic of Macedonia and Doirani in Greece.

Hydrology and hydrogeology

199. The river has its source in the Shara massif (a mountainous area between Albania and the former Yugoslav Republic of Macedonia) and empties into the Aegean Sea at Thermaikos Gulf (Greece). The total length of the river is 389 km, with the 87 km being in Greece. The river has a pronounced mountainous character with an average elevation of about 790 m a.s.l.

200. Major tributaries in the Greek side include the rivers Gorgopis (sub-basin 70 km^2), Sakoulevas (sub-basin 901 km^2) and Vardarovasi (sub-basin 102 km^2). Major tributaries in the former Yugoslav Republic of Macedonia are the Treska (sub-basin 2068 km^2), Lepenec (sub-basin 770 km^2), Pcinja (sub-basin 2840.7 km^2), Bregalnica (sub-basin 4306.8 km^2) and Crna (sub-basin 5890 km^2) Rivers.

Table 30
Water resources in Vardar/ Axios basin[59]

Country	*The former Yugoslav Republic of Macedonia*	*Greece*
Surface water resources ($\times 10^6$ m^3/year)	4,185[a]	
Groundwater resources ($\times 10^6$ m^3/year)	N/A	

[a] average for the years 1961 to 1990

201. There are 120 large and small dams in the former Yugoslav Republic of Macedonia. Floods in the downstream area were considerably reduced due to these dams.

202. Gevgelija/Vardar aquifer, described in the table below, is transboundary between the former Yugoslav Republic of Macedonia and Greece.

[59] Surface water resources: Defined as run-off internally generated from precipitation within the part of the basin that is the country's territory plus incoming water flow from adjacent basin country/countries. Groundwater resources: Defined as estimated annual groundwater recharge derived from precipitation falling on the country’s territory within the river basin concerned, plus entering external groundwater flow. It should be noted that external groundwater flow may also originate from outside the basin.

Table 31

Gevgelija/Axios-Vardar aquifer[60]: type 3 or none of the illustrated transboundary aquifer types, Quaternary alluvial sediments, sands with gravel, partly clayey and silty with cobbles of bedrock - diabases, biotite gneisses and schists. Very shallow water table. Medium to strong link with surface water systems, groundwater flow from the former Yugoslav Republic of Macedonia to Greece and from west to east in the Greek part.

	The former Yugoslav Republic of Macedonia	*Greece*
Area (km^2):	N/A	8
Thickness in m (mean, max)	10-30, 60-100	10-30, 60-100
Groundwater uses and functions	Maintaining baseflow and springs and support of ecosystems; abstractions for agriculture	>75% of abstraction is for irrigation, <25% each for drinking water supply and livestock, also support of ecosystems

Status, pressures and transboundary impact

203. The main forms of land use are cropland (68.7%), grassland (7.4%) and forests (7.9%). In Greece, a large part of the basin is a protected NATURA 2000 site.

204. Water is abstracted for irrigation (63%), fishponds (11%) and drinking water (12%) as well as for municipal and industrial uses (15%). There is an overuse of water in many parts of the river basin, mainly for agricultural purposes. In the former Yugoslav Republic of Macedonia extensive and severe increases in pumping lifts from the Gevgelija/Vardar aquifer have resulted in decline of groundwater levels, reduction in borehole yields, severe reduction of baseflow and springflow locally and degradation of ecosystems; according to the former Yugoslav Republic of Macedonia the observed impacts are also due to pressures at transboundary level.

205. The main pressure on water resources in terms of quality stems from agriculture. In the former Yugoslav Republic of Macedonia, crop and animal production takes place in river valleys, especially the Pelagonija, Polog and Kumanovo valleys, as well as in the whole Bregalnica catchment area.

206. A few industrial installations also affect the aquatic ecosystem. In the former Yugoslav Republic of Macedonia, mining and quarrying activities are particularly located in the catchments area of the eastern tributaries (rivers Bregalnica and Pcinja). Metal industry at Tetovo and heavy metal industry at Veles, as well as chemical industry, petroleum refineries and pharmaceutical industry at Skopje, are additional pressure factors.

207. The treatment and disposal of solid waste and wastewater and their management at communal level is a problem and has to be improved. This is especially true for the former Yugoslav Republic of Macedonia: while there are controlled landfills for solid wastes from bigger cities there are also a number of illegal dumpsites for solid waste from the villages.

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

For the time being, the only properly working wastewater treatment plant is located at Makedonski Brod in the Treska River catchment. Organic matter from waste-water discharges results in a transboundary impact.

208. When last reported (in the First Assessment of Transboundary Rivers, Lakes and Groundwaters), the surface water quality was classified as “good/moderate”, considered to be appropriate for irrigation purposes and to be used for water supply after treatment. While the quality of groundwater had been reported as, in general, very good and often used for water supply without or very little treatment in the former Yugoslav Republic of Macedonia, the existence of nitrogen, pesticides, heavy metals, pathogens, industrial organics and hydrocarbons in the Gevgelija/Vardar aquifer had been reported as well. The salinization observed is of natural origin.

Responses

209. The implementation of the EU Water Framework Directive (WFD)- in progress in both countries, but Greece being an EU Member State is much ahead in this respect - is expected to improve the status of the system in the long term.

210. Implementation of good agricultural practices and public awareness are necessary measures in Greece and abstraction controls and monitoring need to be improved. More efficient groundwater and lake water use, monitoring of the lake’s and the aquifers’ water quantity and quality, raising public awareness, defining protection zones, carrying out vulnerability mapping as well as wastewater treatment is necessary be improved in the former Yugoslav Republic of Macedonia; other measures need to be applied or are planned.

211. Data exchange is deemed necessary by both countries.

Trends

212. Greece and the former Yugoslav Republic of Macedonia are considering drawing up a bilateral agreement to replace the existing 1959 agreement, which dealt primarily with the establishment of a joint body for the joint management of water resources management. The new agreement will be based on the most recent developments in international law and European Union legislation.

XXI. Lake Dojran/ Doirani[61]

Hydrology and hydrogeology

213. Lake Dojran/Doirani is a small (total area 43.10 km^2) tectonic lake with a basin of 271.8 km^2. The lake is shared by the former Yugoslav Republic of Macedonia (27.4 km^2) and Greece (15.7 km^2). The lake is rich with fish – 16 species. The “Aquatic Forest of Mouria” has been listed as a “Natural Monument” and also proposed, together with a small part (2 km^2) of Lake Dojran/Doirani, for inclusion in the NATURA 2000 network.

[61] Based on information mainly from the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Ministry of Environment, Physical Planning and Public Works, Greece; some additional information was provided by the former Yugoslav Republic of Macedonia.

214. Dojran/Doirani Lake aquifer described in the table below, is transboundary between the former Yugoslav Republic of Macedonia and Greece.

Table 32

Dojran Lake aquifer[62]: type 3, Quaternary and Upper Eocene alluvial aquifer, lake deposits and terraces of silts, clays, sands and gravels, overlying metamorphic rocks, sedimentary sequences and carbonate formations - Precambrian, older Paleozoic and Green Metamorphic Complex. Unconfined, with strong links with surface water systems, groundwater flow is from north to south in the Nikolic area of the former Yugoslav Republic of Macedonia, north east to south west on the Greek side and generally towards the lake.

	The former Yugoslav Republic of Macedonia	*Greece*
Area (km^2):	92	120
Thickness in m (mean, max)	150, 250	150, 250
Groundwater uses and functions	Irrigation and water supply	>75% for irrigation, <25% for drinking water supply and livestock, maintaining baseflow and springs and support of ecosystems. Groundwater is 90% of total water use
Other information		Groundwater abstraction exceeds mean annual recharge

Status, pressures and transboundary impacts

215. Lake Dojran/Doirani has been affected by quantity decrease and quality reduction since the early 1990s due to activities in both countries, such as water abstraction and municipal wastewater disposal; water abstraction has been a pressure factor also for the underlying aquifer resulting in the decline of groundwater levels.

216. The situation was aggravated by the low precipitation in the period 1989-1993 and high evaporation rates in the lake basin. Over the last 20 years, the lake's level has dropped continuously also due to increasing Greek abstraction, mainly for irrigation purposes. The most extreme water level and water volume decrease have occurred since 1988; from 262 million m^3 in 1988, the volume decreased to 80 million m^3 in 2000.

217. Pollution is caused by municipal wastewater, municipal solid wastes, sewage from tourist facilities, and agricultural point source and non–point source pollution; since the lake is an entity the impacts are felt in both countries.

218. Water quality is characterized by high alkalinity and elevated carbonate and magnesium hardness. Additionally, concentrations of certain toxic substances are near or even beyond toxic levels. In Greece, there are high values of phosphates; low concentrations of heavy metals have been observed in the aquifer.

219. In recent years, the lake has been struggling for survival. Since 1988, because of the decrease in water level and volume, according to biologists over 140 species of flora and

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

fauna have disappeared. The water level has dropped 1.5 m below its permitted hydro-biological minimum.

Responses[63]

220. The lake, in the former Yugoslav Republic of Macedonia, is being recharged by water coming from the Gjavato wells through a pumping and transfer system that has a capacity of 1,000 l/s; the project “Feasibility study on Dojran lake salvation” was financed by the Ministry of Environment and Physical Planning and the Ministry of Agriculture, Forestry and Water Economy in 2001.

XXII. Struma/ Strymonas River Basin[64]

221. The basin of the Struma/Strymonas[65] River is typically considered to be shared by Bulgaria and Greece; the shares of Serbia and the former Yugoslav Republic of Macedonia in the total basin area are small. The river has its source in western Bulgaria (Vitosha Mountain, south of Sofia) and ends up in Aegean Sea (Strymonikos Gulf – Greece).

Table 33
Area and population in the Struma/Strymonas River Basin

Country	*Area in the country (km²)*	*Country’s share %*	*Population*	*Population density (persons/km²)*
Bulgaria	8 545	46.6	487 206[a]	57.01[a]
Greece	7 282	39.7		
Serbia	865	4.7	N/A	~10
The former Yugoslav Republic of Macedonia	1 648	9.0	120 869[b]	73.3[b]
Total	**18 340**			

[a] 2006 [b] 2002

222. The total length of the river is 400 km, with its last 110 km flowing through Greece. Major tributaries include the rivers Butkovas, Exavis, Krousovitis, Xiropotamos and Aggitis, shared by Bulgaria and Greece; Dragovishtitsa, shared by Serbia and Bulgaria; Lebnitsa and Strumica/Strumeshnitsa shared by the former Yugoslav Republic of Macedonia and Bulgaria.

223. The basin has a pronounced mountainous character with an average elevation of about 900 m a.s.l.

63 See also “Responses” under Vardar/Axios.

64 Based on information from Bulgaria, the former Yugoslav Republic of Macedonia and Serbia. Information about Strumica river catchment area (the former Yugoslav Republic of Macedonia) was based on the Second Communication on Climate Change. Section: Vulnerability Assessment and Adaptation for Water Resources Sector; December 2006, the former Yugoslav Republic of Macedonia. References related to Greece are based on information from the First Assessment of Transboundary Rivers, Lakes and Groundwaters - for which information had been provided by the Ministry of Environment and Water, Bulgaria, and the Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

65 The River is called Struma in Bulgaria and Strymonas in Greece.

224. Parts of the basin in Bulgaria and Greece are under protection status designated as NATURA 2000 sites.

Hydrology and hydrogeology

225. There are about 60 artificial lakes in the Bulgarian part of the river basin, used for water supply, power generation and irrigation purposes. The Kerkini Reservoir in Greece was created with the construction of a levee in 1933 for regulating the river discharges, for irrigation purposes and flood protection (a new levee was constructed in 1982). The Kerkini Reservoir was finally developed into an important wetland protected under the Ramsar Convention on Wetlands. In Greece, irrigation dams exist also at Lefkogeia and Katafyto. The Lisina Reservoir on Dragovishtitsa River in Serbia is a part of the Vlasina hydropower production system.

226. There is high risk of flooding in Bulgaria due to the basin's geomorphologic and hydrological characteristics. Bulgaria reported that global climate change over the last 20 years has resulted in approximately 30% decrease in precipitation and a subsequent decrease in water resources in the basin[66]; provisions regarding the decrease of water resources will be included in the programme of measures of the river basin management plan.

Table 34
Water resources

Country	*Bulgaria*	*Greece*
Surface water resources ($\times 10^6$ m^3/year)	1 961.000[a]	
Groundwater resources ($\times 10^6$ m^3/year)	199.623[b]	
Total water resources ($\times 10^6$ m^3/year)	**2 160.326[b]**	
Total water resources per capita (m^3/year)	**4 435[a]**	

[a] Average for the years 1961 to 2004 [b] Average for the years 1980 to 2004

227. Two transboundary aquifers were identified as hydraulically linked to the surface water system and included in the first assessment: (i) the Sandansky - Petrich aquifer (shared by Bulgaria, Greece and the former Yugoslav Republic of Macedonia) and (ii) Orvilos-Agistros/Gotze Delchev karst aquifer (shared by Bulgaria and Greece - as reported by Bulgaria, it extends also to and is hydraulically linked with the surface water systems of Mesta/Nestos River basin).

228. Bulgaria reported that new data available suggests that the Sandansky – Petrich aquifer is divided in two distinguished aquifers thus, should be substituted by them here[67]: (i) the Sandansky valley aquifer (shared by Bulgaria and Greece) and (ii) the Petrich valley aquifer (shared by the former Yugoslav Republic of Macedonia and Bulgaria).

[66] No detailed information has been provided by Bulgaria on the spatial or temporal extent of the underlying observations.

[67] The position of Greece and the former Yugoslav Republic of Macedonia is not available in this regard.

229. According to Greece[68] the Orvilos-Agistros/Gotze Delchev karstic aquifer is not hydraulically linked with the surface waters of either Struma/Strymonas or Mesta/Nestos basins. In addition, Bulgaria expresses uncertainty whether the aquifer should be considered as transboundary. The reason, reported by Bulgaria, is that the state border between Bulgaria and Greece is located in a highland area where the aquifer is inferred to extend along the local watershed divide[69]. Therefore groundwater is suspected not to flow across the state border, but flow towards Bulgaria in the northern part, and towards Greece in the South.

230. Information about all the aforementioned aquifers is given in the tables below:

Table 35

Sandansky-Petrich aquifer: Pliocene and Quaternary alluvial sands, gravels, clays and sandy clays of the Sandansky (up to 1,000 m thick) and Petrich (up to 400 m) valleys, with aquifer with free level of groundwater from 10 to 100 m, thermal water is characterized from 100 to 300 m in Paleozoic rocky masses with schists and Paleozoic limestones with karst aquifers with different quantity of groundwater. Flow occurs from the former Yugoslav Republic of Macedonia to Bulgaria and Greece

	Bulgaria	*Greece*	*The former Yugoslav Republic of Macedonia*
Border length (km)	18 (GR), 5 (MK)	18 (BG)	5 (BG)
Groundwater uses and functions			Drinking water, irrigation and industry, thermal springs, agriculture

Table 36

Sandansky valley aquifer: Pliocene, predominantly, and Quaternary lake sediments and alluvial sands, gravels, clays and sandy clays of Sandansky (up to 1000 m thick) valley, free groundwater table at a depth varying from 10 to 100 m; flow occurs from Bulgaria to Greece

	Bulgaria	*Greece*
Border length (km)	18	18
Area (km^2):	630.5	
Groundwater uses and functions	Maintaining baseflow and springs. Supports ecosystems.	

[68] Based on information provided by Greece

[69] It should be noted, though, that karstic aquifer flow systems are difficult to characterize and the groundwater divide does not necessarily coincide with the topographic divide.

Table 37

Petrich valley aquifer: Pliocene, predominantly, and Quaternary lake sediments and alluvial sands, gravels, clays and sandy clays of Petrich (up to 400 m) valley, free groundwater table up to 10 m; flow occurs from the former Yugoslav Republic of Macedonia to Bulgaria

	Bulgaria	*The former Yugoslav Republic of Macedonia*
Border length (km)	5	5
Area (km^2):	124	
Groundwater uses and functions	Drinking water, irrigation and industry. Maintaining baseflow and springs. Supports ecosystems.	

Table 38

Orvilos-Agistros/Gotze Delchev aquifer

	Bulgaria	*Greece*
Border length (km)	22	22
Area (km^2):	325	95
Groundwater uses and functions	Irrigated agriculture and drinking water supply; it supports ecosystems.	<25% for irrigation, drinking water supply, industry, mining, thermal spa, livestock, fish production, hydropower, also maintaining baseflow and support of ecosystems

Table 39

Total withdrawal and withdrawals by sectors

Country	*Total withdrawal* $\times 10^6$ *m*^{3}*/year*	*Agricultural* %	*Domestic* %	*Industry* %	*Energy* %	*Other* %
Bulgaria[a]	54.739	7	30	52		11
Greece						

[a] 754.578 × 10^6 m^3/year are used for hydropower production and not included in the table above

Table 40

Water demands in the Strumica catchment area in the former Yugoslav Republic of Macedonia

		Total water demands (×10^6 m^3/year)	*Population and tourists (×10^6 m^3/year)*	*Industry (×10^6 m^3/year)*	*Irrigation (×10^6 m^3/year)*	*Minimum accepted flow (×10^6 m^3/year)*
Strumica	2006	175.3495	11.5109	32.9876	117.941	13.00
	2020	235.0181	18.2334	34.4417	169.343	13.00
Total in the country	**2006**	**2 227.8911**	**218.2691**	**274.1470**	**899.335**	**635.00**
	2020	**3 491.2863**	**348.2613**	**287.0140**	**1 806.711**	**635.00**

Source: Second Communication on Climate Change. Section: Vulnerability Assessment and Adaptation for Water Resources Sector. Prepared by Katerina Donevska. December 2006, the former Yugoslav Republic of Macedonia

231. Although a major part of the basin area in Bulgaria is cropland, only a relatively small share of total water withdrawals is used for agriculture; more than half is used to supply industry. In the part of the Strumica sub-basin that extends to the territory of the former Yugoslav Republic of Macedonia water is mainly used for irrigated agriculture; the respective water demand is expected to increase significantly (more than 40%) until 2020.

Status, pressures, and transboundary impacts

232. Erosion and subsequent accumulation of sediments was reported by Serbia to take place in Dragovishtitsa River basin due to torrents and deforestation. Bulgaria reported that there are morphological alterations in the part of the river extending in the territory of the country due to water abstractions and possible diversions in the Serbian part. According to Bulgaria, sand and gravel abstraction from Struma/Strymonas river at the Greek site causes sliding down of the river bed, which has affected more than 40 km in Bulgarian territory along the river.

233. Hydro-technical constructions in the Bulgarian part such as dams (serving hydropower generation, irrigation and drinking water supply purposes) are pressure factors. Small hydropower stations may exert pressure to the environment; Bulgaria reports that the issue is under investigation.

234. Diversion of watercourses towards artificial reservoirs used for drinking water supply was reported by Bulgaria. There is intensive groundwater abstraction from some aquifers in the region. While degraded water conveyance and distribution infrastructure result to water losses, drinking water quality is of concern in some areas; measures are being taken by regional water companies to improve water distribution infrastructure to reduce water losses.

235. Untreated wastewater is an important pressure factor. In Bulgaria organic matter from wastewater discharges is of concern; the initiated construction of wastewater treatment plants (to be finished until 2014 - for settlements with more than 2,000 inhabitants) will address the issue of lack of collection and treatment facilities in many of the settlements. Strumica town (the major town in the part of Strumica sub-basin extending in the former Yugoslav Republic of Macedonia) lacks a waste water treatment plant.[70]

236. Agricultural runoff is a source of pollution in Bulgaria and so are the many small illegal dumpsites; livestock breeding units' effluents and fish-farming are additional significant sources. Gravel extraction was reported as a very important issue; research on the effects of this pressure is being conducted. According to Bulgaria gravel extraction in the Greek part of the watercourse influences the water table on the Bulgarian side and alters the morphology of the Struma/ Strymonas River.

237. The water quality is generally "good". The water is suitable for use, especially for irrigated agriculture. Decreasing industrial activity after 1990 in Bulgaria resulted in water-quality improvements.

[70] Second Communication on Climate Change. Section: Vulnerability Assessment and Adaptation for Water Resources Sector. December 2006, the former Yugoslav Republic of Macedonia.

Table 41
Water-quality characteristics of the Struma River upstream from the Bulgarian-Greek border (Monitoring station 30065124)

Date/ period	*Value*	*BOD_5 (mg/l)*	*Ammonia (mg/l)*	*Nitrites (mg/l)*	*Nitrates (mg/l)*	*Phosphates (mg/l)*
2000-2005	Maximum	6.5	1.7	0.07	3.5	1.7
2000-2005	Minimum	1	0.1	0.01	1	0.5
31.1.2008		2.28	0.1197	0.0115	1.543	0.2103
03.4.2008		1.79	0.0711	0.0264	1.2257	0.42
16.7.2008		1.95	<0,006	0.0391	0.3253	0.314
15.10.2008		<1,5	0.0752	0.0373	0.9235	0.405

Source: Ministry of Environment and Water, Bulgaria.

238. As can be observed from the table above, the concentrations of phosphates measured in 2008 are lower than the minimum for 2000-2005. The same applies to ammonia (for the three out of four values provided here). According to Bulgaria, a decrease of industrial and agriculture activities may be reasons contributing to this.

Responses

239. The part of the the Struma/Strymonas basin that is within Bulgaria's territory has been assigned to the West Aegean Basin District while the part that is within Greece's territory has been assigned to the Central Macedonia District as well as to the Eastern Macedonia and Thrace Basin District. There is a management authority that has the primary responsibility for water resources management and a basin council (a consultative body) at the level of the river basin district. The Integrated Management Plan for the West Aegean Basin District covers the part of the basin falling within the Bulgarian territory and is expected to be finalized until the end of 2009 (the draft plan has been prepared).

240. There is a monitoring station[71] in Bulgaria near the Bulgarian – Greek borders. Monitoring programmes are being established in both countries in accordance to the EU WFD. Bulgaria reports that joint monitoring regarding the aquifers should be established.

Transboundary cooperation

241. An Agreement between Bulgaria and Greece was signed in 1964. According to it both countries are bound, inter alia, not to cause significant damage to each other, arising from the construction and operation of projects and installations along the valleys of the rivers Struma/Strymonas, Mesta/Nestos, Arda/Ardas and Maritsa/Evros. The agreement provides for exchange of information and data between parties for preventing floods as well as exchange of information concerning the installations subject to the agreement.

242. According to an Agreement signed between the two countries in 1971 a Bulgarian-Greek Commission on cooperation in the field of electro-energy and the water use of the rivers flowing through their territories was set up. Bulgaria reports that the agreement is not

[71] Water quality in this station has been monitored since 2003; 20 basic physico-chemical parameters are being monitored (such as water temperature, BOD, pH, dissolved oxygen, suspended substances, turbidity, conductivity, ammonia, nitrites, nitrates, total phosphorous, phosphates and specific substances as heavy metals, organic pollutions, oils, phenols etc.).

active for the time being (2009) and that discussions regarding its renewal and possible updating are on-going. Finally, an Agreement was signed between the Ministry of Environment and Water of the Republic of Bulgaria and the Ministry for the Environment, Physical Planning and Public Works of the Hellenic Republic (1 November 2002) on Cooperation in the field of Environmental Protection.

Trends

243. The increase of tourism in the Bulgarian part is expected to result in increased water consumption needs.

XXIII. Mesta/ Nestos River Basin[72]

244. The basin of the river Mesta/Nestos[73] is shared by Bulgaria and Greece.

Table 42
Area and population in the Mesta/Nestos River Basin

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Bulgaria	2 785	49.9	140 413	50
Greece	2 834	51.1		
Total				

245. The river has its source in the Rila Mountains in the vicinity of Sofia (Bulgaria) and flowing through Greece ends up in the North Aegean-Sea. The basin has a pronounced mountainous character in its upper part and a lowland character further downstream. Dospat/Despatis[74] is a major transboundary tributary; the river has its source in the Rodopy Mountains in the vicinity of Sarnitsa (Bulgaria) and flows in Mesta/Nestos River in the territory of Greece.

246. Large parts of the basin in Bulgaria and Greece have been designated as NATURA 2000 sites[75]. The Nestos delta, in Greece, is of great ecological importance and has been designated as a Ramsar site.

Hydrology and hydrogeology

247. In Bulgaria surface water resources are estimated to be 958 × 10^6 m^3/year (average for 1961 – 2002) and groundwater resources are 91.770 × 10^6 m^3/year (average for 1980 – 2008). Total water resources per capita are estimated to be 8,188 m^3/year (average 1980 – 2008).

[72] Based on information from Bulgaria; references related to Greece are based on information from the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Ministry of Environment and Water, Bulgaria, and the Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

[73] The river is called Mesta in Bulgaria and Nestos in Greece.

[74] The river is called Dospat as well as Dospatska in Bulgaria and Despatis in Greece.

[75] In Bulgaria, these are (reference code in brackets): West Rodopi (BG0001030), Dolna Mesta (BG0000220), Mesta River (BG0001021), Pirin National Park (BG0000209), Alibotush (BG0001028), Rila National Park (BG0000495).

248. Bulgaria reported that global climate change over the last 20 years has resulted in approximately 30% decrease in precipitation and a subsequent decrease in water resources in the basin[76]; provisions regarding the decrease of water resources will be included in the programme of measures of the river basin management plan. Bulgaria reports that a reduction of flow has been observed on the Mesta from the late 1930s to the early 2000s.

249. Major dams for hydropower generation and irrigation include these of Thisavros (built in 1997) and Platanovrisi (built in 1999) on Nestos River in Greece and the Dospat Dam (on Dospat River – built in 1967) in Bulgaria.

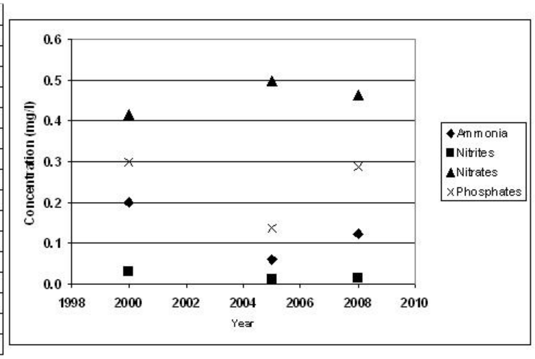
250. Orvilos-Agistros/Gotze Delchev karstic aquifer shared by Bulgaria and Greece (presented in the assessment of the status of the Struma/Strymonas River), extends to and is hydraulically linked with the surface water system of both Mesta/Nestos and Struma/Strymonas Rivers basins (as reported by Bulgaria[77]). According to Greece, the shared aquifer is not hydraulically linked to the surface waters of either basin.

Status, pressures and transboundary impacts

251. When last reported (first assessment) the water quality was "suitable for irrigation and water supply for other users". In the few years preceding the first assessment, the quality of the Mesta had improved as a result of reduced economic activities (including industrial) and the construction of small local wastewater treatment plants in Bulgaria. Values for a few water-quality determinands in the Mesta River downstream from the city of Hadzhidimovo are shown in Figure 4.

Figure 4 **Annual median concentrations (mg/l) of selected water quality determinands in Mesta River at monitoring station 30064117[78] in Bulgaria. In 2000 and 2005, data were available for twelve months, in 2008 for six. Source: Ministry of Environment and Water, Bulgaria**

	Year	2000	2005	2008
Ammonia	Median	0.20	0.06	0.12
	Average	0.34	0.07	0.18
	Minimum	0.00	0.00	0.02
	Maximum	1.70	0.14	0.47
Nitrites	Median	0.03	0.01	0.02
	Average	0.03	0.01	0.02
	Minimum	0.00	0.01	0.01
	Maximum	0.08	0.02	0.03
Nitrates	Median	0.42	0.50	0.46
	Average	0.64	0.51	0.48
	Minimum	0.02	0.06	0.27
	Maximum	2.30	1.00	0.74
Phosphates	Median	0.30	0.14	0.29
	Average	0.27	0.18	0.27
	Minimum	0.20	0.05	0.20
	Maximum	0.40	0.51	0.31



76 No detailed information has been provided by Bulgaria on the spatial or temporal extent of the underlying observations on precipitation. However, the average run off was reported to be 1.5×10^9 m^3 for the period 1935-1970 and 0.958×10^9 m^3 for the period 1970-2005 at the border.

77 Bulgaria expresses uncertainty whether Orvilos-Agistros/Gotze Delchev karstic aquifer should be considered as transboundary. See the section in Struma/Strymonas River basin where the aquifer is described.

78 20 basic physico-chemical parameters are being monitored (such as water temperature, BOD, pH, dissolved oxygen, suspended substances, turbidity, conductivity, ammonia, nitrites, nitrates, total phosphorous, phosphates and specific substances as heavy metals, organic pollutions, oils, phenols etc.) The monthly data values for 2000 and 2005 are shown in the first Assessment.

252. Hydro-technical constructions such as dams (serving hydropower generation, irrigation and drinking water supply purposes) and small hydropower stations in the Bulgarian part have caused hydro-morphological alterations and exert pressure to the environment. Diversion of watercourses towards artificial reservoirs used for drinking water supply was reported by Bulgaria. There are water losses due to degraded water conveyance and distribution infrastructure. While drinking water quality is of concern in some areas, action to address related issues has been taken.

253. Total water withdrawal in Bulgaria, in 2006, was 9.473×10^6 m^3/year. 21 % of total water withdrawal is used for agriculture, 49 % for domestic, 14 % for industry and 17% for other uses. In addition, 133.909×10^6 m^3/year is used for hydropower production.

254. Uncontrolled solid waste disposal in the Bulgarian part had resulted in water pollution hence, potential environmental problems especially in times of heavy precipitation. Measures to address this issue in Bulgaria[79] are being taken.

255. Sand extraction is an issue of concern.

Responses

256. With what concerns institutional arrangements for the management of the water resources at the level of the Mesta/Nestos River basin, the part extending in Bulgaria has been assigned to the West Aegean Basin District while the part extending in Greece has been assigned to the Eastern Macedonia and Thrace Basin District. The Integrated Management Plan for the West Aegean Basin District, in Bulgaria, covers the part of the basin falling within the country's territory.

257. With regard to monitoring in Bulgaria, apart from that described above, new monitoring programmes are established in accordance to the EU WFD. An automatic station on the Mesta/Nestos River, will be established in Bulgaria[80] near the Bulgarian - Greek border by the end of 2009, and measure both water quality and quantity parameters.

Transboundary cooperation

258. Agreements between Bulgaria and Greece touching upon the Mesta/Nestos River basin are those of 1964 and 1971, mentioned in the assessment of the status of the Struma/Strymonas River basin. Besides these, reference should be made to the Agreement that was concluded between Bulgaria and Greece on 22 December 1995 and refers specifically to Mesta/Nestos (additional information about these legal documents can be found in Annex II of document ECE/MP.WAT/WG.2/2011/7–ECE/MP.WAT/WG1/2011/7). According to the 1995 agreement, Bulgaria is obliged to deliver to Greece 29% of the average run off of the river generated in the Bulgarian territory. According to Bulgaria - concerned by the observed reduction of runoff - the actualization of the basis for the calculation is overdue.

259. The existing cooperation framework between the two riparian countries for Mesta/Nestos is linked to the implementation of the EU WFD; integrated water resources

[79] Wastes from all eight municipalities in the river basin are now being collected; about 25 uncontrolled disposal sites were closed and most of them have already been rehabilitated.

[80] In the framework of the PHARE financed "Strengthening of monitoring network of the surface water" project.

management plans are being prepared (the draft plan for the Bulgarian side has already been prepared).

Trends

260. The increase of tourism in the area is followed by increased water consumption needs.

XXIV. Maritsa/ Evros/ Meric River Basin[81]

261. Bulgaria, Greece and Turkey share the basin of the Maritsa/Evros/Meriç River[82].

Table 43
Area and population in the Maritsa / Evros / Meriç River Basins

Country	*Area in the country (km²)*	*Country's share %*	*Population*	*Population density (persons/km²)*
	35 230	62[a]	2 363 273	
	Maritsa sub-basin: 21,928		1 613 241[d]	
	Tundzha sub-basin: 8,029		488 296[d]	62
Bulgaria	Arda sub-basin: 5,273		261 736[d]	50
	3,685 [b]	7[b]		
	Evros sub-basin			
Greece	Ardas sub-basin			
Turkey	14,560	27%[c]	1 033 211[e]	71[e]
	Maritsa sub-basin		N/A	N/A
	Tunca sub-basin		N/A	N/A
	Arda sub-basin		N/A	N/A
Total[f]	52,600[b] or 54,206[c]			

[a]Based on information provided by Bulgaria [b]According to the First Assessment [c]Based on information provided by Turkey [d]2003, [e] 2007, [f] 53,475km2 is the total area of the Basin if calculated as the sum of the figures provided by Bulgaria and Turkey corresponding to the areal extent of the basin in the respective territories and the figure corresponding to the areal extent of the basin in Greece according to the First Assessment.

Hydrology and hydrogeology

262. The Maritsa/Evros/Meriç River is about 500 km long, has its source in the Rila Mountain (Bulgaria) and flows in the Aegean Sea. Major transboundary tributaries include

[81] Based on information from Bulgaria, Turkey. References to Greece are based on the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Ministry of Environment, Physical Planning and Public Works/Central Water Agency, Greece and the Ministry of the Foreign Affairs of Turkey.

[82] The river is called Maritsa in Bulgaria, Evros in Greece and Meriç in Turkey.

the rivers Arda/Ardas[83] (Bulgaria, Greece and Turkey), Tundzha/Tundja/Tunca[84] (Bulgaria, Turkey) and Biala/Erithropotamos (Bulgaria, Greece). The river Ergene is an important tributary, located in Turkey.

263. The basin has a mountainous character at its upper part; low mountains and mostly plains cover the major part of the basin. The average elevation is 100 m a.s.l.

264. The climatic and geomorphologic characteristics of the basin lead to specific run-off conditions characterized among others by high inter-annual flow variability. Floods in all three sub-basins may cause severe damage in all three countries; among the most disastrous were the floods in 2005 (recurrence interval, 1,000 years), in 2006 and in November 2007.

265. Bulgaria reported that global climate change has affected the basin over the last 20 years, resulting in approximately 30% decrease in precipitation and a subsequent decrease in water resources[85].

Table 44

Water resources in Maritsa/Evros/ Meriç River basin

Country	*Bulgaria[a]*	*Greece*	*Turkey*
Surface water resources (× 10^6 m^3/year)	6 950.44		8 330[b]
Groundwater resources (× 10^6 m^3/year)	1 936.625		364[c]
Total water resources (× 10^6 m^3/year)	**8 887.065**		**8 694[c]**
Total water resources per capita (m^3/year)	**5,242**		**8 414[c]**

[a] Information for Bulgarian part of the basin: Maritsa/Evros/Meriç sub-basin: surface water resources 3 403.360 × 10^6 m^3/year (1961-1998), groundwater resources 1 388.091 × 10^6 m^3/year; Arda/ Ardas sub-basin: surface water resources 2 290.302 × 10^6 m^3/year, groundwater resources 157.756 × 10^6 m^3/year; Tundzha/ Tundja/ Tunca sub-basin: surface water resources 1 256.778 × 10^6 m^3/year (1961-1998), groundwater resources 390.778 × 10^6 m^3/year , [b](1986-2005) - Based on information provided by Turkey, [c] (1994-2000).

Table 45

Orestiada/Svilengrad-Stambolo/Edirne aquifer: type 3, Neogene lake and river alluvial sands, clayey sands, gravels, sandy clays and clays of mean thickness 120 m and maximum 170 m. Dominant groundwater flow is from Bulgaria towards Turkey and Greece. Strong links with surface water systems, with recharge from and discharge towards the rivers Arda/Ardas and Maritsa/Evros/Meriç.

	Bulgaria[a]	*Greece*	*Turkey*
Area (km^2):	712	450	N/A
Thickness in m (mean,	120, 170	120, 170	120, 170

83 The river is called Arda in Bulgaria and Turkey and Ardas in Greece.

84 The river is called Tundzha and/or Tundja in Bulgaria and Tunca in Turkey.

85 Measures to improve hydrologic conditions (e.g. forestation), reduce water loses and increase water use efficiency are included in the program of measures of the River Basin Management Plan in Bulgaria; the programme specifically refers to studies to investigate the impact of the climate changes as necessary. No detailed information has been provided by Bulgaria on the spatial or temporal extent of the underlying observations.

max)			
Groundwater uses and functions	Groundwater is 25% of total use. Drinking water supply, irrigation, industry, support ecosystems	Groundwater is 25% of total use. >75% for irrigation and <25% for drinking water supply, also support ecosystems	Groundwater is 25% of total use. N/A

[a] For Bulgaria, the tabled information only refers to the groundwater body identified according to the EU WFD in the porous Neogene formation of Svilengrad-Stambolo (national identification number: BG3G 000000 N 011). Bulgaria reports that in the River Basin Management Plan, the following additional groundwater bodies, connected with Greece and Turkey, are specified: Fissure groundwaters in Ivailovgrad massif (national code BG3G00PtPg2024, surface area 191 km2); 2) Fissure groundwaters in Svilengrad massif (national code BG3G0000Pg025, surface area 48 km2); the position of Greece and Turkey is not available in this regard.

266. As reported by Turkey, Evros/Meriç[86] is a transboundary alluvial aquifer between Turkey and Greece[87]. It drains through the Meriç/Evros River that forms border between Turkey and Greece. It is mainly used for irrigation, industry, and drinking water purposes in Turkey.

267. Topolovgrad Massif, shared by Bulgaria and Turkey is a karstic aquifer with medium connections to surface waters of Tundzha/Tundja River sub-basin (see aquifer table under Tundzha/Tundja River later in the document).

268. Cooperation among the three countries for the delineation of the boundaries of the transboundary aquifers in the basin and the enhancement of relevant knowledge is necessary. Moreover, Bulgaria suggests that countries should cooperate for the clarification of the stratigraphy of the Orestiada/Svilengrad-Stambolo/Edirne and Evros/Meriç aquifers; as reported, due to the Paleogene aquifer in Svilengrad and Ivailovgrad, it is possible that Evros/Meriç extends also in the territory of Bulgaria.

Status, pressures and transboundary impact

269. The delta of the Maritsa/Evros/Meriç River shared by Greece and Turkey (150 out of the 188 km^2 of the delta lies in the Greek territory) is of major ecological significance. It is one of the most important bird wintering areas in the Mediterranean. A major part of the delta in Greece (100 km^2) has been designated as Ramsar site; it enjoys also the status of Special Protected Area and NATURA 2000 site. Extensive areas in the Bulgarian part of the basin (33%) have been also designated as NATURA 2000 sites. Areas of ecological importance in Turkey are under national protection status. Areas near the delta are used as agricultural land.

[86] This is a new aquifer number as this aquifer did not appear in the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

[87] Based on information from Turkey; the position of Greece is not available in this regard. It is possible that Bulgaria is a riparian country (see the body text).

Table 46
Total withdrawal and withdrawals by sectors

Basin/ sub-basin	*Country*	*Total withdrawal ×10⁶ m³/year*	*Agricultural %*	*Domestic %*	*Industry %*	*Energy %*	*Other %*
Maritsa/Evros/ Meriç River basin	Bulgaria[a]	2 721.583	-	-	-	-	-
	Greece						
	Turkey 2009	1 352	82	4	13	0	1
	2015	2 000	78	6	15	0	1
Maritsa / Evros / Meriç River sub-basin	Bulgaria[a]	2 343.85	51	1	3	44	1
	Greece						
	Turkey	N/A	N/A	N/A	N/A	N/A	N/A
Arda River sub-basin	Bulgaria 2007	40.114	31	20	37	-	12
	Greece						
	Turkey	N/A	N/A	N/A	N/A	N/A	N/A
Tundzha/Tundja River sub-basin	Bulgaria[a]	337.619	86	1	1	9	3
	Turkey	N/A	N/A	N/A	N/A	N/A	N/A

[a] Information for Bulgaria refers to water abstraction from surface waters; the percentages given under energy refer to consumptive uses.

270. The total number of reservoirs in the Bulgarian part is as high as 722. Hydropower production is common in the upper part of the basin, and cascades of dams form big reservoirs.[88] Many small dams are used for irrigation purposes and fish-breeding. In Turkey seven dams and one regulator are under operation on the Ergene River and its tributaries serving irrigation, flood control and some drinking water supply purposes (15 % of drinking water of Edirne and Kırklareli cities is supplied from two reservoirs - Suloglu and Armagan). There are also 53 small dams located on several tributaries used for irrigation. In Greece a number of dams are used for irrigation purposes.[89]

271. Depending on the climatic conditions and the needs, the operation of the dams upstream has a share in the variability of flow. Reduced flows, when they occur, may lead among others to saltwater intrusion.

[88] Big water cascades on Maritsa include: Cascade Vacha (2 dams with 5 hydropower stations), Cascade Batak (5 dams with 3 hydropower stations), Cascade Belmeken-Sestrimo (1 dam reservoir with 4 hydropower stations).

[89] These include those on the rivers Ardas, Lyra, Provatonas, Ardanio and Komara (when last reported –First Assessment- the last was under construction)

272. In Bulgaria the operation of small hydropower stations and gravel extraction have led to hydro-morphological changes in the Maritsa, Arda and Tundzha Rivers. Abstraction of groundwater for irrigation and partly for industrial use (textile, food, paper, cement production) in Turkey has led to a decline of piezometric levels of 10-12 m since the 1990's; as a response measure, groundwater abstraction in the Ergene sub-basin has been forbidden.

273. In Bulgaria untreated urban wastewater, is a source of pollution; wastewater collection facilities serve 67% of the population while 30% of wastewaters in the Maritsa sub-basin are treated. Construction of collection and treatment systems is on-going. By magnitude, diffuse sources are the second biggest pressure; 74% of diffuse pollution comes from agriculture. Nitrate pollution in groundwater is one of the effects. Industrial activities in the Bulgarian part (include food production and production of non-ferrous metals and chemicals) may be a potential source of heavy metals as well as organic and nitrogen pollution of local importance. Mining activities at mountainous areas are sources of surface and groundwater as well as sediment pollution; impacts on ecosystems are also possible. Officially registered regional waste disposal sites are gradually replacing the old ones in Bulgaria: along the river basins of the Maritsa, the Arda and the Struma, there are already six in operation.

274. Untreated domestic wastewater is one of the main pollution sources in Turkey, particularly in the Ergene sub-basin; the river is of Class IV (very polluted water), threatening human health and biodiversity. Both urban wastewater and solid waste volumes have been increased due to population growth. The construction of wastewater treatment plants for municipalities in the basin is expected to improve the situation; these are planned to be completed by 2012. Illegal waste disposal is also a pressure factor; pollution of water from controlled disposal areas was also reported. Industrial development since 1980 has led to the increase of the concentration of related pollutants e.g. in Ergene river; this is linked with illegal wastewater discharges. Unsustainable agricultural practices are an additional pressure factor; these are related to (i) the use of fertilizers and pesticides (resulting in nitrogen, phosphorous, and pesticides pollution) and (ii) inefficient irrigation techniques. Groundwater pollution is the outcome of the aforementioned pressures. Turkey reports that there is loss of biodiversity in some parts of the basin.

275. According to Turkish assessments, the water quality status of the Meriç River is of Class III (polluted water) both at the point where it enters the territories of Turkey[90] and at its mouth at the Aegean Sea. Tunca is reported as of Class IV with regard to heavy metals, at the point entering Turkey.

Response measures

276. In Bulgaria the monitoring network include 27 stations for surveillance monitoring and 48 for operative monitoring (quality monitoring is performed). Hydrological parameters are planned to be monitored in 25 stations. In Turkey, monitoring of water quality is carried out periodically at five monitoring stations on the Meriç, one on the Arda, and one on the Tunca Rivers since 1979. Cooperation between the competent authorities of Bulgaria and Turkey has led to the establishment of four telemetry hydrometric stations in the Bulgarian part (one on each of the Arda and Tundzha/Tundja Rivers and two on the Maritsa/Meriç River) that supply real time data.

[90] According to water quality monitoring results at Ipsala water station (Turkey) – quality monitoring has been carried out since 1979 in this station.

277. Bulgaria works for the update of hydrological data, mapping of the sensitive areas and creating of a hazard map. As the downstream countries, Turkey and Greece are highly vulnerable to floods, it is evident that measures for flood prevention can only be improved and their effects be mitigated through cooperation and use of common information sources. Joint development and establishment of integrated information systems such as flood forecasting/early warning systems is essential. The cooperation between Bulgaria and Turkey[91] in this regard, provides a basis for further action. The broadening of the scope of related activities in the future to include also Greece is deemed necessary. The use of better dam operation techniques and rules can considerably mitigate floods.

278. The operation of the dams should be carried out in a coordinated manner among the riparian countries in accordance to the upstream-downstream needs and considerations; the need to preserve the natural values of the delta area should also be taken into account.

279. The implementation of good agricultural practices and the establishment of buffer zones are response measures taken in Bulgaria to address diffuse pollution from agriculture. There is a need for restoration of the existing irrigation infrastructure.

280. In Turkey, the development plans for the Meriç-Ergene basin integrates up to a point the development strategies in water related sectors. There is no conjunctive management of surface water and groundwater. The Protection Action Plan for Meriç-Ergene Basin (2008) assesses the effects of development projects and economic activities on the environment and provides for a short, medium and long term action plan in terms of water resources management. There is also a land use plan for the Meriç-Ergene basin.

281. The respective parts of the Maritsa/Evros basin are within the East Aegean Basin District in Bulgaria and the Eastern Macedonia and Thrace District in Greece; there is a management authority and a basin council in each of these Basin Districts.

282. An Integrated Management Plan for the East Aegean Basin District (Bulgaria) is expected to be finalized until the end of 2009. As reported, stakeholder involvement activities have been implemented in this regard. Water demand management measures in Bulgaria include water abstraction control.

Transboundary cooperation

283. Existing bilateral agreements and cooperation in the basin cover issues of flood protection (in the river Tundzha/Tundja/Tunca) and joint infrastructure projects as well as general environmental cooperation including conservation of protected areas. A reference should be made to the 1975 and 1993 agreements between Bulgaria and Turkey; the 1964 and 1971 agreements between Bulgaria and Greece; and the 1934 agreement between Greece and Turkey (more information can be found in Annex II of document ECE/MP.WAT/WG.2/2011/7–ECE/MP.WAT/WG1/2011/7). There is communication between Bulgaria and Turkey regarding the possible construction of the Suakacagi dam on the Tundzha/Tundja/Tunca River at the border between the two countries, aiming to address flood issues. The major part of the construction would extend to the Bulgarian territory.

284. Building on the existing bilateral cooperation arrangements, the establishment of a cooperation mechanism in the whole basin, involving all three riparian countries, should be considered. Transboundary initiatives that touch upon issues of transboundary concern e.g.

[91] PHARE project Technical Assistance for Flood Forecasting and Early Warning System - "Capacity Improvement for Flood Forecasting in the BG-TR CBC Region" project.

ecosystems and biodiversity may provide the enabling environment for the initiation of an inter-basin dialogue in this regard. The on-going cooperation process between Bulgaria and Turkey to limit and prevent floods and their damaging effects provide an additional “entry point” for the enhancement of cooperation; Greece, should be included as appropriate. A coordination structure including the experts of three riparian countries may be considered as an initial step.

XXV. Arda/ Ardas River[92]

285. Bulgaria, Greece and Turkey share the sub-basin of the river Arda/Ardas. The Arda/Ardas has its source in the Rodopi Mountains (Bulgaria) and discharges into the Meriç River. The Aterinska River is a tributary shared by Bulgaria and Greece.

286. The sub-basin has a pronounced mountainous character with an average elevation of 635 m a.s.l.

Table 47

Discharge characteristics of the Arda/Ardas River at the boundary gauging station in Bulgaria based on observations from 1961 to 1998]

Discharge characteristics	*Discharge (m^3/s)*	*Period of time or date*
Q_{av}	72.63	1961 - 1998
Q_{min}	27.61	1961 - 1998
Q_{max}	148.63	1961 - 1998

Table 48

Mean monthly discharges of the Arda/Ardas River at the boundary gauging station, based on observations from 1961 to 1998

Mean monthly discharges		
October: 23.03 m^3/s	November: 60.34 m^3/s	December: 129.21 m^3/s
January: 114.72 m^3/s	February: 154.94 m^3/s	March: 126.03 m^3/s
R April: 100.41 m^3/s	May: 71.91 m^3/s	June: 47.37 m^3/s
July: 22.51 m^3/s	August: 11.50 m^3/s	September: 10.95 m^3/s
Mean discharge	m^3/s	

Status, pressures and transboundary impact

287. Dams are common for the Arda/Ardas sub-basin; 100 are located in Bulgarian territory. The largest serve multiple purposes: energy production, irrigation, industrial and drinking water supply. Flow regulation is a pressure factor resulting in hydromorphological changes; the change in the water temperature due to the construction of the big dams has had an impact on the macrozoobenthos in the downstream section of Arda in Bulgaria. In Greece a dam was build close to the border with Bulgaria to regulate

[92] Based on information from Bulgaria and Turkey. References to Greece are based on the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Ministry of Environment, Physical Planning and Public Works/Central Water Agency, Greece and the Ministry of the Foreign Affairs of Turkey.

discharge from the Ivailovgrad Dam (Bulgaria); water from the reservoir also covers irrigation needs.

288. Non-treated urban wastewater, waste disposal and animal breeding are pressure factors in the Bulgarian part of the basin resulting in pollution, having impacts on the ecosystem; the impacts are reported by Bulgaria to be of local importance. Eutrophication has been observed at the reservoirs of the (big) dams Kardgali, Studen kladenez and Ivailovgrad. Nitrogen and organic pollution is expected to be reduced since the sewerage system is being extended, now connecting 67% of the population. There are 3 new municipal wastewater plants and a new one is under construction.

289. Mining activities have a local but important impact due to heavy metals contained in the discharges from mines. Five tailing ponds containing mining waste are potential sources of pollution. Industrial activities in the area are possible sources of heavy metals and organic (impact of local importance) pollution.

290. There are nine waste disposal sites in the Bulgarian part; a regional disposal site is under construction.

XXVI. Tundzha/ Tundja/ Tunca River[93]

291. Bulgaria and Turkey share the sub-basin of Tundzha/Tundja/Tunca which has its source in the Stara Planina Mountain (Bulgaria) and flows into the Meriç River. Fishera River is a tributary shared by Bulgaria and Turkey. Topolovgrad Massif is an aquifer that is shared by the two countries.

[93] Based on information from Bulgaria, Turkey and the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Ministry of Foreign Affairs of Turkey.

Table 49

Topolovgrad Massif aquifer[94]: type 2 according to Turkey, type 1 according to Bulgaria, Triassic and Jurassic karstic limestones, dolomites, marbles, schists, in a narrow synclinal structure with complicated, faulted block structure, medium links with surface water systems. Dominant groundwater flow direction: Bulgaria from South to North. Proportion of groundwater in total water use is not known.

	Bulgaria	*Turkey*
Border length (km)	24	24
Area (km^2):	315 (280[a])	N/A
Groundwater uses and functions	For drinking and household purposes[a].25 - 50% Drinking water supply, < 25% each for irrigation and livestock, maintaining baseflow and springs and support of ecosystems	N/A
Pressures	Industry, industrial and household waste waters, problems: impact of the human activity on the chemical status of the groundwater body - waste landfill , mine, in the future: possible qualitative risk, no quantitative risk [a]	
Groundwater management measures	Waste water treatment is needed[a]	
Other information	Bulgaria expresses uncertainty whether the aquifer should be considered as transboundary as the state border between Bulgaria and Turkey is located in an area where the aquifer extends along the local watershed divide, therefore the groundwater flow is suspected not to cross the state border, but divided to the North in Bulgaria, and to the South in Turkey. It should be noted, though, that karstic aquifer flow systems are difficult to characterize and the groundwater divide does not necessarily coincide with the topographic divide	

[a] Bulgaria suggest as transboundary Topolovgrad aquifer the groundwater body “Karst water – Topolovgrad massif” BG3G0000T12034 , after determination of the groundwater bodies in conformity with the requirements of WFD.

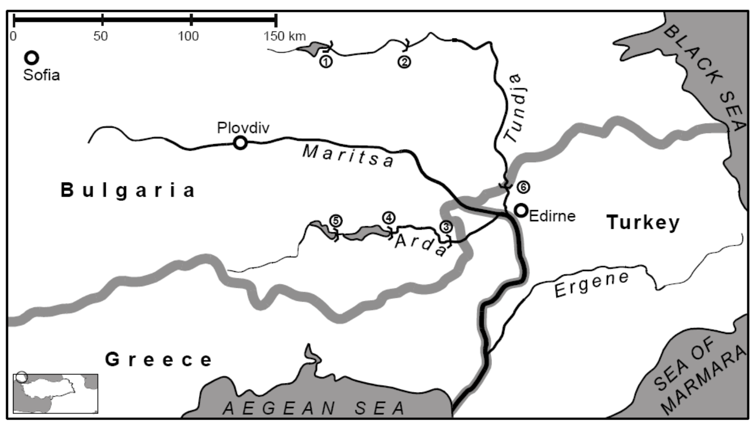
[94] Based on information from the First Assessment of Transboundary Rivers, Lakes and Groundwaters – for which information had been provided by the Basin Directorate for the Black Sea Region, Bulgaria.

Status, pressures and transboundary impact

292. There are 264 dams located in the Bulgarian part. The larger dams/reservoirs serve multiple purposes: energy production, irrigation, industrial and drinking water supply. There are four hydropower stations and three thermal power plants.

293. Eutrophication in the reservoirs of the big dams in Bulgaria as well as nitrate pollution of groundwater, in the middle part of the basin, has been observed. Among pollution sources, wastewater discharge from municipalities and industry ranks in the first place, followed by diffuse pollution (78% of diffuse pollution comes from agriculture). It is reported that measures for the improvement of the situation are taken e.g. wastewater treatment plants are being constructed. The sewerage system currently serves 31% of the population in the Bulgarian part while wastewater treatment plants treat 11% of the urban wastewaters. There are 6 waste disposal sites in the Bulgarian part.

Figure 5 **Map of main dams in the Arda/Ardas and Tundja/Tundzha/Tunca rivers**



(1) Georgi Dimitrov Dam
(2) Jdrebchevo Dam
(3) Ivailovgrad Dam
(4) Studen Kladnetz Dam
(5) Kardjali Dam
(6) Suakacagi Dam (planned)

XXVII. 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)

Table 50

Pelagonia- Florina/Bitolsko aquifer[95]: According to the riparian countries represents none of the illustrated transboundary aquifer types;, Quaternary and Neogene unconfined shallow alluvial sands and gravels with some clay and silt and cobbles, with confined Pliocene gravel and sand aquifer, total thickness average 60 m and up to 100 - 300 m overlying Palaeozoic and Mesozoic schists, medium links to surface waters, groundwater flow from Greece to the former Yugoslav Republic of Macedonia.

	Greece	*The former Yugoslav Republic of Macedonia*
Border length (km)	45?	45?
Area (km^2):	180	N/A
Thickness in m (mean, max)	60, 100-300	60, 100-300
Groundwater uses and functions	25-50% irrigation, <25% each for drinking water supply, industry and livestock, also support of ecosystems. Groundwater is more than 50% of total use	Support of ecosystems and agriculture and maintaining baseflow and springs. Groundwater is more than 50% of total use

294. Agriculture is a pressure factor in Greece; there is local and moderate reduction of borehole yields observed. In the former Yugoslav Republic of Macedonia widespread and severe increase of pumping lifts has resulted in reduction of borehole yields, local but severe reduction in baseflow and spring flow and degradation of ecosystems.

295. Nitrate and heavy metals are present in the Greek side of the aquifer while nitrogen, pesticides, heavy metals, pathogens, industrial organic compounds and hydrocarbons are present in the part that extends to the former Yugoslav Republic of Macedonia. Polluted water is drawn into the aquifer in both countries.

296. According to both countries, there are no transboundary impacts.

297. In Greece, the implementation of appropriate management measures are planned or already implemented in accordance to the EU WFD; monitoring, vulnerability mapping for land use planning and wastewater treatment are needed.

298. Necessary measures in the former Yugoslav Republic of Macedonia include increased efficiency of groundwater use, monitoring of quantity and quality, protection zones, vulnerability mapping, good agricultural practices and public awareness; treatment of industrial effluents need to be improved while other measures are planned.

95 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 the Ministry of Environment and Physical Planning, the former Yugoslav Republic of Macedonia.

299. According to the former Yugoslav Republic of Macedonia exchange of data between the two countries need to be improved.

Aquifer system of Istra and Kvarner[96]

300. The Aquifer system of Istra and Kvarner is divided in the following transboundary aquifers/groundwater bodies[97]:

(a) Sečovlje-Dragonja/Istra;

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

(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 51

Secovlje-Dragonja/Istra aquifer[98]: 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

	Croatia	*Slovenia*
Border length (km)	21	21
Area (km^2):	99	95.74
Thickness in m (mean, max)		Altitude fluctuation 0 - 479
Number of inhabitants		6 451
Population density		67.38
Groundwater uses and functions	Drinking water supply	Local drinking water supply.
Pressures	Communities. Groundwater quality: local bacteriological pollution.	Tourism and transport. Quality problems: pollution from urbanisation and traffic.
Groundwater management measures	There are no protection zones	Pumping station has been disconnected from water supply system

96 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.

97 Based on information from Slovenia.

98 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.

Other information	- Transboundary groundwater under consideration but not approved - The issue of groundwater use has not been resolved with Slovenia. Trends, future prospects: Agreed delineation of transboundary groundwater systems and development of monitoring programmes. In the valley of the Dragonja River.	Trends, future prospects: Development of transboundary water protection areas. In the valley of the Dragonja River

301. 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 52

Mirna/Istra[99] aquifer: 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

	Croatia	*Slovenia*
Border length (km)	10	10
Area (km^2):	198	
Groundwater uses and functions	Drinking water supply; supports ecosystems	Provides part of regional drinking water supply for the town of Piran
Pressures		Tourism and transport. Groundwater quality: pollution from urbanisation and traffic
Groundwater management measures	Existing protection zones	
Other information	Transboundary groundwater under consideration, but not approved. Trends and future prospects: Agreed delineation of transboundary groundwater systems and development of monitoring programmes	Trends and future prospects: Delineation and enforcement of drinking water protection zones

[99] 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 53

Mirna aquifer[100]: type 2, Kenozoic carbonate limestones / silicate-carbonate flysch. Pressure condition: unconfined.

	Croatia	*Slovenia*
Border length (km)		44
Thickness in m (mean, max)		Altitude fluctuation: 108 - 860
Number of inhabitants		604
Population density		13.73
Groundwater uses and functions		Local drinking water supply
Other information		62.5% of the land is forest, 26.6% is cropland and other land uses make up the remaining 10.9%.

Table 54

Območje izvira Rižane aquifer[101]: type 2, Mesozoic carbonate karstic limestones. Pressure condition: unconfined

	Croatia	*Slovenia*
Border length (km)		
Area (km^2):		227.34
Thickness in m (mean, max)		Altitude fluctuation: 69 – 1 015
Number of inhabitants		5 070
Population density		22.30
Groundwater uses and functions		Local drinking water supply
Other information		69.3% of the land is forest, 24.1% is cropland and 1.1% urban or industrial area

[100] Based on information from Slovenia.
[101] Based on information from Slovenia.

Table 55
Opatija/Istra aquifer aquifer[102]: type 2, Mesozoic dominantly carbonate, karstic limestones. Pressure condition: unconfined.

	Croatia	*Slovenia*
Area (km^2):		66.61
Thickness in m (mean, max)		Altitude fluctuation: 476 – 1 065
Number of inhabitants		1 002
Population density		15.04
Groundwater uses and functions		Local drinking water supply
Other information		83.1% of the land is forested, 13.0% is cropland and 0.5% urban or industrial area

Table 56
Riječina – Zvir aquifer[103]: Mesozoic carbonates, dominantly karstic limestones. The dominant groundwater flow direction is from Slovenia to Croatia.

	Croatia	*Slovenia*
Area (km^2):		69.95
Thickness in m (mean, max)		Altitude fluctuation: 785 – 1 786
Number of inhabitants		0
Groundwater uses and functions		Local drinking water supply
Other information		forest makes up 97.3%, cropland 0.1% and other land uses 2.6%. Development of transboundary groundwater protection areas is suggested

[102] Based on information from Slovenia. The aquifer is called Podgrad–Opatija in Slovenia.
[103] Based on information from Slovenia.

Table 57

Notranjska Reka aquifer[104] (part of Bistrica-Snežnik in Slovenia): type 2, Kenozoic carbonate limestones / silicate-carbonate flysch. Pressure condition: unconfined.

	Croatia	*Slovenia*
Area (km²):		315.42
Thickness in m (mean, max)		Altitude fluctuation: 334 – 1 606
Number of inhabitants		11 330
Population density		35.92
Groundwater uses and functions		Local drinking water supply
Other information		From 67.1 to 77.4% of the land 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 58

Novokračine aquifer[105]: type 2, Kenozoic carbonate limestones / silicate-carbonate flysch. Pressure condition:

	Croatia	*Slovenia*
Area (km²):		21.30
Thickness in m (mean, max)		Altitude fluctuation: 428 - 759
Number of inhabitants		856
Population density		40.19
Groundwater uses and functions		Local drinking water supply
Other information		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

302. 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.

[104] Based on information from Slovenia.
[105] Based on information from Slovenia.

Table 59

Cetina aquifer[106]: 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.

	Croatia	*Bosnia and Herzegovina*
Border length (km)	70	70
Area (km^2):	587	2 650
Thickness in m (mean, max)	500, 1 000	500, 1 000
Groundwater uses and functions	Groundwater covers 5% of the water used in Croatian part. Drinking water supply; 95% of groundwater is used for hydropower production.	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
Pressures	Pressure from: crop and animal production. Issues related to water quantity have resulted to widespread but moderate degradation of ecosystems; polluted water is drawn into the aquifer. Transboundary effect from sinkholes in BA	Pressure from: solid waste disposal, wastewater, agriculture and industry. 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. Sinkholes with transboundary effects in Croatia
Groundwater management measures	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	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.
Other information		-Transboundary aquifer

[106] 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.

		under consideration, but not approved -Includes the Glamo_ko-Kupreško and other Poljes with very large springs

Table 60

Dinaric Littoral (West Coast) aquifer[107]: type 2, Jurassic and Cretaceous karstic limestones, average thickness 500 m and maximum greater than 1,000 m, weakly connected to surface water systems.

	Croatia	*Montenegro*
Area (km^2):		200
Thickness in m (mean, max)	500, >1 000	500, >1 000
Groundwater uses and functions		Groundwater provides 100% of total water use. 25-50% each for drinking water supply and industry, <25% each for irrigation and livestock
Pressures		Abstraction of groundwater, widespread and severe saline water intrusion at the coastal area has resulted in high salinity of groundwater
Groundwater management measures		Existing control of abstraction, efficiency of water use, protection zones, agricultural practices, groundwater monitoring and public awareness need to be improved; other measures need to be introduced as well.
Other information	According to existing data, no transboundary groundwater is recognised	

[107] 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.

Table 61

Metohija aquifer[108]: type 4, Tertiary (Miocene) alluvial sediments, weak links to surface water systems. In Montenegro, Type 1, Triassic karstic limestones, weak links to surface water systems. [109]

	Kosovo (UN administered territory under UN Security Council resolution 1244)	*Montenegro*
Area (km^2):	1 000	300 - 400
Thickness in m (mean, max)	100, 200	300, 800
Groundwater uses and functions	25-50% for irrigation, <25% each for drinking water, industry and livestock, maintaining baseflow and spring flow. Groundwater is 20% of total water use	>25% for drinking water, <25% each for irrigation, mining and industry. Groundwater is 20% of total water use.
Pressures	Agriculture and local small industries. Pesticides and industrial organic compounds in the groundwater	no pressures exerted to the aquifer
Groundwater management measures	Several management measures are needed.	Several management measures are needed
Other information	no assessment regarding the status of the aquifer. no transboundary impacts	no transboundary impacts

108 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.

109 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.

Table 62

Pester aquifer[110]: 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.

	Montenegro	*Serbia*
Area (km^2):	>150	317.36
Thickness in m (mean, max)	350, 1 000	350, 1 000
Number of inhabitants		1 742
Population density		6
Groundwater uses and functions	<25 % used for drinking water supply, also used for livestock and for mining activities	75 % for drinking water supply, <25% for industry and livestock. Supports ecosystems, maintains baseflow and springs. Naturally discharging water from springs is used for drinking water supply; the volume of water used is less than the natural discharge
Pressures	domestic wastewater	Local pressure from dewatering of a coal mine. Lack of wastewater collection and treatment facilities at rural settlements is a potential threat. Quality could be endangered through sinkholes in Pester polje
Groundwater management measures	Systematic quantity and quality monitoring and vulnerability mapping for land use planning needs to be established. According to Montenegro exchange of data between the two countries is needed.	Systematic quantity and quality monitoring need to be established. Serbia reports that there is no need for intensive bilateral cooperation for the management of the transboundary aquifer.
Other information		Quality (water supply) and quantity of groundwater is good. Land use: 23.06% forest, 1.69% cropland, 75.06% grassland, 0.12% urban/industrial areas, 0.07% other forms (bare rocks).

[110] 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.

303. Pester area in Serbia, is inaccessible and sparsely populated[111]. Animal husbandry is the main economic activity.

Table 63

Korab/Bistra – Stogovo aquifer[112]: 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, 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.

	Albania	*The former Yugoslav Republic of Macedonia*
Area (km²):	~140	N/A
Thickness in m (mean, max)	500 – 700, >2 000	500 – 700, >2 000
Groundwater uses and functions	25-50% for thermal spa, < 25% each for drinking, irrigation and livestock. Groundwater provides >90% of total supply.	Drinking water, irrigation, mining. Groundwater provides >90% of total supply.
Pressures	Waste disposal, sanitation and sewer leakage. 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.	Groundwater abstraction and agriculture. Discharge of the springs has been reduced locally. There are transboundary impacts related to groundwater quantity.
Groundwater management measures	Measures needed: 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
Other information	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	There are transboundary impacts related to groundwater quantity.

[111] There is no related information available for Montenegro.

[112] 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.

304. 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.

Table 64

Jablanica/Golobordo aquifer[113]: type 2, Triassic and Jurassic karstic limestones, weak links to surface waters, groundwater flow occurs in both directions.

	Albania	*The former Yugoslav Republic of Macedonia*
Border length (km)	50	50
Area (km^2):	250	N/A
Thickness in m (mean, max)	700, 1 500	700, 1 500
Groundwater uses and functions	25-50% for irrigation, <25% each for drinking water and industry, also for maintaining baseflow and springs. Groundwater is 70-80% of total water use.	Drinking water supply, thermal water and industry, also hydroelectric power
Pressures	Sanitation, sewer leakage, waste disposal (reported to be modest). Not at risk since population is small and industry is not developed. Moderate pathogens present locally, polluted water drawn into the aquifer	Sanitation and sewer leakage. Moderate pathogens present locally. Reduction of groundwater yields from wells and discharges from springs have been observed locally
Groundwater management measures	None, those that need to be introduced include detailed vulnerability and hydrogeological mapping, groundwater monitoring, protection zones, wastewater treatment and public awareness. Both countries agree that data should be exchanged.	Monitoring of quantity and quality, protection zones, hydrogeological mapping and good agricultural practices are needed. Both countries agree that data should be exchanged.
Other information	Surface karst phenomena are very well developed on Klenja plateau. No impacts reported at transboundary level. There are plans in the country for the use of a large karst spring for hydropower production.	no impacts reported at transboundary level

[113] 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.

Table 65

Mourgana Mountain/ Mali Gjere aquifer[114]: type 1 or 2, karstic aquifer developed in Triassic, Jurassic and Cretaceous limestones in large anticlines with flysch in synclines. 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.

	Albania	*Greece*
Border length (km)	20	20
Area (km^2):	440	90
Thickness in m (mean, max)	100, 150. Alluvium of the Drinos River is 20-80	100, 150. Alluvium of the Drinos River is 20-80
Groundwater uses and functions	Provides 100% of drinking water supply and spa use, and >75% for irrigation, industry and livestock. Groundwater provides about 70% of total water use	50-75% for irrigation, 25-50% for drinking water supply, <25% for livestock, also support of ecosystems and maintains baseflow and springs. Groundwater provides about 70% of total water use
Pressures	Waste disposal and sewer leakage. Increased pumping lifts have resulted in moderate problems related to groundwater quantity locally. Widespread but moderate salinisation; 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.	Agriculture (population in the mountainous area is low)
Other information	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. no transboundary impacts reported	no transboundary impacts reported

305. 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

[114] 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.

collaboration is needed with the aim of setting up transboundary institutions and create a joint basin wide programme for quantity and quality monitoring.

306. 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.