CHAPTER 6 DRAINAGE BASIN OF THE MEDITERRANEAN SEA

This chapter deals with the assessment of transboundary rivers, lakes and groundwaters, as well as selected Ramsar Sites and other wetlands of transboundary importance, which are located in the basin of the Mediterranean Sea.

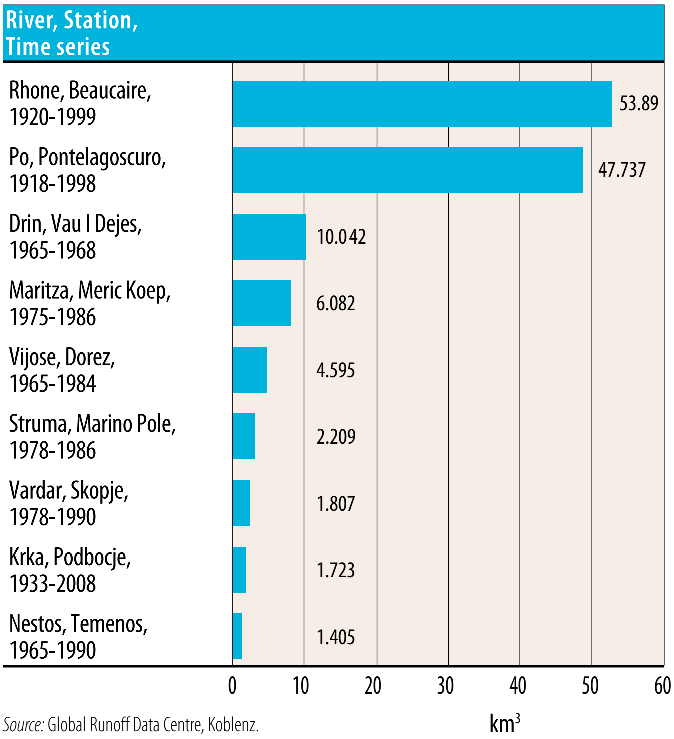
Assessed transboundary waters in the drainage basin of the Mediterranean Sea

Basin/sub-basin(s)	Recipient	Riparian countries	Lakes in the basin	Transboundary groundwaters within the basin	Ramsar Sites/wetlands of transboundary importance
Ebro	Mediterranean Sea	AD, ES, FR			
Rhone	Mediterranean Sea	CH, FR, IT	Lake Geneva, Lake Emosson	Genevese aquifer (FR, CH), *Jurassic limestones and marnes of the Jura Mountains, Jurassic Limestones of the Jura Mountains - Doubs basin, Jurassic limestones of the Jougnena and Orbe basins, Glacio-fluvial formations of Gex region, Sedimentary terrain of Geneva (molasses and form), Jurassic Limestones below Gex region (FR, CH)*	Lake Geneva/Lac Léman wetland area
Po	Mediterranean Sea	AT, CH, FR, IT	Lake Lugano, Lake Maggiore	Folded terrain of the Cenise et Po Basins(FR, IT)	
Isonzo/Soča	Mediterranean Sea	IT, SI		Rabeljski rudnik aquifer, Kobariški stol aquifer, Osp-Boljunec, Brestovica, Vrtojbensko polje (Aquifer system of Gorica-Vipava valley, Alluvial gravel aquifer of Vipava and Soča rivers) (IT, SI)	
Krka	Mediterranean Sea	BA, HR		Krka (BA, HR)	
Neretva	Mediterranean Sea	BA, HR, ME	Bileća Reservoir/ Bilećko Lake	Neretva Right coast, Trebišnjica/ Neretva Left coast (BA, HR), Bileko Lake (BA, ME)	
Drin	Mediterranean Sea	AL, GR, Kosovo[a], MK, ME	Lake Ohrid (AL, MK), Prespa Lakes (AL, GR, MK), Lake Skadar/ Shkoder (AL, ME)	Beli Drim/Drini Bardhe (AL, Kosovo [a]), Prespa and Ohrid Lakes (AL, GR, MK), Skadar/Shkoder Lake, Dinaric east coast aquifer (AL, ME)	Prespa Park Wetlands Ramsar Site (AL, GR, MK), Skadar/Shkoder and River Buna/Bojana Ramsar Sites
Aoos/Vijosa	Mediterranean Sea	AL, GR		Nemechka/Vjosa-Pogoni (AL, GR)	
Vardar/Axios	Mediterranean Sea	GR, MK	Lake Dojran/ Doirani	Gevgelija/Axios-Vardar, Dojran Lake (GR, MK)	
Struma/Stymonas	Mediterranean Sea	BG, GR, MK, RS		Sandansky-Petrich (BG, GR, MK), Orvilos-Agistros/Gotze Delchev (BG, GR)	
Mesta/Nestos	Mediterranean Sea	BG, GR		Orvilos-Agistros/Gotze Delchev (BG, GR)	
Maritsa/Meriç/ Evros	Mediterranean Sea	BG, GR, TR		Orestiada/Svilengrad-Stambolo/Edirne (BG, GR, TR), *Evros/Meriç (BG, GR, TR)*	
- Arda/Ardas	Maritza/ Meriç/Evros	BG, GR, TR			
- Tundzha/Tundja	Maritza/ Meriç/Evros	BG, TR		Topolovgrad massif (BG, TR)	
	Not connected to surface waters[a]	GR, MK		Pelagonia-Florina/Bitolsko	

Basin/sub-basin(s)	Recipient	Riparian countries	Lakes in the basin	Transboundary groundwaters within the basin	Ramsar Sites/wetlands of transboundary importance
	Not connected to surface waters[b]	HR, SI		Secovlje-Dragonja/Istra, Mirna/Istra, Mirna, Območje izvira Rižane, Opatija/Istra, Riječina-Zvir, Notranjska Reka, Novokračine	
	Not connected to surface waters[b]	BA, HR		Cetina	
	Not connected to surface waters[b]	HR, ME		Dinaric Littoral (West Coast)	
	Not connected to surface waters[b]	Kosovo,[a] ME		Metohija	
	Not connected to surface waters[b]	ME, RS		Pester	
	Not connected to surface waters[b]	AL, MK		Korab/Bistra – Stogovo, Jablanica/Golobordo	
	Not connected to surface waters[b]	AL, GR		Mourgana Mountain/Mali Gjere	

Note: Transboundary groundwaters in italics are not assessed in the present publication.
[a] United Nations administered territory under Security Council Resolution 1244 (1999).
[b] The transboundary groundwaters indicated as not connected to surface waters either discharge directly into the sea, represent deep groundwaters, or their connection to a specific surface water course has not been confirmed by the countries concerned.

Long-term mean annual flow (km³) of rivers discharging to the Mediterranean Sea



Source: Global Runoff Data Centre, Koblenz.

EBRO RIVER BASIN[1]

The Ebro River rises near the Atlantic coast in the Cantabrian Mountains in northern Spain, drains an area of 86,000 km² between the Pyrenees and the Iberian mountains, and discharges through a wide delta into the Mediterranean Sea. The Ebro River Basin is shared by Andorra, France and Spain. Due to the very small share of Andorra and France in the total basin area, the Ebro River was not assessed in the present publication.

RHONE RIVER BASIN[2]

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 a.s.l., flowing through France to the Mediterranean Sea. Before entering the Mediterranean Sea the Rhone divides into two branches which form the Camargue delta; one of the major wildlife areas of Europe.

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

Basin of the Rhone River

Country	Area in the country (km²)	Country's share (%)
France	90 000	92
Switzerland	7 739	8
Italy	50	
Total	**97 789**	

Source: Freshwater in Europe – Facts, Figures and Maps. UNEP/DEWA-Europe, 2004.

Hydrology and hydrogeology

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 by river training works and land reclamation. The average elevation of the catchment area of the Rhone River in Switzerland is 1,580 m a.s.l.

In the Alpine Rhone in Switzerland, precipitation amounts to approximately 7.26 km³/year, and surface water resources generated upstream from Lake Geneva are estimated at 5.71 km³/year. The outflow of the Rhone below Lake Geneva is regulated.

[1] Based on the First Assessment.
[2] Based on information provide by Switzerland, the First Assessment, "The Rhone River: Hydromorphological and Ecological Rehabilitation of a Heavily Man-Used Hydrosystem" (Y. Souchon, Cemagref; available at http://cmsdata.iucn.org/downloads/france.pdf), as well as information on the official website of the French Water Information system for the Rhone-Mediterranean Basin (http://www.rhone-mediterranee.eaufrance.fr/) and of the Rhone-Mediterranean and Corsica Water Agency (http://www.eaurmc.fr/).

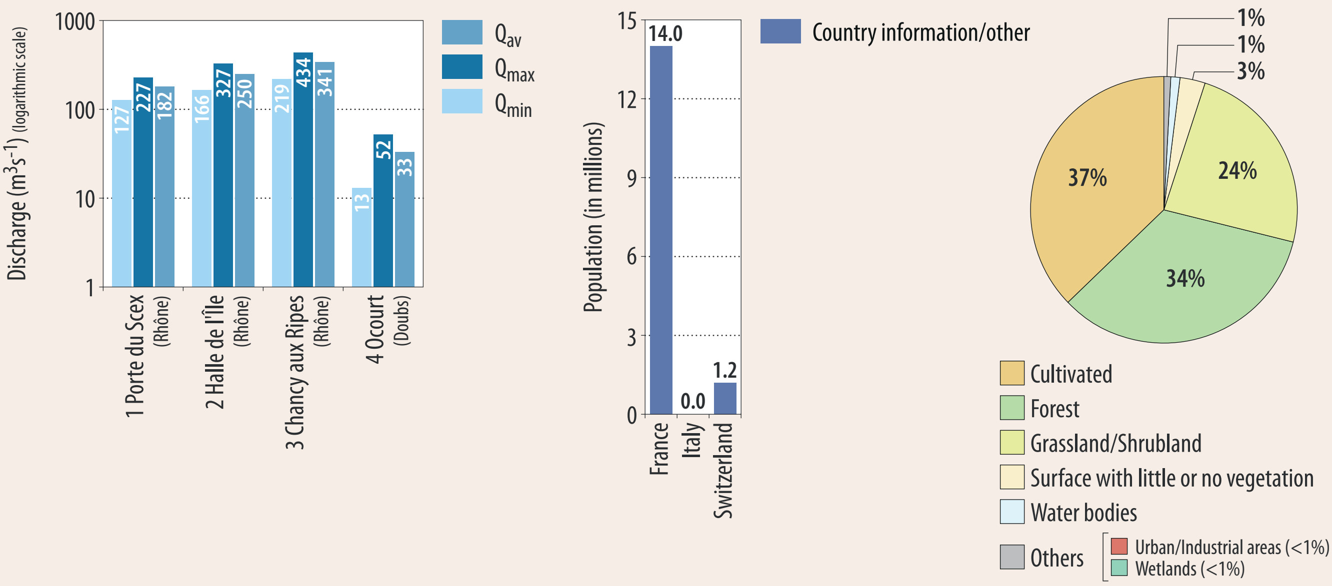
Source: UNEP/DEWA/GRID-Europe 2011.

The total water storage in the basin is 7 km^3, representing about 7.3% of the annual run-off 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.

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.

Natural groundwater flow from the Genevese aquifer (No. 123) — the main transboundary aquifer in the basin — to the Lake Geneva is about 789,000 m^3/year and to River Rhone about 1.9 × 10^6 m^3/year.

DISCHARGES, POPULATION AND LAND COVER IN THE RHONE RIVER BASIN



Sources: UNEP/DEWA/GRID-Europe 2011; OECD-EUROSTAT reporting for Switzerland in 2010 (the population figure for 2005); The Rhone-Mediterranean and Corsica Water Agency, France (the figure for Rhone-Mediterranean Basin).

GENEVESE AQUIFER (NO. 123)

	France	Switzerland
Silty-sandy gravel of glacial and glacio-fluvial origin (glacial period Wurm), lying directly on a Molasse formation; groundwater flow directions are from the Arve to the lake, and 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).		
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: mean, max (m)	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 of water has an impact on costs, social development and key sectors of economy.
Pressure factors	Annual average withdrawal from wells, five in France and ten in Switzerland, is 15.6×10^6 m^3 (1980-2010).	Local and moderate pressure from natural/background pollution, pollution from 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. Vulnerability mapping, protection zones for drinking water supply and water safety plans have been set up. A joint commission is in place for the protection and management of the joint resource.	
Other information		Private drilling and individual geothermal boreholes are an issue to groundwater protection: an attempt is made at getting the same level of legislation between Switzerland and France.

Pressures

In the whole Rhone-Mediterranean basin — and hence as indicative only for the Rhone Basin — some 70% of surface water withdrawn is for agricultural purposes, 15% for domestic use and 15% for industry. Groundwater is mainly used for domestic use (65%), and less for industry (25%) or for agriculture (10%).[3]

The main pressures in the Alpine Rhone section are hydropower production, intensive tourism, and recreation activities.

The main Rhone valley has been affected by river corrections and flood control measures, and is under pressure from settlements, traffic routes and industrial areas. The Rhone Basin is densely populated, and most of the pollution originates from agriculture, industry and transport. In the Swiss part of the basin, 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. Pesticides and herbicides, medicines and synthetic organic compounds from consumer products can pollute the surface waters and also infiltrate groundwaters. Trace concentrations of such micropollutants are increasingly being detected in surface waters and groundwaters. On the valley bottoms and agglomeration areas there is a pressure on river water quality from motorway traffic.

The damage potential of flooding is high in densely populated areas and in valley bottoms. Albeit periodical, flooding is assessed to have a widespread impact in Switzerland. In the lower part of the Rhone (the French part), flow regulation and hydropower production has been developed (as described above).

The importance of scarcity and drought, as well as thermal pollution, is ranked as local and moderate. Pressure from suspended sediments and mudflows are assessed as local but severe in Switzerland.

Status and transboundary impacts

The overall reduction of biodiversity of the river is evaluated as widespread but moderate in Switzerland; there is a scarcity of species whose life histories are linked to a dynamic fluvial system. Species preferring fast-moving water have declined, and communities shifted more to species living in marshes or pools. The impacts of change in physical habitat have been considerable in ecological terms. The morphology of the river channel has been altered by straightening and canalizing, in some places becoming eroded and incised. This is ranked as a widespread and severe pressure in the Swiss part of the Rhone, in the main Rhone valley. Furthermore, the level of groundwater has decreased. Due to groundwater depletion, several natural biotopes have disappeared, and riparian forest has evolved to hardwood forest. Dams block the migration of amphibiotic fish (such as shad, eel, and lamprey), and numerous lateral connections with tributaries or side channels have been modified, and sometimes cut off.

Transboundary cooperation and responses

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

A new agreement (following the 1978 agreement) relating to the use, recharge and monitoring of the 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 a joint commission allowed identification of the roles and responsibilities on each side, and determined the financial modalities governing the use of the resource. Cooperation evolved from the initial need to manage the aquifer to respond to groundwater depletion resulting from heavy abstraction. The agreement is a good example of advanced cooperation for the management of transboundary groundwater.

[3] Source: www.eaurmc.fr.

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).

In response to hydromorphological pressures, an amendment of the Swiss Water Protection legislation (Act and Ordinance) entered into force in 2011, demanding waters be returned to their natural functions and strengthening their social benefit, along with more stringent measures to eliminate the major negative environmental effects arising from hydroelectric power generation. The regulations also include a planning and financing scheme for the implementation of required measures.

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

Flood risk prevention in the Swiss part of the Rhone Basin includes a preliminary flood risk assessment and hazard mapping by 2011, along with the promotion of a modern flood protection policy.[4]

Trends

According to the climate scenarios available for the Alpine area, precipitation is predicted to increase during winters and decrease during summers. 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 of +2.7 °C by 2100.

The temperature rise and the significant reduction in the extent and volume of the snow cover will lead to changes in the hydrological run-off regime: stronger and longer-lasting low-flow conditions in summer, higher run-off in winter, 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 must be based on expert judgement.[5]

Climate change may cause more extreme events such as water scarcity and floods, which will have a negative impact on managed aquifer recharge, due either lack of water or to higher turbidity.

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

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 water bodies, and also cause structural changes to surface waters.

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, might aggravate conflicts concerning water.[7]

LAKE GENEVA/LAC LÉMAN[8]

Lake Geneva/Lac Léman is one of the largest lakes in Western Europe. It covers an area of some 580 km^2, and has a volume of 89 km^3. Approximately 60% of the lake surface area belongs to Switzerland, the rest to France. The lake forms part of the course of the river Rhone. The lake has a glacial origin, with an average depth of 153 m and a maximum depth of 310 m.

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

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

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

[5] *Source:* Aschwanden, H., Schädler, B. Climate Change and Water Resources Management. Proceedings of the 4th Yangtze Forum. Nanjing, China. April 2011. (The adaptation strategy in the field of water described in the paper is part of a wider initiative "Adaption to Climate Change in Switzerland – The National Strategy" (working title), which is under preparation.).

[6] *Source:* Aschwanden, H., Schädler, B. Climate Change and Water Resources Management. Proceedings of the 4th Yangtze Forum. Nanjing, China. April 2011.

[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.

LAKE GENEVA/LAC LÉMAN WETLAND AREA[9]

General description of the wetland area

There are four Ramsar Sites in the area of Lake Geneva/Lac Léman. Two of them were designated by France. The "Rives du Lac Léman" Ramsar Site includes 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 "Impluvium d'Evian" Ramsar Site is made up of seasonal and permanent freshwater marshes, forested and non-forested peatlands, rivers and streams. Both Ramsar Sites designated by Switzerland cover parts of the Rhone River: "Les Grangettes" Ramsar Site includes parts of the Rhone delta, open water, reedbeds, marshes, and riparian woodland; and "Le Rhône genevois – Vallons de l'Allondon et de La Laire" Ramsar Site covers a section of the Rhone River in and downstream from the city of Geneva, including the shores of the lake, riverbanks, and along two small tributaries, the Allondon and La Laire. While habitats include reedbeds, grasslands subject to seasonal inundation, and scrub and alluvial woodland, the key value of this site is that it includes some of the last remaining relatively unmodified stretches of the Rhone in Switzerland.

Main wetland ecosystem services

The lake 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 "Les Grangettes" Ramsar Site. 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 600-1,100 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 hydropower plants situated in the upper part of the Rhone, there are also two plants in operation at Verbois and Chancy-Pougny in the lower parts of the Rhone. The area of the "Impluvium d'Evian" Ramsar Site is particularly important for the production of "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

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 the village of Russin. Furthermore, its landscape and its climate give the area a special aesthetic value that is complemented by the multitude of historical monuments along the shores of the lake, such as castles and churches from the 11th to the 15th century.

Biodiversity values of the wetland area

The lake is the second most important wintering area for water birds in France. Areas of the lake (including parts of the Swiss side) are used as breeding and staging sites. Species include the Great Crested Grebe and the Black Kite, as well as large numbers of wintering ducks such as the Tufted Duck. In particular, "Les Grangettes" Ramsar Site also harbours small flocks of non-breeding Common Eider, an unusual range extension for this generally marine duck. Within Switzerland, the "Rhône genevois" offers one of the most important wintering sites for Goosander, as well as the Little Grebe.

In addition to various mammals in the surroundings, the lake supports over 60 fish species including the spirlin and the perch. The "Impluvium d'Evian" Ramsar Site provides an important habitat for invertebrates, in particular for two butterfly species, the Large Heath Butterfly and the Cranberry Fritillary, whose populations are in decline everywhere else in the region.

The area also offers a rich flora. Different species of orchids, such as the Fen Orchid, can be found.

Pressure factors and transboundary impacts

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 for biodiversity. The latter is also threatened by the increase in abundance of invasive species such as the Japanese Knotweed. Pollution was greatly reduced in the last decades. However, there is still need for reduction of the amounts of agricultural fertilizer, as well as micropollutants from agriculture, households and industry. Further threats include erosion as well as pressures from navigation and tourism activities.


Photo by Tobias Salathe

Transboundary wetland management

While 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, has been mostly focusing on the improvement of water quality. It is now also involved in restoration projects within the catchment area, in order to preserve biodiversity. CIPEL fulfils an important role as a government advisory body. Its policy recommendations are based on annual monitoring of the lake, and help coordinate water policy for the lake basin 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 micropollutants 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.

[9] *Sources:* Information Sheets on Ramsar Wetlands; CIPEL, Action Plan 2011-2020.

LAKE EMOSSON[10]

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 for hydropower generation. The water, collected from the Mont Blanc Massif, is channelled into the reservoir, located at an altitude of 1,930 m a.s.l. The water comes from the high valleys 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 % is generated in winter. The energy used for pumping represents 110 GWh per year.

PO RIVER BASIN[11]

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 into the Adriatic Sea (Mediterranean Sea). The average altitude of the basin area is 740 m a.s.l.

Near the outflow to the sea, the river forms a wide delta area, which presents a habitat of precious environmental and landscape value. The protected Bolle di Magadino area is located in the Swiss part of the basin.

Basin of the Po River

Country	Area in the country (km^2)	Country's share (%)
France	230	0.4
Italy	70 000	94.4
Switzerland	4 118	5.2
Total	**74 348**	

Hydrology and hydrogeology

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. The most significant transboundary river is the Ticino River, also shared by Italy and Switzerland.

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.

In the Swiss part of the basin, precipitation is 4.161×10^9 m^3/year, run-off is 3.099×10^9 m^3/year, and external inflow from adjacent basins/countries is reported to be 0.019×10^9 m^3/year.

Pressures and status

The Po River and its tributaries flow through several cities in Northern Italy. Pressures arise from agriculture, industry and urban areas. Some 37% of industry in Italy is in the Po Basin. Moreover, some 38% of the livestock and 36% of the agricultural production in Italy is located in the basin, even if the agricultural surface area in the basin represents only 24% of the total agricultural area in Italy.

The main water management problems in 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, landslides), and environmental conservation and restoration.

The fragmentation of administrative functions adds to the above problems. In the Italian part, the importance of the basin from the economic point of view and the deriving conflicts between users also generate tensions, which can be an obstacle to finding effective solutions.

Hydropower generation and the trend to increase hydropower production create pressures, which may be at odds with the protection of ecosystems. Issues related to the impacts of residual flow and hydro-peaking are assessed as moderate.

Responses and trends

Response measures (implemented and planned) in the Po River Basin Management Plan include, for example, policy integration; reduction of nutrient, organic compound and pesticide pollution; preservation of mountain basins; and improvement of land use, in order to mitigate hydrogeological risk and to improve environmental status of water bodies. Current actions also include saving and using water resources sustainably, especially in agriculture.[12]

The impacts of climate change in the Alpine part of the Po Basin are 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 summer — and snow cover is predicted to be affected by the higher temperatures, with changes to the run-off regime. Current actions related to climate change in the Italian part include the preparation of a Water Balance Plan.

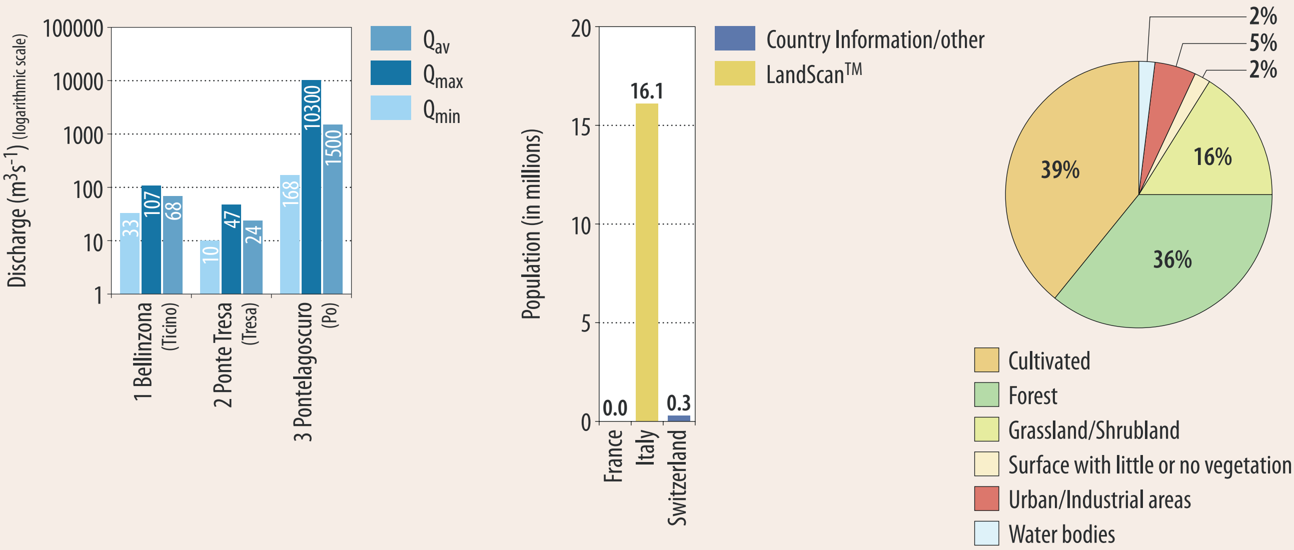
Total water withdrawal and withdrawals by sector in the Po River Basin

Country	Total withdrawal $\times 10^6$ m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Total (both countries)[a]	**20 537**	**80[b]**	**12[c]**	**7[d]**	**N/A**	**N/A**

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

[10] Based on the First Assessment.
[11] Based on information provided by Italy and Switzerland, and on the First Assessment.
[12] For information on the response measures taken in Switzerland to address the hydromorphological pressures and for flood control, please refer to the assessment of the Rhone.

DISCHARGES, POPULATION AND LAND COVER IN THE PO RIVER BASIN



Sources: UNEP/DEWA/GRID-Europe 2011; Po River Basin Authority, Italy; Hydrological Yearbook of Switzerland for 2008.

LAKE LUGANO[13]

Lake Lugano is shared by Italy and Switzerland, and is part of the Po River Basin. The lake is a popular location for recreation; being well-managed, recreation and tourism activities only have a moderate impact.

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

In 1972, the International Commission for the Protection of Italian-Swiss Waters (CIPAIS), was created with the aim of studying 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, such as eliminating phosphorus in detergents and cleaning products both in Italy and in Switzerland (1986), and improvement of treatment efficiency at the main wastewater 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 present, the external nutrient load derives from anthropogenic (85%), industrial (10%) and agricultural (5%) sources.

The catchment areas of Lake Maggiore and Lake 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.

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

[13] Based on the First Assessment.

LAKE MAGGIORE[14]

Lake Maggiore 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.

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.

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

During 1960s and 1970s the lake underwent a process of eutrophication; its 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 the elimination of phosphorus in detergents and cleaning products. The total phosphorus in-lake concentration is currently below 10 µg/l (at winter mixing), compared to a maximum value of 30 µg/l in 1978.

ISONZO/SOČA RIVER BASIN[15]

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

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

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

Basin of the Isonzo/Soča River

Country	Area in the country (km^2)	Country's share (%)
Italia	1 150	34
Slovenia	2 250	66
Total	3 400	

Hydrology and hydrogeology

Precipitation in the basin varies significantly, ranging from 1,000 mm/year in the plain area up to 3,100 mm/year in the Alpine area.

The basin area is characterized by the presence of groundwater bodies related to different transboundary aquifers, which are hydrogeologically different even if hydraulically connected. The Isonzo River's clastic alluvials (mainly gravel and sand of Quaternary age) form a porous aquifer system. In the sub-basin of the Timavo River, there is a karst and fractured aquifer in rock (mainly Cretaceous carbonatic sequences).

In the southern part of the basin, the river recharges the aquifers through the permeable alluvial deposits.

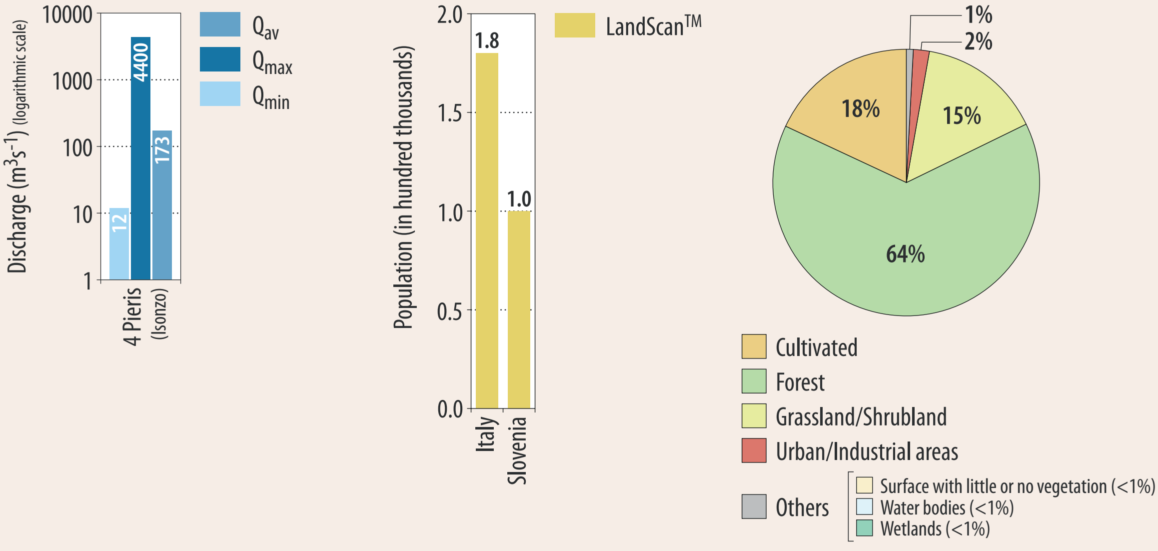
The Soča aquifer system (fissured, dominantly dolomite and limestone aquifers of western catchment area of Isonzo/Soča river)[17] is divided into the transboundary groundwaters of Rabeljski rudnik (No. 124) and Kobariški stol (No. 125).

RABELJSKI RUDNIK AQUIFER (NO. 124)

	Italy	Slovenia
Type 2; Triassic carbonates, karstic limestones and dolomites, marlstones; unconfined aquifer; dominant groundwater flow from Italy to Slovenia.		
Area (km^2)	N/A	66
Thickness: mean, max (m)	N/A	>1 000 m, -
Pressure factors	N/A	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 below risk limits for human health. Special threshold values have not been defined.
Groundwater management measures	N/A	The condition and stability of the mine's dewatering tunnel need to be thoroughly investigated, and protective measures should be taken to decrease accident risk.
Other information	N/A	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. Population: 167.

[14] Based on the First Assessment and on information posted on the web site of the CIPAIS (http://www.cipais.org).
[15] Based on information provided by Italy and Slovenia, and on the First Assessment.
[16] The river is known as Isonzo in Italy and Soča in Slovenia.
[17] Based on information provided by Slovenia.

DISCHARGES, POPULATION AND LAND COVER IN THE ISONZO/SOČA RIVER BASIN



Sources: UNEP/DEWA/GRID-Europe 2011; Ministry of the Environment, Land and Sea, Italy.

KOBARIŠKI STOL AQUIFER (NO. 125)

	Italy	Slovenia
Type 3; Triassic and Jurassic limestones, carbonates, karstic limestones; unconfined; dominant groundwater flow from Italy to Slovenia; recharge and discharge areas are located both in Slovenia and Italy, possible discharge to surface water systems occurs from the karstic area near Kobarid into the gravel fill of Isonzo/Soča valley and reverse.		
Area (km²)	N/A	37
Thickness: mean, max (m)	N/A	>300, -
Groundwater uses and functions	N/A	Groundwater is not currently used but is considered to be a strategic reserve for drinking water supply.
Pressure factors	N/A	Microbial pollution and turbidity are the main problems observed during rain events.
Groundwater management measures	N/A	The groundwater resource 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 to the issue of joint management, using groundwater as a regional drinking water source should be considered. International cooperation can be of support on both issues.
Other information	N/A	Population: 480 (13 inhabitants/km²).

The aquifer system of Brestovica (highly karstified aquifers on the Adriatic coast and Timavo River)[18] is divided into the transboundary groundwaters of Osp-Boljunec (No. 126) and Brestovica (No. 127).

OSP-BOLJUNEC GROUNDWATER BODY (NO. 126)

	Italy	Slovenia
Type 2; Cenozoic/Quaternary dominantly carbonates, karstic limestones, and partly carbonate-silicate alluvial; unconfined; dominant groundwater flow direction from Slovenia to Italy.		
Area (km²)	N/A	36
Groundwater uses and functions	N/A	Local drinking water supply.
Other information	N/A	Population: 769 (21 inhabitants/km²).

Pressures, status and transboundary impacts

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

In both countries there are dams along the river that can create pressure on natural river discharges. The Salcano, Sottosella and Canale Dams are situated in Slovenia, and Crosis Dam in Italy. The Salcano Dam is used for flood regulation; the reservoir operations have a direct influence on the downstream discharge, creating conflicts mainly with the agricultural uses in the Italian part of the basin (on top of possible impacts on ecosystems due to hydro-peaking).

[18] Based on information provided by Slovenia.

BRESTOVICA AQUIFER (NO. 127)

	Italy	Slovenia
Type 2; dominantly Cretaceous, partly Tertiary carbonates, and karstic limestones; unconfined; dominant groundwater flow direction from Slovenia to Italy but partly also from Italy to Slovenia.		
Area (km²)	N/A	499
Groundwater uses and functions	N/A	The aquifer is of major importance for the whole Slovenian karst area as it is the only drinking water source for the region, and is also used to supply south-west Slovenia, since a large volume of groundwater is transferred to the coastal zone during drought events. Groundwater covers 90% of the water used. Groundwater maintains baseflow and springs.
Pressure factors	N/A	Waste disposal (landfill near Sezana), agricultural activities (extensive vineyards), transportation (important roads and railroads) and groundwater abstraction (drinking water supply) are important pressure factors. Pressures from urban wastewater are also important. Groundwater is of good quality for water supply; however turbidity and bacteria occurrence during intensive precipitation events is an issue of concern.
Groundwater management measures	N/A	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	N/A	International cooperation is needed to: develop transboundary water protection areas; develop the groundwater resources potential for the water supply of the coastal area; develop regional waterworks systems; prepare a strategic plan for the development of settlements; and detailed research of fresh water/salt water interface. Makes up part of the Brestovica aquifer system. Population: ~20 700 (41 inhabitants/km²).

VRTOJBENSKO POLJE AQUIFER (AQUIFER SYSTEM OF GORICA-VIPAVA VALLEY, ALLUVIAL GRAVEL AQUIFER OF VIPAVA AND SOČA RIVERS) (NO. 128)[19]

	Italy	Slovenia
Type 2; Quaternary carbonate-silicate alluvial; unconfined.		
Area (km²)	N/A	9
Groundwater uses and functions	N/A	Local drinking water supply.
Other information	N/A	Land is mainly used for agricultural activities (67% of land area); 29% is covered by urban and industrial areas and 3% by forests. Population: ~5 000.

Dumped mining residues of the Idrija mercury mine in Slovenia cause mercury contamination in marine sediments. Wastewater discharges from Nova Gorica in Slovenia are flushed into the Corno River, causing organic contamination on the Italian side of the Isonzo/Soča Basin. In general, organic matter from wastewater discharges and heavy metals cause a transboundary impact, and affect the water quality in the Adriatic Sea.

Between Italy and Slovenia there are differences in the local water uses, and in the quantity and quality status of waters, which creates a possibility of conflicts.

According to Italian data,[20] eight monitoring stations show a "good status" of surface waters, and one station a "high" status.

Transboundary cooperation and responses

The River Basin Management Plan of the Eastern Alps Hydrographic District in Italy recognizes the Permanent Italian-Slovenian Commission for Hydro-economy as the official body in which to discuss transboundary water problems. The first step of the Commission was to set up an expert group to prepare a road map for the implementation of the "First Italian Slovenian Isonzo-Soča Common Management Plan".

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

Total water withdrawal and withdrawals by sector in the Isonzo Basin

Country	Total withdrawal $\times 10^6$ m³/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Italy	N/A	64	5	4	27	N/A
Slovenia	N/A	N/A	N/A	N/A	N/A	N/A

[19] Based on information provided by Slovenia.
[20] *Source:* Ministry of the Environment, Land and Sea, Italy.

KRKA RIVER BASIN[21]

Basin of the Krka River

Country	Area in the country (km²)	Country's share (%)
Bosnia and Herzegovina	300	12
Croatia	2200	88
Total	**5 613**	

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

Hydrology and hydrogeology

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).

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

Hydrogeologically, the basin of the upper course of the Krka River around the town of Knin and the Kosovo Polje valley is mostly made up of impermeable and poorly permeable deposits, less vulnerable to pollution transport.

Pressures, status and transboundary impacts

The main forms of land use include grasslands (44%), forests (30%) and cropland (15%).

In the Croatian part of the basin, 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%.

The pressure from agriculture is insignificant as agricultural production of fruits, vegetables and olives is still low, as is animal husbandry. However, production is slowly increasing, which in turn may lead to increasing pressure and transboundary impact. Sustainable agriculture and technological development are necessary.

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

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

There are still unfinished sewerage systems and untreated urban wastewaters from Knin (40,000 p.e.) and Drniš (10,000 p.e.) towns. The three controlled dumping sites do not cause significant impact; however, there are also several small illegal dumpsites. The generally good chemical status of groundwater in the Krka River basin indicates insignificant salinization and seawater intrusion.

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

The water bodies mostly have 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 Drniš and Knin, which are located upstream. Phosphorus concentrations have increased in some areas, but not significantly. BOD and COD have increased, particularly in the vicinity of Knin. The area of the port of Šibenik is extremely eutrophic.

Reduced springflow in Bosnia and Herzegovina results in ecosystem degradation; nevertheless the Krka aquifer (No. 129) is not at risk.

Responses and trends

Croatia has partly transposed the WFD into its legal framework. A river basin management plan (in accordance to the WFD) has been developed for the Krka river basin, being a pilot for the country.

There was an oil spill 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.

The tourism sector has developed favourably in the past years, and the capacity to receive tourists is planned to increase.

NERETVA RIVER BASIN[23]

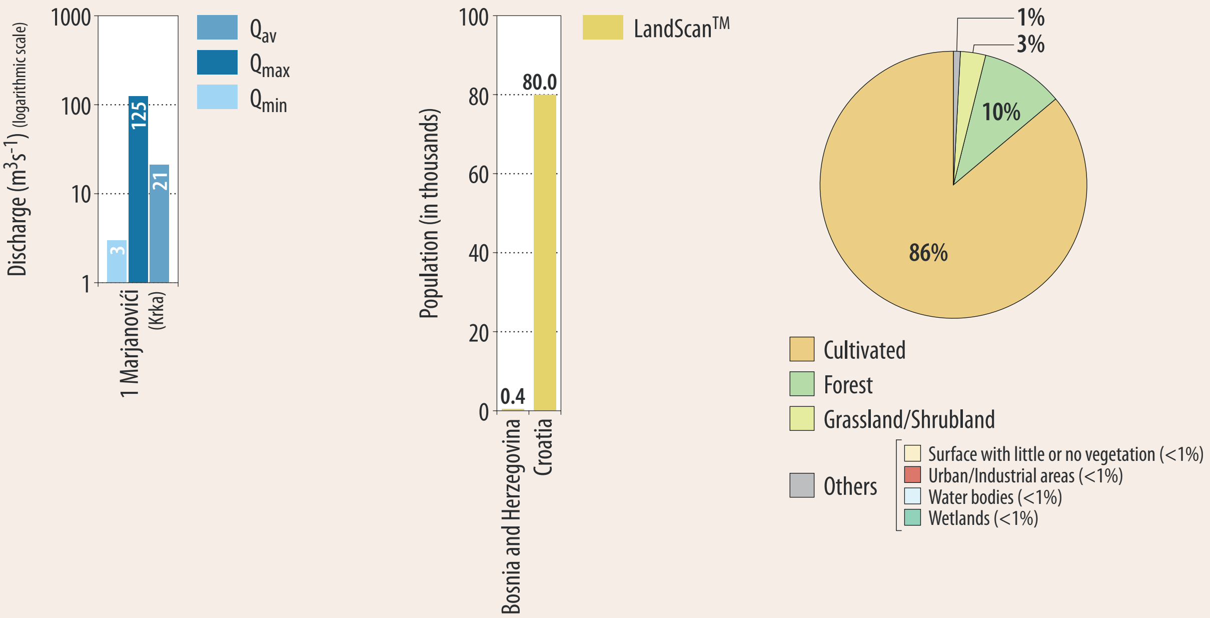
The Neretva River basin is shared by Bosnia and Herzegovina and Croatia, and through the Trebišnjica River, which is hydraulically connected with the Neretva, also by Montenegro. Some 10,100 km² of the basin area is in Bosnia and Herzegovina, and 280 km² in Croatia.[24]

KRKA AQUIFER (NO. 129)[22]

	Bosnia and Herzegovina	Croatia
Does not correspond to any of the described model aquifer types; Cretaceous karstic limestone; strong links to surface water system; groundwater flow from Bosnia and Herzegovina to Croatia.		
Groundwater uses and functions	>95% to support ecosystems, <5% for drinking water.	Drinking water supply.
Pressure factors	Solid waste disposal; polluted water locally drawn in the aquifer.	Industry.
Management measures	Groundwater quantity and quality monitoring need to be improved, as do abstraction control, protection zones and wastewater treatment.	Protection zones need to be established. The two countries should cooperate for the delineation of transboundary groundwaters, and in the field of monitoring.
Other information	Border length 42 km. Not at risk.	Border length 42 km. Transboundary aquifer under consideration, but not approved.

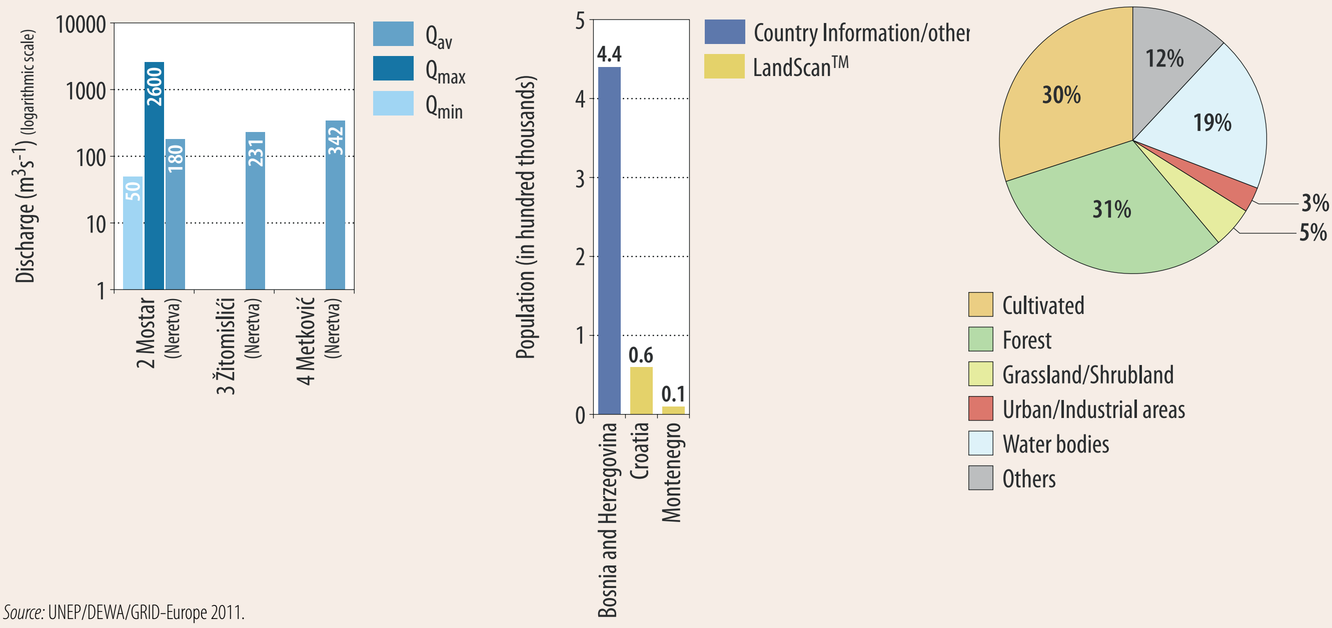
[21] Based on information from Croatia and the First Assessment.
[22] Based on information from the First Assessment.
[23] Based on information from Bosnia and Herzegovina, Croatia; the Environmental Performance Review of Bosnia and Herzegovina (UNECE 2004); and the Neretva and Trebišnjica Management Project, Appraisal Document, The World Bank/GEF.
[24] Including also the basin of the Trebišnjica River.

DISCHARGES, POPULATION AND LAND COVER IN THE KRKA RIVER BASIN



Source: UNEP/DEWA/GRID-Europe 2011.

DISCHARGES, POPULATION AND LAND COVER IN THE NERETVA RIVER BASIN



Source: UNEP/DEWA/GRID-Europe 2011.

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

The Lower Neretva valley contains the largest and the most valuable remnants of Mediterranean wetlands on the eastern Adriatic coast, and is one of the few areas of this kind remaining in Europe. The area is a significant 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 into Bosnia and Herzegovina has protected status and Herzegovina has protected status (Hutovo Blato Nature Park). The Hutovo Blato (74.11 km^2) has been designated as a Ramsar Site (2001), and so is the delta area extending in Croatia (designated in 1993). Five protected areas exist in the Croatian part of the delta, covering a total area of 16.2 km^2; two other sites (total of 7.77 km^2) have also been proposed for designation. The 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 also includes Dinaric karst water ecosystems.

Hydrology and hydrogeology

Major transboundary tributaries of the Neretva 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).

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

The karst geology of the area results in high interaction between surface waters and groundwater. The Trebišnjica and Trebižat Rivers are characteristic examples. The Trebišnjica River emerges near Bileća town (Bosnia and Herzegovina). It is a characteristic example of a "sinking river" that 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[26] is also a "sinking river"; the Vrljika River (Croatia) drains into the underground and re-

NERETVA RIGHT COAST AQUIFER (NO. 130)[25]

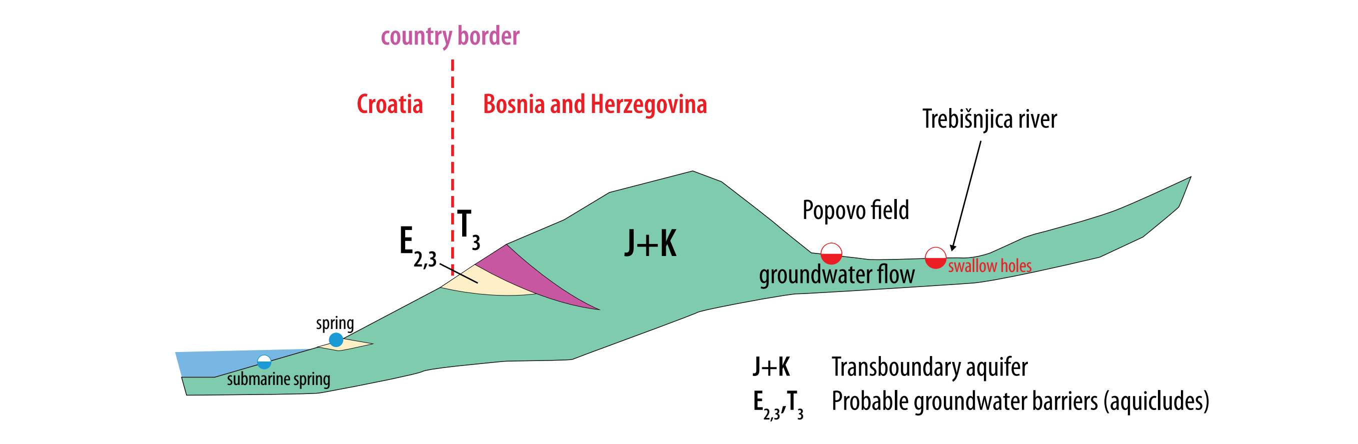
	Bosnia and Herzegovina	Croatia
Does not correspond to any of the described model aquifer types; Cretaceous limestones and dolomites and Eocene flysch; medium to strong link to surface waters; groundwater flow from Bosnia and Herzegovina to Croatia.		
Area (km^2)	> 1 600	862
Thickness: mean, max (m)	250-600, 600-1000	250-600, 600-1000
Groundwater uses and functions	Predominantly 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. An agreed delineation of transboundary groundwater is needed.

[25] Based on information from Bosnia and Herzegovina, Croatia and the First Assessment.
[26] The river is also known as Tihaljina and Mlade.

TREBIŠNJICA/NERETVA LEFT COAST AQUIFER (NO. 131)[27]

	Bosnia and Herzegovina	Croatia
Does not correspond to any of the described model aquifer types (see Figure 1); Triassic, Jurassic, Cretaceous layered and massive limestones, with local Eocene flysch; groundwater flow from Bosnia and Herzegovina to Croatia; medium to strong links to surface water systems.		
Border length (km)	124	124
Area (km²)	>2 000	242
Thickness: mean, max (m)	1 000, 2 500-3 000	1 000, 2 500-3 000
Groundwater uses and functions	50-75% for hydroelectric power, <25% for drinking water supply and irrigation, also used to support ecosystems. Groundwater is 100% of total water use.	Dominantly drinking water supply (Slamo and Ombla springs), supplies Dubrovnic. Groundwater is 100% of total water use.

Figure 1: Sketch of the Trebišnjica/Neretva Left aquifer (No. 131) (provided by Bosnia and Herzegovina)



BILEKO LAKE AQUIFER (NO. 132)[28]

	Bosnia and Herzegovina	Montenegro
Does not correspond to any of the described model aquifer types; Triassic, Jurassic and Cretaceous limestones and dolomites; weakly linked to surface waters; groundwater flow from Montenegro to Bosnia and Herzegovina.		
Area (km²)	>1 000	N/A
Thickness: mean, max (m)	-, 3 000	-, 3 000
Groundwater uses and functions	>75% for hydroelectric power, small amounts for drinking water and irrigation. Groundwater provides 100% of total water use.	N/A
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.	

emerges at the Tihaljina spring (Bosnia and Herzegovina), then flows as the Tihaljina-Mlade-Trebižat River.

Pressures and transboundary impacts

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

Both Neretva and Trebišnjica are particularly important in terms of energy production. In Bosnia and Herzegovina's part of the Neretva and Trebišnjica basins, there are 13 reservoirs. Dams with accompanying reservoirs on the Neretva include those of Jablanica, Grabovica, Salakovac and Mostar. A hydroelectric production system has been constructed on the Trebišnjica River. This includes two dams on the river (Trebinje I or Grančarevo and Ttrebinje II, in the Bosnia and Herzegovina) and two channels: a channel through Popovo polje (Popovo field) towards Čapljina plant (Bosnia and Herzegovina), and a second one across the borders towards Dubrovnik plant (Croatia). Additional infrastructure is planned to be constructed through the "Upper horizons" project, which involves regulation of Gatačko, Nevesinjsko, Dabarsko and Fatničko fields. A hydropower plant exists also in the Rama River.

The operation of the different existing infrastructures should be coordinated, taking into account upstream/downstream uses and needs, as well as evolving climatic conditions, so as to prevent potential negative impacts on ecosystems and economic activities. Plans for future hydropower development in both countries should also take these factors into account.

Alteration of the hydrological regime as a consequence of water use for agricultural, municipal, industrial, and hydropower generation purposes is a pressure factor. There are water losses due to degraded water supply and distribution systems, and the efficiency of agricultural water use is limited. Other problems include reclamation of wetlands, uncontrolled urbanization and excessive illegal hunting and fishing in the wetlands. The erosion of riverbeds and land, as well as the decline of ground-

[27] Based on information from Bosnia and Herzegovina, Croatia and the First Assessment.
[28] Based on information from the First Assessment.

water levels in the Trebišnjica/Neretva Left coast aquifer (No. 131), have been observed in Bosnia and Herzegovina, together with a reduced springflow in both Neretva Right coast (No. 130) and Trebišnjica/Neretva Left coast aquifers (No. 131).

Point-source pollution (from untreated municipal and industrial wastewaters and uncontrolled dumpsites, both for municipal and industrial wastes) and diffuse pollution (due to unsustainable agricultural practices) exert pressure both on surface waters and on aquifers. The widespread but moderate drawing of polluted water in the Neretva Right coast (No. 130) and Trebišnjica/Neretva Left coast aquifers (No. 131) exacerbates the situation. Bosnia and Herzegovina reported that water pollution by nutrients, pesticides, heavy metals and organic compounds are issues of concern. Access by the population to sanitation systems has been low in Bosnia and Herzegovina, and there is room for improvement in treatment facilities for municipal wastewater. There is pollution from municipal wastewater in the areas of Metković, Rogotin and Opuzen in Croatia. The following has been reported: occasional microbiological pollution in the Neretva Right coast (No. 130) and the Trebišnjica/Neretva Left coast aquifers (No. 131) in Croatia; moderate nitrogen, pathogen and organic compounds pollution in the Neretva Right coast aquifer (No. 130); and wide but moderate nitrogen, pathogens and heavy metals and some local, moderate pesticide pollution in the Trebišnjica/Neretva Left coast aquifer (No. 131) in Bosnia and Herzegovina. Groundwater pollution has effects at the transboundary level.

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

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 may, for example, cause impacts of point pollution that occur downstream to be transported in groundwater to other parts of the basin.

Responses

A number of water resource management plans and measures are implemented in Croatia, reflecting the changes made to water management legislation, aimed towards harmonizing it with EU standards and the requirements of the WFD. The preparation of a River Basin Management Plan in accordance with the WFD by Croatian Waters, in cooperation with the Ministry of Regional Development, Forestry and Water Management, is underway.

Bosnia and Herzegovina has established protection zones for drinking water supply for the Neretva Right coast aquifer (No. 130). Wastewater treatment plants exist in the area, but improvements are needed. Vulnerability mapping is planned for the Neretva Right coast (No. 130) and the Trebišnjica/Neretva Left coast aquifers (No. 131) in Bosnia and Herzegovina. Groundwater quantity is being monitored in the Neretva Right coast aquifer (No. 130) in Bosnia and Herzegovina, while groundwater quality is being monitored in Bilećko Lake aquifer (No. 132); improvements are, however, necessary in both cases. Data on Trebišnjica/Neretva Left coast aquifer (No. 131) has been exchanged between the two countries, but improvement is needed in this regard; enhanced monitoring is needed in both countries.

Monitoring of water flow and quality is being improved; more efforts are needed in the area of biological monitoring. This will allow the assessment of the 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 the national institutional capacity to plan, implement and enforce management measures on water demand and water use is indispensable.

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

Transboundary cooperation

An agreement between Bosnia and Herzegovina and Croatia on Water Management Relations was signed in 1996, and is implemented through a joint commission, which is also the key bilateral mechanism for transboundary cooperation in the Neretva and Trebišnjica basins.

A Memorandum on Cooperation on the Neretva River was signed among Bosnia and Herzegovina, Croatia, the 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 the Neretva River, hydropower utilization, and water supply were among the priority themes.

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.

A GEF/World Bank project has been initiated with the objective to support IWRM in the basin, by harmonizing management approaches and legal frameworks across the two countries, and by ensuring improved stakeholder participation at all levels. The WFD principles and guidelines are used for what concerns the preparation of the river basin management plan. The Commission has been involved in the project preparation, and will oversee its implementation.

Trends

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.

Rural tourism is under development in Croatia; it may foster the reduction of pressures in the delta area of Neretva.

BILEĆA RESERVOIR/BILEĆKO LAKE[29]

Bileća Reservoir/Bilećko Lake is located in the territory of 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 the goal of exploiting the hydro-energy power of the Trebišnjica River. The length of the reservoir is about 17 km, and width ranges between 250 and 5,400 m. At largest, the surface area of the lake is about 27.8 km^2, with a volume of about 1,278 × 10^6 m^3. The 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.

Water from the lake is used for hydropower generation at the hydro-power plants of Trebinje in Bosnia and Herzegovina, and of Dubrovnik in Croatia.

DRIN RIVER BASIN[31]

The Drin River starts at the confluence of its two headwaters, the transboundary Black Drin[32] and White Drin[33] Rivers at Kukës in Albania. The interconnected hydrological system of the Drin River basin comprises the transboundary sub-basins of the Black Drin, White Drin, and Buna/Bojana[34] (outflow of Skadar/Shkoder Lake in the Adriatic Sea) Rivers, and the sub-basins of Prespa, Ohrid and Skadar/Shkoder[35] Lakes.

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[36]

Water flows out of Lake Ohrid (average discharge: 22 m^3/s) into the Black Drin River near Struga, in the former Yugoslav Republic of Macedonia. The Radika River is a major transboundary tributary of the Black Drin. The river runs 149 km (as Drin i Zi) until Kukës, 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.

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

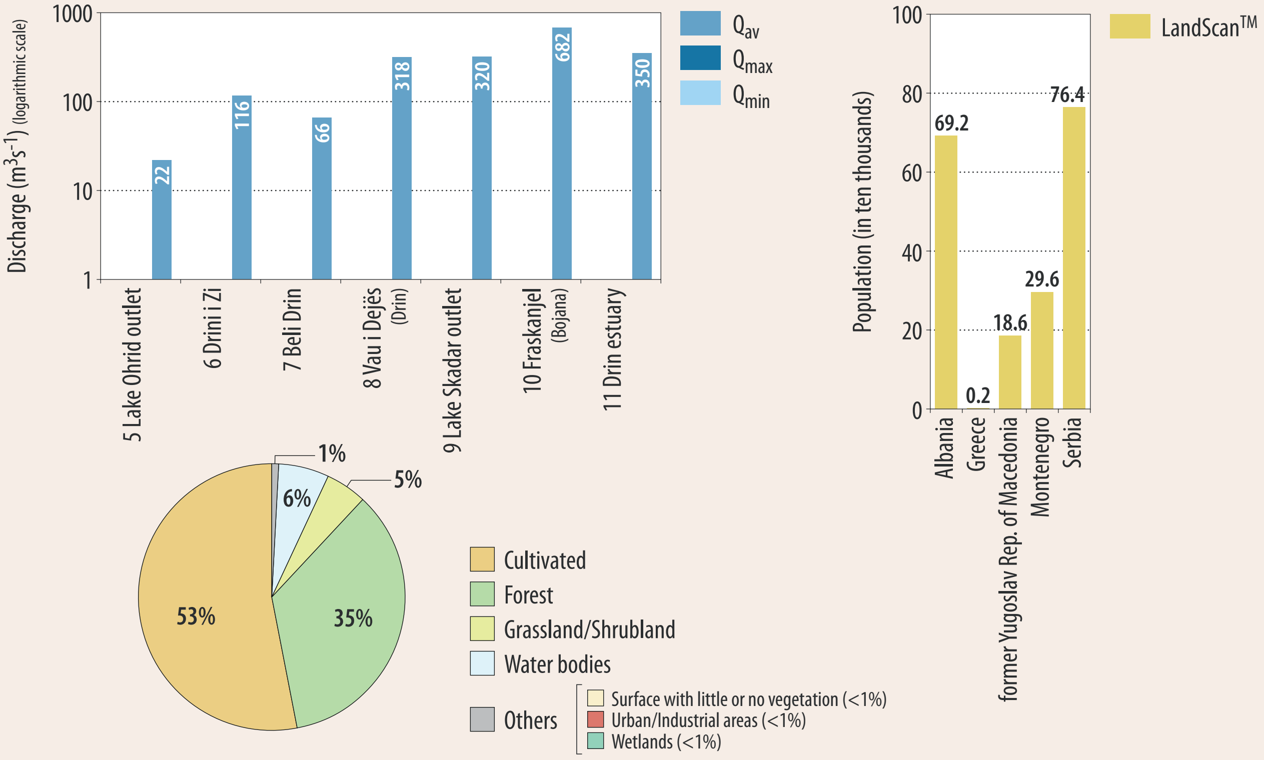
The White Drin is hydraulically connected with the shared karstic Beli Drim/Drini Bardhe aquifer (No. 133).

BELI DRIM/DRINI BARDHE AQUIFER (NO. 133)[30]

	Albania	Kosovo (UN administered territory under UN Security Council Resolution 1244)
Type 3; Lower and Upper Cretaceous karstic and dolomitised limestone, Miocene to Quaternary multilayer sequence; groundwater flow from Kosovo (UN administered territory under UN Security Council Resolution 1244) to Albania; medium to strong links with surface waters.		
Border length (km)	30	30
Area (km^2)	170	1 000
Thickness: mean, max (m)	100, 200	N/A
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.

[29] Based on information provided by Bosnia and Herzegovina.
[30] Based on information from the First Assessment.
[31] Based on information from Montenegro; the First Assessment; and on Faloutsos D., Constantianos V. and Scoullos M. Status Paper - Management of the extended Transboundary Drin Basin. GWP-Med, Athens. 2008. Some information was also provided by the former Yugoslav Republic of Macedonia and Albania. The same sources were used for the assessments of Lake Ohrid, Prespa Lakes and Lake Skadar/Shkoder.
[32] The river is called Drin i Zi in Albania and Crn Drim in the former Yugoslav Republic of Macedonia.
[33] The river is called Drin i Bardhë in Albania and Beli Drin in Kosovo (UN administered territory under UN Security Council Resolution 1244).
[34] The river is called Buna in Albania and Bojana in Montenegro.
[35] The lake is called Skadar in Montenegro and Shkoder in Albania.
[36] Some additional hydrological information is given in the table "Characteristics of the shared water bodies".

DISCHARGES, POPULATION AND LAND COVER IN THE DRIN RIVER BASIN



Source: UNEP/DEWA/GRID-Europe 2011.
Note: The map in the assessment of the Neretva should be referred to for the locations of the gauging stations.

Pressures, status and transboundary impacts

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

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 began in 2009 near Skadar/Shkoder, with capacity downscaled to 40 megawatts (MW) from the original 80 MW, after consultations with Montenegro. There are plans for the construction of an additional plant (Skavica, planned installed capacity of 350 MW), — the process for the expression of interest was initiated in 2008. Two major dams, Globochica and Spilja, exist on the Black Drin in the former Yugoslav Republic of Macedonia, with a main purpose of hydropower production. The alteration of the hydrological characteristics of the 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 on biodiversity.

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

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 (No. 133) is concerned. Nitrogen, pesticides and pathogens (only locally in Albania) have been observed.

In the Black Drin sub-basin, 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 in water demand in the Black Drin sub-basin catchment area[38] for drinking water, irrigation and fisheries will result in increased pressure on the system.

Water demands in the Black Drin Basin District in the former Yugoslav Republic of Macedonia (for 2008 and projection for 2020)[37]

	Year	Total demands $\times 10^6$ m³/year	Population and tourists $\times 10^6$ m³/year	Industry $\times 10^6$ m³/year	Irrigation $\times 10^6$ m³/year	Fisheries $\times 10^6$ m³/year	Minimum accepted flow $\times 10^6$ m³/year
Black Drin River Basin District	2008	274.3	21.2	8.2	49.7	31.3	164
	2020	446.7	36.8	8.6	98.6	138.7	164
Total in the country	**2008**	**2 227.9**	**218.3**	**274.1**	**899.3**	**202.1**	**635**
	2020	**3 491.3**	**348.3**	**287.0**	**1 806.7**	**414.3**	**635**

[37] Second National Communication on Climate Change. Ministry of Environment and Physical Planning, the former Yugoslav Republic of Macedonia, 2008.
[38] 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 Crn 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 km2, or 13.1% of the total territory of the country. The average annual volume of discharged water is approximately 1.64×10^9 m³.

Considerable nutrient loads are 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. In the lower parts of the drainage system, in the Buna River, most of the phosphorus load derives from agriculture, however, 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.

Responses[40]

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]

Numerous measures are needed with regard to Beli Drim/Drini Bardhe aquifer (No. 133); priority should be given to monitoring 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.

LAKE OHRID

Lake 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. The lake is shared by the former Yugoslav Republic of Macedonia and Albania.

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. Lake Ohrid area has been a UNESCO World Natural Heritage Site since 1980. The lakeshore reedbeds and wetlands provide a critical habitat for a high number of wintering water birds, including rare and threatened species.

Hydrology and hydrogeology[42]

Water balance of Lake Ohrid[43]

	Inflow ($\times 10^6$ m^3/year)	Outflow ($\times 10^6$ m^3/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).

Pressures, transboundary impacts and responses

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, and consequently the agricultural run-off and sediment input. Sediment loads have also increased, 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 an improved situation in this regard.

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

Unsustainable agricultural practices exert pressure, leading to pesticides and nutrient pollution. A lack of, or inadequate municipal wastewater 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 (No. 134). Sewage from Pogradec (Albania) has been a major contributor of phosphorus and organic load. The newly-built collection and treatment facilities, which allow treatment of the wastewaters of some 25,000 inhabitants, with further stages planned, are expected to improve the situation. They will also reduce the levels of faecal pathogens. Reduction of pollution from municipal wastewaters has been achieved in the former Yugoslav Republic of Macedonia’s side of the lake, where a sewerage system was constructed that collects wastewater from shoreline communities; treating about 65% of wastewater[44] of the Ohrid – Struga region (in the Black Drin catchment) in a plant with a capacity of 120,000 p.e. and discharging it in the Black Drin. There are plans for the construction of additional systems in the area.

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.

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.

The commercially important fish species in Lake Ohrid, including the famous Lake Ohrid trout, have been over-harvested in recent years, and the populations 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. The alteration of the reed zones has caused deterioration of habitats, also threatening the spawning and wintering grounds of fish species.

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

[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 and others 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, somewhat higher than the corresponding figure for the Danube basin (0.7 kg/ha; Schreiber and others 2003). Source: Borgvang A. and others., “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 referring to the sub-basins of the Drin Basin.

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

[42] See also the respective part in the assessment for Lake Prespa. Some additional hydrological information is given in the table on Characteristics of the shared water bodies.

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

[44] This was the situation with wastewater treatment in 2006.

Transboundary cooperation

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

The development of a "Transboundary Watershed Management Plan" was prepared under the GEF project and endorsed in October 2003, but restricted resources have had an impact on its implementation.

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; the Lake Ohrid Watershed Committee 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 Committee, having as their main duty to assist in the harmonization of related pieces of legislation in the two countries.

PRESPA LAKES

Prespa comprises two Lakes separated by a natural 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 (reconstructed 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[46]

The Prespa Lakes Basin, situated at a mean elevation of 850 m a.s.l., has no surface outflow; its waters drain into Lake Ohrid, which sits at 150 m lower, through the Mali Thate-Galicica karst massive. Lakes Prespa and Ohrid are part of the same hydrogeological basin, and the Prespa and Ohrid Lakes Aquifer (No. 134) is the connecting agent.

PRESPA AND OHRID LAKE AQUIFER (NO. 134)[45]

	Albania	The former Yugoslav Republic of Macedonia	Greece
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.			
Border length (km)	40 with Greece	20 with Greece	40 with Albania, 20 with the former Yugoslav Republic of Macedonia
Area (km^2)	262	972	291
Thickness: mean, max (m)	400, 550	N/A	200, 330

Water quality determinands

Parameter	Unit	Lake Macro Prespa[a]	Lake Ohrid[b]	Lake Skadar/Shkoder[c]
Temperature	°C	4-24.6	6-21.8	16-30
Transparency (Secchi disc)	m	2.5-5	10-20.5	-
Dissolved oxygen	mg/l	0-14	6.92-15.74	5.2-9.2
Oxygen saturation	%	0-131.03	62.71-166.57	60-120
BOD_5	mg/l	0.15-3.3	0.09-2.65	2-4
CO_2	mg/l	0-2.26	0-4.22	-
$KMnO_4$ consumption	mg/l	7.77-10.84	1.14-7.11	2.5-3.2
Total phosphorus	µg/l	0-66	0-36	>0.10
Total nitrogen	µg/l	210-792	100-551.4	-
Chlorophyll[d]	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[d])		Mesotrophic	Oligotrophic	Oligotrophic

[a] Information by the Ministry of Environment and Physical Planning, the former Yugoslav Republic of Macedonia.
[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.
[d] Eutrophication of waters: monitoring, assessment and control. OECD, Paris. 1982.

[45] Based on the First Assessment. All the data in the table refers only to the Prespa basin and not to the Ohrid basin.
[46] See also the respective part in the assessment for Lake Ohrid; some additional hydrological information is given in the table "Characteristics of the shared water bodies".

Characteristics of the shared water bodies[47]

	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,[a] the former Yugoslav Republic of Macedonia	Albania, Montenegro	Albania, Montenegro
Origin	Tectonic and karstic	Tectonic	-	Tectonic-karstic	-
Catchment area (km²)	1 524.9[b] 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 the White and Black Drin Rivers and Ohrid and Prespa Lakes) Albania: 5 973 km²	5 409 Montenegro: 80% Albania: 20%	19 582 (including the catchments of the Drin River and the Skadar/ Shkoder Lake)
Lake's surface area (km²)	Macro Prespa: 253.6–259.4 (282)[c] 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 (km³)	Macro Prespa 3.6 (4.8)[c]	55.4	-	1.7 – 4	-
Lake's mean depth (m)	Macro Prespa: 18[b] Micro Prespa: 4.1[b]	163.7	-	5	-
Lake's maximal depth (m)	Macro Prespa: 48 (54)[c] Micro Prespa: 8.4	288.7	-	8.3 (more than 80 in lake springs)	-
Lake's maximal length (km)	Macro Prespa: 28[b] Micro Prespa: 13.6[b]	30.8	285	44	44
Lake's maximal width (km)	Macro Prespa: 17[b] Micro Prespa: 6.1[b]	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 (7)[c]	70-85	-	2-3 times per year	-
Discharge (average)	There is regulated surface discharge from Lake Micro Prespa to Lake Macro Prespa (in Greece) by means of a sluice gate in the Koula area.	22 m³/s (lake outlet - average)	350 m³/s (at its estuary) Black Drin: 116 m³/s White Drin: 66.4 m³/s	320 m³/s (lake outlet - average)	682 m³/s

[a] United Nations administered territory under Security Council Resolution 1244 (1999).
[b] *Source:* C. Perennou and others. Development of a Transboundary Monitoring System for the Prespa Park Area. Aghios Germanos, Greece. November 2009.
[c] Value in parentheses: in the 1980s before recent water level decline of Lake Macro Prespa. From 2009 to 2011, a water level increase (of about 1.6 m) has been observed, which may alter these data series.

[47] *Source:* Faloutsos D. and others. Status Paper - Management of the extended Transboundary Drin Basin. GWP-Med, Athens. 2008.

PRESPA PARK WETLANDS[48]

General description of the wetland

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

Main wetland ecosystem services

The lakes perform important water storage, flood control and storm protection functions, and serve as a retention basin for sediments and nutrients that are utilized by wetland vegetation. Buffaloes graze on the littoral zone of Lake Micro Prespa as part of a vegetation management scheme, while a few more cattle may graze seasonally; very few cattle breeders will use wetland vegetation for fodder. However, wetland vegetation could potentially be used as a supplementary food source for domestic animals, but with concrete and controlled management objectives, for the benefit of biodiversity. Being part of a complex karst system, the lakes provide groundwater recharge, and make the local climate milder. 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 of the wetland area

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

Biodiversity values of the wetland area

The 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 interest.

The isolation of the basin for millions of years has resulted in high level of endemism: more than 45 invertebrate species and 9 fish species are endemic for Prespa Lakes and their basin.

Large numbers of waterbirds use Prespa Lakes for breeding, feeding, wintering and as a stop-over site during migration. It is the most important breeding site for Dalmatian Pelican, with more than 1,100 pairs, about 18% of the world population of this vulnerable species included in the IUCN Red List.

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

Pressure factors and transboundary impacts

A substantial decrease in Lake Macro Prespa's water level had been observed since the late 1980s, while, since 2009, the water level of the lake has been increasing. It is assumed that the dry period after 1987, in combination with the underground outflow to Lake Ohrid and increased water abstraction, resulted in the decrease of the water level. This affected natural ecosystems and made shoreline areas less attractive for tourists. Combined with increased nutrients input, this has led to increased eutrophication. The 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.

Tourism and recreation need to be developed in a sustainable way, minimizing direct disturbances of the 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. Prussian Carp, Grass Carp, Eastern Mosquitofish, Silver Carp, Tench, White Amur Bream, Stone Moroko, Pumpkinseed Sunfish, Rainbow Trout, European Bitterling, Wels Catfish and Ohrid Trout) that affect native fish and invertebrate populations.

The abandoning of cattle grazing on littoral meadows has led to the loss of these important habitats, and expansion of the reed beds in Micro Prespa. Attempts to partially solve the problem by reed burning led to an 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

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 the establishment

[48] *Sources:* Prespa Park Coordination Committee (www.prespapark.org); UNDP GEF Prespa Regional Project "Integrated ecosystem management in the Prespa Lakes Basin in Albania, the former Yugoslav Republic of Macedonia and Greece"; Strategic Action Plan for the Sustainable Development of the Prespa Park, Aghios Germanos. Society for the Protection of Prespa, WWF-Greece, Protection and Preservation of Natural Environment in Albania, Macedonian Alliance for Prespa.

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

of the trilateral Prespa Park Coordination Committee. Since 2006, transboundary cooperation is enhanced through the project "Integrated ecosystem management in the Prespa Lakes Basin in Albania, the former Yugoslav Republic of Macedonia and Greece", financially supported by the GEF. A number of parallel projects are supported by UNDP, German Development Bank (KfW), Swiss Development and Cooperation Agency, Swedish International Development Cooperation Agency, NGOs and the three national Governments.

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 management at basin level, in accordance with the 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, the management of protected areas, education and public awareness on the Prespa Lakes wetlands are also addressed at transboundary and national level.

In all three countries, lake, shoreline and forest areas have the status of nationally-protected areas. In Albania, Prespa National Park (27,750 ha) covers the whole Albanian catchment. Two park information centers are located in the villages of Gorice Vogel and Zagradec. In Greece, the Prespa National Park (32,700 ha) was designated in July 2009 including Ramsar Site Lake Micro Prespa (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 (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.

LAKE SKADAR/SHKODER

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

Hydrology and hydrogeology

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 and Skadar/Shkoder Lake determines the seasonal variations in the state and characteristics of the lake, as well as the Buna/Bojana and the tributaries in their catchment area, and has an important impact on the morphology of the Buna/Bojana delta. The hydrological regime is conditioned, among others, by water releases from big hydro-power dams in the Drin River in Albania.

The Buna/Bojana bed is lower than sea level ("crypto depression"), resulting in saltwater intruding into the lake's outlet.

Pressures, status, transboundary impacts and responses

In the Montenegrin part, arable land makes up 40%, and pastures 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.

Agricultural as well as industrial pollution (heavy industries in the Montenegrin side are also significant water consumers), and pollution from municipal wastewater, reach 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 on the lake's system. Wastewater collection and treatment facilities that are currently being constructed in the Albanian side, the 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. The Drin contributes to some extent, with trace metals originating from the disposal of by-products from iron and copper mines located upstream.

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

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

Total biodiversity is high, and the region is considered to be a biogenetic reserve of European importance. The large, geograph-

SKADAR/SHKODER LAKE, DINARIC EAST COAST AQUIFER (NO. 135)[50]

	Albania	Montenegro
Type 2; Jurassic, Cretaceous and lesser Palaeogene massive and stratified limestones and dolomites; groundwater flow in both directions; strong links to surface water systems		
Area (km^2)	~ 450	~ 460 (karstic aquifer) ~ 200 (shallow aquifer in Zeta Plain)
Thickness: mean, max (m)	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.
Other information	Border length 35 km (excluding the lake border).	Border length 35 km (excluding the lake border).

[50] Based on information from Montenegro and the First Assessment.

ically and ecologically connected complex system of wetlands of Skadar/Shkoder Lake and the Buna/Bojana River has been identified as one of the 24 transboundary wetland sites of international importance known as "Ecological Brick Sites".

Lake Skadar/Shkoder and the 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 whole of the Lake Skadar/Shkoder and Buna/Bojana River area is under national protection status. Regarding consolidation and harmonization of management of the protected areas, Montenegro is more advanced, and harmonization of measures across borders would be beneficial.

Transboundary cooperation

The Agreement between Albania and Montenegro for the Protection and Sustainable Development of the Skadar/Shkoder Lake, signed in 2008, was the latest legal document on cooperation on environmental 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.

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 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, and protection zones for drinking water supply also need to be applied, established or improved.

Trends

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

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

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

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, Greece, and the European Commission signed an agreement on the protection and sustainable development of the Prespa Park Area in 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, facilitates a regional multi-stakeholder dialogue process, aiming to explore possibilities of moving the level of cooperation from the sub-basin to the Drin Basin level.[51]

Photo by Tobias Salathe

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

LAKE SKADAR/SHKODER AND RIVER BUNA/BOJANA RAMSAR SITES[52]

General description of the wetland

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

Main wetland ecosystem services

The wetland is important for water retention and flood control for 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 the 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. The wetland is also 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 of the wetland area

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

Important migration routes, especially of fish and birds, pass through the wetland area. For waterbirds the wetland area is also important as a breeding and wintering site. Floating islands with colonies of cormorants, herons and pelicans are unique in Europe. A breeding colony of Dalmatian Pelican, a globally threatened species, exists on Lake Skadar/Shkoder, one of only a handful of such colonies in South-Eastern Europe. Other important numbers of wetland birds include ducks, geese, waders, gulls, birds of prey, owls and passerines. The number of wintering waterbirds on the Albanian side only reaches 24,000 – 30,000 individuals.

The globally-threatened Common Sturgeon, Stellate Sturgeon, and Adriatic Sturgeon, as well as other migratory fish, use the Buna/Bojana River to forage and spawn upstream. Coastal bays and lagoons, in particular 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 assessment text on Lake Skadar/Shkoder.

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

Several hydroelectric plants built on the River Drin during the last 30-40 years have reduced the sediment flow to the 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 Morača River – the main tributary of Skadar/Shkoder Lake, flowing through Montenegro – is likely to also have significant impacts on the water level of Skadar/Shkoder Lake.

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

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

Transboundary wetland management

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

The Albanian Lake Shkodra and River Buna (49,562 ha) Ramsar Site includes a number of nationally-protected areas beyond Shkoder Lake and the Buna River and its delta, notably Velipoja beach, Domni marsh, Viluni lagoon, Rrenci mountain, and Velipoja forest. The Montenegrin Ramsar Site (20,000 ha) coincides with National Park Skadarsko Jezero, including some strictly protected areas (permanent ornithological reserves of scientific importance). The National Park has three visitor's centers in the villages of Vranjina, Mirići and Rijeka Crnojevića.

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

[52] *Sources:* Information Sheets on Ramsar Wetlands (RIS). 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.

AOOS/VJOSA RIVER BASIN[53]

The Aoos/Vjosa River[54] basin is shared by Greece and Albania.

Basin of the Aoos/Vjosa River

Country	Area in the country (km²)	Country's share (%)
Albania	4 365	67
Greece	2 154	33
Total	**5 613**	

Hydrology and hydrogeology

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

Major transboundary tributaries include the rivers Sarantaporos (870 km²) and Voidomatis (384 km²).

Pressures

In Greece, the Aoos Springs Hydroelectric Dam was built on the river.

Of the basin area, 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.

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

Pumping lifts have increased locally in Greece, where agricultural activities exert pressure on the Nemechka/Vjosa-Pogoni aquifer (No. 136). There have been sulphate concentrations of 300-800 mg/l observed in many of the springs. In Albania, minor waste disposal and sewer leakages result in local and moderate pathogen occurrence in the aquifer.

Transboundary cooperation and responses

An agreement concluded between Albania and Greece, which entered into force in 2005, provides for the establishment of a Permanent Greek-Albanian Commission on transboundary freshwater issues. The specific tasks of the Commission include setting joint water-quality objectives and criteria, drafting proposals for relevant measures to achieve the water-quality objectives, and organizing and promoting national networks for water-quality monitoring.

In Greece, implementation of the 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 WFD requirements. No management measures are yet used in Albania for the aquifer, but a range of measures need to be applied.

Trends

The river has a "very good water quality", which is appropriate for all uses in the basin. Nevertheless, 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.

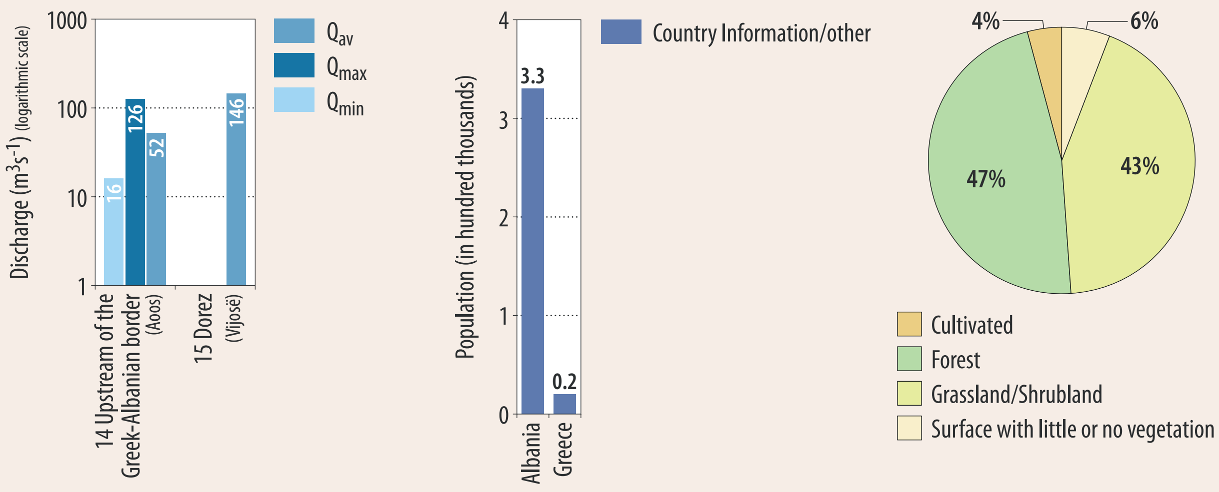
Local and moderate degradation of ecosystems supported by the Nemechka/Vjosa-Pogoni aquifer (No. 136) has been observed in Albania, and related to issues linked to groundwater quantity. The aquifer, however, is not at risk since population is small and industry is not developed.

NEMECHKA/VJOSA-POGONI AQUIFER (NO. 136)[55]

	Albania	Greece
Type 1; succession of large anticlines containing karstic limestones of mainly Jurassic and Cretaceous age and synclines with formations of Palaeocene and Eocene flysch. The complicated geological structures and hydrogeological conditions which bring these formations together produce large karst springs; groundwater discharges towards both countries. The links to surface waters are weak.		
Area (km²)	550	370
Thickness: mean, max (m)	2 500, 4 000	100, 150
Groundwater uses and functions	25-50% irrigation, <25% each for drinking water supply, 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.
Pressure factors	Minor waste disposal and sewer leakage result in local and moderate pathogen occurrence.	Agriculture; pumping lifts have increased locally; sulphate concentrations of 300-800 mg/l observed in many of the springs.
Groundwater management	Need to be applied: detailed hydrogeological and vulnerability mapping, groundwater monitoring, public awareness, delineation of protection zones and wastewater treatment.	Existing monitoring needs improvement.
Other information	Border length 37 km. Large karst groundwater quantities (average about 8 m³/s) discharge into the Vjosa River gorge in Albanian territory. There are also other large karst springs; the Glina sulphate spring is a well-known karst spring for bottled water. The aquifer is not at risk.	Border length 37 km. Large spring discharges of Kalama, Gormou and Drinou

[53] Based on the First Assessment.
[54] The river is known as Aoos in Greece and Vjosa in Albania.
[55] Based on the First Assessment.

DISCHARGES, POPULATION AND LAND COVER IN THE AOOS/VJOSA RIVER BASIN



Source: UNEP/DEWA/GRID-Europe 2011.
Note: The map in the assessment of the Neretva should be referred to for the locations of the gauging stations.

VARDAR/AXIOS RIVER BASIN[56]

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.

Basin of the Vardar/Axios River

Country	Area in the country (km²)	Country's share (%)
The former Yugoslav Republic of Macedonia	19 737	88.7
Greece	2 513	11.3
Total	**23 750**	

Hydrology and hydrogeology

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 (Mediterranean Sea) at Thermaikos Gulf (Greece). The total length of the river is 389 km, with 87 km being in Greece. The river has a pronounced mountainous character, with an average elevation of about 790 m a.s.l.

Surface water resources in the part of the Vardar/Axios Basin that is territory of the former Yugoslav Republic of Macedonia are estimated at 4,185 × 10^6 m^3/year (an average for the years 1961-1990).

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.

Pressures, status and transboundary impacts

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.

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 abstraction from the Gevgelija/Axios-Vardar aquifer (No. 137) have resulted in the 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.

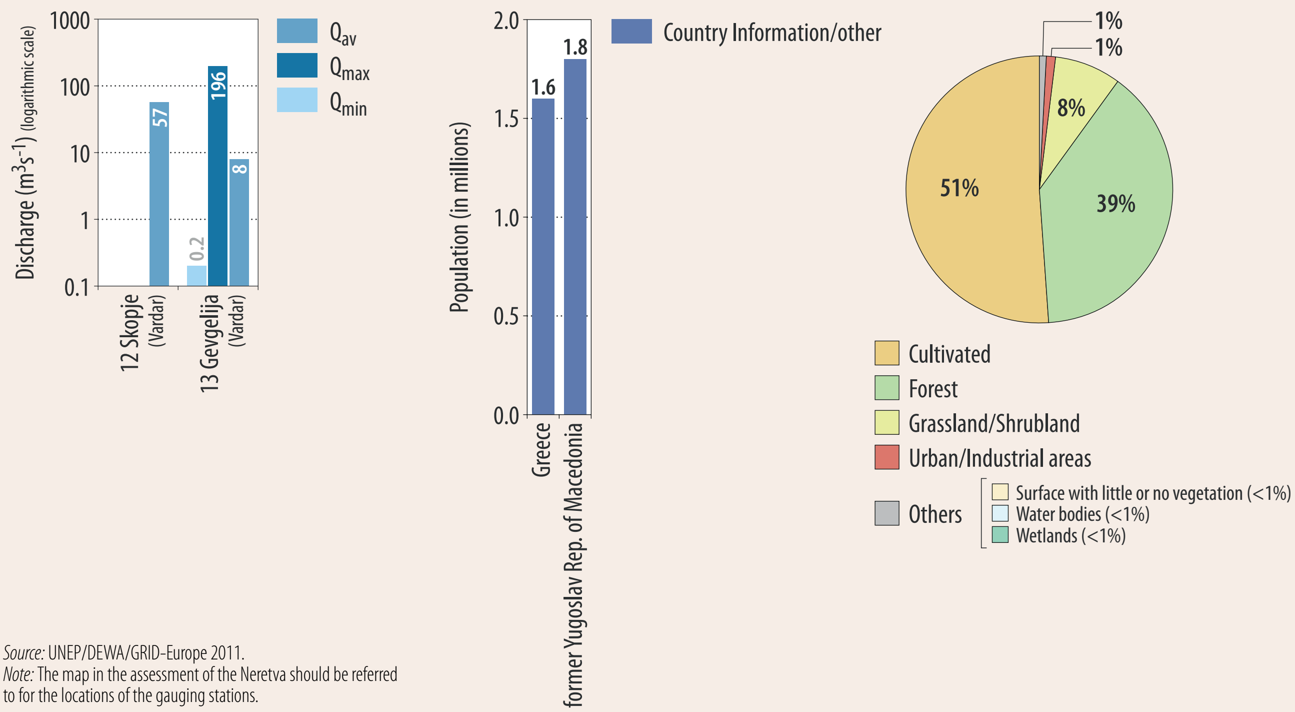
The main pressure on water resources in terms of quality stems from agriculture. In the former Yugoslav Republic of Macedonia,

GEVGELIJA/AXIOS-VARDAR AQUIFER (NO. 137)[59]

	The former Yugoslav Republic of Macedonia	Greece
Type 3 or none of the illustrated transboundary aquifer types; Quaternary alluvial sediments, sands with gravel, partly clayey and silty with cobbles; very shallow groundwater 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.		
Area (km²)	N/A	8
Thickness: mean, max (m)	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.
Pressure factors	Decline of groundwater level, decline of borehole yields, baseflow and springflow; nitrogen, pesticides, heavy metals, pathogens, industrial organics and hydrocarbons detected; salinization.	

[56] Based on information mainly from the First Assessment.
[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.
[59] Based on information from the First Assessment.

DISCHARGES, POPULATION AND LAND COVER IN THE VARDAR/AXIOS RIVER BASIN



Source: UNEP/DEWA/GRID-Europe 2011.
Note: The map in the assessment of the Neretva should be referred to for the locations of the gauging stations.

crop production and animal husbandry is practiced in river valleys, especially the Pelagonija, Polog and Kumanovo valleys, as well as in the whole Bregalnica catchment area.

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

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

When last reported (in the First Assessment), 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 with very little treatment in the former Yugoslav Republic of Macedonia, the occurrence of nitrogen, pesticides, heavy metals, pathogens, industrial organics and hydrocarbons in the Gevgelija/Axios-Vardar (No. 137) aquifer had been reported as well. The salinization observed is of natural origin.

Responses

The implementation of the 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.

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 lake and aquifer water quantity and quality, raising public awareness, defining protection zones, and carrying out vulnerability mapping, as well as wastewater treatment, need to be improved in the former Yugoslav Republic of Macedonia; other measures need to be applied or are planned.

Data exchange is deemed necessary by both countries.

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 EU legislation.

LAKE DOJRAN/DOIRANI[60]

Lake Dojran/Doirani is a small (total area 43.1 km^2) tectonic lake, with a basin of 272 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.

Pressures, status and transboundary impacts

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 also been a pressure factor for the underlying aquifer, resulting in the decline of groundwater levels.

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 also dropped continuously due to increasing Greek abstraction, mainly for irrigation purposes. The most extreme water level and water volume de-

[60] Based on information mainly from the First Assessment.

DOJRAN/DOIRANI LAKE AQUIFER (NO. 138)[61]

	The former Yugoslav Republic of Macedonia	Greece
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); 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.		
Area (km²)	92	120
Thickness: mean, max (m)	150, 250	150, 250
Groundwater uses and functions	Irrigation and drinking 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.

crease have occurred since 1988; from 262 × 10^6 m^3 in 1988, the volume decreased to 80 × $10^6 m^3$ in 2000.

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

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.

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

Responses[62]

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 m^3/s; the “Feasibility study on Dojran lake salvation” project was financed by the Ministry of Environment and Physical Planning and the Ministry of Agriculture, Forestry and Water Economy in 2001.

STRUMA/STRYMONAS RIVER BASIN[63]

The basin of the Struma/Strymonas[64] 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 in the Aegean Sea (Strymonikos Gulf – Greece).

Basin of the Struma/Strymonas River

Country	Area in the country (km²)	Country's share (%)
Bulgaria	8 545	46.6
Greece	7 282	39.7
Serbia	865	4.7
The former Yugoslav Republic of Macedonia	1 648	9.0
Total	**18 340**	

Hydrology and hydrogeology

The total length of the river is 400 km, with its last 110 km flowing through Greece. Major transboundary tributaries include the following 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.

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

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. In Greece, irrigation dams also exist at Lefkogeia and Katafyto. The Lisina Reservoir on the Dragovishtitsa River in Serbia is a part of the Vlasina hydropower production system.

There is a high risk of flooding in Bulgaria due to the basin's geomorphological and hydrological characteristics. Bulgaria reported that climate change over the last 20 years has resulted in an approximately 30% decrease in precipitation and a subsequent decrease in water resources in the basin[65]; provisions to address the decrease of water resources will be included in the programme of measures of the RBMP.

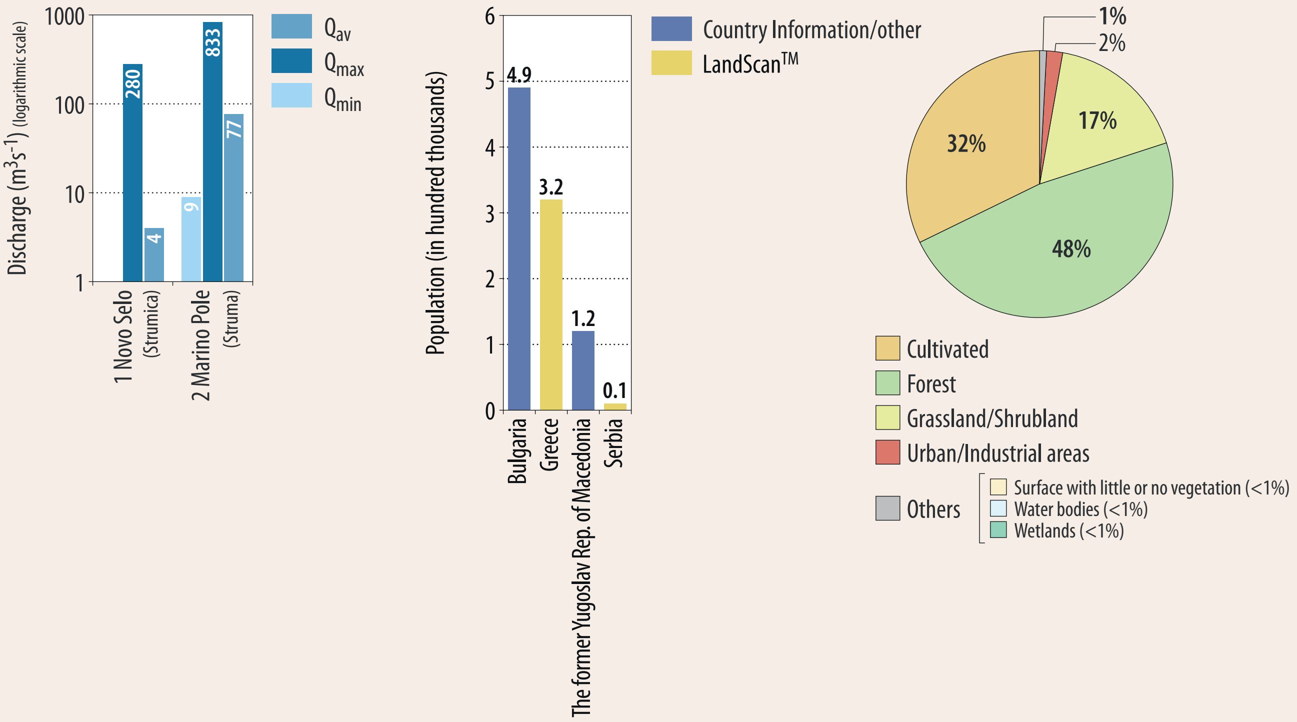
In the part of the basin that is Bulgaria's territory, surface water resources are estimated at 1,961 × 10^6 m^3/year (average for the years 1980-2004) and groundwater resources at some 200 × 10^6 m^3/year (average for the years 1980-2004), adding up to a total of 2,160 × 10^6 m^3/year (4,435 m^3/year).

Two transboundary aquifers were identified as hydraulically linked to the surface water system and included in the first assessment: the Sandansky – Petrich aquifer (No. 139) (shared by Bulgaria, Greece and the former Yugoslav Republic of Macedonia), and the Orvilos-Agistros/Gotze Delchev karst aquifer (No. 142) (shared by Bulgaria and Greece - as reported by Bulgaria, it also extends to and is hydraulically linked with the surface water systems of the Mesta/Nestos River basin).

Bulgaria reported that new data available suggests that the Sandansky – Petrich aquifer (No. 139) is divided into two distinct

[61] Based on information from the First Assessment.
[62] See also “Responses” under Vardar/Axios.
[63] Based on information from Bulgaria, Serbia and the former Yugoslav Republic of Macedonia. Information about Strumica river catchment area (the former Yugoslav Republic of Macedonia) is based on the Second Communication on Climate Change. The former Yugoslav Republic of Macedonia. December 2006. References related to Greece are based on the First Assessment.
[64] The River is called Struma in Bulgaria and Strymonas in Greece.
[65] No detailed information has been provided by Bulgaria on the spatial or temporal extent of the underlying observations.

DISCHARGES, POPULATION AND LAND COVER IN THE STRUMA/STRYMONAS RIVER BASIN



Source: UNEP/DEWA/GRID-Europe 2011; Ministry of Environment and Water, Bulgaria.
Note: The data on Bulgaria is for 2006, and on the former Yugoslav Republic of Macedonia for 2002.

aquifers thus, should be substituted by them here:[66] (i) the Sandansky valley aquifer (No. 140) (shared by Bulgaria and Greece) and (ii) the Petrich valley aquifer (No. 141) (shared by the former Yugoslav Republic of Macedonia and Bulgaria).

According to Greece[67] the Orvilos-Agistros/Gotze Delchev karstic aquifer (No. 142) 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.[68]

SANDANSKY-PETRICH AQUIFER (NO. 139)

	Bulgaria	Greece	The former Yugoslav Republic of Macedonia
Pliocene and Quaternary alluvial sands, gravels, clays and sandy clays of the Sandansky and Petrich 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.			
Groundwater uses and functions	N/A	N/A	Drinking water, irrigation and industry, thermal springs, agriculture.
Other information	Border length 18 km (GR), 5 km (MK).	18 km (BG)	5 km (BG)

SANDANSKY VALLEY AQUIFER (NO. 140)

	Bulgaria	Greece
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.		
Area (km^2)	630.5	N/A
Groundwater uses and functions	Maintaining baseflow and springs. Supports ecosystems.	N/A
Other information	Border length 18 km.	Border length 18 km.

PETRICH VALLEY AQUIFER (NO. 141)

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

ORVILOS-AGISTROS/GOTZE DELCHEV AQUIFER (NO. 142)

	Bulgaria	Greece
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.
Other information	Border length 22 km.	Border length 22 km.

Total water withdrawal and withdrawals by sector in the Struma/Strymonas River Basin

Country	Total withdrawal $\times 10^6$ m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Bulgaria[a]	54.7	7	30	52	N/A	11
Greece	N/A	N/A	N/A	N/A	N/A	N/A

[a] 755 $\times 10^6$ m^3/year used for hydropower production is not included.

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

		Total water demands ($\times 10^6$ m^3/year)	Population and tourists ($\times 10^6$ m^3/year)	Industry ($\times 10^6$ m^3/year)	Irrigation ($\times 10^6$ m^3/year)	Minimum accepted flow ($\times 10^6$ m^3/year)
Strumica	2006	175.3	11.5	33.0	117.9	13.0
	2020	235.0	18.2	34.4	169.3	13.0
Total in the country	**2006**	**2 227.9**	**218.3**	**274.1**	**899.3**	**635.0**
	2020	**3 491.3**	**348.3**	**287.0**	**1 806.7**	**635.0**

Source: Second Communication on Climate Change. The former Yugoslav Republic of Macedonia. December 2006.

[66] The position of Greece and the former Yugoslav Republic of Macedonia in this regard is not available.
[67] Based on information provided by Greece.
[68] This is due to the State border between Bulgaria and Greece being located in a highland area where the aquifer is inferred to extend along the local watershed divide. Thus, the flow may be towards Bulgaria in the northern part, and towards Greece in the south. 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.

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%) by 2020.

Pressures, status and transboundary impacts

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

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 on the environment. Bulgaria reports that the issue is under investigation.

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. Water distribution infrastructure is degraded and results in water losses and problems for drinking water quality in some areas. Measures are being taken by regional water companies to improve water distribution infrastructure, so as to reduce water losses.

Untreated wastewater is an important pressure factor and organic matter from wastewater discharges is of concern in Bulgaria. The construction of wastewater treatment plants has started (to be finished until 2014 for settlements with more than 2,000 inhabitants) and will address the issue 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 wastewater treatment plant.[69]

Agricultural run-off is a source of pollution in Bulgaria, as 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.

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.

Due to decrease of industrial and agriculture activities, the concentrations of phosphates measured in 2008 are lower than the minimum for 2000-2005. The same applies to ammonia (for three out of four values provided).

Water-quality characteristics of the Struma/Strymonas River upstream from the Bulgarian-Greek border

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	Minimun	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.

[69] *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.

Responses and trends

The part of the Struma/Strymonas Basin that is within Bulgaria's territory has been assigned to the West Aegean Basin District, 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. In Bulgaria, 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 RBMP for the West Aegean Basin District was prepared to cover the part of the basin falling within Bulgarian territory.

There is a monitoring station[70] in Bulgaria, near the Bulgarian–Greek border. Monitoring programmes are being established in both countries in accordance to the WFD. Bulgaria reports that joint monitoring of the aquifers should be established.

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

Transboundary cooperation

According to the agreement signed between Bulgaria and Greece in 1964, 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 Struma/Strymonas, Mesta/Nestos, Arda/Ardas and Maritsa/Evros rivers. The agreement provides for exchange of information and data between parties for preventing floods, as well as an exchange of information concerning the installations subject to the agreement.

According to the Agreement signed between the two countries in 1971, a Bulgarian-Greek Commission on cooperation in the field of electric energy and water use of the rivers flowing through their territories was set up. Bulgaria reports that the agreement is not active for the time being, and that discussions regarding its renewal and possible updating are ongoing. 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 in 2002 on Cooperation in the field of Environmental Protection.

In 2010, ministers responsible for water issues in Bulgaria and Greece stated in a joint declaration their political will to start a new dialogue with the aim to promote cooperation for the preservation and protection of shared water resources. As a result, a joint Bulgarian-Greek Working Group on cooperation on water protection was established in May 2011. The joint Working Group will focus its work on: legislative issues linked to transposing the WFD and the Floods Directive; support to the implementation in both countries of the WFD, through RBMPs, and of the Floods Directive; implementation of the basin water management principle in both countries; monitoring of water quantity, water resources assessment and flood early warning systems; and water management bodies and administrative structures.[71]

MESTA/NESTOS RIVER BASIN[72]

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

Basin of the Mesta/Nestos River

Country	Area in the country (km^2)	Country's share (%)
Bulgaria	2 785	49.9
Greece	2 834	51.1
Total	**5 619**	

Hydrology and hydrogeology

The river has its source in the Rila Mountains in the vicinity of Sofia (Bulgaria), and, flowing through Greece, ends in the North Aegean Sea. The basin has a pronounced mountainous character in its upper part, and a lowland character further downstream. The 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 into the Mesta/Nestos River in the territory of Greece.

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.

In Bulgaria, surface water resources are estimated to be 958 × 10^6 m^3/year (average for 1961 – 2002), and groundwater resources are 91.8 × 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).

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

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

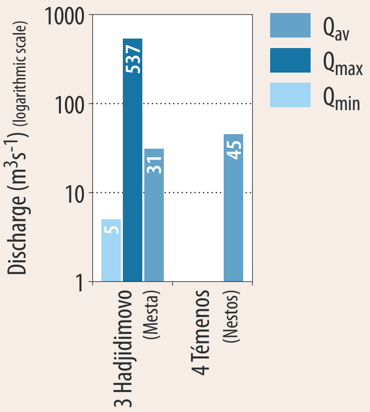
Orvilos-Agistros/Gotze Delchev karstic aquifer (No. 142), shared by Bulgaria and Greece (presented in the assessment of the Struma/Strymonas River), extends to and is hydraulically linked with the surface water system of both Mesta/Nestos and Struma/Strymonas Rivers basins (as reported by Bulgaria)[77]. According to Greece, the shared aquifer is not hydraulically linked to the surface waters of either basin.

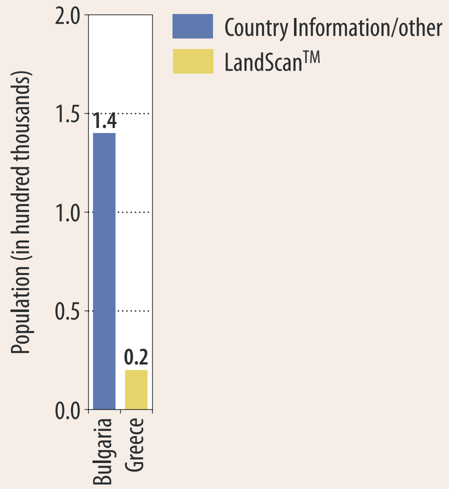
Pressures, status and responses

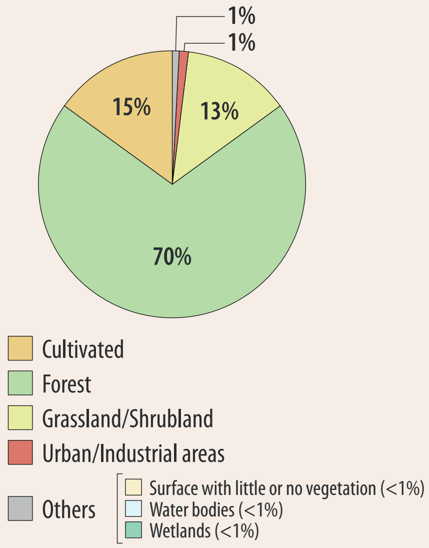
When last reported in the First Assessment, the water quality was "suitable for irrigation and water supply for other uses". In the few years preceding the First Assessment, the quality of the Mesta had improved, as a result of reduced economic activities (including industrial), and the construction of small local waste-

[70] Water quality in this station has been monitored since 2003; 20 basic physico-chemical parameters are being monitored.
[71] Source: Website of the Ministry of Environment and Water of Bulgaria (http://www.moew.government.bg).
[72] Based on information from Bulgaria; references related to Greece are based on information from the First Assessment.
[73] The river is known as Mesta in Bulgania and as Nestos in Greece.
[74] The river is known as Dospat as well as Dospatska in Bulgaria and as Despatis in Greece.
[75] In Bulgaria, these are West Rodopi, Dolna Mesta, Mesta River, Pirin National Park, Alibotush, and Rila National Park.
[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 as to whether Orvilos-Agistros/Gotze Delchev karstic aquifer should be considered as transboundary. See the section on the Struma/Strymonas River basin where the aquifer is described.

DISCHARGES, POPULATION AND LAND COVER IN THE MESTA/NESTOS RIVER BASIN





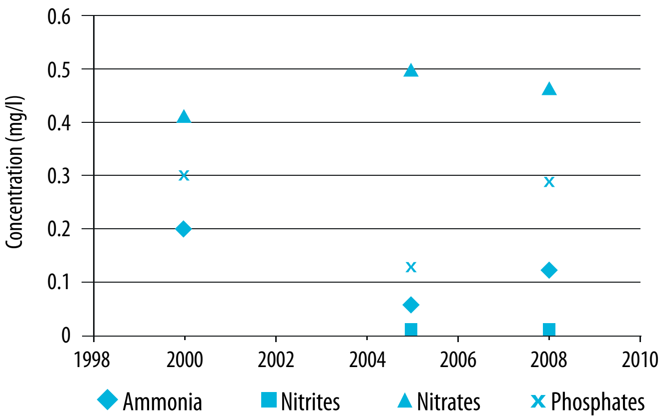


Source: UNEP/DEWA/GRID-Europe 2011.
Note: The map in the assessment of the Struma/Strymonas should be referred to for the locations of the gauging stations.

water 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 2.

FIGURE 2: Annual median concentrations (mg/l) of selected water quality determinands in the Mesta River downstream from the city of Hadzhidimovo[78] in Bulgaria. In 2000 and 2005, data was available for twelve months, in 2008 for six

	Year	2004	2005	2008
Ammonia	Median	0.20	0.06	0.12
	Average	0.34	0.07	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	0.01	0.03
Nitrates	Median	0.042	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



Source: Ministry of Environment and Water, Bulgaria.

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 hydromorphological alterations, and exert pressure on the environment. The diversion of watercourses towards reservoirs used for drinking water supply was reported by Bulgaria. There are water losses due to degraded water distribution infrastructure. Drinking water quality is of concern in some areas, but action to address related issues has been taken.

Total water withdrawal in Bulgaria, in 2006, was 9.473 $\times 10^6$ 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 $\times 10^6$ m^3/year is used for hydropower production.

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

Uncontrolled solid waste disposal in the Bulgarian part had resulted in water pollution, causing potential environmental problems, especially in times of heavy precipitation. Measures to address this issue are being taken: wastes from all eight municipalities in the river basin are now being collected; about 25 uncontrolled disposal sites were closed; most of them have already been rehabilitated.

Sand extraction is an issue of concern.

With regard to institutional arrangements for water management in the basin, the part extending through Bulgaria has been assigned to the West Aegean Basin District, while the part extending through Greece has been assigned to the Eastern Macedonia and Thrace Basin District. The RBMP for the West Aegean Basin District, in Bulgaria, covers the part of the basin falling within the country's territory.

With regard to monitoring in Bulgaria, new monitoring programmes are established in accordance to the WFD. An automatic station on the Mesta/Nestos River was established in Bulgaria[79] near the Bulgarian-Greek border to measure both water quality and quantity parameters.

[78] The monthly data values for 2000 and 2005 are shown in the First Assessment.
[79] In the framework of the project "Strengthening of monitoring network of the surface water" financed by Phare (EU Cross-Border Cooperation).

Transboundary cooperation

Information on cooperation between Bulgaria and Greece is available in the assessment of the Struma/Strymonas River Basin.

According to the agreement that was concluded between Bulgaria and Greece in 1995 referring specifically to the Mesta/Nestos, 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 run-off — the actualization of the basis for the calculation is overdue.

MARITSA/EVROS/MERIÇ RIVER BASIN[80]

Bulgaria, Greece and Turkey share the basin of the Maritsa/Evros/Meriç River.[81]

Basin of the Maritsa/Evros/Meriç River

Country	Area in the country (km²)	Country's share (%)
Bulgaria	35 230	66
	Maritsa sub-basin: 21 928	
	Tundzha sub-basin: 8 029	
	Arda sub-basin: 5 273	
Greece	3 685	7
	Evros sub-basin	
	Ardas sub-basin	
Turkey	14 560	27
Total	**53 475[a]**	

[a] According to information provided by Turkey, the total area of the basin is 54,206 km².

Hydrology and hydrogeology

The Maritsa/Evros/Meriç River is about 500 km long, has its source in the Rila Mountain (Bulgaria) and flows into the Aegean Sea. Major transboundary tributaries include the rivers Arda/Ardas[82] (Bulgaria, Greece and Turkey), Tundzha/Tundja/Tunca[83](Bulgaria, Turkey) and Biala/Erithropotamos[84] (Bulgaria, Greece). The river Ergene is an important tributary, located in Turkey.

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

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), 2006, and November 2007.

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

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

Topolovgrad Massif (No. 144), 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).

Cooperation is necessary among the three countries to deline-

Water resources in the Maritsa/Evros/Meriç River basin

Country	Bulgaria[a]	Greece	Turkey
Surface water resources (× 10⁶ m³/year)	6 950	N/A	8 330[b]
Groundwater resources (× 10⁶ m³/year)	1 937	N/A	364[c]
Total water resources (× 10⁶ m³/year)	**8 887**	**N/A**	**8 694**
Total water resources per capita (m³/year)	**5 242**	**N/A**	8 414

[a] Information for the Bulgarian part of the basin: Maritsa/Evros/Meriç sub-basin: surface water resources 3 403 × 10⁶ m³/year (1961-1998), groundwater resources 1 388 × 10⁶ m³/year; Arda/Ardas sub-basin: surface water resources 2 290 × 10⁶ m³/year, groundwater resources 157.8 × 10⁶ m³/year; Tundzha/Tundja/Tunca sub-basin: surface water resources 1 257 × 10⁶ m³/year (1961-1998), groundwater resources 390.8 × 10⁶ m³/year.
[b] Data for 1986-2005.
[c] Data for 1994-2000.

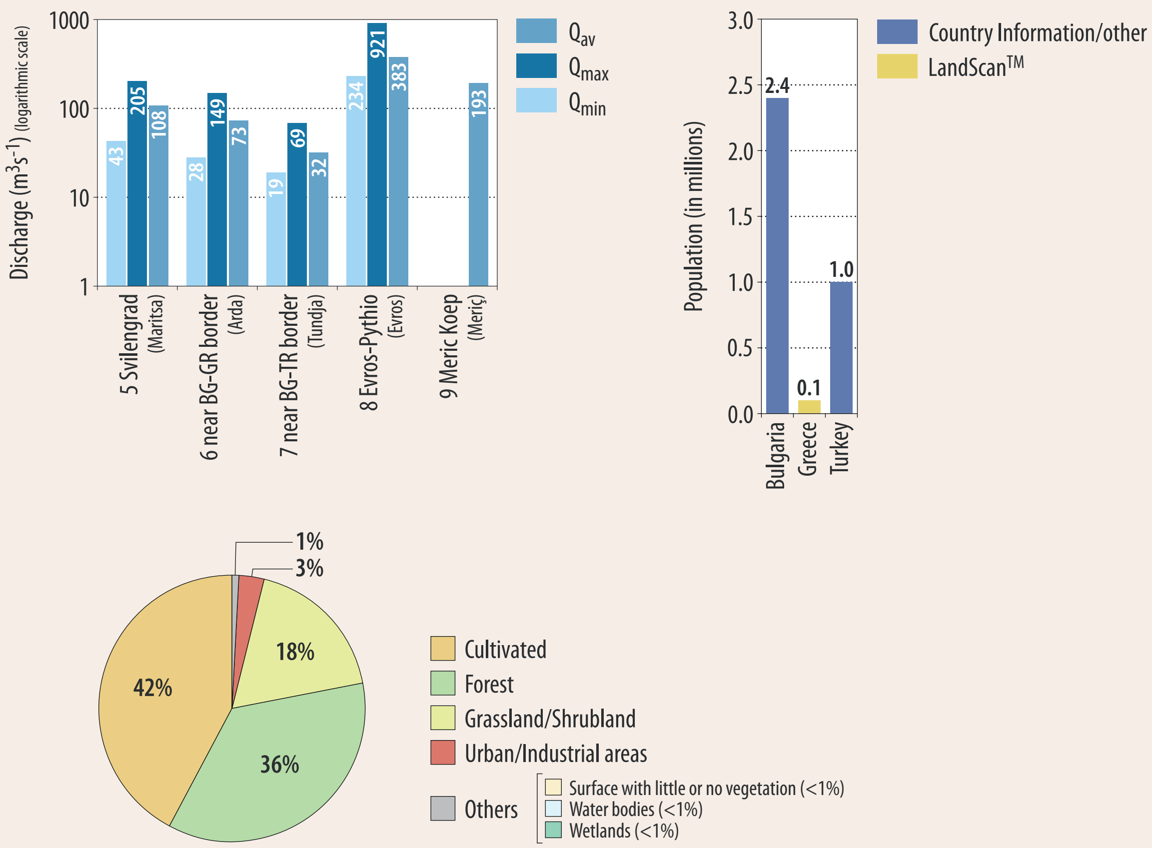
ORESTIADA/SVILENGRAD-STAMBOLO/EDIRNE AQUIFER (NO. 143)

	Bulgaria[a]	Greece	Turkey
Type 3; Neogene lake and river alluvial sands, clayey sands, gravels, sandy clays and clays; 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.			
Area (km²)	712	450	N/A
Thickness: mean, max (m)	120, 170	120, 170	120, 170
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.

[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 code: BG3G 000000 N 011). Bulgaria reports that in the RBMP, the following additional groundwater bodies, connected with Greece and Turkey, are specified: fissure groundwaters in Ivailovgrad massif (national code BG3G00PtPg2024, surface area 191 km²); fissure groundwaters in Svilengrad massif (national code BG3G0000Pg025, surface area 48 km²). The position of Greece and Turkey is not available on this matter.

[80] Based on information provided by Bulgaria and Turkey, and the First Assessment.
[81] The river is called Maritsa in Bulgaria, Evros in Greece and Meriç in Turkey.
[82] The river is called Arda in Bulgaria and Turkey, and Ardas in Greece.
[83] The river is called Tundzha and/or Tundja in Bulgaria and Tunca in Turkey.
[84] The river is called Biala in Bulgaria and Erithropotamos in Greece.
[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.
[86] Based on information from Turkey; the position of Greece is not available. It is possible that Bulgaria is a riparian country (see the body text).

DISCHARGES, POPULATION AND LAND COVER IN THE MARITSA/EVROS/MERIC RIVER BASIN



Sources: UNEP/DEWA/GRID-Europe 2011; Ministry of Environment and Water, Bulgaria and Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.
Notes : The population figure for Bulgaria covers the catchments of the Maritsa, Tundzha and Arda, 2003, Turkey's figure is for 2007. The map in the assessment of the Struma/Strymonas should be referred to for the locations of the gauging stations.

ate the boundaries of the transboundary aquifers in the basin and enhance relevant knowledge. Moreover, Bulgaria suggests that the countries should cooperate to clarify the stratigraphy of the Orestiada/Svilengrad-Stambolo/Edirne (No. 143) 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.

Pressures, status and transboundary impacts

The delta of the Maritsa/Evros/Meriç River, shared by Greece and Turkey (150 out of the 188 km² of the delta lies in the Greek territory), is of major ecological significance. It is one of the most important wintering areas for birds in the Mediterranean. A major part of the delta in Greece (100 km²) has been designated as a Ramsar Site; it also enjoys the status of Special Protected Area and Natura 2000 site. Some 33% of the Bulgarian part of the basin has 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.

Total water withdrawal and withdrawals by sector in the Maritsa/Evros/Meric River Basin

Basin/sub-basin	Country	Year	Total withdrawal $\times10^6$ m³/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Maritsa/Evros/ Meriç River Basin	Bulgaria[a]	N/A	2 722	N/A	N/A	N/A	N/A	N/A
	Greece	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Turkey	2009	1 352	82	4	13	0	1
	Turkey	2015	2 000	78	6	15	0	1
Maritsa/Evros/ Meriç River sub-basin	Bulgaria[a]	N/A	2 344	51	1	3	44	1
	Greece	-	-	-	-	-	-	
	Turkey	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arda River sub-basin	Bulgaria[a]	2007	40	31	20	37	0	12
	Greece	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Turkey	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tundzha/Tundja River sub-basin	Bulgaria[a]	N/A	338	86	1	1	9	3
	Turkey	N/A	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.

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.[87] 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.[88]

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

In Bulgaria, the operation of small hydropower stations and gravel extraction have led to hydromorphological 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 by 10-12 m since the 1990s; as a response measure, groundwater abstraction in the Ergene sub-basin has been forbidden.

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 ongoing. 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 (including food production and production of non-ferrous metals and chemicals) may be a potential source of heavy metals, as well as of organic and nitrogen pollution of local importance. Mining activities in 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: in the river basins of the Maritsa, the Arda and the Struma, there are already six in operation.

Untreated domestic wastewater is one of the main pollution sources also in Turkey, particularly in the Ergene sub-basin; the river is Class IV (very polluted water), threatening human health and biodiversity. Both urban wastewater and solid waste volumes have 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 the use of fertilizers and pesticides (resulting in nitrogen, phosphorus, and pesticides pollution), and inefficient irrigation techniques. Groundwater pollution is the outcome of the aforementioned pressures. Turkey reports that there is loss of biodiversity in parts of the basin.

According to Turkish assessments, the water quality status of the Meriç River is Class III (polluted water), both at the point where it enters the territories of Turkey,[89] and at its mouth at the Aegean Sea. The Tunca is reported as Class IV (very polluted water) with regard to heavy metals at the point entering Turkey.

Transboundary cooperation

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. 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 issues related to flooding. The major part of the construction would extend to the Bulgarian territory.

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. Initiatives that touch upon transboundary concerns e.g. ecosystems and biodiversity, may provide the enabling environment for the initiation of a dialogue. The ongoing cooperation process between Bulgaria and Turkey to limit and prevent the damaging effects of floods provides an additional "entry point" for the enhancement of cooperation; Greece should be included where appropriate. A coordination structure including the experts of three riparian countries may be considered as an initial step.

Responses

In Bulgaria, the monitoring network includes 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, 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/Tunca Rivers and two on the Maritsa/Meriç River) that supply real-time data.

Bulgaria is working to update hydrological data, mapping the sensitive areas, and creating 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[90] in this regard provides a basis for further action. The broadening of the scope of related activities in the future to also include Greece is deemed necessary. The use of better dam operation techniques and rules can considerably mitigate floods.

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

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

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

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

[90] PHARE Technical Assistance for Flood Forecasting and Early Warning System – project on "Capacity Improvement for Flood Forecasting in the Bulgaria-Turkey Cross-Border Cooperation".

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 to restore the existing irrigation infrastructure.

In Turkey, the development plans for the Meriç-Ergene Basin integrate 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 resource management. There is also a land use plan for the Meriç-Ergene basin.

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.

An RBMP for the East Aegean Basin District (Bulgaria) was finalized with the involvement of stakeholders. Water demand management measures in Bulgaria include water abstraction control.

ARDA/ARDAS SUB-BASIN[91]

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.

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

Pressures, impacts and responses

Dams are common for the Arda/Ardas sub-basin; 100 are located in Bulgarian territory. The largest ones 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 the Arda/Ardas in Bulgaria. In Greece, a dam was built close to the border with Bulgaria to regulate discharge from the Ivailovgrad Dam (Bulgaria); water from the reservoir also covers irrigation needs.

Non-treated urban wastewater, waste disposal and animal husbandry are pressure factors in the Bulgarian part of the basin, having impacts of local importance on the ecosystem. Eutrophication has been observed in the reservoirs of the (large) dams Kardgali, Studen Kladenez and Ivailovgrad. Nitrogen and organic pollution is expected to diminish since the sewerage system is being extended; it is now connecting 67% of the population. There are three new municipal wastewater plants, and a new one is under construction.

Mining activities have a local but important impact due to the presence of heavy metals in their discharges; five tailing ponds containing mining waste are potential sources of pollution. Industrial activities in the area are possible sources of heavy metals and organic pollution (impact of local importance).

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

[91] Based on information from Bulgaria and Turkey. References to Greece are based on the First Assessment.

TUNDZHA/TUNDJA/TUNCA SUB-BASIN[92]

Bulgaria and Turkey share the sub-basin of the Tundzha/Tundja/Tunca, which has its source in the Stara Planina Mountain (Bulgaria), and flows into the Meriç River. The Fishera River is a tributary shared by Bulgaria and Turkey.

TOPOLOVGRAD MASSIF AQUIFER (NO. 144)[93]

	Bulgaria[a]	Turkey
Type 2 (TR)/Type 1 (BG);[94] 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.		
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
Pressure factors	Industry, industrial and household wastewaters, problems: impact of human activity on the chemical status of the groundwater body - waste landfill, mine, in the future: possible qualitative risk, no quantitative risk.[a]	N/A
Groundwater management measures	Wastewater treatment is needed.[a]	
Other information	Border length 24 km. Bulgaria expresses uncertainty as to whether the aquifer should be considered as transboundary.	Border length 24 km.

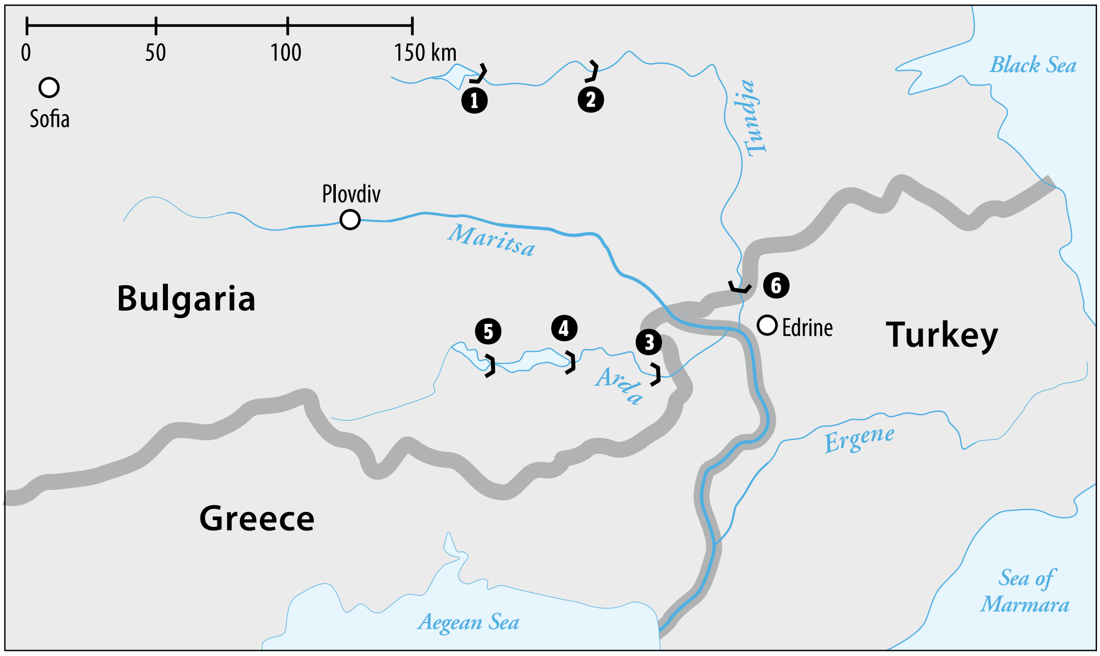
[a] After determination of groundwater bodies in conformity with the requirements of the WFD, Bulgaria suggest that the Topolovgrad aquifer corresponds to groundwater body "Karst water – Topolovgrad massif" (national code BG3G0000T12034).

Pressures, impacts and responses

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.

Eutrophication in the reservoirs of the large dams in Bulgaria as well as nitrate pollution of groundwater, in the middle part of the basin, has been observed. Among pollution sources, waste-water discharge from municipalities and industry ranks in the first place, followed by diffuse pollution (78% from agriculture). Measures for the improvement of the situation are being 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 six waste disposal sites in the Bulgarian part.

FIGURE 3: Map of main dams in the Arda/Ardas and Tundja/Tundzha/Tunca Rivers



(1) Koprinka Dam
(2) Jdrebchevo Dam
(3) Ivailovgrad Dam
(4) Studen Kladnetz Dam
(5) Kardjaali Dam
(6) Suakacagi Dam (planned)

Source: Bulgaria.

[92] Based on information from Bulgaria, Turkey and the First Assessment.
[93] Based on information from the First Assessment.
[94] Bulgaria's doubt as to whether the aquifer is transboundary is due to the State border between Bulgaria and Turkey being located in an area where the aquifer extends along the local watershed divide. Thus, groundwater flow is suspected not to cross the State border, but divide to the North in Bulgaria, and to the South in Turkey. It should be noted, however, that karstic aquifer flow systems are difficult to characterize, and the groundwater divide does not necessarily coincide with the topographic divide.

TRANSBOUNDARY AQUIFERS WHICH ARE NOT CONNECTED TO SURFACE WATERS ASSESSED IN THE MEDITERRANEAN SEA DRAINAGE BASIN

The transboundary aquifers described in this section are either not connected to surface waters — discharging directly to the sea for example — or information confirming such a connection to a particular watercourse was not provided by the countries concerned.

PELAGONIA- FLORINA/BITOLSKO AQUIFER (NO. 145)[95]

	Greece	The former Yugoslav Republic of Macedonia
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, overlying Palaeozoic and Mesozoic schists; medium links to surface waters, groundwater flow from Greece to the former Yugoslav Republic of Macedonia.		
Area (km²)	180	N/A
Thickness: mean, max (m)	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.

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

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.

According to both countries, there are no transboundary impacts.

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

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; the treatment of industrial effluents need to be improved, while other measures are planned.

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

[95] Based on information from the First Assessment.

Aquifer system of Istra and Kvarner

The aquifer system of Istra and Kvarner is divided into the following transboundary aquifers:[96]

1. Sečovlje-Dragonja/Istra aquifer (No. 146);
2. Mirna/Istra aquifer (No. 147) which on the Slovenian side is further divided into Mirna (No. 148) and Območje izvira Rižane (No. 149) aquifers;
3. Opatija/Istra (No. 150);
4. Rijeka/Istra aquifer which is further divided on the Slovenian side into Riječina – Zvir (No. 151), Notranjska Reka (part of Bistrica-Snežnik in Slovenia) (No. 152) and Novokračine (No. 153) aquifers.

SECOVLJE-DRAGONJA/ISTRA AQUIFER (NO. 146)[97]

	Croatia	Slovenia
Type 2 (SI)/represents none of the illustrated transboundary aquifer types (HR); Cenozoic carbonate limestones/silicate-carbonate flysch (SI) — Cretaceous predominantly limestones; Unconfined; groundwater flow from both Slovenia to Croatia and Slovenia to Croatia; weak to medium links to surface waters.		
Area (km²)	99	9
Groundwater uses and functions	Drinking water supply.	Local drinking water supply.
Pressure factors	Communities. Quality problems: 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.
Other information	Border length 21 km. Transboundary groundwater under consideration but not approved. The issue of groundwater use has not been resolved with Slovenia. Future prospects: agreement on the delineation of transboundary groundwater systems and development of monitoring programmes. Located in the valley of the Dragonja River.	Border length 21 km. Some 57.2% of the land is forest, 39.6% cropland, 1.1% urban or industrial area and 2.1% is in other land use. Future prospects: development of transboundary water protection areas. In the valley of the Dragonja River. Population ~6 500 (67 inhabitants/km²).

MIRNA/ISTRA AQUIFER (NO. 147)[98]

	Croatia	Slovenia
Represents none of the illustrated transboundary aquifer types; Cretaceous limestones, weak to medium links to surface water systems, groundwater flow from Slovenia to Croatia. Part of the Istra system.		
Area (km²)	198	N/A
Groundwater uses and functions	Drinking water supply; supports ecosystems; groundwater makes up 100% of the water used.	Provides part of regional drinking water supply for the town of Piran.
Pressure factors	N/A	Tourism and transport; pollution from urbanisation and traffic.
Groundwater management measures	Existing protection zones	N/A
Other information	Border length 10 km. Transboundary groundwater under consideration, but not approved. Trends and future prospects: agreed delineation of transboundary groundwater systems and development of monitoring programmes.	Border length 10 km. Trends and future prospects: delineation and enforcement of drinking water protection zones.

[96] Based on information from Slovenia.
[97] Based on information from. Slovenia, Croatia and the First Assessment. In Slovenia, the name of the aquifer is Območje Marezige – Dragonja.
[98] Based on information from Croatia and the First Assessment.

MIRNA AQUIFER (NO. 148)[99]

	Croatia	Slovenia
Type 2; Cenozoic carbonate limestones/silicate-carbonate flysch; unconfined.		
Groundwater uses and functions	N/A	Local drinking water supply
Other information		Border length 44 km. 62.5% of the land is forested, 26.6% is cropland and other land uses make up the remaining 10.9%. Population ~604 (14 inhabitants/km^2).

OBMOČJE IZVIRA RIŽANE AQUIFER (NO. 149)[100]

	Croatia	Slovenia
Type 2; Mesozoic carbonate karstic limestones; unconfined.		
Area (km^2)	N/A	227
Groundwater uses and functions	N/A	Local drinking water supply.
Other information		69.3% of the land is forested, 24.1% is cropland and 1.1% urban or industrial area. Population 5 100 (22 inhabitants/km^2).

OPATIJA/ISTRA AQUIFER (NO. 150)[101]

	Croatia	Slovenia
Area (km^2)	N/A	67
Groundwater uses and functions	N/A	Local drinking water supply.
Other information		83.1% of the land is forested, 13.0% is cropland and 0.5% urban or industrial area; Population~1 000 (15 inhabitants/km^2).

RIJEČINA – ZVIR AQUIFER (NO. 151)[102]

	Croatia	Slovenia
Mesozoic carbonates, dominantly karstic limestones; dominant groundwater flow direction from Slovenia to Croatia.		
Area (km^2)	N/A	70
Groundwater uses and functions	N/A	Local drinking water supply
Groundwater management	N/A	Development of transboundary groundwater protection areas is suggested.
Other information		Forest makes up 97.3%, cropland 0.1% and other land uses 2.6%. Population: 0.

NOTRANJSKA REKA AQUIFER (NO. 152)[103] (PART OF BISTRICA-SNEŽNIK IN SLOVENIA)

	Croatia	Slovenia
Type 2; Cenozoic carbonate limestones/silicate-carbonate flysch; unconfined.		
Area (km^2)	N/A	315
Groundwater uses and functions	N/A	Local drinking water supply.
Other information		From 67.1 to 77.4% of the land is forested, 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. Population~11,300 (36 inhabitants/km^2).

NOVOKRAČINE AQUIFER (NO. 153)[104]

	Croatia	Slovenia
Type 2; Cenozoic carbonate limestones/silicate-carbonate flysch.		
Area (km^2)	N/A	21
Groundwater uses and functions	N/A	Local drinking water supply
Other information		Some 81.0% of the land area of Novokračine aquifer on the Slovenian territory is forested, 17.8% cropland while 1.2% is urban or industrial area. population~900 (40 inhabitants/km^2).

With what concerns enhancement of transboundary cooperation on Mirna (No. 148), Območje izvira Rižane (No. 149) and Riječina – Zvir (No. 151) aquifers/groundwater bodies, Slovenia reported that development of transboundary water protection areas is an issue in which international cooperation/organizations can be of support.

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

CETINA AQUIFER (NO. 154)[105]

	Croatia	Bosnia and Herzegovina
Represents none of the illustrated transboundary aquifer types; Palaeozoic, Mesozoic and Cenozoic karstic limestones; in hydraulic connection with recent sediments; groundwater flow from Bosnia and Herzegovina to Croatia; strong links to surface water system.		
Area (km²)	587	2 650
Thickness: mean, max (m)	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.
Pressure factors	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 Bosnia and Herzegovina.	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 needs 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 them in Bosnia and Herzegovina as well. Agreed delineation of transboundary groundwaters, and development of monitoring programmes are needed.
Other information	Border length 70 km.	Border length 70 km. Transboundary aquifer under consideration, but not approved. Includes the Glamočko-Kupreško and other Poljes with very large springs.

DINARIC LITTORAL (WEST COAST) AQUIFER (NO. 155)[106]

	Croatia	Montenegro
Type 2; Jurassic and Cretaceous karstic limestones; weakly connected to surface water systems.		
Area (km²)	N/A	200
Thickness: mean, max (m)	500, >1 000	500, >1 000
Groundwater uses and functions	N/A	Groundwater provides 100% of total water use. 25-50% each for drinking water supply and industry, <25% each for irrigation and livestock.
Pressure factors	N/A	Abstraction of groundwater, widespread and severe saline water intrusion at the coastal area has resulted in high salinity of groundwater.
Groundwater management measures	N/A	Existing control of abstraction, efficiency of water use, protection zones, agricultural practices, groundwater monitoring and public awareness need to be improved.
Other information	According to existing data, no transboundary groundwater is recognized.	

[105] Based on information from Croatia and the First Assessment.
[106] Based on information from Croatia and the First Assessment.

METOHIJA AQUIFER (NO. 156)[107]

	Kosovo (UN administered territory under UN Security Council resolution 1244)	Montenegro
Type 1 (in ME)/4; Tertiary (Miocene) alluvial sediments (Kosovo), Triassic karstic limestones (ME); weak links to surface water systems.[108]		
Area (km²)	1 000	300 - 400
Thickness: mean, max (m)	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.
Pressure factors	Agriculture and local small industries. Pesticides and industrial organic compounds in the groundwater.	No pressures exerted on 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.

PESTER AQUIFER (NO. 157)[109]

	Montenegro	Serbia
Type 2; Middle Triassic karstic limestones; weak links to surface water systems, dominant groundwater flow is towards the south-west from Serbia to Montenegro.		
Area (km²)	>150	317
Thickness: mean, max (m)	350, 1 000	350, 1 000
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 recharge.
Pressure factors	Domestic wastewater	Local pressure from dewatering 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 need to be established. Exchange of data between the two countries is needed.	Systematic quantity and quality monitoring needs to be established. 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). The area is inaccessible and sparsely populated. Main economic activity: animal husbandry. Population 1 700 (6 inhabitants/km²).

KORAB/BISTRA – STOGOVO AQUIFER (NO. 158)[110]

	Albania	The former Yugoslav Republic of Macedonia
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; groundwater flow occurs in both directions, but more from the former Yugoslav Republic of Macedonia to Albania; weak links to surface waters.		
Area (km²)	~140	N/A
Thickness: mean, max (m)	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.
Pressure factors	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. Enhanced cooperation, setting up of transboundary institutions and creation of a joint programme for quantity and quality monitoring of the sulfur thermo-mineral springs are needed. Data are exchanged.	Improvements are needed in the monitoring of the aquifer and the protection zone 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. Transboundary agreements covering this aquifer exist.

[107] Based on the First Assessment.
[108] The uncertainty about which drainage basin, Adriatic or Black Sea, this aquifer belongs to has persisted since the First Assessment.
[109] Based on information from Serbia and the First Assessment.
[110] Based on the First Assessment.

JABLANICA/GOLOBORDO AQUIFER (NO. 159)[111]

	Albania	The former Yugoslav Republic of Macedonia
Type 2; Triassic and Jurassic karstic limestones; groundwater flow occurs in both directions; weak links to surface waters.		
Area (km²)	250	N/A
Thickness: mean, max (m)	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, as well as hydroelectric power.
Pressure factors	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	Border length 50 km. 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.	Border length 50 km; no impacts reported at transboundary level.

MOURGANA MOUNTAIN/MALI GJERE AQUIFER (NO. 160)[112]

	Albania	Greece
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.		
Area (km²)	440	90
Thickness: mean, max (m)	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.
Pressure factors	Waste disposal and sewer leakage. Increased abstraction has resulted in moderate problems related to groundwater quantity locally. Widespread but moderate salinisation; concentrations of sulfate in alluvial groundwater are high (300-750 mg/l) and this contributes to increased average sulfate (135 mg/l) in Blue Eye Spring's water.	Agriculture (population in the mountainous area is low).
Groundwater management measures	No measures employed. Detailed hydrogeological and groundwater vulnerability mapping, delineation of protection zones, wastewater treatment and public awareness are needed. Increased cooperation is also needed in setting up transboundary institutions and creating a joint programme for quantity and quality monitoring.	
Other information	Border length 20 km. 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. Has been at low risk, but rapidly developing agricultural and industrial activities could change this.	Border length 20 km. No transboundary impacts reported. The existing monitoring is expected to improve with implementing WFD.

[111] Based on the First Assessment.
[112] Based on the First Assessment.