# CHAPTER 5 DRAINAGE BASIN OF THE BLACK 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 Black Sea.

Assessed transboundary waters in the drainage basin of the Black Sea

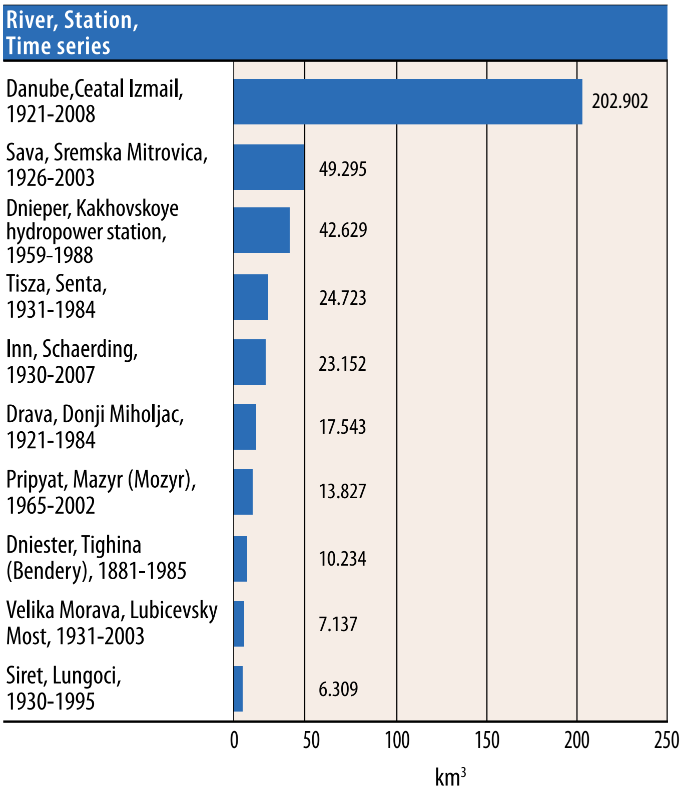
| Basin/sub-basin(s) | Recipient | Riparian countries | Lakes in the basin | Transboundary groundwaters within the basin | Ramsar Sites/wetlands of transboundary importance |
|---|---|---|---|---|---|
| Rezovska/Multudere | Black Sea | BG, TR | | | |
| Danube | Black Sea | AT, BA, BG, HR, CZ, DE, HU, MD, ME, RO, RS, SI, CH, UA | Reservoirs Iron Gate I and Iron Gate II, Lake Neusiedl | *Silurian-Cretaceous (MD, RO, UA), Q,N1-2,Pg2-3,Cr2 (RO, UA),* Dobrudja/Dobrogea Neogene-Sarmatian (BG-RO), Dobrudja/Dobrogea Upper Jurassic-Lower Cretaceous (BG-RO), South Western Backa/Dunav aquifer (RS, HR), Northeast Backa/Danube -Tisza Interfluve or Backa/Danube-Tisza Interfluve aquifer (RS, HU), *Podunajska Basin, Zitny Ostrov/Szigetköz, Hanság-Rábca (HU), Komarnanska Vysoka Kryha/Dunántúli – középhegység északi rész (HU)* | Lower Danube Green Corridor and Delta Wetlands (BG, MD, RO, UA) |
| - Lech | Danube | AT, DE | | | |
| - Inn | Danube | AT, DE, IT, CH | | | |
| - Morava | Danube | AT, CZ, SK | | | Floodplains of the Morava-Dyje-Danube _Confluence |
| --Dyje | Morava | AT, CZ | | | |
| - Raab/Rába | Danube | AT, HU | | Rába shallow aquifer, Rába porous cold and thermal aquifer, Rába Kőszeg mountain fractured aquifer, Günser Gebirge Umland, Günstal, Hügelland Raab Ost, Hügelland Raab West, Hügelland Rabnitz, Lafnitztal, Pinkatal 1, Pinkatal 2, Raabtal, Rabnitzeinzugsgebiet, Rabnitztal, Stremtal (AT, HU) | |
| - Vah | Danube | CZ, PL, SK | | | |
| - Ipel/Ipoly | Danube | HU, SK | | Ipoly völgy/Alúvium Ipľa (SK, HU) | |
| - Drava and Mura | Danube | AT, HR, HU, IT, SI | | Karstwasser-Vorkommen Karawanken/Karavanke (AT, SI), Ormoz-Sredisce ob Drava/Drava-Varazdin (HR, SI), Dolinsko-Ravensko/Mura (HR, SI), Mura (HR, HU), Drava/Drava West (HR, HU), Baranja/Drava East (HR, HU), Černeško-Libeliško (AT, SI), Kučnica (AT, SI), Goričko (AT, SI), Mura-Zala basin/Radgona-Vaš (AT, HU, SI), Kot (HU, SI) | Drava-Danube confluence Ramsar Sites (HR, HU, RS) |

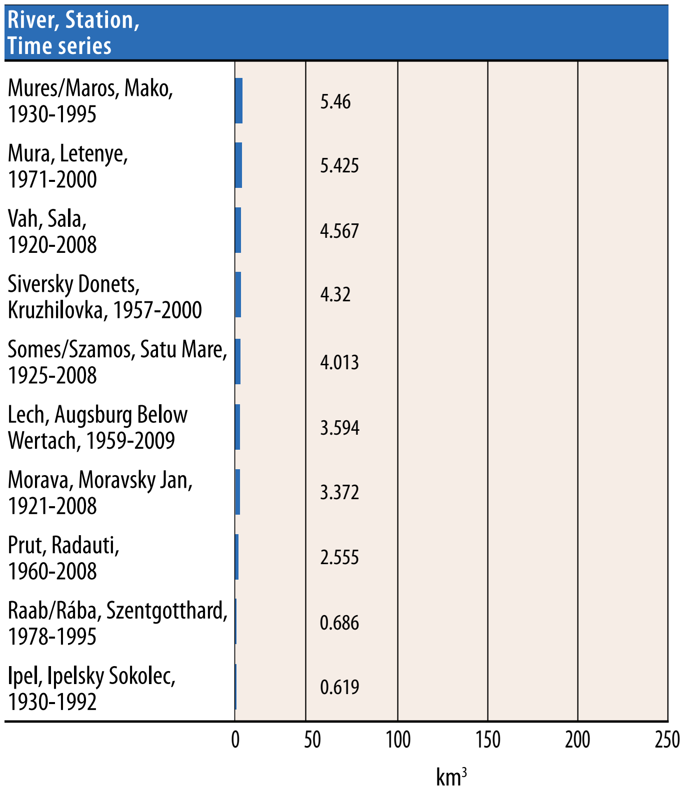
| Basin/sub-basin(s) | Recipient | Riparian countries | Lakes in the basin | Transboundary groundwaters within the basin | Ramsar Sites/wetlands of transboundary importance |
|---|---|---|---|---|---|
| - Tisza | Danube | HU, RO, RS, SK, UA | | Körös – Crisuri holocene, pleistocene (Hortobágy-Nagykunság Bihar Northern Part, Hortobágy, Nagykunság, Bihar northern part), Körös-valley, Sárrét, shallow/Crişuri (RO, HU), Slovensky kras/ Aggtelek (HU, SK), Quaternary alluvial sediments of Bodrog/Bodrogkoz (SK, HU), North and South Banat or North and Mid Banat aquifer (RS, RO), *Alluvial Quaternary aquifer (UA, SK, HU, RO)* | Upper Tisza Valley (HU, SK, UA), Domica-Baradla Cave System (HU, SK) |
| - - Somes/Szamos | Tisza | HU, RO | | Samos/Somes alluvial fan (RO, HU), Nyírség, keleti rész/Nyírség, east margin (RO, HU) | |
| - -Mures/Maros | Tisza | HU, RO | | Pleistocene-Holocene Mures/ Maros Alluvial Fan (RO, HU) | |
| - Sava | Danube | AL, BA, HR, ME, RS, SI | | Cerknica/Kupa, Kočevje Goteniška gora, Radovic-Metlika/Zumberak, Bregana-Obrezje/Sava-Samobor, Bregana, Bizeljsko/ Sutla (Boč, Rogaška, Atomske toplice, Bohor, Orlica) (HR, SI), Dolinsko-Ravensko/ Mura (HR, SI), Srem-West Srem/Sava (HR, RS), Posavina I/Sava, Kupa, Plešević a/ Una (BA, HR), Macva-Semberija (BA, RS), Lim (ME, RS), Tara massif (BA, RS) | |
| - Velika Morava | Danube | BG, MK, ME, RS | | | |
| - - Nisava | Juzna Morava (Velika Morava) | BG, RS | | Stara Planina/Salasha Montana (BG, RS) | |
| - Timok | Danube | BG, RS | | | |
| - Siret | Danube | RO, UA | | Middle Sarmatian Pontian (MD, RO) | |
| - Prut | Danube | MD, RO, UA | Stanca-Costesti Reservoir | Middle Sarmatian Pontian (MD, RO), Alluvial Quaternary aquifer (UA, RO) | |
| Cahul/Kagul | Lake Cahul/Kagul | MD, UA, | | *Pliocene terrigenous aquifer (UA, RO)* | |
| Yalpuh | Lake Yalpuh | MD, UA | | *Alluvial Quaternary aquifer (MD, UA), Alluvial Quaternary aquifer (UA, RO), Pliocene terrigenous aquifer (UA, RO)* | |
| Cogilnik | Lake Sasyk > Black Sea | MD, UA | | *Sarmatian terrigenous carbonate aquifer (UA, MD)* | |
| Dniester | Black Sea | UA, MD, PL | | *Shallow Groundwater (Q)/Qall,N,K2 (MD, UA), Sarmatian terrigenous carbonate aquifer (UA, MD)* | |
| - Yahorlyk | Dniester | UA, MD | | | |
| - Kuchurhan | Dniester | UA, MD | | *Sarmatian terrigenous carbonate aquifer (UA, MD)* | |
| Dnieper | Black Sea | BY, RU, UA | | Paleogene-Neogene terrigenous aquifer, Cenomanian carbonate-terrigenous (BY, UA), Upper Devonian terrigenous-carbonate aquifer (BY, RU), *Q, Pg2+Pg3,Cr2,A+Pt1 (BY, UA), Quaternary alluvial aquifer (UA, BY), Eocene and Oligocene terrigenous aquifer (UA, BY), Eocene terrigenous aquifer (UA, BY), Cretaceous carbonate and terigenous aquifer (UA, RU), Senonian-Turonian carbonate aquifer (UA, BY), Lower Cretaceous-Cenomanian carbonate and terrigenous aquifer (UA, BY), Jurassic and Lower Cretaceous carbonate and terrigenous aquifer (UA, BY)* | |
| - Pripyat | Dnieper | BY, UA | | Paleogene-Neogene terrigenous aquifer (BY, UA), Cenomanian terrigenous aquifer (BY, UA), Upper Proterozoic terrigenous aquifer (BY, UA), *Eocene terrigenous aquifer (UA, BY), Jurassic and Lower Cretaceous carbonaceous and terrigenous aquifer (UA, BY)* | Stokhid-Pripyat-Prostyr Rivers (BY, UA) |
| Elancik | Black Sea | RU, UA | | | |
| Mius | Black Sea | RU, UA | | *Carbonaceous terrigenous-carbonaceous aquifer (UA, RU)* | |
| Siversky Donets | Don > Black Sea | RU, UA | | *Upper Cretaceous-carbonaceous-terrigenous aquifer (UA, RU), Carboniferous terrigenous-carbonaceous aquifer (UA, RU)* | |

| Basin/sub-basin(s) | Recipient | Riparian countries | Lakes in the basin | Transboundary groundwaters within the basin | Ramsar Sites/wetlands of transboundary importance |
|---|---|---|---|---|---|
| Psou | Black Sea | GE, RU | | Psou aquifer (GE, RU) | |
| Chorokhi/Coruh | Black Sea | GE, TR | | | |
| - Machakheliscklai/ Macahel | Chorokhi/Coruh | GE, TR | | | |

*Note:* Transboundary groundwaters in italics are not assessed in the present publication.

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




*Source:* Hungary (Mura); Ukraine (Siversky Donets); GRDC, Koblenz (all other rivers).

## REZOVSKA/MULTUDERE RIVER BASIN[1]

The basin of the Rezovska/Multudere River[2] is shared by Bulgaria and Turkey, and covers an area of approximately 740 km². The river, with a total length of 112 km, springs from the Turkish part of the Strandja Mountain, where it is called Passpalderessi. For almost its entire length, it forms the border between Bulgaria and Turkey. The river runs into the Black Sea near the village of Rezovo, district of Bourgas (Bulgaria). The upper part of the river is in "natural conditions" and most of its downstream parts are in "good ecological and chemical status".

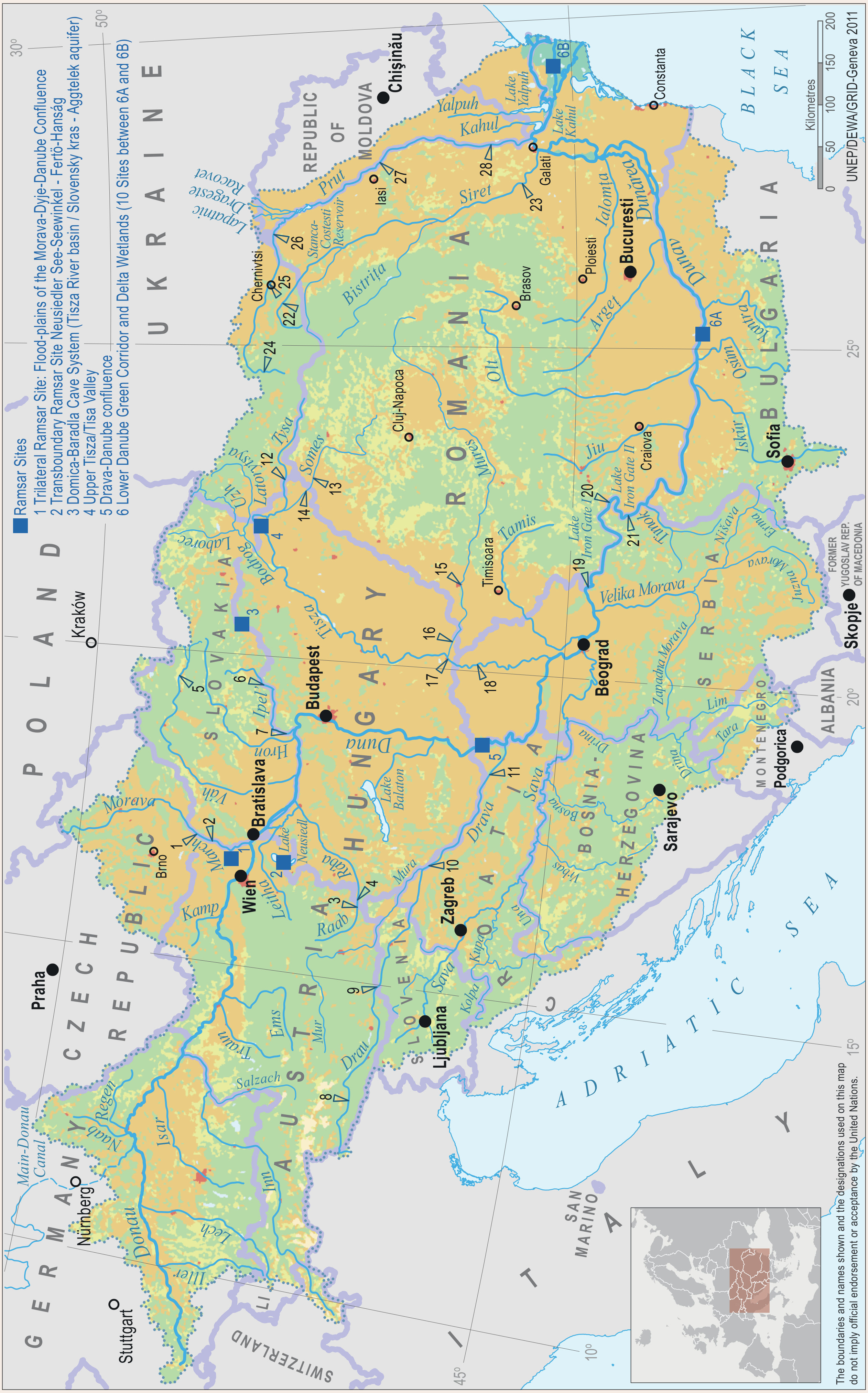
The agreement signed in 1997 by the riparian countries has as an integral part an annex representing a Joint Engineering Project regarding the Free Outflow of the Rezovska/Multudere River.

## DANUBE RIVER BASIN[3]

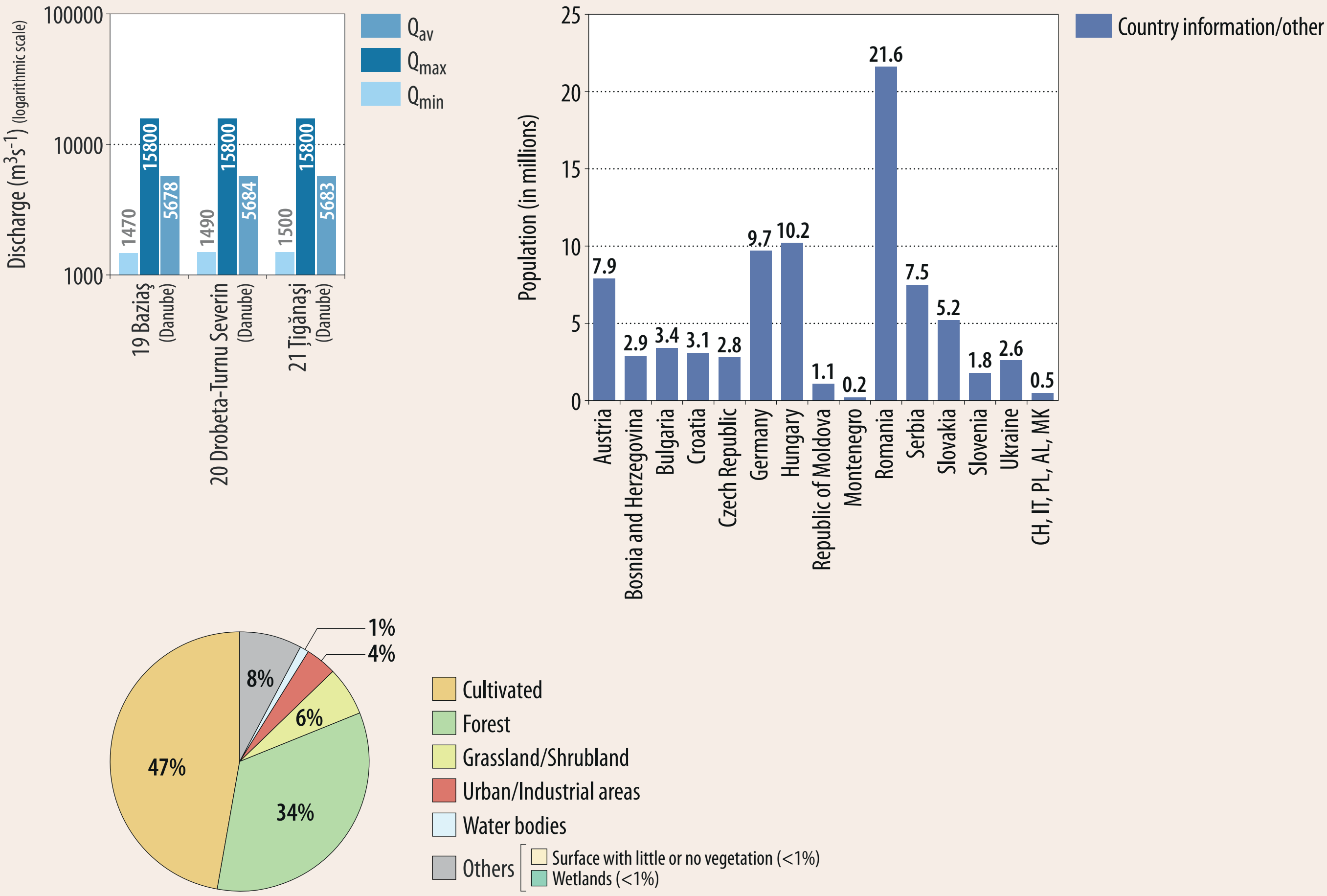
The Danube River Basin (DRB) is the "most international" river basin in the world, covering territories of 19 countries. Of these 19 countries, Albania, Italy, Poland, Switzerland and the former Yugoslav Republic of Macedonia usually do not appear in compilations of the relative share of the 19 countries in the basin due to their very small areas that belong to the DRB. This also applies to the tables in this assessment report; however, the total area of the basin includes the areas of these countries as referenced in relevant footnotes. The Danube River itself has a length of 2,587 km[4] and an approximate discharge of 6,500 m³/s at the river mouth.

Following provisions of the WFD, all watercourses in the Danube River Basin as well as the river basins in Romania discharging to the Black Sea and the Romanian-Ukrainian coastal waters of the Black Sea have been grouped into the so-called Danube River Basin District (DRBD) with an area of 807,827 km² and approximately 80.5 million inhabitants. Note should be taken of the fact in the following assessment reference is made either to the DRB or the DRBD.

[1] Based on information provided by Bulgaria and Turkey.
[2] The river is known as Rezovska in Bulgaria and as Multudere in Turkey. It is also known as Rezvaya.
[3] Based on information provided by the secretariat of the International Commission for the Protection of the Danube River (ICPDR) based on the Danube River Basin District Management Plan.
[4] This value does not include the length of the Chilia and St. Gheorghe Danube Delta branches.


Ramsar Sites
1 Trilateral Ramsar Site: Flood-plains of the Morava-Dyje-Danube Confluence
2 Transboundary Ramsar Site Neusiedler See-Seewinkel - Fertő-Hanság
3 Domica-Baradla Cave System (Tisza River basin / Slovensky kras - Aggtelek aquifer)
4 Upper Tisza/Tisa Valley
5 Drava-Danube confluence
6 Lower Danube Green Corridor and Delta Wetlands (10 Sites between 6A and 6B)
POLAND
UKRAINE
REPUBLIC OF MOLDOVA
CZECH REPUBLIC
SLOVAKIA
GERMANY
AUSTRIA
HUNGARY
ROMANIA
SLOVENIA
CROATIA
BOSNIA-HERZEGOVINA
SERBIA
MONTENEGRO
BULGARIA
ALBANIA
FORMER YUGOSLAV REP. OF MACEDONIA
ITALY
SAN MARINO
SWITZERLAND
LI
BLACK SEA
ADRIATIC SEA
Kraków
Praha
Nürnberg
Stuttgart
Brno
Wien
Bratislava
Budapest
Ljubljana
Zagreb
Sarajevo
Beograd
Podgorica
Skopje
Sofia
Timisoara
Cluj-Napoca
Chernivtsi
Iasi
Chişinău
Galati
Constanta
Brasov
Ploiesti
Bucuresti
Craiova
Main-Donau Canal
Donau
Duna
Dunărea
Dunav
Tisza
Tysa
Drava
Sava
Morava
Velika Morava
Prut
Siret
Olt
Mures
Jiu
Kilometres
0 50 100 150 200
UNEP/DEWA/GRID-Geneva 2011
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

## DISCHARGES, POPULATION AND LAND COVER IN THE DANUBE RIVER BASIN




*Sources:* UNEP/DEWA/GRID-Europe 2011"; National Administration "Apele Romane", Romania (discharges); International Commission for the Protection of the Danube River (population).

Share of DRBD per country; percentage of country's territory within the Danube River Basin District (DRBD); water body[5] delineation for all DRBD rivers with catchment areas >4000 km² and the Danube River

| Country | Surface area (km²) | Share of DRBD (%) | Percentage of country's territory within the DRBD (%) | Length of national DRB river network | Number of water bodies (WB) | | Share of all DRBD WBs (%) |
|---|---|---|---|---|---|---|---|
| | | | | | All | Danube | |
| AT | 80 800 | 10.0 | 96.1 | 2 392 | 190 | 13 | 25.6 |
| BA | 38 000 | 4.7 | 74.9 | 1 602 | 35 | 0 | 4.7 |
| BG | 46 900 | 5.8 | 42.6 | 1 291 | 15 | 1 | 2.0 |
| HR | 34 700 | 4.3 | 61,9 | 1 470 | 33 | 2 | 4.4 |
| CZ | 21 800 | 2.7 | 27.3 | 598 | 32 | 0 | 4.3 |
| DE | 56 500 | 7.0 | 16.0 | 1 503 | 53[a] | 15 | 7.1 |
| HU | 92 900 | 11.5 | 100.0 | 3 189 | 57 | 4 | 7.7 |
| MD | 12 100 | 1.5 | 36.2 | 837 | no information | | |
| ME | 7 300 | 0.9 | 55.0 | | no information | | |
| RO | 239 100 | 29.6 | 100.0 | 9 474 | 182[b] | 7 | 24.5 |
| RS | 81 600 | 10.1 | 92.8 | 3 277 | 63[c] | 10 | 8.5 |
| SI | 16 200 | 2.0 | 81.1 | 834 | 25 | 0 | 3.4 |
| SK | 46 900 | 5.8 | 96.0 | 1 811 | 45 | 4 | 6.1 |
| UA | 36 400 | 4.5 | 6.0 | 1 056 | 13 | 1 | 1.7 |
| **Total** | | **100[d]** | | **25 117[e]** | **68 115** | **4 514** | **100** |

[a] This value includes two artificial canal water bodies (Main-Danube Canal).
[b] This value includes two artificial canal water bodies (Danube-Black Sea Canal).
[c] This value includes 11 artificial canal water bodies (Danube-Tisa-Danube Canal System).
[d] This value includes the area of CH, IT, PL, AL and MK.
[e] This value does exclude doublecounts linked to river stretches shared by countries, and is therefore not the sum of individual river network lengths respectively.

[5] According to the WFD a body of surface water means a discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal, part of stream, river or canal, a transitional water or a stretch of coastal water.

Approximate distribution of Danube River Basin run-off by country/group of countries

| Country/group of countries | Annual volume of run-off (km³/year) | Share of Danube water resources (%) | Ratio of outflow minus inflow + outflow (%) |
|---|---|---|---|
| Albania | 0.13 | 0.06 | 100.00 |
| Austria | 48.44 | 22.34 | 63.77 |
| Bosnia and Herzegovina, Croatia and Slovenia | 40.16 | 16.84 | N/A |
| Bulgaria | 7.32 | 3.99 | 7.35 |
| Czech Republic | 3.43 | 1.93 | N/A |
| Germany | 25.26 | 11.65 | 90.71 |
| Hungary | 5.58 | 2.57 | 4.97 |
| Italy | 0.54 | 0.25 | 100.00 |
| Republic of Moldova and Ukraine | 10.41 | 4.78 | 9.52 |
| Montenegro and Serbia | 23.5 | 10.70 | 13.19 |
| Poland | 0.10 | 0.04 | 100.00 |
| Romania | 37.16 | 17.00 | 17.35 |
| Slovakia | 12.91 | 7.21 | 23.0 |
| Switzerland | 1.40 | 0.64 | 86.67 |
| **Total** | **216.34** | **100.00** | |

*Source:* Danube Pollution Reduction Programme - Transboundary Analysis Report. International Commission for the Protection of the Danube River, June 1999.

## Pressures[6]

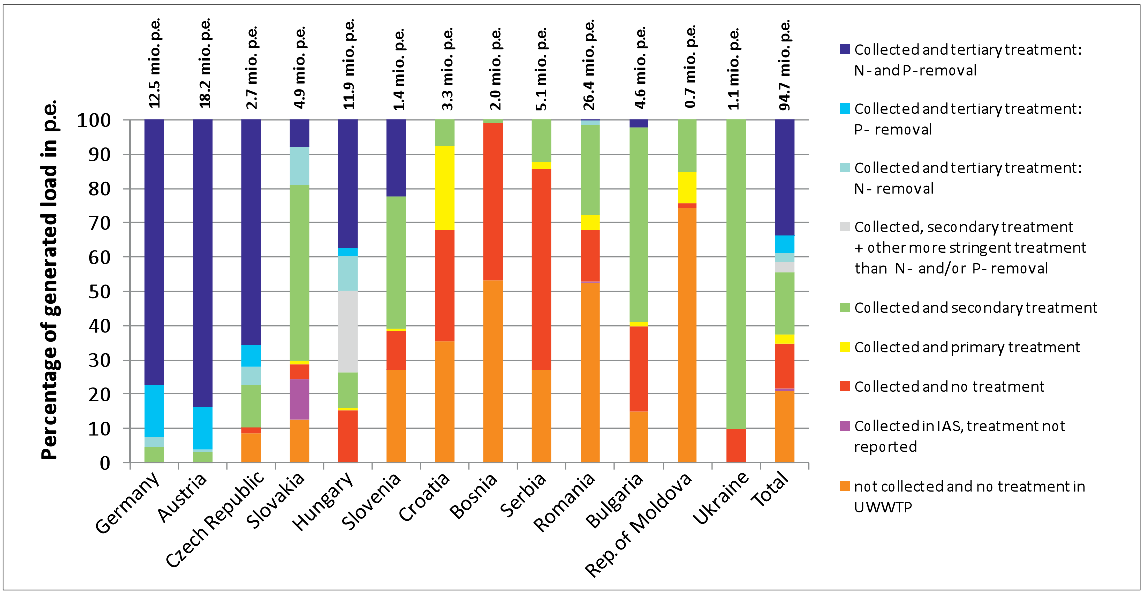
Organic pollution is mainly caused by the emission of partially treated or untreated wastewater from agglomerations, industry and agriculture. Many agglomerations in the DRB have no, or insufficient, wastewater treatment and are therefore key contributors to organic pollution. Very often industrial wastewaters are insufficiently treated or are not treated at all before being discharged into surface waters (direct emission) or public sewer systems (indirect emission).

A total of 6,224 agglomerations with a p.e. ≥2,000 (population equivalent) are located in the DRBD. Out of those, 4,969 agglomerations (21 million p.e.) are in the class of 2,000–10,000 p.e. and 1,255 agglomerations can be classified with a p.e. >10,000 (73.6 million p.e.).

The updated assessment of the Danube River Basin District Management Plan (DRBMP) shows that COD and $BOD_5$ emissions from large agglomerations (>10,000 p.e.) in the DRB are respectively 922 kt/year and 412 kt/year. The assessments have been improved by calculating emissions from agglomerations ≥2,000 p.e. The total emission contribution from these sources is 1,511 kt/year for COD and 737 kt/year for $BOD_5$.

Concerning nutrient pollution, the Danube, as one of the major rivers discharging into the Black Sea, was estimated to introduce on average about 35,000 tonnes of phosphorus (P) and 400,000 tonnes of inorganic nitrogen (N) into the Black Sea each year in the period 1988-2005. The present level of the total P load that would be discharged to the Black Sea (including the P storage that occurs today in the Iron Gate impoundments) would be

**FIGURE 1:** Wastewater treatment levels and degree of connection for the generated load (p.e.) from agglomerations ≥ 2,000 p.e. for reference year 2005/2006[7]




*Note:* IAS — Individual and appropriate systems e.g. cesspools, septic tanks, domestic wastewater treatment plants.

[6] The identification of Significant Water Management Issues in the DRBD was carried out in line with Article 5 of the WFD in the Danube Basin Analysis (2004).

[7] For some countries, a collection rate of less than 100% does not indicate that the remaining percentage is not treated at all. Discrepancies in the pressure analysis results between national level and DRB level can be attributed to the differences in the level of aggregation between national and basin-wide levels, to different reference years (the DRBM Plan considered 2005/2006), and/or to different methodologies used at national levels (i.e. differentiation between emissions to water bodies and emissions into soil).

Total nitrogen ($N_{tot}$) and total phosphorus ($P_{tot}$) emissions from agglomerations ≥2,000 p.e. for each Danube country and the entire DRBD emitted through all pathways (reference year 2005/2006)

| | AT | BA | BG | HR | CZ | DE | HU | MD | RO | RS | SI | SK | UA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions $N_{tot}$ (kt/year) | 9.5 | 7.3 | 6.5 | 10.9 | 2.8 | 12.3 | 14.7 | 1.9 | 69.3 | 16.0 | 3.2 | 11.4 | 2.1 | **168.0** |
| Emissions $P_{tot}$ (kt/year) | 0.8 | 1.6 | 1.3 | 2.8 | 0.4 | 1.0 | 2.8 | 0.4 | 11.5 | 2.9 | 0.7 | 1.7 | 0.7 | **28.6** |

**FIGURE 2:** Industrial direct emissions of nitrogen per relevant types of industries and EU member States (2004; RO: 2005)[8]

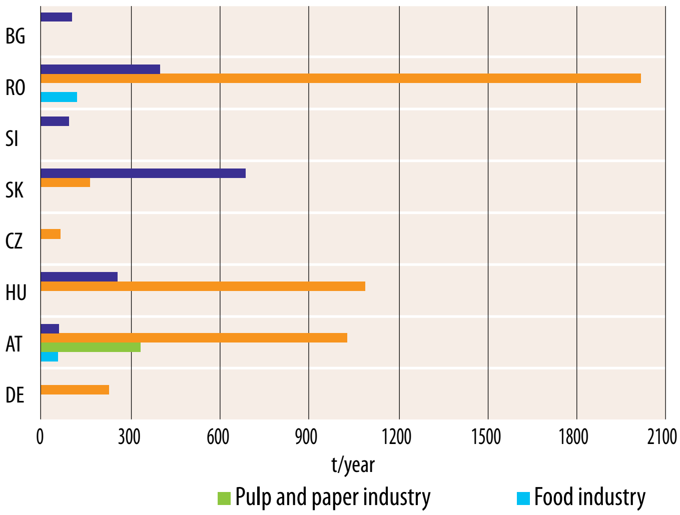
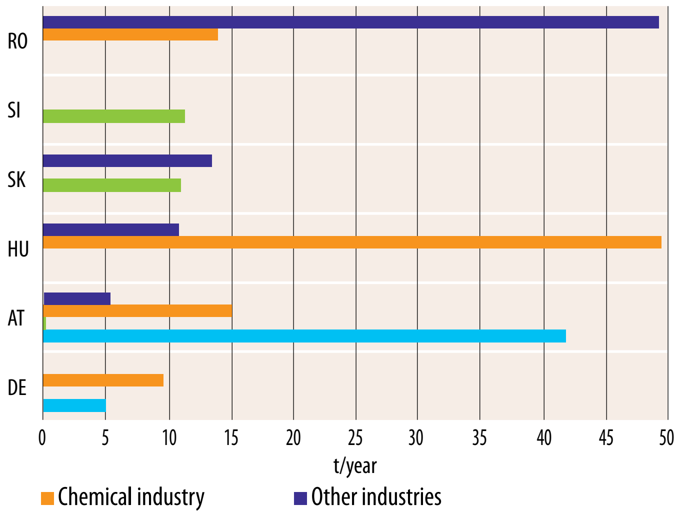



**FIGURE 3:** Industrial direct emissions of phosphorus per relevant types of industries and EU member States (2004; RO: 2005)[9]




about 20% higher than in the early 1960s (based on modelling results). The Iron Gate Dams are a significant factor in reducing the amount of P from countries upstream on the Danube River, as the large amounts of sediment containing attached P settle out in the reservoir.

Pollution by hazardous substances can seriously damage riverine ecology, and consequently impact upon water status, affecting the health of the human population.

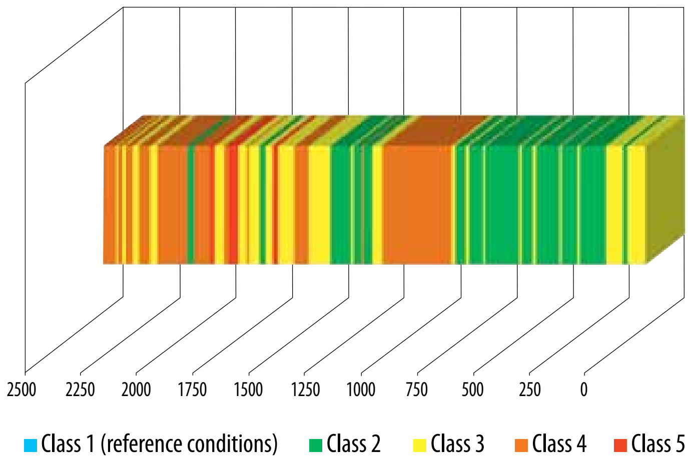
Information provided by the EU member States in the European Pollutant Emission Register (EPER) reporting shows an increase of the reported load values of arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc in 2004 (compared with 2001 values). In 2004, the amount of lead directly discharged was 138 t/year, and for zinc, 171 t/year.

Another major source of hazardous substances is pesticides used in agriculture. Information on pesticides' use within the Danube countries prepared for the DBA[10] showed that 29 relevant active ingredients were used in pesticide products. Of these, only three pesticides are authorized for use in all of the DRB countries, while seven are not authorized in any of the countries, despite the fact that they have been found when testing water and sediments. Compared with Western Europe, and including the upstream Danube countries, the level of pesticide use in central and lower DRB countries is still relatively low.

Three key hydromorphological pressure components of basin-wide importance have been identified: (1) interruption of river and habitat continuity; (2) disconnection of adjacent wetlands/floodplains; and (3) hydrological alterations.

The Joint Danube Survey 2 (JDS 2) in 2007[11] delivered results on hydromorphological alterations for the entire length of the Danube River. A 5-class evaluation for three categories (channels; banks; floodplains) formed the basis for the overall hydromorphological assessment, which concluded that more than one third (39%) of the Danube River from Kehlheim to the Black Sea can be classified as class 2[12]. However, 30% of the Danube River's length is characterised as class 3, 28% as class 4 and 3% as class 5.

**FIGURE 4:** Overall hydromorphological assessment of the Danube River in five classes as longitudinal colour-ribbon visualisation




The pressure analysis in the DRBMP showed that the key driving forces causing eventual river and habitat continuity interruptions in the DRBD are mainly flood protection (45%), hydropower generation (45%) and water supply (10%). Some 600 of the 1,688 continuity interruptions are dams/weirs, 729 are ramps/sills and 359

[8] The total nitrogen emissions in t/year for non-EU countries are currently unknown.
[9] BG, CZ: Data not reported for EPER 2004, therefore no illustration is included. The total phosphorus emissions in t/year for non-EU countries States are currently unknown.
[10] UNDP GEF Danube Regional Project: Inventory of Agricultural Pesticide Use in the DRB Countries.
[11] Liska, I., Wagner, F., Slobodnik, J. (eds), Joint Danube Survey 2, Final Scientific Report. International Commission for the Protection of the Danube River, Vienna 2008.
[12] The meanings of the classes employed the Joint Danube Survey 2: class 1 — channel nearly natural, class 2: — channel slightly modified, class 3 — channel moderately modified, class 4 — channel severely modified, class 5 — channel totally modified.

are classed as other types of interruptions. 756 are currently indicated to be equipped with functional fish migration aids. Thus, as of 2009, 932 continuity interruptions (55%) remain a hindrance for fish migration and are currently classified as significant pressures.

Connected wetlands/floodplains play a significant role when it comes to retention areas during flood events, and may also have positive effects on the reduction of nutrients. To date, 95 wetlands/floodplains (covering 612,745 ha) have been identified as having the potential to be re-connected to the Danube River and its tributaries. The absolute length of water bodies with restoration potential in relation to disconnected wetlands/ floodplains is 2,171 km (9% of the total river network).

The main types of pressure in the DRBD causing hydrological alterations are in numbers: 449 impoundments, 140 cases of water abstractions and 89 cases of hydropeaking (rapid changes of flow). The pressure analysis concludes that 697 hydrological alterations are located in the DRBD, 62 of them in the Danube River.

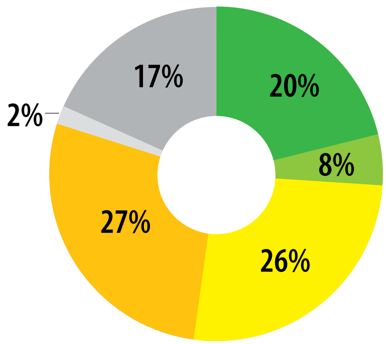
Altogether 112 future infrastructure projects at different stages of planning and preparation have been reported in the DRBD, 70 in the Danube River itself. Some 64 (57%) are related to navigation; 31 (28%) to flood protection; 4 (4%) to water supply; 3 (3%) to hydropower generation and 10 (9%) projects to other purposes. Out of the 112 future infrastructure projects, 22 are at an implementation stage.

## Status

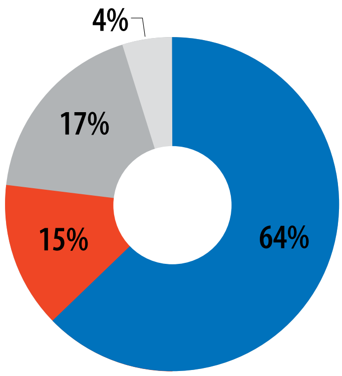
Out of 681 river water bodies in DRB evaluated for the DRBMP, 193 achieved good ecological status or ecological potential (28%), and 437 river water bodies achieved good chemical status (64%).

**FIGURE 5:** Ecological status and potential (a) and chemical status (b) for river water bodies in the DRBD (indicated in numbers and relation to total number of river water bodies)

- Ecological status Good or better
- Ecological potential Good or better
- Ecological status Moderate or worse
- Ecological status Moderate or worse
- No data Non EU-countries
- No data EU member States




- Good
- Failing
- No data EU member States
- No data Non EU-countries




Of the 45 river water bodies the status of which was evaluated in the Danube itself, 3 achieved good ecological status (4%) and 30 achieved good chemical status (67%). For 21 heavily modified water bodies (EU member States), one is assessed with good or better ecological potential.

## Responses

The Joint Programme of Measures (JPM) is structured according to the Significant Water Management Issues (organic, nutrient and hazardous substances pollution and hydromorphological alterations) as well as groundwater bodies of basin-wide importance, and it is based on the national programmes of measures, to be made operational by December 2012.

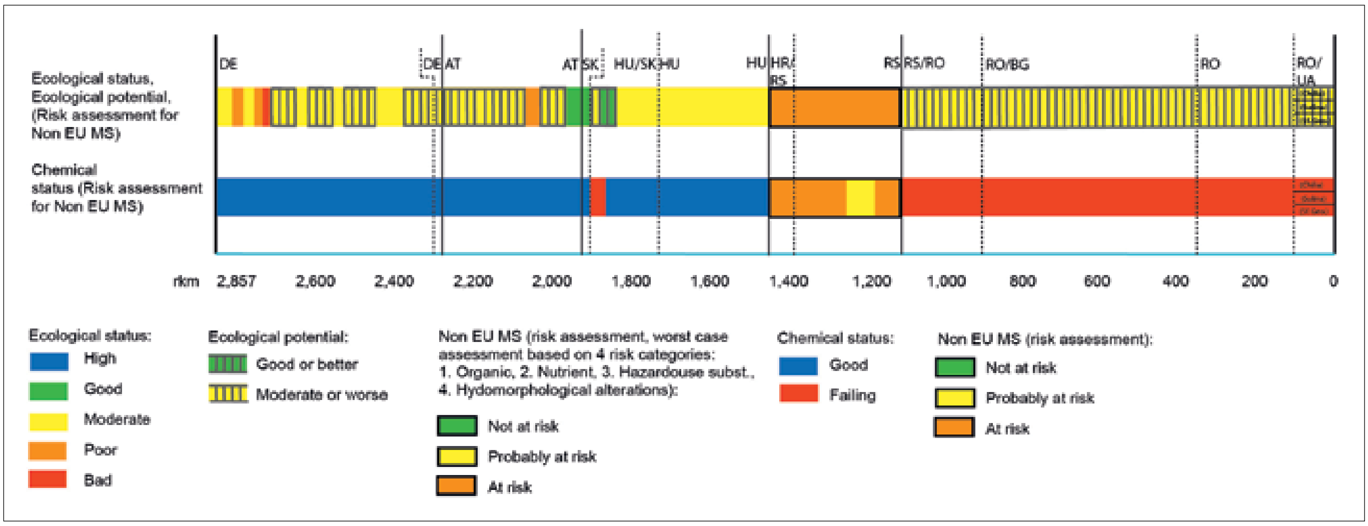
The ICPDR's basin-wide vision for organic pollution is zero emissions of untreated wastewaters into the waters of the DRBD. The implementation of the Urban Wastewater Treatment Directive (UWWTD) in the EU member States and the development of wastewater infrastructure in the non-EU member States are the most important measures to reduce organic pollution in the DRB by 2015 and also beyond. At present, extensive improvements in urban wastewater treatment are under implementation throughout the basin. For full implementation of the UWWTD in the DRB facilities in EU member States with >10,000 p.e. have to be subject to more stringent treatment as the Danube River discharges into Black Sea coastal waters, which are defined under the UWWTD as a sensitive area. Not all emissions of untreated wastewater from agglomerations with >10,000 p.e. will be phased out by 2015. 228 agglomerations with sewerage collecting systems are still lacking wastewater treatment plants (for parts of the collected wastewater), and this needs to be remedied by 2015. 41 agglomerations >10,000 p.e. are not equipped with sewerage collecting systems, and no wastewater treatment is in place for the entire generated load.

Organic point source pollution coming from industrial units is partly addressed by the Integrated Pollution Prevention and Control (IPPC) Directive, as well as by a number of EU Directives covering specific sectors and specific Best Available Techniques (BAT) regulations. The results of the scenarios prepared for the Danube River Basin Management Plan by an ICPDR expert group (see below for details) indicate that a reduction of emissions linked to organic pollution will be achieved by implementing the Baseline Scenario-UWWT 2015, but will not ensure the achievement of the WFD environmental objectives on the basin-wide scale for organic pollution by 2015. The magnitude of reduction depends on political decisions and the economic support for investments in wastewater treatment.

The ICPDR's basin-wide vision for nutrient pollution is the balanced management of nutrient emissions via point and diffuse sources in the entire DRB, so that neither the waters of the DRBD nor the Black Sea are threatened or impacted by eutrophication.

The Danube countries committed themselves to implement the Memorandum of Understanding adopted by the International Commission for the Protection of the Black Sea (ICPBS) and the ICPDR in 2001, and agreed that "the long-term goal is to take measures to reduce the loads of nutrients discharged to such levels necessary to permit Black Sea ecosystems to recover to conditions similar to those observed in the 1960s". In 2004 the Danube countries adopted the Danube Declaration in the framework of the ICPDR Ministerial Meeting, and agreed that in the coming years they would aspire "to reduce the total amount of nutrients entering the Danube and its tributaries to

**FIGURE 6:** Status classification for the Danube River regarding ecological status, chemical status and ecological potential (for those stretches that were designated as heavily modified water bodies) represented as continuous bands




levels consistent with the achievement of good ecological status in the Danube River and to contribute to the restoration of an environmentally sustainable nutrient balance in the Black Sea". Since Romania is a EU member State, the environmental objectives of the WFD are also to be applied to transitional and coastal waters in the Black Sea.

The effects of measures to reduce nutrient pollution by 2015 have been assessed applying the MONERIS model, which takes into account both emissions from point sources and from diffuse sources. MONERIS compares the calculated nutrient input (scenario 2015) with the observed nutrient loads (reference situation average 2001-2005) in the rivers of the DRB, and allows conclusions to be drawn for implementing appropriate measures.

On the basin-wide level, basic measures (fulfilling the UWWTD and EU Nitrates Directive) for EU member States and the implementation of the ICPDR Best Agricultural Practices Recommendation for non-EU countries are the main measures contributing to nutrient reduction.

An overall Baseline Scenario-Nutrients (BS-Nut-2015), which combines the agreed most likely developments in different sectors (urban wastewater, agriculture and atmospheric deposition), has been compared to the expected emissions of nutrients based upon application of the management objectives for the basin-wide scale. Comparison between the Baseline Scenario-Nutrients 2015 and the Reference Situation-Nutrients shows a reduction of N and P pollution in the DRB. However, it can be concluded that the measures taken by 2015 on the basin-wide scale to reduce nitrogen and phosphorus pollution will not be sufficient to achieve the respective management objective and the WFD environmental objectives 2015.

A ban of P containing laundry detergents by 2012 and dishwasher detergents by 2015 (Phosphate Ban Scenario-Nutrients) is seen as a cost-effective and necessary measure to complement the efforts of implementing urban wastewater treatment. This ban would further reduce the P emissions by approximately 2 kt/year to a level only 5% above the values of the 1960s.

Consequently, the 2015 management objective related to the reduction of the nutrient load to the level of the 1960s will be partially achieved for N and P.

The ICPDR's basin-wide vision for hazardous substances pollution is no risk or threat to human health, and the aquatic ecosystem of the waters in the DRBD and Black Sea waters impacted by the Danube River discharges.

Reducing hazardous substances emissions is a complex task that requires tailor-made strategies, as the relevance of different input pathways is highly substance-specific and generally shows a high temporal and spatial variability. Although there is insufficient information on the related problems at a basin-wide level, it is clear that continued efforts are needed to ensure the reduction and elimination of discharges of these substances.

Due to the synergies between measures to address organic, nutrient pollution and hazardous substances, the further implementation of the UWWTD for EU member States contributes to the reduction of hazardous substances pollution from urban wastewater and indirect industrial discharges.

Other relevant measures covering substances being released to the environment include chemical management measures.

The Dangerous Substances Directive, the IPPC Directive, and the UWWTD implementation by EU member States, as well as widespread application of Best Available Technique/Best Environmental Practice throughout the DRB, will improve but not solve problems regarding hazardous substances pollution. An overall improvement in the information available on the use of hazardous substances and their emissions into waters is a priority task for the ICPDR in the future.

A majority of the surface waters of the DRBD fail to meet the WFD objectives because of hydromorphological alterations, signaling the need for measures to achieve the management objectives and the WFD environmental objectives. Interruption of river and habitat continuity, disconnection of adjacent wetland/floodplains, hydrological alterations and future infrastructure may impact water status and are therefore addressed as part of the JPM. Measures reported by the Danube countries to restore hydromorphological alterations have been screened for their estimated effect on the basin-wide scale.

The ICPDR's basin-wide vision for hydromorphological alterations is the balanced management of past, ongoing and future structural changes of the riverine environment, so that the aquatic ecosystem in the entire DRB functions holistically and includes all native species. This means, in particular, that anthropogenic barriers and habitat deficits should no longer hinder fish migration and spawning; and sturgeon species and specified other migratory species should be able to access the

Danube River and relevant tributaries. The latter two species are represented with self-sustaining populations, according to their historical distribution. The focus for measures in the DRBD is on establishing free migration for long and medium distance migrants of the Danube River and the connected lowland rivers.

To address the disconnection of adjacent floodplains/wetlands, the ICPDR's basin-wide vision is that floodplains/wetlands in the entire DRBD are to be re-connected and restored. The integrated function of these riverine systems ensures the development of self-sustaining aquatic populations, flood protection and reduction of pollution. The DRBMP reports the area of floodplains/wetlands to be reconnected by 2015 for both the Danube River and its tributaries. The inter-linkage with national River Basin Management Plans (RBMP) is vital for wetland reconnection, as, for example, significant areas are expected to be reconnected to rivers with catchment areas <4,000 km$^2$. The approach will be further developed during the second RBM cycle.

The ICPDR's basin-wide vision for hydrological alterations is that they are to be managed in such a way that the aquatic ecosystem is not influenced negatively in its natural development and distribution. Impoundments, water abstraction and hydropeaking are key pressures that require measures on the basin-wide scale. The installation and application of appropriate control mechanisms at the national level regarding measure implementation will be important to achieve this basin-wide aim.

The ICPDR's basin-wide vision for future infrastructure projects is that they are to be conducted in a transparent way using best environmental practices and best available techniques in the entire DRBD; impacts on or deterioration of the good status and negative transboundary effects are fully prevented, mitigated or compensated. For new infrastructure projects, it is of particular importance that environmental requirements are considered as an integral part of the planning and implementation process.

The ICPDR initiated in cooperation with the Danube Navigation Commission and the International Commission for the Protection of the Sava River Basin the "Joint Statement on Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin".

The ICPDR's basin-wide vision for groundwater is that the emissions of polluting substances do not cause any deterioration of groundwater quality in the DRBD. Where groundwater is already polluted, restoring good quality will be the goal. Prevention of deterioration of groundwater quality and any significant and sustained upward trend in concentrations of nitrates in groundwater has to be achieved primarily through the implementation of the Nitrates Directive and the UWWTD.

To prevent pollution of groundwater bodies by hazardous substances from point sources, the following measures are needed: an effective regulatory framework ensuring prohibition of direct discharges of pollutants into groundwaters; the setting of all necessary measures required to prevent significant losses of pollutants from technical installations; and the prevention and/or reduction of the impact of accidental pollution incidents.

The ICPDR's basin-wide vision is that groundwater use is appropriately balanced and does not exceed the available groundwater resource in the DRBD, considering the future impacts of climate change.

Appropriate controls regarding abstraction of fresh surface water and groundwater and impoundment of fresh surface waters (including a register or registers of water abstractions) must be put in place, as well as the requirements for prior authorisation of such abstraction and impoundment. In line with the WFD, it must be ensured that the available groundwater resource is not exceeded by the long-term annual average rate of abstraction. The concept of registers of groundwater abstractions is well developed throughout the DRBD.

# TRANSBOUNDARY AQUIFERS IN THE DANUBE BASIN[13]

### DOBRUDJA/DOBROGEA NEOGENE – SARMATIAN AQUIFER (NO. 56)[14]

| | Bulgaria | Romania |
|---|---|---|
| Type 1 or 4; Neogene – Sarmatian oolitic and organogenic limestones in Romania, limestones, marls and sands in Bulgaria, with some sands and clays; weak to medium links with surface water systems, largely unconfined groundwater; dominant groundwater flow from W-SW (Bulgaria) to E-NE (Romania); groundwater levels at depth ranging between 5 m and 100 m. | | |
| Area (km²) | 3 308 | 2 178 |
| Renewable groundwater resource | $174 \times 10^6$ m³/year (average for the years 2007-2008) | $155 \times 10^6$ m³/year (average for the years 1995-2007) |
| Thickness: mean, max (m) | 80, 250 | 75, 150 |
| Groundwater uses and functions | Total abstraction ~12 300 m³/year (2009), which is practically only used for domestic purposes. Groundwater supports also ecosystems. | Total abstraction ~20 600 m³/year (2007) |
| Pressures | Agriculture is the main pressure, with N species detected in moderate concentrations (10 -100 mg/l). | |
| Other information | Border length 110 km. Almost 90% of the aquifer area is cropland. Two out of the three groundwater bodies (BG2G000000N016 and BG2G000000N017) are in good status. Not at risk. Transboundary cooperation on-going through the working groups established under the 2005 agreement. Exchange of data is reported as needed. Population ~422 200 (41 inhabitans/km²). | Border length 90 km. Almost 80% of the aquifer area is cropland. Not at risk. Transboundary cooperation on-going through the working groups established under the 2005 agreement. Exchange of data is reported as needed. Population ~220 000 (101 inhabitants/km²). |
| | Transboundary cooperation on-going through the working groups established under the 2005 agreement. Exchange of data is reported as needed. | |

*Note:* Bulgaria reported that the part of the aquifer extended in its territory consists of three distinctive groundwater bodies. Their areal extent is as follows: BG2G000000N015 - 1,079 km²; BG2G000000N016 - 1,365 km²; BG2G000000N017 - 2,407 km².

### DOBRUDJA/DOBROGEA UPPER JURASSIC – LOWER CRETACEOUS AQUIFER (NO. 57)[15]

| | Bulgaria | Romania |
|---|---|---|
| Type 4; Upper Jurassic – Lower Cretaceous karstic limestones, dolomites and dolomitic limestones; weak links with surface water systems; largely confined by overlying marls and clays; groundwater flow from north-west (Bulgaria) to south-east (Romania). | | |
| Area (km²) | 13 034 | 11 427 |
| Renewable groundwater resource | $498 \times 10^6$ m³/year (2008) | $1,677 \times 10^6$ m³/year (average for the years 1995-2007) |
| Thickness: mean, max (m) | 500, 1 000 | 350, 800 |
| Groundwater uses and functions | Groundwater is 22% of total water use. Abstraction ~$27.50 \times 10^6$ m³ (2008; groundwater bodies BG2G000J3K1040 and BG1G000J3K1051 only). The use is mainly for domestic purposes (88%), ~10% for industry, 1% for agriculture and 1% for thermal spa. Groundwater also supports ecosystems. | Abstraction ~$95.12 \times 10^6$ m³ (2007). Groundwater is used mainly for drinking water supply as well as (some) for irrigation and industry. |
| Pressures | No pressures. | No pressures. |
| Management pressures | Measures (in RBMP) include: (i) implementation and enforcement of the water use permitting/ licensing system; (ii) setting up protection zones; (iii) control of illegal discharges in the aquifer's recharge area. Improvement of monitoring is necessary. | |
| Other information | Border length 280 km. Population ~400,100 (density 84 inhabitants/km²). Some 78% of the aquifer area is cropland and 9% urban/ industrial area. Water bodies not at risk. | Border length 290 km. Water bodies not at risk. |

*Note:* Bulgaria reported that the part of the aquifer extending in its territory consists of three distinctive groundwater bodies delineated according to the definition of WFD. Their areal extent is as follows: BG2G000J3K1040 – 3,422 km²; BG2G000J3K1041 – 6,327 km²; BG1G0000J3K048 –8,971 km².

[13] These transboundary aquifers have been identified from earlier inventories such as the "Status assessment for groundwater: characterisation and methodology" (Annex 9 of the Danube River Basin Management Plan by the ICPDR) to be located within the Danube Basin. It should be noted that a number of transboundary aquifers have been identified as linked to specific sub-basins and are therefore presented as part of those assessments. Some aquifers were also identified as transboundary in the 1999 inventory of transboundary aquifers by the UNECE Task Force on Monitoring and Assessment.

[14] Based on information from Bulgaria, Romania and the First Assessment, supplemented by the Danube Basin Analysis (EU WFD Roof Report 2004).

[15] Based on information from Bulgaria, Romania, and the First Assessment, supplemented by the Danube Basin Analysis (EU WFD Roof Report 2004).

### SOUTH WESTERN BACKA/DUNAV AQUIFER (NO. 58)[16]

| | Serbia | Croatia |
|---|---|---|
| Type 3; Eopleistocene alluvial aquifer of mainly medium and coarse grained sands and some gravels, of average thickness 20 m and up to 45 m; partly confined with medium links to surface water systems; dominant groundwater flow direction from Serbia to Croatia. | | |
| Area ($km^2$) | 441 | N/A |
| Groundwater uses and functions | 50-75% of the groundwater is used for drinking water supply (covering the total of drinking water needs in the area) and less than 25% for irrigation, industry and livestock. Groundwater also supports ecosystems. | N/A |
| | Groundwater abstraction is the main pressure. Apart from the Danube riparian zone, abstraction from deep horizons with a natural renewal rate that does not meet consumption. Groundwater depletion observed in some deep wells (Pliocene sediments) while groundwater level has dropped locally (< 5 m - from the 1960s until 2000) in the Quaternary aquifer; Natural organic compounds, ammonia, Fe, Mn at high concentrations. Widespread naturally-occurring arsenic at concentrations from 10 to 100 µg/l. Ammonium pollution and pathogens result from inappropriate sanitation. | N/A |
| Other information | Population ~32,500 (density 74 inhabitants/$km^2$) Part of the Panonian Basin, within the Danube basin. Some 50% of the aquifer area is cropland, ~30% forest. | According to existing data, no transboundary groundwater is recognized. |

### RANGE OF CONCENTRATIONS OF CHARACTERISTIC QUALITY PARAMETERS IN DRINKING WATER IN TOWNS AND VILLAGES IN THE SERBIAN AREA[17]

| Town/village | Population | Fe (mg/l) | Mn (mg/l) | $NH_3$ (mg/l) | $KMnO_4$ consumption (mg/l) | As (mg/l) |
|---|---|---|---|---|---|---|
| Apatin | 19 289 | 1.6-2.7[a] | 0.09-0.3[a] | 2.2[a] | 11[a] | 0.006-0.012[b] |
| Prigrevica | 4 786 | | | | | Connected to Apatin waterworks |
| Svilojevo | 1 354 | Not Detected | Not Detected | Not Detected | Not Detected | Not Detected |
| Sonta | 4 994 | 1-3[a] | 0.1-0.13[a] | 1.5[a] | 12-26[a] | 0.001-0.26[a] |
| Bogojevo | 2 120 | 0.1-0.5[a] | | 0.08-0.23[a] | 9.6-45.6[a] | 0.134[a] |

[a] Concentrations exceeding limits set for drinking water.
[b] Concentrations below limits set for drinking water.

The construction of the regional water supply system of Backa, which will use groundwater from the Danube alluvium and serve more than 200,000 inhabitants of Western and Mid Backa Region (work is in the preparatory phase – field investigations and some studies have been completed), is included in the DRBMP and the Programme of Measures (final draft) prepared by ICPDR. It is among the measures planned to provide a solution to problems related to drinking water supply and to reduce or even eliminate the quantitative risk that the aquifer is currently under. The groundwater body is not at risk as far as quality is concerned. Nevertheless, its status was reported by Serbia as poor.

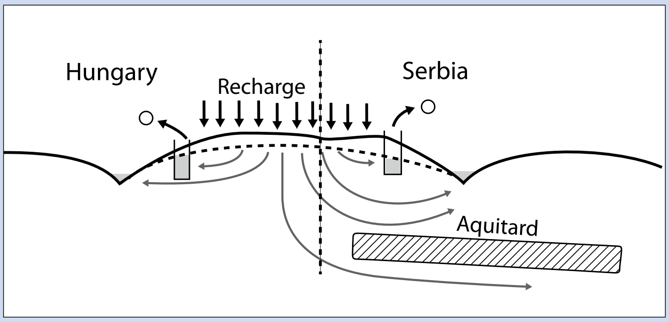
Transboundary cooperation on the aquifer has not been considered so far by Serbia as it is assumed that joint decisions are not needed.

[16] Based on information from Serbia and Croatia.
[17] *Source:* Project 353 Final Report: Sustainable solutions to improve quality of drinking water affected by high arsenic contents in 3 Vojvodinian regions (AP Vojvodina, Provincial Secretariat for Env. Protection and Sust. Development, 2006) – Provided by the Ministry of Agriculture, Forestry and Water Management, Serbia.

### NORTHEAST BACKA/DANUBE -TISZA INTERFLUVE OR BACKA/DANUBE-TISZA INTERFLUVE AQUIFER (NO. 59)[18]

| | Serbia | Hungary |
|---|---|---|
| According to the riparian countries represents none of the illustrated transboundary aquifer types. Part of North Pannonian basin, Miocene and Eopleistocene alluvial sediments; partly confined, predominantly sands with clayey lenses; medium to strong links to surface waters; groundwater flow from Hungary to Serbia; groundwater covers 80% of the total water use in the Serbian part and is >80% of total supply in the Hungarian part. | | |
| Area (km$^2$) | 5 648 | 4 065 |
| Thickness: mean, max (m) | 50-100, 125-150 | 150-400, 250-650 |
| Groundwater uses and functions | 75% for drinking water supply (100% of drinking water supplied in Voivodina comes from the aquifer) and less than 25% for irrigation, industry and livestock; also supports ecosystems. | >75% for drinking water, <25% for irrigation, industry and livestock; also supports ecosystems. |
| Pressures | Abstraction is the main pressure. Groundwater depletion observed on most of the wells in the Pliocene and Quaternary aquifer (near the borders with Hungary). Groundwater levels have dropped (from the 1960s until 2000) ~5-10 m regionally, >15 m locally. Severe reduction in borehole yields, and moderate land subsidence locally. Natural background groundwater quality is an issue; natural organic compounds, ammonia, and As detected in high concentrations. As 10 -50 µg/l. At Subotica-Mikićevo an increasing trend in electric conductivity from 1998 until 2007 (the end of data available). Widespread but moderate N and pathogens pollution due to inappropriate sanitation and naturally occurring iron. | Abstraction of groundwater exerts pressure; local and moderate increased pumping lifts, reduced borehole yields and baseflow, as well as degradation of ecosystems. Widespread and severe naturally occurring As at 10-200 µg/l, widespread but moderate $NO_3$ at up to 200 mg/l and pesticides at up to 0.1 µg/l. |
| Other information | Population 530 000 (93 in habitants/km$^2$). Some 87% of the aquifer area is cropland, ~5% urban/industrial area. | Border length 139 km. Population ~189 100 (density 47 inhabitants/km$^2$). Some 64% is cropland, 15% forest, 14% grassland and ~5% urban/industrial area. |

**FIGURE 7:** Conceptual sketch of the Northeast Backa/Danube-Tisza Interfluve aquifer (No. 59) (provided by Serbia)




In Serbia, abstraction management and water use efficiency measures have been taken, a system of protection zones established, and best agricultural practices and monitoring implemented. Nevertheless, as reported, this range of measures needs to be improved and other measures also need to be introduced. In Hungary, groundwater abstraction regulation is used and effective; water use efficiency measures, monitoring, public awareness, protection zones and wastewater treatment and data exchange need to be improved; and vulnerability mapping, regional flow modeling, good agricultural practices, integration with river basin management, and arsenic treatment or import of arsenic free water are needed.

According to Serbian assessments, the current status of the aquifer is poor; there is a possible risk related to quantity, but not related to quality. There is a possibility of using groundwater from the Danube alluvium instead of groundwater from deeper aquifers.

Evaluating the utilisable resource is a necessary action according to Hungary.


Bilateral cooperation concerning groundwater is in an inception phase. For its enhancement regarding this specific groundwater body, Serbia reported the two following areas in which international cooperation/organizations can be of support: (1) establishment/improvement of bilateral cooperation regarding the sustainable management of the transboundary aquifer; and (2) share of experience aiming to address the issue of naturally occurring arsenic.

Hungary suggested that joint monitoring (mainly quantitative) and joint modelling is needed.

[18] Based on information from Serbia; references to Hungary included here was based on information from the First Assessment. Northeast Backa/Danube-Tisza Interfluve is the name of the aquifer used in the First Assessment; Backa/Danube-Tisza Interfluve is the name of the aquifer used under this assessment by Serbia.

# RESERVOIRS IRON GATE I AND IRON GATE II[19]

The Iron Gate is a gorge between the Carpathian and Balkan mountains on the Danube River on the border between Romania and Serbia. Historically, it was an obstacle for shipping. Iron Gate I (upstream of Drobeta-Turnu Severin) includes one of Europe's largest hydroelectric power dams, operated as a run-off-the-river plant. The dam was built by Romania and the former Yugoslavia between 1970 and 1972. The Iron Gate II dam was built in 1985, also by Romania and the former Yugoslavia.

## Hydrology and hydrogeology

The total area of the Iron Gate I Reservoir is 330 km$^2$ and the total volume 3.5 km$^3$. The reservoir is relatively shallow; the mean depth is 25 m while its deepest point is at 70 m.

Iron Gate II, located downstream of Drobeta-Turnu Severin is smaller (79 km$^2$) than Iron Gate I; the total volume of the lake is 0.8 km$^3$. The reservoir is shallower than Iron Gate I, the mean depth is 10 m and its deepest point is at 25 m.

Floods are an issue of concern in Romania; extreme events usually occur during the high flow period (March – May). Among the most severe floods were events in 1999, 2005 and 2008. The construction of the dams facilitated flood control, as well as navigation activities.

## Pressures

The construction of the Iron Gates has caused an alteration of the hydrological regime of the Danube River. Reduction of sediment transport capacity, leading to sediment deposition at certain parts and alteration of the character of the aquatic and riparian habitats, were among the main effects. Sediment deposition induced the gradual increase of high water levels upstream, reducing the safety of the existing flood protection system. While pressure has been exerted on some fish species, others (some rare species) have benefited.

The lack of proper sewage collection and treatment facilities in the Drobeta-Turnu Severin agglomeration is the main pressure in the Romanian territory related to Iron Gate II. Some smaller towns, such as Orsova, also lack a treatment plant. Pressure factors reported by Romania as of low importance include decreasing forest cover; mining activities, open storage of wastes as well as tailings dams; the wastewater discharges from a unit which produces raw heavy water causing thermal pollution as well as sulphide hydrogen pollution (although wastewaters are treated); some inappropriate industrial wastewater collection and treatment facilities; and uncontrolled dumpsites in the riverbeds, especially in rural areas. The construction of new wastewater collection and treatment systems for human settlements and the rehabilitation of the existing systems for human settlements and industries are in progress, in accordance with the UWWTD.[20]

## Status and transboundary impacts

There are no major water quality problems in the Iron Gate I and II reservoirs. Nevertheless, the Iron Gates' water quality significantly depends on the input of pollutants from upstream Danubian countries. Pollutants accumulated in the sediments of the reservoirs may be of concern; heavy metals as well as other chemical substances have been detected in the sediments of the reservoirs, which also function as phosphorous traps.

The concentration of total suspended solids in the reservoirs has remained at approximately the same level, 27.5-32.5 mg/l, during the above-mentioned period.

## Responses

In Romania, the Iron Gates Reservoirs have been assigned to the Jiu River Basin Administration; a water management authority and a river basin committee (at the river basin level) have been established. Plans prepared at the national and River Basin Administrations' level include: a River Basin Management Plan and a River Basin Development Plan (the first focuses on water quality issues and the latter on water quantity issues); a Regional Action Plan for Environment; a Preventing and Fighting Accidental Pollution Plan; and a Drought Periods Water Use Operational Plan. The Rules of Operation of the Iron Gates include water demand management measures and measures aiming to increase water use efficiency.

In Serbia, the Iron Gate Authority is responsible for reservoir management, pursuant to the water permit issued in 2005. Water management plans pursuant to the WFD, as envisaged in the new water law (May 2010) will be prepared in the following years.

In Romania, monitoring has been established and functions in accordance with the WFD. The Iron Gates are covered by the Jiu Water Quality Monitoring System, which includes surveillance and operational monitoring. Wastewater discharges and water abstractions are also monitored.

Concentration of heavy metals in the sediments of Iron Gate I Reservoir (Serbia), based on a specific investigation of heavy metals in sediment cores taken from the reservoir bottom were done in 2009, approximately 50 km upstream of the Iron Gate I Dam (location with the largest deposits)

| | Concentration (mg/kg) | | Sediment quality criteria, ICPDR (mg/kg) | |
|---|---|---|---|---|
| Element | Range | Average | Quality target | Basic Level |
| Iron | 17 606.7 – 42 350.4 | 29 205.0 | | |
| Manganese | 523.4 - 1124.6 | 866.3 | | |
| Zinc | 129.4 - 823.8 | 291.2 | 200 | 130 |
| Copper | 15.7 - 118.6 | 51.8 | 60 | 35 |
| Chromium | 27.7 - 120.9 | 82.1 | 100 | 10-50 |
| Lead | 19.4 - 126.1 | 56.6 | 100 | 25 |
| Cadmium | 0.69 - 4.03 | 1.68 | 1.2 | 0.25 |
| Arsenic | 0.0 - 15.5 | 7.1 | 20 | 10 |
| Nickel | 34.3 - 140.8 | 74.7 | 50 | 10 |
| Mercury | 0.0 - 1.0 | 0.25 | 0.80 | 0.2 |

[19] Based on information from Romania and from Serbia.

[20] Romania, being a recent EU member country, was given a transition period for its implementation; the final date for the compliance with the Directive for agglomerations of less than 10,000 p.e. is 31 December 2018.

For the time being, monitoring of the Serbian part of both reservoirs is organized by the Iron Gate authority, and includes 9 specific sub-programmes for the monitoring of: (1) river flow and backwater levels; (2) groundwater levels and drainage systems operation; (3) sediment regime and deposition; (4) ice regime; (5) agricultural land preservation measures; (6) forests and wetlands; (7) flood control structures; (8) quality of water and sediment; and (9) riverbank and landslide stability. A monitoring systems that complies with the WFD is still in its planning phase.

Romania and Serbia participate in the TransNational Monitoring Network (TNMN), established to support the implementation of the Danube River Protection Convention in the field of monitoring and assessment.[21] Cooperation between Serbia and Romania on monitoring the water quality of the Danube River is regulated by the "Methodology on joint examination of the water quality in the transboundary section of rivers which form or are crossed by the Romanian-Serbian State border".[22]

### Transboundary cooperation

Cooperation between Serbia and Romania is based on the 1955 agreement covering hydro-technical issues on shared watercourses. A Joint Commission on transboundary waters was established the same year, to monitor and facilitate its implementation. The most recent agreement concerning the operation and maintenance of the Hydropower National System and of the Navigation National System in Iron Gates was signed between the two countries in 1998, and includes the present operation rules of the reservoirs.

Efforts to enter into a new legal arrangement on transboundary waters shared by Serbia and Romania date back to 1996, when Romania made a proposal to initiate negotiations on a new agreement taking into account the provisions of the UNECE Water Convention and the Danube River Protection Convention. This initiative was followed by communications between the two countries and an exchange of draft agreement texts in the period 2006-2007. The most recent draft text also incorporates provisions for the implementation of EU directives, in particular the WFD. The development of cooperation mechanisms is among the provisions. Serbia adopted a framework for the negotiations and finalization of the new agreement between the Republic of Serbia and Romania in field of water resources in October 2009. The first round of negotiation of the new agreement took place in November 2010.

## LAKE NEUSIEDL[23]

Lake Neusiedl[24] is located on the Austrian and Hungarian border. It belongs to the Danube River Basin District.

Lake Neusiedl is a natural lake of tectonic and erosion origin, which is the last and most western member of the so-called "soda lakes" in Europe. The age of the lake is estimated to be circa 10,000–15,000 years. The basin has a pronounced lowland character with an average elevation of 115.6 m a.s.l. The open water is surrounded by a 180 km$^2$ reed belt (>50% of the lake surface, about 85% in the Hungarian part), which is the largest closed monoculture of Phragmites in Central Europe.

Lake Neusiedl is visited by around 1.4 million tourists per year.[25]

Area of the Neusiedl Lake

| Country | Area in the country (km$^2$) | Country's share (%) |
|---|---|---|
| Hungary | 75 | 24 |
| Austria | 240 | 76 |
| **Total** | **315** | |

*Source:* http://www.ksh.hu/maps/teratlas/index_eng.html.

### Hydrology and hydrogeology

The lake has two major inflows: the Wulka River in Austria (mean discharge 0.53 m$^3$/s; average for the years 1966–2008), and the Rákos-creek in Hungary (mean discharge 0.049 m$^3$/s; average for the years 1994–2006). In addition, there are some smaller creeks. The lake has no natural outflow, other than the artificial, regulated, Hansag-Channel.

Surface water resources are between 215 and 243 × 10$^6$ m$^3$/year (from precipitation and inflow). The overflow through the outlet sluice gate in Fertőszél was 1.44 m$^3$/s (about 45.5 × 10$^6$ m$^3$/year) in 2009.

The weir gate located on Hungarian territory (Fertőszél) is used to stabilise the level of Lake Neusiedl. During flood events, the water flow through the weir is increased to lower the water level in the lake (the maximum discharge set in the jointly agreed operation rules is 15 m$^3$/s); conversely, the weir is more or less closed in times of drought, in order to maintain the water level.

### Pressures

On the Austrian side, 47% of the basin area is covered by cropland, 20% by forest, 14% by waterbodies, and 12% of the surface area has little or no vegetation.

As urban wastewater is collected and subject to advanced treatment (nutrient removal), there are no significant pressures in place in the catchment. The main activity still exerting some pressure is agriculture, but it is only moderate, as considerable parts of the catchment are either Natura 2000 areas or national park.[26]

Demand for drinking water in the Austrian part of the basin is met from outside the region, and in the Hungarian part the total withdrawal varies — in 2008 it was estimated at 150,000 m$^3$/year, and in 2009 at 250,000 m$^3$/year.

There are three harbours in the Hungarian part of the lake, and some recreational use thereof.

### Status and transboundary impacts

The lake water has a naturally high salt concentration, alkaline pH, and a high content of dissolved organic matter of natural origin. The overall trophic situation of the shallow lake is meso-eutrophic. Lake Neusiedl had a good ecological and chemical status in 2009, according to the requirements of the WFD. Since the 1990s and the early 2000s, the diffuse nutrient load (e.g., nitrate-nitrogen) has markedly decreased.

[21] The TNMN monitoring network is based on national surface water monitoring networks and includes 79 monitoring locations with up to three sampling points across the Danube and its main tributaries. The minimum sampling frequency is 12 times per year for chemical determinands in water and twice a year for biological parameters.
[22] Agreed by the Romanian-Serbian Hydrotechnic Joint Commission (Novi Sad, 1998); established in the framework of the Agreement on transboundary waters signed on 7 April 1955.
[23] Based on information provided by Austria and Hungary.
[24] The lake is also known as Neusiedler See in Germany and Fertő tó in Hungary.
[25] *Source:* www.neusiedlersee.com/static/files/jahr_2010.xls.
[26] Lake Neusiedl/Lake Fertőis, since 1996, part of the Natura 2000 network. The protected area and landscape covers about 417 km$^2$. Part of the catchment and of the surrounding area, called "Seewinkel", has been designated as National Park by Austria and Hungary in 1993 and covers about 300 km$^2$. The area has been designated as a UNESCO Biosphere Reserve (1979), a European Biogenetic Reserve (1988), a Ramsar Site (1989), a IUCN National Park, category II (1991) and a UNESCO Cultural World Heritage site (2001).

Due to its shallow depth (maximum depth is less than 2 metres), the lake is turbid and opaque, with a low degree of transmission. Even light breezes whirl up mud and organic/inorganic substances.

The most serious water-quality problems affecting the status of the lake are the following:

- nutrient pollution, water quality problems occurring especially in the reed belt (low oxygen in the summer);
- occasional low water levels;
- spread of the reed-belt that causes a decrease of the water surface, and reed over-growth in channels; and,
- the accumulation of sediments, which is characteristic of the southern part of the lake, due to the dominant wind-direction.

## Transboundary cooperation and responses

Issues related to Lake Neusiedl are covered under the Austrian-Hungarian Transboundary Water Commission. This Commission was established on the basis of the 1956 Hungarian-Austrian Agreement on Water Management Issues in Border Areas. The Commission agrees, among other issues, on the assessment of joint lake monitoring data and the resulting classification, and jointly decides on the stabilisation of the water level of Lake Neusiedl, and thus the operation rules for the weir regulating the outflow of the lake.

The management goals are directed towards a strong protection and conservation of flora, fauna, habitats and the landscape, on the one hand, and a moderate level of development of tourism, on the other.

The maintenance of the natural aging processes of Lake Neusiedl and conservation of the Lake's good status require Austrian-Hungarian cooperation. To this end, the Austrian-Hungarian Water Commission entrusted the two parties with working out the "Strategy Study of Lake Neusiedl", which led to the preparation of a measure-catalogue in 2008 and to the establishment of a common leading team in 2009.

The comprehensive set of measures[27] in place, aimed at conservation of the good ecological status of Lake Neusiedl and of the present volume and size, cover a broad range, starting with collecting and treating all wastewaters with advanced treatment (nutrient removal), applying the Austrian Nitrate Action Plan for this area, minimizing nutrient and sediment pollution, controlling sediment transport, limiting spread of the reed-belt, and reconstruction of the channel-system.

## Trends

Trends include increasing tourism caused by the economic development of Hungary. A permanent challenge is the request to open up limited areas in the reed belt for development of new infrastructure (e.g., for secondary residences).

Wet and dry periods in the history of the lake have alternated. According to information provided by Austria, the predicted temperature increase caused by climate change is expected to be bigger in summer and in autumn. Precipitation is predicted to increase in winter and in spring, and decrease in autumn. Evaporation may increase, and it is possible that the lake will again dry up, which would have impacts on biodiversity and birdlife through disappearance of the reed-belt.

[27] The measures planned in the River Basin Management plan are harmonized with the Strategy Study of Lake Neusiedl.

# LOWER DANUBE GREEN CORRIDOR AND DELTA WETLANDS[28]

## General description of the wetland area

Downstream of the Iron Gates dams, where the Lower Danube forms the border between Bulgaria and Romania, extensive floodplains remain (>1 million ha), mostly on the Romanian side. Further downstream, after the mouths of the left-side tributaries Siret and Prut, the wider Delta area of the Danube starts, including a number of liman lakes (former estuaries) and lagoons on the Black Sea, shared between the Republic of Moldova, Romania, and Ukraine (>1 million ha). This area is one of the largest natural river floodplain and delta areas in Europe, and one of the world's most important ecoregions for biodiversity, included in the WWF Global 200 list.

## Main wetland ecosystem services

Floodplains and river deltas are among the most valuable ecosystems in Europe. Their ecosystem services include significant flood retention capacities, water purification (due to a large capacity to absorb and filter nutrients and pollutants), groundwater recharge (for agricultural and domestic uses), climate regulation, prevention of coastal erosion and storm protection, retention of sediments, soil formation, accumulation of organic matter, fish nurseries, fibre and timber production, nutrient cycling and storage.

From ancient times until now, fishing has been an important economic activity along the Lower Danube and in the Delta. Other economic and subsistence activities associated with wetlands include cattle rearing, agriculture (vegetables, fruits, wine), fish breeding, waterbird hunting and reed harvesting (also for export). Due to their aesthetic landscape values, microclimate (cooler and fresher in summer) and rich cultural heritage, the Lower Danube and Delta region is increasingly used for leisure activities, including sport fishing, hunting, rural and nature tourism. The many existing protected areas have high educational and scientific values.

## Cultural values of the wetland area

Access to the river and sea meant that the region was and is a major trading centre and a crossroad for human migrations.

[28] *Sources:* Information Sheets on Ramsar Wetlands (RIS); Scientific Reserve "Lower Prut". Management Plan for the period 2008-1011. Moldsilva, Chiőnau; Srebarna Biosphere Reserve Management Plan; WWF Danube-Carpathian Programme; ICPDR (www.icpdr.org); Colonial waterbirds and their habitat use in the Danube Delta, as an example of a large-scale natural wetland. RIZA report 2004.002. Institute for Inland Water Management and Wastewater Treatment (RIZA), Lelystad. 2004; Vegetation of the Biosphere Reserve "Danube Delta" with Transboundary Vegetation Map. RIZA rapport. 2002.049. RIZA, Lelystad. 2002.

In particular, in the Danube Delta, many different groups (Orthodox old-church believers, Muslims, Jews, and others) settled over the centuries and maintained their specific cultures, including ways of nature management and uses of natural resources. The historical evolution of the settlements and the associated economic activities influenced architectural designs, including fish collecting points, houses and churches. The region harbours important archaeological sites, and a great cultural heritage.

## Biodiversity values of the wetland area

Wetlands along the Lower Danube and especially in its Delta support a very rich variety of life, including a number of globally threatened species, as well as habitats and species of Europe-wide concern. This area is internationally known for its bird fauna, both in terms of numbers (e.g., several million waterbirds stop over in the delta during their migration; it is also of great importance for breeding, moulting and wintering waterbirds) and of rare species. Noteworthy are, among others, globally important breeding colonies of Pygmy Cormorant and pelicans. In some winters, the Danube delta hosts almost the entire world population of the globally threatened Red-necked Goose. The delta is also important for fish spawning, nursery and migration, including commercially important and threatened species, such as sturgeon.

## Pressure factors and transboundary impacts

Threats to hydrological flows, habitats, biodiversity, water quality and wetland ecosystem services derive from man-made changes in the area, through the construction of industrial plants, shipping canals, large polders, river banks, dikes, locks, and sluices, as well as drainage of wetlands along the entire Danube and its tributaries. Simultaneously with these changes comes a dramatic reduction in the catch of high-value fish, a visible increase in eutrophication, and increased rates of sedimentation. In particular, industrial pollution, agricultural run-offs and urban wastewater, as well as overfishing and direct destruction of breeding grounds of wetland fauna, are additional pressures.

Building in the floodplain increases the risk of severe impacts of flooding, as it removes water retention capacity, and results in floods with higher intensity and duration downstream. Results of a recent study, financed by the Global Environmental Facility (GEF) and carried out by WWF, showed that over 80% of the Danube River Basin wetlands and floodplains have been destroyed since the turn of the 20th century, which also means a decrease of the ecosystem services provided by these wetlands and floodplains. Most recently, hydro-morphological modifications, made in view of increasing navigation corridors and partly subsidized through EU transport policies, are increasingly changing the river ecosystem.

Other notable negative factors include poaching, overgrazing, illegal tree cutting and unsustainable agricultural and forestry practices, including turning natural alluvial forests into plantations. Disturbance from recreational activities and visitors is increasing. Further pressures include disturbances from fishery and by-catch of birds and otters, oil extraction and transportation (with the danger of regular and accidental spills), solid waste disposals, invasive exotic species of plants and fishes, high numbers of wild boars, reed-burning, unsustainable collection of medical plants, landslides, and more frequent occurrence of drought periods. Diminishing rural populations is a problem, because traditional practices have become part of the functioning of the ecosystem, and lively rural areas have an important tourism potential.

Photo by Tobias Salathe

## Transboundary wetland management

Along the lower Danube, a mosaic of protected areas exists that includes Ramsar Sites, Biosphere reserves, World Heritage Sites, Natura 2000 sites, National/Nature Parks, and others. Ten Ramsar Sites are upstream: Ibisha Island (372 ha), Belene Islands Complex (6,898 ha) and Srebarna (1,357 ha; also World Heritage Site and Biosphere Reserve) in Bulgaria, Small Island of Braila (17,586 ha) in Romania, Lower Prut Lakes (19,152 ha) in the Republic of Moldova, Kartal Lake (500 ha), Kugurlui Lake (6,500 ha) and Sasyk Lake (21,000 ha, with 3,850 ha belonging to the Danube Delta Biosphere Reserve) in Ukraine, included in the Transboundary Biosphere Reserve Danube Delta (647,000 ha, also World Heritage Site) in Romania and Kyliiske Mouth (32,800 ha) in Ukraine.

On 5 June 2000, the Ministers of Environment from Bulgaria, Romania, the Republic of Moldova and Ukraine signed a Declaration (deposited with the Ramsar Convention Secretariat) on Cooperation for the Creation of a Lower Danube Green Corridor, to take concerted actions, establish new protected areas, and restore natural floodplains. This initiative was triggered by and receives support from WWF. The commitment was to include in the Corridor 773,166 ha of existing protected areas, 160,626 ha of new protected areas, and 223,608 ha of areas to be restored. In 2010, this was exceeded, with over 1.4 million ha now under protection. Different wetland restoration projects have been implemented in all four countries, but they have not yet reached their target for the restoration of former wetland areas.

Another agreement was signed on the same day under the aegis of the Council of Europe, for the Creation and Management of a Cross-Border Protected Area between the Republic of Moldova, Romania and Ukraine in the Danube Delta and the Lower River Prut Nature Protected Areas.

In December 2007, the Republic of Moldova, Romania and Ukraine signed the Joint Declaration to work towards a River Basin Management Plan for the Danube Delta supporting Sustainable Development in the Region, that provided the three countries with the necessary framework to cooperate for the good ecological status of the Danube delta and to meet the objectives set by the WFD.

Transboundary cooperation exists between the Romanian and Ukrainian parts of the Transboundary Biosphere Reserve and Ramsar Sites, notably in the field of inventories and monitoring (e.g., published inventories of vegetation and colonial waterbirds).

# LECH SUB-BASIN[29]

The basin of the Lech, a 254-km long tributary of the Danube, is shared by Austria and Germany, and covers an area of approximately 4,125 km. Discharge at the mouth of the river is 115 $m^3/s$ (based on the years 1982-2000), discharge in the border section is 44 $m^3/s$ (based on the years 1982-2000).

The Austrian part of the catchment area is rather mountainous, and covered mostly by forest and grassland. The impact from human activities is low. The quality of the water is excellent, and the status is at least good in the part that is in Austrian territory.

Between Austria and Germany, issues such as flood protection, hydropower generation, wastewater treatment and status and ecological potential of the river are solved in line with the provisions of EU WFD, within the framework of the joint bilateral transboundary commission.

# INN SUB-BASIN[30]

The catchment of the 515-km long Inn, a tributary of the Danube, is shared by Austria, Germany, Italy and Switzerland. The main tributary of the Inn is the Salzach River, which is shared by Austria and Germany.

The total area of the sub-basin is 26,130 $km^2$, of which the Swiss part of the basin covers 2,093, the Austrian part 15,842 and the German part 8,195 $km^2$.

The Swiss part of the catchment is somewhat mountainous, the Austrian part mainly mountainous, while in the German part a minor share of the catchment is mountainous. These mountainous areas are characterized by high levels of precipitation (up to 2,000 mm and more), while the fertile, slightly hilly forelands of the Alps receive considerably less precipitation.

## Hydrology and hydrogeology

The Inn is the third largest tributary of the Danube by discharge (735 $m^3/s$ at the mouth, 1921-1998).

Surface water resources generated in the Swiss part of the Inn sub-basin are estimated at 2.36 $km^3$/year based on measured precipitation for the years 1901 to 2000 and the run-off is estimated to be 1.84 $km^3$/year. Austria's purely national run-off (without the inflow from Switzerland) near the border of Austria and Germany at Kirchbichl gauging station is 7.4 $km^3$/year, adding to an overall run off of 9.2 $km^3$/year. A rough approximation of the Inn´s total run-off near the mouth is 23.3 $km^3$/year (including all tributaries from Switzerland, Germany and Austria).

## Pressures

The mountainous parts of the Inn River sub-basin are characterized by forests, grassland and land without or with little vegetation cover. Recreation and tourism (intensive but well-managed) is widespread. Settlements, commercial activities, and traffic routes are situated in the narrow valleys and small catchments within the Alps. This infrastructure has to be protected against natural hazards such as floods, torrents and avalanches, which have resulted in hydromorphological changes of the river and its banks.

The forelands of the Alps are characterized by considerably more anthropogenic activities, a considerably higher density of population, and significantly intensive agriculture.

Nevertheless, anthropogenic pressures potentially affecting water quality are low, mostly local and moderate in importance, as wastewater is treated in line with stringent national provisions (fully in line with the provisions for nutrient sensitive areas of the UWWTD for Austria and Germany) and the treated wastewater is diluted further by the abundance of water in these parts of the sub-basin.

The abundance of water and the steep slopes in the Inn River sub-basin also provide perfect preconditions for the generation of hydropower, but result also in erosion, accumulation of sediments, and suspended sediments in river water and mud flows, which also create local but severe pressures.

The infrastructure in place has to be protected against natural hazards such as floods, torrents and avalanches; this need for protection – together with the pressures inherent to hydropower generation – has resulted in considerable hydromorphological changes of the river and its banks. These pressures are of more local nature in the Swiss share of the sub-basin, and more widespread in the Austrian and German share of the Inn River sub-basin as there is a chain of hydropower plants on the Lower Inn.

## Responses

Transboundary river commissions have been in place for quite some time so as to coordinate, on a bilateral basis, all issues of relevance of water management.

Considerable efforts were taken to remediate impacts on water quality. As a result all urban wastewater is treated in line with stringent national and stringent EU legislation. As a consequence, BOD and ammonium levels in the Inn are rather low and have still a slight decreasing tendency according to the Trans National Monitoring Network (TNMN) in the Danube River Basin. Switzerland reports, however, that trace concentrations of synthetic organic compounds (from wastewaters) are increasingly detected in surface waters.

Challenges which are being tackled are the restoration of river continuity to allow for appropriate migration by fish, and the improvement of hydromorphology. Wherever and whenever feasible, more room is given to the river, providing protection against natural hazards and enhancing nature, nature protection and biodiversity.[31]

A protected Ramsar Site, Vadret da Roseg, and two parks of national importance, the Swiss National Park and the Biosfera Val Müstair, are located on the Swiss side of the sub-basin. The water reservoirs along the Austrian-German border for hydropower generation on the Lower Inn and Salzach are protected Ramsar Sites.

The programme of measures in line with the WFD is well-coordinated in the shared parts of the Inn and its tributaries, within the frame of the joint transboundray water commission of Austria and Germany.

## Trends

As described in more detail in the assessment of the Rhone, the predicted variability and decrease in the amount of precipitation,

[29] Based on information provided by Austria and on the First Assessment.
[30] Based on information provided by Switzerland and Austria, and on the First Assessment.
[31] For information on the response measures taken in Switzerland to address the hydromorphological pressures, please refer to the attachment on the Rhone.

together with the higher temperatures, will significantly affect the snow cover in the alpine region, resulting in changes in the hydrological regime. Climate change, together with increasing development of hydropower, is expected to lead to intensification of water use. These factors might also alter flow conditions, hydromorphology and habitats. However, efforts are in place within the frame of the Alpine Convention, where guidelines for the use of small hydropower have been worked out, as well as within the frame of the implementation of the WFD, to strive for solutions acceptable to both sides.[32]

# MORAVA AND DYJE SUB-BASINS[33]

The 329-km long Morava River[34] is a tributary of the Danube. The Morava River starts its run in the northern part of the Czech Republic in the Kralicky Sneznik mountains (1,380 m a.s.l.). In the lower part of its run, it forms the country borders between the Czech Republic and Slovakia, and also Austria and Slovakia. Its mouth is situated about 10 km upstream Bratislava. The 80-km long section of the Morava River forms the Austrian-Slovak border, and from the confluence with the Dyje River, the Slovak-Czech State border, while the River Dyje – a tributary to Morava River – forms the border between Austria and the Czech Republic.

Sub-basin of the Morava River

| Country | Area in the country (km²) | Country's share (%) |
|---|---|---|
| Czech Republic | 21 688 | 78.5 |
| Slovakia | 2 282 | 8.2 |
| Austria | 3 642 | 13.2 |
| **Total** | **27 612** | |

*Sources:* Ministry of Environment of Czech Republic and Ministry of the Environment of the Slovak Republic, River Basin Management Plan 2009.

## Hydrology and hydrogeology

In the Slovak part of the sub-basin, surface water resources are estimated at 350 × $10^6$ m³/year (average for the years 1961 to 2000), and groundwater resources at 92.18 × $10^6$ m³/year (average for the years 2000 to 2009). These add up to a total of 442.18×$10^6$ m³/year (average for the years 1961 to 2000), which is 2,211 m³/year/capita (average for the years 1961 to 2000).

In the Czech part of the Morava sub-basin, surface water resources are estimated at 1,360 ×$10^8$ m³/year, and 836×$10^6$ m³/year in the Dyje sub-basin. Groundwater resources in the Czech Republic's part of the Morava sub-basin are estimated at 571×$10^6$ m³/year, and in the Dyje sub-basin at 421 ×$10^6$ m³/year. Total water resources in the Czech Republic's part of the latter sub-basin are 2,200 ×$10^6$ m³/year, equaling 793 m³/year/capita.

There is a transboundary aquifer in sandy Quaternary sediments between the Czech Republic and Slovakia, with a surface area of 217 km², from which groundwater discharges to the Morava River (Type 3 aquifer). No related transboundary groundwater body has yet been identified, even though both countries discussed this during the first planning cycle under the WFD.

## Pressures, status and transboundary impacts

Cropland covers 47% of the sub-basins areas in Slovakia, and 44% in the Czech Republic. Forest makes up 36% and 31%, respectively.[35] In Slovakia, there are three large protected areas – Zahorie covers valuable natural ecosystems along the lower part of the Morava River, and two Ramsar localities cover the alluvium of the Rudava River and the lower part of the Morava River (see the separate assessment).

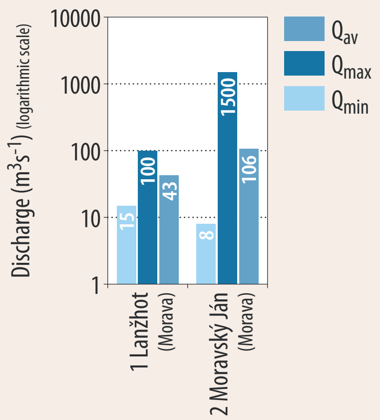
Hydromorphological changes are assessed as widespread, varying from moderate to severe.

Different pressures on water quality result from unsuitable agricultural practices (assessed as widespread and severe): fertilizers and manure are spread at high risk times, manure storages have a low capacity, and grassing of agricultural land, especially along river sides, is insufficient to function properly as buffer strips. Erosion and flooding have mostly had a local impact, with little transboundary effect.

Point-source pollution of surface waters, due to discharges of insufficiently treated municipal wastewaters and deficient infrastructure for sewerage collection and wastewater treatment, is judged as severe and widespread. Discharges of industrial wastewaters (metal, chemical and food processing industries) have a more moderate impact, as do old sites contaminated through groundwater pollution.

Owing to inappropriate wastewater treatment and agricultural practices, the nutrient content in the waters of the transboundary section of the river is rather high, resulting in eutrophication, organic pollution, and bacterial pollution.

DISCHARGES IN THE MORAVA SUB-BASIN




*Source:* UNEP/DEWA/GRID-Europe 2011.
*Note:* For locations of the gauging stations, the map of the Danube should be referred to.

Total water withdrawal and withdrawals by sector in the Morava sub-basin

| Country | Year | Total withdrawal ×$10^6$ m³/year | Agricultural % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|---|
| Slovakia | N/A | 100.8 | 13 | 63 | 23 | N/A | N/A |
| Czech Republic | 2009 | 328 | 5.4 | 46.4 | 6.3 | 40 | 1.2 |
| Austria | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

[32] Please refer to the Rhone assessment for more information.
[33] Based on information provided by the Czech Republic and Slovakia, and the First Assessment.
[34] The river is also known as March.
[35] The figures are based on Corine landcover, 2000 (Slovakia) and Corine 2006 (Czech Republic).

The status of the main course of the Morava in the border section in the Czech Republic was classified as “polluted water” (class III in the Czech national system) in 2007-2008, which is a clear improvement from the situation in 1991-1992 when the same stretch was classified as “heavily polluted” or “very heavily polluted water” (classes IV and V, respectively).

The Morava basin is characterized by rather intensive agriculture in the Austrian part, and by widespread protection of infrastructure against floods, which has resulted in hydromorphological changes of the river and its banks.

Anthropogenic pressures potentially affecting water quality from point sources are low in Austria, and mostly local and moderate in importance, as wastewater is treated in line with stringent national provisions.

According to the WFD, the Austrian and Slovakian joint assessments of the Morava, as well as the Austrian and Czech joint assessments of the Dyje, have determined a good chemical and a moderate ecological status of the river in 2010.

### Responses

The Czech Republic reports mainly legislative and technical measures that have been taken. As a concrete example, some old contaminated sites have been clean, so as to reduce groundwater pollution. Charges for groundwater abstraction have also been increased. On good agricultural practices, the Czech Ministry of Agriculture has, since 2009, a programme for reconstructing irrigation systems and building more efficient ones.

The Czech Republic and Austria have a bilateral Commission for Transboundary Waters, wherein issues related to the Morava are dealt with, and Austria and Slovakia have a bilateral Commission for Transboundary Waters to also deal with theses issues; the focus is on water quantity, quality, and WFD issues.

The agreement between the Czech Republic and Slovakia on transboundary waters (in force since 1999) provides the framework for cooperation. The Czech-Slovak Commission for Transboundary Waters functions on this basis, with three joint working groups focusing on water quantity, quality and WFD issues.

Multilateral cooperation is carried out in the framework of the International Commission for the Protection of the Danube River (ICPDR). For instance, the Morava and the Dyje are covered by the Trans-National Monitoring Network in the Danube River Basin.

Recently-agreed transboundary actions include joint measurements, data harmonisation, exchange of data and experience, as well as joint projects. Focused monitoring programmes with concrete objectives are approved by the Czech – Slovak and Czech – Austrian commissions. Among the main objectives of bilateral cooperation on transboundary water is the harmonized implementation of the WFD.

The Morava and the Dyje are covered by the CEframe (Central European Flood Risk Assessment and Management in Central Europe) initiative (to 2013) — triggered by knowledge gaps revealed by the flooding in 2006, with bilateral water commissions taking the first contacts — to improve flood management, with institutions from Austria, the Czech Republic, Hungary and Slovakia.

The trilateral expert conference of Austria, the Czech Republic and Slovakia on measures of transboundary meaning referring to the Morava and the Dyje deals with hydrographic and hydromorphologic issues, as well as with the use of the waterways by tourist boats.

### Trends

No significant changes in water withdrawal are expected in Slovakia by the year 2015 in comparison with the current situation. By 2015, in the Czech part of the Morava sub-basin and the Dyje sub-basin, withdrawal for energy may increase the most (up to 5%), industrial withdrawal may even decrease slightly (down to 5%), and agricultural and domestic withdrawal increase by 2% at most.

New areas where the legislative base requires strengthening indicated by the Czech Republic include the use of hydrothermal energy/heat pumps, and dealing with drought situations. Restrictions could be better employed in legal provisions related to agricultural production.

## FLOODPLAINS OF MORAVA-DYJE-DANUBE CONFLUENCE[36]

### General description of the wetland area

The trilateral Ramsar Site Floodplains of the Morava-Dyje-Danube Confluence is situated on the Danube River between Vienna and Bratislava, and extends further north of the Danube, starting from the Danube-Morava confluence in Devín, and continuing alongside the Morava and Dyje Rivers. The 80-km long section of the Morava River forms the Austrian-Slovak border, and from the confluence with Dyje River[37] forms the Slovak-Czech State border, while the River Dyje — a tributary to the Morava River — forms the State border between Austria and the Czech Republic. In the Czech Republic, the site continues northwest of the town of Břeclav into the Czech territory, alongside the Dyje River, also encompassing part of the Novomlýnské nádrže water reservoirs. The transboundary Ramsar Site comprises of the three national Ramsar Sites: Donau-March-Thaya-Auen (Austria): 36,090 ha, Mokřady dolního Podyjí (Czech Republic): 11,525 ha and Moravské luhy (Slovakia): 5380 ha (total area 52,995 ha).

The site consists of fluvial plain formed by alluvial sediments, fluvo-eolic hilly plain and dune hilly plain on sediments of fluvial terraces and blown sands. Though large areas of former floodplain meadows were ploughed in order to increase the area of arable land, 3,450 ha of alluvial meadows in total were preserved until the present, most of them located in Slovakia. Around 45% (app. 24,000 ha) of the site’s total area is covered by forests. The elevation varies from 130 – 180 m a.s.l. The climate is warm to moderate with mild winters; precipitation can vary widely annually.

### Main Wetland Ecosystem Services

The site represents the largest natural complex of floodplain meadows in Central Europe, and as such provides food, cover, resting and breeding opportunities for many species. Additionally, its hydrological importance is very high. Despite the intensive water engineering works, in large areas the natural flood and groundwater dynamics have remained. The site rep-

[36] *Source:* Information Sheets on Ramsar Wetlands (RIS).
[37] The river is also known as the Thaya.

resents an important groundwater source used for drinking water supply and irrigation in all three countries. It has also an important water retention and flood protection function, and is regularly flooded in spring/summer during the snow melting period. The Danube River is also used for navigation purposes, while on the Morava and Dyje rivers only recreational boating is allowed from June to December. The most important economic uses of the area are forestry (timber production), agriculture and tourism.

## Cultural values of the wetland area

The floodplains of the Morava and Dyje rivers were first inhabited in the Mesolithic period (8,000 – 6,000 B.C.). The warm climate and fertile soil induced the continuous settlement of the area. The evolution of the floodplain ecosystem was significantly influenced by people of the Hallstatt culture (700 – 400 B.C.). The Celts and the Romans also inhabited the area, followed by Slavic and German tribes. Thus, the area is extremely rich in archaeological monuments and artefacts.

The highlight of the site is surely the Schloss Hof, which extends over more than 50 ha, situated directly nearby the Morava River encompassing Baroque Palace, the Manor farm and vast Terraced Garden.

Today, the Stork Festival takes place in June in the town of Marchegg which hosts one of the largest White Stork colonies in Europe.

## Biodiversity values of the wetland area

The Floodplains of Morava-Dyje-Danube Confluence represent a diverse complex of wetlands — river channels, oxbow lakes, seasonal pools, alluvial meadows, sedge marshes and reed beds, floodplain forests, etc., including 16 habitat types of European importance. As such, it hosts the largest complex of species-rich alluvial meadows, and also the largest floodplain forest systems in Central Europe. The site provides habitat for almost 800 species of vascular plants, 275 species of birds, 55 fish species, 300 species of beetles and numerous groups of other invertebrates. Altogether 42 species of European importance are present including: beetles, dragonflies, molluscs, and fish, which latter include especially abundant European Bitterling, rare streber, and extremely rare ziege or Sabre Carp. Furthermore, amphibians, reptiles and mammals such as prosperous populations of beaver inhabit the site. Bats connected to wetland and water habitats are also present, and raptors such as eagles, Black Kite, or Saker Falcon regularly breed at the site. It is also an important winter roosting place for many birds, especially geese.

## Pressure factors and transboundary impacts

River regulation and engineering works have had the most significant impact on the site, with the first regulation works dating back to between 1882 to 1900, straightening and shortening the rivers as well as reducing their floodplain areas. The construction of the Nové Mlýny reservoirs on the Dyje River (1976–1989), intended to provide flood retention and a possibility to enhance low flow during droughts, changed the character of the river below the reservoir, and, besides other changes, reduced spring floods of the neighbouring floodplain. The most negative impact of river regulation works is nowadays the dredging of the riverbed, causing disconnection of the river-floodplain system, decrease of the water table, and potentially threatening groundwater sources. Additionally, the site suffers from intensified agricultural production in some parts, while in other parts former agricultural fields are now being abandoned. Transport development also poses threats to the site; this includes plans for navigability improvement and water engineering on the Danube and the so-called Danube-Odra-Elbe Canal. There are several road construction projects planned to cross the site in different locations, which could lead to habitat fragmentation.

## Transboundary wetland management

Since 1994, the environmental NGOs DAPHNE (SK), Distelverein (AT), Veronica (CZ) and WWF have worked together with the goal of supporting the trilateral region along the Morava and Dyje rivers through awareness raising, environmental policy and conservation management of the site. They have implemented a number of joint projects, facilitated cross-border networking, and finally contributed substantially to constituting the Memorandum of Understanding on the Morava-Dyje Floodplains, signed by the national Ramsar authorities of Austria, the Czech Republic and Slovakia in August 2001 on the basis of which the Trilateral Ramsar Platform was established. It consists of the representatives of environmental ministries, nature conservation authorities, Ramsar site and river basin managers and NGOs. As a first step forward, the common goals and principles for the transboundary site management were agreed in 2003 – 2004, and the trilateral Ramsar site Floodplains of the Morava-Dyje-Danube Confluence was designated in 2007. The joint effort is now focusing especially on the preparation of a common management strategy for the Trilateral Ramsar Site, and the development of a joint information system to make decision-making more efficient. Besides having been designated as a trilateral Ramsar Site, the major parts of the area were designated as Special Protection Areas under the EU Birds Directive 79/409/EEC, and also as proposed Sites of Community Interest under the Habitats Directive 92/43/EC.

# RAAB/RÁBA SUB-BASIN[38]

The sub-basin of the 311-km long Raab/Rába is shared by Austria and Hungary. The river has its source in the Fischbacher Alps in Austria, and discharges into the Moson-Danube at Győr. The basin has a typical mountain and hilly character, with a few lowland parts. The average altitude is around 210 m a.s.l. in Hungary; in the Austrian part the elevation ranges from 228 to 1,750 m a.s.l.

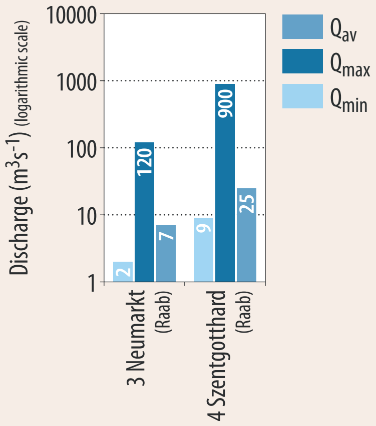
Major transboundary tributaries include the Lapincs/Lafnitz, Pinka/Pinka, Gyöngyös/Güns, Strem/Strembach, Repce/Rabnitz; all of them originating from Austria.

Sub-basin of the Raab/Rába River

| Country | Area in the country (km²) | Country's share (%) |
|---|---|---|
| Hungary | 6 847 | 56 |
| Austria | 4 480[a] | 44 |
| Total | 10 113 | |

[a] The surface areas of the sub-basins in Austria: Raab 1,009 km²; Lafnitz 1,990 km²; Pinka 742 km²; Strem 428 km²; Güns 260 km²; others 51 km².
*Source:* Federal Ministry of Agriculture, Forestry, Environment and Water Resources, 2011.

**DISCHARGES IN THE RAAB/RÁBA SUB-BASIN**




*Sources:* UNEP/DEWA/GRID-Europe 2011; Hydrographical yearbook 2008. Federal Ministry of Agriculture, Forestry, Environment and Water Resources. 2010 (for Neumarkt gauging station).
*Note:* For locations of the gauging stations, the map of the Danube should be referred to.

## Hydrology and hydrogeology[39]

At the Sárvár gauging station in Hungary, surface water resources are estimated at 1.12 km³/year (the long-term average discharge is 35.6 m³/s, based on observations from 1956 to 1992), out of which 0.82 km³/year come from Austria upstream and 0.13 km³/year originates from Hungary. At the Neumarkt gauging station in Austria, surface water resources generated in Austria are estimated to be 0.21 km³/year (average for 1976-2008[40]).

Groundwater resources in Hungary are estimated to be 128 km³/year. Groundwater inflow from outside the Hungarian border is small, estimated at 1.3 – 1.9 km³/year (1–1.5 %).

In total, water resources in the Hungarian part of the sub-basin are estimated to be 1.25 km³/year, which equals 5,710 m³/year/capita.

The long-term average discharges of the transboundary tributaries of the Raab are as follows: Pinka 3.4 m³/s (at Felsőcsatár, Hungary); Strem 1.46 m³/s (at Heiligenbrunn, Austria); Güns 1.57 m³/s (at Kőszeg, Hungary); Lafnitz 13.8 m³/s (Eltendorf, Austria — near the border with Hungary); and Rabnitz 0.89 m³/s (at Rabnitz, Austria).[41]

Up to 2,000 m thick Pannonian sediments overlie the predominantly Palaeozoic crystalline basement formation; the lower part has low hydraulic conductivity, the upper part (0-1,500 m) has good hydraulic conductivity, storing thermal water and supplying drinking water. Above the Upper-Pannonian lies a Pleistocene sand-gravel aquifer (on average 10 m thick), which has strong links with surface waters (see the tables of aquifers/groundwater bodies for details). The transboundary groundwaters in this sub-basin are presented as individual groundwater bodies or aquifers from either the Austrian or the Hungarian side. Small groundwaters are summarized in Austria as groups of groundwater bodies.

Total water withdrawal and withdrawals by sector the Raab/Rába sub basin

| Country | Total withdrawal ×10⁶ m³/year | Agricultural % | Domestic % | Industry % | Energy % | Other% |
|---|---|---|---|---|---|---|
| Hungary, surface water | 0.38 | 99.86 | 0.04 | 0.02 | 0 | 0.08 |
| Hungary, surface water | 11.66 | 0.78 | 90.92 | 8.22 | 0 | 0.08 |

**RABA SHALLOW AQUIFER (NO. 60)**

| | Hungary[a] | Austria[b] |
|---|---|---|
| Type 5; Aleurite, clay, sand, gravel; Pleistocene, dominant groundwater flow from west to east; strong links with surface water. | | |
| Area (km²) | 1 650 | N/A |
| Thickness: mean, max (m) | 10, 20 | N/A |
| Groundwater uses and functions | For drinking water, agricultural sector (including irrigation). | N/A |
| Other information | Agriculture exerts pressure on water quality; This Pleistocene aquifer overlying the Upper Pannonian sustains river flow during dry periods. | N/A |

[a] This aquifer is part of a boundary groundwater body in Hungary.
[b] Due to limited information, it was not possible to link this aquifer to a corresponding aquifer in Austria.

[38] Based on the information given by Austria and Hungary.
[39] The sources of the information concerning aquifers and groundwater bodies in Austria are the following: 1) Austrian Federal Agency for Environment; and 2) Report Inventory under Article 3 and 5 of the WFD, Danube River Basin. Planning Area Leitha, Raab and Rabnitz, Work Package "Location and Boundaries of Groundwater". 2005.
[40] *Source:* Hydrographical yearbook 2008. Federal Ministry of Agriculture, Forestry, Environment and Water Resources, Unit VII 3, vol. 116, 2010.
[41] *Source:* Hydrographical yearbook 2008. Federal Ministry of Agriculture, Forestry, Environment and Water Resources, Unit VII 3, vol. 116, 2010.

### RABA POROUS COLD AND THERMAL AQUIFER (NO. 61)

| | Hungary[a] | Austria[b] |
|---|---|---|
| Type 5; Aleurite, clay, sand; Upper-Pannonian; dominant groundwater flow from west to east; weak links with surface water. | | |
| Area (km²) | 1 650 | N/A |
| Thickness: mean; max. (m) | 800; 1 500 | N/A |
| Groundwater uses and functions | For drinking water, agricultural sector (irrigation included). | N/A |
| Other information | Upper-Pannonian down to the depth of 1 500 m) has got good hydraulic conductivity. The lower part of Upper-Pannonian stores thermal water and the upper 250 m is used to supply drinking water. | N/A |

[a] This aquifer is part of a boundary groundwater body in Hungary.
[b] Due to the limited information, It was not possible to link this aquifer to a corresponding aquifer in Austria.

### RABA KŐSZEG MOUNTAIN FRACTURED AQUIFER (NO. 62)

| | Hungary[a] | Austria[b] |
|---|---|---|
| Type 5; Phyllite (carbonate-bearing), Jurassic to Cretaceous, fracture aquifer; dominant groundwater flow from north-west to south-east; weak links with surface water. | | |
| Area (km²) | 52 | N/A |
| Thickness: mean, max. (m) | >100, - | N/A |
| Groundwater uses and functions | For drinking water, agricultural sector (irrigation included). | N/A |

[a] This aquifer is part of a boundary groundwater body in Hungary.
[b] Due to limited information, it was not possible to link this aquifer to a corresponding aquifer in Austria.

Transboundary groundwaters shared by Austria and Hungary in the Raab/Raba Basin.[42] The aquifers or groundwater bodies are commonly only a few metres thick, up to about 10 m. The thickness of Günstal aquifer and groundwater bodies of the Günser Gebirge Umland group reaches some 30 m, and Rabnitzeinzugsgebiet 165 m. Groundwater is mainly used for drinking water and for the agricultural sector (including irrigation). For all the groundwaters, exept Günstal for which it has not been specified, the dominant groundwater flow direction is from Austria to Hungary.

| Name and number | Aquifer/ groundwater body | Groundwater characteristics | National identification code(s) | Surface area (km²) | Pressure factors |
|---|---|---|---|---|---|
| Raabtal (No. 63) | aquifer | Mainly porous, with more local and limited porous-, fissured- or karst groundwater | PG13310, GWK100131 | 114 | Industry, existing waste deposits, agriculture and forestry; agricultural land use 94% of the area |
| Lafnitztal (No. 64) | aquifer | Mainly porous, with more local and limited porous-, fissured- or karst groundwater | PG13350, GWK100129 | 96 | Artificial recharge of groundwater, waste dumps and agriculture; agricultural land use 92% |
| Pinkatal (No. 65) | aquifer | Mainly porous, with more local and limited porous-, fissured- or karst groundwater | PG13321, GWK100130 | 44 | Waste dumps and agriculture, agricultural land use 90% |
| Pinkatal 2 (No. 66) | aquifer | Mainly porous, with more local and limited porous-, fissured- or karst groundwater | PG13322, GWK100130 | 40 | Waste dumps and agriculture, agricultural land use 90% |
| Stremtal (No. 67) | aquifer | Mainly porous, with more local and limited porous-, fissured- or karst groundwater | PG13340, GWK100136 | 50 | Old landfills and agriculture; agricultural land use 90%. |
| Rabnitztal (No. 68) | aquifer | Mainly porous, with more local and limited porous-, fissured- or karst groundwater | PG13260, GWK100132 | 40 | Agricultural land use 94%. |
| Hügelland Raab West (No. 69) | Group of groundwater bodies | Predominantly porous | 100187 | 1 352 | Agriculture and forestry and existing waste deposits; agricultural land use 56%. |
| Hügelland Raab Ost (No. 70) | Group of groundwater bodies | Predominantly porous | 100181 | 1 079 | Pressures from agriculture and forestry and existing waste deposits and dumps; agricultural land use 53%. |
| Günstal (No. 71) | aquifer | porous | GWK 100127 | 14 | Agricultural land use 66%. |

[42] The information here refers only to the Austrian part of these aquifers/groundwater bodies, as there was no information available on the territory of Hungary. *Sources:* 1) Austrian Federal Agency for Environment; and 2) Report Inventory under Article 3 and 5 of the WFD, Danube River Basin. Planning Area Leitha, Raab and Rabnitz, Work Package "Location and Boundaries of Groundwater". 2005.

| Name and number | Aquifer/ groundwater body | Groundwater characteristics | National identification code(s) | Surface area (km²) | Pressure factors |
|---|---|---|---|---|---|
| Günser Gebirge Umland (No. 72) | Group of groundwater bodies | Predominantly fissured | 100139 | 165 | Pressures from agriculture and forestry and existing waste deposits and dumps; agricultural land use 19%. |
| Hügelland Rabnitz (No. 73) | Group of groundwater bodies | Predominantly porous | 100146 | 498 | Agricultural land use 49% |
| Rabnitz catchment area (No. 74) | Deep groundwater body | Deep groundwater | 100168 | 1 742 | Agricultural land use 75% |

## Pressures

The basin is characterized by extreme run-off conditions, such as frequent heavy flooding. Modification of surface water bodies for flood protection and hydropower generation is a problem in both countries.

In the Hungarian part of the basin, significant water management problems occur concerning regulation of the rivers, load from nutrients and organic substances, salinity and heat stress and hazardous materials.

The river valley from the border to Sárvár is subject to frequent flood events, requiring protection of settlements.

The Sorok–Perint tributary is one of the most polluted watercourses in the entire sub-basin, due to the phosphorus concentration of the sewage discharged by Szombathely Town Wastewater Treatment Plant. The wastewater discharged is insufficiently diluted because of the low discharge of the Sorok-Perint.

Hungary notes abandoned, illegal dumpsites as a potential point pollution source. There is also a risk of accidental pollution by petrol from transportation

Protective strips and buffer zones are missing between big croplands and watercourses in Hungary, aggravating the problem of diffuse pollution. Groundwater pollution in Hungary includes problems with nitrate, ammonium and other pollutants.

In the whole sub-basin urban and industrial wastewaters create notable pressure. While all urban wastewaters in the Austrian share of the sub-basin have been treated at least with secondary treatment, but mostly with tertiary treatment (nutrient removal) for years in line with the provisions of the UWWTD, conventionally and biologically, treated wastewaters from Austrian leather factories have influenced the water and created disturbing foam in the Raab at the weir in Szentgotthárd in the past. The salt content of the water was also high due to the same sources. This had some harmful effect on quality of the irrigation water used in the lower part of the Raab/Rába, however, no legally binding limits were exceeded.

## Status and transboundary impacts

The status of the Raab/Rába is assessed as good or moderate in both countries. In the border region the status is assessed as moderate by both countries, and is being monitored.

A particular challenge has been to address the problem of foam in the Raab/Rába, caused by anthropogenic factors, related mainly to tanneries, and by natural ones. Extensive enhancements of wastewater purification facilities with tertiary treatment are carried out by the tannery industry within the framework of the Austrian/Hungarian action plan, by which the impact of the pressures on surface water was reduced considerably due to measures taken in the recent past in Austria; all urban wastewaters in Austria has been treated fully in line with the provisions of the UWWTD for years.

## Responses

The Ministers for environment from both countries convened to set up a task force in order to find viable solutions for the problems of water quality of the Raab/Rába in the border area of Szentgotthárd. In October 2007, an agreement in principle was adopted on an action programme covering a broad set of measures addressing, *inter alia,* treatment of wastewater from tanneries, new discharge limits, the use of thermal water, an improvement of hydromorphology and a comprehensive monitoring programme. This package of measures was handed over together with a priorisation of measures to a special working group of the Hungarian – Austrian Transboundary Water Commission in order to follow up implementation of these measures.

A key part of the package of measures was addressing the three tanneries in this area. Two out of the three tanneries have put in place upgraded modern wastewater treatment plants since 2010; the wastewater treatment plant for the third tannery is under construction and will be in operation by the end of 2011.

Both countries together will have to further improve the hydromorphological and ecological status of Raab/Rába in line with the WFD from the Raab/Rába canyon to Körmend (133 km) through rehabilitation work (ongoing in 2011) and improve the functioning of the Raab/Rába River as a natural and recreation area.

## Trends

No major change is expected in the structure of agriculture and industry. Retention of precipitation has to be increased in the area in order to reduce the harmful effects of climate change.

Actions foreseen in the National River Basin Management Plan on both sides of the border will improve water quality further in order to achieve good qualitative and quantitative status.

The forthcoming Flood Risk Management Plans (set up in line with the provisions of the EU Floods Directive) will contribute further to preparedness and prevention in this area. Ongoing efforts to provide more space to rivers will continue also in future, and measures of a more technical nature will be exclusively reserved for urban areas in cases where no other “soft” option for flood protection is feasible.

Climate change is predicted to have an impact on precipitation and temperature, with an increase in precipitation during winters and decrease during summers. These impacts are predicted to have an effect on river discharge with an increase in frequency, extent and impacts of floods and possibly constant low water levels in lakes. Quality and quantity of groundwaters will also be affected. Irrigated agricultural areas are predicted to increase, affecting water use. Other problems related to agriculture, such as soil degradation, are also expected.

# VAH SUB-BASIN[43]

The Vah (398 km) is a right-hand tributary of the Danube. Most of its sub-basin is located in the territory of Slovakia, but minor parts are in Poland and the Czech Republic.

Sub-basin of the Vah River

| Country | Area in the country (km²) | Country's share (%) |
|---|---|---|
| Slovakia | 19 148 | 97.4 |
| Czech Republic | 300 | 1.5 |
| Poland | 212 | 1.1 |
| **Total** | **19 661** | |

*Source:* Ministry of Environment and Water, Hungary, and Ministry of the Environment of the Slovak Republic, River Basin Management Plan 2009, the Danube Basin Analysis (WFD Roof Report 2004).

## Hydrology and hydrogeology

In the Slovakian part of the basin, total groundwater resources are estimated at 572.9 × 10⁶ m³/year (average for the years 2004 to 2006), and surface resources are estimated at 4,995 × 10⁶ m³/year (average for the years 2004 to 2006).

Discharge of the Vah River at the mouth is 194 m³/s (1961–2000).

## Pressures, status and transboundary impacts

The most important and problematic pressure factor is inappropriate wastewater treatment. Generally, municipal wastewater treatment plants discharge organic pollutants, nutrients and also heavy metals into the river and its tributaries.

Diffuse pollution mainly stems from agriculture, including potential pollution from application of pesticides.

There are 40 hydropower stations on the Vah River; the installed hydropower capacity is 3,166 MW. The reservoir volume in Slovakia is 899 × 10⁶ m³. Hydromorphological changes on rivers have interrupted natural river and habitat connectivity and the hydrological regime.

Natural water flow in the river is highly variable seasonally.

Permitted industrial discharges are a source of chemical pollution. There are chemical, paper and pulp industries, as well as metal working companies in the river basin. The extent of pressures from illegal discharges is not known.

Uncontrolled dump sites result in significant pollution of groundwater and also of surface waters.

The most serious water-quality problems impacting on the status are eutrophication, organic pollution, bacterial pollution, and pollution by hazardous substances.

Generally, the water bodies in the Vah sub-basin in Slovakia were evaluated to have moderate ecological status[44] and two (SKV0005 and SKV0007) had a good ecological status. Chemical status was mostly good,[45] but in two water bodies (SKV0006 and SKV0007) the chemical status was failing to achieve this status.

## Responses

Planned measures are focused on the protection, conservation and restoration of wetlands/floodplains to ensure biodiversity.

Transboundary water cooperation on the Vah is realized through the Slovak-Poland Commission and its subsidiary working groups, on the basis of the 1997 agreement between the governments of the two countries. Recently agreed transboundary actions include joint measurements, data harmonisation, exchange of data and experience, and joint projects.

## Trends

The ecological and chemical status of the transboundary section of the Vah River is expected to improve as a result of implementing basic and supplementary measures in the basin.

However, good status for the Vah River is not expected till 2015, as measures will be realized gradually up to 2025, due to high costs. These include mainly hydromorphological and supplementary measures in small agglomerations (less than 2,000 p.e.[46]), where more than 50% of the inhabitants in the sub-basin live.

The extent to which climate change may affect surface water status has not been specifically assessed thus far, but the Slovakian National climatic programme and research on the impacts of climate change on ecological and chemical status of surface waters continues to be carried out.

# IPEL/IPOLY SUB-BASIN[47]

Slovakia and Hungary share the sub-basin of the 212 km-long Ipel/Ipoly, which has its source in the Slovak Ore Mountains in central Slovakia. It flows along the border until it discharges into the Danube. The major cities along the river itself are Šahy (Slovakia) and Balassagyarmat (Hungary). There are 14 reservoirs on the river. The Kemence is a major transboundary tributary.

The alluvium of Ipel (No. 75) is not identified yet as a transboundary aquifer, but a bilateral agreement is in progress.[48]

Sub-basin of the Ipel/IpolyRiver

| Country | Area in the country (km²) | Country's share (%) |
|---|---|---|
| Slovakia | 3 649 | 70.8 |
| Hungary | 1 502 | 29.2 |
| **Total** | **5 151** | |

*Source:* Ministry of Environment and Water, Hungary, and Ministry of the Environment of the Slovak Republic, River Basin Management Plan 2009, the Danube Basin Analysis (WFD Roof Report 2004). Based on information provided by Hungary and Slovakia, and the First Assessment.

## Hydrology and hydrogeology

Surface water resources generated in the Slovak part of the Ipel/Ipoly sub-basin are estimated at 474 × 10⁶ m³/year (average for the years 1961 to 2000).

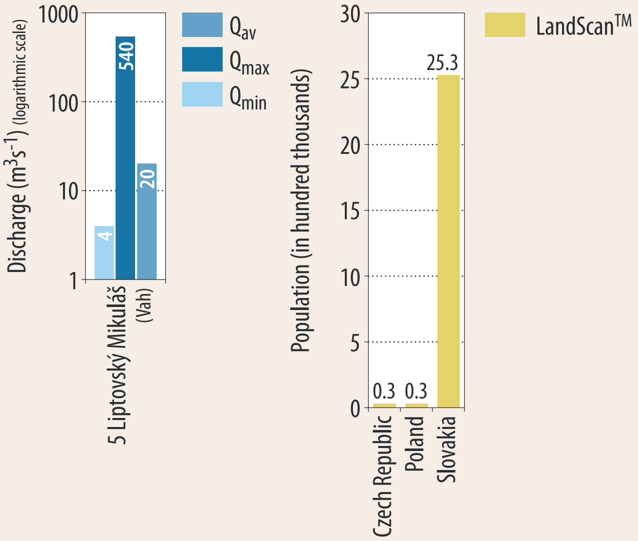
Total water withdrawal and withdrawals by sector in the Vah sub-basin

| Country | Year | Total withdrawal ×10⁶ m³/year | Agricultural % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|---|
| Slovakia | 2008 | 113.4 | 1.5 | 20.7 | 75.5 | 0 | 2.3 |

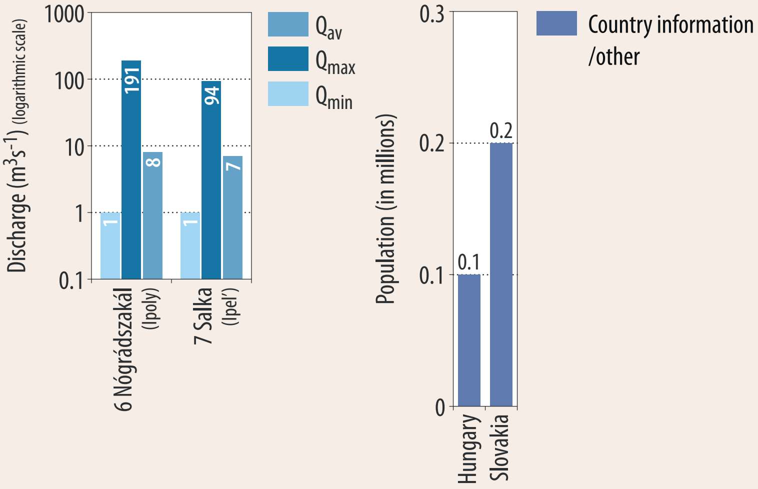
*Notes:* No significant changes in abstraction in Slovakia are expected by year 2015 in comparison with current situation (energy is included in industry sector).

[43] Based on information provided by Slovakia and the First Assessment.
[44] Namely water bodies SKV0006, SKV0008, SKV0019 and SKV002.
[45] Water bodies: SKV0005, SKV0008 and SKV0019.
[46] Population equivalent.
[47] Based on information provided by Hungary and Slovakia, and the First Assessment.
[48] National groundwater body code: SK1000800P; aquifer no. 52 in the Inventory of Transboundary Groundwaters by UNECE Task Force on Monitoring and Assessment (1999).

**DISCHARGES AND POPULATION IN THE VAH SUB-BASIN**




**DISCHARGES AND POPULATION IN THE IPEL/IPOLY SUB-BASIN**




*Sources:* UNEP/DEWA/GRID-Europe 2011; Ministry of Environment and Water, Hungary; Ministry of the Environment of Slovakia, River Basin Management Plan 2009; the Danube Basin Analysis (WFD Roof Report), 2004.
*Note:* Observation in the gauging station Vyškovce nad Ipľom was cancelled in 2006, new station Salka started observation in 2007. For the location of the gauging stations, the basin map of the Danube River should be referred to.

**IPOLY VÖLGY/ALÚVIUM IPĽA AQUIFER (NO. 75)**

| | Slovakia | Hungary |
|---|---|---|
| Type 3; sandy and loamy gravels; Quaternary (Holocene); groundwater flow in both directions across the border; medium links with surface water. | | |
| Area (km$^2$) | 198 | N/A |
| Renewable groundwater resource | $4.66 \times 10^6$ m$^3$/year[a] | N/A |
| Thickness: mean, max (m) | 5-10, 15 | N/A |
| Groundwater uses and functions | Groundwater abstraction is approximately 0.118 $\times 10^6$ m$^3$/year: agriculture - 50.4%, domestic - 38.9%, industry - 8.3% and other use - 2.4%. | N/A |
| Other information | National groundwater body code SK1000800P | N/A |

[a] For groundwater body SK1000800P only, average for the years 2004 to 2006.

## Pressures

An increase of nutrients is observed in surface waters and groundwaters, due to incorrect application of organic and inorganic fertilizer in agriculture, with possible pollution from pesticides application, affecting both surface waters and groundwaters.

Agglomerations without a collecting system or treatment for wastewaters are a significant source of nutrient pollution, organic pollution and chemical pollution of groundwater and surface water. The chemical pollution originates mainly from permitted discharges. The extent of pressure from illegal discharges is not known.

Hydromorphological changes on rivers interrupting natural river and habitat connectivity and hydrological regime are ranked as widespread, but moderate in influence.

Significant seasonal variability of natural water flow is problematic.

The impact of both mining and industry/manufacturing is assessed as local, the latter being more severe. In recent years, degradation by mining and industry is not significant, but these activities still have effects.

Uncontrolled dump sites result in significant pollution of groundwaters and surface waters, but the influence remains local.

Water withdrawals for public water supply and industrial purposes are of low significance as a pressure factor in this sub-basin.

## Status and transboundary impacts

The most serious water-quality problems are eutrophication, organic pollution, bacterial pollution, and pollution by hazardous substances. Owing to inappropriate wastewater treatment and agricultural practices, the content of nutrients in the waters of the transboundary section of the river is rather high, and gives rise to the excessive growth of algae.

According to the assessment of the groundwaters chemical status in 2007, in the groundwater body SK1000800P, concentrations of nitrates exceeded threshold values in 64% of the area, as did, concentrations of ammonium ions in 36% of the area. Exceeded concentrations of atrazine are a local characteristic in the eastern part of the groundwater body.

**Total water withdrawal and withdrawals by sector in the Ipel/Ipoly sub-basin**

| Country | Total withdrawal $\times 10^6$ m$^3$/year | Agricultural % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|
| Slovakia | 361 | 3 | 75 | 11 | 0 | 11 |
| Hungary | | 16 | 81 | 2 | 0 | 1 |

*Note:* Prospects for abstraction in Slovakia by year 2015: no significant changes in comparison with current situation.

## Responses

Transboundary water cooperation in the Ipel/Ipoly sub-basin is carried out in the framework of the Hungarian-Czechoslovakian (today: Slovakian) Committee on Transboundary Waters, which has operated since 1978 on the basis of a bilateral agreement (1976; followed by a new agreement in 1999). Multilateral co-operation takes place, with the International Commission for the Protection of the Danube River (ICPDR) as the platform.

Protection, conservation and restoration of wetlands and flood-plains are carried out to ensure biodiversity, the good status in the connected river by 2015, flood protection and pollution reduction.

Recently-agreed transboundary actions include joint measurements, data harmonisation, exchange of data and experience, as well as joint projects.

## Trends

The ecological status and the chemical status of transboundary section of the Ipel/Ipoly River will improve, due to realization of basic and supplementary measures in the river basin.

However, good status in the Ipel/Ipoly is not expected to be achieved by 2015, as the realization of measures — mainly hydromorphological and supplementary measures in small agglomerations of the river basin (more than 50% inhabitants live in agglomerations below 2000 p.e.) — will be realized gradually up to 2025, due to high financial needs.

Climate change may affect the surface water status, but the extent of its impact has not been specifically predicted so far. To this end, efforts continue in implementing the national climate programmes and in research on the impacts of climate change on the ecological and chemical status of surface water.

Implementing the UWWTD by the year 2010 has required building and upgrading wastewater treatment plants in both Slovakia and Hungary. In Hungary, individual connections to the sewage network have increased about 20% over the past 5 years.

Organic pollution and pollution by dangerous substances is thus expected to substantially decrease. The trend of nutrient pollution from agriculture is still uncertain.

# DRAVA AND MURA SUB-BASINS[49]

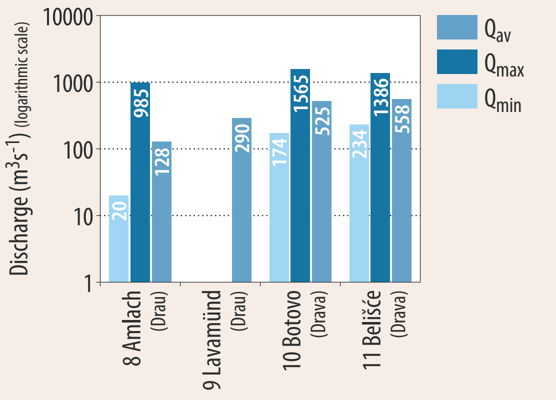
The sub-basin of the Drava River[50] is shared by Austria, Croatia, Hungary, Italy and Slovenia. This river of about 890-km rises in the Italian Alps (Toblach, ~ 1,450 m a.s.l.); it is navigable for about 100 km from Čađavica to Osijek in Croatia, where it joins the Danube. It is the Danube's fourth largest tributary with a surface area of 41,238 km².

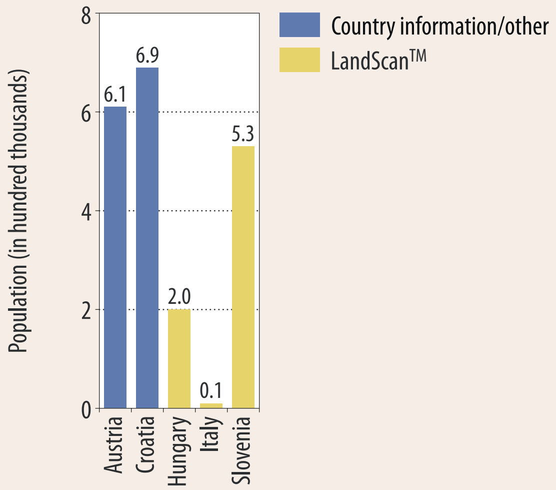
Sections of the Drava in Hungary and Croatia are some of the most natural and unspoiled waters in Europe, hosting many rare species.

The Mura River[51] (445 km long) is the largest tributary of the Drava. It rises in Austria in the "Niedere Tauern" (~ 1,900 m a.s.l.), and meets the Drava at the Croatian-Hungarian borders. The sub-basin of the Mura extends over an area of some 13,800 km², and is shared by Austria, Croatia, Hungary and Slovenia.

The Drava forms a big part of the Croatian-Hungarian borders, while the Mura forms a small part of the Austrian-Slovenian, Slovenian-Croatian and Croatian-Hungarian borders.

**DISCHARGES AND POPULATION IN THE DRAVA SUB-BASINS**




*Source:* UNEP/DEWA/GRID-Europe 2011.
*Note:* For the location of the gauging stations, the basin map of the Danube River should be referred to.

## Hydrology and hydrogeology

Three dams with associated reservoirs and hydropower plants exist in Austria, Hungary, Slovenia and Croatia.

The Drava River has a pluvial-glacial (rain-and-ice) water regime, characterized by small quantities of water during winter and large quantities of water in late spring and early summer.

The average flow of the Drava at the point where it enters Slovenia flowing from Austria is 290 m³/s, and in Croatia above the confluence with the Mura it is already 552 m³/s (1961-1990). The average flow of the Mura at the point where it flows into the Drava River is 182 m³/s.

Hungary estimates the surface water resources for Hungary's part of the Mura sub-basin to add up to 0.176 km³/year, and groundwater resources to approximately 0.202 km³/year (based on averages for the years 1951-1980). In total, these make up 2,300 m³/year/capita. In the Drava sub-basin, the surface water resources in Hungary's territory are estimated at 16.4 km³/year, and groundwater resources at 0.0314 km³/year (based on averages for the years 1960-2008).

Several transboundary aquifers or groundwater bodies are linked with the surface water system of the Drava and Mura rivers.

[49] Based on information from Austria, Croatia, Slovenia and the First Assessment.
[50] The river is called Drava in Italy, Slovenia and Croatia, Drau in Austria and Dráva in Hungary.
[51] The river is called Mura in Slovenia and Croatia, and Mur in Austria.

The “Karstwasser-Vorkommen Karawanken” (Karavanke transboundary groundwater body (No. 76) was identified by the two countries following an agreement between Slovenia and Austria (2004), and was characterized in accordance with the WFD requirements. A “Water supply” commission for Karavanke Mountains has been established; meetings take place twice per year.

The Karavanke/Karawanken groundwater body (No. 76) is further divided in five cross-border aquifers: (1) the Kepa/Mittagskogel aquifer (furthest west); (2) the long (60 km), but narrow massif Košuta aquifer; (3) the Bela/Vellach valley aquifer; (4) the Mount Olševa/Uschowa, which is an important aquifer - groundwater discharges to the Austrian side; (5) the massif Peca/Petzen (furthest east); water from this aquifer drains to both countries, and the recharge areas of individual sources within the aquifer are intertwined with each other.

### KARSTWASSER-VORKOMMEN KARAWANKEN/KARAVANKE AQUIFER (NO. 76)[52]

| | Austria | Slovenia |
|---|---|---|
| Type 2; Triassic limestone, dolomite (Austria); Limestones and dolomites/carbonate; Triassic rocks form aquifers, barriers to groundwater flow are formed from various rocks from Paleozoic to Tertiary rocks (Slovenia); groundwater flow direction from Slovenia to Austria, with medium links to surface waters. Groundwater flow is variable; from one country to the other depending on the aquifer (in the Peca aquifer direction is from Austria to Slovenia - in the Kosuta aquifer flow is predominately parallel to the State boundary). There are weak links with surface water systems. Pressure condition: partly confined, partly unconfined. Groundwater covers the total of water used in the Slovenian part. | | |
| Area (km$^2$) | 210 | 414 |
| Thickness: mean, max (m) | 700, 1000 | Max > 1000 (thickness varies strongly) |
| Groundwater uses and functions | Covers about 14% of drinking water supply in the Austrian part (200 l/s out of 1,460 l/s in total) covering related needs of 30,000 inhabitants and up to 15,000 tourists (total hotel beds capacity in the area). It is considered and treated as a drinking water reserve for future use. A part is used for irrigated agriculture. Groundwater supports also ecosystems and maintains baseflow and springs. | Drinking water supply; also supports ecosystems and maintaining baseflow and springs (there are several springs with outflow up to 1 m$^3$/s). Water is used locally for spa related tourism. There is also small scale hydropower production. |
| Pressure factors | No pressure factors. | Winter tourism activities and settlements (local importance). Spring water quantity fluctuates significantly due to the karstic geomorphology. Bacteriological quality problems (of local character). Turbidity in spring/rain season. |
| Groundwater management measures | In accordance to the WFD. | Basic measures are implemented; no supplementary or additional measures are foreseen. |
| Other information | In line with the target set in WFD, good status is expected to be maintained. | Population some 8,700 inhabitants (density 22/km$^2$); it is predicted that climate change will result in diminished infiltration in the southern slopes thus lowered spring yield. Vulnerability is high, however anthropogenic activities in the area are not intense, hence the risk is low; tourism development may become a risk factor in the future. Establishment of transboundary groundwater protection areas is needed. |

### ORMOZ-SREDISCE OB DRAVA/DRAVA-VARAZDIN AQUIFER (NO. 77)[53]

| | Slovenia | Croatia |
|---|---|---|
| Type 2; Quaternary sands and gravels of average thickness 50 m and maximum 150 m; groundwater flow from Slovenia to Croatia; strong links with surface water systems. | | |
| Area (km$^2$) | 27 | 768 |
| Thickness: mean, max (m) | 50, 150 | 50, 150 |
| Groundwater uses and functions | Drinking water supply; supporting ecosystems and agriculture. | Drinking water supply, agriculture; also supports ecosystems. |
| Pressure factors | Agriculture, hydropower schemes, Drava river regulation. | Agriculture and population of local communities. Nitrate concentrations above the drinking water standard in the first shallow aquifer; in the deeper aquifer, the water is of good quality. |
| Groundwater management measures | None | Existing protection zones |
| Other information | No groundwater quality or quantity problems observed. Good chemical status. No transboundary impact. | Population: ~4 400 (6 inhabitants/km$^2$); agreed delineation of transboundary groundwaters, and development of monitoring programmes are needed. No transboundary impact. |

[52] Based on information from Slovenia and Austria.
[53] Based on information from Croatia and the First Assessment.

### DOLINSKO-RAVENSKO/MURA AQUIFER (NO. 78)[54]

| | Slovenia | Croatia |
|---|---|---|
| Quaternary alluvial sands and gravel, groundwater hydraulically corresponding to surface water systems of the Mura River and in strong connection; groundwater flow from Slovenia to Croatia and from Croatia to Slovenia. | | |
| Area (km²) | 449 | N/A |
| Groundwater uses and functions | Drinking water supply of town Murska Sobota, local water supply systems. | N/A |
| Pressure factors | Intensive agriculture; pan-European transport corridor. | N/A |
| Problems related to groundwater quantity | Degradation of the Mura River due to river regulation and hydropower schemes. | N/A |
| Problems related to groundwater quality | Nitrate, pesticides. | N/A |
| Trends and future prospects | At risk. Delineation of transboundary groundwater systems needs common research and bilateral expert group decision. | N/A |
| Other information | Probably only part of the Dolinsko-Ravensko groundwater system is relevant. No transboundary impact. | According to existing data, no transboundary groundwater is recognised. |

### MURA AQUIFER (NO. 79)[55]

| | Hungary | Croatia |
|---|---|---|
| Type 3/4; Quaternary alluvial aquifer of sands and gravels; strong links to surface waters of the Mura River; groundwater flow towards the river. | | |
| Area (km²) | 300 | 98 |
| Thickness: mean, max (m) | 5-10, 30 | 5-10, 20 |
| Groundwater uses and functions | >75% drinking water, <25% for industry, irrigation and livestock, provides >80% of total water supply, maintaining baseflow and support of ecosystems. | No demand for groundwater. |
| Pressure factors | Agriculture and settlements (fertilisers, pesticides, sewage, traffic), groundwater abstraction. Local and moderate groundwater depletion (at settlements), increased pumping lifts, reduced yields and baseflow, degradation of ecosystems. Local but severe nitrate pollution from agriculture, sewers and septic tanks at up to 200 mg/l, pesticides at up to 0.1 µg/l. | No data |
| Groundwater management measures | Groundwater abstraction management used and effective; transboundary institutions, monitoring, public awareness, protection zones, treatment, need improvement; vulnerability mapping, regional flow modeling, good agricultural practices and priorities for wastewater treatment, integration with river basin management need to be introduced. | N/A |
| Other information | Border length 52 km. No transboundary impact. Evaluation of the utilizable resource is needed. Exporting drinking water. | Border length 52 km. |

### DRAVA/DRAVA WEST AQUIFER (NO. 80)[56]

| | Hungary | Croatia |
|---|---|---|
| Type 3/4; Quaternary alluvial aquifer of sands and gravels; medium to strong links to surface waters; groundwater flow from Hungary to Croatia, but mainly towards the border river. | | |
| Area (km²) | 262 | 97 |
| Thickness: mean, max (m) | 10, 70 | 10, 100 |
| Groundwater uses and functions | >75% drinking water, <25% for irrigation, industry and livestock | Agriculture; supports ecosystems |
| Pressure factors | Agriculture (fertilizers and pesticides), sewage from settlements, traffic, gravel extraction under water in open pits. Local increases in pumping lifts, reduction of borehole yields and baseflow and degradation of ecosystems; affected by gravel extraction under water from open pits. Widespread but moderate nitrate pollution at up to 200 mg/l from agriculture, sewers and septic tanks, pesticides at up to 0.1 µg/l. | Extraction of sand and gravel under water in pits. Changes in groundwater levels detected. |

[54] Based on information from Croatia and the First Assessment. In the First Assessment, this aquifer was indicated to be located within the Sava River basin. However, Croatia reports that it is part of the Drava River Basin.
[55] Based on information from Croatia and the First Assessment.
[56] Based on information from Croatia and the First Assessment.

**DRAVA/DRAVA WEST AQUIFER (NO. 80)** -continued-

| | Hungary | Croatia |
|---|---|---|
| Groundwater management measures | Groundwater abstraction management used and effective; transboundary institutions, monitoring, protection zones need improvement; vulnerability mapping, regional flow modeling, good agricultural practices and priorities for wastewater treatment, integration into river basin management, protection of open pit areas need to be introduced. | None |
| Other information | Border length is 31 km. Exporting drinking water. Evaluation of the utilisable resource is needed. No transboundary impact. | Border length is 31 km. Needed: agreed delineation of transboundary groundwaters (presently under consideration), and development of monitoring programmes. |

**BARANJA/DRAVA EAST AQUIFER (NO. 81)**[57]

| | Hungary | Croatia |
|---|---|---|
| Type 4; Quaternary fluvial sands and gravels; medium to weak links to surface waters; groundwater flow from Hungary to Croatia. | | |
| Area ($km^2$) | 607 | 955 |
| Thickness: mean, max (m) | 50-100, 200 | 50-100, 100 |
| Groundwater uses and functions | >75% drinking water, >25% for irrigation, industry and livestock, maintaining baseflow and spring flow; Groundwater makes up 80-90% of total water use. | Provides 20% of total supply. Supports ecosystems. |
| Pressure factors | Agriculture, sewers and septic tanks, traffic. Widespread but moderate pollution by nitrate at up to 200 mg/l, local and moderate pesticides up to 0.1 µg/l, widespread but moderate arsenic up to 50 µg/l. Local and moderate increases in pumping lifts, reductions in borehole yields and baseflow, degradation of ecosystems. | None. Iron occurs naturally. No problems related to groundwater quantity. |
| Groundwater management measures | Control of groundwater abstraction by regulation used and effective; transboundary institutions, water use efficiency, monitoring, public awareness, protection zones, effluent treatment and data exchange need improvement; vulnerability mapping, regional flow modeling, better agricultural practices, priorities for wastewater treatment, integration with river basin management and arsenic removal need to be applied. | Need to establish protection zones. |
| Other information | Border length 67 km. No transboundary impact. Evaluation of the utilisable resource and status of groundwater quality are needed and so are joint monitoring (mainly quantitative) and joint modeling. | Border length 67 km. No transboundary impact. Needed: Agreed delineation of transboundary groundwaters (presently under consideration), and development of monitoring programmes. |

**ČERNEŠKO-LIBELIŠKO AQUIFER (NO. 82)**[58]

| | Austria | Slovenia |
|---|---|---|
| Type 2; Quaternary silicate/carbonate gravel and sand alluvial; dominant groundwater flow direction is from Austria to Slovenia; pressure condition: unconfined; depth of groundwater levels at 20-30 m; strong links with surface water systems. | | |
| Area ($km^2$) | | 11 |
| Thickness: mean, max (m) | 25, 35 | 25, 35 |
| Groundwater uses and functions | N/A | Support ecosystems and maintain baseflow and springs. |
| Pressure factors | N/A | Municipal wastewater and agriculture. Nitrate pollution (below quality standards) from municipal wastewater and agriculture; also pesticides pollution. |
| Groundwater management measures | N/A | Basic measures are implemented, supplementary measures are not foreseen. Groundwater dependent terrestrial ecosystems criteria for hydrogeological characterization are to be defined. |
| Other information | Austria expresses uncertainty about the location of this aquifer. | Population ~4 400 (density 388 inhabitants/$km^2$). No transboundary impact. Decreased intensity of significant pressures is expected till 2015. Transboundary groundwater flow characterization is needed. |

[57] Based on information from Croatia and the First Assessment.
[58] Based on information from Slovenia, the Černeško-Libeliško and Kučnica are part of the alluvial aquifers system of Drava and Mura rivers at Austrian – Slovenian borders.

### KUČNICA AQUIFER (NO.83)[59]

| | Austria | Slovenia |
|---|---|---|
| Type 2; Quaternary carbonate-silicate alluvium.; groundwater flow direction from Austria to Slovenia; pressure condition: unconfined; depth of groundwater levels at 1.5–4 m; medium links with surface water systems. | | |
| Area (km$^2$) | N/A | 449 |
| Thickness: mean, max (m) | 10, 15 | 10, 15 |
| Groundwater uses and functions | N/A | Water is used for agriculture; supports ecosystems and maintains baseflow and springs. |
| Pressure factors | N/A | Municipal wastewater, agriculture and industry. Nitrate pollution (above national quality standards) from municipal wastewater and agriculture, synthetic substances as well as pesticides pollution. |
| Groundwater management measures | N/A | Basic measures are implemented, supplementary measures are foreseen. Additional measures are necessary, mostly related to agriculture and pesticides use. Groundwater-dependent terrestrial ecosystems criteria for hydrogeological characterization are to be defined. |
| Other information | Austria reported that the aquifer does not extend into the country's territory. | Population: some 61 300 (density 137 inhabitants/km$^2$). Transboundary groundwater flow characterization is needed. Development of measures for adaptation to climate change effects is also needed. There is a need for continuous data exchange between the two countries. |

### GORIČKO AQUIFER (NO. 84)[60]

| | Slovenia | Hungary |
|---|---|---|
| Type 1; Tertiary/Quaternary silicate-carbonate sand and silt with clay alternations; groundwater flow direction from north-west to south-east; pressure condition: partly confined, partly unconfined; depth to groundwater levels at 0-115 m; weak links with surface water systems. The aquifer is recharged from the hills of Goričko and discharges through springs at the basin fringe; it recharges the deep thermal aquifer south of Goričko. | | |
| Area (km$^2$) | 494 | N/A |
| Thickness: mean, max (m) | > 100, > 300 | > 100, > 300 |
| Groundwater uses and functions | Water is used for drinking water supply and agriculture; it also supports ecosystems and maintains baseflow and springs. | N/A |
| Pressure factors | Abstraction for drinking water supply, municipal wastewater and agriculture. Groundwater level is decreasing due to the rapid increase of groundwater abstractions for drinking water supply as well as of thermal water from the deeper part of the adjacent aquifer (which is recharged by this aquifer) during the past decade. Widespread nitrate (wastewater and agriculture) and pesticides pollution. Elevated background concentrations for $NH_4$, Fe, Mn and As at local level. | N/A |
| Other information | No transboundary impact. Population some 22 500 (46 inhabitants/km$^2$). Water and thermal water demand is expected to increase. Decrease of infiltration is expected due to climate change, and increase of pumping from boreholes may result from a further drop of groundwater levels. Shallow groundwater is affected by pollution and therefore alternative water supply (deeper boreholes or development of more remote resources) has to be identified and used; this is expected to cause increase of drinking water supply costs.<br>Enhanced information exchange between Slovenia and Hungary has to be established, possibly followed by joint management of the aquifer. | N/A |

[59] Based on information from Slovenia, the Černeško-Libeliško and Kučnica are part of the alluvial aquifers system of Drava and Mura rivers at Austrian – Slovenian borders.
[60] Based on information from Slovenia. According to Slovenia, Goričko and Mura – Zala basin/Radgona – Vaš are part of the Goričko aquifer system.

### MURA – ZALA BASIN/RADGONA – VAŠ AQUIFER (NO. 85)[61]

| | Slovenia | Austria | Hungary |
|---|---|---|---|
| Type 4; Paleozoic to Tertiary silicate – carbonate clay, silt, sand, marl, sandstone, marlstone, Mesozoic limestone and dolomite, Palaeozoic metamorphic rocks; pressure condition: confined; dominant groundwater flow direction not known; weak to medium links with surface water systems. | | | |
| Area (km²) | > 494 | N/A | N/A |
| Thickness: mean, max (m) | > 1 000 | > 1 000 | > 1 000 |
| Groundwater uses and functions | Thermal water for spa and heating. | N/A | N/A |
| Pressure factors | Spa-related tourism, urbanization; thermal water abstractions. Widespread and moderate, locally severe drop of groundwater level or discharge due to groundwater abstractions. | N/A | N/A |
| Groundwater management measures | Optimization of basic measures or supplementary measures is foreseen. | N/A | N/A |
| Other information | Population ~22 500 (density 46 inhabitants/km²). There is possibly transboundary impact. Water and thermal water demand increase due to tourism (spa) and urbanization. This with the expected decrease of infiltration due to climate change may result in fa urther drop in groundwater levels.Higher costs for further abstraction of thermal water is expected.<br><br>Trilateral cooperation for further characterization of the deep thermal aquifer is needed. Research for modeling and heat availability assessment is needed, and so is improvement of existing re-injection technologies. | Austria reported that the aquifer does not extend into the country's territory. | N/A |

### KOT AQUIFER (NO. 86)[62]

| | Slovenia | Hungary | Croatia |
|---|---|---|---|
| Type 2; Quaternary gravel - silicate/carbonate alluvial; pressure condition: unconfined; groundwater flow from Slovenia to Croatia; strong links with surface water systems. | | | |
| Area (km²) | 449 | N/A | N/A |
| Thickness: mean, max (m) | 20 | 20 | 20 |
| Groundwater uses and functions | Drinking water supply and agriculture; also supports ecosystems. | N/A | N/A |
| Pressure factors | Municipal wastewater and agriculture: nitrate, pesticide pollution. | N/A | N/A |
| Groundwater management measures | Nitrates have to be monitored through operational monitoring. Advanced analysis of nitrogen surplus distribution, as well as further development and optimization of the environmental program is needed, and so are adaptation measures to climate change effects. | N/A | N/A |
| Other information | Population ~61 300 (137 inhabitants/km²). Information exchange among the three countries sharing the aquifer is needed. | N/A | N/A |

## Status, pressures and transboundary impacts[63]

Floods are reported to be a continuous threat, requiring protection measures along the watercourses.

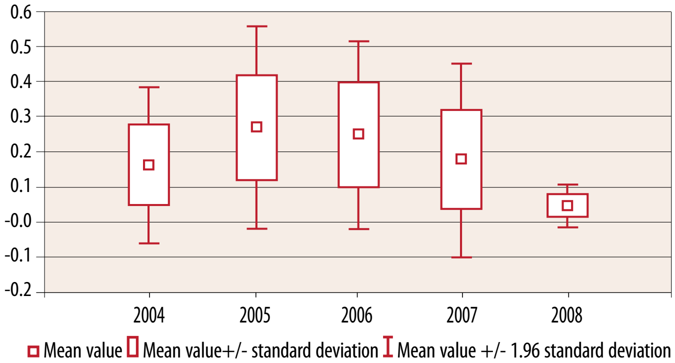
Regulation of the flow of water, due to the construction and operation of hydropower production infrastructure, influences the water regime in the downstream parts in Croatia.

Significant portions of the Drava (72%) and Mura (37%) in Austria have been assessed as heavily modified (according to the WFD); according to Austria the same is true for the parts of the rivers that extend downstream in Slovenia.

Austria reports that agricultural activities affect groundwater in the Mura in limited areas and with decreasing tendency; however, it is of low importance. In Slovenia, nitrogen and pesticide pollution due to agriculture and livestock breeding is an important issue for what concerns surface and particularly groundwater quality. In the eastern part (Mursko and Dravsko fields), $NO_3$ concentrations are between 31 and 242 mg/l, while some pesticides' concentrations are elevated, exceeding EU drinking water standards. Concentrations of ammonium nitrogen in the Mura have decreased in the past few years, as observed at the Spielfeld monitoring station on the Austrian side of the border with Slovenia. Potassium and zinc concentrations are increasing in the Dravsko field.

[61] Based on information from Slovenia. According to Slovenia, Goričko and Mura – Zala basin/Radgona – Vaš are part of the Goričko aquifer system.
[62] Based on information from Slovenia. According to Slovenia, Kot is part of the alluvial aquifer system of Drava and Mura Rivers at Hungarian – Slovenian – Croatian borders.
[63] Information about the status, pressures and impacts for the shared groundwater bodies in the basin is given in the tables above.

**FIGURE 8:** Ammonium nitrogen concentration (mg/l) in the Mura River at Spielfeld monitoring station[64]




Groundwater from alluvium in the Drava sub-basin is discharged into the Drava River, thus the pressures from diffuse pollution sources have an important impact in terms of nitrogen loads entering the river.

Only 22% of the settlements in the part of the Drava sub-basin that is Hungary's territory have sufficient wastewater treatment. There are controlled and uncontrolled dumpsites in areas where groundwater resources of the alluvial aquifers of the Drava and Mura rivers are highly vulnerable to pollution. Uncontrolled landfills sometimes pollute surrounding soil and groundwater in Croatia. Industrial pollution in Slovenia (due to significant chemical industry) in the Drava sub-basin is reported to be in decline.

## Responses

A River Basin Management Plan has been prepared for both sub-basins in Austria in conformity with the WFD. Permit and licensing systems are in place and enforced, vulnerability mapping for land use planning exists, good agricultural practices have been developed and implemented, and protection zones for drinking water supply have been established. Water protection is integrated in agricultural policy and in licensing procedures for industrial plants, as well as in hydropower development. Wastewater treatment infrastructure is in place. Austria reports that there is no urgent necessity for measures to adapt to climate change; scenarios have been developed and possible consequences investigated. Joint monitoring with neighbouring countries is not practiced, but information and data in the boundary region are harmonized.

Hungary completed the River Basin Management Plan on the Drava according to the requirements of the WFD in May 2010.

In Slovenia, water quality monitoring is carried out in 18 different water bodies; 84 sampling points are used.

A number of water resource management plans and measures are implemented in Croatia. Monitoring in Croatia is conducted 26 times per year, using one station on the Mura River and four on the Drava River.

Monitoring of both rivers is also conducted jointly by Croatia and Hungary in accordance with the work plan of the Water Protection Sub-commission under the Croatian-Hungarian Commission for Water Management (see below). The project "Integrated Drava Monitoring" that involved Slovenia, Hungary and Croatia, carried out from 2004 to 2006 in framework of the Interreg IIIA Neighbourhood Programme posted all the national surface monitoring stations real-time data (chemical and biological) on a common website.[65]

Cooperation between Austria and Slovenia on the Drava and Mura Rivers dates back to 1954 (Slovenia was then within the State of Yugoslavia), and covers all issues that might have a negative effect on the rivers. There is a permanent Austrian — Slovenian Commission dealing with all related issues.

A Croatian — Hungarian Water Management Commission has been created under the Agreement on Water Management Relations, signed by the two countries in 1994. Sub-commissions have been set up for, among others: Drava and Danube water management; the Mura River; water use and pollution control; and water quality control. An environmental impact study was carried out based on joint models and plans for setting up technological measures to prevent erosion of riverbanks at the confluence of the Drava and the Mura, in order to protect the near-by railway.

There is also an agreement between Slovenia and Hungary; in the framework of the Hungarian — Slovenian transboundary commission, a reservoir on Kebele creek was put into use to reduce flood impact in 2008.

The 1996 agreement between Slovenia and Croatia also covers water resources in the Drava and Mura sub-basins.

A project is developed by Croatia for the preparation of an Integrated River Basin Management Plan for the Drava River.

Representatives from the Drava River riparian countries signed a declaration on joint approaches to water management, flood protection, hydropower utilization and nature and biodiversity conservation in the Drava River basin in Maribor, Slovenia in September 2008 on the occasion of an international symposium entitled "Drava River Vision". This symposium was prepared by the Drava countries in the framework of the WFD joint Drava River Basin Management plan till 2015.

Hungary considers that there is a need to start establishing groundwater protection zones for drinking water supply on the transboundary level. Transboundary cooperation in structural and technological measures is also a gap that Hungary believes should be addressed.

## Trends

Croatia reports that the decrease in precipitation has resulted in a decrease of groundwater levels. Hungary reports that in the last decades the decreasing amount of snow is expected to result in a decrease of the level of shallow groundwater level. Hungary notes that there is a need for joint "Drava basin scenarios" to assess the impacts of climate change.

Photo by Tobias Salathe

[64] Data provided by Austria.
[65] http://www.dravamonitoring.eu/.

# DRAVA-DANUBE CONFLUENCE RAMSAR SITES[66]

## General description of the wetland

The wetland where the Drava River enters the Danube is the largest and best-preserved flood retention area on the Middle Danube. It represents a naturally functioning inner delta with typical floodplain habitats, featuring a unique combination of lakes, marshes, wet grasslands, reed beds, willow shrubs and riverine forests. The entire area beyond the river embankments is flooded annually in spring, for a duration of one to three months.

## Main wetland ecosystem services

The wetland is important for water flow regulation and flood control (although this role was more significant before the river embankments were constructed), purification of the river waters, sedimentation of transported matters, and groundwater recharge. The presence of vast forest and wetland areas humidifies the regional climate.

The wetland is used for timber production, hunting, fishing and tourism. Wetland water is used for irrigated agriculture and fish-pond farming. Wetland aquifers provide important drinking water supplies. Leisure and tourist activities, such as nature tours and village tourism, are developing rapidly.

## Cultural values of the wetland area

Local life has always been connected to the rivers, their forests and marshland. A number of traditional events are connected with fishing. Local *Phragmites* reed is used for constructions, and *Typha* reed serves to make bags and mats. These uses avoid overgrowing of the open water surfaces.

## Biodiversity values

The wetland is exceptionally rich in biodiversity, including a large number of threatened species, as well as a number of natural habitats of European Union-wide interest. The wetland is important for large numbers of waterbirds, and several species of birds of prey depend on the floodplain and its forest.

The floodplain is the most significant fish spawning ground on the Middle Danube with more than 50 species, including Sterlet and wild Carp, two vulnerable species on the IUCN Red List. The wetland is also an important foraging, nursery, and overwintering area, and a migratory route for fish.

## Pressure factors and transboundary impacts

The most significant pressures on the wetland ecosystem stems from water management, timber plantations and logging, agricultural and industrial effluents polluting the water, household sewage and urban wastewater run-offs, disturbance through fishing, hunting and leisure activities, and the spread of alien invasive species. The transformation of water bodies for navigation purposes puts further pressures on the wetland ecosystem.

River regulation and flood control measures have had serious impacts on the hydrological regime. River channels have been shortened and narrowed, resulting in a significant increase of water flow speed and erosion force, leading to the degradation of the river bed and a lowering of the river water level. This resulted in shorter inundation periods of the natural floodplain, and lowered groundwater levels. These processes, together with amelioration and hydrotechnical activities for agricultural purposes, lead to the loss of alluvial habitats and the deterioration of living conditions for fish, amphibians and shorebirds. The continuous aggradation of the floodplain due to the sediments carried by the river and deposited in inundation areas enhances desiccation problems. The construction of protective levees along the Danube in the 1960s prevented the temporary inundation of large areas on the Serbian side. The increased nutrient content of the water inflows resulted in eutrophication of the floodplain waterbodies.

Forestry plantations are increasingly replacing native gallery woodlands and wet meadows, and high numbers of wild boar and red deer prevent natural forest regeneration. Non-sustainable levels of fishing and hunting may threaten specific populations. The abandonment of fish farming ponds and of mowing of wet meadows leads to the loss of these habitats. The occasional burning of reed beds reduces this habitat, creating unnecessary carbon release into the atmosphere.

The wetland was an area of armed conflict during the 1990s, and this resulted in the temporary suspension of conservation measures, infrastructure destruction, creation of un-mapped minefields, and the abandonment of traditional settlements in the protected floodplain. A new phase of wetland conservation and management started in 1997, when Croatia created the Kopački Rit Nature Park, followed in 2001 by the proclamation of the Special Nature Reserve Gornje Podunavlje on the Serbian side. However, intensive timber exploitation and illegal waterfowl hunting continue to exert pressures on the ecosystem.

## Transboundary wetland management

The core wetland area benefits in all three countries from a specific legal protection status, and was designated as a Ramsar Site.

The Croatian Ramsar Site (23,894 ha) coincides with the Nature Park Kopački rit. With the financial support of the Global Environment Facility, an ecological research, monitoring and education centre was put in place, and a new visitor centre was opened. The Serbian Ramsar Site (22,480 ha) includes the Gornje Podunavlje Special Nature Reserve (19,648 ha). The Hungarian Ramsar Site Béda-Karapancsa (1,150 ha) forms part of the Duna-Dráva National Park.

A number of wetland restoration and management activities are implemented on the Croatian and Hungarian sides, also as a part of transboundary cooperation. With the declaration of the Serbian Ramsar Site, the management of the Gornje Podunavlje Reserve is also increasingly developed in consultation and cooperation with the Hungarian and Croatian neighbors. At a wider scale, the area is intended to become part of the planned Transboundary Biosphere Reserve along the Drava and Mura rivers, with parts in Austria, Croatia, Hungary, Serbia and Slovenia.

[66] *Sources:* (1) Information Sheet on Ramsar Wetlands (RIS), available at the Ramsar Sites Information Service: Nature Park Kopacki rit (Kopački rit) Ramsar Site; Croatia (RIS updated in 2007); Béda-Karapancsa Ramsar Site; Hungary (RIS updated in 2006); Gornje Podunavlje Ramsar Site; Serbia (RIS submitted in 2007). (2) Environmental Status Report (Environmental Assessment), Social Impact Assessment (Public Consultation) – Final report within the DDNP Component of the Reduction of Nutrient Discharges Project; prepared by VITUKI, Environmental and Water Management Research Centre, VTK Innosystem Ltd.

# TISZA SUB-BASIN[67]

Hungary, Romania, Slovakia, Serbia and Ukraine share the sub-basin of the 966-km long Tisza.[68] The Tisza has the largest sub-basin of the Danube River Basin. Major transboundary tributaries include the Mures/Maros, Körös/Criş, Somes/Szamos and Slaná/Sajó, and Bodrog (shared by Hungary, Slovakia and Ukraine), among others.

The sub-basin of the Tisza River can be divided into two main parts: (1) the mountainous catchments of the Tisza and the tributaries in Ukraine, Romania and Eastern –Slovakia; and (2) the lowland parts, mainly in Hungary and in Serbia. The Tisza River itself can be divided into three parts: the Upper-Tisza, upstream from the confluence of the Somes/Szamos River; the Middle-Tisza between the mouth of the Somes/Szamos and the Mures/Maros rivers; and the Lower-Tisza, downstream from the confluence of the Mures/Maros River.

Sub-basin of the Tisza

| Country | Area in the country (km²) | Country's share (%) |
|---|---|---|
| Ukraine | 12 732 | 8.1 |
| Romania | 72 620 | 42.6 |
| Slovakia | 15 247 | 9.7 |
| Hungary | 46 213 | 29.4 |
| Serbia | 10 374 | 6.6 |
| **Total** | **157 186** | |

*Source:* Ministry of Environment and Water, Hungary and Central Statistic Office (Hungary, Budapest), 2009; the Danube Basin Analysis (WFD Roof Report 2004).

Renewable water resources in the Tisza sub-basin

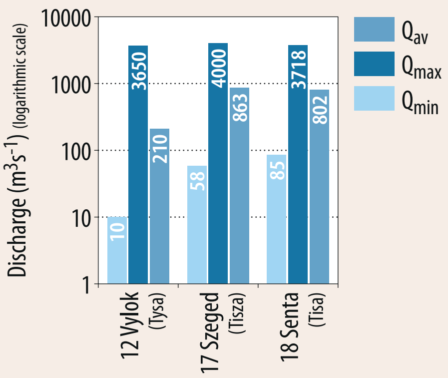
| Country | Surface water resources (×10⁶ m³/year) | Groundwater resources (×10⁶ m³/year) | Total water resources (×10⁶ m³/year) | Water resources per capita (m³/year/person) |
|---|---|---|---|---|
| Ukraine | 7 040[a] | 333.5 | 7 374 | 5 924 |
| Romania | 2 770 | 1 495 | 4 264[b] | 819 |
| Slovakia | 5 216[c] | 430[d] | 5 646 | 3 381 |
| Hungary | 27 215[e] | 901 | 28 116 | 6 945 |
| Serbia | 25 291[f] | 500 | 25 791 | 26 738 |

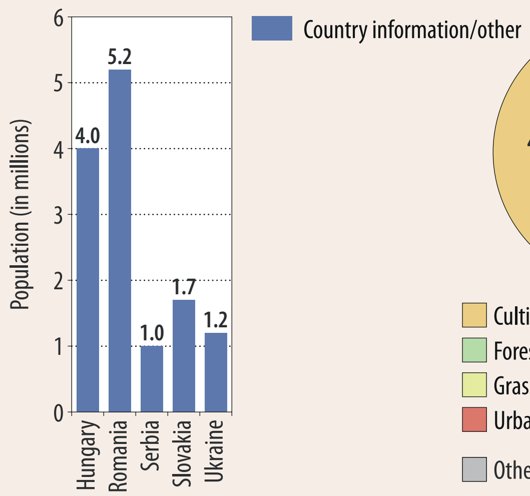
[a] *Source:* Regional Environmental Report on Zakarpaskaya oblast, 2009.
[b] Mean value for 1995-2007 period. *Source*: Environmental Management Programms in hydrographic basins of rivers Mures/Maros, Somes/Szamos-Tisza, Krisuri, Banat.
[c] Mean value for 1961-2000 period.
[d] Determined for year 2008.
[e] Based on average surface water run-off for the years 1960 to 2000. Source: Middle-Tisza District Environment and Water Directorate (Szolnok, Hungary).
[f] Determined at Senta hydrographic station as the average value for the years 1946 to 2006.
[g] Average annual run-off.

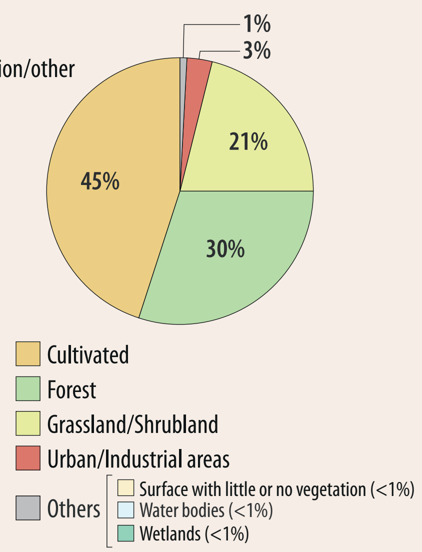
### KÖRÖS – CRISURI HOLOCENE, PLEISTOCENE TRANSBOUNDARY AQUIFER (HORTOBÁGY-NAGYKUNSÁG BIHAR NORTHERN PART) (NO. 87)

| | Romania | Hungary |
|---|---|---|
| Holocene - end of Pleistocene, sand, loess, loessal sand, boulders, gravel to fine sands; medium links with surface water. | | |
| Area (km²) | 6 700 | 9 000 |
| Thickness: mean, max (m) | 25, - | N/A |
| Groundwater uses and functions | Used for drinking water, irrigation water, livestock farms. | N/A |
| Other information | Associated groundwater body ROCR01 (Oradea) is of good quantitative and chemical status. | Associated groundwater body HU_p.2.6.1 (Nyírség Southern Part, Hajdúság) is of poor quantitative status. HU _p.2.6.1 is of good chemical status. |

### POPULATION AND LAND COVER IN THE TISZA SUB-BASIN




*Source:* UNEP/DEWA/GRID-Europe 2011.
*Note:* For the location of the gauging stations, the basin map of the Danube River should be referred to.

[67] Based on information provided by Hungary, Romania, Serbia, Slovakia and Ukraine, as well as the Draft of Integrated Tisza River Basin Management Plan for public consultation.
[68] The river is also known as the Tysa.

### HORTOBÁGY, NAGYKUNSÁG, BIHAR NORTHERN PART (NO. 88) AQUIFER

| | Romania | Hungary |
|---|---|---|
| Holocene, end of Pleistocene, loess, loessal sand, sand, mud; medium links with surface water. | | |
| Area (km²) | 3 148 | N/A |
| Thickness: mean, max (m) | 30 | N/A |
| Groundwater uses and functions | Used for drinking water, water supply of industry, livestock farm. | N/A |
| Other information | N/A | Associated groundwater body HU _p.2.6.2 is of poor quantitative status. |
| | N/A | HU _p.2.6.2 is of good chemical status. |

### KÖRÖS VALLEY, SÁRRÉT, SHALLOW CRIŞURI AQUIFER (NO. 89)

| | Romania | Hungary |
|---|---|---|
| Holocene - end of Pleistocene, eolian sediment, gravel to fine sands; medium links with surface water. | | |
| Area (km²) | 4 288 | 4 162 |
| Thickness: mean, max (m) | 27, 15/120-150 | 30-40 |
| Groundwater uses and functions | Used for drinking water, water supply of industry, livestock farms. | N/A |
| Other information | Associated groundwater body ROCR06 is of good quantitative and chemical status. | HU _p.2.12.2 is of good quantitative status. HU _p.2.12.2 is of good chemical status. |

### BODROG AQUIFER (NO. 90)

| | Slovakia | Hungary |
|---|---|---|
| Type 2; Holocene – Pleistocene, loamy and sandy gravels; medium links with surface water. | | |
| Area (km²) | 1 471 | N/A |
| Renewable groundwater resource (m³/d) | $256 \times 10^3$ (for groundwater body SK1001500P) | N/A |
| Thickness: mean, max (m) | 20-23, 30 | N/A |
| Groundwater uses and functions | Used 100% for drinking water, (regionally important) abstracted primarily through springs, a small proportion through wells. Total abstraction $465 \times 10^6$ m³ in 2007. | N/A |

### SLOVENSKY KRAS/AGGTELEK AQUIFER (NO. 91)

| | Hungary | Slovakia |
|---|---|---|
| The most important aquifer part is karstified Middle and Upper Triassic limestone and dolomites. | | |
| Area (km²) | 4 493[a] | 598 |
| Renewable groundwater resource (m³/d) | 43 800 ($16 \times 10^6$ m³/year) | 110 700 ($40.4 \times 10^6$ m³/year) |
| Thickness: mean, max (m) | 600, 1 000 | |
| Groundwater uses and functions | Used 100% for drinking water, (regionally important) abstracted primarily through springs, a small proportion through wells. Total abstraction $465 \times 10^6$ m³ in 2007. | Mainly for drinking water (significant resource) |
| Other information | Population in the aquifer area 14 800 (30 inhabitants/km²), in the infiltration area 7 430. Important hydrogeological units (Hungary) are Alsóhegy, Nagyoldal, Hasagistya and Galyaság, which contain the Aggtelek-Domica cave system.[b] National parks cover the majority of the area. Forestry a predominant activity (forests cover 55% of the area), there is also non-intensive agriculture and settlements (2% of the area). Of the aquifer area, cropland covers 18% and grassland 24%; 5% and 14% of the infiltration area, respectively. The total area of the groundwater body is considered as Nitrate-sensitive. Country code HU_K.2.2. | National parks cover the majority of the area. Forestry a predominant activity, there is also non-intensive agriculture and settlements. Country code: SK200480KF. |

[a] The area of the uncovered part is 181 km².
[b] See the related Ramsar Site assessment.

### NORTH AND SOUTH BANAT OR NORTH AND MID BANAT AQUIFER (NO. 92)

| | Serbia | Romania |
|---|---|---|
| Type 4; thick (up to 2 000 m) alluvial aquifer of sands and gravels of Tertiary to Pleistocene age in a deep tectonic depression, forming a confined aquifer sequence with Quaternary lacustrine and alluvial sediments above. Part of the Panonian basin. Weak links to surface water systems, dominant groundwater flow from Romania to Serbia. The depth of groundwater levels is 10-30 m. | | |
| Border length (km) | 255 | 267 |
| Area ($km^2$) | 2 560[a] | 11 393 |
| Groundwater uses and functions | A very important aquifer – provides 100% of drinking water supplies in Vojvodina | The share among water uses is: 50% drinking water, 30% industry and 20% irrigation. |
| Other information | Population 135 000 (density 53 inhabitants/$km^2$). Separate groundwater bodies in Serbia as North and Mid Banat (both in Tisza catchment). National codes of related groundwater bodies: RS_TIS_GW_SI_4, RS_TIS_GW_SI_7,RS_TIS_GW_I_4,RS_TIS_GW_I_7. | Population 857 600 (density 75 inhabitants/$km^2$); the share among water uses is: 50% drinking water, 30% industry and 20% irrigation. |

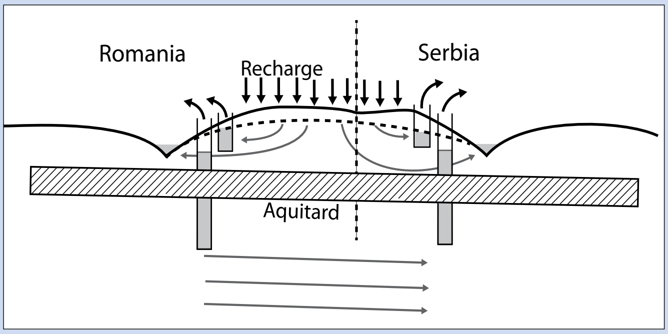
[a] Only groundwater bodies – the regional aquifer extents at about 20,000 $km^2$.

Land cover/land use in the area of the North and South Banat or North and Mid Banat aquifer (No. 92) (% of the part of the aquifer extending in each country)

| Country | Water bodies (%) | Forest (%) | Cropland (%) | Grassland (%) | Urban/industrial areas (%) | Surfaces with little or no vegetation (%) | Wetlands/Peatlands (%) | Other forms of land use (%) |
|---|---|---|---|---|---|---|---|---|
| Romania | 0.27 | 19.03 | 72.04 | 3.01 | 5.57 | N/A | N/A | N/A |
| Serbia | 2.00 | 1.93 | 81.72 | 9.74 | 4.61 | - | - | - |

*Notes:* In the Romanian part, protected area make up 6.4% of the area.

**FIGURE 9:** Conceptual sketch of the North and South Banat or North and Mid Banat aquifer (No. 92) (provided by Serbia)




Groundwater in the aquifer is recharged by precipitation and from rivers in the outcropping zone towards the mountains, as well as through the overlying younger porous-permeable strata. The estimated recharge is 112 × $10^6$ $m^3$/year (average for the years 1995-2007).

Total water withdrawal and withdrawals by sector from the North and South Banat or North and Mid Banat aquifer (No. 92)

| Country | Year | Total withdrawal $m^3$/year | Agricultural % | Domestic % | Industrya % | Energy % | Other % |
|---|---|---|---|---|---|---|---|
| Romania | 2008 | 36 100 | 5.10 | 74.32 | 19.94 | N/A | N/A |
| Serbia | Prospects for 2015 | 78 100 | 3.25 | 73.54 | 22.42 | N/A | N/A |

In Serbia the abstracted groundwater covers 90% of the water being used; 75% of the abstracted groundwater is used for drinking water supply (covering the total of drinking water supply in the area), and less than 10% for irrigation, industry, livestock and spa centres; it also supports ecosystems.


A severe increase in pumping lifts locally, which is a concern in Serbia, led to the local decrease of borehole yields and the decline of groundwater levels of 0.5 m/year (in Kikinda). Groundwater depletion has been observed on most of the wells in North part of Banat, near the borders with Romania. Groundwater level has dropped (from the 1960s until 2000) about 5-10 m in the area; a drop of more than 15 m has been observed locally. Romania reports that there are no transboundary impacts; however, this should be studied further, in cooperation with Serbia.

In Serbia, natural/background groundwater quality does not meet national standards due to the occurrence of natural organic compounds; ammonia, boron and arsenic in high concentrations (for arsenic, more than 100 µg/l in some parts of

Banat). According to Serbia this is an important issue for the entire groundwater body. Romania reported that nitrite and phosphates appear to be an issue at the rural areas near the border; studies on the issue are ongoing.

Sanitation, irrigated agriculture, waste disposal, industry and oilfields are the main pressure factors in Serbia.

In Romania, quality and quantity monitoring has been established according to the requirements of the WFD. In Serbia, monitoring of quantity and quality requires improvement; a wide range of other measures need to be introduced or are planned, including the construction of the regional water supply system of Banat — as a supplementary measure in the respective River Basin Management Plans. This will use groundwater from the Danube alluvium (area between Kovin and Dubovac). The preparations, including studies, are expected to be completed by 2015.

Serbia expects the regional water supply system to provide an adequate supply of drinking water of good quality, and to reduce, or even eliminate the quantitative risk that the aquifer is currently under. The aquifer is under low qualitative risk due to the good natural protection of deep groundwater from surface pollution.

Romania's assessment is slightly different: the aquifer is in good status and there is no risk either in terms of quality or quantity.

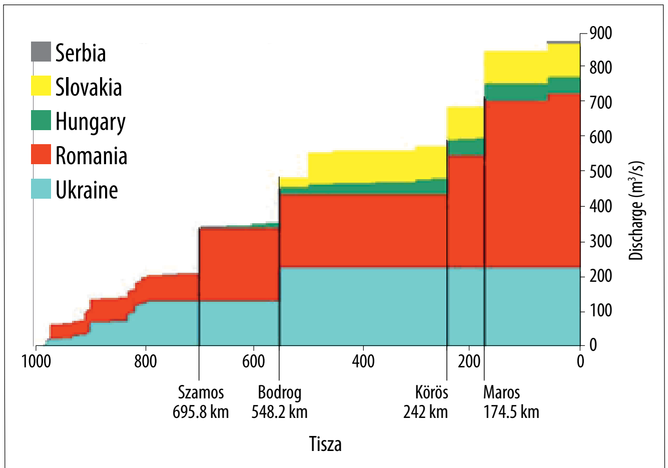
With regard to enhancement of cooperation between the two countries, Serbia reported that assistance would be supportive in the establishment/improvement of bilateral cooperation between Serbia and Romania regarding the sustainable management of the transboundary aquifer; Romania reported that the cooperation on groundwater issues will be included in the new intergovernmental agreement on transboundary waters, through the revision of the existing 1955 Agreement for bilateral cooperation between the two countries. The process of negotiation in this context began at the end of 2010. Sharing of experience between the two countries with the aim of addressing the issue of naturally occurring arsenic is also a field in which, according to Serbia, assistance would be of help.

**Total water withdrawal and withdrawals by sector in the Tisza sub-basin, including Szamos/Somes and Maros/Mures sub-basins**

| Country | Total withdrawal $\times 10^6$ m$^3$/year | Agricultural % | Domestic % | Industry[a] % | Energy % | Other % |
|---|---|---|---|---|---|---|
| Hungary | 1 120.3 | 17.67 | 21.29 | 9.68 | 48.73 | 2.99 |
| Ukraine | 36.83 | 23 | 54 | 23 | - | - |
| Romania | 19.7 | 0.76 | 14.41 | 51.16 | 33.67 | 0 |
| Slovakia | 5.71[b] | 2.7 | 79.1 | 6.8 | - | 11.4 |
| Serbia | N/A | N/A | N/A | N/A | N/A | N/A |

*Notes:* Increased irrigation and related surface water abstraction.
[a] The industrial sector uses the abstracted water mainly for technological cooling water.
[b] From groundwater body SK 1001500P only.

**FIGURE 10:** Longitudinal profile of the Tisza River and contribution of water from each country (in %) to the mean discharge of the Tisza (in m$^3$/s)[69]




*Source:* Analysis of the Tisza River Basin 2007, ICPDR.

## Hydrology and hydrogeology

The occurrence of floods of different types causes problems in the Tisza, where changes in land-use and river engineering have modified the natural structure of the river, and resulted in the loss of natural floodplains and wetlands, increasing exposure to flooding. Repeated rainfall in the upstream parts may cause multi-peak floods of long duration in April and May, due to the extremely mild slope of the riverbed of the Middle- and Lower-Tisza.

## Pressures

There is a "natural pressure" due to geochemical processes in areas with naturally elevated background concentrations of heavy metals.

Land in the sub-basin is mainly used for agriculture, forestry, pastures (grassland), and nature reserves, as well as urbanized areas. As a result of intensive agricultural development over the past decades, many natural ecosystems, particularly the Tisza floodplains, have been transformed into arable lands and pastures. In the upper part of the sub-basin, notably in Ukraine and Slovakia, deforestation in mountain areas is responsible for changes of the flow regime and typical habitats. In addition, extensive use of fertilizers and agro-chemicals led to soil and water contamination with heavy metals and persistent organic pollutants, and river and lake eutrophication from organic materials and nutrients.

In Romania there are low/moderate nutrient emissions to the surface waters due to agriculture and animal farms. As concerns animal husbandry, cattle density is below the Danube basin average.

Hydromorphological changes on rivers interrupt the natural river and habitat connectivity and the hydrological regime. In the Tisza sub-basin, 228 barriers are located in rivers with basin areas larger than 1,000 km$^2$ (UA — 1; RO — 100; SK — 60; HU — 55; RS — 12). Out of the 228 barriers, 67 are dams/weirs and 134 are ramps/sills. In the Romanian part of Tisza

[69] Information based on data of the JRC-IES dataset (1991-2002) and runs of the VITUKI NFHS flood routing module.

Relative importance of the influence of different pressure factors in the Tisza sub-basin by country (1 — local and moderate, 2 — local but severe, 3 — widespread but moderate, 4 — widespread and severe).

| Pressure factors | Ukraine | Romania | Slovakia | Hungary | Serbia |
|---|---|---|---|---|---|
| Geochemical processes or other natural pressure factors | | 3 (heavy metal) | x | 4 (sedimentation) | |
| Natural water flow in the basin (extreme events, seasonality) | 4 (floods) | 2 (floods) | 4 (floods), 2 (scarcity) | 4 (floods), 2 (ecological demand/scarcity) | 3 (drought, flooding) |
| Hydromorphological changes | 2 (bank erosion) | 2 (interruption of river and habitat continuity) | | 4 (sedimentation), 2[a] | |
| Agriculture and animal production | 2 | 2 | 3 | 3 | 3 |
| Forestry | | | | 4[b] | |
| Mining and quarrying | | 3 | 2 | 2 (desiccation from lignite mining) | |
| Industry and manufacturing | | 2 | | | |
| Electricity and generation (e.g. hydropower, thermal power, nuclear power station) | | 1 | | 2 | |
| Sewerage (e.g. untreated/insufficiently treated urban wastewater) | 3 (degraded infrastructure) | 3 | 3 | | 2 |
| Waste management (e.g. controlled and uncontrolled dump sites) | 4 | 2 | 3 | 3 | |
| Transportation (road, pipelines) | 4 (oil, gas etc pipes) | | | | |
| Storage (including tailing dams for mining and industrial wastes) | 1 | 3 (Cd, Cu mining) | | 3 (ind./waste) | |
| Navigation | | | | | |
| Industrial accidents | 2 | 1 | | | |
| Discharges (permitted and illegal) from industries | | 2 | x | - | 2 |
| Groundwater abstraction | 1 | | 2 | 4/2 | 3 (level decline) |
| Surface water withdrawal | 1 | | | | |
| Recreation and tourism | | | | 1 (baths) | |

[a] The longitudinal habitat continuity (mainly for fish) along the Tisza is not ensured because of the hydromorphological changes (for example: barrages) on the Hungarian part of the river.
[b] Forestation of the floodplain by invasive tree species (obstructs flow during flood events).

Photo by Margit Miskolczi

sub-basin, 110 barriers are located in rivers with basin areas larger than 1,000 km². Out of 223 river water bodies on the Tisza River and its tributaries, 75 were designated as heavily modified (75 with final status, 4 with provisional status and 2 have unknown status) representing 34% of the total river water bodies. Further, 18 river water bodies were designated artificial water bodies, representing 8% of the total number of river water bodies.

Problems related to the natural flow include various types of flooding, the challenges of meeting ecological water demands in the smaller Tisza tributaries, and the water scarcity in the Körösök.

Afforestation of the floodplain is needed, and the spreading of invasive tree species is a concern. Another concern is lignite mining, which requires groundwater abstractions to lower the water table in the mining areas.

Industrial activities such as metallurgy and mining, as well as solid waste disposals, can contribute to deterioration of the quality of water resources in the Tisza sub-basin. Large storage tanks of chemicals and fuels are also potential accidental risk spots in the area. Manufacturing industries are responsible for a part of the emission of organic substances and nutrients (especially the chemical, pulp and paper, and food industries).

The main pressures arise from untreated or insufficiently treated urban wastewater, which increases the nutrients' and organic substances' concentrations in the rivers. The UWWTD has not yet been fully implemented in Hungary, Romania and Slovakia. In 2007, 50% of the total population in the Romanian part of Tisza sub-basin was connected to the sewerage systems, and only 43% to the wastewater treatment plants. Discharges to the smaller tributaries in particular result in a problem of nutrient and organic loads. In the Ukrainian part, a significant share of the wastewater (and water supply) infrastructure is in a degraded condition.

Solid waste-related problems, such as plastic bottles and plastic bags blocking up rivers during high floods, are also an issue. Pollution from sites contaminated by former industrial activities or waste disposal has been identified as still significant in the event of a flood. In the Ukrainian part, a large part of the landfills for solid municipal waste have exceeded their design capacity.

Accidental pollution from the industrial sites has more commonly only local effects, but may at worst have transboundary impacts in the Tisza sub-basin, and, as the cyanide accident at Baia Mare in 2000 demonstrated, insufficient precautionary measures at the site of the tailings management facilty has had significant harmful effects on people, transboundary watercourses and the environment, in general, and caused significant economic impact. Flood events, including the floods in August 2002, highlighted the problem of inundation of landfills, dump sites and storage facilities where harmful substances are deposited. Transfer of both pathogens and toxic substances into the water may occur.

Among other pressures and impacts that play a role in two or more of the Tisza countries are also loss of wetlands, and groundwater depletion due to abstraction.

## Status and transboundary impacts

The surface water status (good ecological potential, ecological status and chemical status) and the groundwater status (quantitative and qualitative status) were evaluated in each country according to the requirements of WFD.

Some 42.4% of the Tisza's length (~410 km) were identified as "highly modified water bodies" or "provisionally highly modified water bodies". The distribution along the length of the river is shown in Figure 11.

Altogether, 223 river water bodies were evaluated for water-quality in the Analysis of the Tisza River Basin in 2007.[70] Out of these, 51 (23%) achieved high ecological status and 51 (23%) achieved moderate or worse ecological status. Some 36 (16%) river water bodies achieved high ecological potential, and 46 (21%) achieved a moderate or a worse status. The status of 39 river water bodies (17%) remained undetermined in the Non-EU countries. Based on the data mentioned above, approximately 40% of the river water bodies in the Tisza sub-basin obtained a good or better ecological status or ecological

**FIGURE 11:** Heavily modified water bodies of the Tisza River[71]

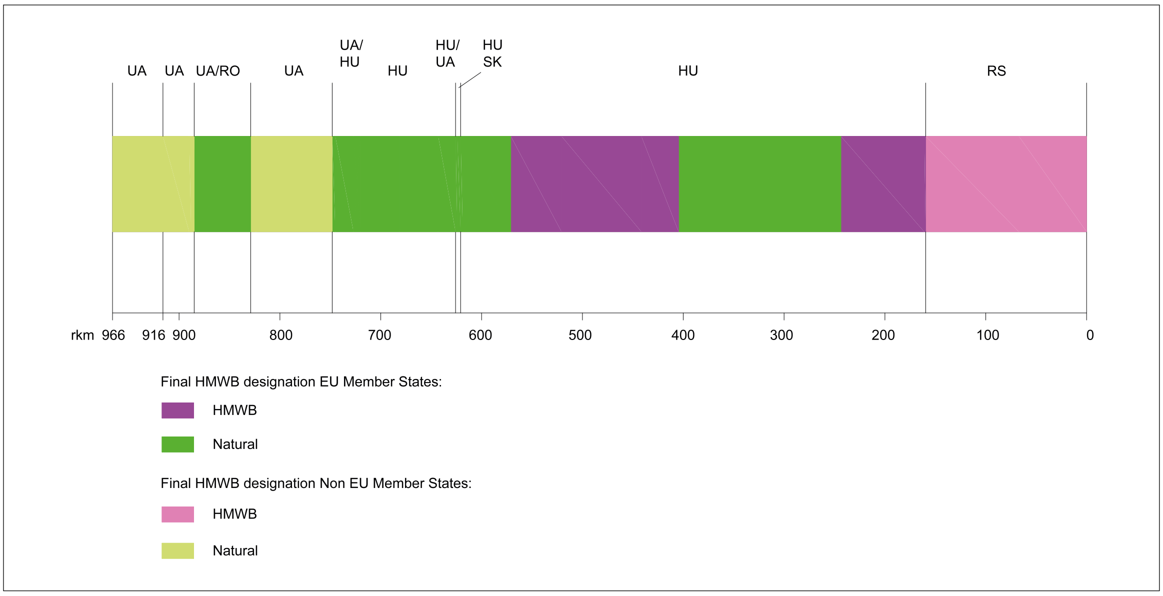
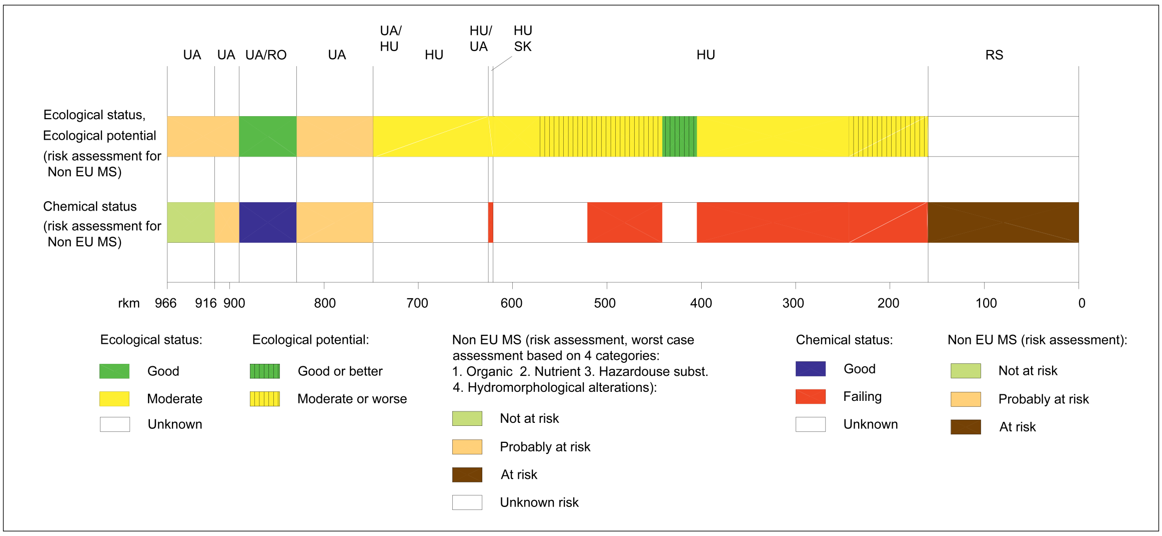



**FIGURE 12:** Status classification for the Tisza River[72]




[70] *Source:* Draft of Integrated Tisza River Basin Management Plan.
[71] *Source:* Draft of Integrated Tisza River Basin Management Plan. In Serbia these were not finally designated, because there is no legal obligation to do so.
[72] Draft of Integrated Tisza River Basin Management Plan.

potential, and around 44% have moderate or worse ecological status or ecological potential. Regarding the chemical status, 107 (48%) of the 223 river water bodies reached good chemical status and 43 (19%) failed. The chemical status is unknown for 73 (33%) river water bodies.

## Responses

The Tisza countries have a long history of cooperation, including the agreement on the protection of the Tisza and its tributaries in 1986, the establishment of the Tisza Forum to address flood issues in 2000, as well as the adoption of the Budapest Initiative (2002) at the Prime Minister level to strengthen international cooperation for sustainable management of floods. In addition to having signed the Danube River Protection Convention (1994) — the most comprehensive agreement in force for all Danube countries — all Tisza countries are Parties to the Carpathian Convention (2003).

In 2004, the five Tisza countries committed themselves to producing the Integrated Tisza River Basin Management Plan (ITRBM Plan, at the sub-basin level) by signing a Memorandum of Understanding. The ICPDR established the Tisza Group as the platform for strengthening coordination and information exchange related to international, regional and national activities in the Tisza River Basin, and to ensure harmonization and effectiveness of related efforts. The plan integrates issues of water quality and quantity, land and water management, floods and drought. It was further developed in 2010 for submission to the public participation process, and the final plan was introduced to the ICPDR Tisza Countries Heads of Delegation in December 2010. This process (2008-2011) is supported by the UNDP/GEF Tisza project[73] (and project partners by the ICPDR, UNDP, EU and UNEP), and is based on the Analysis of the Tisza River Basin (2007).[74]

Europe‘s largest flood defense system in the basin encompasses the regulation of rivers, construction of flood embankments and floodwalls, systems of drainage canals, pumping stations and designated flood detention reservoirs (polders).

Bilateral agreements on management of transboundary waters include those signed by Hungary with Romania, Ukraine, former Yugoslavia (currently implemented with Serbia) and former Czechoslovakia (currently implemented with Slovakia)

Joint bodies include the Hungarian-Romanian Joint Water Commission, the Hungarian-Serbian Committee on Water Management, the Hungarian-Slovakian Committee on Transboundary Waters, and the Serbian-Romanian Hydrotechnical Commission. All of these committees consist of plenipotentiaries and their members/experts. Sub-committees or expert groups have been formed, in particular to deal with flooding and water quality related issues, but also on hydrology and water management.

The plenipotentiaries of Hungary and Ukraine, Ukraine and Slovakia, as well as Romania and Ukraine also meet regularly. Bilateral Ukranian-Hungarian and Ukranian-Slovak cooperation is oriented in two directions: environmental protection (nature reserve management and studies), and protection of surface waters; Ukranian-Romanian cooperation is focused on surface waters protection.

The Joint Programme of Measures (JPM) is structured according to the Significant Water Management Issues (organic, nutrient and hazardous substances pollution, hydromorphological alterations and groundwater).[75] In addition, it includes other issues on integration of water quality and water quantity as relevant issues for the Tisza sub-basin. The implementation of measures of basin-wide importance is ensured through their respective integration into the national programme of measures of each Tisza country. A continuous feedback mechanism from the international to the national level and vice versa will be crucial for the achievement of the basin-wide objectives to improve the ecological and chemical status of the water bodies.

A range of measures to address the sources of the solid waste problems, such as plastic bottles, is being tested under the UNDP/GEF Tisza Project in Ukraine with ICPDR/Coca Cola support, and the active support of local authorities. These measures range from education and awareness-raising to collection and recycling activities.

Water scarcity, droughts and floods are major challenges in the Tisza sub-basin and have been identified as the key water quantity issues along with climate change, affecting low flow in particular. Among implemented measures are the construction of Cigánd and Tiszaroff (already completed and operational), and Hanyi-Tiszasüly and Nagykunság flood reservoirs (under construction) in Hungary, as part of the “Update of the Vásárhelyi Plan”.

In Romania, works are carried out to reduce the effects of natural disasters in the Barcau catchment area (Suplacu de Barcau Reservoir) and for ecological restoration of Crisu Repede River. Wastewater treatment plants are rehabilitated or constructed in Cluj Napoca, Targu Mures, Satu Mare, Oradea, and Timisoara.

## Trends

The implementation of the Urban Wastewater Treatment Directive and the implementation of the EU Nitrates Directive are decisive steps to significantly improve the status of the Tisza in Hungary and its tributaries in Slovakia and Romania.

According to the Analysis of the Tisza River Basin (ICPDR, 2007), water quality evaluation must be improved by:

- Unifying the approaches to risk assessment between countries, as well as providing data for impact assessment to validate risk estimation;
- Refining the assessment of the risk of failing to meet Good Ecological Status; and,
- Improving the monitoring of all parameters required by the WFD.

Water quantity evaluation must be improved by improving data on water uses; and developing flood maps including flood hazard and risk maps.

Management of water quality and quantity must be better integrated by: improving flood risk maps; improving inventories of pollution hot spots; collecting and organising information on planned infrastructure projects; improving assessments regarding excessive river engineering projects; and, defining minimum flows for ecological quality and pressure criteria.

Due to the common elements, the following horizontal measures were identified relevant to the identified three key water

[73] UNDP/GEF Tisza MSP - Integrating multiple benefits of wetlands and floodplains into improved transboundary management for the Tisza River Basin.
[74] Developed by the ICPDR Tisza Group and supported by the EU via the EU Grant – TISAR 2007 (Development of Tisza cooperation on River Basin Management), as well as by UNDP/GEF Danube Regional Project.
[75] *Source:* Draft of Integrated Tisza River Basin Management Plan for public consultation.

# UPPER TISZA VALLEY[76]

## General description of the wetland

The Tisza River has the character of a slow-flowing lowland river, with oxbow lakes and dynamic watercourses, and its entire inundation space is periodically flooded. The floodplain along the Tisza is a representative example of natural and near-natural wetland types of river middle reaches within the Pannonian biogeographic region (and the Carpathian region). It includes willow-poplar woods, willow shrubs, wet meadows and pastures, reed swamps, as well as aquatic vegetation.

## Main wetland ecosystem services

The wetland area is important for the recharge of aquifers in the Tisza sub- basin, storage and retention of water, flood regulation, soil formation, sediment retention and accumulation of organic matter, as well as nutrient cycling.

The Tisza forms a landscape that has high economic, nature conservation and aesthetic values and that is used for fisheries, recreation and tourism, hunting, pastoral agriculture, biological research and environmental education. It also ensures water for irrigation of agricultural lands.

## Cultural values of the wetland area

Archaeological relics of the Paleolithic period confirm that the Upper Tisza Valley has been inhabited and used by different cultures for thousands of years.

## Biodiversity values of the wetland area

Being a large, continuous natural area, the Upper Tisza Valley provides habitats for numerous species, including some threatened at global or European scales, as well as endemic species. Its wetlands provide feeding, spawning and nursery grounds, as well as migration paths on which fish stocks depend. Noteworthy fish species include the Carpathian Brook Lamprey, endemic to

the Tisza river basin, the globally-threatened Sterlet, the Russian Sturgeon, Danube Salmon, and European Mudminnow (the two last species are endemic to the Danube river system). The wetland area maintains important habitats for Eurasian otter, many waterbirds and Long-tailed mayfly.

## Pressure factors and transboundary impacts

The most significant factors adversely affecting the wetland ecosystem are unsustainable forest management, uncontrolled fish-


ing activities, introduction of non-native fish species, spreading of invasive alien plant species, dredging of gravel, and illegal dumps, as well as unregulated recreation and tourism. The damage to the Tisza river ecology in the past was caused by environmental accidents in Romania, namely cyanide and heavy metals pollution spills from mines and industry. Eutrophication from the agricultural run-off and treated sewage water is also increasing.

## Transboundary wetland management

In 1998-1999, international projects on coordinated protection and management of this transboundary area were implemented, and proposals for multilateral designation of the Ramsar Site on the Upper Tisza Valley in Hungary, Romania, Slovakia and Ukraine were developed. Based on this study, Felsö-Tisza (Upper Tisza) Ramsar Site (22,311 ha) in Hungary and the Tisza River Ramsar Site (735 ha) in Slovakia were designated in 2004, and declared as transboundary. The Hungarian Ramsar Site includes the Szatmár-Beregi Landscape Protection Area (LPA), and is under the management of Hortobágy National Park Directorate; the floodplain is designated as a NATURA 2000 site. In Slovakia, the Ramsar Site and the wider Tisza River and Latorica Protected Landscape Area are managed by the State Nature Conservancy of the Slovakia. In Ukraine, the Prytysianskyi Landscape Park was created in 2009 for the protection of the Tisza, Borzhava and Latoritsa rivers' floodplains. (The latter is a counterpart to the Latorica Protected Landscape Area and Ramsar Site in Slovakia).

The ICPDR Tisza Group, which coordinates activities and information exchange related to the cooperation for the integrated river basin management, also plays an important role in managing the transboundary wetlands.

## Additional information

It is likely that there will be increasing water demand in the Tisza sub-basin for irrigation; already vulnerable aquatic ecosystems will be particularly endangered in the summer. Other water uses (municipal and industrial water supply, agricultural uses (e.g., livestock farms and fish production), hydropower or navigation) will not significantly increase by 2015. No new hydropower plants are planned in the Slovakiaand Hungary, but one on the border between Romania and Ukraine has been under discussion in the past years. Following a relatively dry decade, a succession of abnormal floods has set new record water levels on several gauges over the last few years.

[76] *Sources:* Information Sheets on Ramsar Wetlands (RIS); Hamar, J., Sárkányi-Kiss, A. (eds) The Upper Tisza Valley. Preparatory proposal for Ramsar Site designation and an ecological background. Hungarian, Romanian, Slovakian and Ukrainian co-operation. TISCIA monograph series. Tisza Klub & Liga pro Europa, Szeged. 1999; Seizova, S. Towards Integrated Water Management in the Tisza River Basin. ICPDR, Vienna. 2009; Shepherd, K., Csagoly, P. (eds) Tisza River Basin Analysis 2007. ICPDR, Vienna. 2007; UNDP/GEF Project "Integrating multiple benefits of wetlands and floodplains into improved transboundary management for the Tisza River Basin".

# DOMICA-BARADLA CAVE SYSTEM[77]

## General description of the wetland area

The 25-km long Domica-Baradla Cave System is the largest (2,697 ha) subterranean hydrological system of the karst transboundary plateau shared by Slovakia and Hungary. The site is characterised by a permanent and episodic subterranean stream, ponds, rich dripstone features and diverse representatives of subsurface fauna, as well as rich archaeological findings. The site lies in a low-lying karst area in the catchment of the Sajó River, which flows into the Tisza.

## Main wetland ecosystem services

Groundwater is mostly stored in karst hydrogeological structures of Triassic limestones and dolomites. The discharge of the karst springs varies between a few l/min and a few thousand l/min.

The cave system also plays a part in water purification and flood control. Caves with (seasonally) active groundwater streams have a fundamental role in supplying high quality potable water to several villages, e.g., Kečovo (Slovakia), supplied from the Brezovsko–Kečovský aquifer, which also supports forestry, agriculture, tourism and recreation.

The importance of the karstic springs has been recognised locally since medieval times for crushing ore, to mill grains, and to generate electricity. Therapies for respiratory diseases have been practised in the Béke cave since 1957. The Domica-Baradla Cave System is a famous tourist site, with around 130,000 visitors annually. Regular programmes include cave tours, hiking and hunting.

## Cultural values of the wetland area

The whole Cave System is an important archaeological site, with Neolithic settlements of the Bükk Mountain Culture and charcoal drawings unique in Central Europe. Archaeological findings unearthed from the fill of 53 caves (38 in Slovakia and 15 in Hungary) provide evidence of different cultures from the last 40,000 years.

The caves fantasy- and awe-inspiring beauty is reflected in early myths and legends, literary, artistic and musical works.

## Biodiversity values of the wetland area

The Domica-Baradla Cave System is home to more than 500 species of cave-dwelling and cave-tolerating animal species. The fauna includes rare, threatened and endemic species, as well as species first described from this region that have adapted to the dark, nutrient-poor environment. Rich bat fauna is noteworthy.

This karst region represents an independent floral area on the border between the Carpathian and the Pannonic regions. The karst surface, with its specific geological and microclimatic conditions, results in a particularly high diversity of habitats and species. Over a thousand plant species and nearly eight thousand animal species are found here.

## Pressure factors and transboundary impacts

Caves are threatened primarily by human negligence, rather than by intentional damage. Indirect threats are posed by activities on the surface affecting the caves, such as inappropriate agriculture, forestry or industry, infrastructure development, waste disposal and sewage run-off (see the assessment of the Tisza for more information on the pressures). Direct damage may be caused by works inside the cave, pollution, and collection of artefacts (biological, archaeological or palaeontological). Nowadays, any activity that may change the conditions in the cave requires official permission.

## Transboundary wetland management

The Ramsar Sites Baradla Cave System and related wetlands (2,075 ha, Hungary) and Domica (622 ha, Slovakia) were formally designated as a Transboundary Ramsar Site in 2001. They form part of the Transboundary Biosphere Reserve and the Aggtelek (Hungary) and Slovenský kras (Slovakia) National Parks. Both are included in the World Heritage List, and are part of the Natura 2000 network.

Conservation management is harmonised across the border by means of regular expert meetings and contacts. There is good cooperation in terms of cultural programmes, tourism and sport, public events and publications. An Agreement on cooperation between the State Nature Conservancy of Slovakia and the Aggtelek National Park Directorate in Hungary (2001) is followed up through annual implementation protocols. Long-term cooperation exists through the Slovak-Hungarian Working Group for Nature and Landscape Protection. The Hungarian-Slovak Committee on Transboundary Waters governs water use and management.

The foreseeable future of the site is likely to be positive, with growing interest in ecotourism, and developments taking into consideration the protected natural and cultural heritage, thanks to the various designations of the site. However, climate change may have serious consequences. Two consecutive floods of unprecedented water levels occurred in May-June 2010, damaging human settlements. Serious droughts have also taken place in recent years, testing the adaptive abilities of wildlife as well as human populations.

[77] The site is linked to the Tisza River basin and Slovensky kras – Aggtelek aquifer.
*Sources:* Information Sheets on Ramsar Wetlands (RIS); Tardy J. (ed) The world of wetlands in Hungary – Hungary's Ramsar Sites (in Hungarian). 2007.

quantity issues: international coordination, communication and consultation (including education and awareness-raising), and incentives (e.g. related to land uses).

Currently, studies are being undertaken to predict the possible impacts of climate change in the sub-basin, and it is crucial that their results are followed up and adaptive measures are identified accordingly. The EU's Sixth Framework Programme project CLAVIER (CLimate ChAnge and Variability: Impact on Central and Eastern EuRope) aims to contribute to coping with the related challenges (Hungary, Romania and Bulgaria are studied in detail). It is already estimated that, in the long term, it is likely that extreme events such as floods and droughts will occur more frequently and with greater intensity. Ukraine predicts a substantial impact on rain floods, and water availability in the sub-basin is reported to have decreased by 2-5% due to the decrease in run-off during the cold period. Working towards more resilient ecosystems, which are more resilient to climate change impacts, is a 'no-regret' measure. In addition, it is already clear that long-term costly infrastructure works could be developed with different climate scenarios in mind.

## SOMES/SZAMOS SUB-BASIN[78]

The sub-basin of the river Somes/Szamos[79] is shared by Romania and Hungary. The river has its source in the Rodnei Mountains in Romania and discharges into the Tisza. The sub-basin has an average elevation of about 534 m a.s.l.

There are the following reservoirs in the Romanian part: Fantanele, Tarnita, Somes Cald, Gilau, Colibita and Stramtori-Firiza. There are also two natural lakes in the sub-basin, Stiucilor and Bodi-Mogosa, and numerous fishponds.

Major transboundary tributaries in the Hungarian part of the sub-basin include the Northern Main Channel and the Eastern Channel, which are, however, only partly natural. The Szamos-Somes alluvial fan aquifer is located in the sub-basin.

Sub-basin of the Somes/Szamos River

| Country | Area in the country (km²) | Country's share (%) |
|---|---|---|
| Hungary | 306 | 2 |
| Romania | 15 740 | 98 |
| **Total** | **16 046** | |

*Sources:* Ministry of Environment and Water, Hungary; National Administration "Apele Romane", Romania.

### Hydrology and hydrogeology

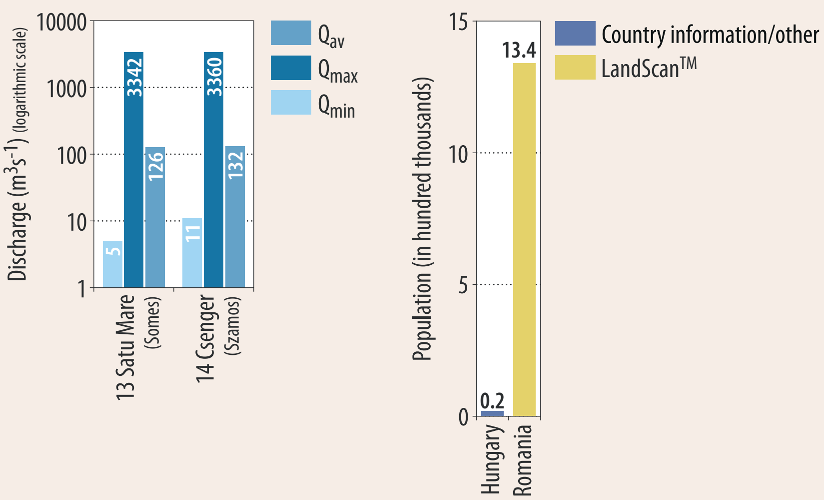
Total theoretical renewable surface water resources are estimated at 4,012 × $10^6$ m³/year, and groundwater resources to some 349 × $10^6$ m³/year (calculated for year 2007) in the Romanian part of the sub-basin. In the Hungarian part, the surface water resources are estimated at 652 × $10^6$ m³/year, and groundwater resources at 41 × $10^6$ m³/year. The total in the Hungarian part equals 3,171 m³/year/capita.

Seventeen surface water bodies are heavily modified in the Romanian part of the sub-basin (including 6 reservoirs) because of river regulation works, embankments and bottom sills. The hydromorphology of the Hungarian part is also affected; upon regulating the river in 1890, 22 cuts through river bends were made to straighten the river.

### Pressures, status and transboundary impacts

Untreated or insufficiently treated urban wastewater discharges cause nutrient pollution. Some 55% of the total population is connected to the sewerage system (and the wastewater is treated). The influence is ranked as widespread but moderate. Discharges from manufacturing are assessed as insignificant due to decreased industrial production in the 1990s, especially in heavily water-consuming industries, which has remained somewhat low. Furthermore, the new activity developed since, in particular small industry, is technologically up to environmental standards. Uncontrolled dump sites are also a concern, but exceedence of the threshold values for ammonium, organic substances and lead have also been recorded in the area of the controlled Satu Mare waste dump. During exceptional flooding, trash such as driftwood and plastic bottles gets washed into the river and transported across the border.

**DISCHARGES AND POPULATION IN THE SOMES/SZAMOS SUB-BASIN**




*Sources:* UNEP/DEWA/GRID-Europe 2011; National Administration "Apele Romane", Romania (gauging station Satu Mare); Upper-Tisza regional Environmental and Water Directorate database, Hungary (gauging station Csenger).
*Note:* For the location of the gauging stations, the basin map of the Danube River should be referred to.

[78] Based on information provided by Hungary and Romania, as well as the First Assessment.
[79] In Romania, Somes sub-basin is considered separately to Crasna sub-basin, but the Hungarian position is that there is a single Szamos sub-basin.

### THE SOMES/SZAMOS ALLUVIAL FAN AQUIFER (NO. 93)[80]

| | Romania | Hungary |
|---|---|---|
| Type 2/4[81]; consists of two overlapped groundwater bodies: ROSO01 and ROSO13. The ROSO01, located between 15 and 40 m depth, is consists of alluvial sediments: sands, gravel, clay and rare fragments of boulders. (Upper Pleistocene- Lower Holocene). Under this groundwater body, between 40 and maximum 130 m depth, the ROSO13 (Lower Pleistocene) is located. Its lithologic composition is similar to ROSO01. Only the ROSO01 is linked (medium link) with surface water bodies (the Somes, Homorod and Turt rivers). The dominant groundwater flow is from east (Romania) to west (Hungary). The covering layer is soil and clayey sands (unsaturated zones of 1-20 m). The depth of groundwater levels is at 5-20 m. The estimated groundwater recharge amounts to 141 × $10^6$ $m^3$/year (average for the years 1995-2007). | | |
| Area ($km^2$) | 1 390 | 1 035 |
| Thickness: mean, max (m) | 40, 130 | 370, 450 |
| Water uses and functions | Upper aquifer: 50% of the groundwater is used for industry, 42% for drinking water supply and 8% for irrigated agriculture. Lower aquifer: 68% of the groundwater is used for drinking water supply and 32% for industry; a minor share is used for agriculture. There are some thermal water abstractions. Abstractions lower than natural availability. Groundwater also supports ecosystems. | >75% drinking water supply, less than 10% each for irrigation, industry and livestock, maintaining baseflow and support of ecosystems. More than 98% of total water use is from groundwater in the Hungarian part. |
| Other information | Border length 35; population ~134 800 (97 inhabitants/$km^2$); comprises two separate groundwater bodies in Romania, ROSO01 and ROSO13, which are not at risk — quantitative status: good. | Border length 35; population ~68 100 (66 inhabitants/$km^2$); groundwater bodies in Hungary: HU_sp.2.1.2, HU_p.2.1.2, HU_sp.2.3.2, HU_p.2.3.2. |

Land cover/use in the area of the Somes/Szamos alluvial fan aquifer (No. 93) (% of the part of the aquifer extending in each country)

| Country | Water bodies (%) | Forest (%) | Cropland (%) | Grassland (%) | Urban/ industrial areas (%) | Surfaces with little or no vegetation (%) | Wetlands/ Peatlands (%) | Other forms of land use (%) |
|---|---|---|---|---|---|---|---|---|
| Romania | 0.74 | 33.76 | 54.61 | 8.09 | 2.15 | N/A | N/A | 0.63 |
| Hungary | 1.84 | 6.04 | 73.42 | 14.15 | 4.36 | 0 | 0.18 | 0 |

*Notes:* In the Romanian part, protected areas make up 0.02% of the surface area.

Total water withdrawal and withdrawals by sector from the Somes/Szamos alluvial fan aquifer (No. 93)

| | Year | Total withdrawal × $10^6$ $m^3$/year | Agriculture % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|---|
| Romania | 2005 | 17.624 | 2 | 72 | 26 | 0 | 0 |
| | 2006 | 17.603 | 1 | 66 | 33 | 0 | 0 |
| | 2007 | 18.421 | 0 | 63 | 37 | 0 | 0 |
| Hungary | 2005 | 4.917 | 5.1 | 87.2 | 7.1 | 0 | 0.2 |
| | 2006 | 5.497 | 6.7 | 87.7 | 5.3 | 0 | 0.2 |
| | 2007 | 5.386 | 7.9 | 85.6 | 6.2 | 0 | 0.3 |

Local and moderate increases of pumping lifts and small drawdown have been observed around two major well fields near Satu-Mare in Romania; nevertheless, groundwater abstractions are reported to be effectively controlled. In Hungary there are local and moderate increases observed in pumping lifts, as well as reduction in borehole yields and spring flow, and degradation of ecosystems.

In Romania, 45% of the total population in the area is not connected to a sewerage system. Agriculture (practiced in accordance with the EU legislation – also, without the use of fertilizers in some areas) is a pressure factor. Cases of maximum concentration values for $NH_4$ and $PO_4$ exceeding national threshold values for drinking water in 2007 have been recorded in two wells in the Satu Mare area. Industry and waste are also of concern: cases of maximum concentration values for $NH_4$, organic substances and Pb exceeding threshold values for drinking water have been recorded in certain wells in the area. All are, however, of low importance. Nutrient pollution has been observed in some vulnerable zones.

Agriculture, sewers and septic tanks exert pressure on the quality of the groundwater of the aquifer in Hungary. There is widespread but moderate natural arsenic occurrence (up to 50 µg/l), widespread but moderate nitrate (up to 200 mg/l) and local and moderate pesticide pollution (up to 0.1 µg/l).

Quality and quantity monitoring of the water bodies have been established in Romania according to the requirements of the WFD, being operational since the beginning of 2007.

Both Romania and Hungary consider that vulnerability mapping is needed in order to improve land use planning. According to Hungary, groundwater abstraction regulations exist and relevant control is effective. However, application of financial mechanisms, water use efficiency, monitoring, public awareness, protection zones, wastewater treatment, data exchange and arsenic removal need to be improved. Improved agricultural practices and integration into river basin management are also needed according to Hungary, as well as evaluation of the utilizable groundwater resources and their quality status. Hungary also calls for joint monitoring (mainly quantitative) and update of existing joint modelling.

The aquifer is of good status, not being under risk in terms of either quantity or quality.

[80] Based on information from Romania and the First Assessment, supplemented by the Danube Basin Analysis (WFD Roof Report 2004). Pleistocene Some/Szamos alluvial fan is the name of the aquifer used in the First Assessment; Somes/Szamos alluvial fan is the name of the aquifer used in this Second Assessment. According to Ukraine, groundwater resources related to this aquifer have not been assessed in its territory.

[81] Romania reports that the unconfined upper part of the aquifer is Type 2, while the confined lower part of the aquifer is Type 4.

**NYÍRSÉG, KELETI RÉSZ/NYÍRSÉG, EAST MARGIN AQUIFER (NO. 94)**

| | Romania | Hungary |
|---|---|---|
| Quaternary and Pleistocene-Pannonian Fine gravel, sands, intercalated with numerous clay and silt lenses. Upper part unconfined. | | |
| Area (km$^2$) | 633 | 607 |
| Thickness: mean, max (m) | Consists of 0-30 m thick Quaternary and 30-280 m thick Pleistocene-Pannonian sediment sequences | Consists of 120-280 m thick Quaternary and 80-100 m thick upper Pannonian sediment sequences |
| Notes | The Quaternary groundwater body is referred to with the code ROSO06 (in Kraszna sub-basin) and the Pleistocene-Pannonian as ROCR06. | Groundwater table at a depth of 8 to 12 m. There are some 800 wells in the aquifer. Both of the shallow and deeper groundwater bodies are of good quantitative and chemical status, have low TDS and chloride content (below 10 mg/l). Groundwater body HU_sp 2.3.1. corresponds with ROSO06 on Romania's side. |

Total water withdrawal and withdrawals by sector in the Somes/Szamos sub-basin

| Country | Year | Total withdrawal $\times 10^6$ m$^3$/year | Agricultural % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|---|
| Hungary | 2006 | 7.3 | 8 | 85 | 6 | 0 | 1 |
| Romania | 2005–2007 | 17.624 | 2 | 72 | 26 | 0 | 0 |

In the central part of the basin, in Romania's territory, heavy metal pollution (copper, zinc, lead, cadmium and mercury) from mining and related tailings dams is ranked as widespread but moderate in influence. Background levels of some heavy metals are also naturally elevated, for example arsenic in Hungary, and lead, cadmium, manganese and iron in Romania.

Groundwater abstracted in Martinesti – Micula and Doba - Vetis is used to supply drinking water to the Satu Mare and Carei cities in the Romanian part. Deep groundwater (at depths > 600m) is used for thermal spas in Satu Mare.

Some impact from agriculture is observed periodically through elevated phosphate and ammonium concentrations in Romania, but this remains local and moderate.

The influence of hydromorphological changes is considered widespread and either moderate (Romania), or severe (Hungary).

Indirect and direct water withdrawal is assessed in Hungary as less than the usable water resource.

## Responses

Both quality and quantity of surface and groundwaters are regularly monitored in both countries. Surface water monitoring in the Hungarian part involves monitoring basic chemistry, biological parameters, dangerous substances and hydromorphology, as well as frequent gauging.

Sewerage systems and/or wastewater treatment plants are rehabilitated, built and extended in Romania. In Hungary, the construction of sewerage systems and wastewater treatment plants for several settlements is either completed — Csenger, Csengersima, Szamosszeg, Tunyogmatolcs, Kocsord, Tyukod, Fehérgyarmat, Ököritófülpös in 2009 — or planned — Csenger in 2012, Nagyecsed-Fábianhaza and Jánkmajtis-Csegöld in 2013, and extension of the capacity of Szamosszeg in the near future.

Mine wastewater treatment plants are also rehabilitated, and mine closures are taking place. The County Council of Satu Mare is developing a Master Plan for waste management for the county, and similar plans are under preparation in other counties of the Somes sub-basin. There are local investments for the rehabilitation and clean-up of areas around closed mines as well as tailings ponds.

Diffuse pollution from agriculture is addressed through action programmes in zones vulnerable to nitrates to adhere to the good agricultural practices' code, involving, for example, the improvement of manure application practices, and the creation of buffer zones around streams.

Some flood prevention measures are also being taken, including the EU-financed construction of the Hungarian Szamos-Kraszna reservoir to reduce water levels in the Somes/Szamos during high flows.

## Transboundary cooperation

The bilateral agreement of 2003 between Romania and Hungary has a dedicated section on the harmonization of transboundary surface water and groundwater bodies. Under this agreement, the Romanian-Hungarian Joint Hydrotechnical Commission was established that operates through three sub-commissions: hydrometeorology and water management, water quality, and defence against floods. From 2007 to November 2010, under the Subcommission on hydro-meteorology and water management, a WFD Working Group was constituted, in order to harmonize delineation and characterization of transboundary surface water bodies and groundwater bodies. Since November 2010, the tasks under the WFD will be dealt with within the Water Management and Hydrometorology Sub-commission.

Developing and updating existing joint models of aquifers between Romania, Hungary and Ukraine is an important challenge for the future, and should be one of the main aims for further trilateral cooperation on groundwater issues.

## Trends

During the last 50 years, an increase of annual average temperature and a decreasing tendency of the total annual precipitation has been observed in Hungary. Hungary predicts an increase of the average temperature, a decrease of average annual precipitation and a change of its distribution (more in the winter, less in the summer) in the following decades, together with the increase of the frequency and intensity of extreme weather conditions. Higher and earlier flood levels are expected, due to increased winter run-off. The quantity of shallow groundwaters of the Great Plain, which are mainly used for irrigation, is predicted to decrease, also affecting groundwater quality and those ecosystems that depend on them. Harvests are predicted to be affected by drier and hotter summers, which will not be compensated for by warmer and rainier winters and a longer vegetative stage.

With the exception of irrigation, which is expected to remain stable, water demands for all other uses are expected to increase until 2020 in the Romanian part of the sub-basin, in particular for surface water resources in its southern part.

Thanks to the implementation of the programme of measures developed in the River Basin Management Plan, pollution levels for almost all pollutants are expected to decrease until 2015.

Some improvement of water quality has been observed in the last decade, mostly due to decreasing pollution due to the implementation of the "polluter pays" principle and EU legislation; further improvement is expected till 2021 to meet the requirements of the WFD.

# MURES/MAROS SUB-BASIN[82]

The sub-basin of the river Mures/Maros is shared by Romania and Hungary. The river has its source in Romania, and discharges into the Tisza.

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

A major transboundary tributary to the Mures/Maros is the canal Szárazér/Ier main canal, with its source in Romania.

The transboundary aquifer Mures/Maros alluvial fan is an important water resource for both countries, in particular for drinking water.

Sub-basin of the Mures/Maros

| Country | Area in the country (km²) | Country's share (%) |
|---|---|---|
| Hungary | 1 885 | 6.2 |
| Romania | 28 310 | 93.8 |
| **Total** | **30 195** | |

*Source:* National Administration "Apele Romane", Romania.

## Hydrology and hydrogeology

The total renewable surface water resources are estimated at 5,876 × $10^6$ m³/year, and groundwater resources to some 140 × $10^6$ m³/year (the latter figure is an average for years from 1995 to 2007) in the Romanian part of the sub-basin. In the Hungarian part, the surface water resources are estimated at 5,793× $10^6$ m³/year (average for years from 1950 to 2006), and groundwater resources at about 214 × $10^6$ m³/year. Added up, these equal 72,360 m³/year/capita in the Hungarian part.

## Pressures and status

Pressure factors ranked as widespread and severe in influence by one of the riparian countries include: hydromorphological alterations due to which the river is characterized as being "at risk" (the river is classified as "heavily modified" because of embankments);

### PLEISTOCENE-HOLOCENE MURES/MAROS ALLUVIAL FAN AQUIFER (NO. 95)[83]

| | Romania | Hungary |
|---|---|---|
| Type 4; Pleistocene and Holocene alluvial sediments, predominantly pebbles, sands and silts; weak to medium links with surface water systems; groundwater flow direction from Romania to Hungary. In Romania, the shallow (15-30 m) upper part is considered to be a separate groundwater body (ROMU 20) to the deeper, confined part of the sequence (ROMU22 developed from the depth of 30 m to 150 m). | | |
| Area (km²) | 2 222 (ROMU20); 1 683 (ROMU22) | 1 245 (HU sp.2.13.1, HU p.2.13.1); 3 744 (HU sp.2.13.2, HU P.2.13.2) |
| Thickness: mean, max (m) | 18, 33 (ROMU20); 65, 75 (ROMU22) | 30 (HU sp.2.13.1, HU sp.2.13.1); 417 (HU p.2.13.1, HU p.2.13.2) |
| Water uses and functions | 75% for drinking water supply, 15% for industry and 10% for irrigation (shallow), and 45%, 35% and 20% respectively for the confined aquifer. | >75% drinking water, <25% for irrigation, industry and livestock, support of agriculture and ecosystems. Groundwater is 80% of total use in Hungary. |
| Other information | Border length 90 km. | Border length 90 km. Population 344 600 (density 69 inhabitants/km²). National codes for groundwater bodies in Hungary: HU_sp.2.13.1, HU_p.2.13.1, HU_sp.2.13.2, HU_p2.13.2. The lateral flow across the border from Romania to Hungary is estimated at 15–20 × $10^6$ m³/d (uncertain, based on available knowledge). |

Groundwater abstraction exerts pressure on the aquifer in Romania; local and moderate increase of pumping lifts has led to small drawdowns locally.

In Hungary, groundwater abstraction - there is moderate increase in pumping lifts locally - is also a pressure factor, as are agriculture and septic tanks. Reduced borehole yields and reduced baseflow have been observed. Local but severe degradation of ecosystems are due to problems related to groundwater quantity. Widespread but moderate nitrate pollution (up to 200 mg/l), moderate local pesticide pollution (up to 0.1 µg/l) and widespread and naturally occurring arsenic in high concentrations (up to 300 µg/l) have been observed.

There are no transboundary impacts.

Management measures in Hungary pertaining to groundwater abstraction regulation are considered efficient, while water use efficiency, monitoring, delineation of protection zones, arsenic removal, wastewater treatment, and public awareness need to be improved; good agricultural practices, as well as integration of groundwater management with river basin management, need to be applied. Both countries stress the need for vulnerability mapping.

Romania considers that one groundwater body (ROMU22) is of good chemical status, and the other groundwater body (ROMU20) is of poor chemical status. There is no risk from the quantity point of view for either water bodies. According to Hungary, the aquifer is possibly at risk in terms of both quality and quantity. Hungary considers as needed evaluation of the quality status and the utilizable resources, joint monitoring (mainly quantitative) and joint modelling, including the estimation of the amount of transboundary groundwater flow. There is a potential need to import water to compensate for local needs, due to the presence of arsenic in the water.

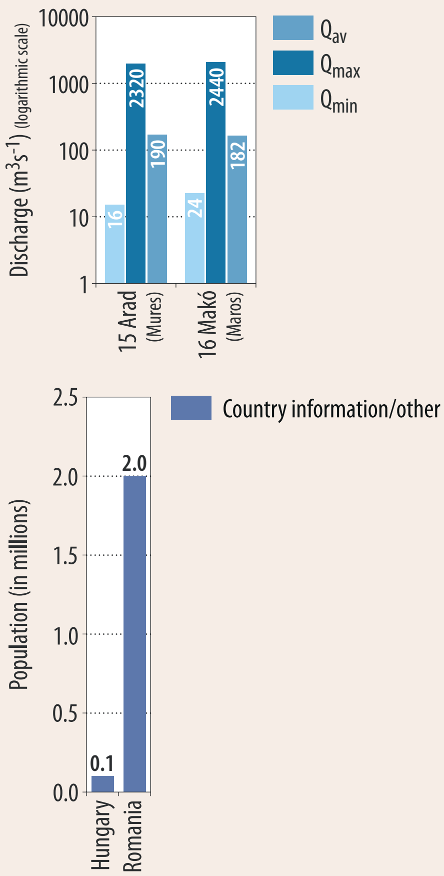
[82] Based on coordinated information provided by Hungary and Romania as well as the First Assessment.
[83] Based on information from Romania, Hungary and the First Assessment.

Total water withdrawal and withdrawals by sector in the Mures/Maros sub-basin

| Country | Year | Total withdrawal $\times 10^6$ m$^3$/year | Agricultural % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|---|
| Hungary | 2007 | 37.9 | 37 | 56 | 4 | 0 | 3 |
| Romania | 2007 | 904.9 | 5 | 9 | 13 | 73 | |

*Notes:* For both countries the situation in 2007 is shown.

**DISCHARGES AND POPULATION IN THE MURES/MAROS SUB-BASIN**




*Source:* UNEP/DEWA/GRID-Europe 2011.
*Note:* For the location of the gauging stations, the basin map of the Danube River should be referred to.

agricultural water use for irrigation (Hungary, including groundwater abstraction); and hydrological extremes (Hungary).

The most significant point pollution sources in Romania — but with local influence — are mining units causing heavy metal pollution downstream, in particular by copper and zinc.

More minor pressures of local and moderate influence include low/moderate nutrient emissions to the surface water due from agriculture and animal farms in Romania, discharges of untreated or insufficiently treated wastewater, manufacturing facilities, thermal pollution from power generation, uncontrolled dump sites and accidental water pollution events.

Apart from some local exceptions, the status of the Mures/Maros is assessed as "good" and its trend is "stable".

### Responses

To tackle pollution from municipal wastewater, wastewater collection and treatment infrastructure is being rehabilitated, built and/or extended.

Heavy metal pollution is reduced in Romania by rehabilitating mine wastewater treatment plants — and mine closures also will reduce the impact. According to Romania, there is no transboundary impact, because of the high level of dilution due to the flow of the Mures/Maros River, and due to the large distance between the mines and the border.

Diffuse pollution from agriculture is addressed through Action Programmes in zones vulnerable to nitrates, including voluntary adherence to the good agricultural practices code. For reduction of nutrient pollution, implementation of basic measures according to the EU Nitrates Directive and the Urban Wastewater Directive are central, and in the case of groundwater vulnerability, so is mapping for land use planning.

### Transboundary cooperation

Joint monitoring programmes, including data collection and data management, are carried out through the Romanian-Hungarian Hydrotechnical Commission (described in the assessment of the Somes/Szamos).

The transboundary "Development of the protection against floods in the common Hungarian-Romanian attention area on the Mures River" project, developed by the Mures River Basin Administration in collaboration with the Szeged River Directorate, is in the final phase of assessment. The Transboundary Cooperation Programme Romania-Hungary 2007-2013 continues the transboundary co-operation programmes implemented in the region. The proposed two-year project is to be funded from the European Regional Development Fund, country budgets, and both the River Basin Directorates.

### Trends

All water uses are expected to increase in the Romanian part of the basin until 2020.

Implementation of EU legislation has improved water quality in the last decade, and, through implementation of the measures developed in the River Basin Management Plan, the trend is expected to continue, driven by the effort to comply with the WFD requirements.

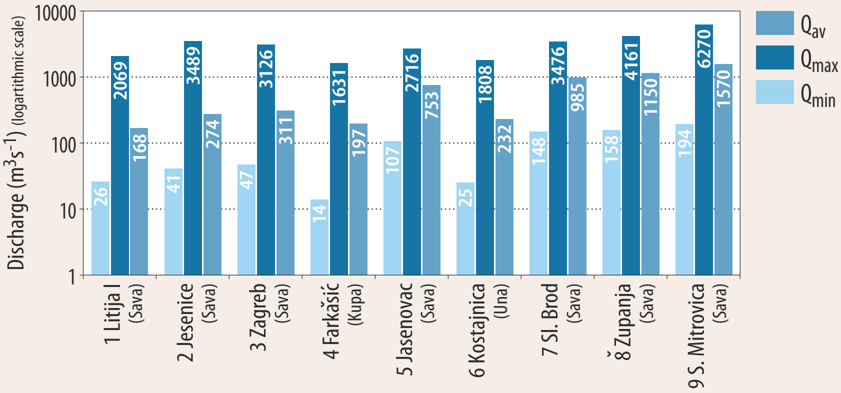
Predicted impacts of climate change have been assessed for the Tisza Basin as a whole.

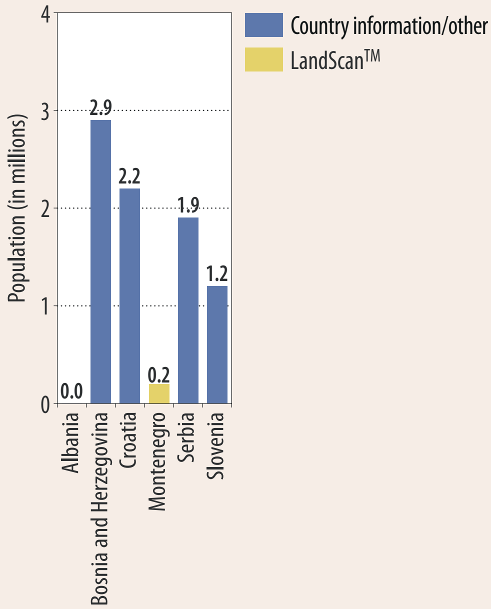
## SAVA SUB-BASIN[84]

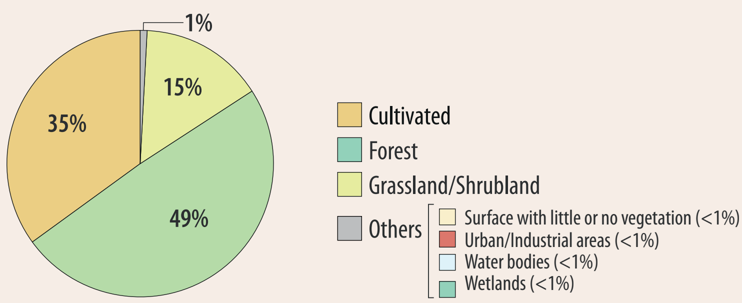
The sub-basin of the Sava River covers considerable parts of Slovenia, Croatia, Bosnia and Herzegovina, Serbia, Montenegro and a small part of Albania. A large part of the population of each of the first four riparian countries live in the basin, ranging from approximately 25% to approximately 75% of the total number of inhabitants (Bosnia and Herzegovina: 75.0%, Slovenia: 61.4%, Croatia: 49.75%, Serbia: 24.9%).

[84] Based on information from 1) International Sava River Basin Commission (ISRBC); 2) ISRBC annual report (April 2008 - March 2009); 3) Bosnia and Herzegovina; 4) Croatia; 5) the First Assessment.


## DISCHARGES, POPULATION AND LAND COVER IN THE SAVA SUB-BASIN




*Source:* UNEP/DEWA/GRID-Europe 2011; International Sava River Basin Commission (data).

Sub-basin of the Sava River

| Country | Area in the country ($km^2$) | Country's share (%) |
|---|---|---|
| Slovenia | 11 734.8 | 12.0 |
| Croatia | 25 373.5 | 26.0 |
| Bosnia and Herzegovina | 38 349.1 | 39.2 |
| Serbia | 15 147.0 | 15.5 |
| Montenegro | 6 929.8 | 7.1 |
| Albania | 179.0 | 0.2 |

## Hydrology and hydrogeology

The Sava River emerges in the mountains of western Slovenia, and flows into the Danube in Belgrade, Serbia. The river is the third longest tributary (about 945 km) to the Danube, and the largest by discharge (1,722 $m^3/s$, at its mouth). In Croatia, the average discharge of the Sava River immediately upstream from the mouth of the Sutla River is around 290 $m^3/s$; it is 314 $m^3/s$ in Zagreb, and around 1,179 $m^3/s$ at the point where the Sava exits Croatia.

The morphology of the terrain of the basin varies. While rugged mountains (the Alps and the Dinarides) dominate in the upper part, the middle and lower parts of the sub-basin are characterized by flat plains and low mountains. The areas in the south, in Croatia, Bosnia and Herzegovina, Montenegro and Albania, drained by tributaries ending in the middle section of the Sava watercourse, are characterised by mountainous landscape. Elevation varies between 2,864 m a.s.l. (Triglav, Slovenian Alps) and about 71 m a.s.l. at the mouth of the Sava.

The Sava receives water from a number of rivers, many of which are also transboundary. The most important is the Drina (itself transboundary); its main tributaries are the Piva, Tara, Lim and Uvac rivers.

Main transboundary rivers of the hydrographical network of the Sava sub-basin.

| River | Sub-basin area ($km^2$) | Countr(ies) that the sub-basin is extending to | Length (km) |
|---|---|---|---|
| Sotla/Sutla | 584.3 | SI, HR | 88.6 |
| Kupa/Kolpa | 10 225.6 | HR,SI | 297.2 |
| Una | 9 828.9 | BA,HR | 214.6 |
| Drina | 20 319.9 | ME, AL, BA, RS | 346.0 |
| Bosut | 2 943.1 | HR, RS | N/A |

The Sava sub-basin hosts large lowland forest complexes and the largest complex of alluvial wetlands in the Danube basin (Posavina - Central Sava basin).

The Sava is a fine example of a river where some of the floodplains are still intact, supporting both mitigation of floods and biodiversity. There are six designated Ramsar Sites; a number of areas of ecological importance are under national protection status.

The Sava sub-basin is characterized by diverse geological structures and a complex tectonic setting under which two main units stand out, determining the type of aquifers that occur: the Pannonian area with dominant inter-granular aquifers and the Dinarides with mostly limestone aquifers.

The following transboundary aquifers were identified as hydraulically linked to the surface waters of the Sava River basin, and included in the First Assessment:

(1) Cerknica/Kupa (No. 96), shared by Croatia and Slovenia;[85]
(2) Radovica-Metlika/Zumberak (No. 98), shared by Slovenia and Croatia;[86]
(3) Bregana-Obrezje/Sava-Samobor (No. 99), shared by Slovenia and Croatia;[87]
(4) Bizeljsko/Sutla (No. 101), shared by Slovenia and Croatia;[88]
(5) Srem-West Srem/Sava (No. 107), shared by Serbia and Croatia;
(6) Posavina I/Sava (No. 108), shared by Bosnia and Herzegovina and Croatia;
(7) Kupa (No. 109), shared by Bosnia and Herzegovina and Croatia;[89]
(8) Pleševica/Una (No. 110), shared by Bosnia and Herzegovina and Croatia;
(9) Lim (No. 111), shared by Serbia and Montenegro;
(10) Tara massif (No. 112), shared by Serbia and Bosnia and Herzegovina;[90] and,
(11) Macva-Semberija (No. 113), shared by Serbia and Bosnia and Herzegovina.

Since the First Assessment, further research by some of the countries has revealed the existence of additional transboundary groundwater bodies that form part of the earlier identified aquifers.[91] Information on the transboundary aquifers that have been identified as hydraulically linked with the surface water systems of the Sava River are already in the First Assessment. It is likely that the list developed is not exhaustive.

Total water withdrawal and withdrawals by sector in the Sava sub-basin[a]

| | Total withdrawal $\times 10^6$ $m^3$/year | Agricultural % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|
| **Total** | **48 969** | **11.2** | **16** | **5.9** | **66.9** | **-** |

[a] Figures for years 2003-2005.

[85] According to Croatia this transboundary aquifer is under consideration but not approved.
[86] According to Croatia this transboundary aquifer is under consideration but not approved.
[87] According to Croatia this transboundary aquifer is under consideration but not approved.
[88] According to Croatia this transboundary aquifer is under consideration but not approved.
[89] According to Croatia this transboundary aquifer is under consideration but not approved.
[90] According to both countries there are negligible conditions for nomination as a transboundary groundwater.
[91] Bosnia and Herzegovina, Croatia, Slovenia and Serbia identified the most important groundwater bodies for the needs of the Sava River Basin Analysis Report, being prepared by the ISRBC. According to the ISRBC secretariat, information related to groundwater bodies was incomplete. As far as the issue of transboundary groundwater bodies is concerned, this will be reconsidered in the next phase of the preparation of the Sava River Basin Management Plan (coordinated by the ISRBC).

### CERKNICA/KUPA AQUIFER (NO. 96)[92]

| | Croatia | Slovenia |
|---|---|---|
| Type 2 (SI)/the aquifer represents none of the illustrated transboundary aquifer types (HR); Mesozoic/Triassic and Cretaceous limestones and dolomites with some alluvium in the river valley; unconfined; groundwater flow from Croatia to Slovenia and Slovenia to Croatia; weak to medium links with surface waters systems. | | |
| Area (km²) | 137 | 238 |
| Groundwater uses and functions | Drinking water supply; supports ecosystems. | Local drinking water supply. |
| Pressure factors | None, very scattered population; occasional bacteriological pollution the only reported problem. | None, sparsely populated, forested with some extensive agriculture and pasture. |
| Groundwater management measures | Existing protection zones. | None |
| Trends and future prospects | Border length 32 km. No transboundary impact. Delineation of transboundary groundwater is needed (through common research), and development of monitoring programmes. | Border length 32 km. Population ~10 635 (45 inhabitants/km²). No transboundary impact. Not at risk. Good chemical status. It is unclear which groundwater systems in the two countries correspond to each other; delineation of transboundary groundwater needs common research and a bilateral decision to propose a transboundary groundwater, if appropriate. |
| Other information | Transboundary aquifer under consideration, but not approved. | In the basin of the Kolpa/Kupa River, within that of the Sava River. |

### KOČEVJE GOTENIŠKA GORA AQUIFER (NO. 97)[93]

| | Croatia | Slovenia |
|---|---|---|
| Type 2; Mesozoic carbonates, dominantly karstic limestones; pressure condition: unconfined; weak to medium links to surface water systems. | | |
| Area (km²) | 595 | |
| Groundwater uses and functions | Local drinking water supply | |
| Other information | Population ~18 200 (density 31 inhabitants/km²) | |

### RADOVICA-METLIKA/ZUMBERAK[94] AQUIFER (NO. 98)

| | Croatia | Slovenia |
|---|---|---|
| Type 2 (SI)/represents none of the illustrated transboundary aquifer types (HR); Upper Triassic dolomites, Upper Jurassic limestones, Cretaceous predominantly carbonate flysch, karstic limestones; pressure condition: partly confined, partly unconfined. Recharge area is both in Croatia and Slovenia; the discharge area is in Slovenia. Possible drainage to surface water systems; groundwater covers the total of the water used in the Slovenian part; groundwater flow direction from Croatia to Slovenia. | | |
| Area (km²) | 158 | 27 |
| Thickness: mean, max (m) | N/A | > 1 000 |
| Groundwater uses and functions | Dominantly drinking water supply; supports ecosystems. | Drinking water supply (town of Metlika; minimum yield of the Obrh spring discharge is about 50 l/s, maximum yield > 1 000 l/s). |
| Pressure factors | None | Agricultural activities, lack of sewerage in the spring recharge area, illegal dump sites. Spring water quantity fluctuates significantly due to the karstic geomorphology; water scarcity in summer; possible problem regarding the surface stream hydrological minimum during drought. Excessive pesticide content, possible microbiological pollution; turbidity of water is observed during the rainy season. |
| Groundwater management measures | Need to establish protection zones. | Wastewater treatment infrastructure and septic tank systems being developed in the recharge area (in progress); uncontrolled dump site inventory and appropriate addressing of the issue is planned for the future. |
| Other information | Border length 12 km. Agreed delineation of transboundary groundwaters, and development of monitoring programmes are needed. No transboundary impact. Transboundary aquifer under consideration, but not approved | Border length 12 km. Population ~2 500 (density 95 inhabitants/km²). No transboundary impact. Possible additional and more frequent discharge reduction in drought seasons as a consequence of climate change.<br><br>It is unclear which groundwater systems in the two countries correspond to each other; delineation of transboundary groundwater systems needs common research and a bilateral expert group decision to propose a transboundary groundwater, if appropriate.<br><br>Establishment of transboundary water protection areas is needed; the bilateral water commission will discuss this issue. |

92 Based on information from Slovenia, Croatia and the First Assessment. Part of the Kolpa - carbonate fissured and karst aquifers of the Kolpa and Ljubljanica area; Kupa/Kolpa (shared by Slovenia and Croatia) and Ljubljanica (Slovenia) Rivers are tributaries to the Sava. Cerknica/Kupa and Kočevje Goteniška gora are part of the same system.

93 Based on information from Slovenia. Part of the Kolpa - carbonate fissured and karst aquifers of Kolpa and Ljubljanica area; Kupa/Kolpa (shared by Slovenia and Croatia) and Ljubljanica (Slovenia) Rivers are tributaries of the Sava. Cerknica/Kupa and Kočevje Goteniška gora are part of the same system.

94 Based on information from Slovenia, Croatia and the First Assessment. Part of the Kolpa - Carbonate fissured and karst aquifers of Kolpa and Ljubljanica area; Kupa/Kolpa (shared by Slovenia and Croatia) and Ljubljanica (Slovenia) Rivers are tributaries of the Sava.

### BREGANA-OBREZJE/SAVA-SAMOBOR AQUIFER (NO. 99)[95]

| | Slovenia | Croatia |
|---|---|---|
| Represents none of the illustrated transboundary aquifer types; Quaternary alluvial sands and gravels, strong link with surface waters of the Sava River; groundwater flow from Slovenia to Croatia. | | |
| Area (km²) | 4 | 54 |
| Thickness: mean, max (m) | 5 – 10 | 20 – 30, 50 |
| Groundwater uses and functions | Local drinking water supply. | Dominantly drinking water supply (for Samobor and part of Zagreb), and some industry. |
| Pressure factors | Surface water hydropower schemes and associated river regulation on the Sava; transport routes. No problems related to groundwater quality or quantity. | Agriculture, population, extraction of gravel and river regulation. Changes in groundwater level detected. Hydrocarbons - oils and occasionally nitrogen, iron and manganese. |
| Groundwater management measures | None | Existing protection zones. |
| Other information | Border length 7 km. Chemical status good. No transboundary impacts. It is unclear which groundwater systems in the two countries correspond to each other; delineation of transboundary groundwater systems needs common research and bilateral expert group decision to propose a transboundary groundwater, if appropriate. Very small part in Slovenia. | Border length 7 km. Transboundary impact from hydropower plants and extraction of gravel. Agreed delineation of transboundary groundwaters (common research and a relevant bilateral decision is needed), as well as development of monitoring programmes are needed. Transboundary aquifer under consideration, but not approved. |

### BREGANA AQUIFER (NO. 100)[96]

| | Slovenia | Croatia |
|---|---|---|
| Type 2; Quaternary carbonate gravel and sands; pressure condition: unconfined; dominant groundwater flow from Slovenia to Croatia. | | |
| Area (km²) | 16 | N/A |
| Groundwater uses and functions | Local drinking water supply | N/A |
| Pressure factors | N/A | N/A |
| Groundwater management measures | N/A | N/A |
| Other information | Population ~2 000 (125 inhabitants/km²) | N/A |

### BIZELJSKO/SUTLA AQUIFER (NO. 101)

| | Slovenia | Croatia |
|---|---|---|
| Represents none of the illustrated transboundary aquifer types; Triassic dolomites; weak links to surface water systems; groundwater flow from Slovenia to Croatia; groundwater covers 100% of water used in the Croatian part. | | |
| Area (km²) | 180 | 12 |
| Groundwater uses and functions | Drinking water. | Local drinking water supply. |
| Pressure factors | No problems related groundwater quantity or quality reported. | None reported. Local lowering of groundwater levels detected. |
| Groundwater management measures | None | Existing protection zones. |
| Other information | Good chemical status. It is unclear which groundwater systems in the two countries correspond to each other; delineation of transboundary groundwater systems needs common research and bilateral expert group decision to propose a transboundary groundwater, if appropriate.<br>Area uncertain – possibly only part of the Bizeljsko groundwater system is relevant. | Transboundary impact: Indications that water supply abstraction for Podčetrtek impacts on groundwater levels; Need for coordination between areas on both sides - agreed delineation of transboundary groundwaters, and development of monitoring programmes.<br>Transboundary aquifer under consideration, but not approved. |

[95] Based on information from Slovenia.
[96] Based on information from Slovenia. The Bregana groundwater body forms part of the Bregana-Obrezje/Sava-Samobor aquifer.
[97] Based on information from the First Assessment. Part of carbonate and sandy aquifers of the Sotla/Sutla River shared by Slovenia and Croatia; the Sotla/Sutla River is a tributary to the Sava.
[98] Based on information from Slovenia.

The Bizeljsko/Sutla transboundary aquifer (No. 101) is further divided in five transboundary aquifers:[98]

1. Boő(No. 102);
2. Rogaška (No. 103);
3. Atomske toplice (No. 104);
4. Bohor (No. 105);
5. Orlica (No. 106).

### BOČ AQUIFER (NO. 102)[99]

| | Slovenia | Croatia |
|---|---|---|
| Type 4; Kenozoic carbonates – limestones and dolomites; pressure condition unconfined. | | |
| Area (km²) | 48 | N/A |
| Groundwater uses and functions | Local drinking water supply. | N/A |
| Other information | Population ~2 100 (45 inhabitants/km²); This transboundary aquifer has not been yet characterized in detail in accordance with the WFD. | N/A |

### ROGAŠKA AQUIFER (NO. 103)[100]

| | Slovenia | Croatia |
|---|---|---|
| Area (km²) | 178 | N/A |
| Groundwater uses and functions | Local drinking water supply. | N/A |
| Other information | Population ~21 400 (120 inhabitants/km²). No related groundwater bodies have been defined according to the WFD. | N/A |

### ATOMSKE TOPLICE AQUIFER (NO. 104)[101]

| | Slovenia | Croatia |
|---|---|---|
| Type 4; Mesozoic carbonate rocks. Fissured aquifers, including karst aquifers; pressure condition: partly confined, partly unconfined; possibly recharged in the areas where carbonate rocks outcrop (Rudnica, Kuna gora) and discharged at the foothills where impermeable rocks intersect the flow; low drainage to surface water systems; dominant groundwater flow from Croatia to Slovenia (Kuna Gora) and from Slovenia to Croatia (Rudnica). | | |
| Area (km²) | 51 | N/A |
| Groundwater uses and functions | Local drinking water supply and thermal water abstractions. | N/A |
| Other information | Population 2 400 (47 inhabitants/km²). | N/A |

### BOHOR AQUIFER (NO. 105)[102]

| | Slovenia | Croatia |
|---|---|---|
| Type 4; Mesozoic, dominantly Triassic, and Tertiary carbonate rocks; dominant groundwater flow from Slovenia to Croatia; pressure condition: partly confined, partly unconfined; weak links to surface water systems. Recharge takes place in the Kozjansko region in Slovenia, where carbonate rocks outcrop; aquifer discharges in river valleys in Slovenia and Croatia, where warm thermal water outflows from fissures in the anticline fold apex. | | |
| Area (km²) | 153 | N/A |
| Thickness: mean, max (m) | > 500, > 1 000 | > 500, > 1 000 |
| Groundwater uses and functions | Local drinking water supply. | N/A |
| Other information | Population 6 800 (44 inhabitants/km²); the identification of the common transboundary water body should be carried out by the two countries. Possibilities for development and management of regional water source are to be discussed. | N/A |

### ORLICA AQUIFER (NO. 106)[103]

| | Slovenia | Croatia |
|---|---|---|
| Type 4; Mesozoic, dominantly Triassic, and Tertiary carbonate rocks; dominant groundwater flow from Slovenia to Croatia; pressure condition: partly confined, partly unconfined; weak links to surface water systems. Recharge takes place in the Orlica massif in Slovenia, where carbonate rocks outcrops; aquifer discharges in river valleys in Slovenia and Croatia, where warm thermal water outflows from fissures in the anticline fold apex. | | |
| Area (km²) | 180 | N/A |
| Thickness: mean, max (m) | > 500, > 1 000 | > 500, > 1 000 |
| Groundwater uses and functions | Local drinking water supply. | N/A |
| Trends and future prospects | Population ~17 600 (98 inhabitants/km²); the identification of the common transboundary water body should be carried out by the two countries. Possibilities for development and management of regional water source are to be discussed. | N/A |

[99] Based on information from Slovenia. Part of carbonate and sandy aquifers of the Sotla/Sutla River shared by Slovenia and Croatia; the Sotla/Sutla River is a tributary to the Sava.

[100] Based on information from Slovenia. Part of carbonate and sandy aquifers of the Sotla/Sutla River shared by Slovenia and Croatia; the Sotla/Sutla River is a tributary to the Sava.

[101] Based on information from Slovenia. Part of carbonate and sandy aquifers of the Sotla/Sutla River shared by Slovenia and Croatia; the Sotla/Sutla River is a tributary to the Sava.

[102] Based on information from Slovenia. Part of carbonate and sandy aquifers of the Sotla/Sutla River shared by Slovenia and Croatia; the Sotla/Sutla River is a tributary to the Sava.

[103] Based on information from Slovenia. Part of carbonate and sandy aquifers of the Sotla/Sutla River shared by Slovenia and Croatia; the Sotla/Sutla River is a tributary to the Sava.

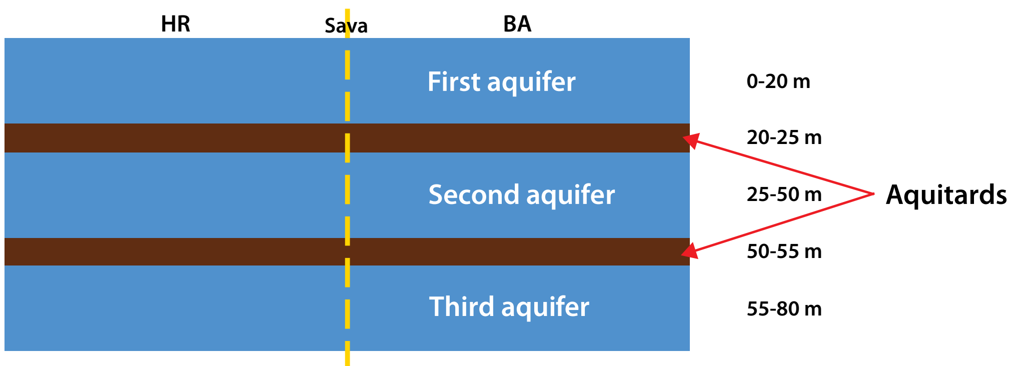
### SREM-WEST SREM/SAVA AQUIFER (NO. 107)[104]

| | Serbia | Croatia |
|---|---|---|
| Type 3; Sequence of Pliocene (Pontian, Paludine) and Eopleistocene sands, gravely sands and gravels of the Danube valley; upper, shallow unconfined part has medium to strong links to surface water system; deeper parts confined or semi-confined by silts and clays; groundwater flow from Serbia to Croatia and also parallel to the river in a south and south-west direction within each country. | | |
| Area (km$^2$) | 627 | N/A |
| Thickness: mean, max (m) | | 80-150, 250-400 |
| Groundwater uses and functions | 50-75% drinking water, <25% each for irrigation, industry and livestock; groundwater provides about 70% of total supply | Supports agriculture. |
| Pressure factors | Groundwater abstraction, agriculture, industry. Local and severe increased pumping lifts and reduction of borehole yields. Local, moderate nitrate and pesticides from irrigated agriculture, heavy metals, organics and hydrocarbons from industry, naturally occurring iron and manganese. | N/A; naturally occurring iron the only quality problem reported. |
| Groundwater management measures | No transboundary impact in terms of quantity or quality; Existing quantity and quality monitoring need to be improved, as do abstraction control, protection zones and wastewater treatment, other management measures not yet used but needed. | N/A |
| Other information | Possible qualitative risk, no quantitative risk. | A transboundary aquifer probably exists, but no detailed research has been conducted hence, there is no data available. |

### POSAVINA I/SAVA AQUIFER (NO. 108)[105]

| | Bosnia and Herzegovina | Croatia |
|---|---|---|
| Type 3 (HR)/Represents none of the illustrated transboundary aquifer types (BA); Quaternary alluvial sands, gravels, clays and marls; groundwater flow generally from south to north from Bosnia and Herzegovina to Croatia weak to medium links to surface water systems. | | |
| Area (km$^2$) | Not defined | 396 |
| Altitude fluctuation (m) | N/A | N/A |
| Thickness: mean, max (m) | 100 | 5 - 10 |
| Groundwater uses and functions | Predominantly drinking water, smaller amounts (<25% each) for industry and livestock; groundwater is 100% of total water use | Regional water supply system of eastern Slavonia. |
| Pressure factors | Wastewater, industry and agriculture. No groundwater quantity problems; naturally occurring iron at 1-4 mg/l in the upper aquifer (15 to 60 m). | Agriculture; No groundwater quantity problems; naturally-occurring iron and manganese is a quality issue. |
| Groundwater management measures | Abstraction management, quantity and quality monitoring, protection zones and agricultural measures are used but need improvement, water use efficiency and wastewater treatment are needed or planned. Common delineation of the transboundary aquifer and development of monitoring programmes is needed. | Existing protection zones |
| Other information | Border length 85 km. No transboundary impact; in lower aquifer (depth 90 to 115 m), naturally-occurring iron is <0.7 mg/l; there is no new relevant information since the first assessment about this transboundary aquifer. | Border length 85 km. Transboundary aquifer under consideration, but not approved. |

**FIGURE 13:** Conceptual sketch of the Posavina I/Sava groundwater body (No. 108) provided by Bosnia and Herzegovina; sketch is a result of exchange of unofficial data between Bosnia and Herzegovina and Croatia.




[104] Based on information from Croatia and the First Assessment.
[105] Based on information from Bosnia and Herzegovina, Croatia and the First Assessment.

### KUPA AQUIFER (NO. 109)[106]

| | Bosnia and Herzegovina | Croatia |
|---|---|---|
| Type 2 (HR)/represents none of the illustrated transboundary aquifer types (BA); Triassic and Cretaceous karstic limestones and dolomites; groundwater flow generally from east to west from Bosnia and Herzegovina to Croatia (HR)/from south to north (BA); strong links to surface water systems (associated with the Kupa River in BA and Korana River in HR). | | |
| Area (km²) | N/A | 100 |
| Groundwater uses and functions | No data | Predominantly drinking water; also supports ecosystems; 20% of total water used groundwater. |
| Groundwater management measures | Agreed delineation of possible transboundary groundwater is needed. | Agreed delineation of transboundary groundwaters, and development of monitoring programmes are needed. Need to establish protection zones. |
| Other information | Border length 130 km. Possible transboundary aquifer should be considered. There is no clear indication (based on field research) that this aquifer is transboundary. | Border length 130 km. Transboundary aquifer under consideration, but not approved. |

### PLEŠEVICA/UNA AQUIFER (NO. 110)[107]

| | Bosnia and Herzegovina | Croatia |
|---|---|---|
| Type 2 (BA)/represents none of the illustrated transboundary aquifer types (HR); thick Mesozoic (dominantly Cretaceous), Neogene (dominantly Miocene) and Quaternary limestones and dolomites; flow from Croatia (swallow holes in Krbavsko, Lapačko and Koreničko fields and the area of National Park Plitvice) to Bosnia and Herzegovina (towards the strong karstic springs in the Una River watershed, namely Klokot I and II, Privilica, ostrovica, Žegar etc); thick Palaeozoic, Mesozoic and Cenozoic limestones and dolomites, in hydraulic connection with overlying alluvial sediments; strong links with surface waters; flow from Croatia to Bosnia and Herzegovina. | | |
| Area (km²) | N/A | 1 564 |
| Thickness: mean, max (m) | 1 000, > 1 500 | 200, 500 |
| Groundwater uses and functions | >75% to support ecosystems and fishing, 25-50% of abstraction is used for drinking water supply. | Predominantly drinking water supply; also supports ecosystems; some 25% of total water use is groundwater. |
| Pressure factors | Wastewater from septic pits is the main pressure factor. PCBs from former military airport Željava and relay station in Plješevica mountain might be an issue of concern; more research is needed in this regard. Solid waste disposal is also a pressure factor. Polluted water is locally drawn into the aquifer. Local but severe nitrogen, heavy metals and pathogens. | Communities. No problems related to groundwater quantity. |
| Groundwater management measures | Many used but need improving, others needed or currently planned. | Protection zones exist at Klokot, Privilica, Toplica, Ostrovica and need to be established in Korenički Izvor, Stipinovac and Mlinac. |
| Other information | Transboundary impact for quality only. | Sinkholes in Bosnia and Herzegovina with transboundary effects in Croatia. Transboundary aquifer under consideration, but not approved. |
| | Border length 130 km. Delineation of transboundary groundwaters needs common research and bilateral decision to propose a transboundary groundwater, if appropriate. Development of monitoring programmes is needed. | |

[106] Based on information from Bosnia and Herzegovina, Croatia and the First Assessment.
[107] Based on information from Bosnia and Herzegovina, Croatia and the First Assessment.

### LIM AQUIFER (NO. 111)[108]

| | Montenegro | Serbia |
|---|---|---|
| Type 1; Triassic karstic limestone and dolomite (main aquifer), covered by mostly impermeable diabase-chert formation, limited fissured aquifer in peridotites and in Triassic clastic rocks, Quaternary alluvium; medium connection to surface water. Groundwater flow direction relatively equally shared in both countries; perpendicular to the Lim valley in the karstic aquifer, and parallel to the stream in the alluvium. Karstic-fissured part: Recharge in the mountains and drainage along the foothill or on local impermeable barriers; Porous part: Recharge from precipitation and rivers, drainage into rivers. The covering layer constitutes of a thin soil layer in the mountain-hilly area, and thick and fertile soil in the Lim valley. The depth of groundwater levels are at >100 m in karstic aquifers, and at 2-5 m in the alluvium. Pressure condition: unconfined. Groundwater resources amount to ~ $35 \times 10^6$ $m^3$/year (average for the years 1980 to 2000). | | |
| Area ($km^2$) | N/A | 600 – 800 (of which ~150 karstic aquifers) |
| Thickness: mean, max (m) | 200, 500 | 200, 500 |
| Groundwater uses and functions | <25% of the total abstraction is for agriculture. | Total annual abstraction is some $10 \times 10^6$ $m^3$ (2007), most of it (60%) for domestic use, 12% for agriculture, 12% for industry, 10% for energy and 6 for other. Some 40% of total water use from groundwater. |
| Pressure factors | Waste disposal, agriculture and industry. | Untreated urban wastewater, inappropriate waste disposal, industry (illegal discharges of untreated wastewater may pose a threat to the groundwater quality - this has to be evaluated) and rather intensive mining. Local but severe nitrogen, heavy metals, pathogens, industrial organic and hydrocarbons pollution of surface water and groundwater is possible. |
| Groundwater management measures | Abstraction management, protection zones and vulnerability mapping for land use planning need to be applied, together with monitoring of groundwater quantity and quality. | Abstraction management and protection zones already in use need to be improved; other measures are also needed. Adequate precautionary measures to minimize impacts from small industry and tourism development are needed. Having in mind the special characteristics of karstic aquifers, protection measures are necessary to avoid any possible deterioration of the quality of groundwater nearby and along the border area between Serbia and Montenegro (in the remote and non-populated mountain zone - neither heavily polluted nor the pollution threats are significant). |
| Other information | | Population ~100 000. Current status is most probably good (limited data). Quality of groundwater in alluvium and terrace deposits along Lim River valley and downstream in Prijepolje plain is under risk; water reserves are estimated to be sufficient to sustain medium and long term projected development in the area - nevertheless, possible longer dry episodes as a consequence of climate change may have a negative impact on the recharge of the karstic aquifer, Pollution of Lim River occurring at the upper catchment area has impacts at transboundary level. Great potential for hydropower development; 6 hydropower plants with total capacity of more than 50 MW are planned to be constructed in the Lim valley (an environmental impact assessment will be prepared prior to their construction). Systematic joint monitoring at transboundary level, that will assist to assess the qualitative and quantitative status of the surface and groundwater resources as well as in management planning, should be established along the Lim valley. Common efforts towards environmental protection should be crystallized in a joint strategy. By 2025, groundwater abstraction is expected to increase by ~20%. Some 35% of the aquifer area is covered by forest, another 35% by grassland, 20% by cropland and 10% by urban/industrial areas. |

[108] Based on information from Serbia and the First Assessment.

### TARA MASSIF AQUIFER (NO. 112)[109]

| | Serbia | Bosnia and Herzegovina |
|---|---|---|
| Type 3; Triassic and Jurassic karstified limestones, strong links to surface water systems, groundwater flow from Serbia to Bosnia and Herzegovina (generally perpendicular to Drina River). The recharge area is estimated at 75-80 km$^2$, while the discharge area is well defined and present as major karst springs (Perucac spring, and one submerged spring in artificial reservoir of Bajina Basta reversible hydropower plant). Depth of groundwater levels varies from 100 to over 300 m. Pressure condition: Unconfined. According to Serbia groundwater resources of Tara Massif amount to 4.47 × 10$^6$ m$^3$/year. Groundwater covers 10% of the water being used in the Serbian part. | | |
| Area (km$^2$) | 211 | >100 |
| Thickness: mean, max (m) | 250 – 300, 600 | 250 – 300, 600 |
| Groundwater uses and functions | 80% of groundwater for drinking purposes, 10% for irrigated agriculture; also supports fish breeding and ecosystems. Total water withdrawals were 6 × 10$^6$ m$^3$/year in 2008 (not taking into account water used for hydropower generation; the figure corresponding to total water withdrawals is 1.15 × 10$^9$ m$^3$/year). | Drinking water, mostly small amounts for supplying villages. |
| Pressure factors | Hydropower (Bajina Basta reversible hydropower plant system - including two reservoirs located at the top of the Tara plateau); intensive tourism activities at zones that are highly vulnerable to pollution; lack of sewage collection and treatment facilities (apart from a small wastewater facility treating wastewater in a touristic area); partially uncontrolled dumpsites. Moderate to strong environmental impacts (related to the Bajina Basta reversible hydropower plant system). Issues related to intensive tourism activities at zones that are highly vulnerable to pollution; continuous bacterial pollution due to leakage of septic tanks; potential pollution from uncontrolled dumpsites; accidental pollution (road). | Wastewater, mining activity. Local moderate drawing of polluted water into the aquifer. Bacteriological contamination is a quality problem. |
| Groundwater management measures | Groundwater abstraction management and quantity monitoring in use needs improvement. Assessment of the vulnerability of karst groundwater is necessary as a basic tool for groundwater protection and development planning in an area that is almost entirely (91%) a National Park; establishment of an integrated monitoring system is essential in this regard. | Protection zones needed for some significant but as yet unused karst springs. |
| Other information | Estimated reserves of groundwater can sustain drinking water supply and further economic development, particularly with regard to fish breeding, tourism and some minor hydropower generation. Population density ranges from 1 to 5 inhabitants/km$^2$. No transboundary impact reported. Controlled quarrying in the area has relatively negative impacts. Some 80% of the land use is forest, 15% grassland, cropland and urban area each <5%. Population density 1-5 inhabitants/km$^2$. | No transboundary impact. |
| | Negligible conditions for nomination as a transboundary groundwater. | |

### MACVA-SEMBERIJA AQUIFER (NO. 113)[110]

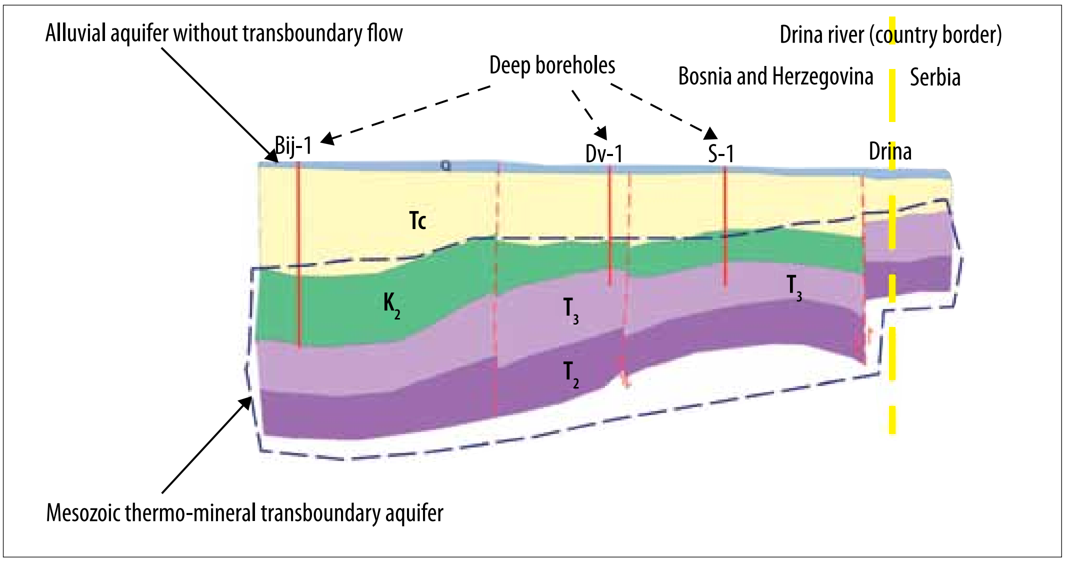
| | Serbia | Bosnia and Herzegovina |
|---|---|---|
| Alluvial aquifer - Type 3; Quaternary alluvial gravels, sandy gravels, sands, with clayey lenses; there is no transboundary flow. Drina River is a hydraulic boundary (and country border) dividing the body into two separate aquifers. In Semberija (Bosnia and Herzegovina), groundwater flow is from south to north (towards the Sava River). The Semberija alluvium aquifer is mainly recharged by the Drina River. Thermo-mineral aquifer: Type 4, Mesozoic limestones; strong links to surface water systems. Groundwater is 40-60% of total water use in the Serbian part, and 100% in the part in Bosnia and Herzegovina. | | |
| Area (km$^2$) | 967 | 250 |
| Thickness: mean, max (m) | Alluvial aquifer: 35–60, 75–100; thermo-mineral/Mesozoic limestone aquifer: >1 000 m | |
| Groundwater uses and functions | 50-75% drinking water, <25% for irrigation, industry and livestock, and support of ecosystems. | Drinking water, irrigation, industry and livestock. |
| Pressure factors | Agriculture and wastewater, some industry. Local and moderate increase in pumping lifts, no declines in groundwater levels. Local and moderate nitrogen and pesticides from agriculture, local and moderate heavy metals and organics from industry, natural Fe and Mn in alluvium. | Agriculture and wastewater; local and moderate increase in pumping lifts, no significant declines in groundwater levels. Local and moderate nitrogen and pesticides from agriculture. |
| Groundwater management measures | Abstraction control, monitoring of groundwater, protection zones and wastewater treatment need improvement, other management measures need to be introduced or are currently planned. | Groundwater abstraction regulation and quantity monitoring, protection zones, and good agricultural practices used and effective, water use efficiency, public awareness, wastewater treatment need to be applied. |

[109] Based on information from Serbia and the First Assessment.
[110] Based on information from Bosnia and Herzegovina and the First Assessment.

**MACVA-SEMBERIJA AQUIFER (NO. 113)** -continued-

| | Serbia | Bosnia and Herzegovina |
|---|---|---|
| Other information | No transboundary impact. Possibly at chemical risk, not at quantitative risk. | No transboundary impact. Research regarding the exploitation of the thermo-mineral aquifer has been conducted for the last two years. There are significant possibilities for the groundwater to be used for energy production and agriculture; more intensive cooperation between Bosnia and Herzegovina and Serbia regarding the equitable and sustainable utilisation of this aquifer is needed. Agreed delineation of transboundary groundwater, and development of monitoring programmes are needed. |

**FIGURE 14:** Conceptual sketch of the Macva-Semberija aquifer (No. 113) (provided by Bosnia and Herzegovina)




## Pressures[111]

Hydropower generation, agriculture and industry are the main economic sectors, sharing the major part of the available water resources in the sub-basin. The construction of water regulation structures and weirs at its tributaries; drainage networks, and flood protection systems, in combination with water abstractions, have caused hydrological and morphological alterations, including disconnection of adjacent wetland/floodplains. Interruption of river and habitat continuity and loss of wetland areas in the lower-middle and lower Sava areas are among the impacts. Erosion is an issue of local character reported by Croatia.

Organic, nutrient and hazardous substances pollution are also important pressure factors. Untreated municipal and industrial wastewater and agricultural run-off are the main pollution sources. Unsustainable disposal of wastes (including these from mining activities) is also of concern. Sediment management, both in terms of quality and quantity, is an additional issue. Invasive species is a potential threat to biological diversity.

## Status and transboundary impacts

The risk assessment[112] carried out by the ISRBC for the Sava and its tributaries for impacts, except from hazardous substances pollution, from organic, nutrient and other pollution as well as by hydromorphological alterations, has shown that the risk is rather high for the Sava — 83% of the water body is at risk, while 10% is possibly at risk. With regard to its tributaries, 33% are at risk.

Major reservoirs in the Sava sub-basin (capacity over 50 Mm$^3$)

| Category (capacity range Mm$^3$) | Country | Location: River Basin | Location: River | Location: Name | Reservoir: Volume (Mm$^3$) | Reservoir: Purpose[a] | Dam height (m) |
|---|---|---|---|---|---|---|---|
| 50-100 | BA | Vrbas | Vrbas | Bočac | 52.7 | EP | 52 |
| | BA | Sava | | Modrac | 88 | IW, DW, FP, EP | 28 |
| | RS | Drina | Drina | Zvornik | 89 | EP | 42 |
| 100-200 | BA | Drina | Drina | Višegrad | 161 | EP | 48.16 |
| | RS | Drina | Beli Rzav | Lazici | 170 | EP | 131 |
| 200-500 | RS | Kolubara | Jablanica | Rovni | 270 | DW, IR | 12 |
| | RS | Drina | Uvac | Kokin Brod | 273 | EP | 82 |
| | RS | Drina | Drina | Bajina Basta | 340 | EP | 90 |
| > 500 | ME | Drina | Piva | Mratinje | 880 | EP, FP | 220 |

[a] Legend for the purpose: IR – irrigation, DR – drainage, DW - drinking water supply, IW - industrial water supply, R – recreation, EP - electricity production, FP - flood production.

[111] Information about the status, pressures and impacts for the shared aquifers is given in the tables above.
[112] The risk assessment took into consideration data available from Croatia, Serbia and Slovenia.

## Responses

Addressing the identified issues will need time and the investment of considerable resources at national level. A step to address the issue of hazardous substance pollution will be taken by establishing a cadastre of industrial emissions of dangerous and harmful substances. Action at national level and adoption of appropriate management approaches and instruments is necessary for addressing the aforementioned issues. The necessary cooperation to deal in an integrated way with the range of managerial challenges in the sub-basin is conducted through the International Sava River Basin Commission (ISRBC) established under the Framework Agreement on the Sava River Basin (FASRB).

The FASRB was signed by Bosnia and Herzegovina, the Federal Republic of Yugoslavia,[113] the Republic of Croatia and the Republic of Slovenia in 2002, and entered into force in 2004. The FASRB integrated all aspects of water resources management, and became the framework of cooperation among the Parties to the agreement. The four Parties to the FASRB financially support, on an equal basis, the operation and the work under the ISRBC and its Secretariat. Costs of activities that fall under the interest of a certain country(ies) may be financed by them. Additional resources for specific activities under the work-programme have been raised by the ISRBC Secretariat from the European Commission and the international donor community.

Having the Secretariat as its administrative and executive body, the ISRBC has worked for the achievement of the goals of the Agreement. In this regard, a set of activities for the rehabilitation of the Sava River waterway and the development of navigation, a priority issue, have been implemented, and relevant work is on-going. While navigation is important for the economic development in the basin, the interventions in the watercourse for rehabilitation of navigation and the construction of related hydro-engineering structures may become additional pressure factors. ISRBC is cooperating with joint management bodies of international watercourses elsewhere in Europe, with the aim of using available experience and developing appropriate action for the minimization of impacts.

The process for the preparation of a River Basin Management Plan (RBMP - in accordance with the WFD) is on-going and is expected to be finalized by the end of 2011. The Sava River Basin Analysis Report was developed as a first step towards this direction. The Analysis deals with all main surface and undergroundwater bodies; it looks at the hydrological and morphological characteristics, assesses the quantitative and qualitative status of waters, and also deals with monitoring and economic issues. A programme of measures is under finalization, and the RBMP has been drafted. The Analysis provides the basic information background also for the preparation of the Sava River Basin Flood Risk Management Plan (in accordance with the EU Floods Directive).

A number of integrated information systems, the Geographical Information System, the River Information Services (for the improvement of navigation safety), and the Flood Forecasting and Early Warning System are planned to be prepared by 2012 (according to the Strategy of implementation of the FASRB). The Accident Emergency Warning System is in place; enhancement of countries' capacity is needed before the latter becomes fully operational.

With regard to monitoring, there are 90 quality- and 148 quantity-monitoring stations in total operated by the Parties to the FASRB. Bilateral agreements regarding exchange of information/data exist

between some countries. Agreement of all countries on the provision of the most relevant data is the eventual goal. There are also twelve TransNational Monitoring Network stations (in the framework of ICPDR) operating in the Sava River Basin.[114] Individual countries are responsible for different stations. In addition to monitoring, the riparian countries are planning and implementing water resources management measures at national level, in line with the national legal framework and strategic planning documents, and with varied success.

A project linked to climate change adaptation (being executed by the World Bank) will, among others, provide input for planning appropriate adaptation measures to be incorporated in the programme of measures; the aim is to address issues linked to the impacts of climate change in the basin.

Cooperation among the Parties to the FARSB through the ISRBC represents the most advanced effort of its kind in the South-Eastern Europe, showing the way to the riparian countries of other shared basins. The participation of Montenegro in this will be an additional step towards the integrated management of the sub-basin. Montenegro has already been approached in this regard by the ISRBC.

# VELIKA MORAVA SUB-BASIN[115]

Sub-basin of the Velika Morava River

| Country | Area in the country (km²) | Country's share (%) |
|---|---|---|
| Bulgaria | 1 237 | 3.3 |
| Serbia and Montenegro[a] | 36 163 | 96.6 |
| The former Yugoslav Republic of Macedonia | 44 | 0.1 |
| **Total** | **37 444** | |

[a] At the date of publication of the above report, Serbia and Montenegro still formed part of the same State.
*Source:* The Danube River Basin District. Part B: report 2004, Serbia and Montenegro. International Commission for the Protection of the Danube River, Vienna.

The 430-km long Velika Morava River is a tributary of the Danube which is formed by the confluence of two tributaries, the Juzna Morava and the Zapadna Morava. The most significant transboundary tributary of the Juzna Morava is the 218-km long Nisava River.

The mouth of the Velika Morava is critically polluted.

[113] The Republic of Serbia is the successor country after the dissolution of the State Union of Serbia and Montenegro that succeeded the Federal Republic of Yugoslavia.
[114] There are nine TransNational Monitoring Network Stations on the Sava, and three on Sava main tributaries.
[115] Based on information from the First Assessment and from the publication: The Danube River Basin District. Part B: report 2004, Serbia and Montenegro. International Commission for the Protection of the Danube River, Vienna.

# NISAVA SUB-BASIN[116]

Sub-basin of the Nisava River

| Country | Area in the country ($km^2$) | Country's share (%) |
|---|---|---|
| Bulgaria | 1 151 | 27.7 |
| Serbia | 3 010 | 72.3 |
| **Total** | **4 161** | |

The sub-basin of the Nisava River is shared by Bulgaria and Serbia. It has its source at the Stara Planina Mountain in Bulgaria and flows into the Juzna Morava River near the city of Nis in Serbia. The Nisava sub-basin is part of the Velika Morava River system.

Major transboundary tributaries include the Visočica,[117] Gaberska[118] and Jerma/Erma[119] Rivers.

The sub-basin is characterized by a diverse relief. The elevation ranges from 173 m a.s.l. to 2,169 m a.s.l., the average being 700-800 m a.s.l. In terms of geology, the sub-basin is dominated by karstic formations of the Karpato–Balcanides region.

## Hydrology

There is a high risk of floods and droughts in the Serbian part, due to the sub-basin's geomorphologic and hydrological characteristics.

Serbia reports that the flow of the river has decreased by ~0.42 $m^3/s$ (average value) since the diversion of the Nisava River, in Bulgaria, towards the Brzija River in 1953.

## Pressures

The Serbian part is dominated by forestland.

Hydromorphological changes in the Nisava River in Serbia include bank reinforcement, and hydrotechnical structures for flood protection in the areas of major settlements (Nis, Pirot, Dimitrovgrad), but this pressure was reported as of minor importance. The Pirot hydropower plant (capacity 80 MW) and the Zavoj Reservoir (capacity $180 \times 10^6$ $m^3$) were brought into use in 1990 on the Visočica River.

The major pressure in the Serbian part stems from the lack of wastewater treatment plants. The most significant sources of pollution are the cities of Nis (emission level higher than 150,000 p.e.) and Pirot (emission level higher than 100,000 p.e.). Management of solid waste is an issue of concern. Pressures in Bulgaria derive from coal mining effluent discharge into surface waters. Such effluents have high concentration of suspended solids and of iron.

## Responses

A bilateral cooperation agreement was signed between Yugoslavia and Bulgaria in 1958. A new bilateral agreement on the management of transboundary waters shared by Serbia and Bulgaria appears to be needed (see also the assessment of the Timok River basin).

### STARA PLANINA/SALASHA MONTANA AQUIFER (NO. 114)[120]

| | Serbia | Bulgaria |
|---|---|---|
| Type 2; Triassic and Cretaceous karstic limestones with some overlying Quaternary alluvium; medium links to surface water systems; groundwater flow from north east to south west, from Bulgaria to Serbia. | | |
| Area ($km^2$) | | 3 375 (Karst waters in the Western Balkans, BG1G0000TJK044); 53.3 (Salasha-Monatan karst aquifer system). |
| Thickness: mean, max (m) | 100 - 200, 400 | 100 – 200, 400 |
| Other information | Population 11 000 (18 inhabitants/$km^2$) | |

The information regarding Serbia included here concerns the part of the aquifer system that is hydraulically linked with the surface waters of both the Nisava sub-basin (in the south; shared by Bulgaria and Serbia) and the Timok sub-basin (in the north); this is further divided into four groundwater bodies (the characteristics and uses are given in the table below).

Characteristics and uses of groundwater bodies in the part of Stara Planina/Salasha Montana (No. 114) in the territory of Serbia

| Groundwater body/National identification code | Karst waters in Nisava Basin/ RS_NI_GW_K1 | Karst waters in Nisava Basin/ RS_NI_GW_K2 | Fissured waters in Nisava Basin/RS_NI_GW_P1 | Fissured waters in Nisava Basin/RS_NI_GW_P4 |
|---|---|---|---|---|
| Area ($km^2$) | 285 | 337 | 110 | 456 |
| Type | Karst | Karst | Fissured | Fissured |
| Predominant lithology/ lithologies | Limestones, dolomitic and sandy limestones | Karstic limestones dolomitic limestones | Conglomerates, quartz sandstones | Magmatic – metamorphic complex |
| Stratigraphy and age | Jurassic and Cretaceous karstic limestones | Triassic and Jurassic karstic limestones | Cambrian, Permian and lower Triassic deposits | Mesozoic and Paleozoic |
| Thickness | average:150 m; max: 400 m | 100 m - 500 m | 100 m – 500 m | 600 m -900 m |

Bulgaria reported that there are four groundwater bodies in the area, which are not hydraulically connected and hence do not form

[116] Based on information from Bulgaria and Serbia. Bulgaria and Serbia reported that parts of the Stara Planina/Salasha Montana aquifer are hydraulically linked to the surface water system of the Nisava and Timok Rivers Basins – see respective part of the assessment for additional information.
[117] The sub-basin covers 441 $km^2$, 25 % of which is in Bulgaria.
[118] The sub-basin covers 258 $km^2$, 77% of which is in Bulgaria.
[119] Called Jerma in Serbia and Erma in Bulgaria. The sub-basin covers 800 $km^2$, 55% of which is in Bulgaria.
[120] Based on information provided by Bulgaria and Serbia. Bulgaria reports that:
- "Karst waters in West Balkan Karst Basin" are hydraulically linked with the surface water systems of Timok River Basin (shared by Bulgaria and Serbia); there is no available information with regard to the hydraulic connection of this body with the Nisava River basin.
- "Karst waters in Godech massif" are hydraulically linked with the surface water systems of Nisava River Basin.
- "Fissured waters in Volcanogenic- sedimentary formation" are hydraulically linked with the surface water systems of Timok River Basin; there is no information available with regard to the hydraulic connection of this body with the Nisava River basin.

The three above-mentioned groundwater bodies are part of the Stara Planina/Salasha Montana aquifer system. The Vidlic/Nishava, which in the first Assessment was reported as a part of the Stara Planina/Salasha Montana aquifer system, is actually a separate transboundary aquifer, in the Nisava River Basin.

one aquifer system (identified in accordance with the WFD); their characteristics and uses are given in the table below.

Characteristics and uses of groundwater bodies in the part of Stara Planina/Salasha Montana (No. 114) in the territory of Bulgaria.

| Groundwater body/ National identification code | Karst waters in West Balkan Karst Basin/BG1G0000TJK044 | Karst waters in Godech massif/BG1G00000TJ046 | Fissured waters in Volcanogenic- sedimentary formation/BG1G00000K2038 | Porous groundwater in alluvial quaternary of Bregovo – Novo selo low land/BG1G0000Qal001 |
|---|---|---|---|---|
| Area (km$^2$) | 53 | 1 836 | 2 109 | 137 |
| Type | Karst | Karst | Fissured | Fissured |
| Predominant lithology/lithologies | Limestones, marl limestones, clayey limestones and marble | Karstic limestones and dolomites | Magmatic and volcanogenic rocks, sediments | Sands, clayey sands, pebbles |
| Stratigraphy and age | Triassic and Jurassic karstic limestones | Triassic and Jurassic karstic limestones | Triassic and Jurassic karstic limestones | Quaternary |
| Thickness | average:150 m; max: 300 m | max: 600 m | max: 200 m | average: 13 m |
| Pressure condition | Unconfined | Unconfined | Unconfined | Unconfined |
| Water flow (×10$^3$ m$^3$/year) | 298 646 | 92 400 | 13 245 | 17 345 |
| Total withdrawal (×10$^3$ m$^3$/year) | 3.7 | 7 511 | 2 729 | 2 460 |
| Uses and functions | 80-90% of groundwater is used for drinking purposes and industry | | 29 % of groundwater is used for drinking purposes. | |
| Other information | In good condition; no additional management measures are needed. | | | |

In Serbia, the area is sparsely populated. More than half is covered by forests; crop production is the second most important land use.

Land cover/use in Stara Planina/Salasha Montana aquifer (% of the part of the aquifer extending in each country).

| Country | Water bodies (%) | Forest (%) | Cropland (%) | Grassland (%) | Urban/ industrial areas (%) | Surfaces with little or no vegetation (%) | Wetlands/ Peatlands (%) | Other forms of land use[a] (%) |
|---|---|---|---|---|---|---|---|---|
| Bulgaria | 0.01 | 63.01 | 11.1 | 8.2 | 2.5 | N/A | N/A | 15 |
| Serbia | 0.84 | 52.92 | 22.83 | 22.41 | 0.37 | - | - | 0.63 |

[a] For Bulgaria — sparsely vegetated areas, for Serbia — bare rocks.

Groundwater covers 50% of the water being used in the Serbian part. While 25-50% of groundwater is used for drinking purposes, less than 25% is used for irrigation, industry, thermal spa and livestock. Groundwater also supports ecosystems.

Water abstraction is not a significant pressure factor in Serbia. Wastewater is collected and treated in the largest settlement (Dimitrovgrad), while in rural areas septic tanks are mainly used. Communal waste disposal and agriculture activities may locally put groundwater quality at a risk. The moderate nitrogen and pathogen pollution observed may have an effect on groundwater quality.

The construction of a regional waste disposal site in the town of Pirot (begun in 2008), which would also serve the town of Dimitrovgrad, should be followed by an end to operations, followed by a clean up of local dump sites in order to minimize risks for groundwater quality. There is a need for establishing systematic quantity and quality monitoring.

In Serbia, pathogens are an issue for groundwater quality, local but severe in nature, originating from farming. No transboundary impacts have been observed in Serbia.

Serbia indicated the need for a number of groundwater management measures, namely the following: transboundary institutions, groundwater abstraction management by regulation, monitoring of both groundwater quantity and quality, exchange of data, establishment of protection zones for public water supplies, good agricultural practices, as well as treatment of urban wastewater and industrial effluents. Furthermore, groundwater needs to be integrated into river basin management.

# TIMOK SUB-BASIN[121]

Sub-basin of the Timok River

| Country | Area in the country ($km^2$) | Country's share (%) |
|---|---|---|
| Serbia | 4,607 | 97.2 |
| Bulgaria | 132.5 | 2.8 |

The sub-basin is shared by Bulgaria and Serbia. The 180-km long river starts at the confluence of the Beli Timok and the Crni Timok (in Serbia) near the city of Zajecar. For a distance of 17.5 km before it empties into the Danube, the Timok forms the border between the two countries. The sub-basin is characterized by a diverse relief including mountains, valleys, depressions and narrow passages. The highest altitude is 2,070 m a.s.l.; the average elevation is 472 m.

The mean value for discharge at the mouth was 31 $m^3/s$ for the period 1950 -1980.

## Pressures and transboundary impacts

Copper and gold mining activities in Serbia, especially in the Bor area, are the major pressure factor and it is of transboundary importance. Unsustainable operations, storage practices, effluent discharged into surface waters and waste management have resulted in severe pollution of the surface water and groundwater.

Heavy metals (Cu, As, Zn, Fe and Ni) were detected on the generated effluents in the Bor area in 2005, in concentrations above limits set in Serbia; the pH was found to be highly acidic.

The Crni Timok ("Black Timok") River, with its tributaries, drain the highly polluted area of Bor. Contamination of the Borska River is clearly visible between Bor and Slatina. Accidents that took place in the past at the Bor tailings pond have deposited tailings at the riverbanks. An accidental pollution incident resulted in severe contamination of over 40 $km^2$ of the most fertile agricultural land along the banks of Borska and Timok Rivers in Serbia and in Bulgaria (4.5 $km^2$) by heavy metals and other toxic substances. Old plans for the re-cultivation of the contaminated soils have not yet been realized due to financial constraints.

The water of Borska River is still acidic, and contains elevated levels of suspended solids and copper concentrations as far as 10 km from the metallurgical complex. The Kriveljska stream south of the Veliki Krivelj mine and tailings ponds is also acidic, and contains high levels of suspended solids, iron, copper and zinc. Pollutants have been accumulated in the rivers' sediments.

Untreated urban wastewater is also a major source of pollution in both countries, resulting in impacts on water-related ecosystems.

Human health is at risk due to the bioaccumulation of heavy metals in the fish species that are caught and eaten.

## Responses

Reducing pollution stemming from the mining industry is a priority for Serbia. The privatization process of the mining sector in the area will continue, with the assistance of the World Bank.

Reduction of pollution caused by urban wastewater discharges is also a priority; the construction of sewage networks and wastewater treatment plants is necessary in both countries.

Sustainable use and management of groundwater is another important future task.

Two agreements were signed in 1954 and 1961 concerning issues linked to the position of the riverbed of Timok, and hence the border between the two countries. An agreement was signed between Yugoslavia and Bulgaria under which a Mixed Commission was established. Quality and allocation of transboundary waters were the main issues discussed. The last meeting of the Commission took place in 1982; joint activities have since come to an halt.

A project led by the Regional Environmental Center for Central and Eastern Europe (REC), in cooperation with UNECE, under the ENVSEC initiative, has resulted in (1) the publishing of the Environment and Risk Assessment of the Timok River Basin, prepared by Serbian and Bulgarian experts, and, (2) the establishment of the Timok River Forum, a multistakeholder platform to facilitate transboundary cooperation, in particular at the local level.

There is also an on-going cooperation between the two countries in the framework of the Convention for the Protection of the Danube River.

## Trends

The situation in the Timok River basin calls for joint action; the two riparian countries should initiate a realistic dialogue to define priorities and long-term objectives and actions, taking into account the economic development prospects in the area and the need to reduce, or even eliminate, risks to the environment and human health in the long term.

Managing environmental and technological risks and natural disasters is one of the priorities of an eventually enhanced co-operation, as is reducing pollution from industry and urban wastewater as well as from agriculture (through the introduction of agricultural good practices). Cooperation for the restoration of polluted and degraded lands is needed.

Both countries reported that the on-going discussions about the Timok River should result in the preparation and conclusion of an agreement on the management of transboundary watercourses.

# SIRET SUB-BASIN[122]

The sub-basin of the 559-km long Siret River is shared by Ukraine and Romania. The river has its source in the Eastern Carpathian Mountains (Ukraine), and discharges to the Danube. There are over 30 man-made lakes in the sub-basin. Natural lakes in Romania include the Rosu, Lala, Balatau, Cuejdel, Vintileasca and Carpanoaia Lakes. The sub-basin has a pronounced mountain character in the upper reaches, and downstream flows through lowland. The average elevation is about 515 m a.s.l. Transboundary tributaries include the Mikhidra, Bilka, Small Siret and Kotovets.

The Middle Sarmantian Pontian transboundary aquifer (No. 115), shared by Romania and the Republic of Moldova, is weakly linked to the surface waters of the Siret.[123]

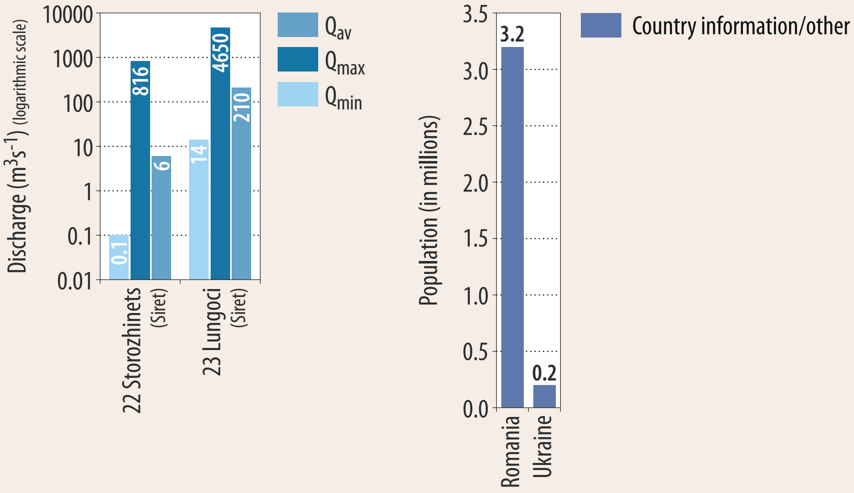
Hydropower is generated at over 25 sites along the river.

[121] Based on information from Bulgaria, Serbia and the "Environmental and Risk Assessment of the Timok River basin" report elaborated by Ventzislav Vassilev, Svetoslav Cheshmedjiev, Momir Paunovićand Vladica Simićin the framework of the ENVSEC Timok project, implemented by REC and UNECE. Bulgaria and Serbia reported that parts of the Stara Planina/Salasha Montana aquifer are hydraulically linked to the surface water system of the Timok and the Nisava Rivers Basins – see respective part of the assessment for additional information.

[122] Based on information provided by the Republic of Moldova, Ukraine and Romania, and the First Assessment.

[123] As Middle Sarmantian Pontian aquifer is also linked to the surface waters of the Prut, it is assessed together with the Prut.

**DISCHARGES AND POPULATION IN THE SIRET SUB-BASIN**




*Note:* For the location of the stations, please refer to the Danube River Basin map.
*Sources:* UNEP/DEWA/GRID-Europe 2011; Ministry of Environment and Natural Resources of Moldova.

Sub-basin of the Siret River

| Country | Area in the country ($km^2$) | Country's share (%) |
|---|---|---|
| Romania | 42 890 | 90.1 |
| Ukraine | 4 720 | 9.9 |

## Hydrology and hydrogeology

In the Romanian part of the sub-basin, based on average values over period from 1995 to 2007, surface water resources amount to 6 × $10^6$ $m^3$/year. Groundwater resources are estimated to be 1.278 × $10^6$ $m^3$/year in the Romanian part. The total, 7.278 × $10^6$ $m^3$/year, equals 2,292 $m^3$/year/capita. In the Ukrainian part, groundwater resources are estimated at 17.63 × $10^6$ $m^3$/year,[124] and are related to Quaternary deposits.

## Pressures

Floods and hydromorphological changes are assessed by Romania to be widespread but moderate as a pressure factor, due to eight surface water bodies being classified as heavily modified due to river embankments. In Ukraine, hydromorphological changes have not been assessed. Pollution during seasonal flooding is, according to Ukraine, severe but moderate in impact. River erosion is ranked by Ukraine as a widespread but moderate pressure factor.

Of severe but local influence in both the Romanian and the Ukrainian part of the sub-basin is the discharge of insufficiently treated wastewater, discharged mostly from the medium-sized and smaller treatment facilities of municipal and industrial sources. Modernization of the treatment facilities is known to be needed. Of local, but possibly severe impact, are uncontrolled landfills, and their polluted leachate waters.

Some pollution occurs in the Romanian part as a result of agricultural activities and animal husbandry, but their impact remains local and moderate. On the same level of impact is sediment that is washed into the river from agricultural lands in Ukraine. Other pressures of local and moderate impact in the Romanian part are mining and related tailings dams (copper, zinc, lead, coal and uranium mining), industries (light industry as well as paper, wood, chemical and food industries) and power generation (Borzesti thermal power station).

## Status and transboundary impacts

Surface waters of the upper part of the sub-basin are assessed by Ukraine as of good status, and the situation is stable.

At the Terebleche and Cherepkivtsy monitoring stations, which are located close to the border with Romania, in 2008 and 2009 water quality fell into quality category II, "clean water", with suspended solids and transparency as the most common defects.

## Responses

To facilitate transboundary cooperation, authorized representatives have been appointed by the countries in order to coordinate the special working groups. A Working Group has been established in the Prut sub-basin on issues related to the Prut and the Siret rivers

Wastewater discharges are mainly addressed in Romania according to the programme of measures, defined in the Siret River Basin Management Plan.

The major part of measures, and the most important ones, are a response to obligations for compliance with the provisions of the Urban Wastewater Treatment Directive and the Treaty of Accession. With the granted transition time, this implies compliance with the Directive in collecting urban wastewater needs, to be achieved in 263 large agglomerations (>10,000 p.e.) by the end of 2013, and in 2346 small agglomerations (<10,000 p.e.) by the

Total water withdrawal and withdrawals by sector in the Siret sub-basin

| Country | Total withdrawal ×$10^6$ $m^3$/year | Agricultural % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|
| Romania | 441.9 | 11.0 | 29.3 | 32.4 | 27.3 | - |
| Ukraine | 5.07 | 63 | 13 | 24 | - | - |

*Note:* Groundwater use in the Ukrainian part of the basin is estimated at 13,900 $m^3$/day (5.07 × $10^6$ $m^3$/year), 76% of which was for domestic use and 24 for industry (Geoinfrom, Ukraine).
*Source:* Main indicators of water use in Ukraine in 2009, State Committee for Water Management

[124] *Source:* Geoinform, Ukraine.

Water quality classification[125] of the Siret River and its tributaries in Romania

| Class/year | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|
| Class 1 | 1 245 km (45%) | 1 332 km (48.2%) | 920 km (31.8%) | 2 186 km (75.17%) | 2 333 km (80.22%) | 2 330 km (80.12%) | 2 269 km (78%) |
| Class 2 | 628 km (22.7%) | 921 km (33.3%) | 1 168 km (40.3%) | 720 km (24.75%) | 567 km (19.5%) | 512 km (17.6%) | 568 km (19.53%) |
| Class 3 | 641 km (23.2%) | 297 km (10.7%) | 555 km (19.2%) | 0 km | 2 km (0.07%) | 64 km (2.2%) | 50 km (1.7%) |
| Class 4 | 111 km (4%) | 15 km (0.5%) | 109 km (3.8%) | 2 km (0.07%) | 6 km (0.2%) | 2 km (0.07%) | 2 km (0.07%) |
| Class 5 | 139 km (5%) | 199 km (7.2%) | 145 km (5.0%) | 0 km | 0 km | 0 km | 0 km |
| **Total length (km) classified** | **2764 km** | **2 764 km** | **2 897 km** | **2 908 km** | **2 908 km** | **2908 km** | **2 889 km** |

*Source:* National Administration "Apele Romane", Romania.

end of 2018. For the same number (and size) of agglomerations, compliance with the Directive in urban wastewater treatment and discharge needs to be reached by the end of 2015 and 2018, respectively.

Efforts for building and rehabilitation of wastewater treatment plants in both riparian countries have been ongoing. In the past few years in Romania, the sewage network was extended and rehabilitated, and the urban wastewater treatment plants were modernized for agglomerations Fălticeni, Rădăuţi, Focşani and Roman, with investment costs around 48 million Euro.

To limit nutrient pollution, good agricultural practices are also required as mandatory measures in vulnerable areas in the Romanian part.

A Flood Master Plan and a related investment plan have been elaborated by Romania for the Siret River, including two main tributaries (Trotus and Buzau). After carrying out feasibility studies and an Environmental Impact Assessment, support will be supplied from the Cohesion Fund for flood risk mitigation projects. Improvements have been made to the hydrological warning and forecasting systems in the Romanian part in the past few years through projects that involved integrating data from existent systems, and modernizing the hydrological information system including through, e.g., data acquisition through automatic stations, and integrating project output for disaster response. The Action Plan for flood protection for the medium-term (2009-2012) in Romania also includes new hydraulic structures in frequently affected zones, a higher safety degree of existing works, and finalizing ongoing ones. The Action Plan foresees 1,850 km of river regulation, 976 km of dikes, 810 km of riverbank consolidation, and identification of new zones as wetlands. In January 2010, a law referring to the obligatory insurance for houses against natural disasters, including flooding, came into force in Romania.

Romania's related transboundary cooperation with Ukraine refers to wide online operative flood defense information exchanges and, in the near future, a common position on flood risk mapping, according to the International Commission for the Protection of the Danube River (ICPDR) requirements. Siret River is included in a Ukrainian governmental programme for developing integrated flood protection, initiated in 2009. In Ukraine, construction and protection works are being carried out on the areas most vulnerable to erosion. The restoration of 2.46 km of retention dams and 1.86 km of river bank protections in these areas was implemented in 2009 in Ukraine under this programme.

Elaboration of the Danube River Basin Management Plan — facilitated by ICPDR as the coordinating platform where common criteria for related analysis were agreed — as the basis to address transboundary water management issues, has served to initiate a process of harmonization in institutional arrangements.

There is ongoing exchange of information and forecasts between the Romanian authorities and the State Committee for Hydrometeorology of Ukraine through the Global Telecommunication System of the World Meteorological Organization and through local telecommunication systems. Volumes, terms, and the order of information and prognoses exchange are regulated by joint agreements.

## Trends

An increase in water demand — mainly for surface water — is expected until 2020 for all uses in the Romanian part.

Water quality is expected to improve by 2021, because of the requirement, according to the WFD, for the water bodies to attain good status by implementing the programme of measures.

Under the State Programme of Ecological Monitoring of the Environment in Ukraine, it is planned to optimize the surface water-monitoring network and establish a Center of Transboundary Waters.

As part of the adaptation of Ukrainian legislation to EU legislation, the principle of managing water resources at basin level is planned to be implemented in compliance with the requirements of the WFD, with corresponding changes to the regulatory framework. Individual elements are already being implemented.

In the Ukrainian part there is a trend of restoring the biodiversity of previously drained and forested areas to natural systems (as protected areas).

Study and prediction of the impacts of climate variability and change in the area is so far limited. Ukraine plans to carry out an assessment of vulnerability in the basin to develop measures to improve resilience to climate change impacts. Techniques for climate change adaptation are felt to be missing at the regional level.

[125] The limit values used in the Romanian classification system of water quality are stipulated in Ministerial Order no. 1146/2002, and the classification of the surface water quality for establishing the ecological status of water bodies is specified in Ministerial Order no. 161/2006. Class 1 is "high," class 2 "good" etc.

# PRUT SUB-BASIN[126]

The Prut sub-basin is shared by the Republic of Moldova, Romania and Ukraine. The 967-km long Prut has its source in the Ukrainian Carpathians, and, further downstream, forms the border between Romania and Ukraine for 31 km, and between Romania and the Republic of Moldova for 711 km, discharging into the Danube. The basin has a pronounced upland character around the source, with lowland in the lower reaches. The average elevation is about 200 m a.s.l. in the Romanian part of the basin, and in the Ukrainian about 450 m a.s.l.

The Lopatnic (57 km), as well as the Draghiste (56 km) and its tributary Racovat (67 km), are transboundary tributaries between Ukraine (upstream) and the Republic of Moldova. Most of the tributaries are regulated by reservoirs. Romania and the Republic of Moldova jointly operate the Hydrotechnical Knot Stanca-Costesti.

Joint water samplings are organized quarterly. Data are exchanged between the riparian countries, and there is intercalibration control of laboratories. Data from the Moldovan part is also provided to the TransNational Monitoring Network (TNMN) for the Danube Basin.

Sub-basin of the Prut River

| Country | Area in the country (km$^2$) | Country's share (%) |
|---|---|---|
| Ukraine | 8 840 | 31.8 |
| Romania | 10 990 | 39.5 |
| Republic of Moldova | 7 990 | 28.7 |
| **Total** | **27 820** | |

*Sources:* Ministry of Environment, the Republic of Moldova, National Administration "Apele Romane", Romania; Directory of Administrative-Territorial Division and Statistical Yearbook, Chernivtsi oblast, Ukraine.

Based on average values up to 2009, surface water resources are estimated to amount to 395 × 10$^6$ m$^3$/year, and groundwater resources to some 40 × 10$^6$ m$^3$/year in the Romanian part of the basin. The total — 435 × 10$^6$ m$^3$/year — equals 198 m$^3$/year/capita. Based on statistical data, groundwater resources in the Ukrainian part of the river Prut sub-basin are estimated at about 190 × 10$^6$ m$^3$/year,[127] and about 99% of them are related to Quaternary formations. About 43 % of the basin territory lacks occurrence of groundwater resources that can be used as drinking water.

## Pressures

The main anthropogenic pressure in the basin is the discharge of insufficiently treated municipal and industrial wastewaters, ranked in influence as widespread but moderate in Romania, and as local but severe in Ukraine and in the Republic of Moldova. In the Ukrainian part, the impact of the mining industry is limited to one mine, from which highly mineralized water is discharged to the river. Many uncontrolled landfills do not meet sanitary requirements, and in some the capacity is exceeded, the leachate possibly causing groundwater pollution. In the Moldovan part of the basin, inadequate management of municipal, animal and industrial wastes has a negative impact on water resources. Potential sources of pollution include non-respect of water protection zones and buffer strips, illegal dumping of household waste and storage of pesticides, as well as inappropriate agricultural practices.

Flooding is perceived as a factor of widespread but moderate influence; the record flood of July 2008 and the flood of 2010 are fresh in memories. Seasonal flooding on the Prut mobilizes pollution.

Assessed as local, but severe in influence, are the discontinuity to hydromorphology caused by the Stanca-Costesti Reservoir and the dikes along the Prut, which extend over more than 350 km.

Total water withdrawal and withdrawals by sector in the Prut sub-basin

| Country | Total withdrawal ×10$^6$ m$^3$/year | Agricultural % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|
| Romania, 2006 | 130.5 | 29 | 40 | 30.6 | | 0.4 |
| Romania, 2007 | 243.4 | 8.2 | 46.7 | 28.7 | | 16.4 |
| Romania, 2009 | 126 | 75.3 | 10.3 | 12.3 | | 2.1 |
| Republic of Moldova, 2009 | 28.2 | 30 | 13 | 5 | | 52 |
| Ukraine[a] | 46.48 | 40 | 52 | 8 | | - |

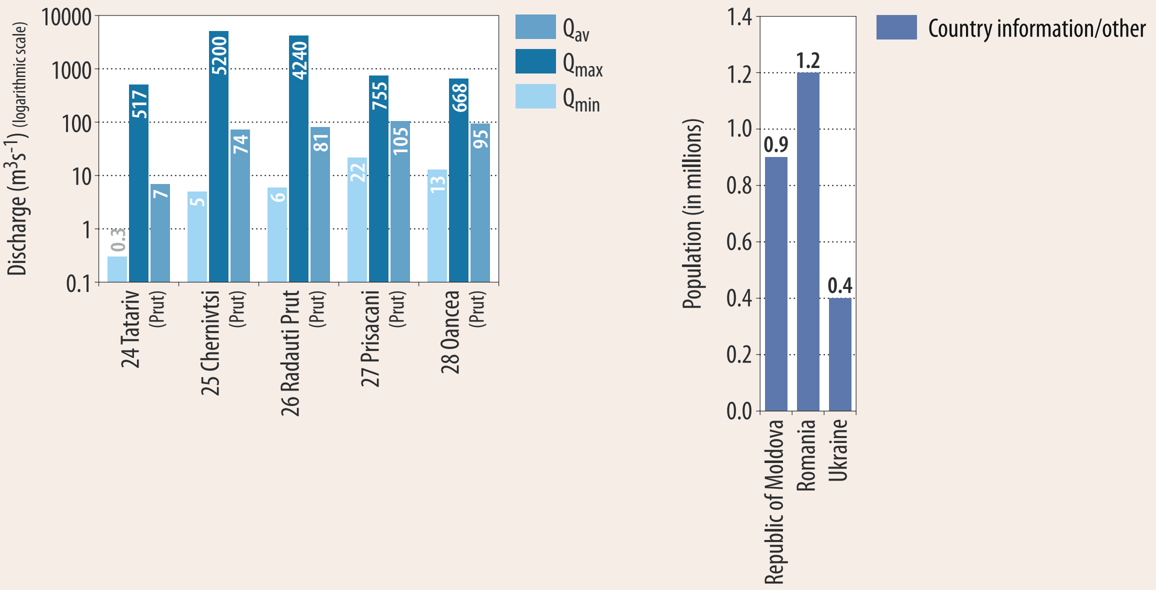
*Notes:* Some 3% of the total water use in the Romanian part of the basin is covered by groundwater; groundwater abstraction in the Ukrainian part is 16.75x10$^6$ m$^3$/year, with 52% for domestic use, 40% for agriculture and 8% for industry (Geoinform, Ukraine).
[a] Source: Key indicators of water use in Ukraine of 2009. Gosvodkhoz.

### MIDDLE SARMANTIAN PONTIAN AQUIFER (NO. 115)[128]

| | Romania | Republic of Moldova |
|---|---|---|
| Type 4; Middle Sarmatian – Pontian sediments from the Central Moldovian Plateau, predominantly sands, sandstones and limestones (porous aquifer); confined conditions provided by overlying clays up to 50 m thick, with weak links with surface water systems; dominant groundwater flow from N – NW to S - SE. The thickness of the unsaturated zones is in the range 40-60 m. Recharge is estimated to amount to 148 × 10$^6$ m$^3$/year (average for the years 1995-2007). | | |
| Area (km$^2$) | 12 532 | 9 662 |
| Groundwater uses and functions | Domestic supply followed by industrial supply, are the main water uses. | N/A |
| Pressure factors | Crop production is main land use; settlements and industries cover more than 8% of the area. | N/A |
| Other information | Border length 140 km. Population density is ~55 inhabitants/km$^2$. Located within the Prut and Siret sub-basins. Natural moderate to severe salinity at local scale in Romania. Good status; no potential threats due to planned activities or economic development in the area. Economic importance is reported to be low. | Border length 140 km. |

[126] Based on information provided by the Republic of Moldova, Romania and Ukraine.
[127] Mainly in Quaternary formations, with minor contributions from the Neogene, Palaeogene and Cretaceous formations (Geoinform, Ukraine).
[128] Based on information from Romania and the First Assessment. Whether the aquifer is also transboundary with Ukraine has not been agreed. Ukraine reports that transboundary groundwaters have not been studied.

**DISCHARGES AND POPULATION IN THE PRUT SUB-BASIN**




*Note:* For the location of the stations, please refer to the Danube River Basin map.
*Sources:* UNEP/DEWA/GRID-Europe 2011; Prut Barlad River Basin Administration, Romania (gauging station Oancea); Ministry of Environment and Natural Resources of the Republic of Moldova (gauging station Sirauty); National Administration "Apele Romane", Romania. (gauging station "Stanca"); Ministry of Environment, the Republic of Moldova, National Administration "Apele Romane", Romania; Directory of Administrative-Territorial Division and Statistical Yearbook, Chernivtsi oblast, Ukraine.

In the Romanian part, agriculture is considered a significant source of pollution, estimated to represent some 65% of the total diffuse emissions. Nevertheless, when considering agriculture also in the Republic of Moldova, where there are large irrigation systems, the co-riparian countries rank the influence of agriculture as local and moderate. A high rate of soil erosion in agricultural lands adds to pollution of surface waters. Because of poor maintenance of drainage infrastructure, waterlogging of agricultural land is a concern.

The influence of other pressure factors, such as groundwater abstraction, surface water withdrawal, and groundwater pollution through surface water, are assessed as local and moderate in influence.

Flow regulation and water abstractions cause low water levels in downstream river sections in the Southern part of the Republic of Moldova, resulting in particular in dry years with interruptions of flow to natural lakes in the floodplain.

## Status

Seasonal deficit in dissolved oxygen, and at times increased $BOD_5$ as well as microbiological pollution are of concern. In the Ukrainian section of the Prut in 2008-2009, BOD, nitrite, and suspended solids were the most common defects.

According to the 2009 data of the Prut Barlad Water Basin Administration, ten reservoirs located in the Prut Basin showed a degree of eutrophication, indicated by total phosphorus, nitrogen, chlorophyll a and phytoplankton biomass.

The middle part of the Prut is somewhat more polluted than the upper sections due to tributaries and settlements, but in general no major changes have been observed in recent years in the Republic of Moldova. Moderate pollution is characteristic of the years 2005-2007, but from 2008 to 2009 the situation appears to have improved.[129] Both in the Republic of Moldova and Ukraine, the quality is generally classified as "clean water" (class II in the national classifications). Compared to 2005, there was a slight improvement of the water quality of the Prut River in the Republic of Moldova. In 2005, four monitoring stations of the seven fell in class III and three stations in class II. In 2008, all seven stations fell in class II. However, this classification is only based on six water quality determinands, using the Moldovan water pollution index.[130]

In Romania, the monitoring system has been established and functions in accordance with the EU WFD. In Romanian territory, on the Prut River, there are 11 monitoring stations. According to the Romanian monitoring results in 2009, the Prut River is of class I (high) on 12% of its length (115 km between Stanca –Costesti Reservoir and confluence with Baseu tributary), and class II (good) on 88%.

## Transboundary cooperation

A new agreement between the Romanian and Moldovan Governments regarding cooperation on the protection and sustainable use of the Prut and the Danube Rivers was signed in June 2010. Among the provisions is a regulation on the maintenance and operation of the Hydrotechnical Knot Stanca-Costesti on the Prut River. A Joint Subcommission for Operation of the Hydrotechnic Knot "Stanca-Costesti" currently acts on the basis of the Regulation from 1985,[131] and the 2010 bilateral agreement on transboundary waters.

A joint working group of the Republic of Moldova and Romania concerning fisheries on the Prut River and in Stanca-Costesti Reservoir acts on the basis of the 2003 agreement of the countries on cooperation concerning fishing.

[129] *Source:* Water Quality Monitoring Yearbooks 2005-2008. State Hydrometeorological Service, Chisinau, Moldova, 2009.
[130] The national 7-point scale classification for quality of surface water in Moldova is based on post-Soviet period guidelines developed by Rostov Hydrochemical Institute in Russia. Pollution is assessed using a relative, dimensionless index of water pollution, which in Moldova is calculated taking into account the six most common pollutants in surface waters, which include $BOD_5$, dissolved oxygen, N-NO2, N-NH4, oil products and phenols. A more elaborate system, using some 80 determinands, is currently in the consultation process within the Government, and is likely to be approved in 2011. It will be used for the 2012-2013 classification of the Prut and Dniester rivers.
[131] *Source:* River basin commissions and other institutions for transboundary water cooperation. UNECE. 2009.

A Memorandum of Understanding was signed in April 2010 between the Ministry of Environment and Forests of Romania, and the Ministry of Environment of Republic of Moldova on cooperation in the field of environmental protection. The national authorities of Romania and the Republic of Moldova signed protocols in the early 2000s related to cooperation in the fields of hydrology and meteorology.

### Responses

The lack of wastewater treatment plants in settlements and the rehabilitation needs of related infrastructure are addressed in the Romanian part according to the Programme of measures. This includes construction of wastewater treatment plants, in accordance with the requirements of UWWTD, as well as on-going rehabilitation and upgrading of wastewater treatment plants.

As erosion is due in particular to deforestation and agricultural practices, the application of codes of agricultural practice[132] related to the implementation of Nitrates Directive is the main means of addressing the issue. Protection zones and bands are established on the riverbanks in Ukraine to limit pollution load.

As part of the implementation of the EU's Flood Directive, a flood master plan for the Prut-Bârlad rivers, together with a related investment plan, has been elaborated in Romania. After carrying out feasibility studies and an Environmental Impact Assessment, a Cohesion Fund Application will be elaborated for each river flood risk mitigation project, involving both structural and non-structural measures. In Ukraine, work is underway to strengthen riverbanks and levees, repair of pumping stations, bridges, and clearing the riverbed. Ukraine has worked out the specifications, and budgeted for a measurement and information system in the Pre-Carpathian area. Flow regulation in Romania also plays a role in flood response.

Consultation and identification of common activities between Romania, the Republic of Moldova and Ukraine concerning the technical works for the Flood Master Plan for the Prut River will be carried out when the technical works are planned. According to the new bilateral agreement between Romania and the Republic of Moldova, the countries need to consult each other to apply the requirements of WFD and the Flood Directive.

### Trends

In the Republic of Moldova, decreasing pollution trends have been observed in the past few years thanks to a decrease in wastewater discharges, implementation of new projects for improving management of household and industrial waste (pesticides), and construction of wastewater treatment facilities. There is further improvement of the regional management system of household waste and wastewater in the southern zone in the Republic of Moldova, which will have a positive impact on water quality. Romania expects a decreasing pollution level for almost all pollutants until 2015, due to the implementation of the programme of measures developed in the River Basin Management Plan. Romania attributes most of the improvement in water quality in the past decade to a reduction of pollution from sources due especially to the reduction of economic activity, but also due to application of the "polluter pays" principle; the implementation of the EU legislation is inferred to have played a role.

An increase of the demand for water for all uses until 2020 is expected in the Romanian part of the sub-basin, with the exception of irrigation, which is predicted to slightly decrease.

In land use, in the Ukrainian part, there is an on-going restoration of the natural systems of protected areas.

## STANCA-COSTESTI RESERVOIR

The Stanca-Costesti Reservoir was built during the 1973 – 1978 period. Placed on the River Prut, at approximately 580 km upstream from its confluence with Danube, with a surface area of 59 km$^2$, usable volume of 450 × 10$^6$ m$^3$ and total volume of 1,400 × 10$^6$ m$^3$, it is the biggest reservoir on the Prut. The reservoir is relatively shallow; the mean depth is 24 m, while its deepest point is at 41.5 m. Ecological flow, i.e. minimum discharge downstream from the reservoir, is 25 m$^3$/s, as stipulated in the agreement between Romania and the Republic of Moldova. The reservoir is jointly operated by Romania and the Republic of Moldova. Hydropower generation capacity of the power plant is 32 MW, of which 16 MW is allocated for each country.

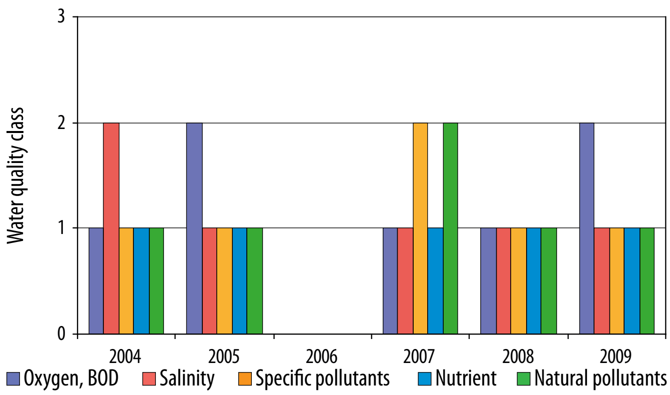
The construction of the reservoir has caused the alteration of the hydrological regime of the Prut River. The main hydromorphological pressures consist in the discontinuity of the flow, and the flows regulation. Building the Stanca-Costesti Dam led to modifications of the habitat.

The area around the Stanca-Costesti Reservoir is covered by arable lands (70%), perennial crops (17 %), forests and urban areas.

In Romania, monitoring has been established and functions in accordance with the WFD. The Stanca-Costesti Reservoir is covered by the Prut Water Quality Monitoring System: surveillance and operational monitoring are carried out. Wastewater discharges and water abstractions are also monitored.

Diffuse pollution by nutrients and accumulation of heavy metals are the most serious pressure factors affecting the reservoir.

**FIGURE 15:** Classification of water quality in the Stanca-Costesti Reservoir according to groups of indicators for 2004 to 2009




According to Romanian standards in 2009, Stanca-Costesti was in class I of quality according to the physical chemical indicators (dissolved oxygen 7.75 mg/l, COD 12.0 mg/l, $BOD_5$ 4.2 mg/l, TDS 343 mg/l, N-$NH_4$ 0.02 mg/l, Cu 5.48 µg/l). Organic micropollutants had values which did not exceed the limit values. With the exception of 2008, the reservoir has been in class II of the Moldovan water pollution index from 2005 to 2009.

By eutrophication indicators, the reservoir is mesotrophic.

[132] The EU member States are required, according to the nitrates Directive, to establish codes of good agricultural practice, which are voluntary schemes for farmers, the provisions of which include at least the application of fertilizer and the storing of manure.

# CAHUL/KAGUL RIVER BASIN[133]

The basin of the river 44-km long Cahul/Kagul[134] is shared by Ukraine and the Republic of Moldova. The river has its source in the Republic of Moldova and discharges into Lake Cahul/Kagul, shared by both countries. Some 605 km$^2$ of the basin area is Moldovan territory; Ukrainian territory is mainly downstream from the lake.

The basin area is lowland.

Groundwater resources amount to 0.032 km$^3$/year, and are related to Neogene formations. Total groundwater withdrawal amounts to 0.69 × 10$^6$ m$^3$/year; 100% is used for domestic purposes.

There is practically no permanent river network in the Cahul/Kagul River Basin.

## Pressures and status

The total withdrawal in the Moldovan part of the basin was some 1.62 × 10$^6$ m$^3$ in 2009, most of which (71%) was for irrigation and fisheries, 20% for other agricultural purposes, 7% for domestic purposes, and 2% for industry. Total groundwater abstraction is 0.69 × 10$^6$ m$^3$/year and is completely used for domestic purposes.

In the period from 2005 to 2009, water in Lake Cahul/Kagul fell in to water quality class III, "moderately polluted water" accordingly to the Moldovan national Water Pollution Index. From 2006 to 2008, for example, the average concentrations of $BOD_5$ varied from 5.1 to 6.9 mg/l, and $COD_{Cr}$ from 33.0 to 46.8 mg/l, according to the data of the State Hydrometeorological Service of the Republic of Moldova.

# YALPUH RIVER BASIN[135]

The basin of the 114-km long river Yalpuh[136] is shared by Ukraine and the Republic of Moldova. The river has its source in the Republic of Moldova, and discharges into Ukraine's Lake Yalpuh.

The basin has a pronounced lowland character.

Basin of the Yalpuh River

| Country | Area in the country (km$^2$) | Country's share (%) |
|---|---|---|
| Republic of Moldova | 3 180 | 49 |
| Ukraine | 3 280 | 51 |
| **Total** | **6 460** | |

Groundwater resources amount to 0.02 km$^3$/year, 98% of which is related to Quaternary formations, and the rest to Neogene formations.

There is practically no permanent river network in the Yalpuh River Basin.

## Pressures and status

Total withdrawal in the Moldovan territory of the Yalpuh basin was 4.98 × 10$^6$ m$^3$/year in 2009. Some 47% of the withdrawal is for agricultural purposes, another 33% for irrigation and fisheries, 18% for household needs and 2% for industry. Total groundwater abstraction in the Ukrainian part of the basin — fully for domestic purposes — is 2.41 x 10$^6$ m$^3$/year.

Based on monitoring by the State Hydrometeorological Service of the Republic of Moldova at the Comrat and Taraclia reservoirs, water quality is in class III according to the Water Pollution Index, namely "moderately polluted". From 2005 to 2008, for example, the average concentrations of $BOD_5$ varied from 5.6 to 7.2 mg/l and $COD_{Cr}$ from 40.0 to 60.1 mg/l at Comrat Reservoir. During the same period, at Taraclia Reservoir, $BOD_5$ varied from 5.2 to 7.9 mg/l and $COD_{Cr}$ from 54.0 to 70.0 mg/l.

# COGILNIK RIVER BASIN[137]

The basin of the Cogilnik is shared by Ukraine and the Republic of Moldova. The river has its source in the Republic of Moldova and discharges into Lake Sasyk in the Black Sea Basin. The main transboundary tributary is the 116-km long Chaga.

The basin has a pronounced hilly character, with an average elevation of some 100 m a.s.l.

Basin of the Cogilnik River

| Country | Area in the country (km$^2$) | Country's share (%) |
|---|---|---|
| Republic of Moldova | 1 900 | 45 |
| Ukraine | 2 350 | 55 |
| **Total** | **4 250** | |

## Hydrology and hydrogeology

In the Moldovan part of the Cogilnik Basin, surface water resources are estimated at 8.83 × 10$^6$/year (average for the period 1959–2008). Groundwater resouces in the Ukranian part of the basin amount to 0.02 km$^3$/year, and are related to Neogene rock. There is no permanent river network in the Ukrainian part of the basin. In dry years with low levels of precipitation, the river dries out.

Transboundary groundwaters in the basin are of Type 1. Work has been carried out, but additional study is needed about surface and groundwater interactions.

## Pressures and status

Among the pressure factors are pollution from urban wastewaters and from agriculture (irrigation); both classified as local but severe by the Republic of Moldova. The importance of industrial wastewater discharges and euthophication is ranked as local and moderate.

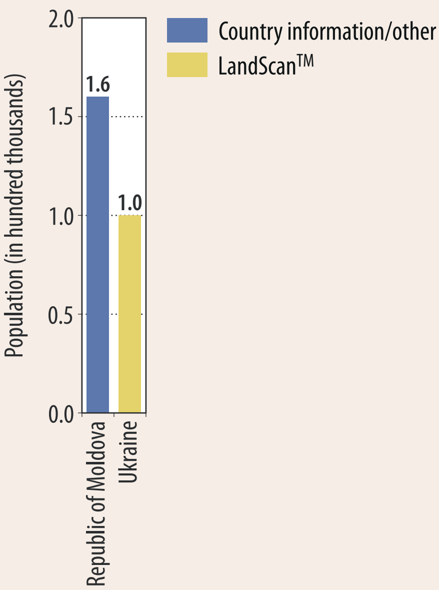
Total water withdrawal and withdrawals by different sector in the Cogilnik Basin

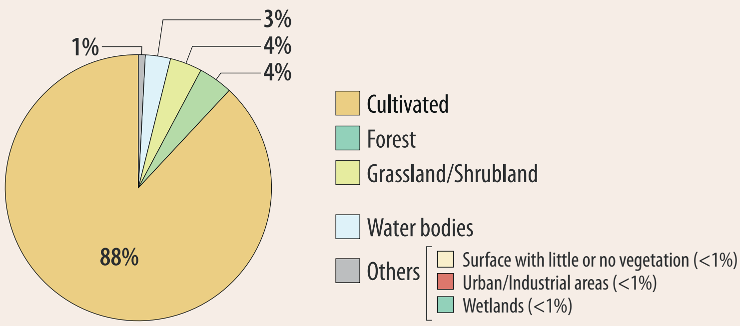
| Country | Total withdrawal ×10$^6$ m$^3$/year | Agricultural % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|
| Republic of Moldova | 2.74 | 64.2 | 32.5 | 1.9 | - | 1.4 |
| Ukraine | 5.6 | - | 74 | 26 | - | - |

*Source:* Water State Cadastre of the Republic of Moldova, 2008.

[133] Based on information provided by Moldova and the First Assessment.
[134] The river and lake are known as Cahul in the Republic of Moldova, and as Kagul in Ukraine. The river is usually considered as a separate first-order river, but it has become part of the Danube River Basin District.
[135] Based on information provided by Moldova and the First Assessment.
[136] The Yalpuh is usually considered as a separate first-order river, but it has become part of the Danube River Basin District.
[137] Based on information provided by Moldova and the First Assessment.


## POPULATION AND LAND COVER IN THE DNIESTER AND COGILNIK RIVER BASINS




*Source:* UNEP/DEWA/GRID-Europe 2011; Ministry of Environment and Natural Resources, Republic of Moldova.

Hydrochemical characteristic of the Cogilnik at the monitoring site Hincesti in the Republic of Moldova

| Determinands | MAC | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|
| $BOD_5$, mg/l | 3.0 | 5.51 | 2.29 | 12.99 | 8.47 |
| $COD_{Cr}$, mg/l | 30 | 27.55 | 14.01 | 39.94 | 28.56 |
| $N\text{-}NH_4$, mg/l | 0.39 | 2.36 | 1.15 | 1.34 | 3.13 |
| $N\text{-}NO_2$, mg/l | 0.02 | 0.190 | 0.210 | 0.040 | 0.07 |
| $N\text{-}NO_3$, mg/l | 9.0 | 1.75 | 2.48 | 2.19 | 2.11 |
| $P\text{-}PO_4$, mg/l | 0.2 | 0.3 | 0.24 | 0.20 | 0.69 |
| Petroleum hydrocarbons, mg/l | 0.05 | 0.28 | 0.05 | 0.34 | 0.09 |
| Cu, mg/l | 0.001 | 0.004 | 0.010 | 0.003 | N/A |
| Zn, mg/l | 0.01 | 0.001 | 0.002 | 0.013 | N/A |

*Source:* State Hydrometeorological Service of the Republic of Moldova.

There is a high level of organic pollution (indicated as BOD and COD) in the river. The average annual concentrations of nitrogen compounds exceed the MAC and the phosphorus content tends to increase. The river is considered by the Republic of Moldova as very polluted by organic substances. The oxygen content downstream from Kotovska is low.

## Responses

In accordance with the bilateral agreement between the riparian countries on the joint use and protection of transboundary waters (1994), the laboratory of the Moldovan State Hydrometeorological Service exchanges information on water quality in the Cogilnik with Ukraine. The Republic of Moldova regrets that governmental funding is insufficient for renewing instruments and equipment, for paying for technical maintenance, and for the purchase of materials and spare parts. Project funding is partly used for this, and is sought in order to train specialists. Efforts are being made to improve monitoring (adapting principles of the WFD).

Gaps in the institutional frameworks include a lack of specific action to involve interested non-governmental organizations and a lack of river basin commissions. There is no legal requirement for public involvement.

# DNIESTER RIVER BASIN[138]

The basin of the 1,362-km long river Dniester is commonly considered shared by Ukraine and the Republic of Moldova, as the share of Poland is very small. The river has its source in the Ukrainian Carpathians, and discharges into the Black Sea. Major transboundary tributaries include the Kuchurhan and the Yahorlyk. The basin is mountainous in the upper part, and lowlands prevail in the lower part. Valuable wetland systems extend along the Dniester Estuary, including some 100 wetland lakes (10-15 of the lakes are major). They play a vital role in maintaining the water balance and supporting the basin's biological diversity.[139]

Basin of the Dniester River

| Country | Area in the country ($km^2$) | Country's share (%) |
|---|---|---|
| Ukraine | 52 700 | 72.1 |
| Republic of Moldova | 19 400 | 26.8 |
| Poland | 226 | 0.4 |
| **Total** | **72 326** | |

*Source:* Statistical Yearbook Environment of Ukraine, Kyiv 2008; Ministry of Environment, the Republic of Moldova.

## Hydrology and hydrogeology

Surface water resources in the Ukrainian part of the Dniester basin are estimated at 10.7 $km^3$/year in an average year (at 6 $km^3$/year in a dry year) and groundwater resources at 1.87 $km^3$/year. More than 90% of the total flow of the Dniester is generated in Ukraine. Approximately 40% of the groundwater resources are in Cretaceous formations, less than 20% in Quaternary, and around 12-13% each in Neogene, Devonian and Silurian.[140] The majority of the aquifers are only weakly connected to surface waters.

In the Moldovan part, surface water resources are estimated at 9.87 $km^3$/year (average for the years 1954 to 2008).

The Dniester has a highly specific flood regime, featuring up to five flood events annually, during which water levels may increase by 3–4 m or even more. The significant variability of water levels, especially in the upper Carpathian reach, is attributed to the river channel's low capacity.

The level of flow regulation is very low in the upper reach of the Dniester, with only one small reservoir established on the Chechvinsky tributary (storage capacity 12.1 × $10^6$ $m^3$). The largest dams in the middle section are the Dubossary (1954) and Dniestrovsky (1983).

Total water withdrawal and withdrawals by sector in the Dniester Basin

| Country | Total withdrawal $\times 10^6$ $m^3$/year | Agricultural % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|
| Ukraine | 610.6[a] | 29.9 | 58.6 | 4.7 | 5.7 | 1.1 |
| Republic of Moldova | 765.16[b] | N/A | N/A | N/A | N/A | N/A |

*Notes:* Groundwater use is some $10^6 \times 10^6$ $m^3$/year in the Moldovan part of the basin. Groundwater also has important functions such as maintaining baseflow and springs and supporting ecosystems. In Ukraine, groundwater is mainly used for household water. Surface water is used for agriculture, household needs and for industry.

[a] Total groundwater abstraction amounts to 186 $\times 10^6$ $m^3$/year in the Ukranian part of the basin; of which 14% is used for agriculture, 78% for domestic purposes and 8% for industry. (Geoinform, Ukraine)

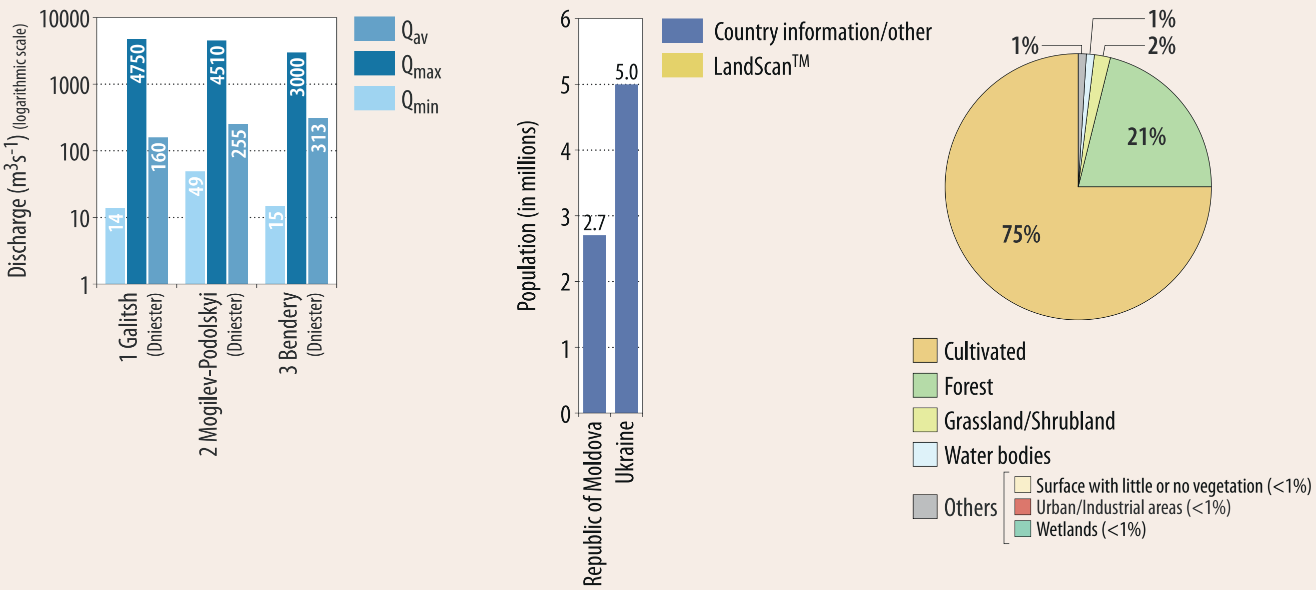
[b] Major part of withdrawal used for cooling of a power station, i.e. all water comes back with about the same quality.

[138] Based on information provided by the Republic of Moldova and Ukraine, and the First Assessment.

[139] The total area of the Dniester Wetlands enjoying international recognition under the Ramsar Convention includes both Moldovan and Ukrainian parts of the Dniester Estuary (with a total surface area of 150,000 ha). In 2005, the area along the Dniester and its Unguri-Holosnita valley on the Moldovan side were added to the Ramsar List. A similar decision was recommended in 2005 on the basis of a transboundary diagnostic study carried out in the framework of an OSCE/UNECE project for the same area along the Dniester on the Ukrainian side, so as to support its joint management.

[140] *Source:* Geoinform, Ukraine.

**DISCHARGES, POPULATION AND LAND COVER IN THE DNIESTER RIVER BASIN**




*Sources:* UNEP/DEWA/GRID-Europe 2011; Long-term data on the status and resources of surface waters, 1981-2000 and the entire period of observation, Ukraine; Statistical Yearbook Environment of Ukraine, Kyiv 2008; Action Programme to Improve Transboundary Cooperation and Sustainable Management of the Dniester River Basin (Dniester – III).

## Pressures

The high level of land use for agriculture has led to a significant increase of diffuse pollution loads. The pressure from field run-off and wastewater discharges from animal farms is assessed by Ukraine as widespread but moderate. Extensive diversion of water for irrigation reduces flow in the river, contributing to increased salinity in the liman (estuary).

Pollution through surface water affects the quality of shallow groundwater; for example nitrates (in Anenii Noi), chlorine (in Stefan Voda) and ammonium have been detected in elevated concentrations.

Discharges of municipal wastewaters are among the main pressure factors in the basin, which has many densely populated areas (influence widespread and severe according to Ukraine), especially as in many settlements wastewater is not collected. Most of the treatment plants in Ukraine and the Republic of Moldova operate ineffectively and are in need of major repairs and upgrading. There is also a decreasing trend of discharges treated according to regulatory requirements in Ukraine. The impact of the presence of viruses and bacteria from insufficient wastewater treatment is, however, assessed by the Republic of Moldova as local and moderate. In Ukraine, 15% of surface water samples do not meet the requirements for bacterial indicators.

Both permitted and illegal discharges from industries add to the pollution load. Industrial activity in the basin includes mining and petrol extraction, wood-processing, and the food and chemical industries (e.g. oil refining). Industries are clustered in the main urban centres: in Ukraine Lviv, Chernivtsy, Ivano-Frankivsk, Ternopil and Kamianets-Podilsky; and in the Republic of Moldova Balti, Chisinau, Soroca, Orhei, Ribnita, Dubossary, Tiraspol and Bendery. In the last few years, industrial accidents have been associated with the accidental breaking through of a sewage collector near Mogilev-Podolskyi. There is also a risk of failing for the storage dam of a reservoir holding industrial brines close to Stebnik or the tailings dams of Dombrovskyi mine in Ivano-Frankovskoi oblast.

The impact of the change of thermal regime — in addition to the flow speed — as a result of building the dams for hydropower development in the Middle Dniester in particular is assessed to be widespread and severe in the Moldovan territory.

Solid waste management in the Moldovan part of the basin is reported to be inadequate, with the only authorised or controlled dump sites existing in Chisinau. In Ukraine, municipal solid waste landfills do not meet environmental and health regulations (widespread but moderate influence). Dumping trash on the riverbank strips is reported to be widespread in Ukraine.

Flooding causes problems on the river (assessed as widespread and severe by Ukraine); at a larger scale most recently in July 2008 in the western region of Ukraine.

Hydromorphological changes are a concern, and regulation for hydropower use affects the ecological status of the river (e.g. downstream from the Dnestrovsky hydropower station). The dams trap suspended sediment and pollutants such as organic compounds and heavy metals. The water surfaces of the Dniester wetlands are gradually shrinking due to intensive sediment deposition and plant overgrowth. In the Ukrainian territory, there is a high level of soil erosion, with washing-away affecting some 70% of the basin area, with tree-cutting (illegal and legal) and over-grazing adding to it. The loss of biodiversity in surface waters and water-related ecosystems is reported to be widespread (but moderate) in the Republic of Moldova.

## Status

Previously, the quality status was affected more by industrial pollution, but, at present, urban wastewater discharges (especially in the Lower Dniester, the Odessa region), run-off from agricultural land/irrigation return flows and erosion are more prominent factors. In the Lower Dniester an increase of organic and nutrient pollution and a decrease of water quality into category 4 (or quality class III) are observed. Water in most of the monitored river sections in Ukraine was in quality category 3 (or quality class II).

The Republic of Moldova assesses that water in the Upper and Middle Dniester basin are in class II ("clean water"), whereas the Dniester tributaries are substantially polluted.[141] During the dry season water quality gets worse due to wastewater discharges.

[141] State Hydrometeorological Service, Republic of Moldova.

Hydrochemical characteristic of the Dniester River at the monitoring site Olanesti in the Republic of Moldova (85 km from the river's mouth, latitude 46°30', longitude 29°56'), a slight increase in phosphate-phosphorus can be observed.

| Determinands | MAC | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|
| $BOD_5$ mg/l | 3.0 | 2.69 | 2.35 | 2.13 | 2.33 |
| $COD_{Cr}$ mg/l | 30 | 15.19 | 17.43 | 16.38 | 14.79 |
| $N\text{-}NH_4$ mg/l | 0.39 | 0.38 | 0.26 | 0.30 | 0.33 |
| $N\text{-}NO_2$ mg/l | 0.02 | 0.030 | 0.030 | 0.020 | 0.030 |
| $N\text{-}NO_3$ mg/l | 9.0 | 1.59 | 2.14 | 1.50 | 1.38 |
| $P\text{-}PO_4$ mg/l | 0.2 | 0.03 | 0.05 | 0.07 | 0.09 |
| Petroleum hydrocarbons, mg/l | 0.05 | 0.03 | 0.05 | 0.03 | 0.02 |
| Cu, mg/l | 0.001 | 0.003 | 0.007 | 0.003 | N/A |
| Zn, mg/l | 0.01 | 0.003 | 0.002 | 0.007 | N/A |

*Source:* State Hydrometeorological Service of the Republic of Moldova.

No significant changes in surface water quality have been registered in Ukraine during the period from 2007 to 2009. At Mogilev-Podolsky and Jampol utilities, in 2008–2009 exceedence in the concentrations of organic matter (as COD) and ammonium-nitrogen were observed. The main pollutants are nitrogen, organic matter (BOD), phosphates, suspended solids and synthetic surfactants. At some monitoring points, copper is also a quality defect that occurs. In the Carpathian part of the Dniester, concentrations of metals systematically exceed MACs (e.g. iron and manganese).

## Transboundary cooperation and responses

Programmes have been implemented in Ukraine to modernize wastewater treatment in the housing sector with surveillance of compliance. In the Republic of Moldova, construction of wastewater treatment plants is planned in Soroca, Criuleni, Soldanesti and Calarasi cities, among others.

An action plan has been developed in accordance with a 2010 Decree of the President of Ukraine, declaring the territory of the town of Kalush and Kropivnik and Seva villages in the Kalysh region an ecological emergency situation zone.

Flood zone maps are being developed in Ukraine, complementing forecasting in flood preparedness. Reconstruction of dams for flood protection has been carried out in the Republic of Moldova.

The Dniester River Basin Council was established in 2008 in Ukraine with an advisory role to bring together the interests of the various water users. Its main task is to take part in the definition of strategy and development of a river basin management plan.

One of the four working groups established by plenipotentiaries under the 1994 agreement between the Republic of Moldova and Ukraine about transboundary waters deals with the Dniester River. A transboundary diagnostic study of the Dniester River Basin was developed in 2005.

There is a cooperative environmental monitoring programme between the State hydrometeorological services of the riparian countries. In the framework of the Dniester III project,[142] a transboundary Geographical Information System (GIS) was developed for the basin — including data on water quality parameters. A pilot project on exchange of water quality monitoring data between the Republic of Moldova and Ukraine has been set up, with financial support from France.[143] Harmonization of methods and approaches to determine water quality is reported to be needed. A Regulation on Cooperation in Sanitary Epidemiological Monitoring of Water Quality, initially developed in an ENVSEC project, has been prepared for signing.

The Dniester Wetlands have demonstrated potential as a target for developing and strengthening international cooperation between Ukraine and the Republic of Moldova through — for example — planning and implementing joint conservation measures, research programmes etc.

## Trends

Despite improvement of water quality over the last decade, related to a decrease in economic activity, significant water quality problems remain. Trends of salinization and eutrophication of the Dniester estuary are observed.

The scope of the existing transboundary agreements does not cover the whole river basin, and a new bilateral agreement on the protection and sustainable development of the Dniester Basin between Ukraine and the Republic of Moldova is therefore needed. The current agreement does not include some key principles of international law. Moreover, notification and consultation procedures in the case of plans with potential transboundary impact are not developed, and procedures for resolving any disputes are not well worked out. By the end of 2009, the draft bilateral basin agreement had passed the first round of comments among the authorities concerned in the Republic of Moldova and Ukraine, and a revised agreement was being prepared for signing. The draft agreement refers to the basin principle in water management, and provides for the establishment of a basin commission.

Full-scale implementation and enforcement of environmental laws and regulations represent a significant challenge for both Ukraine and the Republic of Moldova. The Republic of Moldova is currently reforming its national water policy, and a new water law is under preparation.

There is no model for managing surface waters and groundwaters in the basin in an integrated way. A basin approach is felt to be lacking. An international strategic plan for managing the environmental condition of the Dniester is called for.

According to the Republic of Moldova, the seasonal flow distribution pattern has changed over the past decade, with spring flood flows having become lower and flows recorded in the low-water periods having increased. Related to adaptation to climate change, Ukraine is carrying out national dialogues.

[142] The "Transboundary cooperation and sustainable management in the Dniester River basin: Phase III - Implementation of the Action Programme" (Dniester III) is a project funded by Sweden and Finland under the umbrella of ENVSEC, and implemented by OSCE and UNECE in close collaboration with the authorities and NGOs from the Republic of Moldova and Ukraine.

[143] Source: Fonds Français pour l'Environnement Mondial (FFEM).

# KUCHURHAN SUB-BASIN[144]

The basin of the river Kuchurhan is shared by Ukraine and the Republic of Moldova. The river has its source in Ukraine, and discharges into the Kuchurhan estuary.

The basin has a pronounced lowland character. A permanent river network almost does not exist.

Sub-basin of the Kuchurhan River

| Country | Area in the country ($km^2$) | Country's share (%) |
|---|---|---|
| Ukraine | 2 090 | 90.3 |
| Republic of Moldova | 225 | 9.7 |
| **Total** | **2 315** | |

Groundwater resources in the Ukrainian part of the sub-basin are estimated at $46.97 \times 10^6$ $m^3$/year, about a half in Quaternary and another half in Neogene formations.

## Pressures

According to Ukraine, the main concerns related to water quantity in the Kuchurhan Basin include drying up of the river in the summer, flow regulation by construction of hydraulic structures, and underflooding of settlements by groundwater located near the Kuchurhan Reservoir. Threats to water quality include discharge of untreated sewage, economic activities in water protection zones, as well as cutting down trees on the banks of the river.

## Status and responses

A slight increase in the salt content, $BOD_5$, and iron was observed in Ukraine in 2008. According to Ukraine, the situation with regard to dissolved substances is stable, and the oxygen conditions satisfactory in the Kuchurhan Reservoir. The sanitary condition of the reservoir is assessed as satisfactory.

# DNIEPER RIVER BASIN[145]

The basin of the river 2,200-km long Dnieper is shared by Ukraine, the Russian Federation and Belarus. The river has its source in the southern part of Valdai Hills in the Russian Federation and discharges into the Dnieper estuary in the Black Sea. Transboundary tributaries of the Dnieper include the Pripyat, Desna, Sozh, Psel and Vorskla.

The 800-km section of the river furthest downstream is a chain of consecutive reservoirs. The Dnieper is connected with the Bug River through a canal. The basin has a pronounced lowland character.

Basin of the Dnieper River

| Country | Area in the country ($km^2$) | Country's share (%) |
|---|---|---|
| Russian Federation | 90 700 | 18 |
| Ukraine | 292 700 | 58 |
| Belarus | 121 000 | 24 |
| **Total** | **504 400** | |

*Source:* UNDP-GEF Dnipro Basin Environment Programme; Ukraine.

## Hydrology and hydrogeology

Surface water resources in the Belarusian part of the basin (without Pripyat) are estimated at 19.9 $km^3$/year. Groundwater resources are estimated at 9.71 $km^3$/year in the Belarusian part.

## Pressures

Due to insufficient capacity and the poor technical condition of treatment plants, wastewater discharges from industry and settlements have a significant negative impact on water resources. In Belarus, Orsha, Mogilev, Rechytsa, Love, Borisov, Minsk (especially Svisloch area), Gomel and Bobruisk are among the main sources of industrial wastewaters. Within the Belarusian part of

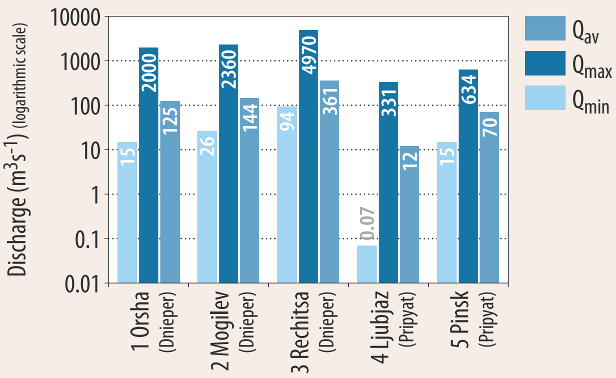
Total water withdrawal and withdrawals by sector in the Kuchurhan Basin

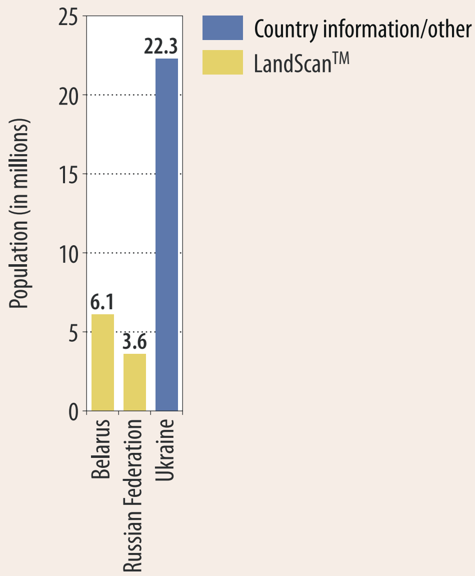
| Country | Year | Total withdrawal $\times 10^6$ $m^3$/year | Agricultural % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|---|
| Ukraine | 2009 | 2.064 | 51.0 | 19.1 | 29.0 | - | 0.9 |
| Republic of Moldova | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

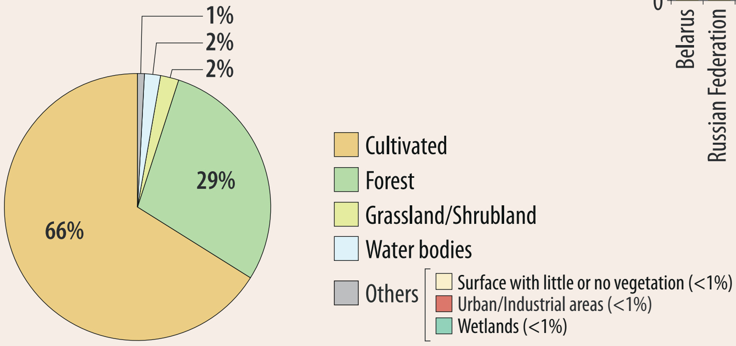
*Notes:* Groundwater abstraction in the Ukrainian part of the basin amounts to 14,700 $m^3$/day, which equals $5.37 \times 10^6$ $m^3$/year. Of this amount, 75% goes for domestic use, 24% to industry and about 1% to irrigation.

[144] Based on information provided by Ukraine.
[145] Based on information provided by Belarus, and the following sources: 1) First Assessment; 2) River basin commissions and other institutions for transboundary water cooperation. UNECE. 2009; 3) Second Environmental Performance Review of Ukraine. UNECE. 2007.


## DISCHARGES, POPULATION AND LAND COVER IN THE DNIEPER RIVER BASIN




*Sources:* UNEP/DEWA/GRID-Europe 2011; UNDP-GEF Dnipro Basin Environment Programme; Ukraine; Long-term data on the status and resources of surface waters, 1981-2000 and the entire period of observation, Ukraine (gauging station Ljubjaz); Annual data on the regime and surface water resources for 2008, volume 3, State Water Cadastre, 2009 (Pinsk and Mozyr gauging stations).

**PALEOGENE-NEOGENE TERRIGENOUS AQUIFER (NO. 116)**

| | Belarus | Ukraine |
|---|---|---|
| Sand, sandstones of Paleogene-Neogene age; groundwater flow direction is from Belarus to Ukraine; medium links with surface waters. | | |
| Thickness: mean, max (m) | 25–75, 150 | N/A |
| Groundwater uses and functions | Groundwater is mainly used for household/drinking water. | N/A |

**CENOMANIAN CARBONATE-TERRIGENOUS AQUIFER (NO. 117)**

| | Belarus | Ukraine |
|---|---|---|
| Sand, sandstones, chalk, marl of Cenomanian age (Cretaceous); groundwater flow direction is from Belarus to Ukraine; weak links with surface waters. | | |
| Thickness: mean, max (m) | 50-100, 290 | N/A |
| Groundwater uses and functions | Groundwater is mainly used for household/drinking water. | N/A |

**UPPER DEVONIAN TERRIGENOUS-CARBONATE AQUIFER (NO. 118)**

| | Belarus | Russian Federation |
|---|---|---|
| Type 2/4; limestone, sandstone and marl of Upper Devonian age; groundwater flow direction is from Russian Federation to Belarus; weak links with surface waters. | | |
| Thickness: mean, max (m) | 100-150, 180 | N/A |
| Groundwater uses and functions | Groundwater is mainly used for household/drinking water. | N/A |

the basin, the most significant pollution load as urban/municipal wastewater originates from Svisloch, where the Minsk wastewater treatment plant is located, but some load also originates from Mogilev. Nutrients are the most important pollutants. Belarus assesses the impact of municipal wastewaters as widespread but moderate. The Dnieper is among the biggest recipients of pollutants in Ukraine, where until at least until recently (2004) metallurgy was the biggest wastewater producer, followed by the coal industry and the chemical and petrochemical industries. Zaporozhye oblast has a large industrial zone, including metallurgy. Untreated or insufficiently treated wastewaters of these industries typically contain heavy metals, phenols, oil products and other hazardous substances.[146]

Run-off from agricultural areas has a local but severe impact on water resources (Belarusian part). Large-scale development of timberland and draining of waterlogged lands for agriculture, as well as pollution with surface run-off from urban and agricultural areas, has impacted on the environment in the basin. In recent years, pollution by household waste, including waste left by holiday-makers, has increased along the Dnieper River and its tributaries.

Belarus ranks the impact related to nuclear power generation as widespread and severe. However, the transboundary transfer of cesium-137 from the radioactively contaminated Belarus-Bryansk area, transported through surface waters of Sozh and its tributaries, has naturally decayed to insignificant levels. The activity of lower-activity strontium-90 is markedly amplified during flooding. Radioactive elements have been monitored since the Chernobyl catastrophe. In the reservoirs of the Dnieper cascade, a decrease in mean annual cesium-137 and strontium-90 concentrations is observed.

## Status and transboundary impacts

The chemical status of the river in the Belarusian part has remained stable during the period from 2006 to early 2010, or the general condition of water bodies has even improved. According to the classification of water resources adopted in Belarus, 76.1% of water in the basin is classified as "relatively clean", 19.7% as "moderately polluted", 1.4% as "polluted" and 2.8% as "dirty". In general, the Dnieper's water resources can be classified as "clean water" (II class of quality in the national classification of Ukraine). Main pollutants are nutrients (nitrogen compounds), organic substances (including phenols) and heavy metals.

The high degree of flow regulation contributes to eutrophication of water bodies, as well as accumulation of polluted sediments.

## Transboundary cooperation

A draft intergovernmental agreement between Belarus, Russian Federation and Ukraine on Cooperation in the Field of Management and Protection in the Dnieper River Basin was developed within the framework of the UNDP-GEF Dnipro Basin Environment Programme. The draft agreement, which provides for the establishment of a joint commission has not yet been adopted.[147]

The Russian Federation-Belarus Commission has developed an effective programme for joint monitoring of transboundary sections of the Dnieper.

## Responses

In the border zone in Belarus, groundwater monitoring is carried out at eight monitoring stations; three times a month for levels and temperature, once a year for physico-chemical parameters. According to Belarus, the current groundwater monitoring network is not sufficient, and joint monitoring is lacking. A gradual development of a network of monitoring wells for transboundary groundwaters is planned from 2011 to 2015.[148] A joint Belarus and Ukraine project aims at transboundary monitoring. Joint monitoring of Ukraine and the Russian Federation has been challenging.

To ensure effective functioning of the majority of company/industry treatment facilities, they have been included in the system of local monitoring. Belarus also reports that protection zones have been established around water bodies. In Ukraine, measures for water protection are carried out in the framework of the State programme of ecological rehabilitation of the Dnieper Basin and improvement of drinking water quality. Both Belarus and Ukraine report on-going efforts to reconstruct and extend wastewater treatment facilities.

[146] *Source:* Second Environmental Performance Review of Ukraine. UNECE. 2007.
[147] River basin commissions and other institutions for transboundary water cooperation. UNECE. 2009.
[148] This is to be made under the National Development Plan of the National Environmental Monitoring System in the Republic of Belarus for 2011-2015.

# PRIPYAT SUB-BASIN[149]

The sub-basin of the 710-km long Pripyat River is shared by Ukraine and Belarus. The Pripyat originates in Ukraine in the area of Shatski Lakes, and, after traversing Belarusian territory, returns to Ukraine, before discharging into the Dnieper.

Among the many smaller transboundary rivers in the Pripyat sub-basin are the following: Styr, Goryn, L'va, Stviga, Ubort and Slovechna.

Sub-basin of the Pripyat River

| Country | Area in the country (km²) | Country's share (%) |
|---|---|---|
| Belarus | 52 700 | 43 |
| Ukraine | 69 140 | 57 |
| **Total** | **121 840** | |

*Source:* Report of Water Management in the Pripyat River Basin, Joint Programme TACIS, 2003. Blue Treasure Belarus: Encyclopedia. BelEn, Minsk. 2007.

## Hydrology and hydrogeology

Water resources in the Ukrainian part of the basin are estimated at 7.4 km³/year.[150] Groundwater resources are estimated at 484.6 × $10^6$ m³. Some 86% of these groundwater resources are in Cretaceous formations. About a half of the remaining resources are in Palaeogene formations, a significant share in Jurassic formations, and some also in Quaternary formations.

In the Belarusian part, surface water resources are estimated at 5.6 km³/year and groundwater resources at 2.56 km³/year.

## Pressures

The flow being fed by marshlands, and forest and peatlands being abundant in the basin, results in the water of the Pripyat and most of the tributaries having low salinity and being rich in organic substances. Elevated concentrations of iron and manganese in groundwater are common. These natural factors have a widespread but moderate influence on water quality. The content of organic matter and also of nutrients is increased by agriculture in Ukrainian territory, also locally (but potentially severely) affecting water entering the territory of Belarus.

The basin is still affected by the radioactive fallout that resulted from the nuclear accident at Chernobyl in 1986 (judged widespread and severe by Belarus), even though a decreasing trend in radioactive cesium (Cs) and strontium (Sr) is reported by Ukraine in most monitoring points. Higher levels of radionuclides mainly occur in basins within 30 km from Chernobyl. The transboundary transport of $^{90}$Sr varies, depending on the extent of annual flooding. Transport of radioactive pollution occurs both in dissolved form and with sediments. While in normal operation, thermal pollution from nuclear power station at Rivne (of the same type as Chernobyl), Ukraine on the Styr River is reported to be negligible. Concentration of $^{137}$Cs and $^{90}$Sr radionuclids in the surface waters at monitoring stations near the Rovenskaya nuclear power plant, as well as in industrial wastewaters and storm waters, is insignificant and does not exceed permissible limits (12-15 times lower).

Wastewater treatment plants are not working effectively — most of them are in need of renovation and major repairs — and the pressure from resulting discharges is ranked by Ukraine as widespread and severe. In the following towns or settlements, the load is reported to exceed the capacity of treatment plants: Slutsk, Pljuban and Starie-Dorogi in Belarus; and Korosten in Ukraine. Among the sources of industrial wastewaters in Belarus are the oil processing plant at Mosyr in the lower catchment area,

### PALEOGENE-NEOGENE TERRIGENOUS AQUIFER (NO. 119)[151]

| | Belarus | Ukraine |
|---|---|---|
| Type 2/4; sand and sandstone; mean thickness 25–75 m, maximum thickness 150 m; groundwater flow direction from Belarus to Ukraine; Medium connection to surface waters. | | |

### CENOMANIAN TERRIGENOUS AQUIFER (NO. 120)[152]

| | Belarus | Ukraine |
|---|---|---|
| Type 2/4; sand and sandstone, sandy loam; groundwater flow direction from Belarus to Ukraine; weak link to surface waters. | | |
| Thickness: mean, max (m) | 50-100, 290 | N/A |

### UPPER PROTEROZOIC TERRIGENOUS AQUIFER (NO. 121)[153]

| | Belarus | Ukraine |
|---|---|---|
| Type 2/4; sand and sandstone; groundwater flow direction from Ukraine to Belarus; weak link to surface waters. | | |
| Area (km²) | N/A | N/A |
| Thickness: mean, max (m) | 200, - | N/A |

Total water withdrawal and withdrawals by sector in the Pripyat sub-basin

| Country | Year | Total withdrawal × $10^6$ m³/year | Agriculture % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|---|
| Belarus | 2000-2009[a] | 371.2 | 64.4 | 23.0 | 11.0 | 1.3 | 0.3 |
| Ukraine | 2009 | 525.6 | 37.1 | 17.3 | 7.0 | 37.4 | 2.0 |
| Ukraine | | 158.1[b] | 13.7 | 66.6 | 10.0 | - | 9[c] |

*Notes:* Groundwater is used for drinking and household water both in Belarus and Ukraine. In Ukraine groundwater is partly used for industrial purposes.
[a] The withdrawal figure is an average for years from 2000 to 2009.
[b] Groundwater only.
[c] Removal of water from mines (not actual consumptive use).

[149] Based on information provided by Belarus and Ukraine, and the First Assessment.
[150] Report of Water Management in the Pripyat River Basin, Joint Programme TACIS, 2003.
[151] Based on information from Belarus.
[152] Based on information from Belarus.
[153] Based on information from Belarus.

and companies located in Pinsk. Belarus reports the wastewater quality from the Mozyr plant to be stable, and the concentration of major pollutants does not exceed allowable concentrations (being 0.2–0.6 times MAC). Drainage and storm water overflows with high concentrations of phosphates and metals (iron, manganese and zinc) are discharged to the Goryn tributary from the phosphorus-gypsum piles of the Rovnoazot company. The main pollutants from municipal wastewaters are organic matter (indicated by $BOD_5$), ammonia nitrogen, suspended solids and phosphate-phosphorus. The main volume of wastewater discharged (>10 × $10^6$ $m^3$/year) into the Pripyat in Belarus and into the Morotsh in Soligorsk is from municipal housing organisations in Mozyr and Pinsk. The pressure from wastewater discharges is ranked by Belarus as local and moderate. According to Ukraine, industrial accidents can also have widespread but moderate impact.

## Responses

To reduce impact, Belarus reports that wastewater treatment installations have been constructed. To ensure effective treatment in enterprises, these have been included in the coverage of local monitoring. In Ukraine, industrial discharges are regulated through "special use" permits, which need to be paid for, and MACs. Programmes to modernize wastewater treatment processes are also carried out in Ukraine. Protection zones have been established in Belarus around water bodies to limit economic or other activities. Abandoned artesian wells are being sealed in Ukraine to avoid these forming pathways to pollution.

Among the surface water bodies monitored in Belarus are nine transboundary bodies which are parts of the following rivers: Pripyat, Prostyr, Styr Horyn, Leo, Stviga, Ubort, Slovechna. Radioactivity is monitored by Belarus in the Pripyat (at Mosyr) and in the Lower Braginka (at Gden), and Ukraine monitors for $^{137}Cs$ and $^{90}Sr$ at transboundary monitoring stations. According to the results, concentrations of radionuclides are insignificant, and do not exceed permissible limits. Groundwater monitoring is carried out by Belarus in four points in transboundary areas (levels, temperature, physical properties and chemistry), but there is no joint monitoring. As described in the assessment of the Daugava Basin, a review and development of the groundwater monitoring network in Belarus is planned. A NATO project launched in late 2009 aimed at upgrading flood monitoring and forecasting capacity in the Pripyat Basin, involving setting up automated monitoring stations on tributaries in both countries (~20 in total).

In 2008, an agreement was signed among all oblasts of Ukraine in the basin on cooperation in the use and protection of the water resources of the Pripyat River, as a basis for direct exchange of information on water quality and quantity. The creation of a coordinating body at basin level is planned in Ukraine. A draft management plan for the Pripyat River Basin was developed in the framework of the TACIS project "Transboundary River Basin Management: Phase 2 for the Pripyat Basin".

## Status and transboundary impacts

Observations in recent years indicate an improvement in the situation with regard to priority pollutants in the Pripyat. The chemical regime of the rivers in the basin has remained "stable" for the past five years. According to the classification adopted in Belarus, some 76% of water bodies are characterized as "relatively clean", and some 21% as "moderately polluted". In the Ukrainian part, water of the Pripyat fell into quality classes "clean" (II) and "moderately polluted" (III) in 2009, and among the most commonly observed quality defects were organic matter (measured as COD) and ammonium-nitrogen.

The transboundary transfer of radionuclides with the river is reported to have a significant impact on surface water pollution in the territory of Belarus and in the area around Chernobyl in Ukraine.

## Trends

The water quality of the Pripyat will remain problematic since it is lowered by natural factors — high content of organic matter, high acidity and colour.

In the Ukrainian part, natural systems of previously drained lands are being restored and new protected areas are being established (e.g. Drevlyansky nature reserve in 2009, 30,873 ha).

A proposal has been prepared to establish a joint commission for the Pripyat Basin,[154] but this has not yet materialized. The programme of cooperation between Ukraine and Belarus needs to be strengthened.

Related to water sector adaptation to climate change, Ukraine is carrying out national dialogues. Other related work is described in the assessment of the Siret. For the time being, there is a lack of recommendations for adaptation measures, which are needed according to different scenarios of possible change of hydrological regime.

[154] *Source:* River basin commissions and other institutions for transboundary water cooperation. UNECE 2009.

# STOKHID-PRIPYAT-PROSTYR RIVERS[155]

## General description of the wetland

The upper reaches of the Pripyat River are characterized by numerous river beds, arms, oxbow lakes and creeks with dozens of sandy islands, surrounded by forests, mires and lakes. Together they represent one of the largest remaining European floodplain meadow and fen complex shared by Belarus and Ukraine. On the Ukrainian side, three Ramsar Sites cover natural floodplains along the Pripyat River and its tributaries Stokhid, Stviga and L'va, as well as Perebrodi bog. The adjacent Ramsar Site in Belarus includes fen mires and wet meadows between the rivers Pripyat, Prostyr, Gnilaya Pripyat and Styr.

## Main wetland ecosystem services

The wetland area has large groundwater reserves that contribute to the hydrological regime of the region. Due to its considerable size and water retention capacity, this wetland area plays an important role in reducing the risk of disastrous floods in the Pripyat floodplain.

Natural habitats are used for haymaking, cattle pasturing, forestry (in Ukraine), small scale commercial and recreational fishing, sport hunting and various recreational activities. In general the Belarusian part is less accessible. Tourist activities have begun on the Ukrainian side thanks to the efforts of the National Park administration. In Belarus, there is also a good potential for further development of nature tourism.

## Cultural values of the wetland area

The everyday life of local residents is closely connected with nature and natural resources; they are used in a sustainable way. In Ukraine, there are several ancient villages with typical Polissyan architecture, and good examples of the traditional use of local construction materials (wood, reed and cattail). The area also has numerous religious buildings, architectural monuments and memorials.

## Biodiversity values of the wetland area

The large, relatively untouched natural area is characterized by a rich biodiversity, including globally threatened species, and species and habitats of European concern. It forms one of the major transboundary ecological corridors in Europe — an important contribution to the European Nature Conservation Network currently in development.

During the migration seasons the wetland area offers stop-over sites for geese, ducks, coots, rails, terns, gulls, waders, swallows and other birds (the total number exceeds 100,000 individuals). The wetland also provides breeding grounds for more than 10,000 pairs of waterbirds, including some listed on the IUCN Red List of Threatened Species, including Greater Spotted Eagle and Aquatic Warbler.

Long floods and well preserved wet meadows create favorable conditions for spawning fish. There are also important feeding, nursery and wintering sites for fish.

## Pressure factors and transboundary impacts

The Polesie region covers southern Belarus, northern Ukraine and adjacent areas of Poland and the Russian Federation. It lost most of its natural wetland areas as a result of drainage, accompanied by irreversible losses of biodiversity. The remaining natural and semi-natural areas are now extremely vulnerable to outside impacts.

Changes of the hydrological balance and of the river water level started in the 1960-70s, when a number of irrigation systems were constructed and the Pripyat was narrowed and diked. This lead to the deterioration of valuable habitats (including spawning sites) and loss or decrease of populations of wetland species. Accidental pollution from agricultural lands, loss of habitats due to overgrowing of abandoned meadows with bushes and (in Belarus) spring fires are additional pressures. In Ukraine, illegal fishing and hunting, and in some places overgrazing, are noticed.

## Transboundary wetland management

In Belarus, the Ramsar Site Prostyr (9,500 ha) includes a national landscape reserve of the same name. In Ukraine, Ramsar Sites Stokhid River Floodplains (10,000 ha), Prypiat River Floodplains (12,000 ha) and Stvigi and L'va Rivers' Floodplains (12,718 ha) include landscape and hydrological reserves, as well as parts of "Prypiat-Stokhid" National Park, "Prypiat-Stokhid" Regional Landscape Park and "Rovenskiy" Wildlife Management Area. All three Ramsar Sites are Important Bird Areas. In 2008 the Governments of Belarus and Ukraine designated a transboundary Ramsar Site "Stokhid-Prypiat-Prostyr" with the aim of continuing collaboration for the joint management of this wetland area. This work is largely supported by the UNDP/GEF projects "Catalyzing sustainability of the wetland protected area system in Belarusian Polesie through increased management efficiency and realigned land use practices" and "Strengthening governance and financial sustainability of the national protected area system in Ukraine".

[155] *Source:* Information Sheets on Ramsar Wetlands (RIS).

# ELANCIK RIVER BASIN[156]

The basin of the Elancik River is shared by Ukraine and the Russian Federation. The river has its source in the Russian Federation and discharges into the Black Sea (Sea of Azov). The 77-km long Suhoi Elancik is a transboundary tributary. Flow in the Elancik and the Suhoi Elancik is regulated to a large degree. In the Russian territory, there are six reservoirs.

The basin is lowland, with an average elevation of 110 m a.s.l.

Basin of the Elancik River

| Country | Area in the country ($km^2$) | Country's share (%) |
|---|---|---|
| Russian Federation | 310 | 60.2 |
| Ukraine | 197 | 38.3 |
| **Sub-total, Suhoi Elancik tributary** | **507** | |
| Russian Federation | 978 | 70.4 |
| Ukraine | 316 | 22.7 |
| **Total, Elancik** | **1 294** | |

In the Russian part of the basin, surface water resources are estimated at 0.0151 $km^3$/year (based on observations from 1950 to 1962), and groundwater resources at 0.209 $km^3$/year, adding up to a total of 0.224 $km^3$/year.

The basin of the Elancik is located within the Azov-Kuban Artesian Basin, where there are six major aquifer systems in the Upper Cretaceous, Paleocene-Eocene, Miocene and Quaternary sediments. Groundwater is used to support agriculture in the basin.

In total, there are some 20 ponds on the Elancik and the tributaries, which are used for fish farming. The river regulation causes reduction of reservoir volume by accumulating sediment, which, according to the Russian Federation, has a local but severe impact. The Elancik dries up in the summer, and ecosystems being negatively affected is a concern.

With a centralized water supply and wastewater collection lacking, wastewater is discharged into dug canals/pits. Water quality is affected in the Russian part by violations of limitations to economic activity in water protection zones, uncontrolled landfills, and watering livestock. All these factors are assessed by the Russian Federation as severe, but local in impact. Recreational use of the water bodies is a minor pressure.

In the Ukrainian part of the basin, there is hardly any economic activity; only one agricultural enterprise used water in 2009. Some 67% of the water use is met from groundwater. The trend of water withdrawal for agricultural use in the Ukrainian part has been decreasing since 2001. Urban wastewater discharges in Ukraine were limited in 2009 to one housing company.

## Status and responses

The concentration of sulphates, among other elements, is naturally elevated. Anthropogenic pressure in the Russian part is less pronounced, limited to the concentrations of some substances exceeding MAC, among them nitrites and $BOD_5$, as well as pesticides. In general, in Marfinka, 75 km from the river's mouth, water is classified as "dirty" (class 4b) according to the Russian system. These results are in line with the previous years.

An analysis of the current state of water resources in the Donetsk region — including the Elancik — was made in 2009 through a programme of restoring and maintaining the flow and cleanness of water in small rivers, financed from a local fund for environmental protection.

More than nine km of the river channel, from the Ukrainian border to Anastasievka village in Rostov oblast, have been dredged by the Russian Federation, contributing to both the reduction of impacts from flooding and clean-up of accumulated pollution. In the Russian Federation, the implementation of water conservation measures is constrained by the financial capacity of water users.

The Elancik is not included in joint monitoring between Ukraine and the Russian Federation. Ukraine underlines the need for harmonisation of methods and approaches in determining water quality at transboundary level, noting also a lack of prediction models for changes in the ecological status of water resources.

## Trends

No significant improvement is expected in the condition of the river. Regarding climate change, a scenario up to 2030 has been developed in Ukraine. Sector-specific vulnerability assessment at basin level is planned, to be followed by developing measures to improve resilience to climate change. The introduction of IWRM and rationalization of water use are already identified as a means to that end.

# MIUS BASIN[157]

The basin of the river Mius is shared by Ukraine and the Russian Federation. The river has its source in Ukraine and discharges into the Black Sea (Sea of Azov). The Krinka is a major transboundary tributary originating in the Donetsk region, and discharging into the Mius in the Rostov region of the Russian Federation.

The basin is characterized by Donetsk ridge and Pryazovska elevated plain, consisting mainly of lowland.

Sub-basin of the Mius River

| Country | Area in the country ($km^2$) | Country's share (%) |
|---|---|---|
| Ukraine | 2 530 | 96.2 |
| Russian Federation | 100 | 3.8 |
| **Sub-total, Krinka** | **2 630** | |
| Ukraine | 1 384 | 20.7 |
| Russian Federation | 5 296 | 79.3 |
| **Total** | **6 680** | |

Most of the annual run-off occurs during snow melting period, but, during low flow period, groundwater contribution

Total water withdrawal and withdrawals by sector in the Elancik Basin

| Country | Year | Total withdrawal $\times 10^6$ $m^3$/year | Agricultural % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|---|
| Russian Federation | 2009 | 0.34[a] | 76 | 24 | - | - | - |
| Ukraine | 2009 | 0.024[b] | 100 | - | - | - | - |

[a] Use is predicted to stay approximately at the same level until 2013.
[b] Main indicators of water use in Ukraine for 2009. Gosvodkhoz.

[156] Based on information provided by the Russian Federation and Ukraine.
[157] Based on information provide by Ukraine and the Russian Federation.

Total water withdrawal and withdrawal by sector in the Mius Basin

| Country | Year | Total withdrawal $\times 10^6$ m³/year | Agriculture % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|---|
| Russian Federation | 2009 | 14.94[a] | 28 | 51 | 3 | - | 19 |
| Ukraine | 2009 | 187.3[b] | 0.4 | 17.4 | 82 | - | 0.2 |

[a] Water use is predicted to stay at this same level as 2010 until 2013. Some 30% of the use is met by groundwater. Groundwater supports agriculture.
[b] The total groundwater abstraction in the Ukrainian part is reported to be some $154.7 \times 10^6$ m³/year (including the Krinka sub-basin), but the reported (consumptive) uses only make up $9.64 \times 10^6$ m³/year. The rest — 93.8% — is groundwater pumped from mines. Of the reported (consumptive) use, 22.7% is used for domestic supply and 76.8% for industry.

is important, as is, currently also mine waters and wastewater discharged by companies. In the Ukrainian part, Grabowski and Shterovskim reservoirs are used to regulate the flow. In the Russian part, there are 59 ponds and reservoirs. Groundwater occurs in Upper Pliocene and Quaternary formations, and commonly has medium links to surface water.

In the Ukrainian part, groundwater resources are estimated at 0.177 km³/year[158] (some 97% in Carboniferous formations, the rest in Cretaceous ones). They are considered to mostly link strongly with surface waters. In the Russian part of the basin, surface water resources are estimated at 0.397 km³/year (an average for years from 1948 to 1981), out of which 0.182 km³/year is estimated to come as inflow from Ukraine and rest forms in the Russian territory. Groundwater resources are estimated at $0.49 \times 10^6$ m³/year.

The load of heavy metals and dissolved mineral salts associated with discharges from active and abandoned coal mines in Donbas area in Ukraine is considerable, with a widespread and severe impact. A factor ranked as equally significant is the inappropriate disposal of solid waste: the operation of most landfills violates the regulations, and some have already exceeded their planned capacity. The other pressure factors in the Ukrainian part assessed as widespread but moderate include industrial discharges, surface water withdrawal, and groundwater abstraction. In the Russian part, the impact from discharges of urban wastewater not meeting the set regulatory requirements is widespread and severe. A lack of wastewater collection in rural settlements and wastewater treatment by local companies not being up to standard are more local concerns in the Russian part. Most wastewater treatment plants are in need of renovation. Among other pressure factors in the Ukrainian part of the basin are power plants' ash dumps, tailings ponds, metallurgical enterprises' stored liquid wastes, and waste rock from coal mining industry.

The closing of collective livestock and other farms significantly decreased the impact of agriculture on water resources. The trend of the total volume of return waters discharged to surface waters in the Mius Basin has been constantly decreasing, from about $280 \times 10^6$ m³/year in 2000 to some $160 \times 10^6$ m³/year in 2009, which relates to a decline in production by the coal industry (including closure of several mines), ferrous metallurgy, as well as water consumption by housing and communal services enterprises. The same tendency is reflected in the amount of dissolved solids discharged. Both discharge of mine waters and water abstraction for agriculture (irrigation) are assessed by the Russian Federation as local but severe in impact. Silting of the riverbed caused by flow regulation is a minor factor.

### Status and responses

The current state of water resources in small rivers of the Donetsk Region in Ukraine — including the Mius and the tributary Krinka — was analyzed in 2009 in the framework of a recovery programme for these rivers.

The water quality in the Mius and in the Krinka has been classified as "polluted"[159] (class IV) according to the Ukrainian system from 2006 to 2009, due to the level of sulphates, metals and $BOD_5$. According to the Russian Federation's classification, water quality in the Mius at Kuibyshev station at the border of Rostov and Donetsk oblasts is in class 4, "dirty", which has been the level in previous years. Anthropogenic influence is indicated by for example the following elements exceeding the MAC: phosphate-phosphorus, nitrites, ammonium-nitrogen and $BOD_5$. Elevated concentrations of sulphate and some metals are, according to the Russian Federation, linked to the naturally high salinity of the water.

According to an order by the Ministry of Natural Resources (July 2009) concerning measures to control water demand and to improve water efficiency, the Russian Federation requires quarterly reporting by water users to the oblast level on withdrawals and on meeting related requirements. At the end of 2006, the Government of the Russian Federation introduced fees for water withdrawal, use of the water surface and water use for electricity generation.

Work to identify areas vulnerable to flooding was carried out in the Ukrainian part between 1995–2006, but because of financial constraints, no flood zone maps have been produced. The Russian Federation is planning to dredge the river channel of the Mius in two locations by 2012: from the Ukrainian border to Kuybyshev district (12 km), and for a 7.5 km section in Kurgan district, which will serve mainly to reduce impacts from flooding.

The prediction of impacts of climate change and variability is at the same stage as for the Elancik.

Currently, the exchange of water quality data at border points is carried out quarterly, according to the bilateral agreement (1992). According to the Russian Federation, the convergence of test results of parallel and synchronous sampling is satisfactory. Nevertheless, according to Ukraine, the technical and methodical base of laboratories needs strengthening, especially in quality control.

A request has been prepared for funds from the Ukrainian State Fund for Environmental Protection in order to improve the monitoring of transboundary rivers in the Azov region and to explore the possibility of developing a Ukrainian-Russian joint project for improvement of the condition of transboundary waters in the basins of the Mius (including the Krinka) and the Elancik.

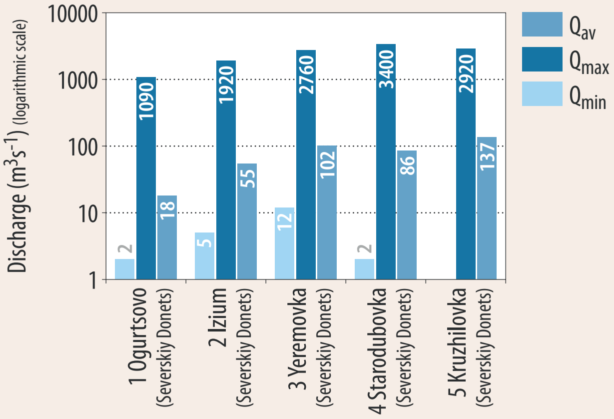
## SIVERSKY DONETS SUB-BASIN[160]

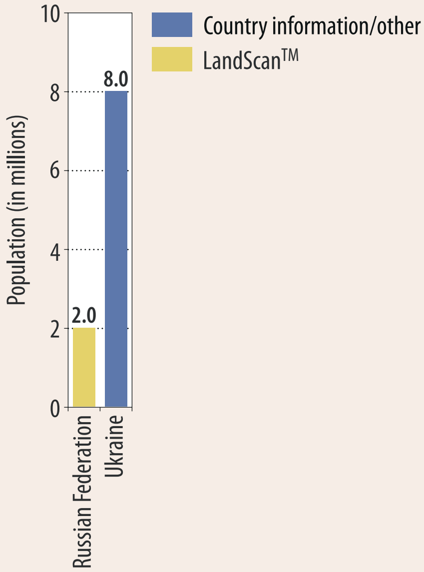
The basin of the river Siversky Donets is shared by Ukraine and the Russian Federation. The river has its source in the Russian Federation, and discharges into the Don, which in turn discharges into the Black Sea. The Oskol is a transboundary tributary.

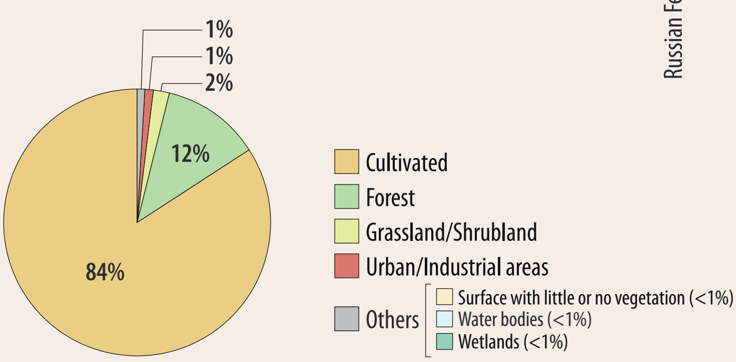
The character of the basin ranges from upland to lowland. Elevation varies from 140 to 200 m a.s.l. in the Russian part of the basin, to less than 100 m a.s.l. in the Ukrainian part.

[158] Including the sub-basin of the Krinka tributary. Source: Geoinform, Ukraine.
[159] The Krinka was exceptionally classified as "dirty" in 2008.
[160] Based on information provided by the Russian Federation and Ukraine, and the First Assessment.


**DISCHARGES, POPULATION AND LAND COVER IN THE SIVERSKY DONETS SUB-BASIN**




*Source:* UNEP/DEWA/GRID-Europe 2011.

Total water withdrawal and withdrawals by sector in the Siversky Donets sub-basin

| Country | Year | Total withdrawal $\times 10^6$ m³/year | Agriculture % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|---|
| Ukraine | 2009 | 1 431[a] | 4.7 | 69 | 25.7 | 9 | 0.6 |
| Russian Federation | N/A | 373.8[b] | 19.5 | 46 | 47[c] | 1.3 | 3.5 |

[a] Some 27% of this amount is groundwater abstraction. Some 40% of the total groundwater abstraction of 287.3 $\times$ 10⁶ m³/year is groundwater dumped from mines. Groundwater is used as drinking and household water (some 75% of the abstraction, mine water excluded) and for industry (21%); only 4% is abstracted for agriculture and irrigation. Surface water is used for agriculture and household needs.
[b] Some 86% of water consumption is met by groundwater. Groundwater supports agriculture, and is also used to supply household water and for industry. Groundwater is the source of water supply in areas outside the reach of the centralized distribution network.
[c] A reduction of industrial water withdrawals by 30% in the period from 2010 to 2013, due to the changes in facilities and products, is possible according to the Russian Federation.

Sub-basin of the Siversky Donets River

| Country | Area in the country (km²) | Country's share (%) |
|---|---|---|
| Ukraine | 3 910 | 26 |
| Russian Federation | 10 890 | 74 |
| **Sub-total, Oskol** | **14 800** | |
| Ukraine | 54 400 | 55 |
| Russian Federation | 44 500 | 45 |
| **Total** | **98 900** | |

*Source:* Report of the Joint Programme on management of the Donets River, Statistical yearbook "Environment of Ukraine" 2007

## Hydrology and hydrogeology

The surface water resources in the Russian part of the basin are estimated at approximately 4,600 × $10^6$ m³/year (based on flow measured at Belaya Kalitva, 119 km from the mouth of river, that is, confluence of the Siversky Donets and the Don).

In the Ukrainian part of the basin, surface water resources amount to 4.67 km³/year in an average year. Groundwater resources are estimated at 3.17 km³/year, most (65%) of which occur in Cretaceous formations, almost 20% in Carboniferous and smaller amounts in Triassic and Palaeogene formations.

The flow of the Siversky Donets is highly seasonally variable. In the Ukrainian part of the basin, the flow is mainly regulated by the Pecheniz'ke (on the Donets) and Krasnooskolskoe (on the Oskol) reservoirs. Channels have been constructed that bring water to the basin. Belgorod, Staroskolskoe and Sokolovsky Reservoir are the biggest — more than 10 million cubic metres — among some 105 reservoirs in the Russian part of the basin.

Hydrogeologically, most of the Siversky Donets Basin consists of the artesian basin of the Donetsk fold zone, and a smaller part of the Azov-Kuban artesian basin. Some 70% of the groundwater reserves are in chalk and marl deposits of Cretaceous age. Some decrease of groundwater levels has been observed due to consecutive dry years.

## Pressures

The coal industry, ferrous and nonferrous metallurgy, chemical and petrochemical industries have the greatest impact on water resources in the basin, accounting for 73% of wastewater discharges, 88% of contaminated water and 41% of water losses from the total volumes they use for production in the basin. Ukraine assesses the impact as widespread and severe. The discharge of highly mineralized waters from both operating and abandoned coalmines exerts pressure, limiting the suitability of water for use. According to Ukraine, most wastewater treatment facilities are in need of renovation, and centralized wastewater collection is lacking in a number of areas. The impact of municipal wastewaters discharges is ranked as local but severe. Limitations to activities in water protection zones are violated in some areas. The Russian Federation ranks all these as widespread but moderate pressure factors.

Locks in the last downstream 227 km of the river are filled during the navigation period, and some oil spills occur. The concentrations of some metals and sulphates are naturally elevated.

Run-off from agricultural land pollutes water bodies in the Ukrainian part.

Most landfills do not meet sanitary regulation requirements; some have already exceeded their design capacities.

The accumulation of sediment affects the reservoirs, e.g. the useful volume of Krasno-Oskol Reservoir has decreased by 50.4 ×$10^6$ m³ since its commissioning.

A lack of necessary funds for the planned reconstruction of sewage treatment facilities is a problem in the Russian part of the basin. As water protection measures tend to be supported from funds that remain after other costs have been covered by users, implementation often remains incomplete.

## Status and transboundary impacts

No significant changes in river water quality have been observed in the Russian part in the past few years. There is an intensive human impact both in Ukraine and in the Russian Federation, mainly from the coal industry, mine water discharges, irrigated agriculture, and public utilities. Industrial discharges have a transboundary impact.

From Lugansk oblast in Ukraine, river water entering the Russian Rostov oblast is reported to be in class 4, "dirty". Periodic releases of distillation liquids from a sodium carbonate company in Lugansk are reported. The Russian water management authorities had planned to strengthen water quality monitoring in 2010. The exchange of monitoring information between Ukraine and the Russian Federation is regular.

The discharges of return flows, salts (or dissolved solids) and organic matter (as BOD) has been decreasing since at least 2000, due to a decline in the production of the ferrous metallurgy and coal industries, and in water consumption in municipal housing services.

Ukraine reports that water quality in Siversky Donets at the village Ogurtsovo at the border of Belgogrod and Kharkiv oblasts fell into quality class 3, "moderately polluted" from 2006 to 2009. During the same period, water at the Popovka station at the border of Lugansk and Rostov oblasts in Ukraine was classified as "polluted" (class III). Water quality at Staraya Tavolzhanka (950 km from the river's mouth) in the Belgorod oblast of the Russian Federation, at the border with the Kharkov oblast of Ukraine, was classified as "polluted" (class 3) and the parameters exceeding MACs[161] were Cu, $Cr^{6+}$, Fe and $BOD_{5.}$

As mine water discharges have decreased due to the reduction of production and the closure of several mines, the related load has decreased, and no trend of significant deterioration in the quality of surface waters is observed, but their overall ecological condition is still a concern.

A decreasing trend of pesticide pollution has been observed in the past 15 years according to Ukraine's State Committee of Statistics, and during the past couple of years a small increase has been observed.

## Transboundary cooperation and responses

Cooperation on the Siversky Donets is formalized through the 1992 agreement between Ukraine and the Russian Federation. There are two border monitoring points where parallel sampling is carried out regularly. Based on the agreement, an exchange of data between Ukraine and the Russian Federation about water quality in the border segment is carried out quarterly in the intergovernmental data exchange system, adopted by the plenipotentiaries of Ukraine and Russia for every five years. This includes determining the locations, indicators of cross-sections of transboundary water bodies, a list of defined indicators, and methods and frequency of sampling. The system of data exchange on the status of transboundary waters in the basins of the Siversky Donets River and Azov region between water management organizations of the Siversky Donetsk in Ukraine and of the Don in Russia exists since 2006. A Memorandum of joint actions on the protection and use of water bodies of the Siversky Donets has also been signed (2001), involving Belgogrod, Donetsk, Kharkiv, Lugansk and Rostov oblasts. The oblasts of Lugansk (Ukraine) and Rostov (Russian Federation) have, since 1999, an agreement on the Kundryuchya River (a transboundary tributary).

In 2010, Heads of State of Ukraine and the Russian Federation decided to update the Interregional Ecological Programme on protection and use of waters in the basin of Siversky Donets River, developed in 2004, and to ratify it at the intergovernmental level.

Under the bilateral agreements (1992, 1996) an exchange of hydrometeorological information is carried out, including information about dangerous hydrometeorological events and environmental status.

At the national level in Ukraine, in 2009 Kharkiv, Donetsk and Lugansk oblasts' councils and the regional state administrations signed an agreement on joint use, conservation and restoration of water resources of the Siversky Donets. A River Basin Council for the Ukrainian part of the basin was established in 2007, and organising Ukrainian-Russian "round tables" was initiated in the framework of the Basin Council, bringing together representatives of Donetsk, Lugansk and Kharkiv oblasts.

A number of projects have supported the introduction of planning and management at basin level, the adoption of which is still pending. Among them are the project "Management of transboundary river basin: Phase 2 — Siversky Donets Basin", which led to development of a draft management plan, a TACIS project (2006-2007) where an enlarged River Basin Management Plan was developed and recommendations for experts in water management were prepared, and a Ukrainian-Danish project "Integrated water resources management in eastern Ukraine — the Siversky Donets River" (2006). An initiative has been prepared in 2010 for a third phase of the TACIS project, with the aim of developing a more detailed river basin management plan and program of measures to implement it.

Since 2006, a system of data exchange on the status of transboundary waters in the basins of the Siversky Donets River and Priasovie rivers between water management organizations of Ukraine and the Russian Federation has been developed under the above-mentioned TACIS project. The lack of a unified transboundary monitoring programme and GIS system for the basin is a shortcoming.

Programmes are being implemented in Ukraine to modernize urban wastewater treatment processes and to reduce discharges of untreated wastewaters. Surface waters are monitored for pollutants, and groundwaters are surveyed for possible impact of landfills. Radioactive elements are periodically monitored.

The draft plan for protection zones of water supplies and protective buffer zones around watercourses in the Russian part is reported to require revision. A new scheme of complex use and protection of water resources of the Don (including the Siversky Donets) is planned for 2014 in the Russian Federation.

In the Russian part, flood protection work has been carried out, in particular in the form of clearing some 11 km of river channel by removing silt and aquatic vegetation, and increasing the channel cross-section in narrow points.

[161] In this case MAC for fish life, which are the most strict.

# PSOU RIVER BASIN[162]

The basin of the river Psou is shared by the Russian Federation and Georgia. The river has its source on the Mountain Aigba at an elevation of 2,517 m, and discharges into the Black Sea.

The basin is mountainous in its upper part, with its tributaries forming steep-sided rugged valleys. The lower part of the basin, along the last 15 km, is hilly terrain. The average elevation is about 1,110 m a.s.l.

Basin of the Psou River

| Country | Area in the country (km²) | Country's share (%) |
|---|---|---|
| Georgia | 232 | 55.1 |
| Russian Federation | 189 | 44.9 |
| **Total** | **421** | |

## Hydrology

The river is fed by snow, rainwater and groundwater. The river is characterized by spring floods, with a peak in May. There is a low flow period in the summer (August–October) and in the winter (November–March).

In the part of the Psou Basin that is in Georgia's territory, surface water resources are estimated at 0.545 $km^3$/year (based on data from 1913 to 1955). Surface water resources in the territory of the Russian Federation are estimated to be approximately 0.593 $km^3$/year, and groundwater resources are 0.0219 $km^3$/year, for a total of 0.6149 $km^3$/year in the Russian Federation, or 53,700 $m^3$/year/capita.

## Pressures

Total water withdrawal in the Russian territory in the basin in 2008 was $1.544 \times 10^6$ $m^3$. Of the withdrawal, 87% was for domestic purposes and 13% for agriculture.

According to the Russian Federation, the main problems in the Psou Basin are breaking/erosion of the right bank upon flooding, and contamination of groundwater due to increased anthropogenic loading from the expansion of settlements in the Adler district of Sochi. Flooding is reported to have a widespread but moderate influence. Erosion and suspended sediments are assessed as serious issues, but spatially limited in impact.

The Russian Federation reports that, due to geochemical anomalies in the basin, some elements such as iron, copper, zinc and magnesium occur in elevated concentrations. The influence is local, but may be serious. To a limited extent, hydrotechnical constructions and tourism also affect water resources in the basin.

## Status and transboundary impacts

According to the classification applied in the Russian Federation, the river is clean (class 2).

## Responses

The Russian Federation reports that draft schemes for integrated use and protection of water bodies in the Black Sea Basin — including the Psou Basin — were prepared for a due date in 2010.

## Trends

No serious impact of climate change on rainfall and run-off is predicted in the basin by the Russian Federation. The predicted impacts include reduction of peak flow due to a decrease snow cover in the mountainous part of the basin, increasing the frequency of rain floods in the summer/autumn period.

No changes are expected in water use due to climate change, because of the low level of economic development in the Russian territory in the basin. Nevertheless, by 2020, total water use is expected to increase to $30.08 \times 10^6$ $m^3$/year.

### PSOU AQUIFER (NO. 122)

| | Georgia | Russian Federation |
|---|---|---|
| Type 3/1; alluvial aquifer consisting of boulder-gravels of the river valley alluvium, which is 100% hydraulically connected to surface water. Palaeogene and Quaternary (Holocene) in age. Groundwater flow direction from Georgia and the Russian Federation to the Psou River. 2) Sandstone aquifer. Cretaceous in age. Groundwater flow direction from Georgia to the Russian Federation. The aquifers discharge partly to the Black Sea. Both aquifers are strongly linked with surface water. | | |
| Thickness: mean, max (m) | N/A | 1) 22,60<br>2) 35,50 |
| Groundwater resources (m3/day) | N/A | 60 000 |
| Groundwater uses and functions | N/A | The alluvial aquifer is 57 km long, the sandstone aquifer 47 km. Current abstraction: 3 800 m3/day. |

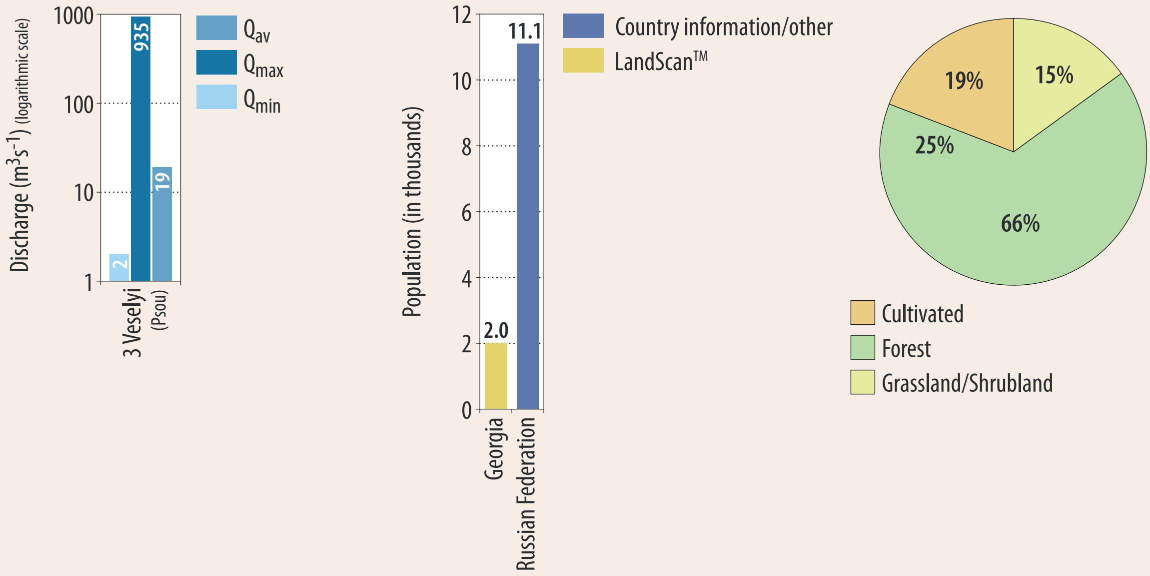
The average concentrations of monitored chemical determinands in the Psou River for the period 2006–2009

| | Total dissolved solids mg/l | Suspended solids mg/l | BOD mg/l | $NO_3^-$ mg/l | $NH_4^+$ mg/l | $Cl^-$ mg/l | $SO_4^{2-}$ mg/l | Fe mg/l | Cu mg/l | $Zn^{2+}$ mg/l | $Mn^{2+}$ mg/l | Pb mg/l | Total P mg/l | Phosphates mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAC[a] | 1 000 | 20 | 2 | 40 | 0.5 | 300 | 100 | 0.1 | 0.001 | 0.01 | 0.01 | 0.006 | 0.5 | 0.2 |
| River mouth | 226 | 30 | 0.82 | 0.48 | 0.53 | 1.21 | 9.81 | 0.22 | 0.007 | 0.01 | 0.09 | 0.004 | 0.09 | 0.05 |
| Upstream | 173 | 30 | 1.16 | 0.67 | 0.10 | 1.66 | 7.20 | 0.25 | 0.007 | 0.01 | 0.02 | 0.003 | 0.03 | 0.05 |
| Middle part | 200 | 30 | 0.99 | 0.81 | 0.39 | 1.43 | 8.51 | 0.23 | 0.007 | 0.01 | 0.06 | 0.003 | 0.06 | 0.05 |

[a] Maximum allowable concentration.
*Source:* Russian Federation.

[162] This section is based on information from Georgia and the Russian Federation, and the First Assessment.

DISCHARGES, POPULATION AND LAND COVER IN THE PSOU RIVER BASIN




*Source:* UNEP/DEWA/GRID-Europe 2011.

# CHOROKHI/CORUH RIVER BASIN

The basin of the river Chorokhi/Coruh[163] is shared by Turkey and Georgia.[164] The more than 430 km-long[165] river has its source in Turkey, at the height of approximately 2,700 m a.s.l., and discharges into the Black Sea. The Machakhelisckali/Macahel River is a transboundary tributary.

The basin has a pronounced high and hilly mountainous character, with an average elevation of about 1,132 m a.s.l. The Coruh River leaves the mountainous topography and enters into meandering floodplain in Georgia before it flows into the Black Sea.

Basin of the Chorokhi/Coruh River

| Country | Area in the country (km²) | Country's share (%) |
|---|---|---|
| Turkey | 19 872 | 91.3 |
| Georgia | 1 900[a] | 8.7 |
| **Total** | **21 772** | |

[a] Source: Resource of Surface Water. National Agency of Environment, Department of Hydrology, Georgia. 1974.

## Hydrology and hydrogeology

In the Turkish part, the flow regimes are irregular, with a large variation in run-off parameters. This part of the river basin is also prone to floods.

Surface water resources in the territory of Turkey are estimated to be approximately 6.3 km³/year, and groundwater resources 0.045 km³/year, making up a total of 6.345 km³/year or 19,650 m³/year/capita. In Georgia's territory (based on observations from 1951 to 1992), the surface water resources are estimated to be approximately 8.711 km³/year or 64,475 m³/year/capita.

## Pressures

Groundwater and spring water is used in both Turkish and Georgian territory for domestic water supply in the settlements of the river basin.

In the Turkish part of the basin, two hydropower stations are operational at the present time: Muratli dam, 100 m upstream from the border, since 2005; and Borçka dam, since 2007. They have installed capacities of 115 MW and 300 MW, respectively. In the Coruh River Development Plan (General Directorate of State Hydraulic Works, Turkey, 1982), 10 hydropower projects along the main river are planned in a cascade style on the upper, middle and lower main course in the Turkish part of the Coruh River. The Lower Coruh projects are either in operation (Muratli and Borcka) or under construction (Deriner). The Middle Coruh projects (Yusufeli and Artvin) are under final design or in the process of arranging investment, and the Upper Coruh projects (Laleli, Ispir, Gullubag, Aksu and Arpun) are either in the early planning or the planning stage. Together, they will have an installed capacity of 2,536 MW, and will be utilized for the generation of 8,320 GWh/year when all the proposed projects are operational. In this development plan, three large reservoirs are to be constructed at Laleli, Yusufeli, and Deriner sites. The regulation will mitigate the effects of floods downstream. Existing and planned hydropower stations will result in some changes in natural river flow regime, river dynamics and morphology.

Total water withdrawal and withdrawals by sector in the Chorokhi/Coruh Basin

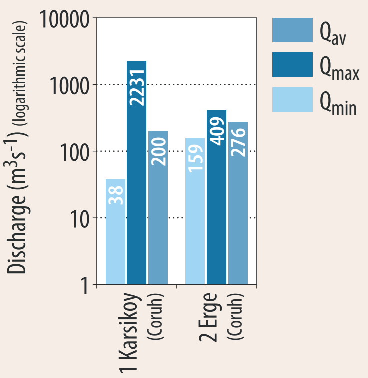
| Country | Total withdrawal $\times 10^6$ m³/year | Agricultural % | Domestic % | Industry % | Energy % | Other % |
|---|---|---|---|---|---|---|
| Georgia | 724 | | 0.4 | 0.1 | 99 | 0.5 |
| Turkey | 81[a] | 56 | 44 | N/A | 0 | N/A |

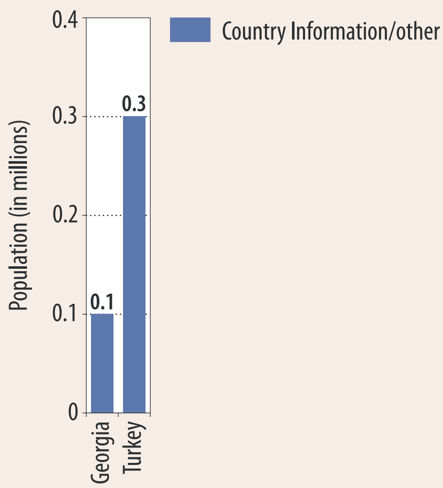
[a] This figure only includes the estimated agricultural ($45 \times 10^6$ m³/year) and domestic use ($36 \times 10^6$ m³/year), which are the main recorded consumptive uses. No consumptive use for energy purposes is reported.

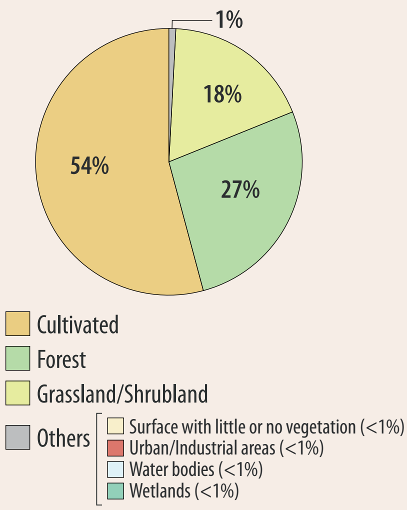
[163] The river is known as Chorokhi in Georgia and as Coruh in Turkey.
[164] For the location, please refer to the map in the assessment of the Samur River.
[165] According to Turkey, the length of the river is approximately 431 km (410 km in Turkey and 21 km in Georgia), and according to Georgia approximately 438 km (*Source:* Resource of Surface Water. National Agency Of Environment, Department of Hydrology, 1974). Georgia reports about 26 km of the river length to be in Georgia.

## DISCHARGES, POPULATION AND LAND COVER IN THE CHOROKHI/CORUH RIVER BASIN


## DISCHARGES, POPULATION AND LAND COVER IN THE CHOROKHI/CORUH RIVER BASIN




*Source:* UNEP/DEWA/GRID-Europe 2011; Turkish Statistical Institute, 2008

A "washing away" problem is experienced in the coastal zone near the river mouth due to reduced sediment load. The maintenance of the sediment transport to sustain sandy beaches at the Black Sea coast is vital for tourism, which is of prime importance to Georgia's earnings. The problem of erosion, manifested by a high load of sediments in the river water (estimated at $5.8 \times 10^6$ $m^3$ annually), is assessed by Turkey as widespread but moderate.

The impact of agriculture is reported to be only local in both countries, but severe in the Georgian part and moderate in the Turkish part of the basin. The nutrient loads from agriculture in the Turkish part of the basin were estimated in 2005 to be 1,528 tons/year of nitrogen and 153 tons/year of total phosphorus.[166]

Because of a lack of wastewater treatment plants in urban settlements, wastewater discharges exert a pressure on water quality. Considered local and moderate in impact, the loads from municipal wastewater in the Turkish part of the basin were estimated in 2005 to be as follows: BOD 1,135 tons/year; COD 2,579 tons/year; nitrogen 213 tons/year; and total phosphorus 43 tons/year. Organic loads from industrial wastewater were estimated to be 858 tons/year as BOD and/or 1,850 tons/year as COD.[167] There are no sanitary landfills in municipalities on the Turkish side yet, and controlled dumpsites are reported to exert pressure on water quality, human health, and landscape.

The region of the Coruh River Basin has a considerable potential for nature and eco-tourism, which at the present is relatively little developed.

## Status

According to water quality measurements, the water quality of the Coruh River generally falls into Class I and Class II (Unpolluted and Less polluted water body), according to Turkish Inland Water Quality Standards (derived from Water Pollution Control Regulation).

According to the Ministry of the Environment and Natural Resources of Georgia, based on data from 2007 to 2009, the chemical and ecological status of the river system is good.

## Transboundary cooperation

There are no joint bodies on transboundary waters in the Chorokhi/Coruh River Basin at the present time. Only some bilateral agreements and protocols exist on water-related issues in the basin between Georgia and Turkey, based on which bilateral technical cooperation and technical meetings have been held since 1994, and a working group for joint monitoring has been in existence since 1998. This cooperation is regular. Based on the agreement between the Turkish and Georgian Governments, three flow-gauging stations were established by the Turkish Government at three locations in Georgia: on the Acara tributary, the Machakhelisckali/Macahel tributary, and on the main river channel at Erge. Since 1999, 20 sets of joint measurements have been carried out, and the results have been communicated to Georgia through diplomatic channels.

In order to identify, monitor and evaluate changes which may occur after implementation of the planned dam projects, including the situation of sediment trapping in reservoirs, Turkey and Georgia have agreed on and implemented, since 1996,

[166] National Action Plan for Land Based Sources for Turkey. Scientific and Technological Research Council of Turkey (TÜBőTAK), Marmara Research Centre (MRC), Chemistry and Environment Institute (CEI), Kocaeli, Turkey. 2005.

[167] National Action Plan for Land Based Sources for Turkey. Scientific and Technological Research Council of Turkey (TÜBőTAK), Marmara Research Centre (MRC), Chemistry and Environment Institute (CEI), Kocaeli, Turkey. 2005.

survey and monitoring work on the Chorokhi/Coruh River, including the Georgian river section, the river mouth, and the Black Sea coastline up to Batumi. An Environmental Impact Assessment for Yusufeli dam was prepared in 2006.

Communications and meetings have been reported between Georgian and Turkish delegations concerning establishment of early warning systems on the Chorokhi/Coruh River.

## Responses

Water resources development projects in the Turkish part of the Coruh River Basin have been carried out according to the developed master plans, which generally include economic development of the basin's water resources for hydropower, irrigation and domestic uses. These master plans also include some other issues, such as flood protection and water quality aspects of the river basin. Presently there is no existing comprehensive IWRM plan for the whole Chorokhi/Coruh River Basin; however, Turkey plans to prepare a Coruh River Basin Management Plan within a 3–10 year time frame as part of an envisaged national adaptation strategy to climate change. According to the project on the strategic orientations of activity of the Ministry of the Environment and Natural Resources of Georgia (2009), the development of a river basin management plan for the part of the Chorokhi Basin that is in the territory of Georgia is scheduled for the period from 2011–2013.

Preliminary work for the installation of a wastewater collecting and treatment plant for Artvin and Bayburt cities located in Turkish part of the Coruh Basin has been carried out. Wastewater treatment for cities and urban areas is required in Turkey, and Turkey reported that treatment facilities would be installed in the near future. Installation of industrial wastewater treatment plants is also required for new and existing industrial facilities in Turkey. Wastewater from villages is generally disposed of via seepage pits.

General erosion control within the Coruh River Basin has been carried out by the Turkish General Directorate of Aforestation and Erosion Control and the General Directorate of State Hydraulic Works (DSI) since 2001. Aforestation activities and campaigns in some areas of the Turkish part of the catchment are ongoing. The Turkish Soil Pollution Control Regulation, dating from 2005, contributes to soil quality protection.

Problems related to flooding, which in the Turkish part of the basin are assessed to be widespread and severe, are addressed through construction of multi-purpose dams and reservoirs on the main river course, as well as by the construction of flood control structures in tributary streams and rivers threatened by flooding.

## Trends

In the part of the basin that is part of Turkey's territory, based on global and long national scenarios and predictions of climate change modelling, by 2100 an increase of 10 to 20% in precipitation and increased variability in precipitation is predicted seasonally. An increase is expected in run-off, in variability of precipitation, and in flood risk. Groundwater levels are also predicted to rise as a result of increased precipitation, and the overall impact of climate change on groundwater quality is expected to be positive. Non-consumptive use of water for hydropower generation is expected to increase. Pressure on water quality from municipal and industrial wastewater is expected to decrease as a result of the installation of wastewater treatment plants. Flooding risk will also be better controlled as a result of river flow regulation, upon completion of the dam projects on the main course of the river.

# MACHAKHELISCKALI/MACAHEL SUB-BASIN

The 37-km-long Machakheliscкali/Macahel River[168] has its source in Turkey at a height of 2,285 m and flows from the Southern side of Mereti Mountain, discharging into the Chorokhi/Coruh River in Georgia.

Sub-basin of the Machakheliscкali/Macahel River

| Country | Area in the country ($km^2$) | Country's share (%) |
|---|---|---|
| Georgia | 188 | 50.9 |
| Turkey | 181 | 49.1 |
| **Total** | **369** | |

Surface water resources in the Georgian part of the basin are estimated at approximately 0.027 $km^3$/year (based on observations from 1951 to 1992), which is about 8,280 $m^3$/capita/year.

Approximately 8% of the land in the Georgian part of the basin is cropland. Non-point source pollution from the use of fertilizers in agriculture is reported by Georgia, but the impact is assessed to be only local and moderate.

In 2008, the only reported water use in the Georgian part of the basin was energy: 177 × $10^6$ $m^3$/year for (non-consumptive) hydropower generation on the Adjaristskali tributary. The water use is expected to remain unchanged in the Georgian part until 2015.

[168] The river is known as Machakheliscкali in Georgia and Macahel in Turkey.