CHAPTER 7
DRAINAGE BASINS OF THE NORTH SEA AND EASTERN ATLANTIC

This chapter deals with the assessment of transboundary rivers, lakes and groundwaters, as well as selected Ramsar Sites or other wetlands of transboundary importance, which are located in the basins of the North Sea and Eastern Atlantic.

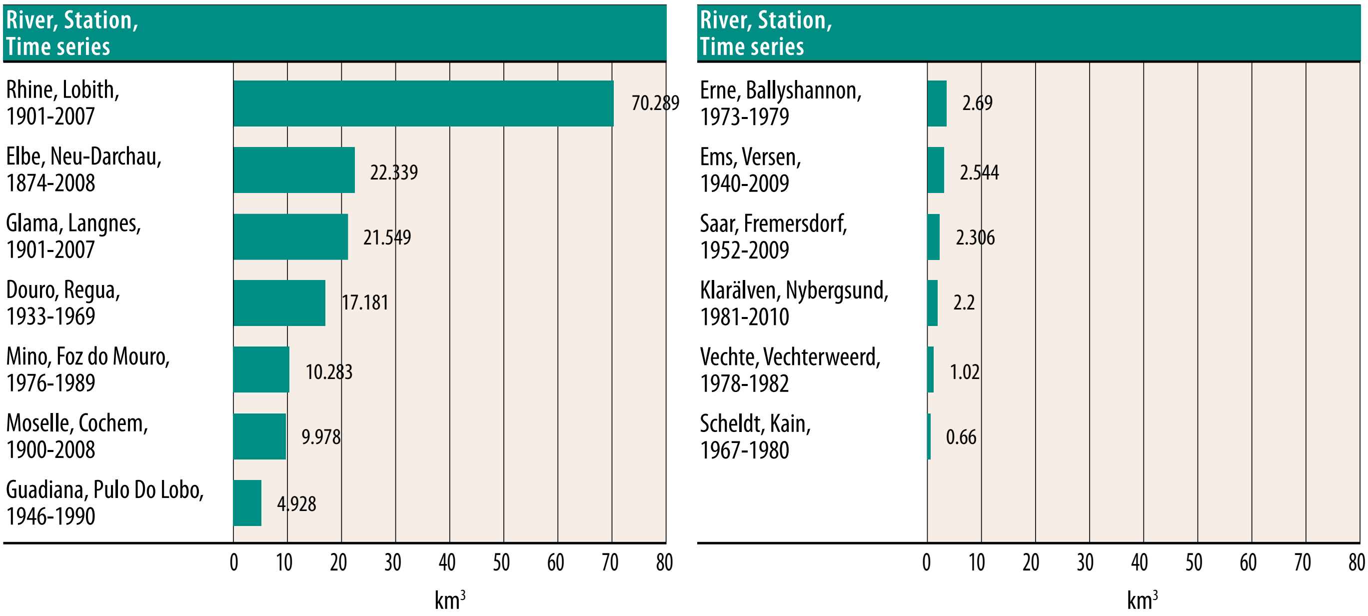
Assessed transboundary waters in the drainage basins of the North Sea and Eastern Atlantic

Basin/sub-basin(s)	Recipient	Riparian countries	Lakes in the basin	Transboundary groundwaters within the basin	Ramsar Sites/wetlands of transboundary importance
Glama/Glomma	North Sea	NO, SE			
Klarälven	North Sea	NO, SE			
Wiedau/Vidaa	North Sea	DK, DE		Wiedau/Vidaa aquifer (DK, DE) (includes *Gotteskoog-Marchen (Ei 22), Gotteskoog-Altmoränengeest (Ei 23) (DE), DK4.1.2.1.Hellevad, DK4.1.1.2.Hjerpsted, DK4.1.2.2.Kliplev, DK4.1.1.1.Tinglev, DK4.1.2.4.Tinglev, DK4.1.3.1.Tinglev, DK4.1.2.3.Tonder(DK))*	Wadden Sea (DK, DE, NL)
Elbe	North Sea	AT, CZ, DE, PL		*Lainsitz Area/Trebon Pan (AT, CZ), Cheb Pan, Decinsky Sneznik Dolni Krmenice and Krimice Cretaceous, Upper Ploucnice Cretaceous, Glaciofluvial Sediments in Frydlant Offspur, Police Pan and Hronov-Porici Cretaceous (CZ, DE)*	Krkonoše/Karkonosze subalpine peatbogs (CZ, PL)
Ems	North Sea	DE, NL		*DE_GB_:37_01, 39_10 (DE, NL). NLGW:0001, 0008 (DE, NL), 2 – 5, 15, 101, 105, 109 – 113 (NL). DE_GB_3_: 01 – 20. DE_GB_36_01 – 05. DE_GB_:37_02 – 03, 38_01 – 02. DE_GB_39_01– 09 (DE).*	Wadden Sea (DK, DE, NL)
Rhine	North Sea	AT, BE, DE, FR, IT, LI, LU, NL, CH	Lake Constance	*DE_GB_3_:01, 04, 08, 09, 11 – 14, 19, 20. DE_GB_37_:01, 02. NLGW:0001, 0008, 109 (DE). Lower Lias Sandstone of Hettange Luxembourg, confined non-mineralized Vosges sandstone (BE, FR), Pliocene of Haguenau and the aquifer of Alsace (FR, DE, CH), unconfined Vosges sandstone, Lower Trias sanstone of Houiller Bassin (FR, DE), Limestones and Jurassic marls of Jura Mountains and, Jurassic limestones of Jura Mountains - BV Doubs and, Jurassic Limestones BV of Jougnena and Orbe (FR, CH), Sediments of Quaternary and Pliocene (FR, DE), Oberrheingraben Mitte/Süd (FR, DE, CH), North-Germany/ Netherlands (GE, NL), Hochrhein (GE, CH)*	Upper Rhine (Rhin supérieur/ Oberrhein) (FR, DE), Wadden Sea (DK, DE, NL)
- Moselle	Rhine	BE, FR, DE, LU			
-- Saar	Moselle	FR, DE			

Basin/sub-basin(s)	Recipient	Riparian countries	Lakes in the basin	Transboundary groundwaters within the basin	Ramsar Sites/wetlands of transboundary importance
Meuse	North Sea	BE, FR, DE, LU, NL		*Lower Lias Sandstones of Hettange Luxembourg, confined non-mineralized Vosges sandstones (BE, FR), Limestones of Avesnois (BE, FR), cks_0200_gwl_1 (BE, NL), blks_1100_gwl_1s, blks_1100_gwl_2s (BE), Chalk du Valenciennois (BE, FR), Brussels sands (BE), Chalks de la Haine (BE, FR), Landenian sands (east) (BE), Schelde Basin Aquifer System (BE, FR, NL), Roerdal Slenk System, Hard Rock (BE, NL), Venlo-Krefeld Aquifer(GE,NL)*	
Scheldt	North Sea	BE, FR, NL		*Limestones of Avesnois, Carboniferous Limestone of Roubaix-Tourcoing, Chalk of Valenciennois, Chalks of Haine, Chalk of the valley of Deule, Chalks of Deûle (BE, FR), Chalk of the valleys of Scarpe and Sensée (FR), Hard Rock (BE, FR, NL), Brussels sands (BE), Landenian sands (east), Landenian sands of Flemish Region (BE), Thanetian sands of Flemish Region, Sands of the valley of Haine, Landenian sands of Orchies (BE, FR), Saline groundwater in shallow layers of sand, Fresh groundwater in shallow layers of sand, Fresh groundwater in bay areas, Groundwater in deep layers of sand (BE, NL), Bruxellien_Brusseliaan_5, Landenien_Landeniaan_3, Hardrock of Brabant, Socle_Sokkel_:1, 2. Ypresien_Ieperiaan_4 (BE), cks_0200_gwl_1 (BE, NL), cvs_0100_gwl_1, cvs_0160_gwl_3 (BE, FR), cvs_0400_gwl_1, cvs_0800_gwl_3 (BE), blks_0600_gwl_1, blks_1100_gwl_2s (BE). ss_1000_gwl_:1 (BE, FR), 2 (BE). ss_1300_gwl_:2 (BE), 1, 4 (BE, FR). kps_0160_gwl_: 1 (BE, FR), 2 (BE), 3 (BE, NL). kps_0120_gwl_: 1, 2 (BE).*	
Bidasoa	Eastern Atlantic	FR, ES			Bidasoa estuary/Txingudi (FR, ES)
Miño/Minho	Eastern Atlantic	PT, ES	Frieira Reservoir	*Alluvium of Minho/Bajo Miño (U.H. 01.26) (PT, ES)*	
Lima/Limia	Eastern Atlantic	PT, ES			
Douro	Eastern Atlantic	PT, ES		*Nave de Haver/Ciudad Rodrigo-Salamanca (U.H.02–19) (PT, ES)*	
Tejo/Tajo	Eastern Atlantic	PT, ES	Cedillo Reservoir	Toulóes/Moraleja (U.H.03–13) (PT, ES)	
Guadiana	Eastern Atlantic	PT, ES		*Miocene-Pliocene-Quatenary of Elvas-Campo Maior/Vegas Bajas (U.H.04–09), Mourão-Ficalho (PT, ES)*	
Erne	Eastern Atlantic	IE, GB	Lough Melvin	*IEGBNI_NB_G_:011, 012, 014, 019. IEGBNI_NW_G_:005, 009 – 014 (IE, GB), 015 (GB), 017, 021, 025 (IE, GB), 027 (GB), 028, 030 – 036, 039, 040, 044, 050, 063 (IE, GB). IE_NW_G_: 018, 042, 043, 045, 046 (IE), 047 (IE, GB), 061, 062, 067 – 073 (IE), 074 (IE, GB), 076 – 084, 086 – 092, 095 – 098. IE_NB_G_:013, 036 (IE).*	
Foyle	Eastern Atlantic	IE, GB		*IEGBNI_NW_G_:005, 010, 011, 014, 017, 044, 048, 050, 051, 059, 094 (IE, GB). IE_NW_G_: 018, 043, 045, 046 (IE) 047 (IE, GB), 049, 052, 054, 056, 058, 067 – 071, 073 (IE), 075 (IE, GB), 076 – 079, 082 – 087, 089 – 091 (IE).*	Lough Foyle wetland (IE, GB)
Bann	Eastern Atlantic	IE, GB	Lough Neagh	*IEGBNI_NB_G_:007, 011, 012, 014, 019. IEGBNI_NW_G_:025, 028, 063 (IE, GB). IE_NB_G_:013, 015 – 018, 021 – 035, 037, 038. IE_NW_G_061 (IE).*	

Notes: The groundwaters in italics have not been assessed for the present publication.

Long-term mean annual flow (km^3) of rivers discharging to the North Sea and Eastern Atlantic



Sources: Norwegian Water and Energy Directorate (Klarälven); Global Runoff Data Centre, Koblenz (all other rivers).

GLAMA/GLOMMA RIVER BASIN[1]

Norway and Sweden share the basin of the about 604-km long Glama/Glomma River[2], as approximately 1% of the catchment lies within Sweden. The main watercourse Glama/Glomma, joined with the Lågen, the western tributary, runs from the Norwegian-Swedish highland areas to Oslofjord. Lake Aursunden and Lake Mjøsa are lakes in the basin.

Basin of the Glama/Glomma River

Country	Area in the country (km^2)	Country's share (%)
Norway	42 019	99
Sweden	422	1
Total	**42 441**	

Source: Norwegian Water and Energy Directorate.

Hydrology and hydrogeology

Some 70% of the catchment area is above 500 m a.s.l., and 20% above 1,000 m a.s.l. The surface water resources are estimated at 22 km^3/year (as run-off). There are more than 40 dams and 5 transfers of water between sub-basins in the watercourse.

The Glama/Glomma has experienced several major floods due to melting snow from Jotunheimen, Rondane and other mountain areas in Norway. In 1995, a combination of snow-melt and heavy rainfall caused extensive damage to infrastructure, buildings, and farm land along the water course.

Transboundary groundwaters are irrelevant water resources in the basin.

Pressures and status

There are 5 Ramsar Sites and 2 national parks partly within the river basin. Some 32 % of the basin is protected against further hydropower development.

The total water withdrawal in the Norwegian part of the basin is 3.9×10^6 m^3/year, out of which 5% is for domestic use, and the rest is temporary reservoir storage for hydropower production[3].

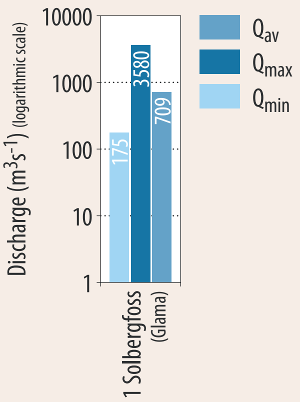
Within the river basin, there are more than 50 hydropower plants and more than 20 storage reservoirs. The hydropower stations on the rivers Glama/Glomma and Lågen cover about 9% of Norway's electricity demand.

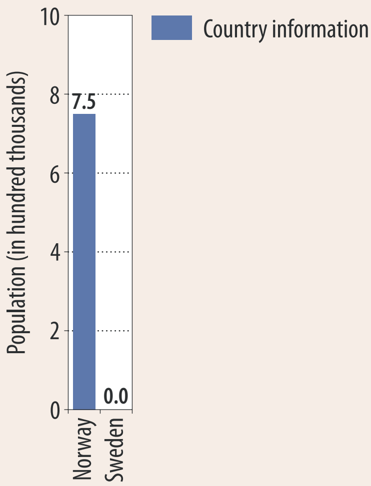
The total agricultural area in the basin, mainly located in the southern part, is about 3,500 km^2. The lower part of the river was industrialized in the beginning of the 20th century, the main activities being pulp and paper industries, and a zinc smelter. Today, one of the main industrial activities is a chromium-titanium plant situated close to the river mouth. There is also a large plant for waste incineration, and the pulp and chemical industry is still important in the community of Lower Glomma.

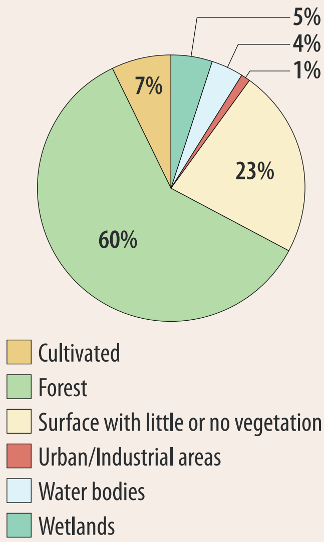
The risk analysis done in accordance with the WFD (2011) shows that approximately 30% of the water bodies are at risk of not achieving good ecological status in 2015. Some 33 % are possibly at risk, and the rest are of good status.

[1] Based on information provided by Norway and the First Assessment.
[2] The river is known as Glama in Sweden and Glomma in Norway.
[3] *Sources:* Norwegian Water and Energy Directorate, the Glommens and Laagens Water Management Association.

DISCHARGES, POPULATION AND LAND COVER IN THE GLAMA/GLOMMA RIVER BASIN







Sources: UNEP/DEWA/GRID-Europe 2011; Norwegian Water and Energy Directorate.
Note: Population in the Swedish part of the basin is approximately 100 inhabitants (LandScan).

The "Riverine inputs and direct discharges to Norwegian coastal waters – 2008" programme shows that the input of total organic carbon (TOC) is 109,124 tons from the Glama/Glomma in 2008 to the Skagerak area. The corresponding figures for total phosphorus is 543 tons, and for total nitrogen is 15,075 tons. This represents an increase in the concentrations of total nitrogen since 1990.

Transboundary cooperation and responses

Transboundary issues between Sweden and Norway are handled in accordance with the Water Convention (1992), and a Memorandum of Understanding (2008) describing the implementation of the WFD by the two countries.

Norway, not being an EU member State, voluntarily implemented the WFD in selected sub-districts across the country from 2007 until 2009, thus gaining experience in River Basin Management planning. River Basin Management Plans for the selected sub-districts were adopted by the County Councils in 2009, and approved by the national Government in June 2010. RBMPs covering the entire country are prepared from 2010 until 2015, synchronized with the time schedule of the second cycle of implementation in the EU.

Trends

More precipitation is anticipated due to climate change, particularly in Western and Northern Norway. The projections from the RegClim research programme show that in the 2030–2050 period, around 20% more precipitation can be expected in autumn in these regions, compared to the period 1980–2000. In Eastern Norway, the increase in precipitation is expected to primarily occur in winter. The temperature is expected to rise over the whole country, but mostly in winter and in Northern Norway.

The average wind velocity is expected to increase a little in most regions during the winter half-year. The frequency of storms causing great damage will probably rise somewhat, and will occur mostly along the coast of "Møre og Trøndelag" county.[4]

KLARÄLVEN RIVER BASIN[5]

The almost 460-km long Klarälven River ("clear river" in Swedish) runs for almost 300 km on Swedish territory. The river begins with a number of streams flowing into Lake Femunden on the Norwegian side of the border. Some of these watercourses also come from Sweden, mainly from Lake Rogen in Härjedalen. The river flowing south from Lake Femunden is first called the Femundselva and later the Trysilelva. The river crosses the border, where it changes its name to Klarälven. It flows through northern Värmland, where it follows a valley towards the south. The river empties into Lake Vänern in Sweden, with a delta near Karlstad.

The Klarälven River has a basin area of about 7,800 km², of which 80% is covered with forests (76% of growing forest and 4% of cutting areas), 10% by wetlands, 6% by water bodies, 2% by cultivated area and 2% by grasslands/shrublands.

The surface water resources are estimated at 2.2 km³/year (as run-off, based on the Nybergsund gauging station some 25 km upstream from the Swedish-Norwegian border).

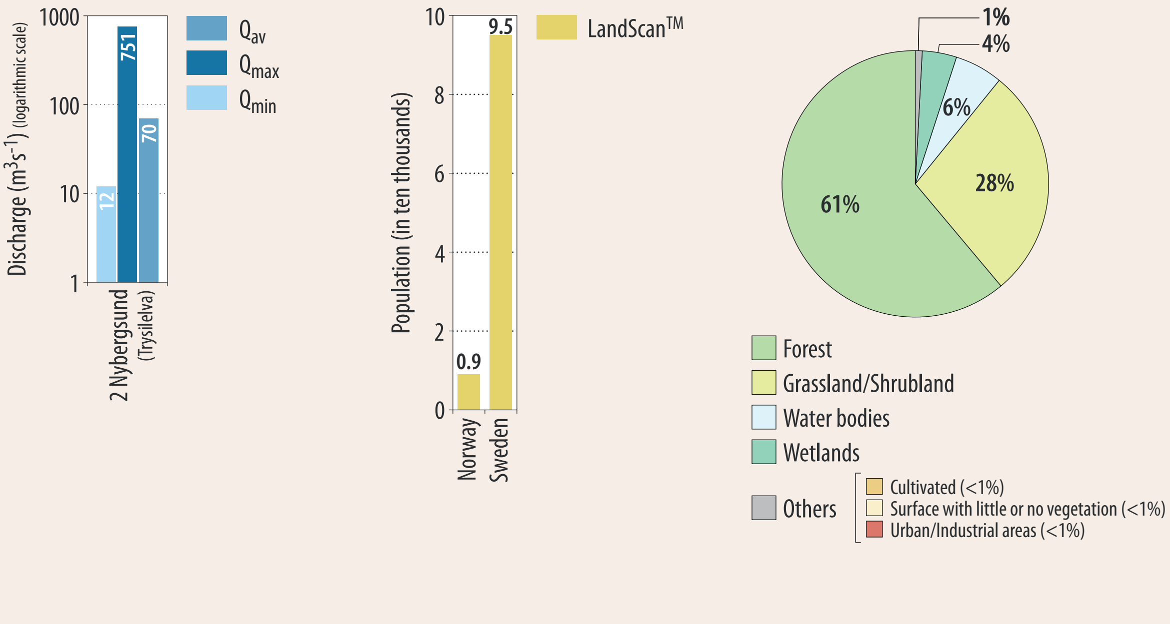
The river's average discharge is 165 m³/s; the maximum measured discharge was 1,650 m³/s. Spring floods are common, mainly caused by run-off from the snowy mountains in the northern areas of the basin.

Status

The Klarälven has clean and fresh water, suitable for bathing. The river is internationally recognized as an excellent sport fishing watercourse. According to monitoring data from the river delta for the period 2003-2009, the river carried on average 53,000 tons of TOC, 66 tons of phosphorus and 1,800 tons of nitrogen per year.

The risk analysis done in accordance with the WFD (2011) in the Norwegian part of the basin shows that approximately 25% of the water bodies are at risk of not achieving good ecological status in 2015. Some 10% are possibly at risk, and the rest are of good status.

DISCHARGES, POPULATION AND LANDCOVER IN THE KLARÄLVEN BASIN



Sources: UNEP/DEWA/GRID-Europe 2011; Norwegian Water and Energy Directorate.

[4] *Source:* Center for International Climate and Environmental Research (CICERO), Oslo.
[5] Based on information provided by Norway and Sweden, and the First Assessment.

The number of waters "at risk" is high for two reasons:[6]

(1) Many waters are acidified but treated with lime, which leads to ecological "good status"; the acidification is still there, however, thus the water bodies are "at risk".
(2) About 60% of the watercourses have water flow changes caused by hydropower, and many of them are "at risk"; 70% of the lakes have lowered status or are "at risk" with respect to water level amplitude. This shows that the effects of hydropower are clearly an issue.

Responses

In recent years, the lower parts of Klarälven and Karlstad have become a flood risk area. Karlstad is presently part of the Interreg project SAWA (Strategic Alliance for Integrated Water Management Actions), and works with a pilot programme within the EU Floods Directive. There is also a Swedish-Norwegian Interreg cooperation programme to promote salmon migration and ensure good ecological status in the whole transboundary river basin.

WIEDAU/VIDAA RIVER BASIN[7]

The Wiedau/Vidaa River[8] is shared by Denmark and Germany (Schleswig-Holstein). It starts east of Tønder (Denmark) and flows to the west, through Ruttebüller Lake/Rudbøl Sø (shared by Germany and Denmark), discharging into the Wadden Sea at the German-Danish North Sea coast (see the assessment of the related Ramsar Site).

The Wiedau is a lowland and tidal river, with an average elevation of only about 7 m a.s.l.

Basin of the Wiedau/Vidaa River

Country	Area in the country (km²)	Country's share (%)
Denmark	1 080	80.5
Germany	261	19.5
Total	**1 341**	

Sources: Ministry of Environment, Nature Protection and Nuclear Safety, Germany; LIFE Houting-project.

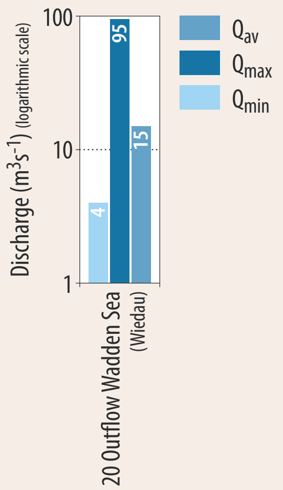
Hydrology and hydrogeology

The Wiedau/Vidaa is highly controlled by weirs and gates to protect it from tides and surges. The sluice at Højer town regulates the water exchange with the Wadden Sea. It discharges into the Wümme River, and finally into the North Sea.

In the past, the main parts of the watercourses in the basin were heavily modified through drainage, dredging and physical alterations. During the last decade, Denmark has completed a number of nature restoration projects, including the reconstruction of 27 smaller weirs to make them passable for migrating fish. Other projects brought 37 km of straightened, modified water stretches back to their original meandering state.

There is one transboundary aquifer (No. 161) in the Wiedau/Vidaa River Basin. In the German part, the aquifer is divided into two nationally defined groundwater bodies, Gotteskoog-Marchen and

DISCHARGES IN THE WIEDAU/VIDAA RIVER BASIN



Source: UNEP/DEWA/GRID-Europe 2011.

WIEDAU/VIDAA AQUIFER (NO. 161)

	Denmark	Germany
Type 3; ands and gravels (glacio-fluvial) of mostly Pleistocene, some Holocene age; groundwater flow direction from varies from north-northwest (groundwater flow toward the Wiedau/Vidaa river) to west-southwest (toward the North Sea); strong links with surface waters.		
Area (km²)	1 080	261
Thickness: mean, max (m)	30, 100	20, 60
Groundwater uses and functions	The use of groundwater for agricultural irrigation is substantial in the DK4.1.1.1.Tinglev and DK4.1.2.4.Tinglev groundwater bodies.	Groundwater supports ecosystems and maintain baseflow and springs.
Pressure factors	Pollution from agriculture (mainly nitrate and pesticides) in DK4.1.1.1.Tinglev and DK4.1.1.2.Hjerpsted.	Natural/background pollution widespread and severe in Ei 22; pollution from agriculture widespread and severe in Ei 23.
Other information	There are substantial amounts of Holocene and Pleistocene sediments (more than 300 m) in parts of the basin, due to sedimentation in buried valley structures.	The aquifer occurs in the entire German part of the Wiedau/Vidaa River Basin; extent defined by the groundwater bodies Ei 22 and Ei 23. The shallow aquifer is mostly recharged in the Pleistocene covered area (groundwater body Ei 23) in the hinterland of the coastal marsh. In the coastal area, the aquifer is covered by marshy sediments and recharge by precipitation is less (groundwater body Ei 22). In the marshy part: upward groundwater flow and aquifer discharge in an artifical drainage system.

[6] *Source:* Karlstad County Administrative Board, Sweden.
[7] Based on information provide by Germany and the First Assessment.
[8] The river is also known as the Vidå.

Total water withdrawal and withdrawals by sector in the Wiedau/Vidaa Basin

Country	Year	Total withdrawal $\times 10^6$ m³/year	Agriculture %	Domestic %	Industry %	Energy %	Other %
Denmark	N/A	34.5[a]	79	16	-	-	5
Germany	2009	2.8	-	100	-	-	-

[a] Total withdrawal is calculated on the basis of the permitted amount.

Land use/land cover in the area of the Wiedau/Vidaa Basin

Country	Water bodies (%)	Forest (%)	Cropland (%)	Grassland (%)	Urban/ industrial areas (%)	Surfaces with little or no vegetation (%)	Wetlands/ Peatlands (%)	Other forms of land use (%)
Denmark	0.78	7.91	86.04[a]	-	4.20	-	-	1.07[b]
Germany	0.62	6.13	54.0	36.5	2.0	-	1.8	-

[a] Grassland is included.
[b] Includes different nature types, also wetlands/peatlands.

Gotteskoog-Altmoränengeest (Ei 22 and Ei 23, respectively). These have been delineated to the State border, which follows the Wiedau/Vidaa river system. In the Danish part, the aquifer is divided into seven nationally defined groundwater bodies, the shallow groundwater bodies: DK4.1.1.1.Tinglev and DK4.1.1.2.Hjerpsted; the regional groundwater bodies: DK4.1.2.1.Hellevad, DK4.1.2.2.Kliplev, DK4.1.2.3.Tonder and DK4.1.2.4.Tinglev; and, the deep groundwater body DK4.1.3.1.Tinglev. Both shallow groundwater bodies are presumed to have hydraulic contact with the Wiedau/Vidaa River. Three of the regional groundwater bodies (DK4.1.2.2.Kliplev, DK4.1.2.3.Tonder and DK4.1.2.4.Tinglev) are assumed to have hydraulic contact to some extent, and the semi-deep groundwater body DK4.1.2.1.Hellevad and the deep groundwater body DK4.1.3.1. Tinglev are presumed to have no hydraulic contact with the river. The shallow groundwater body DK4.1.1.1.Tinglev and the regional groundwater body DK4.1.2.4.Tinglev cover the main part of the Wiedau/Vidaa River Basin, and make up Tinglev Moorplain.

Pressures, status and transboundary impacts

In the German part, agriculture and animal husbandry are the main pressures. 91% of the basin is arable land, and therefore the influence is widespread. This factor also affects the quality of groundwater in groundwater body Ei 23. This is also the case in the Danish part, where 86% of the basin is arable land, and the groundwater bodies DK4.1.1.1.Tinglev and DK4.1.1.2.Hjerpsted are affected. In the Wiedau/Vidaa River it leads to eutrophication and nutrification, and a loss of biodiversity.

Pollution from municipal wastewater is only local and moderate. Problems with erosion/accumulation of sediments and suspended sediments and mud flow are also local but severe. Sea water intrusion affects the groundwater body Ei 22 locally and only moderately.

The groundwater status according to the WFD is good in groundwater body Ei 22, and poor in groundwater body Ei 23. In the Danish part, groundwater status according to the draft water management plan is good in DK4.1.2.2.Kliplev, DK4.1.2.3.Tonder and DK4.1.3.1.Tinglev, and poor in the DK4.1.1.1.Tinglev, DK4.1.1.2.Hjerpsted, DK4.1.2.1.Hellevad and DK4.1.2.4.Tinglev groundwater bodies. The reason for groundwater body Ei 23 and the shallow groundwater bodies DK4.1.1.1.Tinglev and DK4.1.1.2.Hjerpsted failing to achieve good status is diffuse pollution by nitrates.

The surface water bodies' ecological status must be improved, as it is not good according to the WFD.

The river's important uses are fishing and canoeing.

Transboundary cooperation and responses

The bilateral Waters Transboundary Commission between Germany and Denmark is a joint body that coordinates and approves transboundary projects and measures, e.g., dykes or wastewater treatment.

The implementation of the WFD and the Floods Directive is based on a Joint declaration of the environment ministries of Denmark and Germany on the coordination of the management of the transboundary catchments of the Wiedau, Krusau, Meynau and Jadelunder Graben.

Both quality and quantity of surface waters and groundwaters are regularly monitored in both countries. Each country has proprietary national laws, regulations and defined national strategies. A number of management measures are introduced in the programme of measures in the River Basin Management Plan.[9] These include, for example, training for farmers and advisory projects, as well as measures related to the improvement of hydromorphology and to the prevention of diffuse and point sources pollution.

A joint project on transboundary flood protection and climate change in the Wiedau Basin, funded by the EU, has been initiated in 2011.

A transboundary project, the Interreg IV CLIWAT Project,[10] involves this area, and focuses on determining the effects of climate change on groundwater systems, and, through this, on surface water and water supply.

Trends

The European Fund for Regional Development (EFRD) supports the Syddanmark region and the Schleswig region during the period 2007-2013, with 44.3 million euros. Part of that money is used for the renaturalization of floodplains, transboundary flood risk management, restoration of wetlands and awareness-raising activities.

There is a trend to decreasing water use in industry in the German part of the river basin, which is expected to continue due to the following factors:

(1) scientific-technical progress enables the installation of water saving technologies;

(2) the expansion of new renewable energy sources through targeted governmental support is expected to lead to a decrease in conventional energy sources such as fossil fuels and nuclear, which would lead to a decreasing need for cooling water; and,

(3) the trend to a service-based industry, combined with relocation of industry to low-income countries.

[9] Project Eider: http://www.wasser.sh/de/fachinformation/daten/aneider.html.
[10] http://cliwat.eu.

Water pollution is expected to decrease, due to the decline in industry.

The utilization of fertilizers in agriculture in Germany is decreasing; this fact is supported by the following factors: the new agricultural policy of the EU; the increased demand for ecological agriculture; cost pressure for farmers; targeted fertilizer application by advanced technology; and stricter environmental obligations as well as their enforcement.

While areas used for agriculture are being reduced for renaturalization, areas foreseen for restoration of floodplains, for example, are now used for intensive cultivation of biomass, as the production of such raw material is increasing. This could lead to increased nitrification, increased use of pesticides due to monocultures, soil degradation, and erosion, causing negative effects on the surface water and groundwater status.

Climate change might cause a rise in temperature of around 2 °C until 2055, according to scenario studies. Winters are predicted to become more humid, and summers warmer. Higher temperatures will increase eutrophication, especially in lakes. Habitats may change. Restoration of water bodies and improving water retention in the area will mitigate climate change impacts.

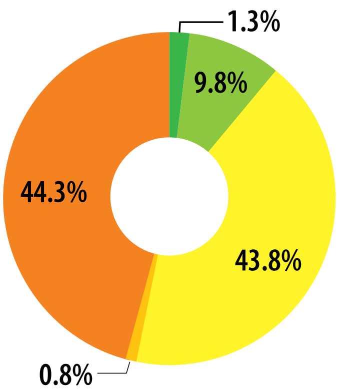
ELBE RIVER BASIN[11]

The Elbe River Basin extends between the territories of four EU member States: Austria, the Czech Republic, Germany and Poland. The Elbe River originates in the Czech Republic, in the Krkonoše Mountains at a height of 1,386 m a.s.l., and empties into the North Sea at Cuxhaven, Germany. The total length of the stream is 1,094.3 km, with 727 km (66.4 %) in Germany and 367.3 km (33. 6 %) in the Czech Republic.

Elbe River Basin District

Country	Area in the country (km²)	Country's share (%)
Czech Republic	49 933	33.6
Germany	97 175	65.5
Austria	921	0.6
Poland	239	0.2
Total	**148 268**	

FIGURE 1: Main pressures on surface water bodies in the Elbe River Basin District (as percentage of the total number of pressures)



Of the total Elbe Basin District area, approximately 50% is lowlands, lying below 200 m a.s.l. in elevation, and the main part is occupied by the Central German Lowland and the North German Lowland. Almost 30 % of the catchment area has an elevation higher than 400 m a.s.l.

No transboundary groundwater bodies have been designated in the Elbe River Basin. The State boundary between Germany and the Czech Republic in the basin predominantly follows the edge of the Krušné Hory Mountains. It is known that in the region of the Cheb Basin (Cheb/Vogtland) and in the Saxonian-Czech Cretaceous Basin (Elbe sandstone), groundwater flow crosses the State boundary. These bodies are monitored within the framework of a special monitoring system. There is a common hydrogeological formation between the Czech Republic and Poland (the Polická Basin), but so far it has not been necessary to define it as a common transboundary groundwater body. Nevertheless, joint monitoring is also carried out.

Hydrology and hydrogeology

More than 60% of the yearly run-off volume flows out during the winter hydrological half-year. The discharge pattern and the water levels in the Lower Elbe below the Geesthacht weir are influenced by the tide. The hydrological regime is, to a great extent, influenced by the accumulation and melting of snow.

Pressures

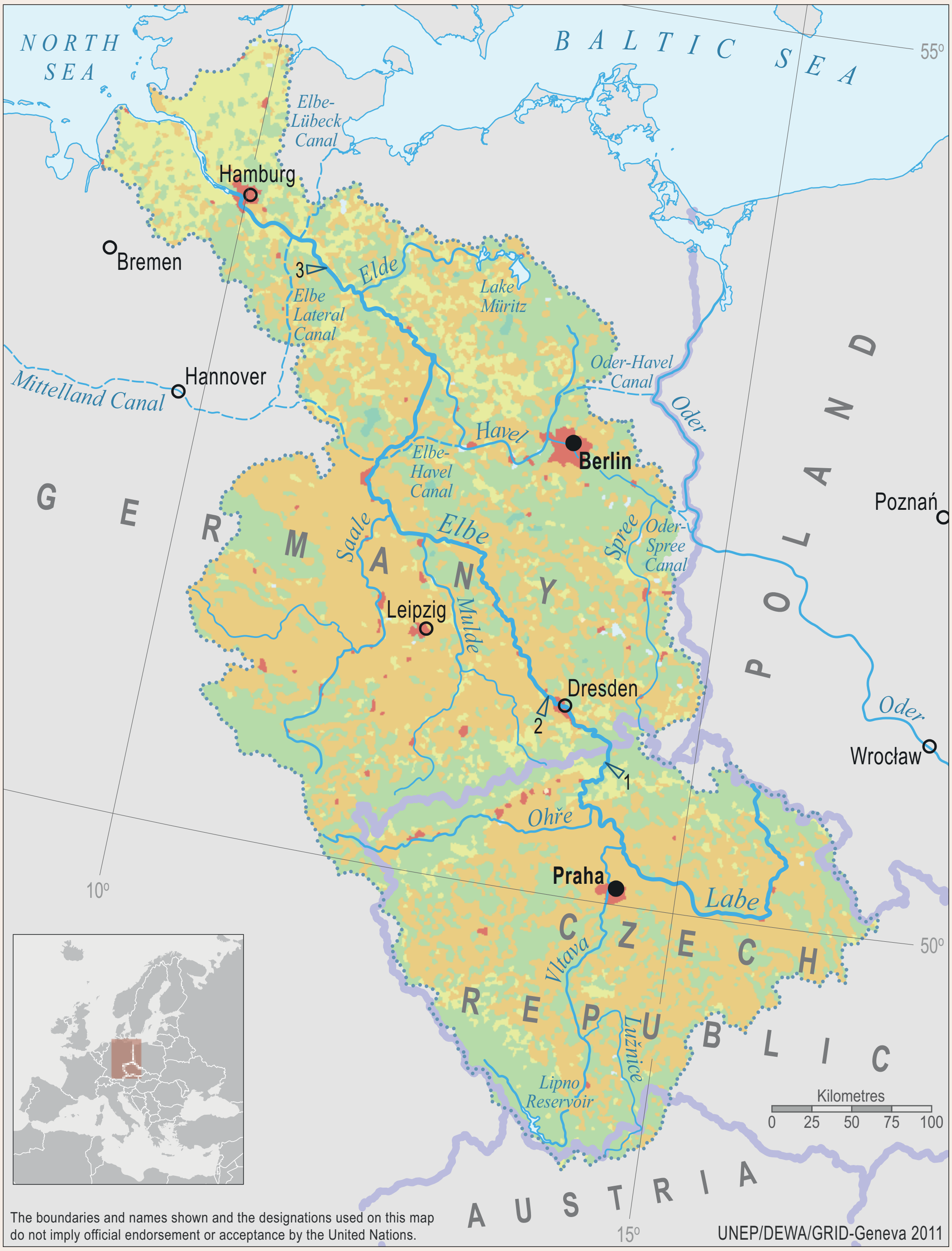
The following are significant problems in water management in the Elbe River Basin District: (1) hydromorphological alterations to surface waters; (2) significant load of nutrients and other pollutants; and, (3) water abstractions and transfer.

The solutions for these are coordinated at international level.

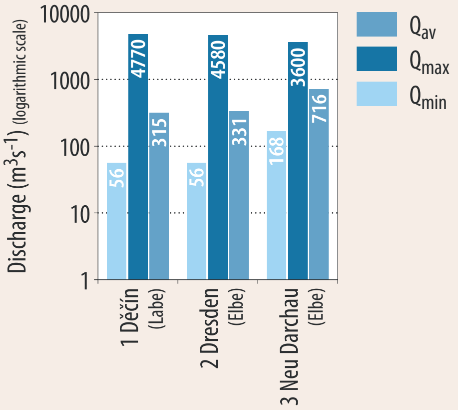
The main types of pressures on surface waters are those caused by hydromorphological alterations, water flow regulation and diffuse source pollution. Loading from point sources of pollution is also significant. Water abstractions and other sources of pressure are of secondary importance.

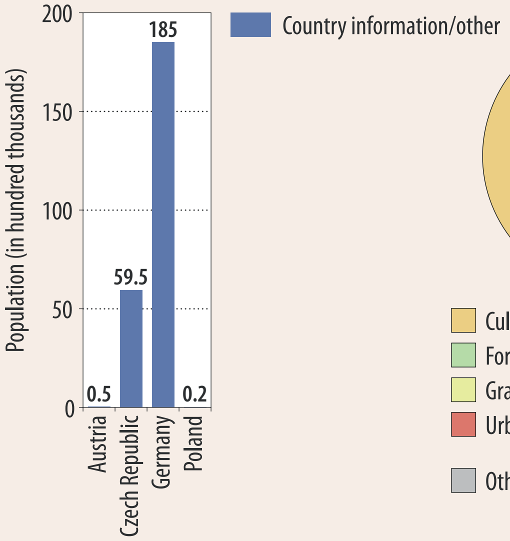
The hydromorphological alterations of watercourses in the Elbe River Basin District are due to intensive modifications of the watercourses through construction, in particular for ship transporta-

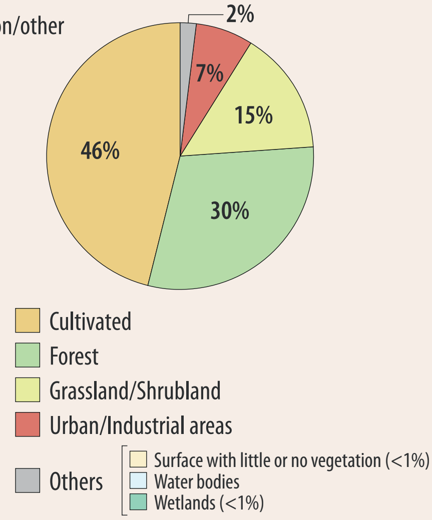
[11] Based on information provided by the International Commission for the Protection of the Elbe River (ICPER), based on the Elbe River Basin District Management Plan.



DISCHARGES, POPULATION AND LAND COVER IN THE ELBE RIVER BASIN







Sources: UNEP/DEWA/GRID-Europe 2011; International Commission for the Protection of the Elbe River (discharges, population and land cover).

tion, land drainage, flood protection, and production of energy, or due to potable water supply and urbanization. A demonstrable effect of these construction modifications, especially in the upper parts of watercourses, is the interruption of their continuity and the disturbance of natural habitats. There are about 530 transversal barriers in important watercourses (i.e. the so-called supra-regional priority watercourses, see below) in the Elbe River Basin, which, for the present time, are not passable for fish and other aquatic life.

The main source of pollution from diffuse sources is agriculture, which plays a decisive part in nutrients input. The share of pollution from point sources has markedly decreased during the last years, due to the construction and renovation of wastewater treatment plants.

It is possible to demonstrate the load of surface waters by pollutants in sediments that are contaminated primarily by former inputs. Current inputs are, in comparison, markedly lower.

The influence of human activity on surface waters is reflected in the high number of designated heavily modified bodies of surface water in the International Elbe River Basin District (26 %).

Proportion of artificial and heavily modified bodies of surface water in the International Elbe River Basin District (2008)

Total number of bodies of surface water	3 896
Artificial bodies of surface water	777
Heavily modified bodies of surface water	1 016

The yearly water withdrawals in the Elbe River Basin during the period from 2005 to 2007 were approximately 8,110 × 10^6 m^3. From these, domestic water supply represented approximately 890 × 10^6 m^3 (11%).

During the same period, 3,468 wastewater treatment plants discharged 1.72 × 10^6 m^3 of urban wastewater every year into the watercourses. Approximately 88.2 % inhabitants were connected to a sewer system.

Since 1996, every year, an overview and evaluation of accidents is produced. Within the period 1996 – 2009, there were 203 cases of accidental water pollution registered in the Elbe River Basin. The most serious of them was an accident caused by a cyanide spill in the Upper Elbe, below the city of Kolín, in January 2006, which led to a fish kill in a sector of 83 km, up to the confluence with the Vltava River.

For groundwater, the following types of pressures, which are the cause of unachieved environmental goals, were identified:

(1) diffuse sources of pollution: agriculture, atmospheric deposition, built-up areas; other sources of less importance including, for example, missing connection to drainage and run-off;
(2) point sources of pollution: old contaminated areas, including old waste dumps, the oil industry, sporadic direct discharge of pollutants (treated wastewater from decontaminated sites);
(3) groundwater abstractions: public potable-water supply, (Czech Republic and Germany), lignite mining (Germany);
(4) other anthropogenic influences: impacts of the extraction of raw materials (effect in the chemical and quantitative status), geothermal boreholes (Czech Republic – effect in the quantitative status); and,
(5) intrusion of salt water (Northern Germany).

Status

From the bodies of water evaluated in the International Elbe River Basin District in 2009. 93% of the bodies of water evaluated in the "rivers" category, and 63% of bodies evaluated in the "lakes" category, did not achieve good ecological status or good ecological potential. From the 6 evaluated bodies of transitional waters and coastal waters, 5 bodies of water (83%) were evaluated as worse than "good". The reason is mostly the quality component such as macrozoobenthos, fish, macrophyta, and phytobenthos, followed by nutrients, other pollutants and phytoplancton.

In the International Elbe River Basin District, in 2009, 88% of bodies of water in the "rivers" category, 91% of bodies of water in the "lakes" category, and all the bodies of coastal waters achieved good chemical status. Only one designated body of transitional waters was not in a good chemical status. The most frequent cause for not meeting the standards of environmental quality were certain pollutants, such as pesticides and PAHs, heavy metals, nitrates and industrial chemicals.

A total of 54% of groundwater bodies in the International Elbe River Basin District did not achieve a good chemical status in 2009. More than a third of the groundwater bodies are affected by nitrate loading. In cultivation, particularly in the application of livestock manure, important amounts of nutrients are released. A total of 25% of groundwater bodies are loaded with other pollutants, such as ammonium or sulphates. Pesticides are considered as another source of pollution for groundwater, having been detected in 4% of water bodies. Significant rising trends of nitrates, pesticides and other pollutants in several groundwater bodies were also detected.

The quantitative balance of groundwater in the International Elbe River Basin District (status of 2009) is disturbed in 15 % of water bodies.

In long stretches of its course, the Elbe has extensive floodplains with dykes, and areas with shallows and alluvial forests. Comparatively, it has many favourable living conditions for a number of native and partially critically-endangered species of plants and animals. The Elbe and its river floodplains also fulfil the function of a "supra-regional" bio-corridor, for instance during the migration or wintering of birds.

Thanks to the improvement in water quality, and hence of improved self-cleaning processes in the river, there is a growing variety of fish species in the Elbe. Currently, it is estimated that 102 different species of cyclostomatous and fish live in the Elbe. The most important migrating fish in the Elbe is the Atlantic Salmon, followed by the eel. Therefore, in 1995, the German side began programmes aimed at encouraging the salmon to return; the Czech side joined this effort in 1998. In addition, in the frame-

work of the German National Action Plan for the resettlement of the Common Sturgeon in rivers. The Elbe was chosen as the first river for releasing fish stocks of sturgeons, during the years 2008 and 2009. Another new fish pass was built at the Geesthacht weir to enable the sturgeons to return to the spawning areas in the Elbe.

Transboundary cooperation and responses

The States of the Elbe River Basin – Austria, the Czech Republic, Germany and Poland – agreed to mutually co-operate, within the International Commission for the Protection of the Elbe River (ICPER), in order to implement the WFD through the international co-ordination group (ICG).

They also agreed to draw up a joint river basin plan, according to the WFD – the International Elbe River Basin Management Plan – which was published in Czech and German in December 2009. It consists of a jointly prepared section with summarized information at international level, and of a section containing the plans developed at national level by the respective States.

"The International Elbe Warning and Alarm Plan" has been a unified system since 1991, enabling the transfer of information on the place, time and extent of accidental pollution of the waters in the Elbe River Basin. The main structure of the Plan is composed of five principal international warning centres. The Plan is updated on the basis of the latest knowledge and experience gained from previous accidents, and on the basis of the results of regular testing.

For the first RBMP, according to the WFD, watercourses of particular importance for fish populations, and suitable for development due to their inter-connecting function, were identified. According to these criteria, the Elbe River and almost 40 tributaries were classified as of "supra-regional priority watercourses". The tributaries, with a total length of approximately 3,650 km, include about 530 transversal barriers, which are so far impassable for fish and other aquatic life. The objective is to achieve "ecological passability" on more than 150 transversal barriers by 2015. This will increase the total length of the tributary stretches that fish and other aquatic life can pass through, from the current 300 km, to almost 1,800 km, of which approximately 62 % will be connected with the North Sea.

With regard to the North Sea coastal waters, the nutrient load of nitrogen and phosphorus from the whole Elbe River Basin is planned to be gradually reduced by approximately 24% by the year 2027 through the following measures:

(1) to minimize excess nutrients when fertilizing agricultural land; and,

(2) to reduce soil surface run-off and washing out nitrates into groundwaters and surface waters by suitable cultivation of land, and by building protective riparian zones.

An important potential for reducing nitrogen and phosphorus inputs can be also seen in the modernization of municipal wastewater treatment plants and improving their efficiency, particularly in the Czech Republic.

In order to gradually reduce pollutant input by the year 2027, a sediment management concept will be developed for the whole Elbe River Basin District, including proposals for measures to handle sediments containing pollutants. The planned decontamination of the old contaminated areas as well as measures to reduce point source pollution, should help to achieve a good status of waters. Other measures at national level have been proposed, aimed at reaching a good status of waters. For surface waters, priority is given to measures reducing hydromorphological effects. Among them are the following measures:

(1) to optimize the maintenance of and renew the passability of watercourses;

(2) to stimulate and enable the dynamic development of the watercourses;

(3) to improve the habitats in the riparian zone (namely, development of forests);

(4) to improve the habitats in the development corridor of watercourses, including the development of fluvial plains;

(5) to revitalize the watercourses (namely, the stream bottom, variability of depths, the substratum);

(6) to improve habitats through modified watercourse routes, modifications of the bank and the stream bottom;

(7) to improve the status of sediments, eventually the management of sediments;

(8) to reconnect main watercourses in the basin to former small tributaries; and,

(9) to increase the number of shallow parts in the tidal stretch of the Elbe.

Among the most frequently considered measures to reduce the input of pollutants from point sources are:

(1) the connection of so far unconnected areas to urban wastewater treatment plants;

(2) other measures to reduce the input of substances through discharged wastewaters and rain waters;

(3) optimization of the operations of urban wastewater treatment plants; and,

(4) reconstruction of urban wastewater treatment plants, with the purpose of reducing phosphorus inputs.

In 1993–2004, the International Commission for the Protection of the Elbe River (ICPER) has drawn up 10 recommendations to prevent accidents, increase the safety of technical equipment and mitigate the consequences of accidents, which became part of the legal framework of the Czech Republic and Germany. ICPER is also striving to create a stable "emergency profile" to trap oil contamination in the transboundary section of the Elbe.

A part of the surveillance monitoring of the Elbe River Basin, according to the WFD, is the "International Programme for the Elbe River Monitoring". This programme includes 9 monitoring profiles on the Elbe River (4 in the Czech Republic and 5 in Germany), and 10 monitoring profiles on its important tributaries. The measurement results are made available on the ICPER[12] web site.

Trends

In the medium and long-term future, adaptation strategies to climate change will play a certain role when selecting and implementing measures. The first scientific results related to these impacts in the Elbe River Basin were taken into account to draw up the measures at the same time as the RBMP was being prepared.

Climate change impacts are difficult to assess. Depending on regions and the season, precipitation frequency and intensity is expected to change, which might lead to an increase in droughts and thus to a rise in water prices in the most affected areas. In the future process of planning measures, the effects of climate change will be taken into account.

[12] www.ikse-mkol.org.

KRKONOŠE/KARKONOSZE SUBALPINE PEATBOGS[13]

General description of the wetland

These oligotrophic mountain-raised peatbogs of subarctic character are situated on granite bedrock on the summit plateaux of the Giant Mountains (The Sudetes – Krkonoše in Czech, Karkonosze in Polish). They are characterised by a mosaic of arctic and alpine features and the occurrence of many endangered and endemic plant and animal species, as well as plant associations.

The site is an exceptional bio-geographical island in Central Europe, in which ancient subarctic phenomena are intermingled with more recent alpine ones. The system of ridge peat bogs developed under extreme climatic conditions within Central Europe. The bog surface has a rich relief, in the form of numerous hummocks, oblong ridges, trough-like hollows filled in with water, and permanent pools. In the pools, a unique flora of algae is to be found.

The depth of the peat layer is highly variable (from several decimetres to 2.8 metres), and the surface morphology is similar to the structure of northern mires, with bog-lake areas of up to 170 m^2.

Interestingly, the wetland lies in the summit area of the west-east oriented mountain range (administratively divided by the Czech-Polish border), just on the divide of the discharge basins of the Baltic Sea (Oder River) and the North Sea (Elbe River). This means that the waters of this small Ramsar Site are drained into two different basins – peat bogs on the northern (Polish) slopes of the mountains drain into the Oder River Basin, peat bogs on the southern (mainly Czech) part into the Elbe River Basin.

The total area of the wetland is 250 ha only; the Czech part being 210 ha and the Polish part 40 ha.

Main wetland ecosystem services

The wetland is situated in the headwaters of two rivers – the Elbe and the Upa. Ecosystem services include the storage and retention of water, flood control and erosion protection. Water from precipitation is accumulated in the raised peat bogs, and retained there by vegetation (especially *Sphagnum* mosses). Subsequently, water is drained by hundreds of very small, deeply meandering water bodies from the peat bogs. The outflow is relatively slow, partly protecting downstream habitats from erosion and floods, especially in spring, when snow melts, as well as after heavy rainfall in summer.

Biodiversity values of the wetland area

The most important element of the vegetation cover is the endemic plant association of dwarf pines with the cloudberry, and several glacial relic plant associations.

It further harbours the endemic alga species *Corcontochrysis noctivaga*, as well as glacial relics, such as the Sudetan Lousewort, the Cloudberry, the Water Beetle, or the Field Vole.

Further, the site is of specific value in terms of biological diversity, as it harbours arctic and alpine plant and animal species simultaneously. Three physiognomic units form the vegetation cover of the wetland – mosses, herbaceous plants and dwarf pines.

The shrub vegetation is formed by mosaic stands of the Swiss Alpine Pine, willows, and solitary individuals of the spruce and the Mountain Ash. Dominant and characteristic plant species of the wetland include moss species, the Leafy Liverwort, sedges, and other species such as the Bog Rosemary, the Common Sundew, the Tufted Bulrush, the Tussock Cottongrass, or the Sudetic Lousewort.

Noteable in terms of fauna are the following: dragonflies, moth, Carabid Beetles, and the Alpine Shrew. The area also serves as an important breeding site for several birds, especially the Red-spotted Bluethroat, the Ring Ouzel, the Scarlet Rosefinch, and the Water Pipit.

Pressure factors and transboundary impacts

There is a considerable impact of tourism in the wetland area, as this part of the mountains is visited by thousands of tourists per day during the peak seasons from June to September. Two historical and reconstructed mountain chalets at the border of the wetland and a network of hiking trails inside the wetland affect surrounding vegetation.

The impact of air pollution, noticed throughout the entire area of the Giant Mountains in the 1970–1990s, and resulting in particular in a large-scale forest decline, has been reduced during the last two decades.

No impact of climate change on the hydrology of the area has been noted as yet. However, a probable impact of climate change on bird communities has been observed recently, as there is an increasing abundance of species preferring lower altitudes, such as warblers and the chiffchaff.

Transboundary wetland management

The entire transboundary wetland area is protected under the following regulations and programmes:

(1) Czech Krkonoše National Park (part of the strictly protected core zone, where only "soft" tourism activities are allowed, e.g. hiking or cross-country skiing along fixed trails for visitors);

(2) Polish Karkonosze National Park (part of the strictly protected core zone with the same regime as mentioned above);

(3) Bilateral Krkonoše/Karkonosze Biosphere Reserve (part of the core zone), under UNESCO's Man and the Biosphere Programme;

(4) Natura 2000 sites on both sides of the border (both Special Protected Areas and Sites of Community Interest), based on the EU Habitats and Birds Directives;

(5) Important Bird Area in Europe under the BirdLife International Programme; and,

(6) Transboundary Wetland of International Importance under the Ramsar Convention on Wetlands (designated officially in September 2009).

The area is managed by both the Krkonoše National Park and Karkonosze National Park Administrations, and no special staff is devoted directly to the Ramsar Site.

Management plans are ready and in use for both the national parks. They cover, inter alia, the management of wetland sites (including the Ramsar Site), in particular control of tourism and elimination of allochthonous plant species spreading along the hiking trails.

As regards transboundary cooperation, a joint Czech-Polish nature trail through the wetland area was prepared for visitors, and multilingual information booklets on the Krkonoše peatbogs are available.

[13] *Sources:* Information Sheet on Ramsar Wetlands; Jenik J. Alpine vegetation of the Giant Mountains (Krkonoše Mountains), the snow mountains of Glatz and the Gesenk mountains (in Czech with a German summary). NCAV, Prague, 1961. Soukupova L., Kocianova M., Jenik J., Sekyra J. Arctic-alpine tundra in the Krkonose, the Sudetes. Opera Corcontica 32, 5-88. 1995.

EMS RIVER BASIN[14]

Germany and the Netherlands share the Ems River Basin.[15] The 371-km long Ems has its source in Germany (North Rhine-Westphalia) and runs further downstream through Lower Saxony (Germany). A characteristic of the Ems River Basin is that there are no natural rivers, which cross the border between Germany and the Netherlands. The tributaries of the Ems River in the Netherlands discharge directly into the Ems-Dollart estuary. The Hase River is the largest tributary. Near the city of Emden, the Ems flows into the Dollart estuary, and finally flows into the North Sea. Important channels within the basin are the Dortmund-Ems-Kanal, the Mittellandkanal, the Küstenkanal, and the Eemskanal. Parts of the Ems River are used for inland navigation and near the mouth as sea waterways.

Basin of the Ems River

Country	Area in the country (km^2)	Country's share (%)
Germany	15 008	~84
Netherlands	2 312	~13
Ems –Dollart estuary	482	~ 3
Total	**17 802**	

Source: International River Basin Management Plan for the Ems River Basin District, Germany and the Netherlands.

Since the end of the Middle Ages, the border in this area is controversial between Germany and the Netherlands. Thus, Germany and the Netherlands made an arrangement in 1960, which regulates the collaboration in the Ems Dollart estuary.

Hydrology and hydrogeology

The Ems River Basin is mainly characterized by lowland.

The elevation in the area of the district ranges from sea level to 331 m a.s.l.

The marshland located in the northern section of the Ems River Basin is characterised by coastal sediments and fluvial deposits over time.

Pressures

The Ems Basin is widely characterized by intensive agriculture - some 65% of the surface of the Ems Basin is used for agricultural purposes, and 15% of the area is covered by pastures.

In addition to local pressures on surface waters, there are also transboundary pressures, for example, due to nitrogen and phosphorus.

The restricted passability of the important transboundary network of water bodies has led to deficits in long-distance migrating fish. The ecological passability and quality of life of aquatic communities is affected by extensive morphological alterations (straightening, bank reinforcements, weir controls, and maintenance).

Almost 99% of the total length of the river water bodies and the channels, and 9 of the 10 lake water bodies assessed have not attained good ecological status/good ecological potential. The two transitional water bodies, and four coastal water bodies up to one sea mile, reveal a poor ecological status. The reason is the macrozoobenthos, macrophyte or phytobenthos quality component, followed by the fish, the content of nutrients and harmful substances, and, in individual cases, also the phytoplankton component.

In the Ems Basin, almost 90% of the total length of rivers of canals and 9 out of 10 lakes achieve good chemical status.

Both transitional water bodies and one coastal water body in the Ems-Dollart estuary show poor chemical status due to the presence of harmful substances. With regard to groundwater bodies, there are still a number of point sources of old pressures — despite the remediation and mitigation that has been carried out.

In the Ems Basin, the diffuse input into groundwater has primarily been caused by excess use of nutrients on areas used for agriculture. This pressure has been identified as significant for practically all groundwater bodies, and will be further investigated. The basis for these investigations comprises land use data, agricultural statistics, nitrogen balance surpluses, and nitrate concentrations in the groundwater.

The pressures from diffuse sources were identified as significant for practically all groundwater bodies. The identified dominant pressure on groundwater bodies in the Ems Basin, with nitrates from agricultural use, correlates to earlier farming methods, which over the past few decades have led to considerable nutrient accumulation in the soil and pressures on the groundwater.

A poor chemical status results from nitrate in 12 groundwater bodies (48.6 % of the total surface area) and from pesticides (mostly from recent decades) in 9 groundwater bodies (32.5% of the total surface area) in the Ems Basin.

The pressures from water abstraction are estimated as not significant.

Transboundary cooperation and responses

Transnational cooperation and harmonisation include the coherent drafting of reports to the European Commission, the drawing up of a coordinated management plan and the elaboration of coordinated programmes of measures. Information and involvement of the public are an essential element in these processes.

The Ministers responsible for protection of the waters in the Ems Basin in Germany and the Netherlands have decided to draw up a joint international management plan for the Ems Basin. International cooperation between the Netherlands and Germany then takes place within two special international forums. At the first level, the International Steering Group Ems (ISE) is responsible for the overall harmonisation and general supervision of joint work. In this forum, the fundamental decisions on collaboration are taken by representatives of the responsible Ministries. At the second level, experts from the Netherlands, from North Rhine-Westphalia and Lower Saxony work within the International Coordination Group Ems (ICE). This forum implements the decisions of the ISE, and arrives at specific agreements on joint implementation of the required operational tasks. The ICE is supported by working groups that — in changing form — work on the various themes of the WFD.

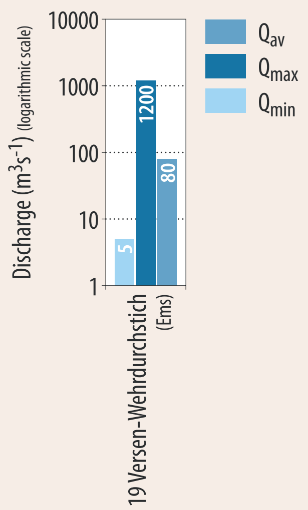
Numerous measures are planned for further improvement of the Ems and its tributaries. As already laid down in the 2005 status review, in implementing the measures, steps will have to be taken for integration in other fields including energy, transport, agriculture, fishery, regional development, and tourism.

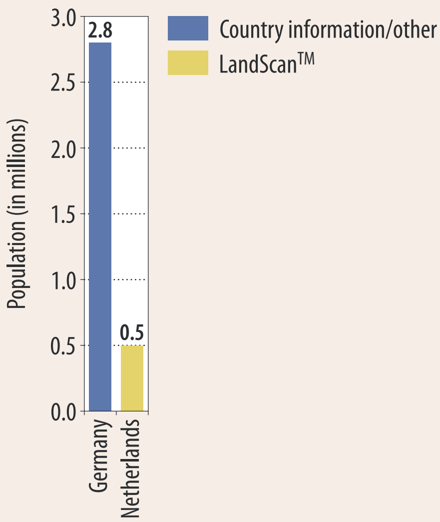
The future management of the Ems Basin essentially calls for the implementation of additional measures, since the underlying minimum requirements have, to a considerable extent, already been achieved by binding legal regulations.

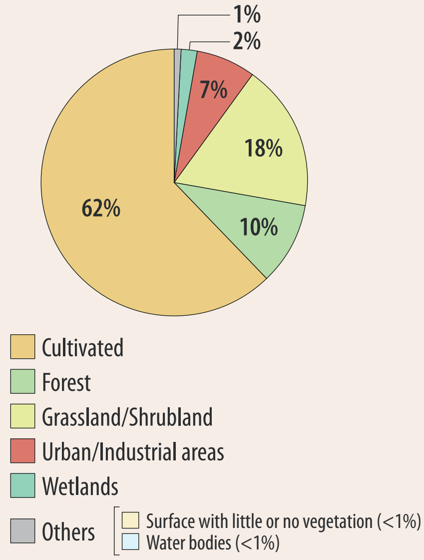
In respect of surface waters, the point of focus within the Ems Basin is on measures to reduce hydromorphological pressure and

[14] Based on information provided by Germany (office of the Ems cooperation) and the First Assessment.
[15] In the Netherlands also known as the Eems. The Ems River Basin District includes the Ems-Dollart estuary.

DISCHARGES, POPULATION AND LAND COVER IN THE EMS RIVER BASIN







Sources: UNEP/DEWA/GRID-Europe 2011; International River Basin Management Plan for the Ems River Basin District, Germany and the Netherlands.

to recover passability. This includes such measures as structural improvement for crossing structures, barrages, bank strengthening, and other civil engineering constructions. Further points of focus are measures to reduce pressures from diffuse and point sources of pollution. For groundwater, activities are concentrated above all on reducing pressure from diffuse sources.

Conceptual measures have been planned to provide support. Advisory measures contribute to reducing the discharges of nutrients and pesticides from diffuse sources. Promotion programmes (agricultural environmental measures) will help to reduce the transport of nutrients into waters. Educational measures, for example for crop maintenance, will also be deployed to improve morphological changes in water bodies.

In deciding these measures, one key element was the estimate of the expected effects and costs. Uncertainties relate as to whether the necessary measures could actually be implemented, or whether, as a result of unavoidable uses for which there was no alternative, technical problems or natural situations, the implementation of the measures would only be possible on a limited scale or not at all. Uncertainty also results from the fact that developments cannot be predicted sufficiently accurately through to 2015.

Trends

In addition to long-term climate changes, annual extremes are predicted to increase in the Ems Basin. General predictions for extreme values have proven difficult, and assessing the effect requires an approach specific to the entire river basin. In the Ems Basin the following changes are assumed:

(1) increase in average air temperature;

(2) sea level rise;

(3) increase in precipitation in winter;

(4) reduced precipitation in summer;

(5) increase in precipitation events; and,

(6) increase of dry periods.

As of yet, confirmed evidence of these assumed changing trends, in particular for precipitation and precipitation extremes, is not available.

Changes in these factors have an immediate effect on essential elements of water management, for example on

(1) coastal protection — due to sea level rise — possible changes in, for example, storms;

(2) flood protection — due to changes in flood discharges, and the resultant change in damage risks (as with coastal protection);

(3) water supply — due to the changing groundwater situation;

(4) water protection — due to the changes in seasonal discharges and temperature ratios;

(5) development of water bodies — due to the change in their dynamics; and

(6) use of water bodies, including storage areas for raising water levels at low water, hydro-electrical use, navigability, and use of water for cooling and agriculture.

Among useful measures and options for action — despite the uncertainties related to climate change — are improved passability, the morphology of water bodies, and the reduction of heat pressure, which have positive effects on living conditions and the sustainability of ecosystems. With regard to groundwater, experience has accrued with managing groundwater abstraction and infiltration, and, for example, measures for water retention and groundwater recharging can be developed.

WADDEN SEA[16]

General description of the wetland

The Wadden Sea is a shallow sea of outstanding natural value, as it forms the largest coherent tidal flat ecosystem in the world, covering over 9,000 km^2 (including ~7,500 km^2 tidal area). It extends for about 500 km along the North Sea coasts of Denmark, Germany and The Netherlands. It is a very dynamic ecosystem, which includes large areas of intertidal sand- and mudflats, partly estuarine, with sand banks, numerous islands, extensive areas of saltmarsh, dunes, heath, beaches and beach plains. The Wadden Sea itself can be divided into three ecological zones: the sublittoral, eulittoral and supralittoral zone, according to their daily inundation regime by seawater. The sublittoral zone mainly includes creeks and channels, while the eulittoral zone includes tidal flats which cover about two thirds of the tidal area and are characteristic of the Wadden Sea. The supralittoral zone, the region above mean high tide levels, includes saltmarshes and dunes. Many important rivers such as the Elbe, Weser, Ems and IJssel, a sidearm of the Rhine River, drain into the Wadden Sea. The size of the catchment area is 231,000 km^2.

Main wetland ecosystem services

Hydrological values of the Wadden Sea include flood control, shoreline stabilization, and sediment retention. Due to its high productivity, the Wadden Sea is an essential nursing habitat for several fish species of the North Sea, is important for shrimp and blue mussel fisheries, and crucial for bird migration. Some of the salt marshes are used for cattle and sheep grazing, and the surrounding areas are used mainly for agricultural purposes. In parts, intensive arable (wheat and rape) farming is practised. It is further used for sand, clay, shell, and gravel extraction, and the extraction of oil and gas. It is of outstanding scientific and educational value, as it contains a great variety of landforms, habitat types, and plant and animal species. For the same reasons, it is used extensively for tourism and recreation purposes, with about 70 million overnight stays per year, and a turnover of 2.8–5.3 billion euros per year.

Cultural values of the wetland area

The Wadden Sea landscape is an area of outstanding natural beauty, as well as of cultural, historical, and archaeological value. Because of the dynamic geomorphological history of the region, many archaeological remains of human settlements are present in the tidal flats. Historically preserved buildings such as lighthouses and towers date back to the 13th century, and some settlement types, such as the Halligen in Schleswig Holstein, which are built on mounds, are unique.

Biodiversity values of the wetland area

The Wadden Sea offers the full range of habitats typical of tidal flats, and thus plays a very important role in the protection of biological diversity. The Wadden Sea is of international importance for birds which breed, moult and winter here, or which

[16] http://www.waddensea-secretariat.org; Information Sheets on Ramsar Wetlands available at: http://www.wetlands.org/rsis/; The Wadden Sea-A shared nature area, H. Marencic, Common Wadden Sea Secretariat.

use it as a migratory staging area. With about 50 geographically distinct populations of 41 bird species, the Wadden Sea supports more than 1% of the East Atlantic flyway populations. Of these, 29 species occur with more than 10% of their flyway population in the Wadden Sea. Every year 10 to 12 million birds pass through, en route from their breeding grounds in Siberia, Iceland, Greenland and North East Canada to their wintering grounds in Europe and Africa. The salt marshes are the most important breeding areas, followed by the dunes and beach plains of the islands. Bird species typical for the Wadden Sea include the Redshank, Black-tailed Godwit, Oystercatcher, Avocet, and a number of species of ducks, geese, gulls and terns. Several species of birds occurring in the Wadden Sea are included in national red lists, e.g. Kentish Plover, Dunlin, Ruff, Gull-billed Tern, and Little Tern. Further, the area is a nursery ground for many North Sea fish species and shellfish, due to its high primary production rates. It also sustains the Harbour Porpoise, and approximately 20% of the world population of Harbour Seals of the North East Atlantic subspecies. Additionally, the salt marshes, marine, and brackish areas support about 4,000 species of spiders, insects and other invertebrates, with a high degree of ecological specialization, many of the species being endemic. In contrast, only a few species of flora and fauna have adapted to the extreme conditions of the tidal flats, such as the lugworm, but they occur in very high numbers.

Pressure factors and transboundary impacts

The Wadden Sea suffers from pollution and disturbance. It is affected by the pollution from discharge of nutrient- and contaminant-rich waters from major rivers and their catchment areas, which are highly industrialized and intensively used for agriculture. Further, it is influenced by polluted water from the North Sea south of Denmark. However, it also receives a large part of its pollution through atmospheric deposition from the countries of North-Western Europe and Central Europe. Further threats include the drainage and cultivation of permanent grassland areas, the increasing impact from recreational activities, and the exploitation of natural resources such as mussels, as well as impacts from transportation and industrial activities such as potential oil spills. Additionally, climate change and the accelerated sea level rise were identified as one of the future concerns in the Trilateral Wadden Sea Plan.

Transboundary wetland management

In the 1970s, environmental scientists warned that the Wadden Sea ecosystem could not be divided according to national borders, and called upon politicians from the three Wadden Sea countries to work together in the protection and conservation of the area. This was followed by a "Joint Declaration on the Protection of the Wadden Sea" (renewed in 2010), and the founding of the Common Wadden Sea Secretariat in 1987, which supports, facilitates and coordinates collaboration activities. The Trilateral Cooperation area covers 14,700 km^2, of which 11,000 km^2 were set aside for conservation. In 1993, the Trilateral Monitoring and Assessment Program (TMAP) was established, with the aim of providing a scientific assessment of the status of the ecosystem. This was followed by the creation of the Trilateral Wadden Sea Plan in 1997, which applies to the entire cooperation area and aims to conserve the quality, as well as the diversity, of habitats, and the species that form this dynamic ecosystem. It contains agreements for a joint policy of nature protection, as well as activities and projects. It covers agricultural and cultural aspects, and even includes areas which are outside the trilateral cooperation area.

Most human activities such as agriculture, fishery, hunting, dredging and dumping, sand and clay extraction, tourism, shipping and energy (wind, gas, oil) are regulated following the principle of sustainable use of the wetland area. Currently, almost the entire Wadden Sea is under environmental protection. The Danish parts are mainly protected through a statutory order on the conservation and establishment of reserves, and their status as Natura 2000 sites. A Natura 2000 management planning process is under implementation. Moreover, the German as well as the Danish parts are mainly protected as National Parks, excluding large river mouths that are important for navigation. The Dutch part is protected under a complex network of protection measures. As of 26th June 2009, the parts of the Wadden Sea in the German Federal states of Schleswig-Holstein and Lower Saxony, as well as the Dutch part of the Wadden Sea, have a combined status as a UNESCO World Heritage Site.

While the area has not been formally designated as a transboundary Ramsar Site, most of the area has been listed as internationally important under the Ramsar Convention. The following eight Ramsar Sites are included in the List: Vadehavet (Wadden Sea) in Denmark, Schleswig Holstein Wadden Sea and adjacent areas, Wattenmeer, Elbe-Weser-Dreieck, Jadebusen & westliche Wesermündung, Ostfriesisches Wattenmeer & Dollart, and Hamburgisches Wattenmeer in Germany, and the combined site Waddeneilanden, Noordzeekustzone & Breebaart, as well as Waddenzee (Wadden Sea) in the Netherlands.

Photo by Tobias Salathe

RHINE RIVER BASIN DISTRICT[17]

The Rhine connects the Alps to the North Sea. It is 1,230 km long. The river basin, covering some 197,100 km², spreads over nine States.

Rhine River Basin District

Country	Area in the country (km²)	Country's share (%)
Austria	2 370	1.2
Belgium	800	0.4
France	23 830	12
Germany	105 670	53.6
Italy	<100	<0.1
Liechtenstein	200	0.1
Luxembourg	2 530	1
Netherlands	33 800	17
Switzerland	27 930	14
Total	**197 100**	

The source area of the Rhine lies in the Swiss Alps. From there the Alpine Rhine flows into Lake Constance (see separate assessment). Between Lake Constance and Basel, the High Rhine largely forms the frontier between Switzerland and Germany. North of Basel, the Franco-German Upper Rhine flows through the lowlands of the Upper Rhine (see the assessment of the Upper Rhine Ramsar Site). The Middle Rhine, into which the Moselle flows in Koblenz, starts at Bingen. In Bonn, the river leaves the low mountain regions and becomes the German Lower Rhine. Downstream of the German-Dutch border, the Rhine splits into several branches, and, together with the Meuse River, forms a wide river delta. The Wadden Sea, adjacent to Lake IJssel, fulfils an important function in the coastal ecosystem (see the assessment of the Wadden Sea Ramsar Site).

Hydrology

The discharge regime in the Rhine River in the summer months is dominated by meltwater and precipitation run-off from the Alps, and by precipitation run-off from the uplands in winter.

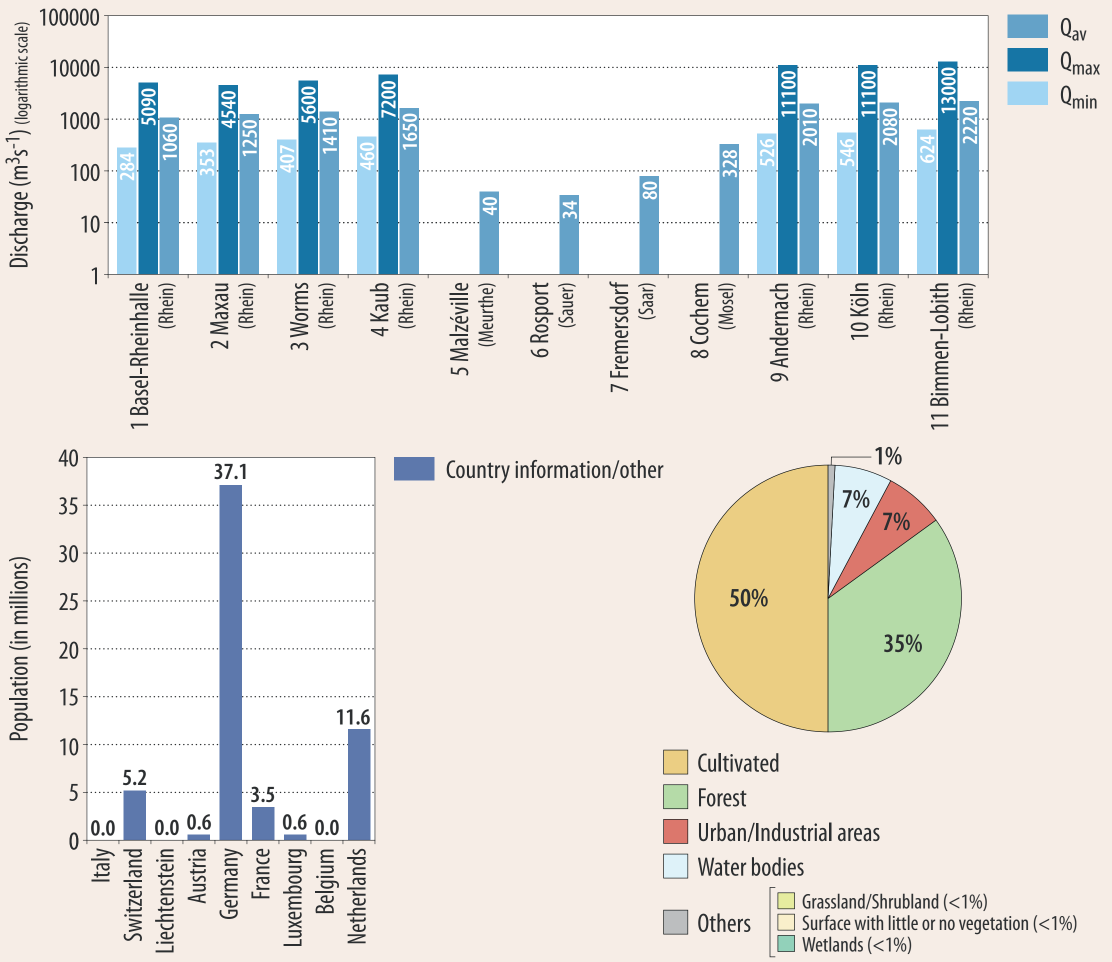
Further downstream, the contribution from the uplands predominates, so that, over the whole year, the discharge is usually well-balanced.

Pressures

The River Rhine is the most intensively used watercourse in Europe. It is an important shipping route – 800 km of the Rhine between Rotterdam and Basel are navigable. Major cities and industrial areas are located on the banks of the River Rhine and its tributaries.

Moreover, the Rhine provides drinking water for a total of 30 million of the 58 million people living in the basin. For drink-

DISCHARGES, POPULATION AND LAND COVER IN THE RHINE RIVER BASIN DISTRICT



Sources: UNEP/DEWA/GRID-Europe 2011; International Commission for the Protection of the Rhine (discharges, population, land cover); International Commissions for the Protection of the Moselle and the Saar (discharges).
Note: Population in the Italian part of the basin is less than 100, in Liechtenstein's part approximately 32,000, and in the Belgian part approximately 44,000 (LandScan).

[17] Based on information provided by International Commission for the Protection of the Rhine (ICPR). www.iksr.org.

ing water purposes, several large water treatment plants abstract raw water directly (Lake Constance) or via riverbank filtration, or abstract Rhine water filtered through the dunes.

The Rhine and a number of its tributaries contain sediments, some of which are considerably contaminated by industrial and mining activities in the past. As a result, during strong flooding or dredging activities, for navigation purposes for instance, remobilized sediments may cause temporary pollution.

Numerous hydraulic measures in the past have resulted in vast hydro-morphological modifications, which have greatly impacted the ecological function of the Rhine. These effects include, among others, the almost complete restriction of river dynamics, the loss of alluvial areas, the impoverishment of biological diversity, and obstacles to fish migration. In addition, rectification and riverbank stabilization have shortened the course of the river and, along longer sections, the construction of dikes cuts the floodplains off from river dynamics. As a result, today there is a deficiency of natural structural variety and of important structural elements required for natural species diversity and intact ecosystems.

Downstream from Iffezheim (Upper Rhine) to the North Sea estuary, the Rhine flows freely without obstacles. For navigation purposes, hydropower generation, flood protection, and to slow down groundwater level decline (due to the deepening of the river bed), the water levels of the main stream of the Rhine upstream from Iffezheim are regulated, and numerous water constructions, such as sluices, barrages and dikes, have been built. Between the outlet of Lake Constance and Iffezheim, there are 21 barrages in the main stream, as well as bypasses serving the purpose of hydropower generation which do not, or only to a limited extent, grant river continuity for fish, biota and sediments. Moreover, because of the Rhine regulation, flood risk has increased in the northern part of the Upper Rhine (downstream of Iffezheim). In the upper reaches of the Rhine (Alps and their foothills), there are numerous reservoirs and barrages serving power generation; during power consumption peaks, hydropower plants often regulate the water supply according to the need for power supply ("hydropeaking operation"). That means that flora and fauna are not only impacted by interference with river continuity, but also by the surge effects of hydropeaking operation.

Furthermore, there are more than 100 barrages (often combined with hydropower plants and shipping) with barrage locks in the Neckar, Main, Lahn and Moselle tributaries.

The marked mining activities in the Rhine Basin, particularly in the Moselle-Saar area, in the Ruhr area and the open-cast brown-coal mining areas along the left bank of the German Lower Rhine, are equally relevant. Even though mining activities have decreased considerably and will continue to do so, their effects still remain in many places.

Status and transboundary impacts

As a result of the investments of the States, municipalities and industry in the basin area, notably into wastewater treatment, water quality has considerably improved. The effects of air-borne diffuse water body pollution or pollution eroded from the soil continue to be problematic. Phosphorus, and, above all nitrogen contents in excess affect the biological quality of water bodies, particularly in the marine environment (Dutch coast, Wadden Sea).

In the Rhine Basin, the following pollutants are locally or widely spread, in excess of the threshold values called environmental quality standards:

(1) heavy metals such as zinc and copper e.g. from buildings and roads, as well as cadmium;

(2) polychlorinated biphenyls (PCB), e.g. from transformers and hydraulic fluids, and polycyclic aromatic hydrocarbons (PAH), e.g. from combustion plants, and which are measured everywhere in the Rhine; and,

(3) bentazone, tributyltin, pentachlorobenzene, diurone, brominated diphenylethers, hexachlorobutadien. These substances are, among others, plant protection agents, conservation agents or industrial chemicals.

In 12% of the water bodies of the main stream of the Rhine the chemical status is good; in 88% it is not good. In most cases, the cause is PAH concentration exceeding environmental quality standards.

On the whole, the quantitative groundwater status in the Rhine Basin can be said to be good, which means that there is no abstraction in excess. Due to draining measures, the status of groundwater in the brown-coal mining area along the Rhine is bad.

Apart from certain groundwater bodies with a bad status, the chemical status of groundwater bodies is largely good. The reasons for the classification "bad status" are the nitrate pollution due to fertilization in agriculture and intensive livestock keeping as well as inputs of plant protection agents.

Biological inventories of the state of flora and fauna in the Rhine have been carried out, and were subsequently compared to earlier investigations. Improved river continuity, water quality and the protection of habitats have had an impact on the fauna of the Rhine. According to these inventories the fish species composition in the Rhine is almost complete: 67 fish species were detected and all historically identified species except for the Atlantic Sturgeon have returned. The macrozoobenthos have recovered to 560 species; species which were extinct or considerably diminished have returned, but many species are still absent. Some 36 water plant species (macrophytes) and 269 fixed diatom species (phytobenthos) have been inventoried in the Rhine. On the other hand, invasive species often spread at the expense of the indigenous fauna. Apart from numerous invertebrate species, even some fish species, among others from the Black Sea area, have been detected.[18]

Responses

In 2005, the most important management issues for the whole Rhine River Basin District have been defined in the management plan report according to the WFD:[19]

(1) "restoration"[20] of biological river continuity, increased habitat diversity;

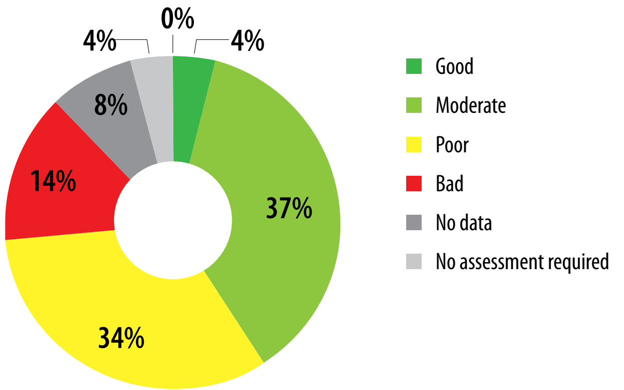
(2) reduction of diffuse inputs interfering with surface waters and groundwater (nutrients, pesticides, metals, dangerous substances from historical contamination and others);

(3) further reduction of classical pollution of industrial and municipal origins; and,

(4) harmonization of water uses (navigation, energy production, flood protection, regional land use planning and others) with environmental objectives.

[18] *Source:* Summary report on the quality components phytoplankton, macrophytes/phytobenthos, macrozoobenthos, fish. ICPR, Report no. 168. 2009.
[19] Internationally Coordinated Management Plan for the Rhine International River Basin District of the Rhine, International Commission for the Protection of the Rhine, December 2009.
[20] As far as possible, river continuity is to be restored.

FIGURE 2: Present ecological status or potential of the water bodies of the main course of the Rhine based on the number of water bodies



Source: Rhine River Basin Management Plan.

Migratory fish are at the same time pilot and indicator species for the living conditions of numerous other organisms.

As far as regards the Lake Constance Lake Trout. which is the indicator species for the region of the Alpine Rhine and Lake Constance, a separate Lake Trout Programme is being implemented.

The States in the Rhine catchment area strive to progressively restore river continuity in the main course of the Rhine as far as Basel, and in certain so-called "programme waters".

The "Master Plan Migratory Fish Rhine" has been drafted with a view of achieving this target.[21] In order to build a self-sustained stock of salmon and Lake Trout, the access to a maximum number of identified spawning and juvenile habitats in the Rhine catchment must be restored, and these habitats must be revitalised. Additionally, among others, the possibilities of upstream migration must be improved. On the whole, with these measures, a total of more than 1,000 ha of spawning and juvenile habitats are supposed to be opened in the Rhine catchment area.

The most important fields of action in the main course of the Rhine and major tributaries will be to:

(1) improve fish migration at the Haringvliet sluices and at the closure embankment of Lake IJssel;
(2) construct fish passages at the two dams in the Upper Rhine upstream of Gambsheim (Strasbourg by 2015, work in Gerstheim to begin before 2015 in order to open the way into the Elz-Dreisam system in the Black Forest);
(3) improve existing fish passages at four dams on the High Rhine, a new construction is planned for the Rheinau Dam; and,
(4) equip several big dams in the navigable tributaries Moselle (19), Main (6), Lahn (20), Neckar (3), with fish migration facilities.

In addition, several hundreds of individual measures will be implemented at smaller barrages in suitable tributaries where the largest spawning habitats are found.

Species diversity may be increased by increasing structural diversity in the riverbed and on the riverbanks. Water maintenance must be environmentally compatible. These measures will contribute towards opening up further habitats for the flora and fauna living in the water, on its banks and in the floodplains. By 2015, various measures for opening up habitats and for increasing structural diversity in the river will have been implemented along the main course of the Rhine, in the old bed of the Rhine, along the big navigable Moselle, Main, and Neckar tributaries and along the Lippe River, as well as in many smaller waters in the Rhine Basin.

To improve water quality, 96 % of the about 58 million people living in the Rhine River Basin District have so far been connected to a wastewater treatment plant. Many big industrial plants or chemical parks (a considerable part of worldwide chemical production is located in the Rhine catchment area) have their own wastewater treatment plants, which are, at the very least, state-of-the-art facilities. As a result of considerable investment in the construction of wastewater treatment plants in all the States, point sources now contribute less often to classical pollutant contamination than in the past. The pollutant and nutrient contamination currently being observed is largely of diffuse origin. Agriculture and municipalities have already made efforts to reduce these discharges.

Mainly with a view to improve the marine environment, a reduction of the load of total nitrogen by 15% to 20% is targeted as a result of reduction at source. Measures already implemented will be taken into account. A reduction of input by 10 to 15% by the first cutoff year according to WFD, 2015, is considered to be achievable.

Generally, zinc and copper inputs are of diffuse origin. For some applications, environmentally friendly alternatives are imaginable (e.g., construction sector, car components, antifouling, treatment of animal's hoofs). No further direct PCB inputs are known. Former PCB pollutions still exist in bottom sediments, and may be released during floods or dredging. These pollution sources must be rehabilitated to the extent possible. Since PAH mainly get into waters as diffuse air-borne pollution, no considerable improvement is expected by 2015 for this group of substances, and thus for the chemical status of the water bodies concerned.

Trends[22]

With climate change, winters are expected to become more humid, while summers will presumably be drier. Regionally, the amount of precipitation falling in a short time may be greater than today. Among other things, for the Rhine this means that run-off levels and water temperature may change. Climate change may impact flood protection, drinking water production, industrial activities, agriculture and nature. In the long run, the increase in temperature will lead to rising sea levels. Since 2007,

[21] Master Plan Migratory Fish Rhine. ICPR, Report no. 179. 2010.
[22] *Sources:* Scenario studies for the discharge pattern of the River Rhine (forthcoming in 2011); Analysis of the state of knowledge on climate changes so far and on the impact of climate change on the water regime in the Rhine watershed - Literature evaluation, available at www.iksr.org.

the ICPR is recording the impact of eventual climate change on the water balance and on water temperatures of the Rhine.

According to present knowledge, air temperature has risen by about 1 °C during the past 100 years, and precipitation in the Rhine Basin has increased. The glaciers of the Alps continue to retreat. There is a tendency towards more humid winters and drier summers, accordingly impacting water discharge. The Rhine water temperature has risen by about 1 °C to 2.5 °C, but it is also impacted by cooling water discharges.

Sustainable development of the river should be the basis for future policies for international rivers, which means the promotion of a balanced use of the river, respecting all interests and interest groups, now and in future. Precaution and prevention are the most important basic principles for river basin management.

During the years to come, the ICPR will work on harmonized adjustment strategies with respect to floods and low water, water temperature, water quality, and ecology in the Rhine Basin. These strategies will be part of the second International Management Plan.

LAKE CONSTANCE[23]

Lake Constance, which belongs to the Rhine Basin, is the second largest pre-Alpine European lake, and serves as an important drinking water supply for 4 million people. A major tributary to Lake Constance is the Alpine Rhine, with its sub-basin in Italy, Switzerland, Liechtenstein and Austria.

The lake basin is situated in the Molasse basin of the northern Alpine foreland, and was mainly formed by water and ice activity during the last Quaternary glaciation period, more than 15,000 years ago. The lake basin area of about 11,000 km² (~20 times the lake surface) covers the territories of five European countries: Germany (28%); Switzerland, Liechtenstein and Italy (48%); and Austria (24%). With an area of 572 km^2 and a total volume of 48.5 km^3, Lake Constance lies 395 m a.s.l. Its two major parts are the Upper Lake Constance (472 km^2, 47.6 km^3, maximum depth 253 m, mean depth 101 m), shared by Germany, Austria and Switzerland, and the Lower Lake Constance (62 km^2, 0.8 km^3, maximum depth 40 m, mean depth 13 m), shared by Germany and Switzerland. More than 75% of the water inflow originates from the Alps, mainly through the tributaries Alpine Rhine (Alpenrhein) and Bregenzerach. The lake has a water retention time of 4.3 years.

Status

It is an intensively monitored hard-water lake with low-phosphorus content. The Upper Lake is almost oligotrophic: phosphorus levels <10 µg/l since 2005). Originally an oligotrophic water body, eutrophication started to threaten the lake in the late 1950s, and remarkably affected the species composition of the biota. Starting in the early 1980s, phosphorus concentrations strongly declined, and overall water quality improved. This was due to reduced nutrient loads (more than 4 billion euros have been invested to improve sewage treatment).

Phytoplankton succession typically shows a spring bloom, followed by the “clear water” phase, with very low phytoplankton abundance due to zooplankton grazing. Diatoms contribute up to 90% of the phytoplankton biovolume in spring. Phytoplankton, bacteria and crustaceans are the most important contributors of biomass. During summer, zooplankton is the main food source for most fish in Lake Constance. About 30 species of fish contribute to the fauna of Lake Constance. The dominant species are whitefish and perch, contributing to 90% of total commercial fishing yield (1,032 tons, annual mean for the period 1995–2004).

Transboundary cooperation and responses

The countries bordering Lake Constance cooperate through the International Commission for the Protection of Lake Constance, in existence since 1959. As the lake is part of the Rhine River Basin, the Alpine Rhine-Lake Constance area of operation is one out of nine such areas in the basin.

Lake Constance is a designated Ramsar Site.

In recent times, the pressures of rising population figures and industrial and agricultural activities may have deserved concern. Today, some 60% of shore and shallow-water zones are characterized as deviating from the natural state, and therefore a main focus is on ecological improvement by shoreline restoration. For this purpose, the International Commission for Protection of Lake Constance has initiated a “Shore-water and Shallow-water Zone” action programme to restore natural shorelines step by step, on the basis of a renaturation guidance, jointly established in 2009. The biological quality of tributaries discharging into the lake varies from unpolluted headwater rivers, to slightly polluted lower reaches. Hydromorphological changes have been severe in these areas, as canalization and artificial riverbeds and banks are common. Recently, revitalization has been undertaken in the floodplains of the Alpine Rhine, and several other tributaries of Lake Constance.

With regard to the Lake Constance Trout and other migratory fish, the International Conference of Plenipotentiaries for Lake Constance fishery started a conservation programme in 2010, with the objective of protecting and increasing the trout population in the lake and its tributaries.

Trends

Lake Constance is also facing climate change, with increasing winter temperatures and higher precipitation in the form of rain. The summers will be dryer and hotter, resulting in lower water levels and changes in the littoral zone. This climatic change might be accompanied by the appearance of an increasing number of exotic species which may threaten indigenous biota.

[23] Based on information in the Rhine River Basin District working area Alpine Rhine/Bodensee, International coordination of the management plans and programmes of measures in implementation of the WFD (2009) and the First Assessment.

UPPER RHINE/ OBERRHEIN RAMSAR SITE[24]

General description of the wetland

The transboundary Ramsar Site "Rhin supérieur/Oberrhein" (designated 2008) extends on both sides of the Rhine over a distance of 190 km from Village-Neuf (France)/Weil-am-Rhein (Germany) in the south to Lauterbourg (France)/Karlsruhe (Germany) in the north. At its widest point, downstream of the incipient meanders, it is 11 km wide. It stretches over a surface area of 47,500 ha: 22,400 ha on the Alsace side and 25,100 ha on the side of Baden-Württemberg. Its boundaries coincide with the sites designated under the Birds and Habitats Directives (Natura 2000) on both sides of the river.

This densely populated Ramsar Site follows the contours of the Rhine's natural floodplain and has all the characteristics typical of an alluvial plain: the river itself, its tributaries, groundwater discharging from springs and alluvial plains. Part of the area is covered by alluvial forests composed of softwood and hardwood that have lost some of their typical features as a result of manmade changes to the hydrological system (canalization of the river during the 20th century). Beyond the forests, the wet meadows, which once covered a large area, have shrunk as land has been converted for agriculture.

Main wetland ecosystem services

The plains of the Upper Rhine are home to the largest groundwater resource in Europe used for water supply (50×10^9 m³). They provide freshwater to 80% of the region's population, in addition to supplying 50% of the water used by industry and 25% of the water used for intensive agricultural irrigation. Water use is estimated to be 270×10^6 m³ for drinking water, 295×10^6 m³ for industrial uses and 51×10^6 m³ for agriculture. These figures cover the uses in the concerned regions in France, Germany and Switzerland. This abundant resource has contributed to the economic development of the region, and shaped the industrial and agricultural landscape. In addition, the Rhine plays a crucial role in flood control throughout its length, and particularly downstream of the area that has been channelled.

Cultural values of the wetland area

The Upper Rhine region has long been a crossroads for trade and communications. It has played an important role in European history and geopolitics, literature, technical innovation, and political and economic development. The region is united by a common Rhine cultural and humanist heritage (philosophers, writers, religious personalities, etc.). Entire centuries have been shaped by thinkers from the universities of Basel, Fribourg en Brisgau and Strasbourg. The region was occupied by the Romans, who left in their wake Gallo-Roman towns and fortress cities (Strasbourg is over 2,000 years old); it was also ruled by the Habsburgs for several centuries. The Alsatian and "Badois" (Badischer Dialekt) dialects, both of which have their origins in the Allemannic dialect group, offer a common point of reference, resulting in a common understanding that goes well beyond the differences between the two countries.

Biodiversity values of the wetland area

The Upper Rhine is home to a tremendous wealth of species diversity, thanks to the presence of dormant and white waters, alluvial forests, cultivated fields and meadows: 9,000 plants, 440 species of Lepidoptera (moths and butterflies), 50 species of Orthoptera (the order including e.g. grasshoppers and locusts), 52 species of Odonata (order of insects including e.g. dragonflies), 250 wild bees, 40 indigenous fish, 23 amphibians, 260 birds, and 49 mammals. 78 of those species are listed under the EU's Habitats Directive (92/43/CEE). It is a breeding ground for large migratory fishes: Atlantic Salmon, Trout, the Allis Shad, and the Sea Lamprey. It is also an important wintering ground for water birds: 60,000 individuals come to the region in January every year, including 10,000 Mallards, 5,000 Gadwalls, 17,000 Tufted Ducks, 1,300 Common Goldeneyes, and 25,000 Blackheaded Gulls.

Pressure factors and transboundary impacts

The Upper Rhine alluvial plain has been significantly reduced and disconnected from the river as a result of development activities (canalization, hydropower development), and many of its characteristic features have disappeared. Agriculture, residential areas, and commercial and industrial activities have developed in much of the area, bringing with them transport infrastructure. This has resulted in the fragmentation and transformation of the landscape. Today, the alluvial gravel deposits are heavily exploited.

In addition, pressure resulting from growing demand for leisure activities along the Rhine sometimes creates local problems. Water-based activities along the banks of the Rhine itself or in its former tributaries disturb the wildlife.

Transboundary wetland management

In light of the important history of the area, the authorities in the Upper Rhine region engaged in transboundary cooperation initiatives very early on: the Tripartite Intergovernmental Conference (France, Germany, Switzerland) and the Rhine Council bring together elected members of the Alsace and Baden Württemberg governments. Similarly, a Ramsar Site steering committee has been in place for several years; it is responsible for coordinating exchanges and sharing of information on administrative and regulatory practices relating to the management of the natural environment. A series of cross-border activities are being implemented: the Integrated Rhine Programme (IRP), the renewal of concessions for hydropower dams, the installation of fish ladders on dams, a programme to revive the Old Rhine (EU-Interreg programme), the restoration of Rhine ecosystems (various LIFE and LIFE+-projects), the creation of an association for the promotion of sustainable cross-border tourism (Association Rhin Vivant), and joint environmental educational programmes (EU-Interreg programme).

[24] *Sources:* Information Sheet on Ramsar Wetlands; www.ramsaroberrhein-rhinsuperieur.eu.

MOSELLE SUB-BASIN AND SAAR SUB-BASIN[25]

The sub-basin of the Moselle and its largest tributary, the Saar, is one of nine sub-basins of the International Rhine River Basin District and makes up about 15% of the district's area. It is shared between France, Luxembourg, Germany (Saarland, Rhineland-Palatinate, North Rhine-Westphalia) and Belgium (Walloon Region).

Sub-basins of the Moselle and Saar Rivers

Country	Area in the country (km²)	Country's share (%)
Belgium	767	2.7
France	15 360	54.3
Germany	9 637	34.1
Luxembourg	2 521	8.9
Total	**28 286**	

Hydrology and hydrogeology

The Moselle originates in the Vosges region of France, and flows into the Rhine 520 km later in Koblenz (Germany). Its main tributaries are the Saar (length 227 km, sub-basin area 7,431 km²), the Sauer River (173 km, 4,234 km²) and the Meurthe River (161 km, 2,900 km²).

Precipitation in the sub-basin ranges from 600 mm/year in the middle and lower Moselle region to 1,800 mm/year in the Vosges (average for the whole basin is 900 mm/year). Taking into account evapotranspiration, the average annual outflow (surface run-off and groundwater recharge) ranges between 550 mm/year in France and 335 mm/year in Saarland (Germany).

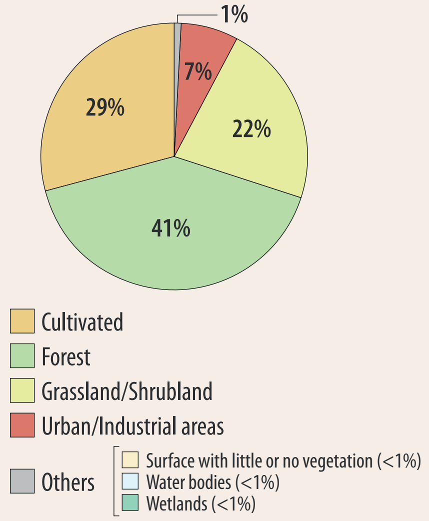
Some 600 water bodies have been identified according to the WFD, including around 30 that belong to two or three different countries. A large proportion of the watercourses in the sub-basins of the Moselle and the Saar remain in a natural state (87%), despite extensive anthropogenic interventions, and only 13% are classified as heavily modified.

In the case of groundwater, variations in the definitions applied have led to country-specific differences in the quantity and size of groundwater bodies. Of the 71 groundwater bodies identified in total in the Moselle-Saar sub-basins, 26 are located in the vicinity of a border.

Pressures[26]

Around half of the area of the sub-basins is used for agricultural purposes, with equal shares of arable land and grassland. Vines are grown extensively on the slopes above the Moselle in Germany and Luxembourg, as well as along the Saar in Rhineland-Palatinate. Around one-third of the area is wooded.

LAND COVER IN THE MOSELLE SUB-BASIN AND SAAR SUB-BASIN



Sources: UNEP/DEWA/GRID-Europe 2011; International Commissions for the Protection of the Moselle and the Saar (data).

The countries in the sub-basins carried out a joint analysis as a part of implementation of the WFD for the identification of the key transboundary problem areas, described here briefly.

Water use along the Moselle and Saar, coupled with local regional planning policy, is not always consistent with the environmental objectives of the WFD, particularly in the areas of navigation, energy generation and flood protection.

The biological continuity of the Moselle and Saar is not guaranteed, which impairs fish migration. Common forms of pollution – particularly nutrients (nitrogen and phosphorus) – and diffuse discharges adversely affect the status of surface waters. Levels of pollution by hazardous substances remain too high in certain parts of the river basin. Groundwater quality is impaired by diffuse pollution (plant protection agents, nitrate, contaminated sites and metals). The ecological equilibrium of the water is impaired by mining (coal and iron ore).

For many decades, the Moselle and the Saar have been developed into major shipping lanes along a large proportion of their length. This has significantly transformed the habitats of flora and fauna; in particular, the 28 locks on the Moselle and a further 6 on the Saar represent a major barrier to fish migration. These physical and biological changes also influence the oxygen balance, and hence the water quality.

So-called common pollutants, whether from point or diffuse sources, originate primarily from discharges from wastewater treatment plants and from agriculture.

Number of wastewater treatment plants and annual discharges in the Moselle and Saar sub-basins:

	Number of wastewater treatment plants				Annual load (t)		
State	> 2 000 inhabitants	> 10 000 inhabitants	> 100 000 inhabitants	Total	COD	Nitrogen total	Phosphorus total
Belgium, Walloon Region	1	1	0	2	76	27	3
France	80	43	3	126	4 912	1 120	55
Germany North Rhine- Westphalia	2	0	0	2	20	4.5	0.6
Germany Rhineland- Palatinate	76	39	1	116	1 990	580	88
Germany Saarland	30	29	2	61	4 900	1 427	142
Luxembourg	28	9	1	38	3 501	1 209	104

[25] Based on information provided by the International Commissions for the Protection of the Moselle and the Saar (ICPMS).
[26] For details, please refer to the international Moselle and Saar River Basin Management Plan (2009) available at www.iksms-cipms.org.

Land use/land cover and selected anthropogenic pressures in the Moselle/Saar sub-basin

Country	Belgium	France			Germany	Luxembourg	Total, Moselle/Saar
Region/State	Walloon Region		North Rhine-Westphalia	Rhineland-Palatina	Saarland		
Surface area (km^2)	767	15 360	88	6 980	2 569	2 521	**28 286**
Population: inhabitants x 1 000	38	1 981	4	855	1 066	399	**4 343**
Communities	17	1 680	2	792	52	114	**2 657**
Towns > 100 000 inhabitants	0	2	0	1	1	0	**4**
Towns> 10 000 inhabitants	2	30	0	18	39	4	**93**
Forested area	38%	30%	51%	46%	33%	35%	**35%**
Agricultural grassland	40.8%	20%	43%	18%	15%	25%	**20%**
Agricultural arable land	17%	27%	1%	19%	15%	24%	**23%**
UGBN[a]/Livestock units (x 1 000)	60	400	5	215	75	150	**961**

[a] UGBN is the common unit used in France for comparison of loading from livestock. 1 UGBN is equal to 32 population equivalent (p.e.) in oxidizable organic matter and to 15 p.e. in nitrogen.

The following main pressures affect the groundwater and influence its quality (ranked in order of importance):

(1) nitrate pollution;

(2) pollution with plant protection agents;

(3) chloride and sulphate; and,

(4) chlorinated solvents.

Pollution with heavy metals, polychlorinated biphenyls (PCB) and polycyclic aromatic hydrocarbons (PAH) has been detected across the entire area.

Chloride from anthropogenic discharges also continues to pose a major problem in the Moselle, downstream of the Meurthe. The lower reaches of this Moselle tributary are affected by salt discharges (or more precisely, calcium chloride discharges $CaCl_2$) from the Lothringian salt industry (soda plants).

Mining activities, both coal and iron ore, have been closed down. Mining has permanently disturbed and altered the ecological equilibrium of surface waters and groundwater, causing a number of cross-regional problems, which will need to be tackled in the long term.

The Saar in particular is affected by discharges of industrial wastewater from mining and from decommissioned mines, leading to high concentrations of chloride and other priority substances. Mining-related changes to the soil and subsoil, and the discontinuation of mining, directly impair the quality of groundwater in the iron ore and coal basin, which in turn affects the water supply to the population at local level.

Status and transboundary impacts

The assessment of the status (also the projected status for 2015) was carried out in close transboundary harmonisation and coordination between the riparian countries, particularly with regard to water bodies in the vicinity of national borders. Despite some differences in assessment methods, particularly with regard to biological aspects, harmonisation was facilitated through discussions between experts, and separately documented in the International River Basin Management Plan.

In the entire Moselle-Saar sub-basins, based on the data from surveillance monitoring (2007), only 118 surface water bodies out of a total of 620 or 19%, have a good status, that is, both the chemical status and ecological status are at least "good". This is due to both a bad chemical and ecological status, as only 261 water bodies (43%) have a good chemical status and 35% a good ecological status. PAHs are primarily responsible for the bad chemical status, and exceed the environmental quality standards at many monitoring sites. If PAHs were disregarded, 85% of surface water bodies would be of good chemical status.

In terms of quantity, 97% of a total of 71 groundwater bodies have a good quantitative status. In qualitative terms, 65% of groundwater bodies have a good chemical status, while 35 % of groundwater bodies are classified as having a bad status due to diffuse pollution with nutrients (nitrate) and plant protection agents.

Transboundary cooperation and responses

The countries sharing the sub-basins collaborate in the International Commissions for the Protection of the Moselle and the Saar (ICPMS) to ensure the sustainable management of all the rivers in the sub-basins. This collaboration also serves to coordinate implementation of the WFD throughout the sub-basins, and the RBMP was drawn up documenting the implementation and its international coordination.[27]

In the Moselle-Saar sub-basins, the sometimes complex transboundary harmonisation of measures and programmes of measures (such as the Moselle-Saar Action Programme 1990-2000) to ensure consistent approaches has the benefit of a long tradition under the umbrella of the ICPMS, supported by its permanent secretariat in Trier (Germany).

Close collaboration between the areas of water management, land use planning, agriculture and forestry makes it possible to develop measures related to water use that fulfill several objectives simultaneously.

The basic measures to improve the hydromorphology of watercourses and reduce pollution are derived from the relevant EU Directives and corresponding legislation of the member States. Technical modifications to the Moselle and Saar and many of their tributaries have considerably altered the aquatic living conditions. Measures to improve biological continuity essentially comprise the conversion or demolition of weirs and other obstacles to migration, the construction of fish ladders, guaranteeing the required minimum outflow, and improving habitats. To this end, the ICPMS drafted an inventory of biological continuity in the Moselle and Saar sub-basins in 2010.

The pressures from human settlements are to be reduced by a raft of measures on buildings, residential areas, wastewater collection systems and wastewater treatment plants. Improved rainwater management, achieved by building new residential areas with

[27] For details, the Moselle and Saar River Basin Management Plan should be referred to.

separate sewer systems, and by the construction of storm water storage tanks in combined sewer systems, will help to further optimise the purification level of wastewater treatment plants. Public education campaigns are being conducted to raise awareness of the problem of waste disposal via the sewer system.

Diffuse pollutants are predominantly due to agricultural practices, but regional and local authorities and private individuals also contribute. One important measure is therefore to provide targeted advice to all user groups on good practices. Diffuse agricultural pollution is also tackled by aiming at optimizing production factors and their sustainability, for example, through improving fertilizer management. Another objective is to avoid or reduce the discharge of nutrients and plant protection agents by means of sustainable land management through measures aimed at extensification of agriculture, extended crop rotation and intercropping, as well as soil cultivation measures, including environmentally sound soil management to prevent erosion and minimize run-off.

Measures to prevent discharges of plant protection agents from agricultural land into rivers have been jointly developed, outlined and evaluated with regard to their effectiveness by the water management and agricultural authorities of all ICPMS Parties. Here too, measures are needed to advise and educate the relevant players, including private consumers. Funding from the European Agricultural Fund for Rural Development (EAFRD) will be used to specifically encourage the introduction or retention of environmentally sound agricultural management and cultivation practices.

PAHs and PCBs are widespread in the Moselle and Saar rivers. Levels of PCB contaminations in suspended matter have been monitored since the early 1990s as part of the international ICPMS monitoring programme, and in 2004 a special monitoring programme with regard to PCB in suspended matter and fish was devoted to this aspect.

It has become evident that it will not be possible to reduce PAH from diffuse sources sufficiently to meet the environmental quality standards by the specified deadline. As these discharges are not solely a water management responsibility, and sometimes extend far beyond the national framework, an EU-wide response is needed.

It is estimated that the coal mine workings will be flooded in the course of coming 10 years. Thereafter, groundwater levels and quality will need to be monitored by means of a suitable monitoring network. Initial expert reports on this issue have been commissioned. As a final decision on the future has yet to be reached, and a number of alternatives are still under discussion, it is not possible to predict exactly how the mine workings are to be flooded, and when long-term stability is likely to set in.

The monitoring networks for surface waters in place since the mid-1960s have been adapted in line with the requirements of the WFD, so as to obtain a coherent and comprehensive overview of water body status. The international monitoring network of the ICPMS currently comprises some 50 monitoring sites. During the course of implementing the WFD, a monitoring network for groundwater comprising a total of 401 monitoring sites started operation.

Trends

Due to their chemical status, only 24% of surface water bodies will achieve a good status by 2015 through the implementation of the programmes of measures accompanying the 2010-2015 RBMP. However, the proportion of water bodies with a good ecological status will improve significantly, to 56.5 %. In the Moselle and Saar sub-basins, it is expected that 99 % of groundwater bodies will achieve a good quantitative status by 2015, and 75 % a good chemical status.

The rise in average air temperatures, the clearest indicator of climate change, will have a tangible influence on the hydrological cycle. Surface waters and groundwater will be affected by changes in the precipitation and evaporation regime. Experts predict that in addition to the long-term changes in current average conditions, annual extremes will also increase. Changes and impacts are expected in key sub-aspects of water management.

The Interreg IV A project FLOW MS (Flood and Low Flow Management Moselle - Saar) was launched in early 2009 under the umbrella of the ICPMS. This 5-year project, with a budget of 3.4 million euros, is 50 % co-financed from ERDF[28] funds. It aims to improve precautionary flood protection, to reduce the potential damage associated with flooding, and advance low flow management in the Moselle and the Saar sub-basins. Within this framework, the impacts of climate change on flooding and low flows will be investigated on a transboundary basis. The results of existing climate scenarios, and those currently under development, serve as the basis for analysis using available hydrological balance models (such as LARSIM).[29]

The ICPMS will continue to function as an international coordination platform for the implementation of the WFD and the Floods Directive of 2007. In this context, the ICPMS Flood Action Plan, which was adopted in 1998 and which outlines measures up until 2020, will be converted into a flood risk management plan under the Floods Directive.

[28] ERDF - European Regional Development Fund.
[29] LARSIM - Large Area Runoff Simulation Model (http://larsim.sourceforge.net/index.en.php).

Meuse River Basin District

	Area in the country/ region (km²)	Country's/ region's share	Number of water bodies "lakes"	Number of water bodies "rivers"	Length of rivers in km	Number of groundwater bodies
Belgium Flemish Region	1 596	4.6	3	17	272	10
Belgium Walloon Region	12 300	35.8	12	245	4 934	21
France	8 919	26.0	5	152	3 363	13
Germany	3 984	11.6	1	227	1 6212	32
Luxembourg	65	0.2	0	3	15	1[a]
Netherlandsb	7 500	21.8	19	133	2 688	5
Total	**34 364**		**40**	**777**	**12 893**	**82**

[a] The groundwater body of Luxembourg is included in, and managed as part of, the International River Basin District Rhine.
Source: Management Plan of the International River Basin District Meuse: Roof report. December 2009.

MEUSE RIVER BASIN DISTRICT[30]

Belgium (the Flemish and Walloon regions), France, Germany, Luxembourg, and the Netherlands share the Meuse River Basin.[31]

The source of the 906-km long Meuse River is on the Langres plateau in France, at an elevation of 384 m a.s.l., in Chatelet-sur-Meuse. The Meuse River flows from its source through France, Belgium and the Netherlands, to the North Sea.

The most important tributaries of the Meuse — most of them transboundary — are the Chiers, Semois, Lesse, Samber, Ourthe, Roer, Swalm, Niers, Dommel and Mark.

The basin of the Meuse comprises a large number of aquifers. Many of these strata extend across borders.

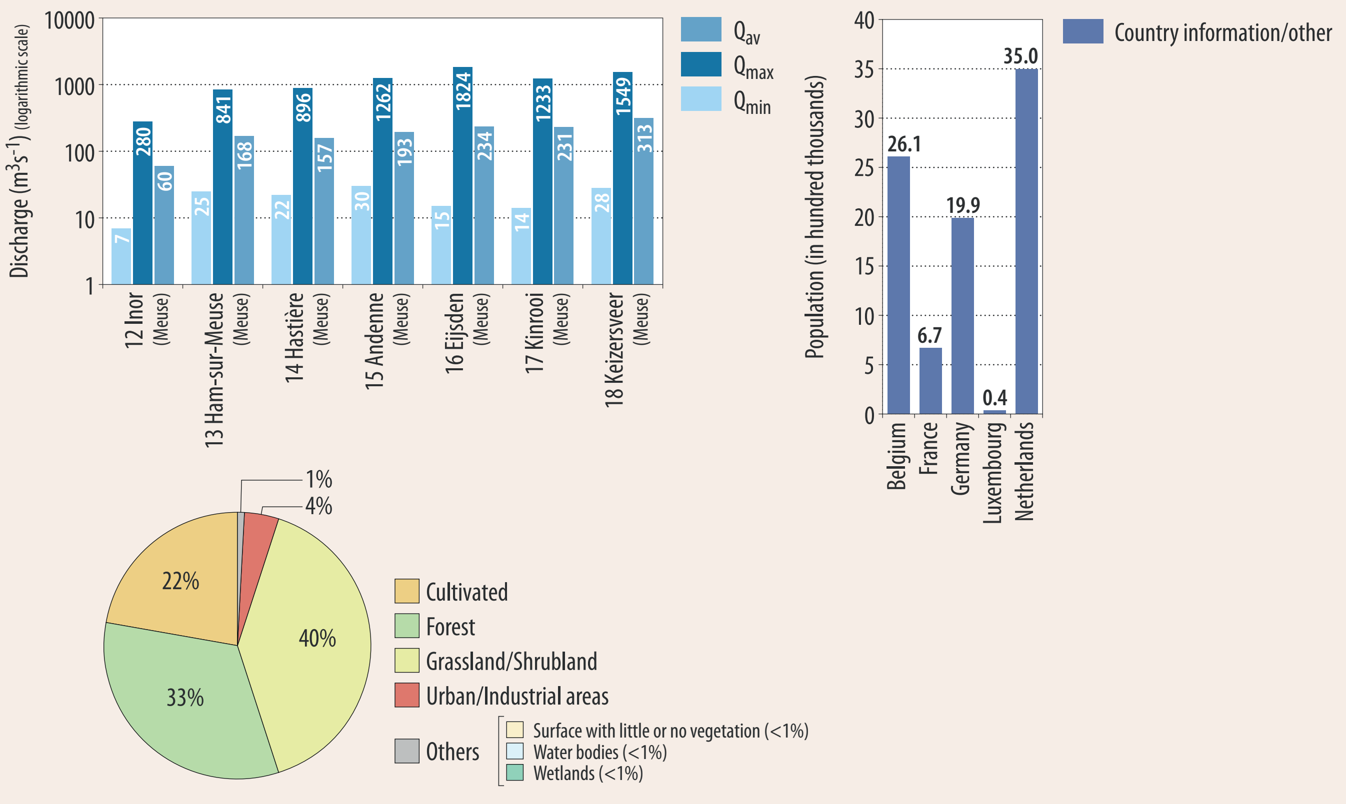
Hydrology and hydrogeology

Peak run-off usually occurs in winter and spring. Summer and autumn are mainly characterized by longer periods of low flows.

The basin of the Meuse River can be divided into three sections, with differing geomorphologic and physical features and human impacts.

The first section, from the source to the city of Charleville-Mézières (France), is characterized by low-flow velocity, and low pressure from industry and municipalities.

DISCHARGES, POPULATION AND LAND COVER IN THE MEUSE RIVER BASIN DISTRICT



Sources: UNEP/DEWA/GRID-Europe 2011; Management Plan of the International River Basin District Meuse: Roof report. December 2009 (population data); International Meuse Commission (discharges).

[30] Based on information provided by the International Meuse Commission with the following specific sources: International River District Meuse - Characteristics, review of the Environmental Impact of Human Activity, Economic Analysis of Water Use', Roof report, March 2005; 'International Meuse Commission: Report on the quality of the Meuse', December 2004; 'The International River District Meuse: a status assessment, November 2005; Management Plan of the International River Basin District of the Meuse', Roof report, December 2009.

[31] The International River Basin District Meuse (IRBD Meuse) is the management unit under the WFD, which includes its associated coastal waters (two coastal water bodies in the Netherlands).

The second section, where the Semois, Lesse, Sambre and Ourthe rivers join the Meuse, stretches from Charleville-Mézières to Liège (Belgium). During periods of heavy precipitation, these tributaries contribute substantially to the flow of the Meuse, and may cause rapid water level rises. The sub-basins of these tributaries make up the principal natural value of this river section, and are especially important as spawning grounds and growth areas for rheophile fish (fish that prefer fast-moving water). A few small islands in the river and parts of the banks have remained in their natural condition, offering habitats for a variety of species of plant and animal life. The section has also many heavily urbanized and industrial sites, both along the main watercourse as well as along the Sambre tributary. Making the main course of the Meuse navigable involved major development.

The third section, a flood plain area, stretches from Liège to the mouth. This section is navigable, which limits the possibilities for a natural low-water channel, and severely reduces fluvial dynamics. This region is also characterized by dense population, intensive agriculture and many industries. Areas of great ecological value exist (e.g. woods, heather fields and marshlands), but their area has been reduced and they are widely dispersed. The north-western part offers an attractive and relatively open area that is surrounded by urban harbour areas.

Pressures

Some 8.8 million people live in the International River Basin District (IRBD) Meuse, and use water for drinking and domestic purposes, agriculture and industry, hydropower generation, navigation and recreation. The water of the Meuse also supports surrounding ecosystems, and is exported by pipelines and canals to provide drinking water to people living outside the basin.

A number of locks and dams were built in the river for navigation purposes or protection against floods, leading to significant modifications of the natural character of the river in most of its sections.

Human impact has altered the natural hydromorphological and ecological conditions. The main driving forces for these alterations are urbanization, industrialization, agriculture, and navigation.

There are different types of pressures in the IRBD Meuse:

- emissions, losses and discharges of pollutants;
- sluices, weirs and dams (flood protection, navigation and hydropower generation);
- canalisation, artificial banks and dikes; and,
- water withdrawals (for canals, agriculture, industry and the production of drinking water).

These pressures result, sometimes individually, sometimes in combination, in the following potential or observed impacts and consequences:

for surface water:

- impairment of ecosystems, including terrestrial ecosystems that interact with the water;
- hampered circulation of fish;
- eutrophication, especially in the main course of the river and in coastal waters; and;
- potential risk for water uses.

for groundwater:

- influence on terrestrial ecosystems; and,
- potential risk for water uses.

For the French part of the river basin, agriculture is the main driving force.

In the Walloon Region (Belgium), in the more densely populated and industrialized sub-basins of the Vesdre Sambre and Meuse aval, urbanization is the major driving force. For the Semois and Lesse rivers, only smaller longitudinal obstacles are present, with no strong driving forces restricting restoration potentials.

In the German, Flemish and Dutch lowlands, urbanization and agriculture are the major causes to alterations in hydromorphological characteristics. In the Dutch part of the Meuse River, most pressures derive from flood defence and shipping. Safety and flood control measures (e.g. delta works and the closure of the Haringvliet estuary in the Netherlands) in the 1970s were essential social measures, but deprived the area of tidal dynamics, resulting in a decreased ecological potential. For the smaller tributaries, especially in the Netherlands, agriculture remains a major driving force. In addition to the strongest estimated impact of longitudinal obstacles and changes in river discharge in the basin, local pressures on habitat quality can seriously affect the ecological integrity of the river.

There are important management issues in the Meuse River Basin District that require multilateral coordination:

- hydromorphological changes (restoration of the natural character and removal of barriers);
- water quality:
  - usual pollutants (organic matter, indicated by COD, nitrogen, phosphorus); and,
  - others (heavy metals, micropollutants – particularly priority substances,[32] copper, zinc, PCBs, other pesticides);
- water quantity:,
  - high tide (prevention and protection against flooding);
  - water shortage and sustainable management; and
- groundwater (qualitative factors: pollution by nitrates and pesticides).

Status and transboundary impacts

The table opposite shows a picture of the current status of the surface water bodies in the IRBD Meuse, and of the status expected in 2015. The number of water bodies not of good status, and the parameters that are responsible for that status, are indicated for each State and Region.

There are problems in nearly all of the Meuse River Basin, due to groundwater pollution by nitrate from urban and agricultural sources, and by pesticides.

Owing to water draining from lignite extraction in the German part of the Meuse River Basin, some groundwater bodies have long been in a poor quantitative or qualitative status.

Transboundary cooperation and responses

The monitoring programmes introduced by the Parties (pursuant to Article 8 of the WFD) concern both surface water and groundwater. The States and regions in 2005–2006 set up their surveillance monitoring programmes in parallel with each other.

[32] Article 16 of the Water Framework Directive (2000/60/EC) sets out a "Strategy against pollution of water", outlining the steps to be taken. The list of priority substances established there (Annex X of the WFD) was later replaced by Annex II of the Directive on Priority Substances (Directive 2008/105/EC).

Number of surface water bodies not of good status in the Meuse River Basin District

			BE Flemish Region	BE Walloon Region	FR	DE	LU	NL
Number of water bodies		Number	17	245	152	227	3	133
		Length	272	N/A	3 363	1622	21	N/A
Number of water bodies not in a good status		Number	17	121	98	205	3	133
		Length	272	N/A	2 817	1 470	21	N/A
Chemical status	Priority substances	Number	>4	50	73	46	N/A	N/A
		Length	63	N/A	2 212	321	N/A	N/A
Ecological status	Chemical & physico-chemical elements decisive for biological elements	Number	17	114	76	202	N/A	N/A
		Length	272	N/A	2 277	1 450	N/A	N/A
		Number	17	84	44	64	N/A	N/A
		Length	272	N/A	1 432	461	21	N/A
	Biological parameters	Number	17	95	36	198	N/A	N/A
		Length	272	N/A	1 722	1 462	N/A	N/A
	Hydromorphology	Number	N/A	N/A	56	N/A	N/A	N/A
		Length	N/A	N/A	1 874	N/A	N/A	N/A

Number of surface water bodies expected not of good status in 2015 in the Meuse River Basin

			BE Flemish Region	BE Walloon Region	FR	DE	LU	NL
Number of water bodies not in a good status in 2015		Number	15	76	84	203	N/A	124
		Length	232	N/A	1 432	1 450	N/A	N/A
Chemical status	Priority substances	Number	N/A	38	36	N/A	N/A	N/A
		Length	N/A	N/A	1 103	N/A	N/A	N/A
Ecological status	Chemical & physico-chemical elements decisive for biological elements	Number	N/A	72	34	N/A	N/A	N/A
		Length	N/A	N/A	1 158	1 417	N/A	N/A
		Number	15	57	24	64	N/A	N/A
		Length	232	N/A	920	461	N/A	N/A
	Biological parameters	Number	N/A	69	[a]	195	N/A	N/A
		Length	N/A	N/A	[a]	1 409	N/A	N/A
	Hydromorphology	Number	N/A	N/A	27	N/A	N/A	N/A
		Length	N/A	N/A	980	N/A	N/A	N/A

[a] Status in 2015 was determined on the basis of the chemical and ecological status.

These programmes are tested against each other in the International Meuse Commission (IMC).[33]

The riparian countries (including the Belgian regions) implement the decisions of their own Governments, as well as the recommendations of the IMC. The IMC has been established under the Agreement on the River Meuse (Ghent, 2002), and acts as the platform for international coordination to implement obligations under the WFD and under the Floods Directive for the IRBD Meuse.

In implementing management plans (programmes of measures) under both directives at their national levels, the parties in the IMC decided to coordinate the following measures, addressing the important management issues identified as requiring multilateral coordination:

- restoration of biological continuity to address hydromorphological changes (restoration of the natural character and removal of barriers);
- water quality:
  - reduction of the emissions from household, industrial and agricultural domains to address pollution by classic pollutants such as organic matter, indicated by COD, nitrogen, and phosphorus; and
  - reduction of the emission of micro-pollutants from household, industrial and agricultural sources to address pollution by other pollutants (heavy metals such as copper and zinc), and micropollutants (particularly priority substances, PCBs and pesticides);
- water quantity:
  - coordinated implementation of the Floods Directive. Coordination and pooling of the requirements of the Floods Directive with the requirements of the WFD, to cope with high tide, that is prevent and protect against flooding;
  - policy measures to protect the natural environment, to maintain water stocks and to use less water in production processes, to address water shortage and manage sustainably; and,
- improve (1) the qualitative status (nitrate and pesticides), and (2) the quantitative status of groundwater.

Trends

Based on the first provisional estimates, about 35% of the surface water bodies are expected to reach the WFD targets in 2015. For many water bodies, a deadline extension[34] will be needed, particularly as regards the implementation of measures for improving the hydromorphology.

[33] This coordination process led to the publication, in March 2007, of a report "Monitoring on the coordination of the surveillance monitoring programmes in the IRBD Meuse" by the coordinating IMC.
[34] The extension is the one referred to in Article 4, paragraph 4 of WFD.

Surface water (rivers): target expected to be reached in 2015 in the Meuse River Basin District

	BE Flemish Region	BE Walloon Region	France	Germany	Luxembourg	Netherlands	IRBD
Number of water bodies where the target is reached in 2015	2	196	72	24	2	9	278
Number of water bodies with deadline extension	15	76	80	196	1	124	492
Deadline extension owing to technical unfeasibility	15	N/A	75	171	1	118	-
Deadline extension owing to natural circumstances	0	N/A	13	48	0	24	-
Deadline extension owing to disproportionate costs	15	N/A	23	159	0	105	-
Number of water bodies with a less strict target	0	0	0	7	0	0	7

Note: The data for Walloon Region are provisional.

Groundwater: target expected to be reached in 2015 in the Meuse River Basin District

	BE Flemish Region	BE Walloon Region	France	Germany	Luxembourg	Netherlands	IRBD
Number of water bodies where the target is reached in 2015	4	16	7	12	-	3	42
Number of water bodies with deadline extension	6	5	6	10	-	2	29
Deadline extension owing to technical unfeasibility	0	0	4	0	-	0	4
Deadline extension owing to natural circumstances	6	5	6	10	-	2	29
Deadline extension owing to disproportionate costs	6	4	2	3	-	0	15
Number of water bodies with a less strict target	0	0	0	10	-	0	10

Note: The data for the Walloon Region are provisional.

To attain the right status, deadline extensions beyond 2015 are provided for most groundwater bodies polluted with nitrates and pesticides. This has to do with the long reaction periods for measures to take effect, and with the disproportionately high costs thereof.

For the quantitative problems owing to lignite extraction in the German part, the exemption rule pursuant to Article 4, paragraph 7 of the WFD shall apply.

The Interreg IVb project AMICE (Adaptation of the Meuse to the Impacts of Climate Evolutions) is being carried out in the Meuse River Basin. This project aims to define a common strategy for the Meuse River Basin for adapting to the consequences of climate change, and to develop measures for tackling these changes. With climate change, higher discharges and lower river drainage are predicted.

The IMC supports the AMICE project, and sees to a good exchange of knowledge and information with the Hydrology and Inundation working group of the IMC.

The results of AMICE contribute also to the multilateral coordination of the implementation of the Floods Directive in the Meuse River Basin.

SCHELDT RIVER BASIN[35]

The basin of the Scheldt River[36] is shared by France, Belgium (Federal Government and governments of the Flemish Region, Walloon Region and Brussels Region), and the Netherlands.

Scheldt River Basin District

Country	Area in the country (km^2)	Country's share (%)
Belgium, Walloon Region	3 770	10
Belgium, Brussels Region	161	0.4
Belgium, Flemish Region	11 991	33
France	18 486	51
Netherlands	2 008	6
Total	**36 416**	

The International River Basin District (IRBD) of the Scheldt comprises two transboundary river basins, namely, the Scheldt (length 350 km) River Basin, and the Yser (length 80 km; basin area 1,749 km²) River Basin. The Yser Basin is shared by France and Belgium.

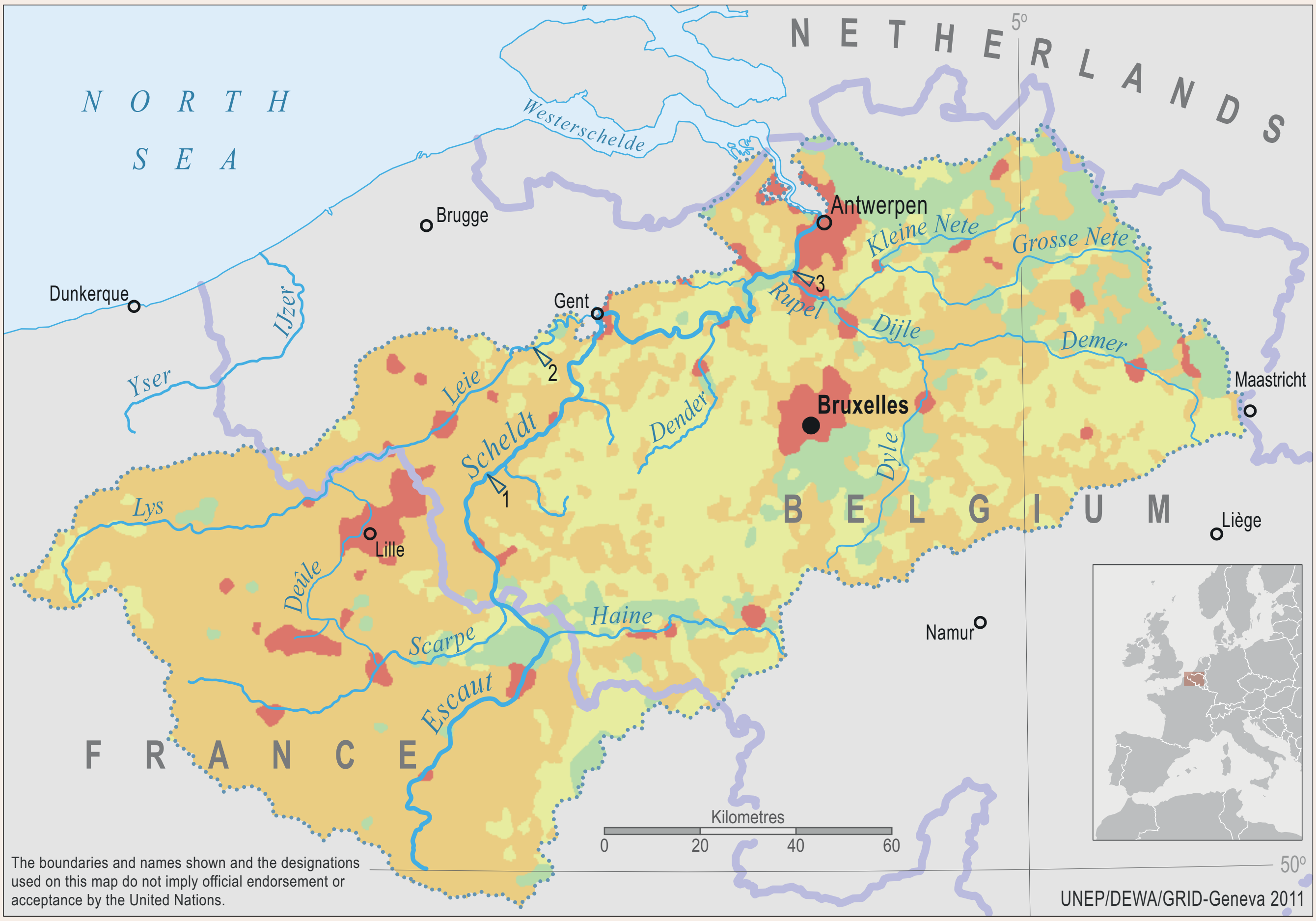
The main tributaries of the Scheldt are the Lys, Dender, Rupel, and Nete.

The elevation of the basin ranges from 2 m below sea level, along the southern coast of Schouwen (Prunje region), to 212 m above sea level in the Walloon Region (Anderlues). Because of this mainly flat relief, the rivers of the Scheldt IRBD are lowland rivers with wide valleys and slow current and discharge velocities.

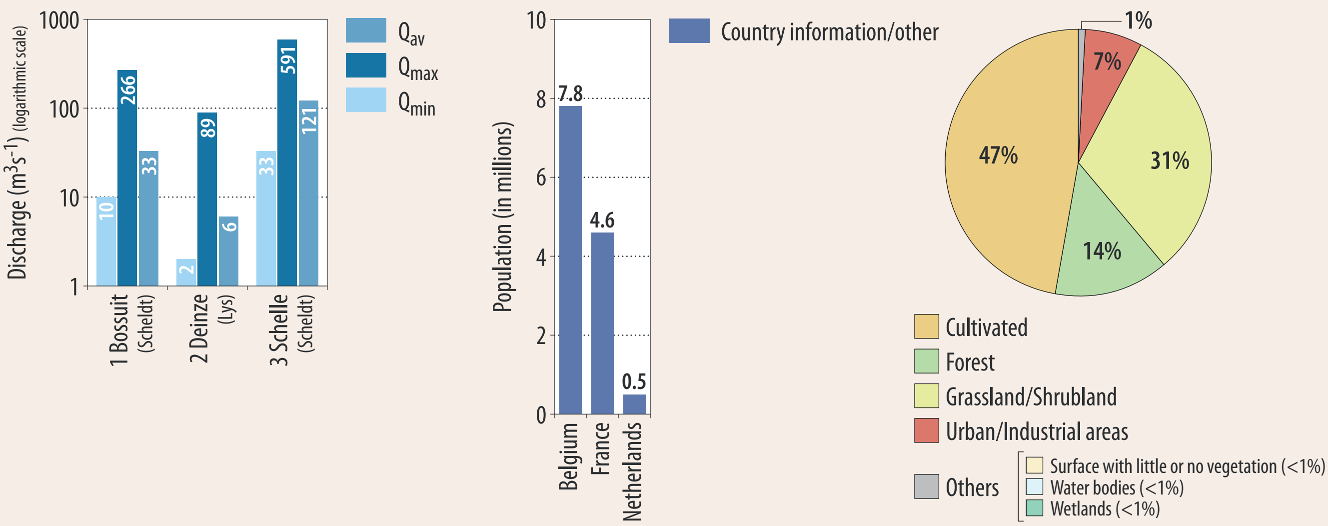
Hydrology and hydrogeology

The 350-km long Scheldt[37] originates near the village of Gouy-Le-Catelet, in northern France. The Scheldt then flows through the Walloon Region, the Flemish Region and the Netherlands,

[35] Based on information provided by the International Scheldt Commission.
[36] The following adjacent river basins, together with the Scheldt River Basin, form the Scheldt River Basin District: Bruges Polders, Yser (IJzer), Aa, Boulonnais, Canche, Authie, Somme and coastal waters. Of the adjacent basins, only the Yser (IJzer) and the coastal waters are internationally shared.
[37] As far as Ghent, the river is called the 'Bovenschelde', between Ghent and Antwerp the 'Zeeschelde', and beyond Antwerp it is referred to as the 'Westerschelde'. The Zeeschelde and the Westerschelde form the Scheldt estuary.

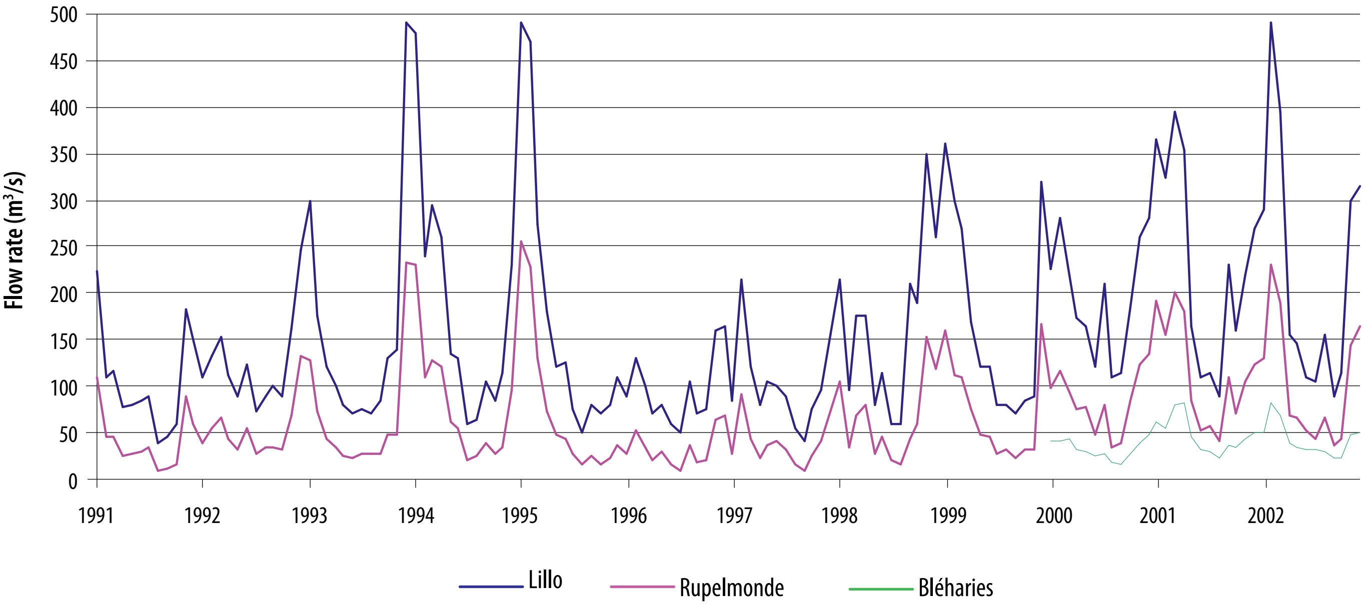


DISCHARGES, POPULATION AND LAND COVER IN THE SCHELDT RIVER BASIN



Sources: UNEP/DEWA/GRID-Europe 2011; International Scheldt Commission (discharge and population data).

FIGURE 3: Evolution of the Scheldt flow rate at the flow meter stations in Bléharies, Rupelmonde, and Lillo for the period 1991–2002



discharging into the North Sea at Vlissingen. Long stretches of the river are canalized: upstream of Ghent, over a 138 km stretch is canalized. On the Scheldt, as well as on its tributaries and the canals of the district, there are more than 250 weirs and locks.

The Scheldt estuary is approximately 160 km long. It and a number of its tributaries downstream are subject to the tides: at Vlissingen, twice a day, more than 1 km³ water flows in and out of the river, while the annual river discharge is approximately 4 km³. The tidal range decreases from 3.86 m in Vlissingen towards Ghent to about 2 metres, where the tidal wave, at 160 km from the mouth, is stopped by the weirs in Gentbrugge.

The flow rate of the Scheldt varies greatly. In the period 1991-2002, the (estimated) average flow rate at Lillo (Belgian-Dutch border) was 161 m³/s. Peak flow rates are usually registered in winter (November-February). The wide and flat valleys in the Scheldt district suffer from numerous floods, especially in late winter, when the groundwater level is highest.

International coordination implied the comparison of 42 transboundary groundwater bodies out of a total of 67 in the IRBD. The comparable groundwater bodies were clustered into 22 cross-border aquifers. 14 out of the 22 aquifers are spread over 2 states or regions, and 8 are spread over 3 states of regions. 20 of the 42 contiguous groundwater bodies are mainly used for drinking water production, and cover 13 aquifers. International coordination was especially focused on three transboundary aquifers, for which clearly defined water management issues had been worked out in terms of cross-border relations:[38]

- The Carboniferous Limestone aquifer which covers parts of France, the Flemish Region and the Walloon Region, and where problems are mainly of a quantitative nature, with a possible negative influence on the quality (impacts on sulfates and fluorine, possibly due to a rising groundwater level;
- The Brusseliaan aquifer, which covers parts of the Brussels Region, the Flemish Region and the Walloon Region, and features increased or constantly increasing nitrate and pesticides contents; and,
- The Oligocene aquifer, which covers parts of the Netherlands and the Flemish Region; in its Flemish part problems are mainly of a quantitative nature.

Pressures

Shipping, urbanization and agriculture are the three main operational usages for which hydromorphological changes have been made to the course of the Scheldt River.

Major pressures in the Scheldt basin include those from domestic areas, industry, agriculture and transport.

On the basis of data from the year 2000 (or 2002 for the Flemish Region), it appears that the wastewater of 53% of the population is collected and treated in urban wastewater treatment plants.

In general, non-collective treatment takes place at the source of the domestic waste load. For nitrogen, suspended solids and phosphorus, the clusters with the highest domestic load correspond to the most populated areas: Zenne, Leie, Scheldt lower

[38] These aquifers have not been assessed in the present publication.

Estimate of the intensity of the pressures of the relevant driving forces per cluster[39]

Cluster of hydrographical units	Population	Industry	Agriculture	Transport networks
Scheldt upper course	++++	+++	++++	**
Scheldt middle course	+++	++	++	***
Scheldt lower course	++++	++++	++++	***
Nete	++	+++	++++	**
Zenne	++++	++	++	***
Dijle-Demer	++++	++	++	**
Dender	++	++	++	**
Leie	++++	+++	++++	* *
Bruges Polders	++	+	++++	**
IJzer	++	+	++++	**
Aa	++	++++	++++	**
Channel coastal basins	+++	++	+++	*
Somme	+++	++	++++	*

Notes: from + to ++++: from low to very high pressure; for transport networks: * = of little importance, ** = only some indicators are higher, *** > IRBD average.

course, Scheldt upper course and Dijle-Demer, which have fewer treatment plants than the other clusters. For a limited number of parameters, high loads are also registered in less populated areas. In certain clusters (such as Scheldt lower course, where 75% is connected), very high loads are observed due to a lack of tertiary processing in the treatment plants.

In addition to a high level of urbanization, the Scheldt IRBD is also characterized by a high level of industrialization, with a number of major industrial zones. The industrial sectors with the strongest presence are the food industry, and metallurgy. Other important sectors are the chemical industry and the textile sector. The chemical sector is positioned in third place, with 14% of the number of companies, clearly less present than the first two sectors. Among European Pollutant Emission Register (EPER) companies, the chemical industry, with one third of all EPER companies, heads the list of the most important activities in the Scheldt district. Metallurgy comes second.

The largest emissions of macro-pollutants (nitrogen, phosphorus, TOC), discharged by EPER companies in the Scheldt IRBD, are located in the clusters Leie, Scheldt lower course, Somme, and Scheldt middle course. The chemical and food industries in the Scheldt district are those contributing most to the emissions of macro-pollutants by EPER companies.

Salt emissions (chlorides, cyanides and fluorides) are by far the most important in the Scheldt lower course. Chloride emissions are also very important in the Nete cluster, as are cyanide and fluoride emissions in the Aa cluster. Chloride emissions are mainly produced by the chemical sector (93%), cyanides by metallurgy (47%) and the materials sector (42%), fluorides by metallurgy (53%) and the chemical sector (46%).

Some 61% (22,077 km²) of the total area of the district is used for agricultural purposes. The agricultural activities in the district include both crop production (in the south), and livestock production (the main agricultural activity in the north).

On the basis of farming activity, the greatest load caused by agriculture is found in the Leie and Yser clusters (a lot of livestock and crop farming), Scheldt lower course (mostly livestock, also with crop farming), Scheldt upper course, Somme and Aa (mostly crop farming, also with livestock), Nete and Bruges Polders (mainly livestock breeding).

For more than a half of the hydrographical units (based on a still incomplete analysis), the sediment quality is deemed to have a highly adverse effect on the aquatic environment or on the use over a medium-sized to large area.

Because of the high level of urbanization of the Scheldt IRBD and the strong presence of agriculture, vast forest and nature areas have become scarce. Moreover, the remaining forest and nature areas are very fragmented. The number of wetlands and other nature areas is very small.

Regarding pressures on groundwaters, most pollution cases occur in surface water, then spread to groundwater. In addition to the major diffuse pressures from agriculture (nitrate and biocides), other pressures assumed as significant for groundwater are polluted sites. The most relevant pressures are direct groundwater abstractions. Managed aquifer recharge — known also as artificial recharge — is of secondary importance at district level.

Annual groundwater abstraction quantities, overall and for the drinking water supply, per region in the Scheldt River Basin District

Country/Party	Abstracted volume (10^6 m³/year)	Abstracted amount for the drinking water supply (10^6 m³/year)
France	418	303
Belgium, Walloon Region	175	137
Belgium, Brussels Region	3.5	2.5
Belgium, Flemish Region	218	115
Netherlands	30	24
Total	**844.5**	**581.5**

The largest volume of groundwater is abstracted in France (especially in the chalk strata), while, in proportion to the area, the abstractions are most intensive in the Walloon Region.

Status and transboundary impacts

In 1998, the International Scheldt Commission (ISC) had already started a joint homogenous monitoring network for the Scheldt basin, which has proven a useful tool in following the evolution of water quality in the Scheldt, and is also helping with coordination between the Parties.

In the 10-year measuring period, the number of wastewater treatment plants in the Scheldt River Basin, as well as the reduction

[39] For the purposes of WFD Article 5 status report (analysis of pressures), a number of the river basins of the Scheldt IRBD is further divided into 31 hydrographical units and regrouped into 13 clusters.

by those plants, have increased, and the plants' average efficiency was improved, demonstrated by lower nitrogen and phosphorus levels. The decontamination of industrial emissions has had a positive influence on oxygenation conditions.

The homogeneous monitoring network's results reveal that the water quality characteristics in the area around Eswars (France) are improving. Little, however, has changed in the French-Belgian border region (Fresnes-Warcoing). The two main improvements occurred in the downstream areas between Pottes (Walloon Region) and Schaar van Ouden Doel (Dutch-Flemish border). In the most downstream area, the Western Scheldt (Netherlands), less improvement is to be noted. The most striking improvement is the increase in the concentration of oxygen, but nitrogen and total phosphorus concentrations have also decreased considerably.

Amongst heavy metals, cadmium shows the strongest decrease, as is also the case, be it to a lesser degree, for copper and zinc. PAHs remain problematic in the river basin, but they mainly come from air pollution. Pesticides and herbicides show a relative improvement. The concentrations of diuron and isoproturon are high, mainly in winter.

Low lindane concentrations are still being registered, whereas atrazine and simazine are found to be below the detection limit.

Responses

International co-ordination for the Scheldt is stipulated in the International Scheldt treaty (2002). The ISC has no supra-national power; it serves as the platform for international coordination on the IRBD level.

Bi- or trilateral issues are treated in the appropriated bi- or trilateral forums, as foreseen in the Scheldt Treaty. Consequently, the treaties, memoranda and agreements between the Flemish Region and the Netherlands concerning the policy and management, deepening, nautical aspects, safety and nature of the Scheldt estuary, are a matter for the Vlaams Nederlandse Schelde Commissie (VNSC) or Flemish-Dutch Scheldt Commission.[40] This cooperation has been formalized in the Treaty of 2005 on cooperation in policy and management in the Scheldt estuary. The VNSC replaces the Technical Scheldt Commission (1948).

Within the International Scheldt Commission, an operational Warning and Alarm System of the Scheldt River Basin District (WASS) has been active since 1998, and includes the procedures to be followed in case of possible cross-border pollution.

All Parties have proposed to spread out the implementation of measures defined with a view of the objectives of WFD on certain water bodies, for the sake of technical feasibility, ecological circumstances and disproportionate costs. Term extensions lead to more realistic programmes of measures.

The programmes of measures and monitoring of the status of waters, according to the WFD, are executed by each Party (as a member State of the EU) taking into account the results of the issues on which it has been agreed to coordinate at the IRBD level.

The ISC is responsible for coordination, involving as tasks, for example, the exchange of information between parties on progress of the implemention of the programme of measures, an update of the database of measures (catalogue of measures), and its use of the catalogue as an instrument for comparison and coordination. Regarding the improvement of biodiversity and fish migration a "master plan on fish in the Scheldt river" is planned Concerning the WASS, an emergency exercise, a yearly workshop with the operators of the Central Warning Stations, and a database of notifications are planned.

Regarding the implementation of the Floods Directive, the ISC is designated as the platform for improving knowledge on interactions between flood from coastal waters and rivers, the definition of significant risk and significant increase of risk, as well as producing maps.

Due to the success of the Scaldit-project (2003–2005),[41] the partners introduced a new Interreg IVB North-West Europe project[42] in the Scheldt IRBD, which aims at finding the best available measures to improve the ecological status of surface water, sediments and groundwater. It includes the following activities:

- implementation and monitoring of a number of transnational river ecosystem development measures, and the elaboration of a transnational inventory on priority fish migration barriers;
- the transboundary monitoring of sediment loads, in order to feed a sediment delivery model and the construction of sediment ponds;[43]
- the transboundary monitoring and modeling of two transboundary groundwater systems as a basis for a joint declaration on transboundary groundwater management;
- the development of a common set of indicators on the level of the Scheldt IRBD to assess the execution of programmes of measures, including costs, effects and benefits of measures; and,
- the dissemination of information on transboundary integrated water management in the Scheldt IRBD by means of events, website, newsletters, and information packages.

Evaluation of the ecological status — in numbers of water bodies — of freshwater rivers in 2007 in the Scheldt River Basin District

Country/Party	Bad	Poor	Moderate	Good	High	No information
France	17	8	19	14	0	0
Walloon Region	29	23	16	1	0	10
Brussels	66	49	46	0	0	0
Flemish	1	1	1	0	0	0
Netherlands	0	0	1	0	0	0
District	**113**	**81**	**83**	**15**	**0**	**10**

[40] http://www.vnsc.eu/english/.

[41] The Scaldit (Scaldis Integrated Testing) project involved testing — as the only pilot and only complete IRBD — all the guidance documents developed by the European Commission, in consultation with the member States, to support the implementation of the WFD. The results of the transnational description of the state of the aquatic environment were the first steps towards a common Scheldt River Basin Management Plan (2009).

[42] http://www.scaldwin.org/scaldwin-2.

[43] In 2011, sediment ponds were constructed on the Molenbeek in Erpe-Mere and on the Vondelbeek.

Trends

The following have been identified as the most important issues in the Scheldt IRBD, considering the future:

- the coordination of the programmes of measures;
- reaching the quality objectives for groundwater and surface waters;
- coordination of the Floods Directive;
- evaluating the impact of climate change (flood, drought, water quality, salinization);
- ecological restoration, fish migration and bio-diversity in general; and
- economic analysis and indicators.

The Scheldt Basin does not suffer from chronic water scarcity, but has to deal with temporary water shortages (drought). The Carboniferous Limestone aquifer, which is under heavy abstraction, is an exception. Salt intrusion from the coastal areas, due to the rise of the sea level, is another impact of the changing climate.

The Scheldt Commission formulated three recommendations for future work on climate change:

- maintain a task team for managing drought: identify vulnerable sectors and map them;
- share results of scientific research on the expected impact of climate change on low water situations; and,
- exchange information on a regularly base on the hydrology within the IRBD.

BIDASOA RIVER BASIN[44]

The basin of the river Bidasoa is shared by Spain and France. The river has its source in Pirineo Navarro, and discharges into Eastern Atlantic Ocean. The transboundary part of the basin is represented by the estuary of Hondarribia and Endaya (see the assessment of the Bidasoa estuary/Txingudi Ramsar Site). Spain reports 750 km^2 as its share of the basin.[45]

Hydrology and hydrogeology

Surface water resources generated in Spain's part of the Bidasoa River Basin are estimated at 464 × 10^6 m^3/year, and groundwater resources at 247 × 10^6 m^3/year, adding up to a total of 712 × 10^6 m^3/year (average for the years 1980 to 2005). Total water resources per capita in the basin are 7.647 m^3/year/capita.

No transboundary aquifers of importance have been identified.

Pressures, status and transboundary impacts

Some 63% of the catchment area in the Spanish part is covered by forest, and 33% by grassland. Less than 2% is cropland.

Hydroelectrical power plant dams, weirs (height 2–3 m), and protection of river banks especially in the estuarine zone cause hydromorphological changes locally, but these are assessed as only moderate, with the exception of the transboundary estuarine zone where the changes are severe. Diversion systems to other rivers or bypasses are also lacking for some hydropower plants/dams.

The only pressures described as severe (but local) are fertilizer pollution and pollution from insufficiently treated urban wastewater (Oronoz and Narbate as well as other urban centres, 1,780 p.e.). Particularly high pressure levels from wastewater discharges have been detected on the estuarine transboundary reach of the Bidasoa.

Transboundary cooperation and responses[46]

The agreement between Spain and France on water management, signed in 2006, sets the framework for transboundary cooperation on the Bidasoa River.

Taking into account the short length and low importance of watercourses that flow between France and Spain, and in view of indications cited in Article 3 of the WFD. the competent authorities in the sense of the WFD did not consider it necessary to define an international river basin district, or establish an international basin commission. The two signatories have agreed that each State is responsible for implementing the WFD, and ensuring management in its territory.

In Spain, the National Sewer System and Water Treatment Plan, and the new National Water Quality Plan, have involved measures aimed at addressing wastewater discharges and agricultural pollution.

Trends

As described in the assessment of the Mino, implementation of several relevant national plans in Spain is expected to improve the status of the Bidasoa River.

It is projected that, due to climate change, there could be an increase of 1 ºC in the annual average temperature by 2027, with no impact on precipitation. River discharge could decrease on average over 2%, and groundwater level is predicted to decrease in the same period.[47]

Photo by Tobias Salathe

[44] Based on information provided by Spain.
[45] *Source:* Spanish National Statistics Institute. 2006 and 2008.
[46] Detailed information is available in the Eastern Cantabrial Region River Basin Management Plan, 2011 (www.chcantabrico.com).
[47] *Source:* National Plan to Adaptation of Climate Change, Ministry of the Environment, Spain, 2009.

BIDASOA ESTUARY/TXINGUDI[48]

General description of the wetland

The Bidasoa estuary (Txingudi) is located in a transboundary area between Spain and France. Administratively, it belongs to the municipalities of Irun and Hondarribia (Gipuzkoa, Basque Autonomous Community), and Handaye (Aquitaine, Pyrénées Atlantiques). It is a coastal wetland, a system of estuaries and marshes in the fluvial-marine interface of the mouth of the River Bidasoa. The estuary is approximately 11 km long. The Ramsar Site covers an area of 130.03 ha that are distributed as follows: Plaiaundi: 39.06 ha, Vega de Jaizubia: 61.68 ha, Bidasoa Islands: 29.29 ha. It holds eight habitats contained in Annex I of the Habitats Directive, of which two are considered priorities (1150 Coastal lagoons and 91E0 Alluvial forests with Common Alder and Common Ash. There is one waterfowl species, the Aquatic Warbler, classified as Vulnerable by IUCN. Additionally, there are at least 15 threatened bird species included in different national catalogues (National Catalogue of Threatened Species, Red Book of Birds of Spain), and four breeding species included in the Basque Catalogue of Threatened Species: Little Ringed Plover, Water Rail, Reed-Warbler, and Little Grebe. There are also three fish species classified as endangered and/or vulnerable by the "Red Book of Continental Fish of Spain": Atlantic Salmon, River Herring, and Sea Lamprey.

Main wetland ecosystem services

The estuary is heavily populated (Irun, Hondarribia, and Hendaye together have a population of nearly 100,000), and has lost about 60% of its original surface due to human occupation. Given its strategic location, land use is mostly urban and industrial (housing, infrastructure, communication), which puts a strong pressure on the ecosystem. In addition, it is intensely used for recreation (marinas in Hondarribia and Hendaye), and less intensively for fishing.

Cultural values of the wetland area

Txingudi is a traditional transit area for the different civilizations that have occupied the territory. Due to its transboundary nature, the area has seen many wars, but it has been also the setting for other historic events as important as the signing of the Treaty of the Pyrenees, which established the borders between Spain and France. At present, it enjoys a high social recognition, due to its environmental value and its status as a restored wetland committed to conservation, and due to its high educational value, in particular among the local population. Educational work is mainly carried out in two visitor facilities focusing on nature conservation: Txingudi Ekoetxea (Plaiaundi, Irun, in the Ramsar Site) and Larretxea (Domaine d´Abbadia, Hendaye).

Biodiversity values of the wetland area

Management by the Basque Government includes monitoring and evaluation of wildlife, habitats and processes (water quality, etc.).

The salt-tolerant vegetation stands out with small size herbaceous formations, mostly grasses, reeds and sedges. In Txingudi, 46 significant flora species have been found, 33% of the species found in the Basque Country, of which 24 (37.5%) are considered rare or very rare in the regional Catalogue of Flora. There is a prominent occurrence of Water Chickweed, Pyrenean scurvygrass, Broadleaved Pepperweed, Yellow Loosestrife, Common Water Plantain, Eelgrass, Gibbous Duckweed, Softstem Bulrush and Many-stalked Spike-rush.

Some 86% of the vertebrate fauna of the rias[49] is found in the estuary. Most individuals (67%) use it temporarily during the migratory seasons, and also for wintering.

Fish species that are rare in the Basque coastal systems can be found in the estuary, such as River Herring and Brown Trout. and some that are unique within the east Cantabrian riverbeds, such as Atlantic Salmon. The site is important for the reproduction of the Three-Spined Stickleback, a species included in the Basque Catalogue of Threatened Species.

The Natterjack Toad is also present in the estuary and is included in the Basque Catalogue of Threatened Species.

Among mammals present in the area, the Southwestern Water Vole and European Polecat are noteworthy.

The area is a strategic migratory hotspot with an average of 175 bird species per year, and a cumulative total (1998–2010) of 254 species in the area of Plaiaundi-Jaitzubia. Gipuzkoa is also the major wintering place for waterfowl, and one of the most important wintering places in the Basque Country.

Txingudi regularly supports 1% of the individuals of the East Atlantic population of the Eurasian Spoonbill, with 120 individuals and an annual average occurrence of 1,078 specimens during autumn migration.[50]

Pressure factors and transboundary impacts

The main direct and indirect impacts are caused by human settlements and transformation of the land due to urban and industrial pressure (urban growth, transportation infrastructure, etc.). Its border location prompts major strategic projects for transportation of people and goods. There are also impacts from recreational use (sailing, rowing, fishing, etc.) as well as illegal fishing. Invasive species such as Nutria, Red Swamp Crayfish, Pampas Grass, and Eastern Baccharis pose a problem, but control programs are underway.

Transboundary wetland management

The estuary as a whole belongs to the Natura 2000 Network, with areas designated as Special Protected Area (SPA) (Txingudi) and Site of Community Interest (SCI) (Txingudi-Bidasoa) in Spain, and SCI Baie de Chingoudy in France, lying adjacent to each other. The Ramsar Site (approximately 130 ha) roughly coincides with the SCI and SPA in Spain. In the early 1990s, the Special Plan of Txingudi was signed, the base for the rehabilitation of the enclave, and including projects Plaiaundi (1998) and Jaitzubia (2005), managed by the Basque Government. This Plan has yet to be completed; meanwhile, the management plan for the prospective SPA Txingudi is in its approval phase. There is a cooperation agreement between the natural protected areas "Marismas de Txingudi" (Basque government) and "Domaine d´Abbadia" (Basque Coast Permanent Centre for Environmental Initiatives) and "Conservatoire du Littoral",[51] in terms of exchange and collaboration of management experiences. Their collaboration has been developing since 2001, when the Txingudi Ekoetxea (Environmental Education Centre associated with marshes) was established, covering different aspects. The main joint activities include environmental education and awareness-raising; celebration of anniversaries such as World Wetlands Day and World Day of Birds; and additionally, exchange of professional experiences between the two teams, which is very valuable.

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[48] *Sources:* www.euskadi.net/txingudi; www.txingudikopadurak.blogspot.com; www.cpie-littoral-basque.eu; www.abbadia.fr; Txingudi EKOETXEA; Basque government, Department for Environment, Spatial Planning, Agriculture and Fisheries, Biodiversity Directorate.

[49] Ria is a coastal inlet formed when a river valley submerges partially.

[50] Data updated in 2010.

[51] Centres permanents d'initiatives pour l'environnement (CPIE) Littoral Basque and Conservatoire du Littoral.

MIÑO/MINHO RIVER BASIN[52]

The basin of the river Miño/Minho[53] is shared by Spain and Portugal. The river has its source in Spain in the Meira Mountains (elevation 750 m a.s.l.), and discharges into the Atlantic Ocean at Caminha. For its last 76 km, the Miño/Minho River forms the Spanish-Portuguese border.

Basin of the Miño/Minho River

Country	Area in the country (km²)	Country's share (%)
Spain	16 230	95
Portugal	850	5
Total	**17 080**	

Source: Spanish National Statistics Institute, 2005.

Hydrology and hydrogeology

Surface water resources generated in the Spanish part of the Miño/Minho River Basin are estimated at 6.74 km³/year and groundwater resources at 4.31 km³/year, adding up to a total of 11,050 × 10^6 m³/year.

In the Spanish part of the basin, there are 47 reservoirs. The biggest are the Belesar Reservoir (Miño River – water storage volume 654 × 10^6 m³), the Las Portas Reservoir (on the Camba River, volume 536 × 10^6 m³) and the Bárcena Reservoir (on the Sil River, 342 × 10^6 m³). Also important, due to its closeness to the border with Portugal, is the Frieira Reservoir.

No transboundary groundwater bodies in the sense of WFD are shared between Spain and Portugal, The Lower Miño aquifer has been identified as transboundary.[54]

Pressures, status and transboundary impacts

The main pressures in the basin include nutrient loading (nitrogen and phosphorous) in agriculture and from livestock, resulting in eutrophication of waters, which Spain assesses as widespread but moderate.

Industry and manufacturing also exert pressure — assessed by Spain as widespread but moderate — namely in the form of both biodegradable and non biodegradable as well as IPPC and non-IPPC industrial waste.[55]

Pressure from urban wastewater is assessed by Spain as widespread but moderate.

The Miño/Minho River Basin is a highly regulated basin, with 59 dams more than 10 m high, 946 dams with a height from 2 to 10 m, 91 transfers and diversions, and 13 river bank protections; the related hydromorphological changes are assessed by Spain as widespread but moderate.

Responses

The Convention on Cooperation for the Protection and the Sustainable Use of waters of the Spanish-Portuguese River Basins (signed in 1998 in Albufeira and revised in 2008)[56] is the framework for cooperation between the Governments of Portugal and Spain, as it is for the Mino River. Key provisions of the Convention are information exchange, public information and consultation, assessment on transboundary impacts, warning and emergency systems, water quality and river flows. In particular, the Agreement and its Protocol define, for each main shared river, the minimum water resources that should be received by the lower riparian country and the final river outlet.

Two bilateral intergovernmental bodies are related to the Convention: the Conference of the Parties at a high political level, and a Commission for the application of the Convention.[57]

In the Spanish part of the basin, planned management measures follow the directions set in the National Water Quality Plan (2007-2015), the Spanish National Action Plan on River Restoration, and the River Basin Management Plan (RBMP) 2010–2015. Autonomous Community Action programmes aim at reducing fertilizer use in agriculture.

Trends

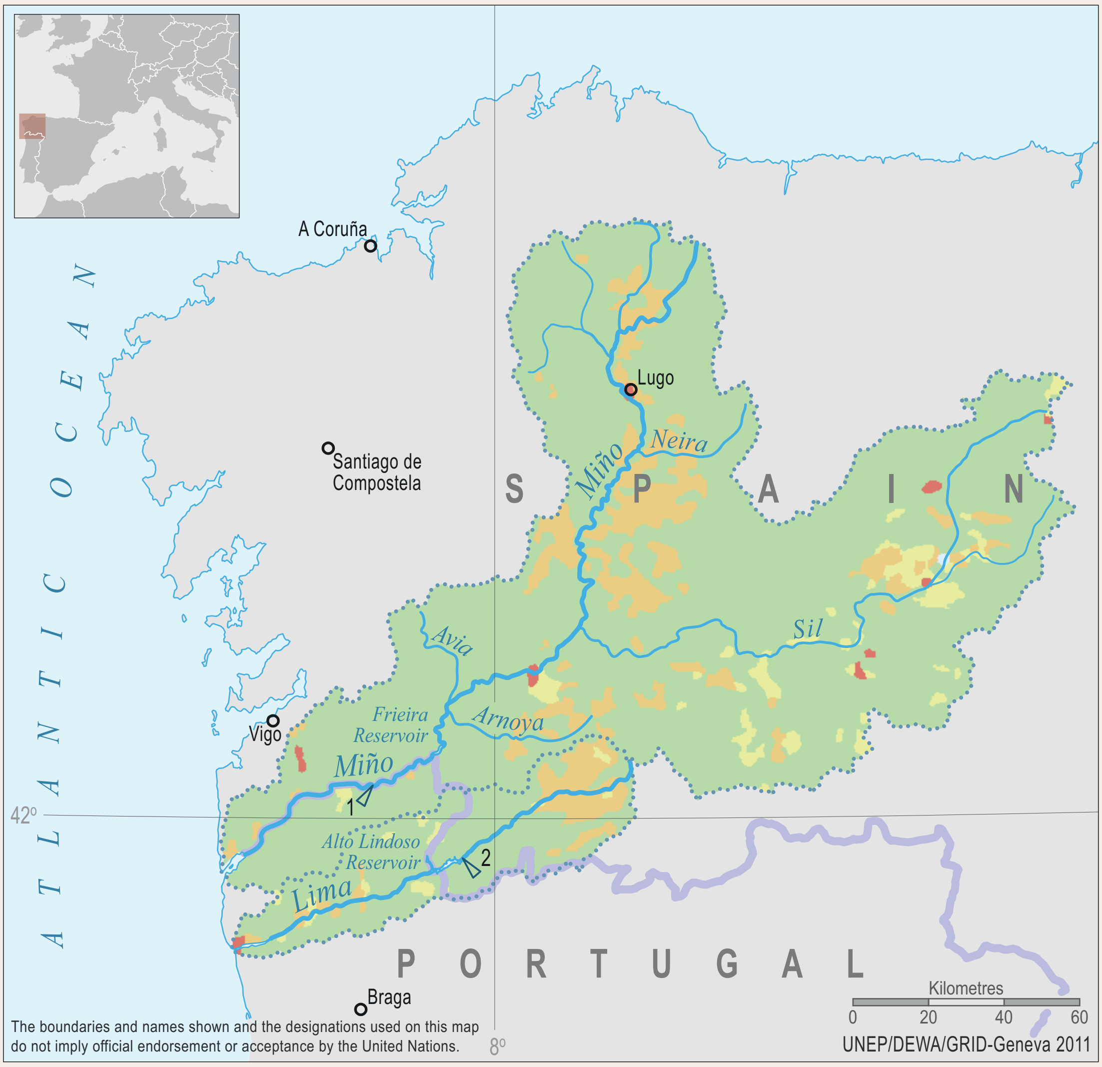
In the Spanish part of the basin, the implementation of the forthcoming new RBMP which covers the Miño, Sil and Limia basins, as well as the National Plan for Sludge from Sewage Treatment Plants, the National Sewer System and Water Treatment Plan, and the new National Water Quality Plan are expected to further improve the status of the Mino River Basin.[58]

Total water withdrawal and withdrawals by sector in the Miño/Minho Basin

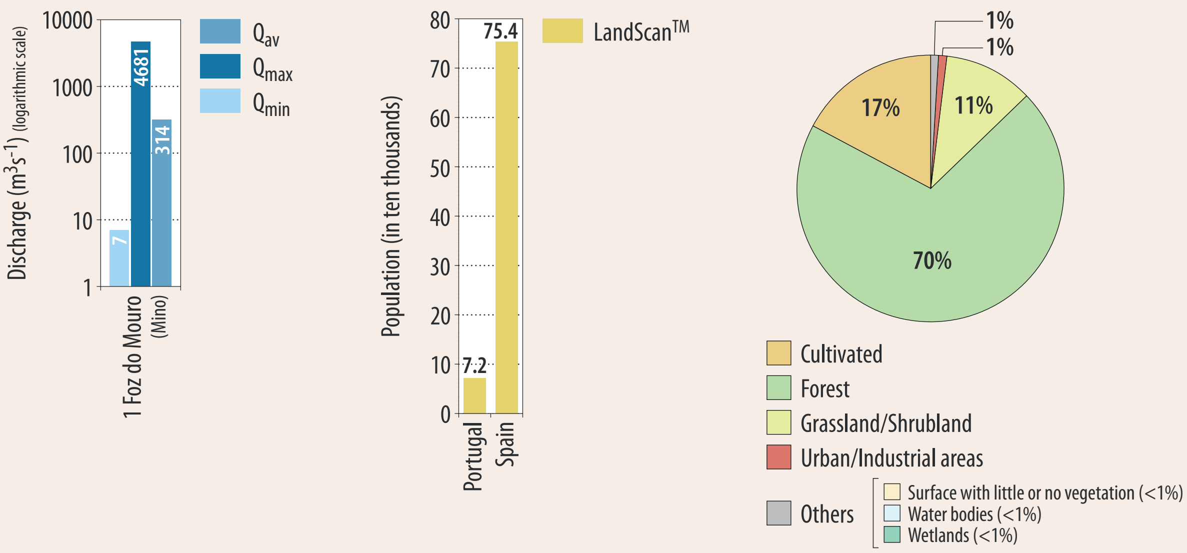
Country	Total withdrawal ×10^6 m³/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Spain	436	75	15	8	-	2
Portugal	N/A	N/A	N/A	N/A	N/A	N/A

Notes: Groundwater abstraction: 25.65 × 10^6 m³/years for agriculture and 14.5 × 10^6 m³/years for population supply. Groundwater abstraction has more widespread impact than surface water withdrawal.

[52] Based on information provided by Spain and the First Assessment.
[53] The river is known as Miño in Spain and Minho in Portugal.
[54] This Quaternary alluvial and terrace sediment aquifer with an area 125 km² and a thickness of 10-15 m (even up to 50 m) in Spain, consisting of silty sands, is listed in the inventory of transboundary groundwaters (No. 284).
[55] The EU Directive 2008/1/EC of 15 January 2008 concerning integrated pollution prevention and control (IPPC Directive) requires industrial and agricultural activities with a high pollution potential to have a permit.
[56] Official State Bulletin, 16 January 2010.
[57] For detailed information, please refer to the web site www.cadc-albufeira.org.
[58] *Source:* Hydrological planning office, Confederación Hidrográfica del Miño-Sil.



DISCHARGES, POPULATION AND LAND COVER IN THE MIÑO/MINHO RIVER BASIN



Sources: UNEP/DEWA/GRID-Europe 2011.

FRIEIRA RESERVOIR[59]

The Frieira Reservoir is situated in Spain, in the Miño River Basin, in the border area between Spain and Portugal. The dam was constructed for hydroelectric power generation. The reservoir is quite shallow, with a surface area of 4.66 km² and a relatively small water storage capacity (0.044 km³). The mean inflow is 9.524 km³/year, and the minimum outflow 3.7 km³/year. The status of the reservoir is "mesotrophic".

Spain and Portugal manage the reservoir jointly, on the basis of the 1998 Convention between the countries.

LIMA/LIMIA RIVER BASIN[60]

The basin of the Lima/Limia River[61] is shared by Spain and Portugal. The river has its source in Spain at Lake Beon (975 m a.s.l.), and discharges into the Atlantic Ocean at the city of Viana do Castelo. The Castro Laboreiro River is a transboundary tributary.

Basin of the Lima/Limia River

Country	Area in the country (km²)	Country's share (%)
Spain	1 300	52
Portugal	1 180	48
Total	**2 480**	

Source: Portuguese National Institute of Water (Instituto da Agua, INAG); Freshwater in Europe – Facts, Figures and Maps. UNEP/DEWA-Europe. 2004.

Hydrology and hydrogeology

Surface water resources generated in the Spanish part of the Lima/Limia River Basin are estimated at 460 × 10⁶ m³/year, and groundwater resources at 300 × 10⁶ m³/year, adding up to a total of 760 × 10⁶ m³/year.

In the Spanish part of the Lima/Limia River Basin two reservoirs are operated for hydropower production: the Salas Reservoir (on the Salas tributary, volume 87 × 10⁶ m³) and the Las Conchas Reservoir (on the Lima/Limia River, 78 × 10⁶ m³). The Alto Lindoso Reservoir is on the border between Spain (upstream country) and Portugal.

No transboundary groundwater bodies are shared in the Lima/Limia Basin between Spain and Portugal.

Pressures

The main pressures include nutrient loading (nitrogen and phosphorous) from agriculture and livestock. Agriculture is also the largest water user in the basin. Dams on the river (related mainly to hydropower generation), water transfers and diversions, as well as river bank protections impact on the hydromorphology. Urban wastewater discharges also exert pressure. Pressure from biodegradable non-IPPC industrial waste is only local and moderate.

Transboundary cooperation and responses

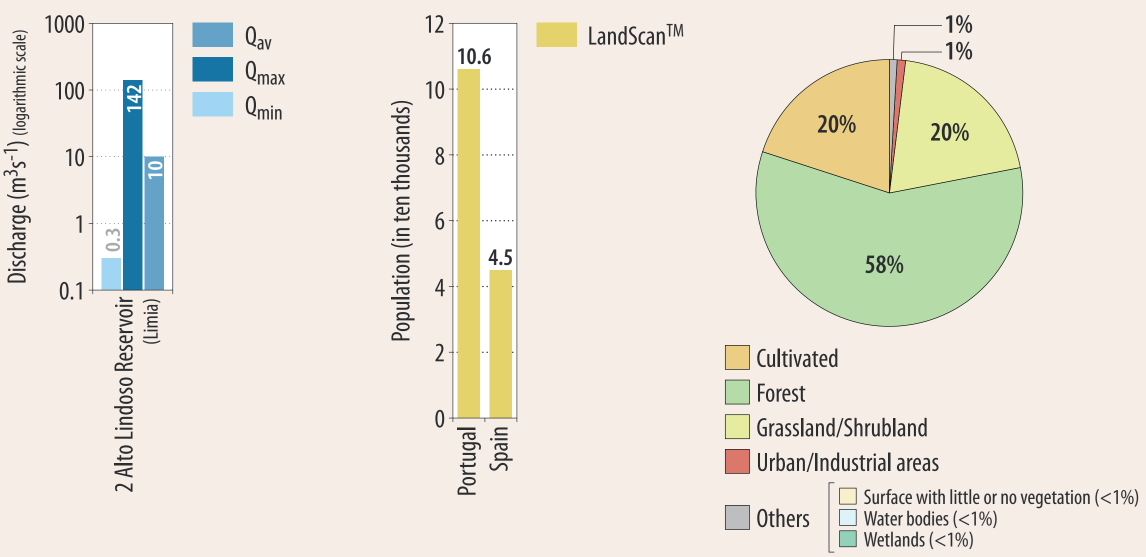
Transboundary cooperation on the Lima/Limia River Basin is carried out on the basis of the bilateral agreement between Portugal and Spain, the so-called Albufeira Convention, dating from 1998 and revised in 2008.[62]

Total water withdrawal and withdrawals by sector in the Lima/Limia Basin

Country	Total withdrawal ×10⁶ m³/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Spain	37.5	30-80	7.5-19	0.2-1	-[a]	-
Portugal	N/A	90	4	6	-	-

[a] It is reported that there is no consumptive use for energy purposes. The volume of non-consumptive use at a reversible hydroelectric power plant is 263 × 10⁶ m³/year.

DISCHARGES, POPULATION AND LAND COVER IN THE LIMA/LIMIA RIVER BASIN



Source: UNEP/DEWA/GRID-Europe 2011.

[59] Based on the First Assessment.

[60] Based on information provided by Spain and the First Assessment. The river Mino, its tributary the Sil, and the Limia Basin together form a River Basin District, implying that the majority of the information available is aggregated for this area.

[61] The river known as Lima in Portugal, and Limia in Spain.

[62] Please refer to the assessment of the Miño/Minho for more information.

Trends

As described in the assessment of the Miño/Minho, implementation of several relevant national plans in Spain is expected to improve the status of the Lima/Limia River.

By 2027, an average decrease of over 2% in river discharge is predicted.[63]

DOURO RIVER BASIN[64]

The basin of the Douro River[65] is shared by Spain and Portugal. The river originates in the Sierra de Urbión (2,080 m a.s.l.) in central Spain, crosses the Numantian Plateau, reaching, after 572 km, the Spanish-Portuguese Border. The international reach — along which the river forms the border between Spain and Portugal — has a length of 112 km. The Douro River discharges to the Atlantic Ocean at Foz do Douro (city of Porto).

Basin of the Douro River

Country	Area in the country (km^2)	Country's share (%)
Spain	78 859	81
Portugal	18 643	19
Total	**97 502**	

Source: Spanish National Statistics Institute, 2005; River Basin Management Plan of the Douro, Northern Hydrographical Region, Portugal.

Hydrology and hydrogeology

Surface water resources generated in Spanish part of the Douro River Basin are estimated at 8.648 km^3/year, and groundwater resources at 3.737 km^3/year, adding up to a total of 12.385 km^3/year (average for the years 1980 to 2006). Total water resources per capita in the basin are 5,600 m^3/year.

Although in the Inventory of Transboundary Groundwaters by the UNECE Task Force on Monitoring and Assessment (1999) the Ciudad Rodrigo-Salamanca aquifer[66] was considered to be transboundary, the extension is irrelevant in Portugal, compared to Spain. Therefore, for the new planning processes according to the WFD, no shared groundwater bodies have been defined within the Douro River Basin boundaries.

Pressures, status and transboundary impacts

Cropland makes up some 11% of the Spanish part of the basin.

The main pressure factors in the Douro Basin include flow regulation: there is about 8,000 × 10^6 m^3 total capacity for water storage in the basin. The international reach of the Douro River has been harnessed for hydropower production. There are some 3,600 barriers, with various degrees of passability for fish population. Canalized reaches include 600 bank reinforcement actions.

Extensive use of irrigation and diffuse pollution from the use of nutrients (nitrogen and phosphorus) in agriculture and from livestock also exert pressure. Discharges of insufficiently treated urban wastewater are the main form of point source pollution.

Responses

The 1998 Convention on Cooperation for the Protection and the Sustainable Use of Waters of the Spanish-Portuguese River Basins also provides the framework for transboundary cooperation on the Douro River.[67]

Trends

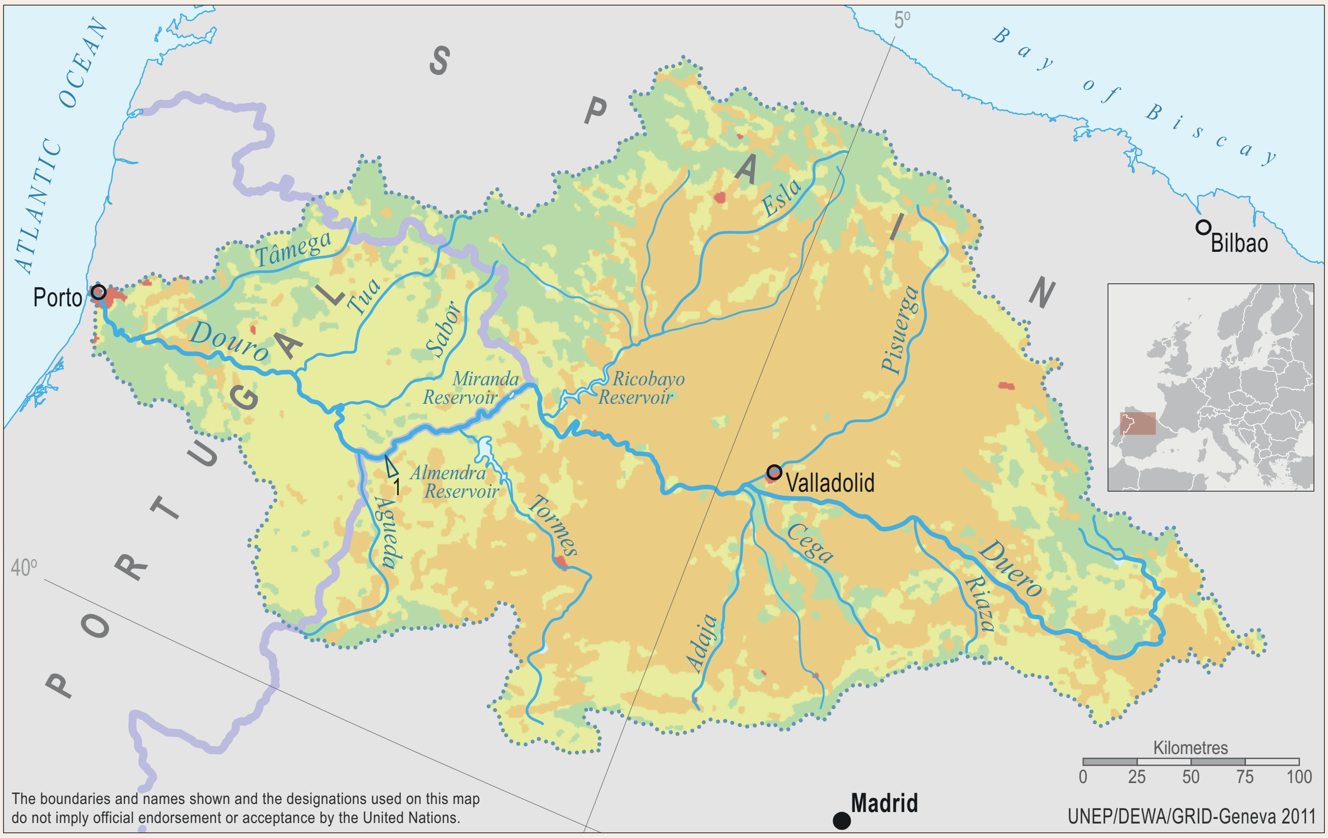
By 2027, Spain predicts agricultural water withdrawal to increase relatively, by two per cent units, to 94%. By the same year, total withdrawal is predicted to increase by about 12%, compared with the 2005 level.

In the Spanish part of the basin, the implementation of the River Basin Management Plan,[68] as well as the National Plan for Sludge from Sewage Treatment Plants, the National Sewer System and Water Treatment Plan, and the new National Water Quality Plan are predicted to further improve the status of the river basin.[69]

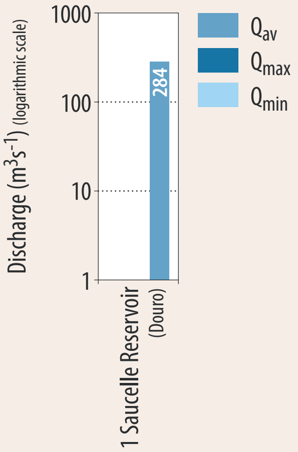
Total water withdrawal and withdrawals by sector in the Douro sub-basin

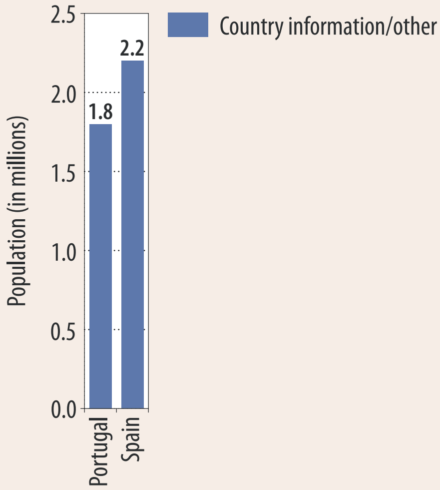
Country	Total withdrawal ×10^6 m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Spain	4 883	92	4	1	N/A	N/A
Portugal	N/A	N/A	N/A	N/A	N/A	N/A

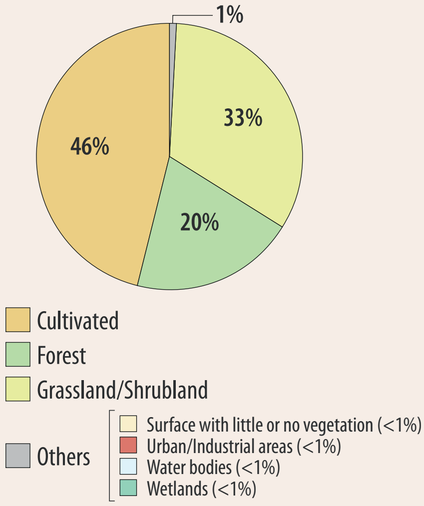
[63] Management Plan Proposal for the Spanish Side of the River Basin District of Miño, Sil and Limia River Basins — Hydrological Plan 2010-2015, public consultation Issue, issue, December 2010.
[64] Based on information provided by Spain and the First Assessment.
[65] The river is known in Portugal as Douro, and in Spain as Duero.
[66] This Tertiary aquifer with an area 417 km^2 and a thickness of 50-250 m in Spain, consisting of silty sands, is listed in the inventory of transboundary groundwaters (No. 283).
[67] For more information, please refer to the assessment of the Miño/Minho River.
[68] The Douro River Basin Management Plan, Proposed Draft, December 2010.
[69] *Source:* Hydrological planning office. Confederation of the Duero basin.



DISCHARGES, POPULATION AND LAND COVER IN THE DOURO RIVER BASIN







Sources: UNEP/DEWA/GRID-Europe 2011; Spanish National Statistics Institute, 2005.

TEJO/TAJO RIVER BASIN[70]

The basin of the river Tejo/Tajo[71] is shared by Spain and Portugal. The river has its source in east-central Spain in the Sierra de Albarracín at an elevation of 1,590 m a.s.l., and discharges into Mar de la Paja, in the Atlantic Ocean near Lisbon.

The basin has a pronounced lowland plateau character in its Spanish part, with an average elevation of about 633 m a.s.l.

Major transboundary tributaries include the rivers Erges and Sever.

Basin of the Tejo/Tajo River

Country	Area in the country (km^2)	Country's share (%)
Spain	55 781	69
Portugal	24 800	31
Total	**80 581**	

Source: Spanish National Statistics Institute, 2005.

Hydrology and hydrogeology

Surface water resources generated in the Spanish part of the Tejo/Tajo river basin are estimated at 8.3 km^3/year, and groundwater resources at 1.65 km^3/year, adding up to a total of 9.95 km^3/year (average for the years 1980 to 2006). Total water resources per capita in the Spanish part of the basin are 1,367 m^3/year (average for the years 1980 to 2006).

No transboundary groundwater bodies have been defined as shared between Spain and Portugal within the Tejo/Tajo River Basin.

Pressures and transboundary impacts

The most significant pressures (ranked as widespread and severe) are water scarcity and drought periods, as well as a high level of river water pollution from the Madrid Metropolitan Area affecting the main river course. Some sewage collection and treatment facilities need to be adapted to comply with the WFD and the UWWTD.

Flow in the basin is highly regulated (total storage capacity 11,000 × 10^6 m^3), and the high number of hydropower plants has implications for ecological flow.

Irrigational agriculture relies on the use of fertilizers and pesticides, and of local groundwater.

Responses

The 1998 Convention on Cooperation for the Protection and the Sustainable Use of Waters of the Spanish-Portuguese River Basins also provides the framework for transboundary cooperation on the Tejo/Tajo River.[72]

Among the management measures implemented in Spain[73] are the development of the National Water Quality Plan (2007–2015) to address pollution from, e.g., municipal wastewater discharges, and the Autonomous Community Action programmes on reduction of fertilizers in agriculture. A Special Drought Plan has been developed for the Tejo/Tajo River Basin.[74] Actions related to ecosystems have been identified in the Spanish National Action Plan on River Restoration.[75]

Trends

The Spanish Tajo River Basin administration body, with other local and State administrations, have made a significant economic effort to implement various measures to improve both quantity and quality water resources. These measures are outlined in different actions plans in Spain, such as the National Hydrological Plan, the Tajo River Basin Hydrological Plan (passed 1998), as well as the National Plan for Sludge from Sewage Treatment Plants, the National Sewer System and Water Treatment Plan, and the new National Water Quality Plan (2007–2015). Water quality has improved in the last decade due to these action plans, and is constantly improving. Water availability is increasing. Nevertheless, a lot of effort and investment still needs to be made to comply with the WFD requirements, although the economic situation will reduce investment.[76]

AQUIFER MORALEJA (NO. 162)

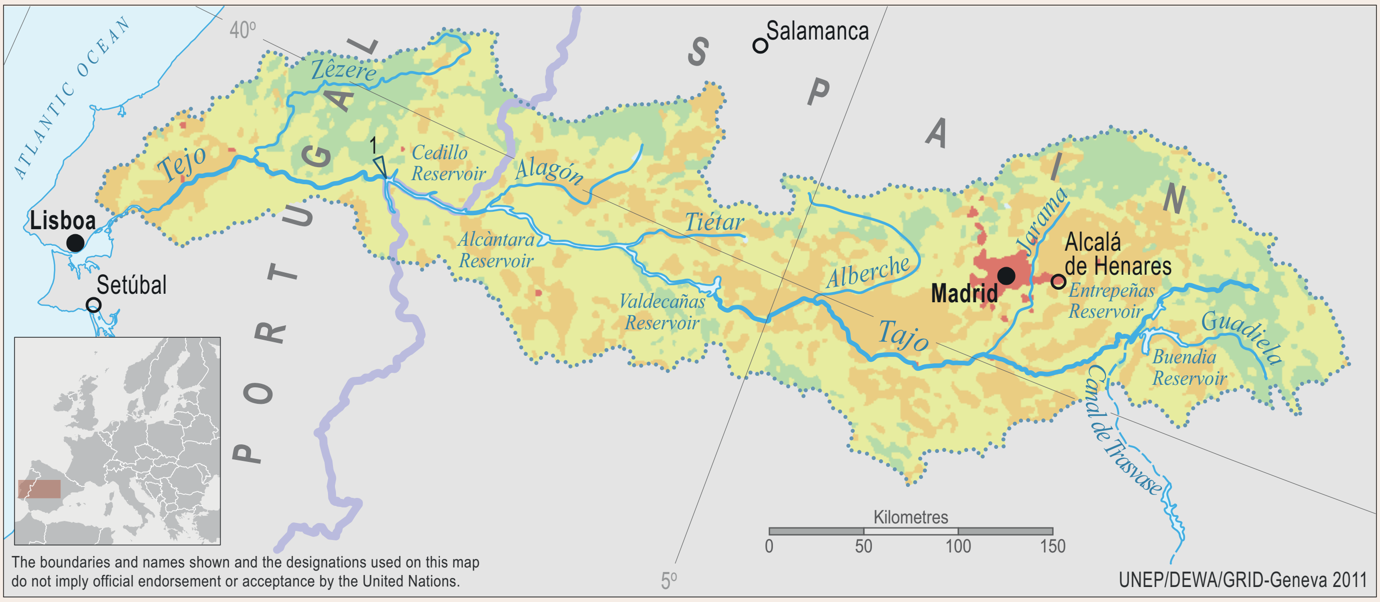
	Spain	Portugal
Type 1; Silty sands; Quaternary and Tertiary; dominant groundwater flow is from higher points in the watersheds to the rivers Rivera de Gata and Tinaja.		
Area (km^2)	311	N/A
Renewable groundwater resource	46 575 m^3/d (17 × 10^6 m^3/year)	N/A
Thickness: mean, max (m)	350, -	N/A
Groundwater uses and functions	Irrelevant groundwater resource (most of the water supply from the reservoirs).	N/A

Total water withdrawal and withdrawals by sector in the Tejo/Tajo sub-basin

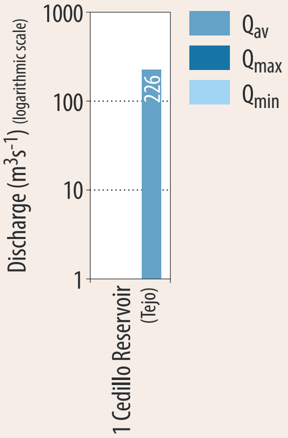
Country	Total withdrawal ×10^6 m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Spain	2 882[a]	68	27	2	3	-
Portugal	N/A	N/A	N/A	N/A	N/A	N/A

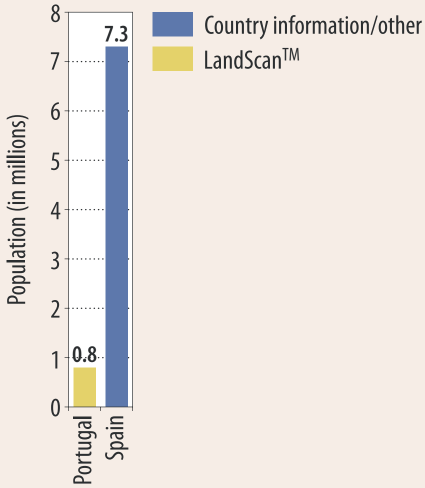
Notes: Some 135 × 10^6 m^3 of groundwater is abstracted annually, mainly for irrigation.
[a] Figures are for the year 2005.

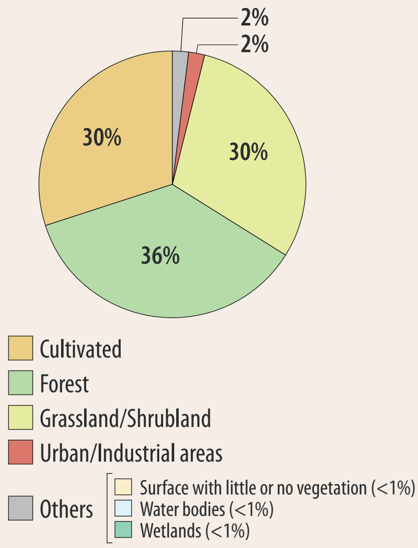
[70] Based on information provided by Spain and the First Assessment.
[71] The river is known as Tejo in Portugal and as Tajo in Spain.
[72] For more information, please refer to the assessment of the Miño/Minho River.
[73] For information on measures for this river basin, please refer to the programme of measures in the preliminary draft of the River Basin Management Plan (www.chtajo.es).
[74] "Plan especial de sequías del Tajo" (www.chtajo.es).
[75] National Strategy for River Restoration, http://www.mma.es/portal/secciones/aguas_continentzonas_asoc/dominio_hidraulico/conserv_restaur/.
[76] *Source:* Spanish Tajo River Basin administration body, Confederación hidrográfica del Tajo.



DISCHARGES, POPULATION AND LAND COVER IN THE TEJO/TAJO RIVER BASIN







Sources: UNEP/DEWA/GRID-Europe 2011; Spanish National Statistics Institute, 2005.

CEDILLO RESERVOIR[77]

The Cedillo[78] Reservoir in the Tejo/Tajo River Basin, constructed for hydropower, is located on the border between Spain and Portugal. The surface area of the reservoir is 14 km^2 and the volume is 0.260 km^3, the mean inflow equals 10.265 km^3 and the minimum outflow should not be lower than 2.7 km^3. Most of the total basin area of the reservoir — 59,000 km^2 — is in Spain (55,800 km^2).

The main human activities in the proximity of the reservoir are livestock farming and hunting.

The reservoir has had a high, but highly variable mean concentration of phosphorus.

GUADIANA RIVER BASIN[79]

The basin of the river Guadiana is shared by Spain and Portugal. The river has its source in Spain at Campo Montiel (1,150 m a.s.l.) and discharges into the Atlantic Ocean.

The rivers Gévora, Caya, Alcarrache, Ardila, Múrtigas and Chanza are major transboundary tributaries.

The basin has a pronounced lowland character, with an average elevation of about 550 m a.s.l.

Basin of the Guadiana River

Country	Area in the country (km^2)	Country's share (%)
Spain	55 527	83%
Portugal	11 500	17%
Total	**67 027**	

Sources: Spanish National Statistics Institute, 2005; Portuguese National Water Plan. Instituto da Agua. 2002.

Hydrology and hydrogeology

Surface water resources generated in the Spanish part of the Guadiana River Basin are estimated at 4,187 × 10^6 m^3/year, and groundwater resources at 533 × 10^6 m^3/year, adding up to a total of 4,791 × 10^6 m^3/year. Total water resources per capita in the basin are 3,298 m^3/year/capita (average for the years 1980–2006).

In the Spanish part of the basin, groundwaters are mainly in karstified permeable aquifers, but there are also a few important aquifers in Quaternary and Tertiary unconsolidated aquifers. The Las Vegas Bajas aquifer is the only aquifer identified as transboundary in the Guadiana Basin.[80] Since it is considered to be irrelevant for the current water resources planning process, no groundwater bodies have not been defined in the basin.

A total of 66 dams, with capacity exceeding a million m^3, is located in the Spanish part of the Guadiana Basin. The total reservoir capacity is 9,436 × 10^6 m^3.

The reservoir of the Alqueva Dam (operational since 2002) in Portugal is 82 km long, and has a surface area of 250 km^2 (63 km^2 in Spain). The reservoir's total capacity is 4,150 × 10^6 m^3 (useful capacity 3,150 × 10^6 m^3). There are 9 other reservoirs with capacity exceeding 10 × 10^6 m^3, with a total additional capacity of 508 × 10^6 of m^3.

Pressures

Pressures assessed in the Spanish part of the Guadiana Basin as widespread but moderate are hydromorphological changes in rivers due to urban areas and croplands, nitrate and phosphorus pollution by wastewater discharges, and diffuse pollution by fertilizers. Pressure factors ranked as local but severe include mining and quarrying, as well as intense rainfall events impacting on cities and cultivated areas. Severe problems are observed related to groundwater abstraction for agriculture use in the Upper Guadiana River Basin. All other pressures, including those caused by contaminated sites, are judged as minor.

Responses and transboundary cooperation

Saltwater coming up the estuary and suspended sediments/mud flows are addressed in the programme of measures through the application of ecological flows. Improvement of efficiency of nitrogen application in agricultural production is also among the measures.

Transboundary cooperation on the Guadiana River Basin is carried out on the basis of the bilateral agreement, the so-called "Albufeira Convention", dating from 1998, and its revision in 2008. Please refer to the assessment of the Miño/Minho for more information.

Trends

By 2015, total withdrawal in the Spanish part of the basin is expected to decrease very slightly (0.4%) compared with the level of withdrawal in 2005. By 2021, withdrawal is predicted to have increased by 0.9%, compared with withdrawal in 2005. From 2005 to 2021, withdrawal for domestic use is predicted to increase by 9%, and for industrial use to increase by more than three times. In absolute terms, withdrawal for agriculture is predicted to decrease in the same period, by 7.5%. Non-consumptive use for hydropower is predicted to decrease.

The implementation of several relevant national plans in Spain — as described in the assessment of the Miño/Minho — is expected to also improve the status of the Guadiana River.

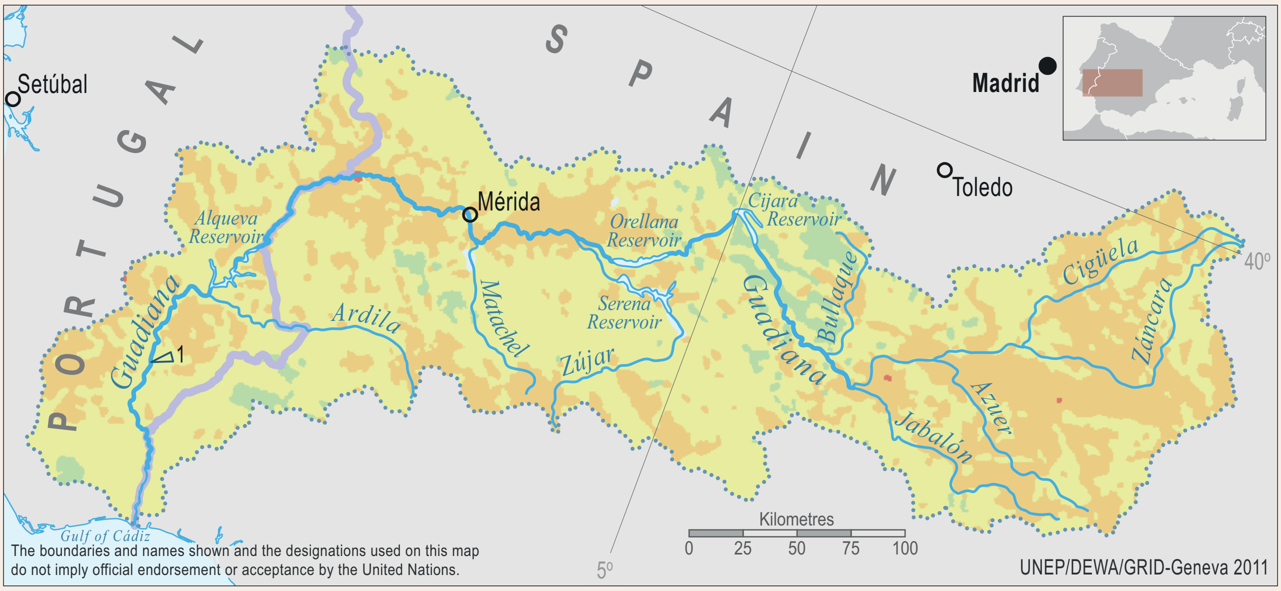
Regarding climate change, an increase of 1 °C in annual average temperature, and a 5% precipitation decrease is predicted by 2030. By 2060, the annual average temperature could increase by 2.5 °C, accompanied by a decrease of 8% in precipitation. River discharge is predicted to decrease by 11% by 2030, and 17% by 2060. A decrease of groundwater level is also predicted to result from climate change, as well as an increase in agricultural water withdrawal.[81]

Total water withdrawal and withdrawals by sector in the Guadiana Basin

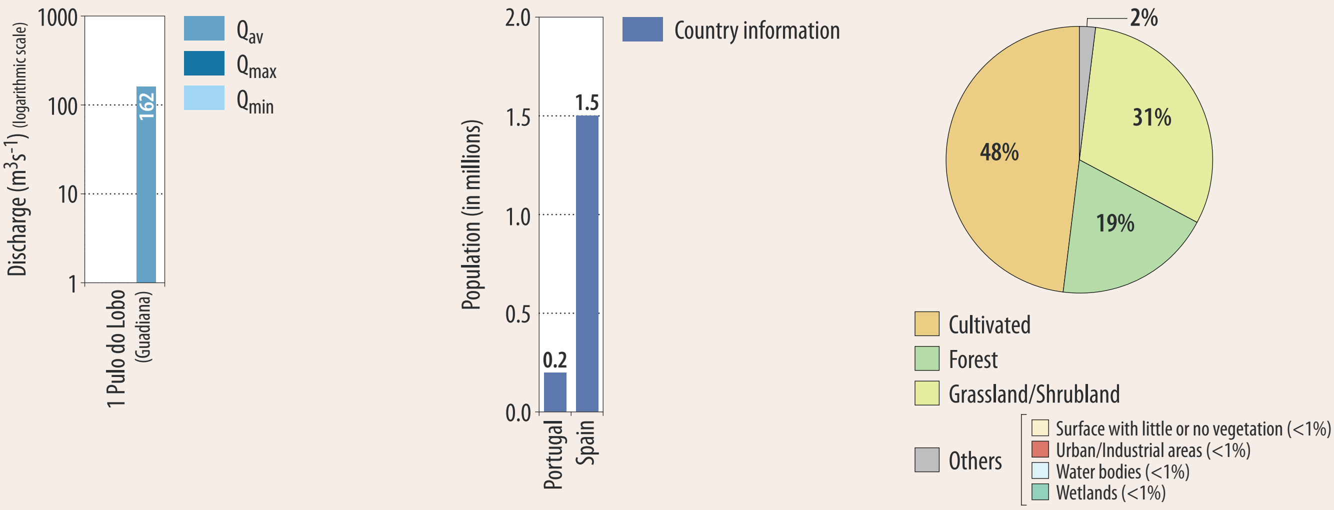
Country	Year	Total withdrawal × 10^6 m^3/year	Agriculture %	Domestic %	Industry %	Energy %	Other %
Spain	2005	2 220[a]	88	9	1.9	-[a]	
Portugal	N/A	N/A	N/A	N/A	N/A	N/A	N/A

[a] No consumptive water use for energy related purposes is reported. The volume of non-consumptive use for hydropower is estimated at 2,293 × 10^6 m^3/year.

[77] Based on the First Assessment.
[78] The reservoir is also known as Cedilho.
[79] Based on information provided by Spain, and the First Assessment.
[80] The Las Vegas Bajas aquifer (UH 04.09) was described as a transboundary aquifer in the Inventory of Transboundary Groundwaters by the UNECE Task Force on Monitoring and Assessment (1999). This silty sand aquifer of Quaternary and Tertiary age which has an area of 325 km^2 and a thickness of approximately 140 m in Spain is listed in the inventory (No. 282).
[81] Comprehensive Assessment of the Impacts of Climate Change in Spain. Ministry of the Environment, 2005 (in Spanish).



DISCHARGES, POPULATION AND LAND COVER IN THE GUADIANA RIVER BASIN



Sources: UNEP/DEWA/GRID-Europe 2011; Spanish National Statistics Institute, 2005; Portuguese National Water Plan. Instituto da Agua. 2002.

ERNE RIVER BASIN[82]

The Erne River Basin is one of the two principal river basins within the North Western International River Basin District (RBD) that are shared between Ireland and Northern Ireland (a region of the United Kingdom), the other river basin being the Foyle. There is also a smaller shared river basin, Lough Melvin, that is fed by the County and Roogagh Rivers.

The 120 km-long Erne River,[83] rises from Lough Gowna in County Cavan (Ireland), and flows north-west through County Fermanagh (Northern Ireland), where the river expands to form two large lakes, the Upper Lough Erne (16-km long), and the Lower Lough Erne (29-km long). The river exits Lower Lough Erne, flowing westwards through Ballyshannon in County Donegal (Ireland), and discharges into the Atlantic Ocean at Donegal Bay.

There are a number of fisheries along the Erne and its tributaries, and the Erne is very popular for trout fishing and boating. Hydroelectricity is produced along the 46 m drop in the river's course between Belleek and Ballyshannon.

Basin of the Erne River

Country	Area in the country (km^2)	Country's share (%)
UK, Northern Ireland	1 900	59
Ireland	2 800	41
Total	**4 700**	

Pressures[84]

Diffuse agricultural sources continue to be the main threat to the quality of Erne system, particularly phosphorus. Pollution from other diffuse sources (urban land use, transportation, unsewered single house dwellings, peat exploitation and forestry) also create pressure on the system. Discharges from point sources, such as urban wastewater treatment plants, stormwater overflows, sludge treatment, IPPC industries,[85] and non-IPPC industries, add to this pressure.

Hydromorphological changes due to the level being artificially controlled to support hydroelectric power generation at Ballyshannon, along with reservoirs, water abstraction, channel alterations, agricultural enhancements, and flood defence also exert pressure on the Erne Basin.

Zebra mussels and other invasive alien species have continued to spread in the Erne system, especially in the lakes, and this is a cause for concern. Zebra mussels are known to impact on other biological elements, with unfavourable repercussions for water ecology.

Status

Eutrophication due to phosphorus enrichment has been identified as a problem resulting from diffuse pollution. With controls on agriculture and nutrient reduction at the larger wastewater treatment works, the situation has been improving.

Average nitrate values in the upper Erne catchment (Ireland) are relatively low, at an average of <0.8 mg N/l. The corresponding average concentrations at over 90 monitoring sites include mean phosphate values in the range 0.02 to 0.05 mg P/l, total ammonia in the range 0.04 – 0.10 mg N/l, and BOD in the 2.0 – 4.0 mg/l range.[86]

Annual mean nitrate values, which have been recorded for the Erne during the 1979-2006 study period, have slightly increased in the last few years of the study (2000-2006). Annual mean phosphate values have been slightly fluctuating over the study period, but mainly remained under "good status".

Overall, in Ireland's rivers, there was a slight decrease in the number of channels classified as seriously polluted, when compared to the 2001–2003 period. A biological assessment of rivers in Ireland covering 456 km of river channel shows 50% of this to be unpolluted, 37.5% slightly polluted (primarily due to eutrophication) and 11.9% moderately polluted, but no seriously polluted stretches were noted. This represents a deterioration compared with the 2004-2006 period, when 66% of 467 km of river channel monitored was satisfactory, 23% slightly polluted, 11% moderately polluted and 0.3% or 1.5km was seriously polluted.

Between the years 2004-2006, the biological status of the Erne channel was assessed to be mostly of good status, 25% moderate, some of poor status, and very little as bad.[87]

According to the UK classification, the ecological status of both the Upper and Lower Lough Erne was classified as of moderate ecological potential.[88] The ecological status was affected by phosphorus levels and plant growth (macrophytes), and the management of the levels to support hydropower and flood defense. Information on the general status of water bodies within the river basin district is covered by the information on the Foyle Basin.

Freshwater pearl mussels are present in some of the tributaries to the Upper and Lower Lough Erne, and these are subject to protection and an improvement programme to promote implantation of the mussels.

The North Western River Basin Management Plan (RBMP) assesses the majority of the rivers flowing into Lough Melvin at of good to high status, and Lough Melvin varies between good and moderate status. However, phosphorus levels pose a risk to its status as a mesotrophic lake, and it is considered to be in unfavourable status as a result.

Responses

The Erne is monitored, and reports on the state of the environment and water quality have been produced regularly. Groundwater monitoring networks have also been developed. Following the publication of the North Western RBMP, an action plan has been developed for the Lower Lough Erne sub-basin, and an action plan will be developed during 2011 for the Upper Lough Erne sub-basin. A further action plan for the Melvin and Arney sub-basin will be developed in 2012.

A bilateral flood-control scheme operates to manage the water level in the Upper and Lower Lough Erne lakes.

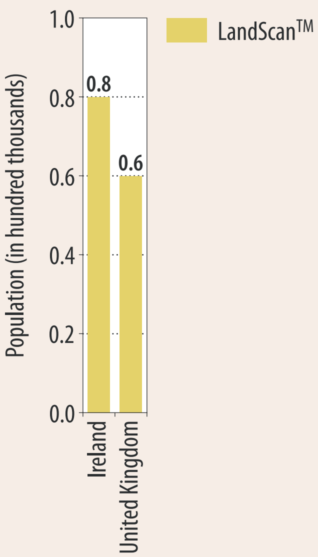
A catchment Management Plan has been developed for the Lough Melvin sub-basin, along with the North Western River Basin Management Plan. These will support actions to address the pressures within the basin.

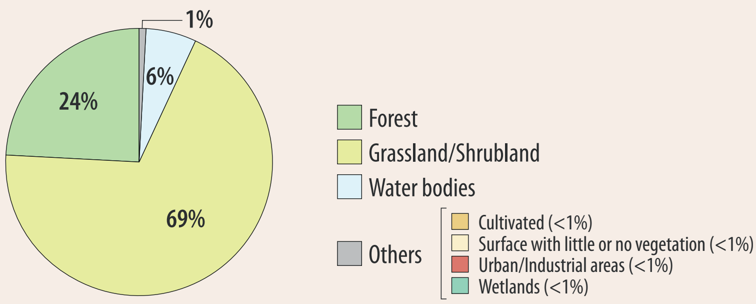
Trends

Recent years have seen more intensive rainfall events occurring, and these pose a risk of flooding in the area. Management of

[82] Based on information provided by Ireland, the Northern Ireland Environment Agency, and the First Assessment.
[83] The river is also known as Ûrn.
[84] A detailed assessment of pressures is available in the River Basin Management Plan for the North West International River Basin District (http://www.wfdireland.ie/docs/).
[85] Industries that fall under the IPPC Directive.
[86] *Source:* Water Quality in Ireland 2007-2009. Environmental Protection Agency, Ireland. 2010.
[87] *Source:* Water Quality in Ireland 2007-2009. Environmental Protection Agency, Ireland. 2010.
[88] *Source:* North Western International River Basin Management Plan Summary, December 2009.

POPULATION AND LAND COVER IN THE ERNE RIVER BASIN





Source: UNEP/DEWA/GRID-Europe 2011.

the levels within the Erne Basin are a critical factor, and need to be kept under review. It is also proposed to develop ecological modelling tools to assist with lake management. The action being taken to manage waste in agriculture should assist in reducing phosphorus loads within the Erne River Basin.

LOUGH MELVIN[89]

Lough Melvin is a unique and internationally-significant lake located in the counties of Leitrim (Ireland) and Fermanagh (Northern Ireland). It is described as "one of the few remaining natural post-glacial salmonid lakes in northwestern Europe". The lake covers an area of 2.2 km^2, and, as an oligo-mesotrophic (low-medium nutrient) lake, is renowned for its unique assemblage of fish species and diversity of flora and fauna. The lake is fed by a number of small rivers rising in County Leitrim and Sligo in Ireland that represent the majority of the catchment, and by the Roogagh River that rises in County Fermanagh (Northern Ireland). The river is drained by the River Drowes the flows westwards through County Leitrim and Donegal and discharges into the Atlantic Ocean at Donegal Bay.[90]

Basin of the Lough Melvin

Country	Area in the country (km^2)	Country's share (%)
UK, Northern Ireland	60	15
Ireland	353	85
Total	**413**	

Pressures

The health and status of the Lough Melvin is vulnerable to human activities, particularly increases in phosphorus loadings from housing, forestry and agriculture. Currently, phosphorus concentrations in the lake have increased by over 40% in almost a decade, and monitoring indicates phosphorus loadings are continuing to increase.

FOYLE RIVER BASIN[91]

The North Western International River Basin District is shared by Ireland and Northern Ireland (a region of the United Kingdom). The river basin district is bounded to the north and west by the Atlantic Ocean, to the east by the Neagh Bann International River Basin District, and to the south by the Shannon International River Basin District. The Foyle River basin has its source in the Sperrins mountains in the County of Tyrone in Northern Ireland, where the River Strule is fed by a number of tributaries. This is joined by the river Derg that rises in County Donegal in Ireland, and further downstream by the Finn River that also has its source in County Donegal. After the confluence with the River Finn, the river is known as the Foyle River and is estuarine in nature as it flows through the city of Londonderry/Derry into Lough Foyle, which discharges into the Atlantic Ocean.

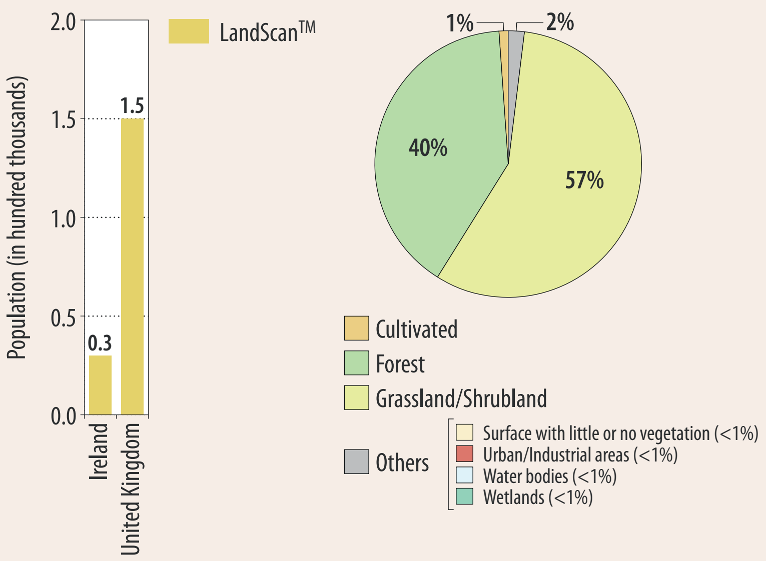
North Western River Basin District

Country	Area in the country (km^2)	Country's share (%)
UK, Northern Ireland	7 400	60
Ireland	4 900	40
Total	**12 300**	

The Foyle Basin and valley are fertile, and support intensive cattle, sheep, pig and arable farming. In the mountainous regions of the Foyle Basin there is coniferous forest and some sheep and cattle grazing. The Foyle River system is recognised as an important and popular fishery for Atlantic Salmon, and has protected status.

Pressures in the Foyle River Basin are principally due to diffuse agricultural sources and increased pressure from growing populations to support industry and disposal of urban wastewater and water abstraction. There are also hydromorpological pressures due to water abstraction, agriculture enhancements and flood defense. Pressures in the estuary complex are described in the assessment of the Lough Foyle wetland area.

POPULATION AND LAND COVER IN THE FOYLE RIVER BASIN



Source: UNEP/DEWA/GRID-Europe 2011.

Photo by Tobias Salathe

[89] Based on information provided by the Northern Ireland Environment Agency.
[90] *Source:* Lough Melvin Catchment Management Plan, June 2008.
[91] Based on information provided by Ireland and the Northern Ireland Environment Agency, and on the First Assessment.

According to the UK classification, the chemical status of the Foyle for the period 2002-2005 was classified as good, and biological status also as good.[92] Ecological status under the WFD was assessed in Ireland, for 200 km of river channel, with 40% of high and good status, 18% moderate, 41% poor and 0.8% of bad status. This represents a deterioration compared with the 2004-2006 survey.[93] Investigative monitoring targeted at suspected pollution from sheep dip and insecticides usage in forestry is being undertaken, with a view to reversing the observed decline in water quality.

Part of the River Foyle and its tributaries, situated in Northern Ireland, are included in an Area of Special Scientific Interest (ASSI). These areas are notable for the physical diversity, natural condition of the banks and channels, and for the richness and natural state of its plant and animal communities.[94]

According to the Groundwater Action Programme in the North-Western International River Basin District (IRBD) Management Plan, the quantitative, chemical and overall status of groundwater is classified as good.

LOUGH FOYLE WETLAND AREA IN THE FOYLE BASIN[95]

General description of the wetland area

The Lough Foyle wetland area is shared by the United Kingdom (Northern Ireland) and Ireland. Lough Foyle[96] is a diverse estuarine wetland complex with a string of habitats both below high water and above, and a 26-km long inlet on the northern coast of Ireland. "The Tuns" — a large submerged sandbank system — forms the northern boundary of the lough, the outer part of which has a more exposed character. The area belonging to Ireland in the West is made up of rocky shores, fishing villages with small harbours, small woodlands, grassland for sheep and cattle grazing, and small tourist resorts with beaches and sheltered coves. In contrast, the Northern Ireland side is dominated by soft coast and low-lying hinterland, with larger agricultural holdings behind sea embankments. A large sand dune system in the North adds to the biodiversity value. The tidal upper estuaries are set in extensive floodplain wetlands with reedbeds, fresh water and salt marshes, and embanked slob lands, especially on the Northern Ireland inner lough side. There are also many small (~1 km) direct inflows of streams from the hinterland, reflecting Ireland's high rainfall, which can have a major influence on the inner lough salinity and nutrient levels.

Main wetland ecosystem services

The area is important for fishing, with mixed inshore sea fisheries, seasonal wild salmon fishing, and passive gear for lobster and crab. In the extensive intertidal area, periwinkles and cockles are gathered. Mussel bottom culture has boomed since its start in the 1990s, with fully mechanized dredgers used to bring in mussel seed, relay, and harvest. Apart from ferry traffic, recreational uses range from bathing and boating to wildlife watching and educational 'tourism'. While large parts of the low-lying lands are embanked, there is still substantial flood retention value in the wetlands.

Cultural values of the wetland area

There are historic settlements on the western shore of the lough, with shell middens and other archaeological features. Derry is one of Europe's walled cities.

Biodiversity values of the wetland area

The lough is a highly productive area. Due to geology, exposure, salinity, and current it offers a wide range of habitats, with rich mudflats, both rock and biogenic reefs, and seagrass beds, and is particularly rich in molluscs and fish – attributes which attract high numbers of wintering wild fowl and waders. Further, the River Foyle and its tributaries have the largest Atlantic Salmon population in Northern Ireland, including high genetic diversity.

Pressure factors and transboundary impacts

Several pressure factors lead to the decline of shared natural resources within the Lough area. Water pollution from agriculture, industry and sewage impact the inner eutrophic lough. With regard to modern mollusc fisheries, in particular mussel bottom culture affects areas of native oyster beds through dredging and introduction of large quantities of seed mussels from the Irish Sea. Gigas oysters, now an invasive species, have been imported and have changed the local hydrology. Shellfish Herpes virus has been introduced, and is now affecting native oysters.

While new transport-related construction pressure is now on the decline, construction for green infrastructure — wind and water energy — is starting. In the immediate hinterland, fragmentation is caused by roads, flood defences, and housing developments. In terms of the entire river basin, agricultural intensification and wetland loss are pressures which are recently increasing again, caused by the rise in market prices for agricultural products. This comes on top of the European Commission's Common Agricultural Policy payments for farmers, which are provided for land in good agricultural condition, but withheld for wetlands. This measure provides incentives to drain or fill in existing wetlands, especially as planning law is too weak. Further, there are control problems in terms of sand and gravel extraction from rivers and estuary. Additional pressures identified are water abstraction, the damming of rivers, peat harvesting and forestry. Finally, climate change, which is associated with an increased erosion risk of vulnerable shores and rising sea levels, which may inundate low lying lands, is likely to cause further flood and erosion defence works.

Transboundary wetland management

The River Foyle is a transboundary wetland and now designated a SAC under the EU Habitats Directive on both the Ireland and Northern Ireland sides, due to its abundance of salmon, as well as lamprey and otter. It is managed by the two responsible Governments, local authorities, and the cross-border Lough Agency — with responsibility for fisheries — set up by agreement between the two states. Both Governments claim the lough up to the mean low water mark of the other. This is one of the reasons why there is no mechanism for designating the entire lough as Natura 2000/Ramsar Site, although much of the rim of the lough has been designated as an Area of Special Scientific Interest (ASSI) under UK regulation, an SPA, as well as a Ramsar Site.

Water quality monitoring of the Lough and its watershed and associated fish monitoring is carried out by the Lough Agency. The Lough is monitored for ecological status under the WFD by the Northern Ireland Environment Agency (NIEA) and status results — the inner Foyle water bodies are classified as being

[92] *Source:* Environment and Heritage Service (EHS), United Kingdom (http://www.ehnsi.gov.uk).
[93] *Source:* Water Quality in Ireland 2007-2009. Environmental Protection Agency, Ireland. 2010.
[94] *Source:* Northern Ireland Environment Agency. (http://www.doeni.gov.uk).
[95] *Sources:* Information Sheet on Ramsar Wetlands; Loughs Agency (http://www.loughs-agency.org/site/).
[96] The watershed of the Lough covers an area of approximately 3,700 km^2, and includes the three main rivers, namely Foyle, Faughan and Roe, as well as their tributaries fanning out to the south and east.

of moderate ecological status and the resulting programmes of measures (restoration by 2021) are included in the River Basin Management Plan (RBMP) for the North-Western IRBD.[97] The county councils on both sides also monitor selected parameters such as bathing water quality and discharges where licensed permits have been granted. The Environmental Protection Agency of Ireland (EPA) and Northern Ireland Environment Agency monitor the larger integrated pollution licenses.

Existing protected areas urgently require management plans and measures, and implementation responsibilities need to be clarified.

While there is no climate change adaptation strategy for the lough, each Government is developing its own climate change strategies which include plans for green energy - wind, tidal and wave. Both have commissioned offshore energy SEAs.

NEAGH BANN RIVER BASIN DISTRICT[98]

The Neagh Bann International River Basin District (IRBD) covers an area of around 6,000 km^2 of Northern Ireland (a region of the United Kingdom), and drains 38% of the land area; a further 2,000 km^2 is within Ireland. Most of the surface water collected by the river systems within the basin drains to Lough Neagh, the largest freshwater lake in the British Isles, before discharging into the Atlantic Ocean, north of the island via the Lower River Bann. Only a small portion of the River Basin District, at the southern end of the catchment, is shared with Ireland. This is principally the Blackwater River system that rises in County Fermanagh in Northern Ireland and flows eastward, skirting the border with County Monaghan in Ireland, before turning northwards to drain into Lough Neagh, in Northern Ireland. Smaller river basins that are shared between the two countries at the southern end of the Neagh Bann River Basin District are the Castletown and Fane rivers, draining into the Irish Sea at Dundalk Bay.

Land around Lough Neagh (surface area 396 km^2) is typified by improved pasture, but it also includes some important wetland habitats. The main land use around the Blackwater River Basin is improved grassland and arable horticulture, with fruit growing in the eastern part of the basin.

The Bann River Basin is important for salmon and eel fisheries.

Neagh Bann River Basin District

Country	Area in the country (km^2)	Country's share (%)
UK, Northern Ireland	5 740	72
Ireland	2 200	28
Total	**7 940**	

Basin of the Blackwater River

Country	Area in the country (km^2)	Country's share (%)
UK, Northern Ireland	1 100	67
Ireland	550	33
Total	**1 650**	

Source: Working together: managing our shared waters. Neagh Bann IRBD. December 2008.

Hydrology and hydrogeology

The average discharge of the Upper Bann (upstream from Lake Lough Neagh) is approximately 5.4 m^3/s at the Dynes Bridge, and of the Lower Bann 92.1 m^3/s at the Movanagher.[99]

Pressures and status

Pressures in the Irish part of the Bann River Basin are principally the same as described in the assessment of the Erne River.

According to UK River Basin Management Plan status assessment (2009), the River Blackwater Local Management Area (LMA), which equates to the Blackwater River Basin in Northern Ireland, had 12% of its water bodies of good status, 42% of moderate status (2% of these being heavily modified resulting in moderate ecological potential), 35% of poor status (6% of these being of poor ecological potential), and 12% of bad status (4% of these being of bad ecological potential).

This results in 88% of surface water bodies within the River Blackwater LMA in Northern Ireland being classified as of less than good status. Many of the rivers failed to achieve good status due to low levels of dissolved oxygen and elevated levels of phosphorus. Invertebrates have also been heavily impacted.

There are a number of pressures that may prevent some waters reaching good quality. The main ones are considered to be:

- abstraction and flow regulation;
- diffuse and point source pollution;
- changes to morphology (physical habitat); and,
- invasive alien species.

According to the Environmental Protection Agency of Ireland, the waters in the portion of the Neagh Bann IRBD situated south of the border are the most polluted, and represent one of the most polluted regions in Ireland. The impact tends from slight pollution, mainly seen as eutrophication with an increasing trend to moderate, usually characterized by marked organic and severe eutrophication effects.

Between the years 2007-2009, the biological status of the Bann channel was assessed over 78 km of tributary river channel in Ireland as follows: 40% high and good, 16% moderate, and 44% poor biological status.[100] The main pressures on these rivers were municipal wastewater discharges and diffuse agricultural pollution.

The overall status of the Neagh Bann IRBD was assessed in 2008 by the UK and Ireland giving initial classification results; 23% of waters of good or better class, 71% of water bodies less than good, with the remaining 6% yet to be assessed.

According to the Groundwater Action Programme in the Neagh Bann IRBD in Ireland, quantitative status is classified mostly as good, and a small part (7 %) as poor. The chemical status of groundwater is classified as good and the overall status as good.

An action plan will be drawn up during 2011 for the River Blackwater LMA, to address those water bodies that are of less than good status.

[97] *Source:* http://www.wfdireland.ie/docs/.
[98] Based on information provided by Ireland and the Northern Ireland Environment Agency, and on the First Assessment.
[99] The discharge values are based on Marsh, T. J., Hannaford, J. (eds). UK Hydrometric Register. Hydrological data UK series. Centre for Ecology and Hydrology. 2008.
[100] *Source:* Water Quality in Ireland 2007–2009. Environmental Protection Agency, Ireland. 2010.