The 2013 Update of the Danube Basin Analysis Report

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Disclaimer

This report is based on data delivered and updated by Danube countries by 15 October 2014. More updated data is planned to be presented in the 2nd Danube River Basin Management Plan. The data has been dealt with, and is presented, to the best of our knowledge. Nevertheless inconsistencies cannot be ruled out.

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List of Acronyms

AEWS	Accident Emergency Warning System
AGR	Agriculture
AL	Albania
AQS	Analytical Quality Control
AT	Austria
AWB	Artificial Water Body
BA	Bosnia and Herzegovina
BAT	Best Available Techniques
BDI	Biological Diatom Index
BG	Bulgaria
BLS	Baseline Scenario
BOD	Biochemical Oxygen Demand
CAL	Caloric Energy
CAP	Common Agricultural Policy
CIS	Common Implementation Strategy
CH	Switzerland
COD	Chemical Oxygen Demand
CP	Contracting Party
CR	Cost Recovery
CZ	Czech Republic
CZI	Czech multimetric index
DBA	Danube Basin Analysis
DE	Germany
DRB	Danube River Basin
DRBD	Danube River Basin District
DRBM Plan	Danube River Basin District Management Plan
DRW	Drinking Water
DRPC	Danube River Protection Convention
DSTR	Danube Sturgeon Task Force
E-PRTR	European Pollutant Release and Transfer Register
ERC	Environmental and Resource Costs
EQS	Environmental Quality Standard
EQSD	European Directive on Priority Substances
EU	European Union
EU MS	EU Member States
EUSDR	EU Strategy for the Danube Region
FD	Flood Directive 2007/60/EC
FIP	Future Infrastructure Projects
FRMP	Flood Risk Management Plan
GLC	Global Land Cover
GW	Ground Water
GWB	Ground Water Body
ha	hectare
HMWB	Heavily Modified Water Body
HR	Croatia
HU	Hungary
IAS	Invasive Alien Species
ICPDR	International Commission for the Protection of the Danube River
IED	Industrial Emissions Directive
IND	Industry
IPPCD	Integrated Pollution Prevention and Control Directive
IRR	Irrigation
IT	Italy
JDS	Joint Danube Survey
JPM	Joint Program of Measures
kg	kilogram
km	kilometre
MA EG	Monitoring and Assessment Expert Group
MD	Moldova
ME	Montenegro
MK	Macedonia
mm	millimetre
N	Nitrogen
ND	Nitrate Directive
NGO	Non-Governmental Organization
P	Phosphorus
PE	Population Equivalent
PFRA	Preliminary Flood Risk Assessment
PL	Poland
PM EG	Pressures and Measures Expert Group
PPP	Purchase Power Parities
RBM	River Basin Management
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RI	Reference index
rkm	River kilometre
RO	Romania
RS	Republic of Serbia
SBS	BioContamination Index
SK	Slovak Republic
SI	Slovenia
SPA	balneology
SSD	Sewage Sludge Directive
SWB	Surface Water Body
SWMI	Significant Water Management Issues
TN	Total Nitrogen
TNMN	Trans National Monitoring Network
TOC	Total Organic Carbon
TP	Total Phosphorus
UA	Ukraine
UWWTD	Urban Waste Water Treatment Directive
WFD	EU Water Framework Directive 2000/60/EC

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1 Introduction and background

1.1 Introduction

Rivers, lakes, transitional and coastal waters, as well as groundwater, are a vital natural resource of the Danube River Basin: they provide drinking water, crucial habitats for many different types of wildlife, and are an important resource for industry, agriculture, transport, energy production and recreation.

A significant proportion of this resource is environmentally damaged or under threat. Protecting and improving the waters and environment of the Danube River Basin is substantial for achieving sustainable development and is vital for the long term health, well-being and prosperity for the population of the Danube region.

Being aware of this issue and due to the fact that the sustainable management of water resources requires transboundary cooperation, the countries sharing the Danube River Basin agreed to jointly work towards the achievement of this objective. The Danube River Protection Convention[1] (DRPC), signed in 1994, provides the legal framework for cooperation on water issues within the Danube basin, which is the most international river basin in the world. All Danube countries with territories >2,000 km^2 in the Danube River Basin are Contracting Parties to the DRPC: Austria (AT), Bosnia and Herzegovina (BA), Bulgaria (BG), Croatia (HR), the Czech Republic (CZ), Germany (DE), Hungary (HU), Moldova (MD), Montenegro (ME), Romania (RO), the Republic of Serbia (RS), the Slovak Republic (SK), Slovenia (SI) and Ukraine (UA). In addition, the European Union (EU) is also a Contracting Party to the DRPC. The International Commission for the Protection of the Danube River (ICPDR) is the organisation which was established by the DRPC Contracting Parties to facilitate multilateral cooperation and for implementing the DRPC.

Furthermore, in October 2000 the EU Water Framework Directive[2] (WFD) was adopted and came into force in December 2000. The purpose of the Directive is to establish a framework for the protection and enhancement of the status of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater, and to ensure a sustainable use of water resources. It aims to ensure that all waters meet ‘good status’, which is the ultimate objective of the WFD, respectively to avoid their deterioration.

EU Member States (EU MS) should aim to achieve ‘good status’ in all bodies of surface water and groundwater by 2015, respectively by 2027 at the latest. Currently not all Danube countries are EU MS and therefore not legally obliged to fulfil the WFD requirements. Five countries (BA, MD, ME, RS and UA) are Non EU Member States (Non EU MS). Out of these Non EU MS, two countries (ME and RS) carry the status of candidate countries. However, when the WFD was adopted in the year 2000, all countries cooperating under the DRPC decided to make all efforts to implement the Directive throughout the whole basin.

The WFD establishes several integrative principles for water management, including public participation in planning and the integration of economic approaches, beside aiming for the integration of water management into other policy areas. It envisages a cyclical process where river basin management plans are prepared, implemented and reviewed every six years. There are four distinct elements to the river basin planning cycle: characterisation and assessment of impacts on river basin districts; water status monitoring; the setting of environmental objectives; and the design and implementation of the programme of measures needed to achieve them. These tasks have already been accomplished for the Danube River Basin and are now updated according to the WFD cyclic approach, allowing for an adaptive management of the basin.

[1] Convention on Cooperation for the Protection and Sustainable Use of the Danube River (Sofia, 1994).

[2] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

1.2 Scope and objective

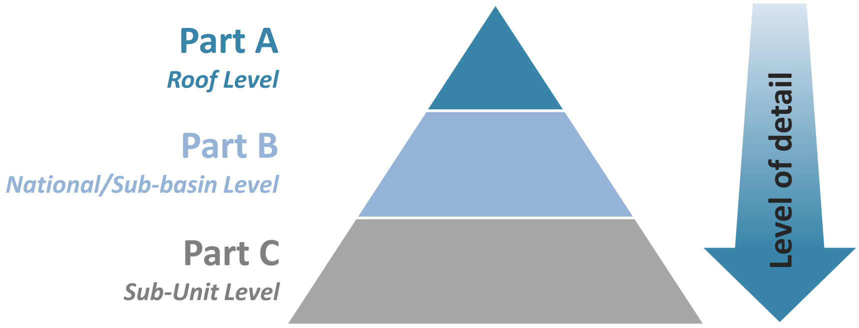
River basins, which are defined by their natural geographical and hydrological borders, are the logical units for the management of waters. This innovative approach for water management is also followed by the WFD. In case a river basin covers the territory of more than one country, an international river basin district has to be created for the coordination of work in these districts.

The Danube and its tributaries, transitional waters, lakes, coastal waters and groundwater form the Danube River Basin District (DRBD), which is illustrated in Map 1. The DRBD covers the Danube River Basin (DRB), the Black Sea coastal catchments in Romanian territory and the Black Sea coastal waters along the Romanian and partly Ukrainian coasts.

Due to reasons of efficiency, proportionality and in line with the principle of subsidiarity, the management of the DRBD is based on the following three levels of coordination (see Figure 1):

- ⇨ **Part A**: International, basin-wide level – the Roof Level;
- ⇨ **Part B**: National level (managed through competent authorities) and/or the international coordinated sub-basin level for selected sub-basins (Tisza, Sava, Prut, and Danube Delta);
- ⇨ **Part C**: Sub-unit level, defined as management units within the national territory.

Figure 1: Three levels of management for WFD implementation in the DRBD showing the increase of the level of detail from Part A to Part B and C



The investigations, analyses and findings for the basin-wide scale (Part A) focus on:

- rivers with catchment areas >4,000 km^2;[3]
- lakes >100 km^2;
- transitional and coastal waters;
- transboundary groundwater bodies of basin-wide importance.

The ICPDR serves as the coordinating platform to compile multilateral and basin-wide issues at Part A ("Roof Level"[4]) of the DRBD. The information increases in detail from Part A to Parts B and C. Waters with smaller catchment and surface areas are subject to planning at sub-basin/national (Part B), respectively sub-unit level (Part C). All plans together provide the full set of information for the whole DRBD, covering all waters (surface as well as groundwater), irrespectively of their size.

Since 2000 the following major milestones were achieved in managing the DRBD and in line with the principles as set by the WFD:

- 2004 – Accomplishment of first Danube Basin Analysis Report according to WFD Article 5
- 2006 - Summary Report on Monitoring Programmes in the DRBD

[3] The scale for measures related to point source pollution is smaller and therefore more detailed.

[4] At the roof level (Part A), the ICPDR agreed on common criteria for analysis related to the DRBM Plan as the basis to address transboundary water management issues. The level of detail of the roof level (Part A) is lower than that used in the national Part B Plans of each EU MS.

- 2007 – Interim Overview on the Significant Water Management Issues in the DRBD
- 2009 – Adoption of the 1st Danube River Basin District Management Plan (1st DRBM Plan)
- 2012 – Interim Report on the Implementation of the Joint Programme of Measures

As a first step in the preparation of the second WFD management cycle (2015-2021), a timetable, work program and statement on consultation measures for the development of the 2nd DRBM Plan was adopted by the ICPDR in December 2012. Following, an updated Interim Overview on the Significant Water Management Issues in the DRBD was developed according to WFD Article 14 by the end of 2013 and therefore two years before the deadline for the finalisation of the 2nd DRBM Plan in 2015. Both documents were made available to the public, allowing for six months to comment in writing in order to allow for active involvement and consultation.

The report in hand provides a characterisation of the river basin district, a review of the environmental impact of human activity and an economic analysis of water use (WFD Article 5), which was first accomplished for the DRBD in 2004 and which is now updated. Even though the WFD does not require a coordinated update of the WFD Article 5 analysis for the Level A (Roof Level), the ICPDR decided to elaborate this 2013 Update of the Danube Basin Analysis (2013 DBA) as a preparatory step and analytical basis for the 2nd DRBM Plan, which will be finalised by December 2015.

Therefore, the major objective of the 2013 DBA is to provide an update for the DRBD on the

- Analysis of its characteristics,
- Review of the impact of human activity on the status of surface waters and on groundwater, and
- Economic analysis of water use

in line with WFD Article 5 and in accordance with the technical specifications set out in Annexes II and III of the Directive.

1.3 Structure and contents

The 2013 DBA is based on one hand on the contents of the 2004 DBA but was updated and adapted according to the structure and findings of the 1st DRBM Plan and latest developments. Beside a general characterisation of the DRBD, the 2013 DBA provides updated information on the designation of water bodies. The pressures analysis was adapted according to the Significant Water Management Issues (SWMIs) Paper from 2007, the 1st DRBM Plan 2009, as well as the updated SWMI Paper from 2013, outlining the issues that affect directly or indirectly the status of surface water and transboundary groundwater in the DRBD:

- Pollution by organic substances
- Pollution by nutrients
- Pollution by hazardous substances
- Hydromorphological alterations

These SWMIs were derived on the basis of the requirements of the EU WFD and mainly relate to quality aspects. For transboundary groundwater bodies, both, the qualitative and quantitative issues are addressed.

The impacts and risk assessment was elaborated for the time horizon 2021, which is the target date for the 2nd WFD management cycle 2015-2021 and therefore of key relevance for the elaboration of the Joint Programme of Measures which will be part of the 2nd DRBM Plan. Beside an updated inventory of protected areas and economic analysis, a specific chapter on integration issues was elaborated, providing information on the latest key developments in linking different water-related sectors.

2 The Danube River Basin District

2.1 General characterisation

The DRBD is the "most international" river basin in the world covering territories of 19 countries. Those 14 countries with territories greater than 2,000 km^2 in the DRB cooperate in the framework of the ICPDR. With an area of 807,827 km^2, the DRBD is the second largest in Europe. Some of its basic characteristics are given in the following Table 1.

Table 1: Basic characteristics of the Danube River Basin District

DRBD area	807,827 km^2
DRB area	801,463 km^2
Danube countries with catchment areas >2,000 km^2	EU Member States (9): Austria, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Slovak Republic, Slovenia, Romania. Non EU Member States (5): Bosnia & Herzegovina, Moldova, Montenegro, Serbia and Ukraine
Danube countries with catchment areas <2,000 km^2	EU Member States (2): Italy, Poland Non EU Member States (3): Albania, FYR Macedonia, Switzerland
Inhabitants	approx. 81 Mio.
Length of Danube River	2,857 km
Average discharge	approx. 6,500 m^3/s (at the Danube mouth)
1st order tributaries with catchment areas >4,000 km^2	Lech, Naab, Isar, Inn, Traun, Enns, March/Morava, Svratka, Thaya/Dyje, Raab/Rába, Vah, Hron, Ipel/Ipoly, Siò, Drau/Drava, Tysa/Tisza/Tisa, Sava, Timis/Tamiš, Velika Morava, Timok, Jiu, Iskar, Olt, Yantra, Arges, Ialomita, Siret, Prut.
Important lakes >100 km^2	Neusiedler See/Fertö-tó, Lake Balaton, Yalpug-Kugurlui Lake System, Lake Razim
Important groundwater bodies	11 transboundary groundwater bodies of basin-wide importance are identified in the DRBD
Important water uses and services	Water abstraction (industry, irrigation, household supply), drinking water supply, wastewater discharge (municipalities, industry), hydropower generation, navigation, dredging and gravel exploitation, recreation, various ecosystem services

The DRBD is not only characterised by its size and large number of countries but also by its diverse landscapes and the major socio-economic differences that exist. Table 2 provides an overview on the shares of countries of the Danube River Basin and the population within the DRB.

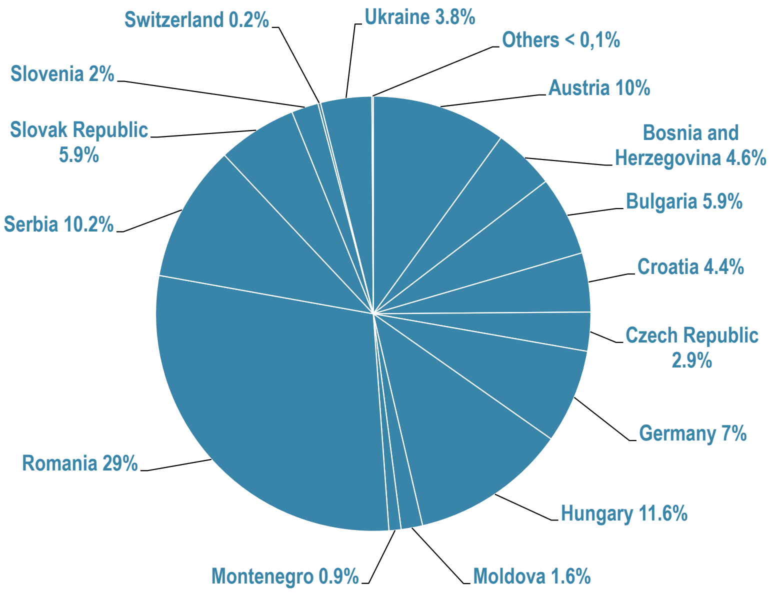
Table 2: Shares and population of countries in the DRB

Country	Code	Coverage in DRB (km^2)	Share of DRB (%)	Percentage of territory within the DRB (%)	Population within the DRB (Mio.)
Albania	AL	126	< 0.1	0.01	< 0.01
Austria*	AT	80,423	10.0	96.1	7.7
Bosnia and Herzegovina*	BA	36,636	4.6	74.9	2.9
Bulgaria*	BG	47,413	5.9	43.0	3.5
Croatia*	HR	34,965	4.4	62.5	3.1
Czech Republic*	CZ	21,688	2.9	27.5	2.8
Germany*	DE	56,184	7.0	16.8	9.4
Hungary*	HU	93,030	11.6	100.0	10.1
Italy	IT	565	< 0.1	0.2	0.02
Macedonia	MK	109	< 0.1	0.2	< 0.01
Moldova*	MD	12,834	1.6	35.6	1.1
Montenegro*	ME	7,075	0.9	51.2	0.2
Poland	PL	430	< 0.1	0.1	0.04
Romania*	RO	232,193	29.0	97.4	21.7
Serbia*	RS	81,560	10.2	92.3	7.5[5]
Slovak Republic*	SK	47,084	5.9	96.0	5.2
Slovenia*	SI	16,422	2.0	81.0	1.7
Switzerland	CH	1,809	0.2	4.3	0.02
Ukraine*	UA	30,520	3.8	5.0	2.7
Total		**801,463**	**100**	**-**	**81.00**

*) Contracting Party to the ICPDR

[5] The data from Serbia do not include any data from the Autonomous Province of Kosovo and Metohija.

Figure 2: Danube countries share of the Danube River Basin in %



2.2 Geographical characterisation

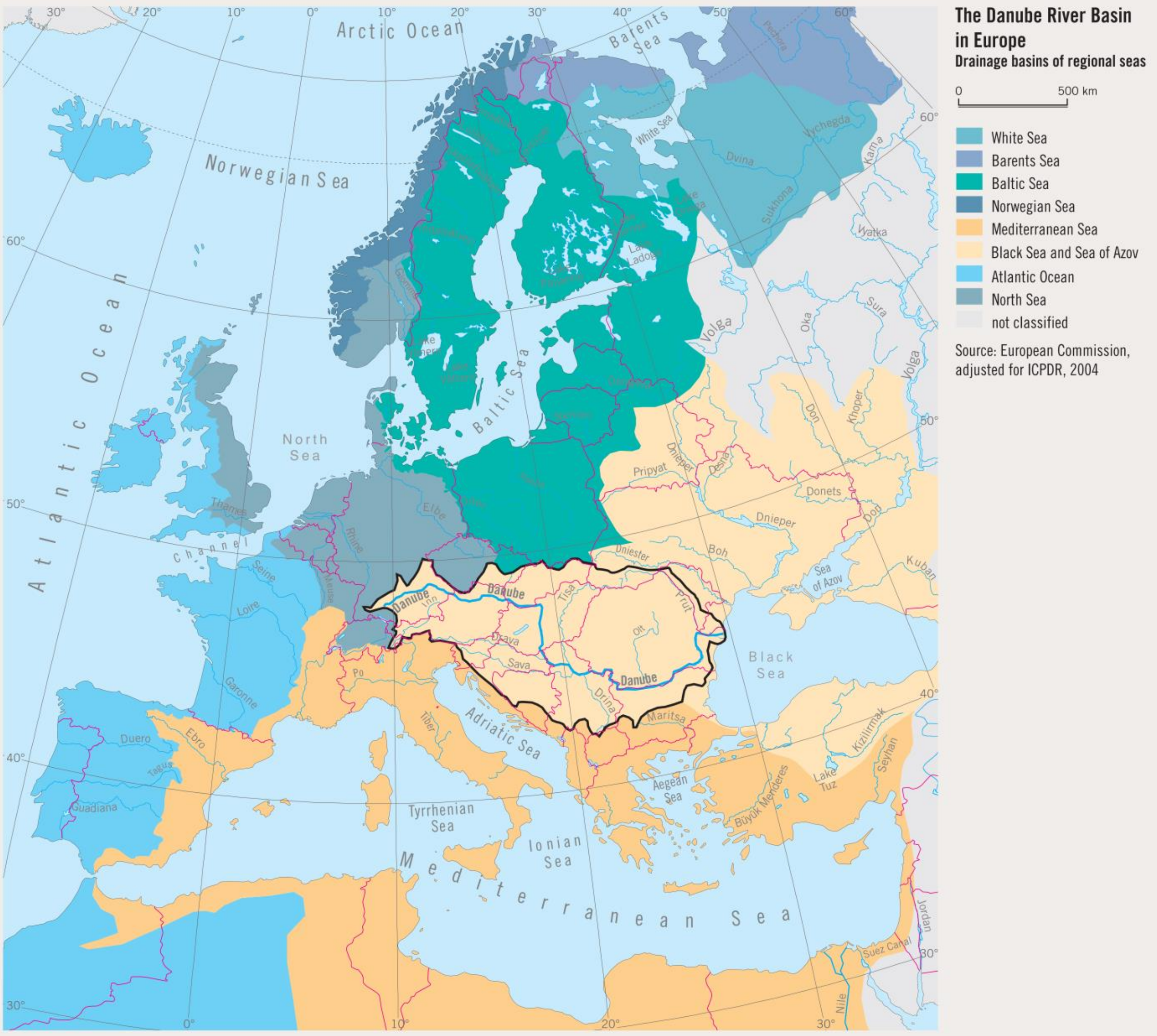
The Danube River Basin covers an area of approximately 10% of Continental Europe and is the second largest river basin in Europe after the Volga (the DRB covers 801,463 km^2 and the DRBD 807,827 km^2). It lies to the west of the Black Sea in Central and South-eastern Europe (see Figure 3). To the west and northwest the Danube River Basin borders on the Rhine River Basin, in the north on the Weser, Elbe, Odra and Vistula River Basins, in the north-east on the Dniestr, and in the south on the catchments of the rivers flowing into the Adriatic Sea and the Aegean See.

Due to its geologic and geographic conditions the Danube River Basin can be divided into 3 main parts:

- The **Upper Danube Basin** reaches from the sources in the Black Forest Mountains to the Gate of Devín, to the east of Vienna, where the foothills of the Alps, the Small Carpathians and the Leitha Mountains meet. The area covers in the north the Swabian and Frankonian Alb, parts of the Oberpfälzer, the Bavarian and the Bohemian Forests, the Austrian Mühl- and Waldviertel, and the Bohemian-Moravian Uplands. South of the Danube lie the Swabian-Bavarian-Austrian Alpine Foothills as well as large parts of the Alps up to the water divide in the crystalline Central Alps.
- The **Middle Danube Basin** covers a large area reaching from the Gate of Devín to the impressive gorge of the Danube at the Iron Gate, which divides the Southern Carpathian Mountains in the north and the Balkan Mountains in the south. The Middle Danube Basin is confined by the Carpathians in the north and the east, and Karnic Alps and the Karawankas, the Julian Alps and the Dinaric Mountains in the west and south. This circle of mountains embraces the Pannonian Plains and the Transsylvanian Uplands.
- The **Lower Danube Basin** covers the Romanian-Bulgarian Danube sub-basin downstream of Cazane Gorge and the sub-basins of the Siret and Prut River. It is confined by the Carpathians in the north, by the Bessarabian Upland Plateau in the east, and by the Dobrogea and Balkan Mountains in the south.

Due to this richness in landscape the Danube River Basin shows a tremendous diversity of habitats through which rivers and stream flow including glaciated high-gradient mountains, forested midland mountains and hills, upland plateaus and through plains and wet lowlands, i.e. the Danube Delta, near sea level.

Figure 3: Location of the Danube River Basin in Europe



2.3 Climate and hydrology

Due to its large extension from west to east, and diverse relief, the Danube River Basin also shows great differences in climate. The upper regions in the west show strong influence from the Atlantic climate with high precipitation, whereas the eastern regions are affected by Continental climate with lower precipitation and typical cold winters. In the area of the Drava and Sava, influences from the Mediterranean climate, can also be detected.

The heterogeneity of the relief, especially the differences in the extent of exposure to the predominantly westerly winds, as well as the differences in altitude diversify this general climate pattern. This leads to distinct landscape regions showing differences in climatic conditions and in the biota, e.g. the vegetation.

Pronounced average air temperature differences are determined by the extensive area and elongated character of the DRB from west to east. Average annual air temperature within the basin ranges from -6°C to + 12°C (see Map 3). The lowest value originates from Sonnblick (in Austria), the highest mean annual temperature was observed in the northern part of the Hungarian Lowland and at the Black Sea coast. In the entire Danube River Basin July is the warmest month, January being the coldest one.

The Alps in the west, the Dinaric-Balkan mountain chains in the south and the Carpathian mountain bow in the eastern centre are distinctive morphological and climatic regions and barriers. These mountain chains receive the highest annual precipitation and the Danube River Basin is therefore benefiting from several "Water Towers", while the inner and outer basins are relatively dry. The precipitation ranges from < 500 mm to > 2,000 mm based on differences in the regions (see Map 2). This in turn has strong effects on the surface run-off and the discharge in the streams.

The Danube rises in the Black Forest in Germany at a height of about 1,000 m a.s.l., flows predominantly to the south-east and reaches the Black Sea after approximately 2,857 km, dividing into the 3 main branches, the Chilia, the Sulina, and the Sf. Gheorghe Branch. At its mouth the Danube has an average discharge of about 6,460 m^3/s. The Danube Delta lies in Romania and partly in Ukraine and is a unique "UNESCO World Heritage Site". The entire protected area covers 675,000 ha including floodplains, natural lakes and marine areas. The Danube is the largest tributary into the Black Sea.

Some of the largest tributaries of the Danube are characterised in Table 3 below, including information on their key hydrologic characteristics.

Table 3: The Danube and its main tributaries (1st order tributaries with catchments > 4,000 km^2)

River	Enters the Danube at	Length in km	Size of catchment in km^2	Average discharge in m^3/s
Danube	-	2,857	801,463	6,460
Lech	Marxheim (near Donauwörth), Germany	254	4,125	115
Naab	Regensburg, Germany	191	5,530	49
Isar	Near Deggendorf, Germany	283	8,964	174
Inn	Passau, Germany	515	26,130	735
Traun	Near Linz, Austria	153	4,257	150
Enns	Mauthausen, Austria	254	6,185	200
Morava/March	Devín, Slovakia	329	26,658	119
Raab/Rába	Győr, Hungary	311	10,113	88
Vah	Komárno, Slovakia	398	18,296	161
Hron	Near Štúrovo, Slovakia	278	5,463	55
Ipel/Ipoly	Near Szob, Hungary	197	5,108	22
Sió	Near Szekszárd, Hungary	121	9,216	39
Drau/Drava	Near Osijek, Croatia	893	41,238	577
Tysa/Tisza/Tisa	Near Titel, Serbia	966	157,186	794
Sava	Belgrade, Serbia	861	95,719	1,564
Tamis/Timis	Near Pančevo, Serbia	359	10,147	47
Morava (RS)	Near Smederevo, Serbia	430	37,444	232
Timok	Bulgarian-Serbian border	180	4,630	31
Jiu	Near Ghighera, Romania	339	10,080	86
Iskar	Gigen, Pleven Province, Bulgaria	368	8,684	54
Olt	Turnu Mugurele, Romania	615	24,050	174
Yantra	Svishtov, Bulgaria	285	7,879	47
Arges	Olteniţa, Romania	350	12,550	71
Ialomita	Near Hârşova, Romania	417	10,350	45
Siret	Galaţi, Romania	559	47,610	240
Prut	Near Reni, Ukraine	950	27,540	110

2.4 Land cover and land use

The Danube basin is characterized by a large variety of anthropogenic and natural features, which are important in terms of their effect on the river systems but also groundwater, e.g. for diffuse nutrient inputs. Map 4 provides an overview on the differing land cover in the DRBD based on the latest available CORINE Land Cover data from 2006, categorised into artificial surfaces like urban areas, arable lands and permanent crops which are in use for agricultural production, pastures and heterogeneous agricultural areas, forests, open spaces with little or no vegetation like in high mountainous areas, as well as wetlands and water bodies like rivers and lakes. For Ukraine and Moldova data from the Global Land Cover 2000 Project (GLC2000) was used.

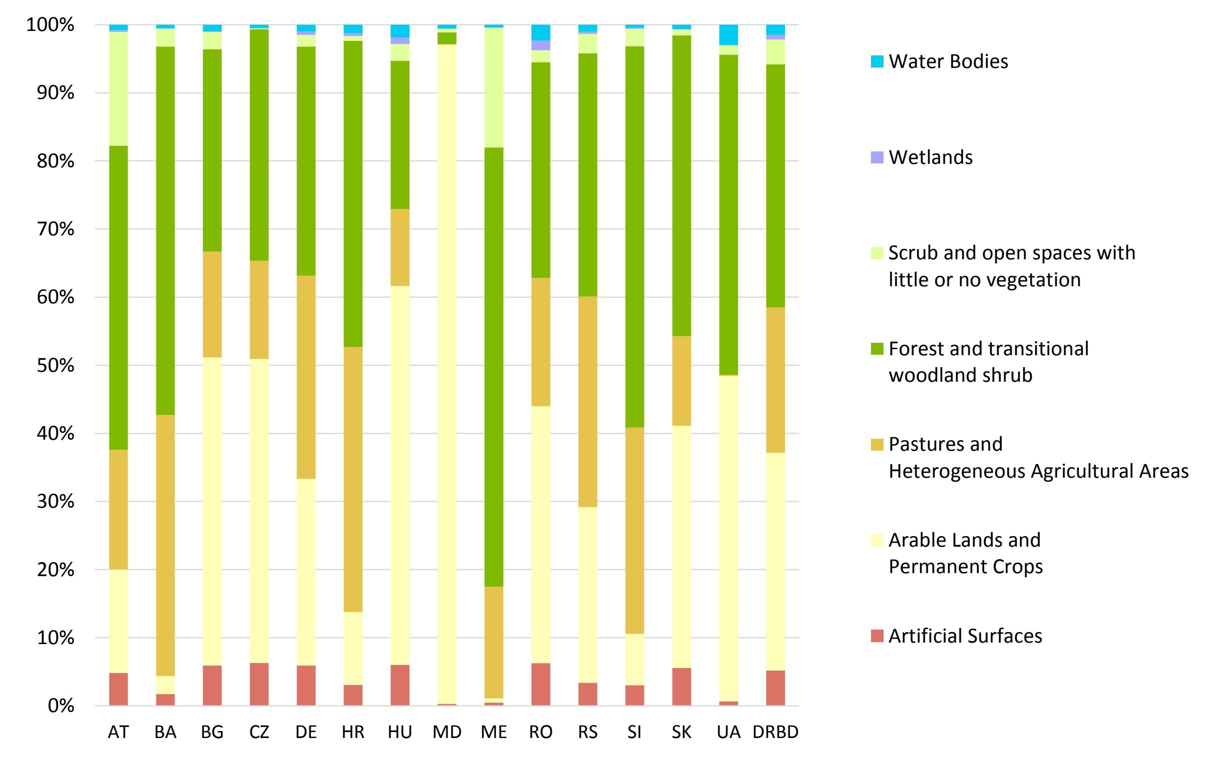
The map illustrates the close correlation between land cover and topography, with forests, pastures and open spaces mainly located in the hilly and mountainous areas of the Alps, Carpathians and Balkan mountains. Areas suitable for agricultural purposes are for instance especially located north of the Alps, the middle Danube in the area of the Great Hungarian Plain, as well as the lower Danube region in Bulgaria, Romania, Moldova and parts of Ukraine.

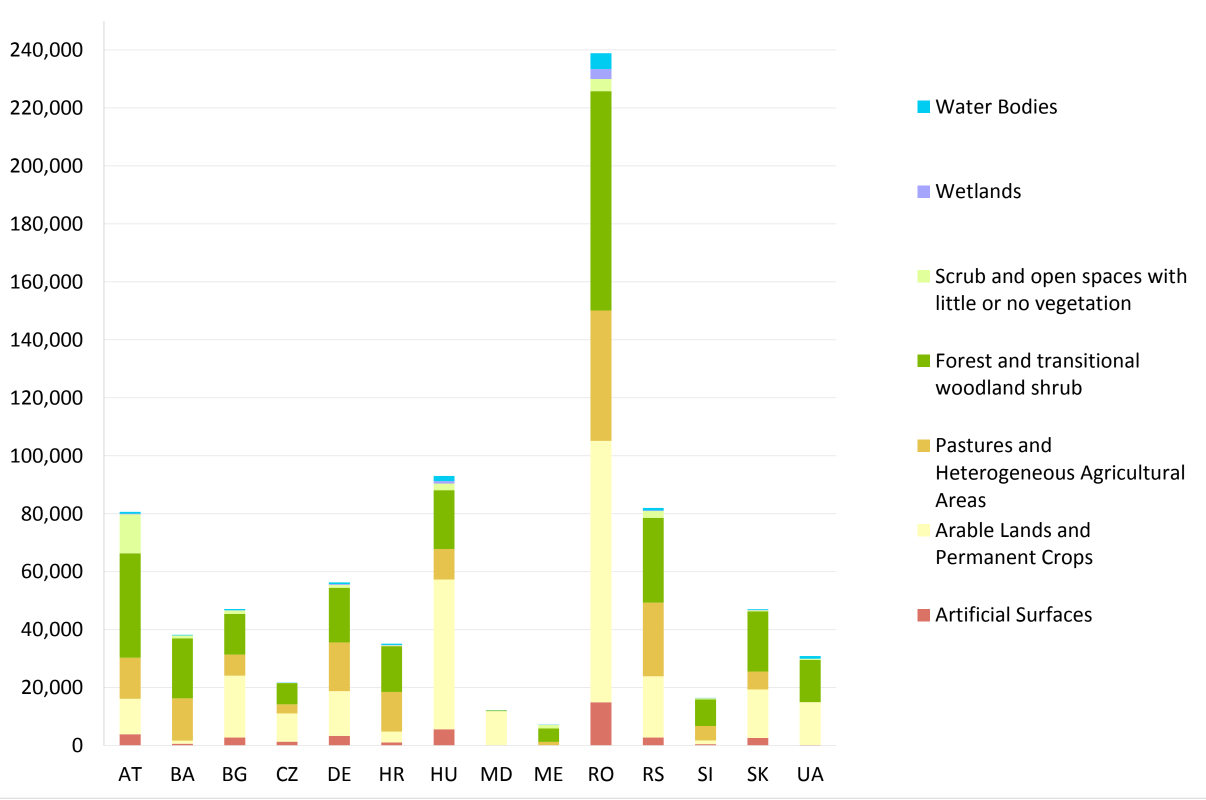
Figure 4 illustrates the shares of different land use categories for Danube countries territories located within the DRBD and the DRBD as a whole, as well as the respective areas for the different countries. The figures for the whole DRBD are provided in Table 4. Forests and transitional woodland scrub, as well as arable land and permanent crops, are the two main land use categories with both together covering an area of around 70% of the basin. With approximately 20% a further substantial share of the total area is covered by pastures and heterogeneous agricultural areas. Wetlands and water bodies cover around 2% of the DRBD.

Table 4: Share of land use categories in the DRBD

Land use category	Area of the DRBD in km²	Share of the DRBD in %
Artificial surfaces	39,788	4.9
Arable lands and permanent crops	271,167	33.6
Pastures and heterogeneous agricultural areas	162,919	20.2
Forest and transitional woodland scrub	287,361	35.6
Shrub and open spaces with little or no vegetation	28,425	3.5
Wetlands	5,259	0.7
Water bodies	11,961	1.5

Figure 4: Share of land use categories in % and total areas in km²

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220,000
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
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AT
BA
BG
CZ
DE
HR
HU
MD
ME
RO
RS
SI
SK
UA
Water Bodies
Wetlands
Scrub and open spaces with little or no vegetation
Forest and transitional woodland shrub
Pastures and Heterogeneous Agricultural Areas
Arable Lands and Permanent Crops
Artificial Surfaces

3 Water bodies in the Danube River Basin District

According to Art. 2 (10) of the EU WFD a body of surface water means a discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal, part of a stream, river or canal, a transitional water or a stretch of coastal water.

Body of groundwater means a distinct volume of groundwater within an aquifer or aquifers.

The characterization and risk assessment of surface and groundwater is carried out on the level of water bodies.

3.1 Surface waters: rivers, lakes, transitional waters and coastal waters

This subchapter provides a brief overview of the identification of the location and boundaries of bodies of surface water on the level A as well as a characterisation of all those bodies. It focuses mostly on changes and progress achieved since the first Danube Basin Analysis (Roof Report) in 2004.

3.1.1 Identification of surface water categories

The following surface waters have been selected for the basin-wide overview and are therefore dealt with in this update of the Danube Basin Analysis:

- rivers with catchment areas > 4 000 km²
- lakes > 100 km²
- transitional and coastal waters.

These surface waters are shown on the Danube River Basin District overview map (see Map 1).

3.1.2 Surface water types and reference conditions

To make a proper assessment of surface water bodies within a river basin district the water bodies shall be differentiated according to type so that always like with like can be compared. A common typology for the Danube River has been developed jointly by the Danube countries. For each surface water category, the relevant surface water bodies within the river basin district need to be differentiated according to type (Annex II 1.1 (ii) WFD). The Directive foresees the use of System A (a defined set of descriptors) or System B (a set of obligatory and a set of optional descriptors) for the development of surface water typologies.

Most of the national typologies of the Danube countries are based on the System B. All typologies show a good degree of coherence.

The implementation of WFD has progressed since the first analysis was prepared. Germany, Austria, the Czech Republic, the Slovak Republic, Hungary, Slovenia, Bulgaria and Romania had developed their typologies before the first Article 5 report had been prepared in 2004. Czech Republic and Bulgaria however revised their national typology in 2009 and in 2010 respectively. Romania has also revised and updated its typology. In Bosnia and Herzegovina a preliminary typology for rivers with catchment areas > 4,000 km^2 was developed in 2006. In Croatia a new typology was developed for the RBM Plan 2013 – 2015. Ukraine has developed in 2011 the typology for the Tisza River Basin based on system A for rivers with catchment area > 500 km^2. Serbia has developed a typology for rivers with catchment sizes greater than 100 km^2 (2006). For the purpose of developing Assessment Systems, the surface water types were divided into six general groups (2011). Moldova started the development of its typology.

3.1.2.1 Ecoregions in the Danube River Basin District

Fauna and flora show different geographical distributions depending on the natural characteristics of the environment. To account for these differences the WFD requests the definition of surface water types and the development of type-specific ecological classification systems to assess the status of water bodies. Ecoregions are regions of similar geographical distribution of flora and fauna species. They are therefore an important basis for the definition of biologically relevant surface water types. These have been delineated by ILLIES and are used in Annex XI WFD. A detailed description of the ecoregions in the Danube River Basin District is provided in the DBA 2004 (see also Map 5).

3.1.2.2 Rivers

3.1.2.2.1 Typology of the Danube River

The typology of the Danube River has been developed in a joint activity by the countries sharing the Danube River for the first DBA in 2004. The Danube typology therefore constitutes a harmonised system used by all these countries. The Danube typology was based on a combination of abiotic factors of System A and System B. The most important factors are ecoregion, mean water slope, substratum composition, geomorphology and water temperature.

Ten Danube section types were identified (see Table 5). The ten Danube section types are defined below. The morphological and habitat characteristics are outlined for each section type. In order to ensure that the Danube section types are biologically meaningful, these were validated with biological data collected during the first Joint Danube Survey in 2001.

Table 5: Definition of Danube section types

Section Type	Name of the Section Type	from - to
1	Upper course of the Danube	rkm 2786: confluence of Brigach and Breg – rkm 2581: Neu Ulm
2	Western Alpine Foothills Danube	rkm 2581: Neu Ulm – rkm 2225: Passau
3	Eastern Alpine Foothills Danube	rkm 2225: Passau – rkm 2001: Krems
4	Lower Alpine Foothills Danube	rkm 2001: Krems – rkm 1807: Gönyű/Kližská Nemá
5	Hungarian Danube Bend	rkm 1807: Gönyű/ Kližská Nemá – rkm 1497: Baja
6	Pannonian Plain Danube	rkm 1497: Baja – rkm 1075 : Bazias
7	Iron Gate (Cazane) Danube	rkm 1075: Bazias – rkm 943: Turnu Severin
8	Western Pontic (Cazane-Calarasi) Danube	rkm 943: Turnu Severin – rkm 375.5: Chiciu/Silistra
9	Eastern Wallachian (Calarasi-Isaccea) Danube	rkm 375.5: Chiciu/Silistra – rkm 100: Isaccea
10	Danube Delta*	rkm 100: Isaccea – rkm 0 on Chilia arm, rkm 0 on Sulina arm and rkm 0 on Sf. Gheorghe arm

* Within this section the Danube divides into the three main branches of the Danube Delta.

Figure 5: Danube section types; the dividing lines refer only to the Danube River itself

3.1.2.2.2 Typology of the tributaries in the Danube River Basin District

The typologies of the Danube tributaries were developed by the countries individually. Stream types relevant on transboundary water courses were bilaterally harmonised with the neighbours. Information on river typologies is available from Germany, Austria, Czech Republic, Slovak Republic, Hungary, Slovenia, Croatia, Serbia, Bosnia and Herzegovina, Bulgaria, Romania and Moldova. Most countries in the Danube River Basin (Germany, Austria, Czech Republic, Hungary, Slovenia, Croatia, Serbia, Romania, Bulgaria, Bosnia and Herzegovina) have applied System B (Annex II, 1.2.1 WFD). The Slovak Republic and Ukraine have used System A.

The common factors used mostly in DRB typologies are ecoregion, altitude, catchment area and geology (Table 6). In the Czech typology the ecoregions are not included, instead of ecoregion sea drainage area (= river basin) is used. In Slovenia no altitude classes were used in river typology.

Table 6 gives an overview of the class boundaries used by the DRB countries for the common descriptors altitude, catchment area and geology. From this table it is obvious that the class boundaries have a good degree of coherence throughout the DRBD however they are tailored to the individual conditions in the countries.

Countries using System B have used a number of optional factors to further describe the river types. River discharge, mean substratum composition and mean water slope are most frequently used.

Table 6: Obligatory factors used in river typologies (System A and B)

Descriptor	Country	Class boundaries				
Altitude	Germany	0-200 m	200-800m	> 800 m		
	Austria	0-200 m	200-500 m	500-800 m	800-1600 m	> 1600 m
	Czech R.	0-200 m	200-500 m	500-800 m	> 800 m	
	Slovak R.	0-200 m	200-500 m	500-800 m	> 800 m	
	Hungary	0-200 m	200-350 m	> 350 m		
	Croatia	0-200 m	200 - 600 m	600-800 m		
	Slovenia	no altitude classes were used in river typology				
	Serbia	0-200 m	200-500 m	> 500 m		
	Romania	0-200 m	200-500 m	500-800 m	> 800 m	
	Bulgaria	0-200 m	200-800 m	> 800 m		
	Bosnia and Herzegovina	< 200 m	200-500 m	500-800 m	> 800 m	
	Moldova	0-200 m	200-800m	> 800 m		
	Montenegro					
	Ukraine	< 200 m	200-500 m	500-800 m		
Catchment area	Germany	10-100 km^2	100-1000 km^2	1000-10,000 km^2	> 10,000 km^2	
	Austria	10-100 km^2	100-500 km^2	500-1000 km^2	1000-2500 km^2	2500-10,000 km^2
	Czech R.	Not applied anymore				
	Slovak R.[6]	10-100 km^2	100 – 1 000 km^2	1000 – 10000 km^2		
	Hungary	10-200 km^2	100-2000 km^2	1000-12,000 km^2	> 10,000 km^2	
	Croatia	10-100 km^2	100-1000 km^2	1000-10,000 km^2	> 10,000 km^2	
	Slovenia	<10 km^2	10-100 km^2	100-1000 km^2	1000-10,000 km^2	> 10,000 km^2
	Serbia	10-100 km^2	100-1000 km^2	1000-4000 km^2	4000-10,000 km^2	> 10,000 km^2
	Romania	10-100 km^2	100-1000 km^2	1000-10,000 km^2	> 10,000 km^2	
	Bulgaria	10-100 km^2	100-1000 km^2	1000-10,000 km^2		
	Bosnia and Herzegovina	<100 km^2	100-1000 km^2	1000-4000 km^2	4000-10,000 km^2	> 10,000 km^2
	Moldova	10-100 km^2	100-1000 km^2	1000-10,000 km^2	> 10,000 km^2	
	Montenegro					
	Ukraine	10-100 km^2	100-1000 km^2	1000-10,000 km^2	> 10,000 km^2	
Geology	Germany	siliceous	calcareous	organic		
	Austria	cristalline	tertiary and quaternary sediments	flysch and helveticum	limestone and dolomite	
	Czech R.	crystalline and vulcanites	sandstones, mudstones and quaternary			
	Slovak R.	mixed				
	Hungary	siliceous	calcareous	organic		
	Croatia	siliceous	calcareous	organic	mixed	
	Slovenia	siliceous	calcareous	flysch[7]		
	Serbia	siliceous	calcareous	organic		
	Romania	siliceous	calcareous	organic		
	Bulgaria	siliceous	calcareous	organic	mixed	
	Bosnia and Herzegovina	siliceous	calcareous	organic		
	Moldova	siliceous	calcareous	organic		
	Montenegro					
	Ukraine	siliceous	calcareous	organic		

[6] The river typology is not based on strict boundaries of catchment area. Rivers > 1,000 km^2 make up individual types; definition of types for smaller rivers is based on ecoregion, altitude and geology.

[7] not for the tributaries in the Danube river basin district

3.1.2.2.3 Reference conditions

Annex II 1.3 (i) WFD requires that for each surface water type, type-specific hydromorphological and physico-chemical conditions shall be established representing the values of the hydromorphological and physico-chemical quality elements specified for that surface water type at high ecological status. Type-specific biological reference conditions shall be established, representing the values of the biological quality elements for that surface water type at high ecological status. This step is very important for the assessment of the water status as it provides the basis for establishing the classification scheme.

On the basin-wide level, the Danube countries have agreed on general criteria as a common base for the definition of reference conditions. These have then been further developed on the national level into type-specific reference conditions. The definition of reference conditions was based on the following approaches:

- spatially based approach using data from monitoring sites, or
- approach based on predictive modelling, or
- definition of temporally based reference conditions using either historical data or palaeoreconstruction,
- or use of expert judgement (where none of the above methods was possible).

The national approaches applied for the development of reference conditions in the Danube countries are presented below.

Germany:

The assessment of the biological quality elements is based on the reference conditions, which are defined for each of the river types. In addition, for fish species zoogeographic and longitudinal factors are taken into account. Reference conditions usually refer to species composition and abundance of the biological quality element as well as to biomass for phytoplankton. The assessment methods are modular and in principle consider the following metric groups depending on the river type: tolerance index, taxonomic composition and abundance, diversity as well as functional metrics.

A description of the characteristics of the type specific biocoenosis can be found in fact sheets for each river type (for more information see: http://www.wasserblick.net/servlet/is/18727).

Austria:

Type specific reference conditions for all biological assessment methods and for the hydromorphology have been established by using reference sites. Where pristine reference sites were not available historical data on reference communities, modelling approaches or expert judgement have been used.

The typology and the reference values for all the metrics used in the assessment methods for the biological quality elements are set down in a legal ordinance and additionally published in detailed guideline papers (available at: http://wisa.lebensministerium.at/)

Czech Republic:

The description of type-specific biological reference conditions is generally based on network of reference and the best available sites.

Reference conditions for the benthic macroinvertebrates are based on reference values of metrics. Type-specific or site-specific reference values of assessment metrics in multimetric system were defined. The following variables are used for assessments: taxonomic composition, abundance, diversity, and the ratio ‘sensitive to insensitive taxa’.

Type-specific reference fish taxa were defined based on the historical knowledge and expert judgement. Consecutively a composition of the type-specific reference fish taxocoenoses were expressed as reference values of several metrics. These metrics are component of the Czech multimetric index (CZI), which is used for ecological status assessment.

Reference conditions for phytobenthos were described as the site specific reference values of the Czech saprobic-trophic index; no type-specific reference taxocoenoses were defined. For macrophytes, the taxonomic composition of the reference communities was defined.

Phytoplankton is used only for an assessment of lowland rivers. The reference conditions were defined as reference values of assessment metrics. The following metrics were used: the relative abundance of bacillariophycea, cyanophyceae, and chlorophycea, and the content of chlorophyll-a. Taxonomic composition, abundance and biomass are included as indicative parameters.

Type-specific physico-chemical conditions were defined using a dataset of reference and the best available sites or by expert judgement.

Slovakia:

Type specific reference values for benthic invertebrates and benthic diatoms (phytobenthos) have been developed using multimetric system reflecting to main stressors with regards to the species composition and abundance. The results from the reference sites (mainly for small and middle size Carpathian rivers), modelling (large rivers) as well as the expert judgement (small and middle size lowland rivers) were used.

As for the macrophytes the results from the reference sites (small and middle size rivers), modelling (large rivers) as well as the expert judgement (small and middle size lowland rivers) were used.

With regards to the classification method the reference values for phytoplankton have been developed for the lowland large rivers only. The metrics as the ratio of different groups of species, abundance and biomass were set by predictive modelling and expert judgement.

Fish reference values have been derived using virtual fish communities for each river type based on the historical knowledge and expert judgement.

Hungary:

Type-specific reference conditions for biological, physico-chemical and hydromorphological quality elements have been established using statistical analysis of the data from best available sites or of the historical data by some parameters/types (physico-chemical and phytoplankton data last 30 years in large and middle size rivers), additionally expert judgement.

Reference values and communities were defined type-specific for biological groups, based on multimetric indexes by phytoplankton, phytobentos, macroinvertebrates and RI index by macrophytes refer to adequate stressors with regards to the taxonomic composition (e.g. functional groups, ratio of sensitive/insensitive species, ratio of type-specific indicator species, diversity) and abundance.

Reference-conditions, type-specific species-composition, hydromorphological conditions and reference-values for indexes were presented in detail in the background document 5.1 of the RBMP (www.vizeink.hu) and Methodological Guidelines for biological elements.

Some river and lake-types have new datasets and reference conditions will be reviewed and complemented for this types and for fish group in the 2nd cycle of RBMP.

Croatia:

Type specific reference values for benthic invertebrates (saprobic index) have been defined in Regulation on Water Quality Standard

Slovenia:

Type-specific reference values were defined for each metric used in the ecological assessment system. Values were defined for metrics based on benthic invertebrates, phytobenthos and macrophytes and fish data. Different approaches were used to derive an ecological type specific reference value. Most often a spatial approach with reference sites was used, whereas in some lowland streams and large rivers a simple modelling approach in combination with expert judgement was used to derive reference values (e.g. extrapolation).

Type-specific hydromorphological values and physico-chemical values were defined for each parameter used in the ecological assessment system. Type-specific values were derived using spatial approach with reference sites, whereas for some rivers a simple modelling approach in combination with expert judgement was used to derive type-specific values.

Serbia:

To date, type-specific reference conditions have been developed for metrics that use benthic macroinvertebrate, algae (phytobenthos and phytoplankton) and aquatic macrophyte data. Reference conditions and values for particular indices were developed based on a combination of data derived from reference sites, best available sites, historical data and modeling, but also expert judgment. The indices used for developing reference conditions/values and the assessment system use both, taxonomical composition and taxa abundance of biological quality elements.

Bosnia and Herzegovina:

In Bosnia and Herzegovina the delineation of reference conditions has not been carried out yet.

Romania:

The description of reference conditions for rivers is based on reference values of metrics (multimetric indexes) for relevant quality elements. The following variables were used in Romania: diversity, EPT_I index, OCH index, IGF (functional groups index), number of families, REO/LIM index and type-specific values for the Saprobic index. For fish the EFI+ index has been applied. For phytobenthos Romania has defined type-specific reference values for number of taxa, diversity index, biological diatoms index (BDI), and for the Saprobic Index. For phytoplankton, type-specific reference values were set for the Saprobic index, chlorophyll "a", diversity index, numerical abundance of Bacillariophyceae Index and number of taxa.

Bulgaria:

The description of the reference conditions is generally based on reference values of the relevant metrics/indexes for each quality element. Type-specific reference values of assessment metrics were defined.

For macroinvertebrates the reference values for the assessment index (Biotic index) have been defined. The metrics included in the Biotic index are taxonomic composition and abundance.

For macrophytes - the Reference index (RI) is used. RI represents the ratio between type-specific sensitive species, dominant at reference conditions, to other species of macrophytes. In this way the assessment of the variations in macrophyte community at reference conditions can be performed.

For phytobenthos, the reference values for the IPS were defined. The values for high ecological status describe the reference conditions of the types. The index uses all occurring taxa (species) in the sample.

Fish fauna is being assessed according to - specific criteria and metrics specifically designed for the conditions in Bulgaria. There are type-specific criteria describing the reference conditions.

The values corresponding to high ecological status of all these metrics/indexes are being used for the description of the reference conditions. Type-specific reference values have been developed using the old data from reference sites (priority for the macroinvertebrates) as well as expert judgment

Moldova:

Moldova did not establish yet the type-specific biological reference conditions representing the values of the biological quality elements for a given surface water type at high ecological status. The preparatory work is ongoing.

Ukraine:

Setting of reference conditions has not been finalized yet.

3.1.2.3 Lakes

3.1.2.3.1 Lake types

The lake typologies were developed individually in the Danube countries. Four lakes have been selected for the basin-wide overview. These are situated in Austria, Hungary, Romania and Ukraine. Only one lake is transboundary in nature (see Table 6). More detailed information is provided in DBA 2004.

Table 7 indicates the lake types for lakes relevant on the basin-wide scale. All lake types are calcareous by geology and dominated by sandy and muddy substratum. They are all oblong in shape and very shallow. Lacul Razim / Razelm is less than 3 metres deep and has monomictic mixing characteristics. Neusiedler See / Fertő-tó is characterised as the last and most western member of the so-called steppe-type lakes in Europe. It has a mean water depth of 1.1 m and is holomictic. Lake Balaton is a very large steppe-type lake. It has a mean water depth of 3.6 m and is polymictic. A typological description of Ozero Ialpug is not available.

Table 7: Lakes selected for the basin-wide overview and their types

Lakes > 100 km²	Country(s)	Type of lake	Ecoregion	Altitude class	Depth class	Size class	Geology
Neusiedler See / Fertő-tó	AT, HU	large shallow, salinic steppe-type lake	11	lowland: < 200 m	< 3 m	> 100 km²	calcareous
Lake Balaton	HU	very large shallow steppe-type lake	11	lowland: < 200 m	3-15 m	> 100 km²	calcareous
Ozero Ialpug	UA	n.a.	12	n.a.	n.a.	> 100 km²	n.a.
Lacul Razim / Razelm	RO	lowland, very shallow, calcareous, very large lake type	12	lowland: < 200 m	< 3 m	> 100 km²	calcareous

3.1.2.3.2 Reference conditions

The reference conditions were developed individually by the countries. The methods most frequently applied were the use of historical data, expert judgement and spatially based methods. Hungary also used historical data and palaeo-reconstruction for phytoplankton and physico-chemical conditions to define reference conditions in its lakes.

A comparison of reference conditions reveals that similar approaches are being applied. All countries are basing their assessment on species composition, abundance and the diversity of species. In some cases, additional parameters were used (e.g. age structure, biomass, ratio of sensitive to insensitive species).

3.1.2.4 Transitional waters

"Transitional waters are bodies of surface water in the vicinity of river mouths, which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows" (Art. 2 (6) WFD). The transitional waters of the DRBD are located in Romania and Ukraine. No information on transitional water was received from Ukraine. On the Romanian coast of the Black Sea the lakes Razim and Sinoe are originally marine waters that have gradually been cut off from the Black Sea by sandbars. In the 1970s the remaining connection to the Black Sea has been closed through hydrological works. Today, Lake Sinoe is a transitional water (lagoon), which still receives marine water at very high tides. Lake Razim is no longer influenced by marine water and has turned into a freshwater lake. For the development of the typology of transitional waters System B was applied.

The transitional waters are differentiated into lacustrine and marine transitional waters (see Table 8). The marine transitional waters are strongly influenced by the Danube, which has an average discharge of about 6,500 m³/s. The freshwater of the Danube is generally transported southwards along the Romanian coast with the predominant southward coastal current. A detailed description of the transitional surface water types and their reference conditions are given in the National report of Romania.

Table 8: Types of transitional waters in the Danube River Basin District

Transitional water	Type
Lake Sinoe	Transitional lacustrine type
Black Sea coastal waters (northern sector) – Chilia mouth to Periboina	Transitional marine type

3.1.2.5 Coastal waters

The coastal waters of the DRBD are located in the coastal area of the Black Sea in Romania and Ukraine but no information on coastal water was received from Ukraine. For the development of the typology of coastal waters the System B was applied in Romania.

Two coastal water types have been defined for the coastal waters in the DRBD. A detailed description of the types as well as the definition of the reference conditions is given in the National report of Romania (Part B).

Table 9: Types of coastal waters in the Danube River Basin District

Coastal water	Type
Periboina – Singol Cape	Sandy shallow coastal water
Singol Cape – Vama veche	Mixed shallow coastal water

3.1.3 Identification of surface water bodies

59 water bodies have been identified on the Danube River, and 644 water bodies have been identified on the tributaries with catchments >4000km^2. Similar approaches for the delineation of water bodies in the Danube countries have been applied.

Water bodies were identified and updated based on the analysis of the pressures and monitoring data. The water bodies described here refer to the Danube River Basin District overview map (see Map 1), i.e. to those relevant on the basin-wide level. All other water bodies are dealt with in detail in the National Reports (Part B). Moldova has identified the preliminary number of the water bodies in the Danube River Basin District focussing on the Prut River Basin and in Ukraine the water bodies were identified in the Tisza basin. Bosnia and Herzegovina has not finalised the identification of water bodies.

3.1.3.1 Water bodies in rivers

59 water bodies have been identified on the Danube River. Two of these are shared by the Slovak Republic and Hungary, one is shared by Germany and Austria, one is shared by the Slovak Republic and Austria, two are shared by Serbia and Croatia, three by Serbia and Romania and one is shared by Bulgaria and Romania. The number of water bodies on the Danube varies per country, e.g. on the German part of the Danube 17 water bodies were delineated, on the Bulgarian part only one. This means that the size of the water bodies also varies significantly. The smallest water body on the Danube is only 7 km long, the longest is 487 km. Table 10 gives an overview of the number of water bodies identified on rivers. 644 water bodies have been identified on the tributaries on the overview scale.

Map 6 gives an overview of surface water bodies identified on the basin-wide level.

Table 11 gives an overview of the criteria used for the delineation of water bodies. A change in type is the most frequent reason for the separation of water bodies as well as a change in pressure, in particular a change in the degree of pollution. Also, changes in the hydrological regime and in morphology were frequently used criteria. From this table it is apparent that similar approaches for the delineation of water bodies in the Danube countries have been applied.

Table 10: Number of water bodies on rivers on the DRBD overview scale

	DE	AT	CZ	SK	HU	SI	HR	BA	RS	BG	RO	MD	UA
Danube River	17*	13*	0	4*	4*	0	2*	0	10*	1*	7*	na	1*
Tributaries	38	180	26	36	53	24	35	33	48	20	139	0	12**

* includes for the Danube transboundary water bodies shared by two countries (10 water bodies)

** Tisza basin catchment only

Table 11: Criteria for the delineation of water bodies in rivers

	DE	AT	CZ	SK	HU	SI	HR	BA	RS	BG	RO	MD	UA
Change in surface water category	x	x	x	x	x	-	x	x	x	x	x	x	x
Change in type	x	x	x	x	x	x	x	x	x	x	x	x	x
Change in pressure													
• pollution	x	x	x	x	x	x	-	-	x	x	x	x	x
• alteration of hydrological regime	x	x	x	x	x	x	-	x	x	x	x	x	x
• change in morphology	x	x	-	x	x	x	-	-	x	-	x	x	x
• fisheries	-	-	-	x	-	-	-	-	-	-	x	x	-

In Bavaria the delineation of water bodies was subject to a revision as part of the update of the river basin analysis. Adjustments were necessary for several reasons. As part of the general revision water bodies were adapted to fit with the new plan units relevant under the Floods Directive. In addition, adjustments were necessary due to newer information on pressures and impacts, including new monitoring results, as well as due to some changes in river types, which were necessary to improve the type-specific assessment of ecological status.

In Austria the re-delineation of water bodies is an ongoing process for adapting the planning instruments to new information and changes in pressures and ecological and chemical status.

The Czech Republic re-delineated the water bodies in 2011. The reason for the re-delineation of water bodies was an incorrect procedure of previous water body delineation which has caused heterogeneity in water body catchments.

Serbia retained the same water body delineation principles. The only change, originating from the national RBM Plan, is one additional water body on the Zapadna Morava River.

In Romania, the re-delineation of the SWBs, performed in 2013 for the scope of updating the Art. 5 Report, was based on the same criteria used in 2004. Even though most of the SWBs from the DRBM Plan 2009 remained unchanged, there were some changes made mainly due to grouping/merging or splitting of some water bodies and to updating/validation of the surface water typology.

The main reason of the re-delineation of the surface water bodies in Bulgaria was the update of the typology in 2010. Additionally some inappropriately delineated SWB were corrected and some large water bodies were split. The drinking water protected areas were delineated as separate water bodies. The updated pressure-impact analysis has been used as basis for the further re-delineation.

3.1.3.2 Water bodies in lakes

Lakes were generally delineated as one water body (Neusiedlersee / Fertő-tó, Lake Balaton, Lake Razim). The delineation of the water bodies for Lake Ialpug is not available.

3.1.3.3 Water bodies in transitional and coastal waters

Romania has delineated two transitional water bodies and two coastal water bodies in the DRBD. For all water bodies mainly the typology and changes in pressures were used for their delineation.

3.2 Groundwater

According to Article 2 of the EU Water Framework Directive (2000/60/EC) ‘Groundwater’ means all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil. An ‘Aquifer’ means a subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater. Finally, a ‘Body of groundwater’ means a distinct volume of groundwater within an aquifer or aquifers.

Such groundwater bodies are subject to analyses and reviews as required under Article 5 and Annex II of the WFD. This is the first review of the Art 5 report for DRBD.

3.2.1 Groundwater in the DRBD

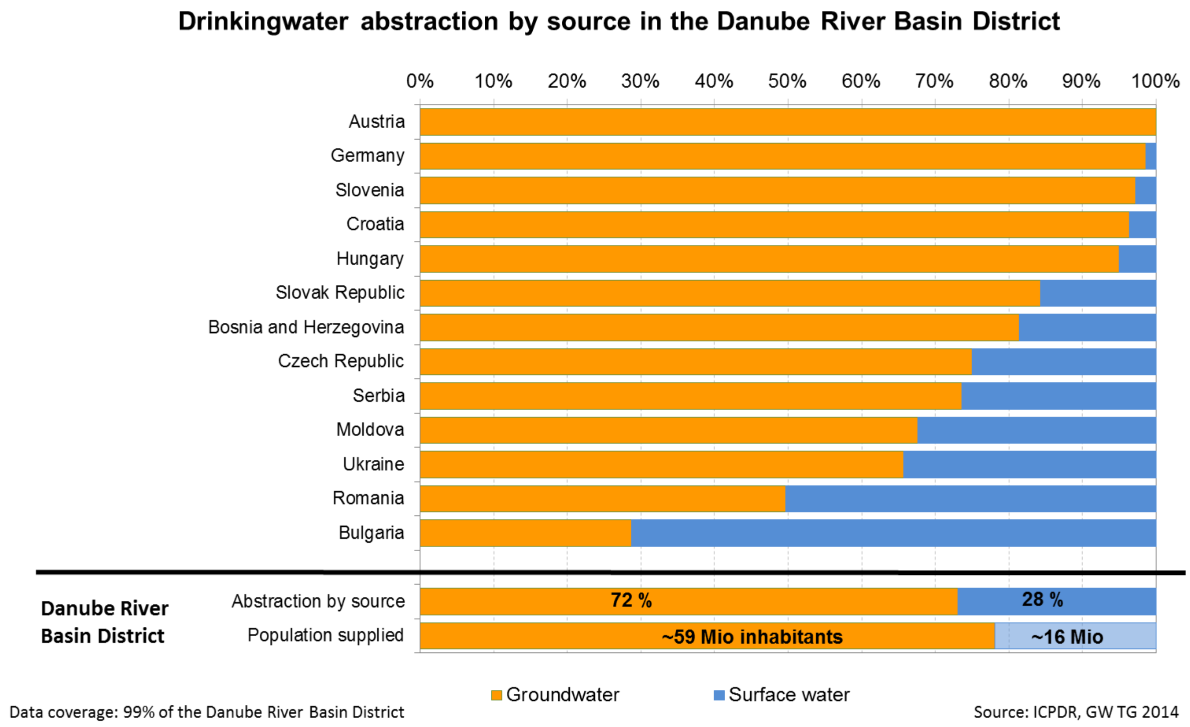
Groundwater in the Danube River Basin District is of major importance and is subject to a variety of uses with the main focus on drinking water, industry, agriculture, spa and geothermal energy purposes

A particular aspect reported by most countries is that shallow aquifers are at risk of pollution in the short as well as long term as a result of use of fertilizers and chemicals as well as untreated sewage and leaching from contaminated soils and waste deposits. In some cases, groundwater sources cannot be used without prior treatment.

The trends in water use have varying character. While in some countries a decrease in water use as a result of the process of economic transformation is still recorded in other countries a slight increase has been observed (SK). Still a decline persists in the agricultural sector. Whereas in the past, agriculture was the largest water user, today water use in the industry sector has the largest share. The water withdrawal by the domestic sector has either remained unchanged or has experienced a slight increase as a result of increase in access to piped water supply.

Groundwater is the major source of drinking water in the DRBD. Data from 13 countries covering 99% of the area of the DRBD indicate that about 72% of the drinking water in the DRBD is produced from groundwater, serving at least 59 Mio. of the 81 Mio. inhabitants. Around 28% of the drinking water is abstracted from surface water serving about 16 Mio. inhabitants. About 6 Mio. inhabitants are not assigned to an abstraction source.

Figure 6: Abstraction of drinking water by source in the Danube River Basin



Note: bank filtered water has been considered as groundwater. Source of data: ICPDR Groundwater Task Group

Due to the heterogenic situation in the DRBD (e.g. different hydrogeological, topographic, climatic, pressure and pollution conditions), the share of groundwater used for drinking water purposes in the single Danube countries is not uniform; it ranges from 30% (DRBD part of Bulgaria) to 100% (DRBD part of Austria).

Different hydrogeological characteristics add another level of complexity to GW resources. While many aquifers lie under the floodplains of large rivers, others do not correspond to surface water bodies, especially in the karstic regions of Austria, Slovakia, Slovenia, Croatia, Serbia and Montenegro. In the karst, groundwater flow is rapid and it is highly vulnerable to pollution.

3.2.2 Transboundary groundwater bodies of basin-wide importance

This report provides an overview of important transboundary groundwater bodies in the Danube River Basin. They are defined as follows:

- important due to the size of the groundwater body which means an area > 4000 km² or
- important due to various criteria e.g. socio-economic importance, uses, impacts, pressures interaction with aquatic ecosystem. The criteria need to be agreed bilaterally.

This means although there are other groundwater bodies with an area larger than 4000 km² and fully situated within one country of the DRB they are dealt with at the national level as they are not transboundary and not of basin wide importance. The link between the content of this report and the national reports is given by the national codes of the groundwater bodies. The importance of groundwater sources for associated ecosystems is dealt with in the national reports.

Currently information on 11 important transboundary groundwater bodies with eight countries concerned (Germany, Austria, Slovak Republic, Hungary, Serbia, Bulgaria, Romania and Moldova) is available (see Map 7). These GW bodies have been agreed by all countries sharing their parts. The exceptional case is GWB3 where the process of finalizing an agreement with MD is still ongoing under the bilateral agreement which cover both transboundary surface and ground waters.

Table 12 gives a list of the currently nominated and bilaterally agreed important transboundary groundwater bodies or groups of groundwater bodies with their key characteristics. The other groundwater bodies are dealt with in the national reports.

Table 12: Nominated important transboundary groundwater bodies or groups of groundwater bodies in the DRBD

GWB	Nat. part	Area [km²]	Aquifer characteristics		Main use	Overlying strata [m]	Criteria for importance
			Aquifer Type	Confined			
1	AT-1 DE-1	1,650 4,250	K	Yes	SPA, CAL	100-1,000	Intensive use
2	BG-2 RO-2	12,844 11,318	F, K	Yes	DRW, AGR, IND	0-600	> 4000 km²
3	MD-3 RO-3	9,662 12,531	P	Yes	DRW, AGR, IND	0-150	> 4000 km²
4	BG-4 RO-4	3,225 2,178	K, F-P	Yes	DRW, AGR, IND	0-10	> 4000 km²
5	HU-5 RO-5*	4,989 2,223	P	No Yes	DRW, IRR, IND	2-30	GW resource, DRW protection
6	HU-6 RO-6*	1,035 1,456	P	No Yes	DRW, AGR, IRR	5-30	GW resource, DRW protection
7	HU-7 RO-7 RS-7	7,098 11,393 10,506	P	No Yes Yes	DRW, AGR, IND, IRR	0-125	> 4000 km², GW use, GW resource, DRW protection
8	HU-8 SK-8	1,152 2,211	P	No	DRW, IRR, AGR, IND	2-5	GW resource, DRW protection
9	HU-9 SK-9	750 1,466	P	Yes	DRW,IRR	2-10	GW resource
10	HU-10 SK-10	492 598	K K, F	No Yes	DRW, OTH	0-500	DRW protection, dependent ecosystem
11	HU-11 SK-11	3,248 563	K F, K	No Yes	DRW, SPA, CAL	0-2,500	Thermal water resource

* ... GWBs overlying

Description

Area	Whole area of transboundary groundwater body covering all countries concerned in km²
Aquifer characterisation	Aquifer Type: Predom. **P** = porous/ **K** = karst/ **F** = fissured. Multiple selections possible: Predominantly porous, karst, fissured and combinations are possible. Main type should be listed first. Confined: **Yes** / **No**
Main use	**DRW** = drinking water / **AGR** = agriculture / **IRR** = irrigation / **IND** = Industry / **SPA** = balneology / **CAL** = caloric energy / **OTH** = other. Multiple selections possible.
Overlying strata	Indicates a range of thickness (minimum and maximum in metres)
Criteria for importance	If size < 4 000 km² criteria for importance of the GW body have to be named, they have to be bilaterally agreed upon.

Criteria for delineation: The most frequent method applied for the delineation of the groundwater bodies is based on geological boundaries in combination with a hydrogeological approach. In some countries other criteria like importance for water supply, groundwater quality, water temperature or surface water catchment areas were additionally taken into account.

Geological overview: Limestone, sandstone, gravel and boulders and permeable fluvial sediments are the main components of the aquifers of the important transboundary groundwater bodies. Due to the different geological formations, the corresponding hydraulic conductivity of the aquifers, and the varying permeability of the overlying strata the aquifers are more or less protected. Geothermal groundwater bodies in limestone formations are also reported.

The majority of the reported aquifers are porous aquifers (6 out of 11). One groundwater body is stated as a karst aquifer whereas the rest is defined by a combination of karst, fissured and porous characteristics. Four groundwater bodies are confined and two bodies are not overlain by impervious or almost impervious formations. The remaining five groundwater bodies show both variations as they are situated in different horizons. The different kinds of the overlying strata reflect the geological formation of the aquifers. High permeable layers are also present as well as very impervious layers. While the geothermal groundwater bodies are covered by overlying strata up to 2,500 m the aquifers in the fluvial sediments have almost no overlying strata. For 5 out of the 11 groundwater bodies the overlying strata ranges only from 0 to 60 metres. Some parts of groundwater bodies of basin-wide importance are overlying each other in the vertical plane.

Groundwater use: For the majority of the important transboundary groundwater bodies main uses of groundwater are drinking water purposes followed by the use for agriculture and industry. Six bodies show the coexistent main uses of drinking water purposes and agriculture and five out of these six show them in combination with the main use for industry. However, in some of the groundwater bodies irrigation, spa and caloric energy are the main uses.

Criteria for selection as 'important': The importance as groundwater resource and/or drinking water protection purposes are the most common criteria for the nomination (seven out of 11 bodies) of the groundwater bodies. The size-criterion which defines a transboundary groundwater body with an area > 4000 km² as important is the determining factor for four bodies. Intensive use, ecological criteria and geothermal potential were also listed as relevant criteria for defining the importance of a transboundary groundwater body.

4 Significant pressures identified in the DRBD

Human activities and needs such as agricultural activities, transportation, energy production or urban development exert pressures on the water environment which are in need to be assessed for the management of the river basin and for taking decisions on adequate measures for addressing and reducing these pressures. The WFD requires information to be collected and maintained on the type and magnitude of significant anthropogenic pressure. When addressing pressures on the DRB at the basin-wide scale, it is clear that cumulative effects may occur (this is one reason why the basin-wide perspective is needed). Effects can occur both in a downstream direction (e.g. pollutant concentrations) and/or a downstream to upstream direction (e.g. river continuity). Addressing these issues effectively requires a basin-wide perspective and cooperation between countries.

In preparation of the 1st DRBM Plan and based on the Danube Basin Analysis 2004, Significant Water Management Issues were identified for the DRBD which represent pressures having a significant impact on the basin-wide level. This chapter addresses each of the significant pressures on concerning surface waters, addresses groundwater issues and includes revised information since the 1st DRBM Plan. Some activities with only local effects will not be discussed in this report and are subject to National Reports.

4.1 Surface waters: rivers

4.1.1 Organic pollution

4.1.1.1 General considerations

Sources and pathways of organic pollution

Organic pollution refers to emissions of non-toxic organic substances that can be biologically decomposed by bacteria to a high extent. The key emitters of organic pollution are point sources. Collected but untreated municipal waste water that discharge organic substances from households and industrial plants connected to the sewer systems are the most important contributors. Significant organic pollution can also be generated by waste water treatment plants of agglomerations without appropriate treatment. Direct industrial dischargers and animal feeding and breeding lots are other important point sources if their waste water is insufficiently treated.

Diffuse organic pollution is less relevant and related to polluted surface run-off from agricultural fields (manure application and storage) and urban areas (e.g. litter scattering, gardens, animal wastes). A specific case of diffuse organic pollution is the emission from combined sewer overflows that represent a mixture of polluted run-off water and untreated waste water. Background emissions of organic substances are related to sediment input arising from soil erosion, surface run-off from naturally covered land and groundwater flow.

Water quality impacts of organic pollution

The primary impact of organic pollution on the aquatic environment is the influence on the dissolved oxygen balance of the water bodies. Significant oxygen depletion can be experienced downstream of pollution sources mainly due to biochemical decomposition of organic matter. Microorganisms consume oxygen available in the water bodies for the breakdown of organic compounds to simple molecules. However, dissolved oxygen concentrations are increasing again once the oxygen enrichment rate via diffusion from the atmosphere and photosynthesis ensured by algae and macrophytes is higher compared to the consumption rate.

Due to the self-purification capacity of water bodies the water quality impacts of a particular source are mostly local. The decrease in oxygen concentration and the length of the affected downstream river section depend on the amount of the organic matter received, the treatment degree of the waste water, the dilution rate and the hydraulic conditions of the recipient. The affected river length usually ranges from several tens to hundreds of kilometres downstream of the source. Decreased oxygen content may seriously affect aquatic organisms especially sensitive species that can be damaged or killed even at low fluctuations in oxygen concentration.

In the most severe cases of oxygen depletion anaerobic conditions might occur, to which only some specific organism can accommodate. Additional impacts of anaerobic conditions could be the formation of methane and hydrogen sulphide gases and dissolution of some toxic elements. Organic pollution can be associated with by the health hazard due to possible microbiological contamination. The usual indicators of organic pollution are biochemical oxygen demand, chemical oxygen demand, total organic carbon, Kjeldahl-nitrogen (organic and ammonium-nitrogen) and coliform bacteria. Secondary (biological) waste water treatment and runoff management practices provide adequate solutions to the organic pollution problem.

4.1.1.2 Organic pollution from urban waste water

According to the recent reporting of the Danube countries on the status of waste water treatment (Annex 1, for the EU MS this is in line with the obligatory data submission for the reference year 2009/2010 to the Commission under the UWWTD) there are 6,152 agglomerations with a population equivalent (PE, the ratio of the total daily amount of BOD produced in the agglomeration to the amount generated by one person at the same time) more than 2,000 in the basin (Table 13). 78% (4,790) of these agglomerations are small sized settlements having a PE between 2,000 and 10,000, 20% are between 10,000 and 100,000 PE whilst only 2% (129) have a PE higher than 100,000. However, almost half (43%) of the generated total waste water load stems from the big agglomerations indicating the necessity to use appropriate treatment technologies in these cities. In total, a waste water load of about 91 Mio. PE is generated in the basin. Despite the high number of small agglomerations they have the smallest contribution (22%) to the total loads, whilst middle-sized agglomerations produce about one-third of the loads. Regarding the discharges of the organic substances into the river systems, about 280,000 tons per year BOD and 670,000 tons per year COD are released from the agglomerations with more than 2,000 PE throughout the basin (Table 14). The ratio of COD to BOD of about 2.4 indicates a considerable fraction of biodegradable organic matter being still released.

The proportion of the agglomerations without collection system is relatively high (41%, Figure 7 left). These are mainly small-sized settlements with PE between 2,000 and 10,000. There is no agglomeration without collection system in the class higher than 100,000 PE and only a few percent can be found in the middle class where sewer systems are missing. Ten percent of the agglomerations have constructed public sewerage but are not connected to urban waste water treatment plants (the agglomeration classes have similar proportion). On basin-wide level, half of the agglomerations with PE higher than 2,000 have already connection to operating treatment plants. Majority of the middle-sized and big settlements discharges municipal waste water into the recipients after treatment is applied (84% and 90%, respectively). However, waste water is conveyed to treatment plants at only 42% of the small-sized agglomerations. Regarding the treatment stages 4% of the agglomerations are only served by primary (mechanical) treatment. The proportion of the secondary (biological) treatment is 19%, out of which 10% represent only partial treatment where less than 80% of the generated PE are transported to the treatment plants (the rest is either not collected or differently treated). Waste water at 27% of the settlements undergoes tertiary treatment aiming to remove nutrients besides organic matter. In the class of small agglomerations the share of the secondary and tertiary treatment is 18% and 20%, respectively. In the upper classes (>10,000 PE) where nutrient removal is either obligatory (EU MS) or recommended (Non-EU MS) these respective figures are 27% and 54% for the middle-sized settlements, whilst 26% and 60% for the big ones.

The distribution of the agglomerations according to their size and connection to treatment plants clearly influences that of the generated loads (Figure 7 right). Only 11% of the generated loads arise from settlements having no sewerage. Additional 13% can be linked to agglomerations with collection systems but without treatment. The majority (76%) of the loads stems from agglomerations already connected to urban waste water treatment plants. Fourteen percent out of it are produced in agglomerations with partial treatment. Three percent of the loads are only related to primary treatment, the loads are mainly transported to either secondary (23%) or tertiary (50%) phases. Considering the BOD and COD discharges (Table 14 and Figure 8), significant fractions of the total discharges (67%

and 57%, respectively) stem from the collected but untreated waste water amounts. The secondary treatment class produces 18% of the BOD and 21% of the COD discharges. Plants with tertiary treatment emit 8% (BOD) and 15% (COD) of the total releases due to their very high elimination rates (over 95%). Despite the smaller waste water amounts subject to primary treatment, its share in the discharges are higher (BOD: 7%, COD: 7%) due to the limited treatment efficiency.

Table 13: Number of agglomerations and generated urban waste water loads in the Danube Basin (reference year: 2009/2010)

Type of treatment	Number of agglomerations	Generated load (PE)
Collected and tertiary treatment	1,560	43,940,890
Collected and partial tertiary treatment	79	1,403,956
Collected and secondary treatment	566	11,175,883
Collected and partial secondary treatment	619	10,043,286
Collected and primary treatment	36	1,322,018
Collected and partial primary treatment	211	1,600,151
Collected and no treatment	589	12,169,385
Not collected and not treated	2,492	9,773,912
Total	**6,152**	**91,429,480**

Figure 7: Share of the collection and treatment stages in the total number of agglomerations and total population equivalents in the Danube Basin (reference year: 2009/2010); left: agglomerations, right: population equivalents.

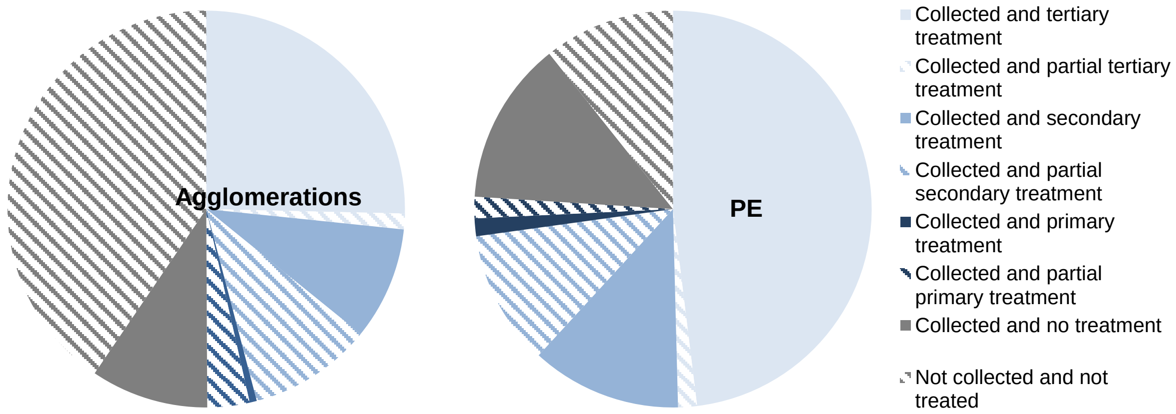
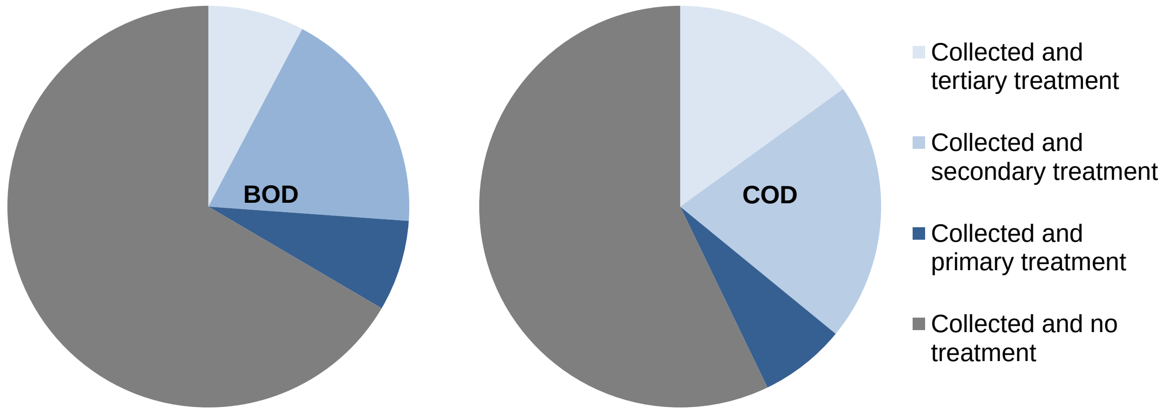


Table 14: BOD and COD discharges via urban waste water in the Danube Basin (reference year: 2009/2010)

Type of treatment	Discharge	
	BOD (t/year)	COD (t/year)
Collected and tertiary treatment	21,759	100,298
Collected and secondary treatment	51,742	139,163
Collected and primary treatment	20,566	46,219
Collected and no treatment	187,158	381,069
Total	**281,224**	**666,749**

Figure 8: Share of the collection and treatment stages in the total population equivalent and total organic pollution of surface waters via urban waste water in the Danube Basin (reference year: 2009/2010); left: BOD discharge, right: COD discharge



Country contributions to the basin-wide generated loads and BOD discharges as well as the proportions of the treatment and collection stages are presented in Figure 9 and Figure 10. The collection and treatment of waste water are at highly enhanced status in the upstream countries, at good conditions in some countries in the middle-basin whilst significant proportions of the generated loads are not collected or collected but not treated in the downstream states. As a consequence, the BOD discharges of the new EU MS and the non-EU MS (except Ukraine) are substantially determined by untreated waste water releases. Hungary, Slovenia, Croatia, Bosnia and Herzegovina, Serbia, Romania and Bulgaria have still great potential to reduce organic pollution of the surface waters in the Danube Basin by introducing at least biological treatment technology.

Figure 9: Share of the collection and treatment stages in the total population equivalents in the Danube countries (reference year: 2009/2010, absolute numbers on the top refer to PE)

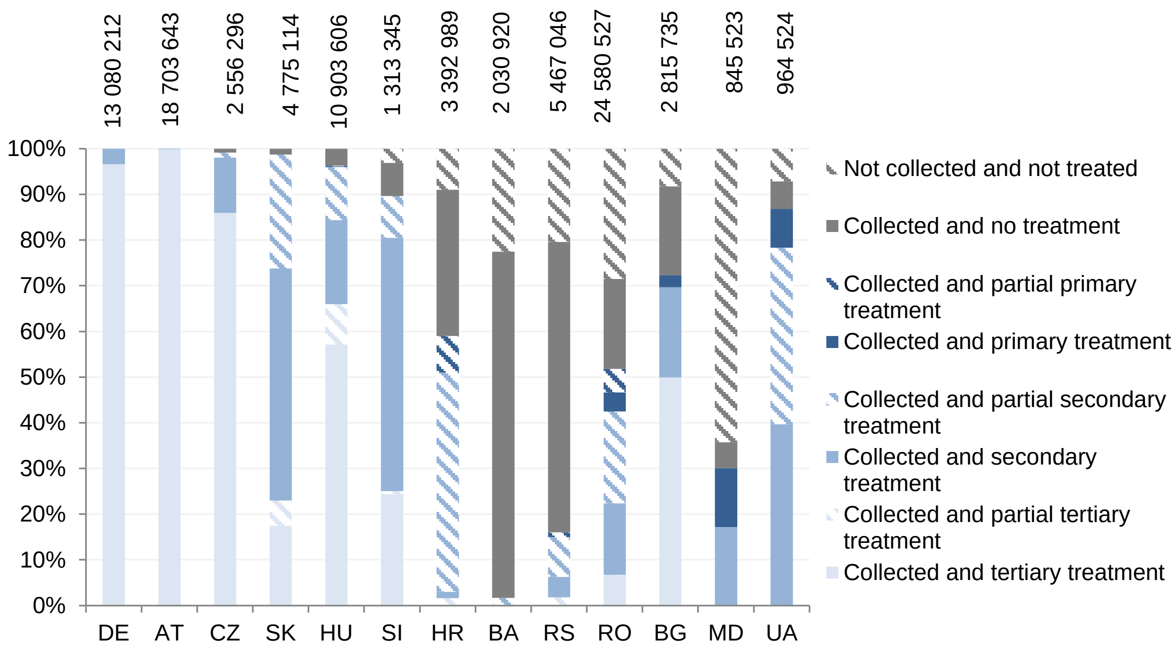
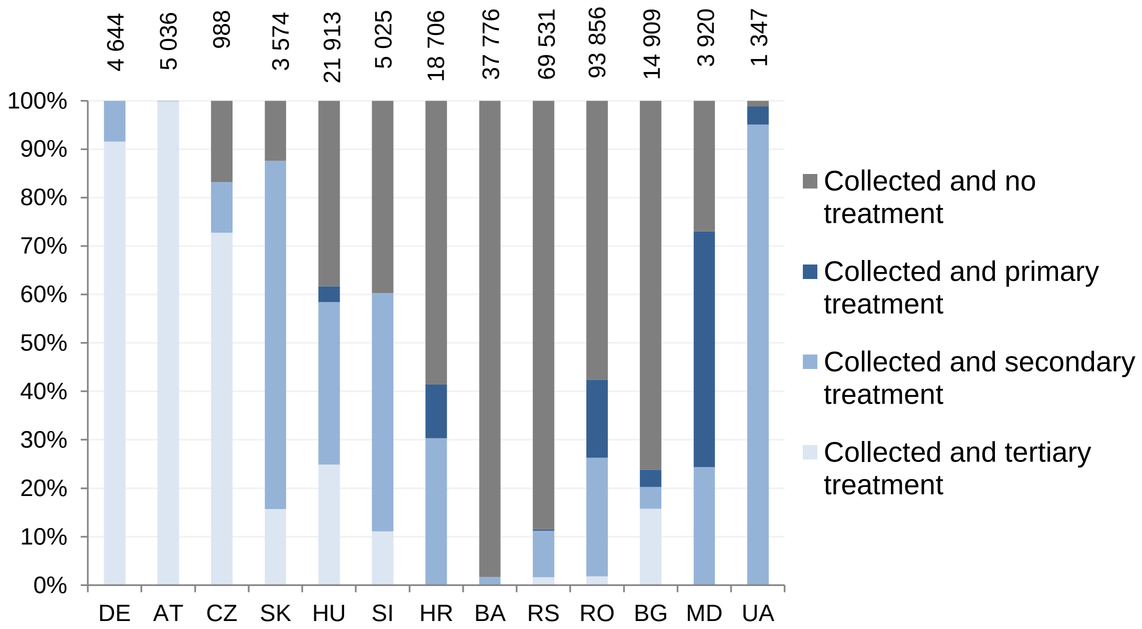


Figure 10: Share of the collection and treatment stages in the total organic pollution of the surface waters via urban waste water in the Danube countries (reference year: 2009/2010, absolute numbers on the top refer to tons BOD per year)



4.1.1.3 Organic pollution via direct industrial discharges and agricultural point sources

Data for the industrial and agricultural direct dischargers were derived from the E-PRTR database which contains the main industrial facilities and their discharges over the emission level of 50 tons TOC per year (Annex 2, reference year 2010/2011). In total, 6 main industrial sectors were reported by the countries being relevant direct discharging activities in the basin. Out of these, the chemical industry (37%), the paper and wood processing (32%) and the food and beverage sector (18%) are the most important fields in terms of organic pollution (Figure 11). In the reference year (2010/2011) some 16,500 tons per year organic substances expressed in TOC were released (Table 15) that approximately equal to 50,000 tons per year of COD discharge. The type of activities, their total releases and proportions are differing among the countries. Germany, Slovakia, Hungary, Serbia and Romania contribute the highest TOC discharges via industrial activities (Figure 12). Czech Republic, Croatia, Bosnia and Herzegovina, Moldova and Ukraine have no facilities reported over the given release threshold.

Table 15: Organic pollution via direct industrial discharges in the DRBD according to different industrial sectors (reference year: 2010/2011)

Activities	Releases to water TOC (t/year)
Energy sector	1,655
Production and processing of metals	564
Chemical industry	6,089
Paper and w ood production and processing	5,290
Intensive livestock production and aquaculture	66
Products from the food and beverage sector	2,925
Total	**16,589**

Figure 11: Share of the industrial sectors in the total organic pollution via direct industrial discharges in the Danube Basin (reference year: 2010/2011)

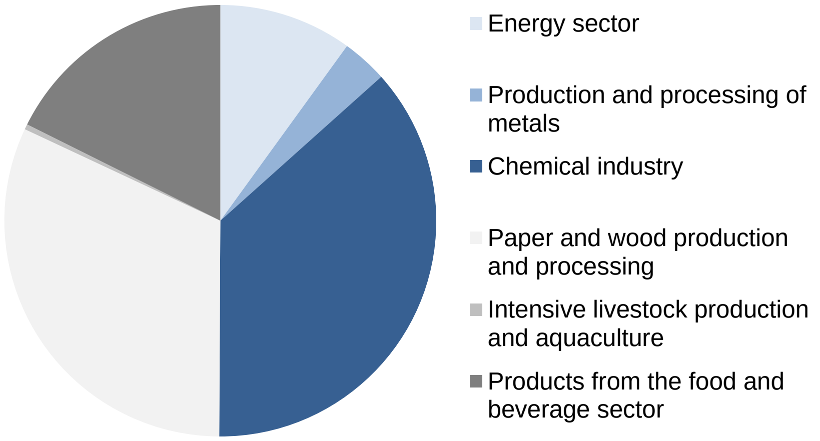
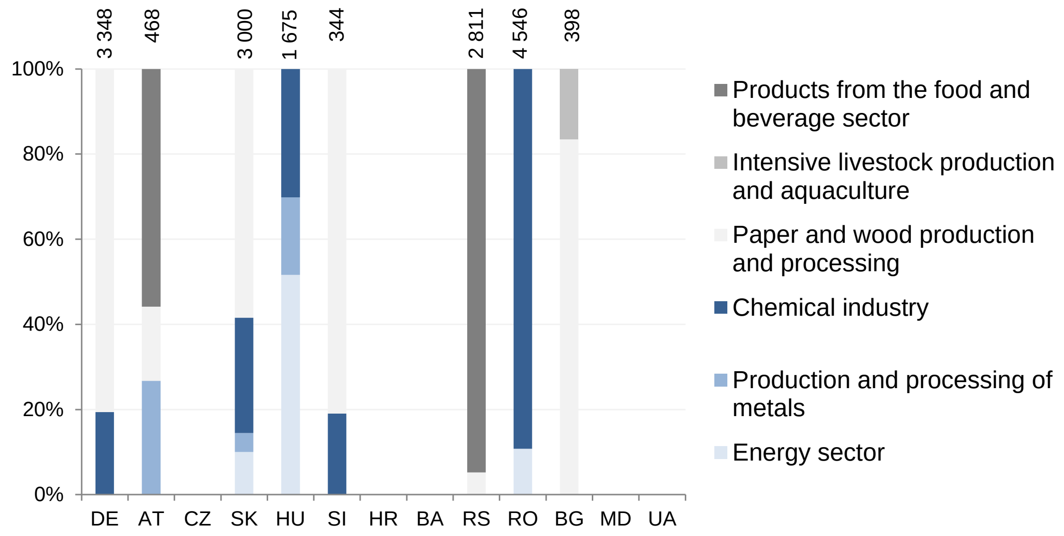


Figure 12: Share of the industrial sectors in the total organic pollution via direct industrial discharges in the Danube countries (reference year: 2010/2011, absolute numbers on the top refer to tons TOC per year)



4.1.1.4 Addressing pressures by the implementation of the Joint Program of Measures 2009-2015

The Danube countries committed themselves in the DRPC, inter alia, to implement measures to reduce the pollution loads entering the Black Sea from sources in the Danube River Basin. The 1st DRBM Plan included major efforts for the improvement of the urban waste water and industrial sector by upgrading or constructing sewer systems and waste water treatment plants as well as introducing Best Available Techniques (BAT) at the main industrial facilities. Management activities are legally determined for the EU Member States (EU MS) through several EU directives. The Urban Waste Water Treatment Directive (UWWTD) specifically focuses on the sewer system and waste water system development. EU MS are obliged to establish sewer systems and treatment plants at least with secondary (biological) treatment or equivalent other treatment at all agglomerations with a load higher than 2,000 PE (also for agglomerations smaller than 2,000 PE appropriate treatment must be ensured). This must have been finished till 2005 in the EU MS, even though the new EU MS have a longer transition period to fulfil the requirements (e.g. Romania till 2018). EU MS must report their activities in the waste water sector to the Commission that makes them transparent to the public through the Waterbase information system. Non-EU MS also make efforts to achieve significant improvements.

They are constructing a specific number of sewer systems and waste water treatment plants till 2015 that is realistically executable.

Organic pollution stemming from industrial facilities and large farms is also addressed by the Danube countries. For EU MS the Industrial Emissions Directive (IED, repealing inter alia the Integrated Pollution Prevention and Control Directive (IPPCD) by the 7th of January 2014) dictates that authorities need to ensure that pollution prevention and control measures at the major industrial units are up-to-date with the latest Best Available Techniques (BAT) developments. The industrial plants covered by the Directive must have a permit with emission limit values for polluting substances to ensure that certain environmental conditions are met. Application of BAT in the large industrial and agro-industrial facilities was mandatory in EU MS till the end of 2007, with a gradual transition period for some new EU MS. It is expected that all relevant facilities in the EU MS will meet the IED requirements according to the legal deadlines. Reporting is also obligatory, information on these industrial facilities must be available for the public. For this purpose, emission data of facilities from different industrial sectors and over a certain capacity threshold have to be uploaded to the European Pollutant Release and Transfer Register (E-PRTR). Application of BAT is recommended for Non-EU MS, especially for some special industrial sectors, like chemical, food, chemical pulping and papermaking industry. For these sectors ICPDR elaborated supplying documents that recommend appropriate BAT. Other Directives like Nitrate Directive (ND) and Sewage Sludge Directive (SSD) that respectively concern the fate of nutrients and hazardous substances have also benefits for organic pollution reduction. Regulation of the manure and sewage sludge application at the agricultural fields positively affects the diffuse organic pollution as well reducing organic matter available at the fields for run-off and sediment transport. Similar regulatory actions are recommended for the Non-EU MS.

4.1.1.5 Summary and outlook

At the basin scale, the urban waste water sector generates about 280,000 tons per year BOD and 670,000 tons per year COD discharges into the surface water bodies of the Danube Basin (reference year: 2009/2010). The direct industrial emissions of organic substances total up to ca. 50,000 tons per year COD for the reference year (2010/2011). This means an overall COD emissions of 720,000 tons per year, out of which 93% are released by the urban waste water sector.

Comparing the actual figures of the waste water sector to those of the 1st DRBM Plan, remarkable reduction of the organic pollution can be recognised according to the reported data. For the reference year (2005/2006) of the first DRBM Plan 480,000 tons per year BOD and 1,040,000 tons per year COD pollution were reported via urban waste water discharges (excluding the agglomerations without collection system and therefore without direct discharges into surface waters). The recently reported emissions are significantly lower, the BOD and COD discharge reduction rates are 41% and 36%, respectively. The reported industrial emissions also decreased by about 60% in comparison to the reference year (2006) of the first DRBM Plan.

In the first management cycle significant investments have been made in the field of organic pollution control in the Danube River Basin District (DRBD) resulting in considerable reduction of organic pollution. This progress also contributes to achieve the UN Millennium Development Goals in the field of sanitation by providing access to sanitation for the urban population. However, additional measures should be taken in the future. According to the presented assessments and the recent 7th Implementation Report of the UWWTD, the new EU MS have a considerable delay in the implementation of the UWWTD mainly due to financial limitations. Another issue of concern is the lack of compliance in a significant number of big agglomerations. The objectives of the 1st DRBM Plan were related to the accession treaty obligations of the new EU MS which were rather optimistic. Thus, the progress achieved is slower than it was originally planned and the objectives will probably be accomplished with a delay as the implementation of the respective measures is lagging behind in many countries. The transition period obtained by some EU MS for the implementation of the UWWTD requirements was considered as a funding prioritisation criterion (i.e. Romania: most agglomerations between 2,000 and 10,000 PE will be in line with the UWWTD provisions after 2015, with a transition period until 2018, and therefore the agglomerations with more than 10,000 PE have a higher priority). Therefore, continuation of the developments in the urban waste water sector is necessary.

For the 2nd DRBM Plan, further measures to achieve the ICPDR's basin-wide vision for organic pollution should be identified and implemented. Ensuring integration of the implementation of the WFD, UWWTD and IED in EU MS and supporting Non EU MS to achieve progress is a challenge in the Danube River Basin and it should be further observed and managed. For Non EU MS, further efforts should be made to continuously implement and update BAT in the chemical, food, chemical pulping and papermaking industrial facilities or to develop new ones.

Realistic planning of investments is needed in line with the WFD/DRBM Plan requirements and funding availability. Efforts are needed to reinforce the capacity of the countries to identify and prepare environmental investment projects, and to improve access to good practice studies with the aim of facilitating the development of investment projects.

4.1.2 Nutrient pollution

4.1.2.1 General considerations

Sources and pathways of nutrient pollution

Nutrient pollution is caused by significant releases of nitrogen (N) and phosphorus (P) into the aquatic environment. Nutrient emissions can originate from both point and diffuse sources. Point sources of nutrient discharges are highly interlinked to those of the organic pollution. Municipal waste water treatment plants with inappropriate technology, untreated waste water, industrial enterprises, animal husbandry can discharge considerable amounts of nutrients into the surface waters besides organic matter. Diffuse pathways, however, have higher importance considering nutrients. Direct atmospheric deposition, overland flow, sediment transport, tile drainage flow and groundwater flow can remarkably contribute to the emissions into rivers, conveying nutrients from agriculture, urban areas, atmosphere and even from naturally covered areas.

The importance of the pathways for diffuse pollution is different for N and P. For N, urban run-off and groundwater flow are the most relevant diffuse pathways. In case of P, groundwater is usually replaced by sediment transport generated by soil erosion. Regarding the sources, agriculture plays a key role due to the significant nutrient surpluses of the cultivated soils caused by inappropriate agricultural practices. Agglomerations with sewer systems but without connection to treatment plant having nutrient removal technology and combined sewer overflows are important urban sources. Deposition from the atmosphere is especially relevant for N as many combustion processes and agricultural activities produce N gases and aerosols that can be subject to deposition. The role of background fluxes is often overlooked even though they might have significant regional contribution especially from poorly covered areas, mountainous catchments or glaciers.

Water quality impacts of nutrient pollution

Impacts on water status caused by nutrient pollution can be recognized through substantial changes in water ecosystems. The natural aquatic ecosystem is sensitive to the amount of the available nutrients which are limiting factors. In case of nutrient enrichment the growth of aquatic algae and macrophytes can be accelerated and water bodies can be overpopulated by specific species. Many lakes and seas have been suffering from eutrophication that severely impairs water quality and ecosystem functioning (substantial algae growth and consequently oxygen depletion, toxicity, pH variations, accumulation of organic substances, change in species composition and in number of individuals) as well as limits or hinders human water uses (recreation, fisheries, drinking water supply). Even though river systems, floodplains and reservoirs can retain nutrients during their in-stream transport (e.g. denitrification, uptake, settling), significant amounts of them can reach lakes and even seas, transposing water quality impacts far downstream from the sources. Therefore, nutrient pollution is clearly a Danube-basin wide problem.

Control of point source nutrient emissions is closely linked to that of the organic pollution and requires nutrient removal at the waste water treatment plants. The management of diffuse nutrient emissions is a challenging task due to their temporal and spatial variability and strong relation to hydrology. Since the diffuse emissions are almost immeasurable at source, catchment-scale assessments and water quality modelling are widely used to help in dealing with the issue. Management actions usually concern a wide range of agricultural best management practices and their combinations. Recovery of an eutrophic water body following management efforts especially on diffuse sources of pollution can take longer time (even several decades) due to the time delay of several contributing pathways (e.g. nitrogen loads via groundwater) and the stored nutrients in the bottom sediments that can re-enter water body (e.g. phosphorus internal loads of lakes). Typical parameters related to nutrient pollution are total nitrogen, dissolved inorganic nitrogen, total phosphorus, orthophosphate-phosphorus and chlorophyll-a.

4.1.2.2 Point source nutrient emissions

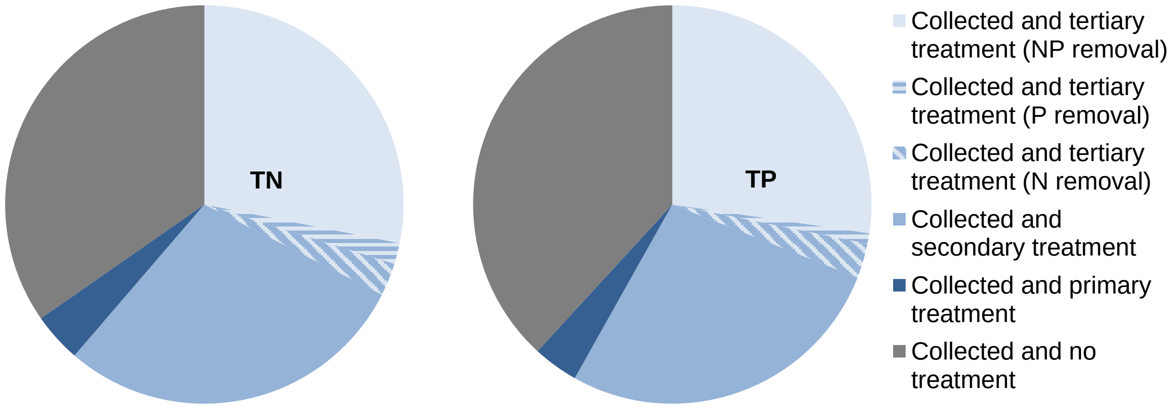
In total, 1,639 agglomerations with a PE of about 45 million are equipped with tertiary treatment aiming nutrient removal in the basin (Annex 1, reference year: 2009/2010). Majority of them (80%) addresses the elimination of both nutrients. Out of the 1,362 agglomerations with a size over 10,000 PE 717 agglomerations (53%) have tertiary technology. In terms of PE, the overall load generation at these agglomerations is 70 million PE, 59% of this load (41 million PE) is subject to nutrient removal.

At the basin scale 104,000 tons per year TN and 16,000 tons per year TP are emitted into the surface waters from the waste water collection and treatment facilities (Table 16). 35% (TN) and 38% (TP) of the emissions can be linked to untreated waste water discharged directly into the recipients (Figure 13). About 4% of the nutrient releases stem from plants having mechanical treatment, whilst the proportion of the waste water treatment plants with secondary treatment is 29% (TN) and 27% (TP). Some 32% and 31% of the nutrient emissions are discharged from plants with stringent technologies. Regarding the upper agglomeration classes (above 10,000 PE), 63% (nitrogen) and 71% (phosphorus) of the nutrient emissions are related to less stringent technologies indicating that further improvement of the treatment at these settlements can significantly reduce the nutrient discharges at the basin scale.

Table 16: Nutrient pollution of surface waters via urban waste water in the Danube Basin (reference year: 2009/2010)

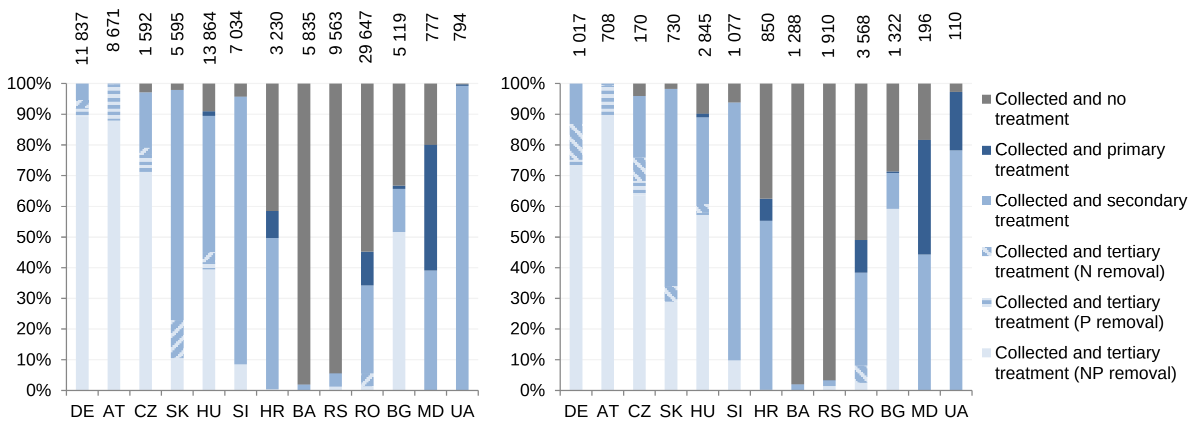
Type of treatment	Discharge	
	TN (t/year)	TP (t/year)
collected and tertiary treatment (NP removal)	29,138	4,314
collected and tertiary treatment (P removal)	1,770	133
collected and tertiary treatment (N removal)	2,750	447
collected and secondary treatment	29,870	4,289
collected and primary treatment	4,158	582
collected and no treatment	35,942	6,028
Total	**103,627**	**15,793**

Figure 13: Share of the collection and treatment stages in the total nutrient pollution of surface waters via urban waste water in the Danube Basin (reference year: 2009/2010); on the left: TN, on the right: TP



Country performances are presented in Figure 14. The variation at the country level is similar to the situation discussed by the organic pollution. Upstream countries have only limited possibilities as they have already introduced nutrient removal at the vast majority of the agglomerations, even for the smaller sized settlements. Middle and downstream countries can, however, remarkably enhance the overall treatment status of the plants, particularly at the agglomerations over 10,000 PE, where the introduction of the tertiary treatment technologies is lagging behind.

Figure 14: Share of the collection and treatment stages in the total nutrient pollution via urban waste water in the Danube countries (reference year: 2009/2010); on the left: TN, on the right: TP (absolute numbers on the top refer to tons TN and TP per year)



Regarding the industrial discharges, the main sectors with nutrient pollution have been reported (Annex 2, reference year: 2010/2011) by the countries are the same as those of the organic pollution. In total, 4,700 tons per year nitrogen and 170 tons per year phosphorus were released in the reference year (Table 17). For the nitrogen, the chemical industry has the highest importance emitting almost 60% of the total discharges (Figure 15). Besides this, energy sector, metal industry and livestock farming are remarkable contributors. In case of phosphorus, metal industry is not relevant whilst all other sectors have significant proportions in the total discharge amounts. Again, chemical industry has the highest share with 30%. The reported industrial emissions are relatively small in comparison to those of the urban waste water, only 5% (TN) and 1% (TP) of the waste water discharges are emitted via industrial facilities. Releases from the chemical industry are mainly relevant in the upstream and middle countries (Figure 16), whilst food and paper industry become important downstream. Slovakia, Hungary and Romania produce the highest direct industrial emissions.

Table 17: Nutrient pollution of surface waters via direct industrial waste water discharges in the DRB (reference year: 2010/2011)

Activities	Releases to water	
	TN (t/year)	TP (t/year)
Energy sector	391	28
Production and processing of metals	467	-
Chemical industry	2,677	49
Paper and w ood production and processing	311	21
Intensive livestock production and aquaculture	692	36
Products from the food and beverage sector	170	39
Total	**4,708**	**174**

Figure 15: Share of the industrial activities in the total nutrient pollution via direct industrial waste water discharges in the Danube Basin (reference year: 2010/2011); on the left: TN, on the right: TP

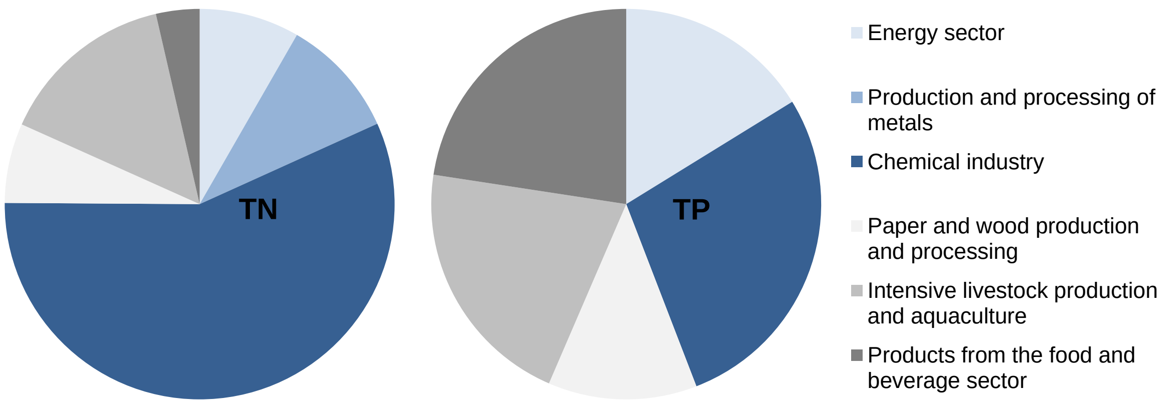
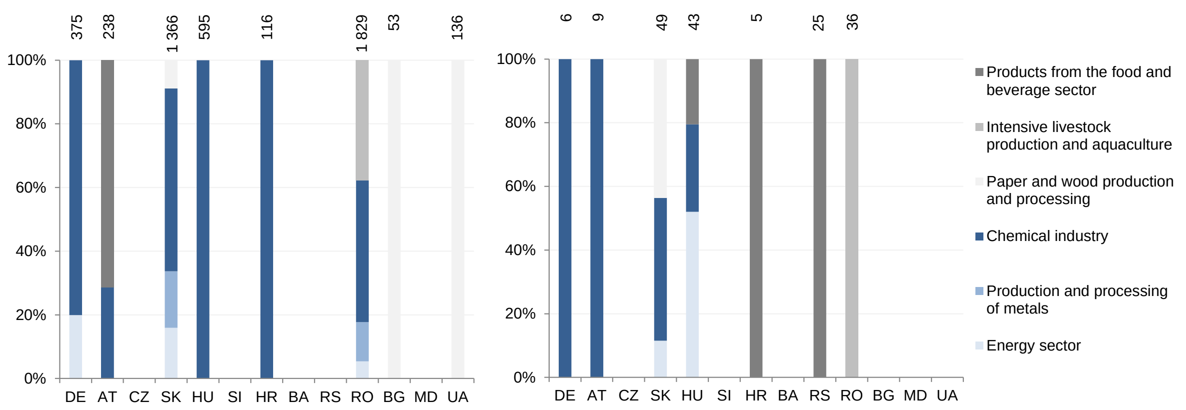


Figure 16: Share of the industrial activities in the total nutrient pollution via direct industrial waste water discharges in the Danube countries (reference year 2010/2011); on the left: TN, on the right: TP (absolute numbers on the top refer to tons TN/TP per year)



4.1.2.3 Diffuse nutrient emissions

To estimate the spatial patterns of the nutrient emissions in the basin and assess the different pathways contributing to the total emissions, the MONERIS model (Venohr et al., 2011) was applied for the entire basin and for long-term average hydrological conditions (2000-2008). The model is an empirical, catchment-scale, lumped parameter and long-term average approach which can supply decision making to facilitate the elaboration of larger scale watershed management strategies. It can reasonably estimate the regional distribution of the nutrient emissions entering the surface waters within the basin at sub-catchment scale and determine their most important sources and pathways. Moreover, taking into account the main in-stream retention processes the river loads at the catchment outlets can be calculated that can be used for model calibration and validation.

The application of the model has a quite long story in the Danube countries and at the basin scale as well in the field of river basin management and nutrient balancing. The model has been enhanced and adapted to the specific ICPDR needs by several regional projects accomplished in the basin. The model reasonably and reliably works that has been proven by comparison of the results to observed river loads at several gauges for a long time period. It can be easily supported by available data, run for the entire basin and frequently updated according to the actual conditions. The model is sensitive for some key management parameters, allowing to elaborate realistic future management scenarios of basin-wide relevance and assess their impacts on water quality. Recently, the input dataset has been updated and extended according to the available latest spatial information. Moreover, the model algorithm has been improved resulting in updated nutrient emission patterns for the Danube basin.

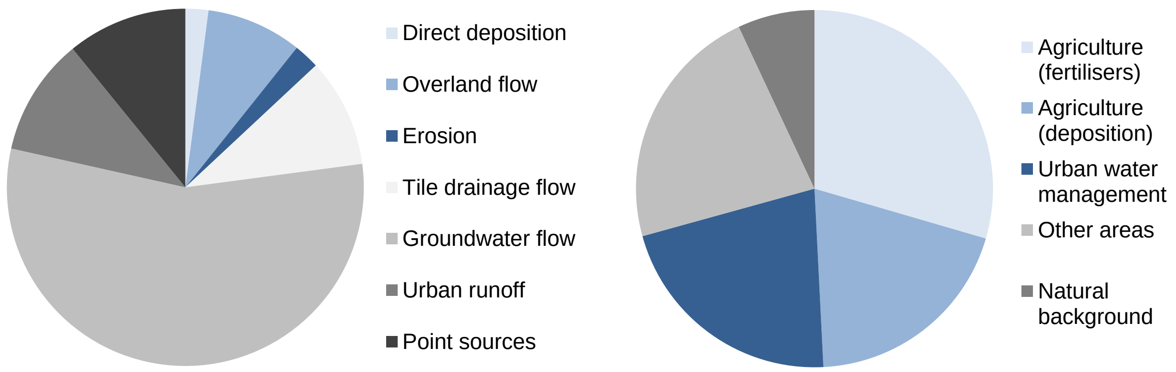
According to the recent calculations, the total nitrogen emissions in the Danube river basin are 670,000 tons per year (8.2 kg per hectare and year) for long-term average hydrological conditions (Table 18). The point source discharges have been updated with those reported in Table 16 and Table 17, whereas point sources in MONERIS represent the summed emissions from waste water treatment plants and direct industrial discharges, whilst untreated waste water discharges are parts of the emissions via urban runoff. The groundwater pathway is responsible for 55% of all TN emissions in the Danube basin and thus the most important pathway (Figure 17 left). Nitrogen inputs via urban runoff have a proportion of 11 %, whilst tile drainages, surface runoff, atmospheric deposition and erosion show a contribution of 10%, 9%, 2% and 2% respectively. Diffuse inputs dominate the basin-wide nitrogen emissions as they have a proportion of 89% in total. Emissions via point sources contribute with 11 % to total nitrogen emissions. Regarding the main sources (Figure 17 right), agricultural fields dominate the emission sources showing a proportion of 49%, although only 29% of the emissions from agricultural areas are related to fertiliser or manure application, whilst the remaining 20% are caused by atmospheric deposition. Urban areas (waste water discharges, runoff from paved surfaces, and combined sewer overflows) and natural lands where atmospheric deposition provides N input are significant source areas as well. This indicates that a significant amount of N sources stem from outside the basin and transported via atmospheric deposition that can difficultly be controlled. Natural background pollution is less important at basin-wide level. The regional distribution of the emissions is shown in Map 8. Regions with high agricultural surplus and shorter groundwater residence time and/or bedrock layers with lower denitrification capacity produce the highest area-specific emissions. Urban areas with significant point sources and urban runoff generate remarkable local fluxes as well.

Table 18: Nutrient emissions of the Danube basin under long-term average (2000-2008) hydrological conditions according to different pathways

Pathway	Water emissons TN (t/year)	Water emissions TP (t/year)
Direct deposition	13,830	329
Overland flow	57,595	377
Erosion	15,435	11,975
Tile drainage flow	65,531	462
Groundwater flow	369,990	4,768
Urban runoff	70,763	16,562
Point sources [1]	72,393	9,938
Total	**665,537**	**44,412**

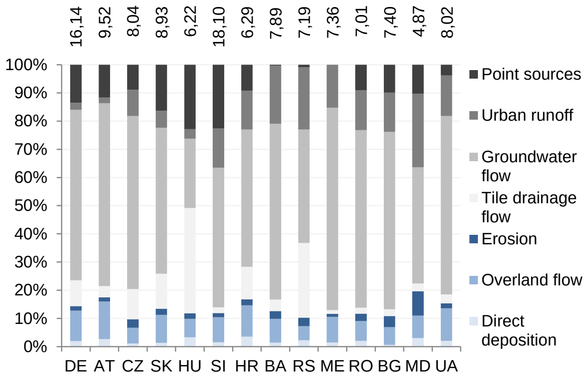
[1] summed emissions from urban waste water treatment plants and industrial direct discharges

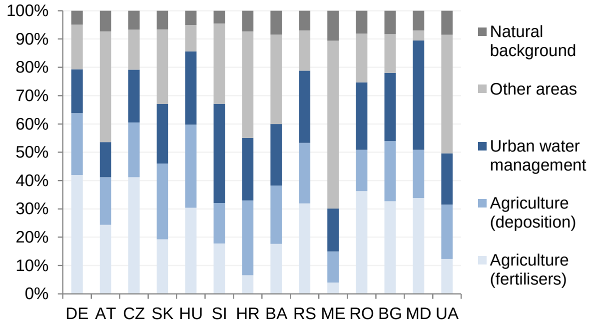
Figure 17: Share of pathways and sources in the overall TN emissions under long-term average (2000-2008) hydrological conditions in the Danube Basin; on the left: pathways, on the right: sources



Country contributions can be seen in Figure 18. Slovenia, Germany, Austria and Slovakia produce the highest area-specific N emissions in the basin. Groundwater flow dominates the distribution of the pathways in most of the countries. Drained agricultural fields have considerable proportion in Hungary and Serbia. Point sources and urban runoff show significant relative contributions in the downstream countries. Regarding the sources, agricultural activities have a principal role in nitrogen emission generation, whereas atmospheric deposition is an equally important nitrogen input than fertilisers in many countries. Urban water management is still an important source, especially in the new and non EU MS. In countries with significant proportion of natural landscapes (Austria, Croatia, Bosnia and Herzegovina, Montenegro and Ukraine) remarkable relative emissions are produced from these areas.

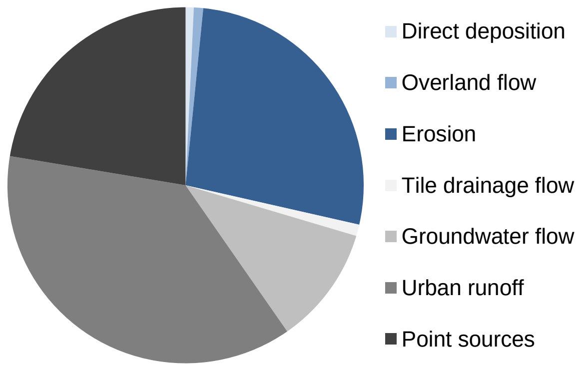
Figure 18: Share of the pathways in the overall TN emissions under long-term average (2000-2008) hydrological conditions in the Danube countries); on the left: pathways, on the right: sources (absolute numbers on the top refer to kg N per hectare and year)

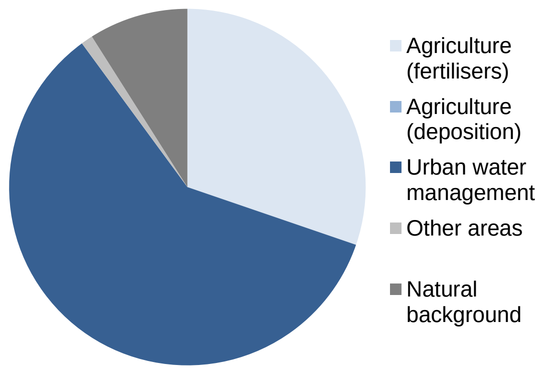




Total phosphorus emissions in the Danube river basin are 44,000 tons per year (0.55 kg per hectare per year) for long-term average conditions (Table 18). TP emissions via the different pathways are presented in Figure 19 (left). The most important diffuse pathway in the Danube river basin is the runoff from the urban systems (including untreated waste water discharges and combined sewer overflows) which is responsible for 37% of all TP emissions. Emissions via erosion contribute with 27% to total phosphorus emissions, groundwater has a proportion of 11%. Emissions via surface runoff, atmospheric deposition and tile drainages contribute with 1% or less to the total phosphorus emissions. All diffuse sources have a total share of 78%, whilst point sources pathway has a contribution of 22%. Source apportionment (Figure 19 right) shows the clear dominance of the urban areas producing 60% of the emissions. Agriculture is responsible for 30% of the total emissions, whilst the rest belongs mainly to background emissions. This suggests a high potential of measures addressing the urban water management to reduce the nutrient emissions. However, the agricultural pressure could strengthen due to the potential future agricultural development especially in the middle and lower parts of the Danube. Hilly regions with intensive agricultural activity or mountainous areas producing high background emission rates generate the largest P inputs of the surface waters (Map 9). Similarly to N, point sources and paved urban surfaces significantly contribute to the total emissions as well.

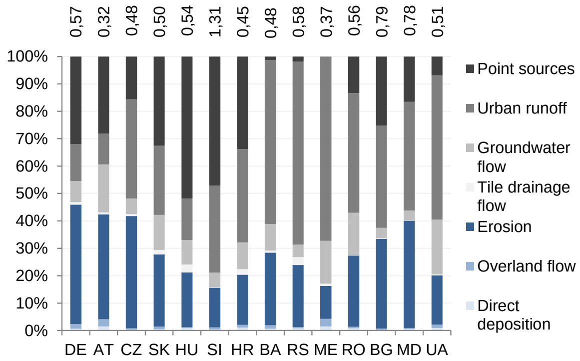
Figure 19: Share of the pathways and sources in the overall TP emissions under long-term average (2000-2008) hydrological conditions in the Danube Basin; on the left: pathways, on the right: sources

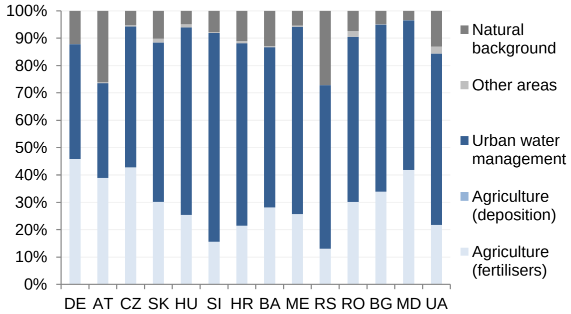




Pathway and source apportionments per country are presented in Figure 20. Slovenia, Bulgaria, Moldova and Serbia generate the biggest P emission rates. Point sources, soil erosion and urban runoff are the most relevant emission components. Their proportion varies according to the state of development in the urban waste water sector and the topographic and land use conditions. Upstream countries show similar importance of the urban water management and agricultural sectors regarding the sources of the P emissions. Moving downstream in the basin urban areas become more dominant indicating the high potential to improve waste water treatment by introducing P removal.

Figure 20: Share of the pathways in the overall TP emissions under long-term average (2000-2008) hydrological conditions in the Danube countries); on the left: pathways, on the right: sources (absolute numbers on the top refer to kg P per hectare and year)





4.1.2.4 Addressing pressures by the implementation of the Joint Program of Measures 2009-2015

The 1st DRBM Plan includes, on the basin-wide level, basic measures in the urban waste water, industrial and agricultural sectors and the implementation of the ICPDR Best Agricultural Practice (BAP) recommendations as the main measures to address nutrient emissions. As the point source pollution for nutrients and organic substances are highly interlinked their regulation is partially ensured by the same measures to be implemented. In the EU MS, the UWWTD requires more stringent removal technology than secondary treatment if the recipient water body is sensitive to eutrophication or the catchment in which a particular urban waste water treatment plant is located belongs to a sensitive water body. Since the Black Sea was significantly suffering from eutrophication and the receiving coastal areas have been designated as a sensitive area under the UWWTD, more stringent treatment technology than secondary treatment is needed at least at the medium-sized and large treatment plants. According to the UWWTD treatment plants with a load higher than 10,000 PE in the EU MS of the DRBD have to be subject to tertiary treatment (nutrient removal) or a reduction of at least 75% in the overall load of total phosphorus and nitrogen entering all urban waste water treatment plants has to be achieved. Old EU MS had to establish nutrient removal technology till 1999, new EU MS obtained longer implementation period. More stringent technology is strongly suggested for the Non-EU MS as well in order to ensure a consistent development strategy in waste water sector. The implementation of the IED in the EU MS and BAT recommendations in Non-EU MS can significantly reduce industrial and agricultural point source nutrient pollution.

Application of phosphate-free detergents in laundry is a great example for source control by phasing out phosphorus inputs from laundry waste water. The introduction of phosphate-free detergents is considered to be a fast and efficient measure to reduce phosphorus emissions into surface waters. For the large number of settlements smaller than 10,000 PE the UWWTD does not legally require phosphorus removal. A reduction of phosphate in detergents could have a significant influence on decreasing phosphorus loads in the Danube, particularly in the short term before all countries have built a complete network of sewers and waste water treatment plants. The ICPDR has been highly supporting the introduction of the phosphate-free detergents in the Danube countries which committed themselves at ministerial level to initiate the introduction of a maximum limit for the phosphate content of the consumer detergents. Some EU MS have already successfully reduced or eliminated the P-content of the detergents. A new EU Regulation (259/2012) regarding the use of phosphate-free detergents has recently been put into force for consumer laundry and will be for automatic dishwashing on the 1st of January 2017 that prescribes limitations on the phosphate contents of a detergent dose in a laundry/dishwashing cycle. The Regulation should be implemented in all EU MS and similar efforts are in progress in some Non-EU MS.

A key set of measures to reduce nutrient inputs and losses related to farming practices and land management has been identified. Agricultural nitrogen pollution of ground and surface water is regulated by the ND in the EU MS. It requires designation of vulnerable zones by either applying the whole territory approach or in so called Nitrate Vulnerable Zones (NVZ). In these zones the amount of nitrate that is applied on agricultural fields in fertilizer or manure is limited and the application is strictly regulated through action programmes with basic mandatory measures. A code of good agricultural practices is also recommended outside the NVZs on voluntary basis to ensure low nitrogen emissions entering the river network. A set of measures related to the concept of Best Agricultural Practices (BAP) is also suggested to be adopted in the entire Danube Basin. The concept has been applied to different extent among the countries to manage inter alia diffuse nutrient emissions that is partly covered by the ND for nitrate pollution in the EU MS. It concerns appropriate land management activities (source and transport control measures) that are able to prevent, control and minimize the input, mobilization and transport of nutrients from fields towards water bodies. The management usually leans on both compulsory actions and voluntary measures that are acceptable for the farming community and subsidized via regional/state funds (e.g. agri-environmental measures under the direct payments and rural development programmes of the EU Common Agricultural Policy, CAP). The critical area concept is an emerging approach in several countries that aims to find technically and economically feasible measures. It considers that management activities should focus on those areas where the highest emissions come from and where the highest fluxes from land to water probably are transported. Targeting management actions to these critical fields can provide cost-efficiency (high river load reduction at minimal implementation costs and area demand).

4.1.2.5 Summary and outlook

The estimated recent, basin-wide nutrient emissions according to long-term average (2000-2008) hydrological conditions are 670,000 tons per year TN and 44,000 tons per year TP. Diffuse pathways clearly dominate the overall emissions having a contribution of 89% (TN) and 78% (TP). For N, groundwater is the most important diffuse pathway with a proportion of 55%. In case of P, urban runoff (37%) and soil erosion (27%) generates the highest emissions. Regarding the sources, agriculture (N: 49%, P: 30%) and urban water management (N: 22%, 60%) are responsible for the majority of the nutrient emissions.

The long-term average (2000-2008) observed river loads estimated from river discharge and nutrient concentration data at the river mouth (station Reni) are 510,000 tons per year (TN) and 25,000 tons per year (TP). These numbers indicate remarkable retentions in the river network comparing them to the total emission values. Twenty-four percent of the TN emissions entering the river systems are retained mainly by denitrification. Some 45% of the TP emissions do not reach the river mouth particularly due to settling. However, the recently transported fluxes are still considerably higher than that of the early 1960ies representing the desired load targets (TN: 300,000 tons per year, TP: 20,000 tons per year), which means a TN and TP load reduction need of 40% and 20%, respectively. This requires further decrease of both, the point source and diffuse emissions generated in the Danube basin.

Similarly to the organic pollution, remarkable decrease is visible regarding the nutrient point source emissions in the Danube basin. For the reference year of the 1st DRBM Plan (2005/2006) 130,000 tons per year TN and 22,000 tons per year TP pollution was reported via direct urban waste water discharges. The recently reported point source nutrient emissions are significantly lower in comparison to those of the first DRBM Plan, the TN and TP discharges declined by 20% and 28%, respectively. Industrial direct emissions dropped by about 40% (TN) and 60% (TP). The recent modelling results of the MONERIS for the basin-wide total emissions represent the impacts of a comprehensive update of the input database and some methodological changes in the model algorithm on the model results rather than the outcomes of a completely different investigation period. Although the total diffuse nutrient emissions have not significantly changed in comparison to the results of the first plan (2000-2005), higher differences can be found for the proportion of the various pathways and for several regions of the basin. These differences are consequences of the model developments and the updated input data.

The measures under implementation are substantially contributing to the reduction of nutrient inputs into surface waters and groundwater in the DRBD but further efforts are still needed. Similarly to the organic pollution, the enhancement of the urban waste water treatment and application of BAT should continue. According to the assessments of the recent Implementation Report of the Nitrates Directive additional actions are needed to reduce and prevent pollution of the ground waters and in terms of extending NVZ designation and reinforcing action programmes in order to avoid eutrophication of the coastal waters. Countries should intensify their efforts to accelerate the identification and implementation of measures to reduce nutrient pollution particularly via diffuse pathways and from agriculture. To further reduce nutrient loads of rivers, coastal waters and seas necessary to meet the environmental objectives of the WFD and DRPC should be further considered through basin-wide nutrient emission estimations and scenario assessment (using tools such as the MONERIS model). Efforts are needed to ensure necessary financial investments and clarification is required on how to finance agricultural measures. Past experience with the implementation of the ND and application of agri-environmental measures have clearly demonstrated the need for financial support out of the CAP. Nevertheless, countries should make use of the CAP-Reform. Between 2014 and 2020, over 100 billion EUR will be invested to help farmers meet the challenges of soil and water quality, biodiversity and climate change by funding environmentally friendly farming practices and agri-environmental measures from both direct payment and rural development pillars. Efforts to extend the introduction of phosphate-free detergents to all Danube countries are also likely to be needed. One of the challenging future tasks of this field is to better understand and realistically predict the possible future economic drivers, the agricultural development and changes and their anticipated impacts.

The measures implemented in the urban waste water sector might have short-term negative impacts if establishment of public sewer systems is not accompanied with appropriate nutrient removal technology before discharging into the recipients. Simple collection and concentrated discharge of waste water without sufficient tertiary treatment usually causes higher nutrient pollution of surface water bodies than dispersed smaller waste water discharges from septic tanks that percolate into groundwater and reach surface waters via base flow. Due to the longer time necessary for an effective management of diffuse nutrient pollution (longer residence time of groundwater, stored nutrients in bottom sediment of reservoirs) the water quality impacts of any changes in agriculture induced by the implementation of the ND or BAP recommendations will probably not be instantly visible but after several years or even decades only.

4.1.3 Hazardous substances pollution

4.1.3.1 General considerations

Sources and pathways of hazardous substances pollution

Hazardous substances pollution involves contamination with priority substances laid down in WFD Annex X and other specific pollutants that might be toxic and have regional relevance. They include both inorganic and organic micro-pollutants such as heavy metals, arsenic, cyanides, oil and its compounds, trihalomethanes, polycyclic aromatic hydrocarbons, biphenyls, phenols, pesticides, haloalkanes, endocrine disruptors, pharmaceuticals, etc. Hazardous substances can be emitted from both point and diffuse sources. Households and public buildings connected to sewerage can contribute to water pollution by emitting chemicals used in the course of daily routine. Industrial facilities that process, utilise, produce or store hazardous substances can release them with waste water discharges. Indirect dischargers are connected to public sewer systems and can transport contaminated industrial waste water to the treatment plants if their own treatment system is not sufficient. Direct dischargers without specific removal technology for hazardous substances can potentially deteriorate water quality.

Diffuse emission pathways are substance-specific. Surface run-off, sediment transport and groundwater flow are the main contributing routes. Urban systems (deposited air pollutants, litter, combined sewer overflows), agriculture (pesticide and contaminated sludge application), contaminated sites (industrial areas, landfills, abandoned areas) and mining sites are the most important source sectors. Background geochemical loads can be considerable in specific regions where the parent rock layers naturally contain hazardous substances (e.g. heavy metals). Hazardous substances contamination can specially be realized through accidental pollutions. Industrial facilities, mining areas and contaminated sites that process or contain such substances in substantial amounts pose hazard (potential risk) to cause pollution even though they might not have any release in their regular operation. However, in case of emergency situations (natural disasters like flood or earthquake as well as operation failures) and without appropriate safety measures in place they might be at real risk to cause water pollution.

Water quality impacts of hazardous substances pollution

Due to the rapid development of the chemical industry that is continuously producing new chemicals, their different and complex environmental behaviour and the long-lasting chronic toxicity of many substances the whole mechanism of the hazardous substances pollution has not been fully clarified so far. Hazardous substances can pose serious threat to the aquatic environment. Depending on their concentration and the actual environmental conditions, they can cause acute (immediate) or chronic (latent) toxicity. They usually attack one of the vital systems of the living organism, like nervous, enzymatic, immune, muscular systems or directly the cells.

Some of the hazardous substances are persistent, slowly degradable and can accumulate in the ecosystem. They can deteriorate habitats and biodiversity and also endanger human health as many of these chemicals are carcinogenic, mutagenic or teratogen. They can also alter proteins and different organs, impair reproduction or disrupt endocrine systems. Many of the pollutants tend to attach to organic compounds, they may be taken up by the organisms during feeding and introduced in the food web through bioaccumulation and biomagnification processes. Moreover, some of the pollutants can be attached to the soil and sediment particles and subject to subsequent resuspension and dissolution. Therefore, hazardous substances pollution is considered as regional or even basin-wide water quality problem and its reduction may take a longer time. Elimination of these substances needs up to date technologies at the industrial sites, enhanced waste water treatment, good agricultural practices to appropriately handle these substances, cessation and replacement of the hazardous substances with others whenever possible and well developed safety system to address accidental events. Total and dissolved concentrations of the hazardous substances are used to describe water quality. Additionally, concentration in sediment and biota can also be applied.

4.1.3.2 Hazardous substances emissions

The Danube countries have made substantial efforts to supplement the insufficient information on the hazardous substances pollution at the basin-wide level. Towards a better understanding and a narrowed information gap in this field the compilation of inventories on priority substances emissions, discharges and losses required under the EU Directive on Priority Substances (EQSD, Article 5) provides a promising possibility. The current ICPDR activities on the hazardous substances pollution are highly related to the recommendations of the Common Implementation Strategy (CIS) Guidance No. 28 on preparing emission inventories of priority substances and other hazardous substances. Recently, a two-steps approach is being conducted to test the guideline for the Danube and its tributaries. The first phase is a more general significance analysis of the priority substances and specific parameters. The aim of this phase is to screen those substances which are clearly of higher relevance at present and in the foreseeable future and allow to prioritise the resources and efforts necessary for the subsequent detailed investigations. It is based on the non-compliance analysis of the water bodies for chemical status, the trend analysis of the available water quality data and their comparison to the Environmental Quality Standard (EQS) values. A substance is initially identified as relevant if at least one of the following criteria is met:

- the substance causes failure of good chemical status (non-compliance);
- the substance has higher annual average or maximum concentration than the half of the respective EQS;
- monitoring results show an increasing temporal trend of substance concentration.

The result of this analysis will be a preliminary draft list of the relevant priority substances and other specific parameters in the Danube Basin. This draft list will subsequently be supported by additional information and eventually extended once the results of the recent Joint Danube Survey (JDS) 3 and its follow-up activities are evaluated and more data are available from the countries by applying advanced analytical methods.

The second phase is a more detailed analysis focusing on the screened relevant substances. It utilizes a specific template that is based on the provisions of the CIS Guidance No. 28. This phase aims to separate the point and diffuse source hazardous substances emissions. It requires point source discharge data (municipal waste water treatment plants and industrial facilities) and observed river loads at certain monitoring points. River loads should carefully be calculated taking into account the uncertainties of the analytical method (e.g. concentrations below the limit of quantification or detection) and the sampling frequency (e.g. unregistered high flow events with considerable pollutant transport). Knowing the point source emissions and the observed river loads, assuming a certain natural background river load and neglecting the in-stream sources and sinks would allow to roughly estimate the total anthropogenic diffuse inputs from the catchment upstream of the monitoring points.

The complied national inventories and the finalised list of relevant priority substances and parameters will serve as a sound basis for the elaboration of the next management plan.

4.1.3.3 Addressing pressures by the implementation of the Joint Program of Measures 2009-2015

The 1st DRBM Plan summarizes the measures of basin-wide importance in the waste water, industrial and agricultural sectors to be implemented in order to reduce and/or eliminate the hazardous substances discharges into the surface water bodies. Appropriate treatment of urban waste water and application of BAT in the industrial plants and large agricultural farms are elementary measures and can significantly contribute to the mitigation of hazardous contaminations. Implementation of the UWWTD and IED in EU MS are highly beneficial for the reduction of hazardous substances pollution. In Non-EU MS the considerable efforts made in order to develop and improve the waste water sector and industrial technologies have also positive effects on water quality related to hazardous substances pollution. Other EU legal documents like the Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), the Plant Protection Products Regulation, the Biocidal Products Regulation, or the Pesticides Directive aim to minimize the release of chemicals in order to protect human health and environment. For instance, they lay down rules for the authorisation of products containing dangerous chemicals and regulating their placing on the market, enforce substitution or exclusion of certain substances, ensure the safe application of products containing dangerous chemicals and prescribe emission limits for the hazardous substances. The EQSD interconnected with the WFD intends to regulate water pollution of priority substances by setting up EQS values for the priority substances and mandating to phase out priority hazardous substance emissions for the dischargers. Reporting on emissions, discharges and losses of these substances is also obligatory.

The progressive development of the urban waste water sector increases the quantities of sewage sludge that requires disposal. The SSD (currently assessed whether a revision is needed) seeks to encourage the use of sewage sludge in agriculture and simultaneously regulates its use in such a way as to prevent harmful effects on soil, vegetation, animals and human beings. Detailed recording is required on the circumstances of sewage sludge application in agriculture and a set of limit values for concentrations of heavy metals in sewage sludge intended for agricultural use and in sludge-treated soils is assigned. Therefore, implementation of the SSD helps to avoid hazardous substances pollution by restricting the application of contaminated sludge to agricultural fields. Management actions similar to those of the EU MS are recommended for the Non-EU MS. Sustainable pesticide usage in the agriculture can also be managed by some BAP measures that are on-going in both EU and Non-EU MS.

4.1.3.4 Summary and outlook

The 1st DRBM Plan, building on the improved analytical capabilities and results from JDS 2 in 2007, provided an improved knowledge on hazardous substances in the DRB. However, it also drew attention to the significant data gap and uncertainty in the current knowledge on pressures due to hazardous substances as well as their impact on water status. Danube countries have taken important steps to fill the existing data gaps in the field of hazardous substances pollution. The recent ICPDR investigations (particularly those related to the current JDS 3) on the priority and other hazardous substances will provide essential information on the relevance of these substances resulting in a much clearer picture on the pollution problem (relevant substances and their magnitude) than ever before. The elaboration of an inventory of emissions, discharges and losses of the priority substances can help to close information gaps on the sources. Measures under implementation in the waste water, industrial and agricultural sectors (e.g. enhanced waste water treatment and BAT, regulated use of sewage sludge and pesticides) can significantly contribute to the reduction of the releases of hazardous substances.

The Danube countries have made efforts in order to prevent accidental pollutions and ensure effective and quick responses to transboundary emergency cases. The Accident Emergency Warning System (AEWS) was developed and is continuously operated to timely recognise emergency situations related to hazardous substances spills. It is activated if a risk of transboundary water pollution exists and alerts downstream countries with warning messages in order to help national authorities to put safety measures timely into action. The alert system has been operated, maintained and enhanced by the ICPDR Secretariat. In addition, Danube countries are collecting data on the industrial and contaminated sites that might be at potential risk of accidental pollution caused by operation failures or natural disasters like floods. Potential risk analysis methods are intended to be used to assess how significant the accidental pollution hazard could be at these sites.

However, despite the substantial progress achieved in many aspects of the hazardous substances pollution the state of the art knowledge needs to be improved and the implementation of measures should be proceeded in the future to appropriately manage the problem. Further efforts are needed to compile the national inventories on discharges, emissions and losses in a comparable and coordinated way and develop a strategy to improve and harmonize the approach for the elaboration of the inventory. In particular the lack of high quality monitoring data on priority substance discharges from waste water effluents has to be addressed prior to the update of the inventories. This will ensure to have a consistent picture on the point sources of the relevant hazardous substances. Further information on in-stream concentrations and river loads via improved monitoring and application of regionalised modelling tools that can examine sources and pathways for certain substances can help filling knowledge gaps. The information to be received from JDS3 and its follow-up activities will strongly facilitate the prioritisation of the hazardous substances that could potentially be relevant in the Danube basin. Furthermore, if the same approach is applied for the tributaries of the Danube River, additional information can be collected offering a more complete picture on the DRB.

Implementation of the measures should be continued with in compliance with the existing legislative framework in order to reduce hazardous substances pollution releases (e.g. enhancing waste water treatment and industrial technologies, phasing out certain substances from the market products and promoting sustainable use of sewage sludge and pesticides in the agriculture). A thorough risk analysis on the industrial, abandoned and mining sites in terms of accidental pollution risk is an important future tasks as well. The real risk of the pre-screened sites with significant pollution hazard is intended to be assessed based on checklists to determine what additional safety measures should be implemented to minimize risk.

4.1.4 Hydromorphological alterations

Hydromorphological alterations and their effects gained vital significance in water management due to their impacts on the abiotic sphere as well as on the ecology and ecological status of the river system.

Anthropogenic pressures resulting from various hydro-engineering measures can significantly alter the natural structure of surface waters. This structure is essential to provide adequate habitats and conditions for self-sustaining aquatic species. The alteration of natural hydromorphological conditions can have negative effects on aquatic populations, which might result in failing the EU WFD environmental objectives. More information on water bodies at risk due to hydromorphological alterations is provided in Chapter 6.

Hydropower generation, navigation and flood protection are the key water uses that cause hydromorphological alterations. Hydromorphological alterations can also result from anthropogenic pressures related to urban settlements, agriculture and other sources. These drivers can influence pressures on the natural hydromorphological structures of surface waters in an individual or cumulative way.

The following three key hydromorphological pressure components of basin-wide importance have been identified:

a) Interruption of river continuity and morphological alterations;

b) Disconnection of adjacent wetlands/floodplains, and;

c) Hydrological alterations, provoking changes in the quantity and conditions of flow.

In addition, potential pressures that may result from future infrastructure projects are also dealt with.

This chapter reflects findings on hydromorphological alterations and their significance from previous EU WFD reports (DBA 2004 and DRBM Plan 2009), as well as from the most recent national data taking into account the ongoing implementation of the JPM. The 1st DRBM Plan 2009, which was also based on the DBA 2004, examined river continuity interruptions, disconnected wetlands/floodplains which have a reconnection potential, as well as hydrological pressures including impounded river sections, water abstractions and hydropeaking.

Information on the extent of these pressure types was updated in order to gain a full picture on the current situation. In addition, information on morphological alterations to water bodies was collected for the first time as a new element, in order to close the existing knowledge gap on this important pressure component for surface waters. With regard to future infrastructure projects, the list of planned hydro-engineering projects has been updated and supplemented with additional information.

In cases where countries share river stretches there is the risk that some hydromophological components (river and habitat continuity interruption, hydrological alterations) are reported twice because the information has been reported separately by the Danube countries. Due to this reason bilateral harmonisation of reported data is important in order to avoid a potential distorting of the overall assessment and discrepancies in the results.

Finally, information on hydromorphological alterations of the Danube River itself has been collected in the frame of JDS 1 and JDS 2 and was included in the 1st DRBM Plan. Further information on the hydromorphology of the Danube River is obtained through JDS 3 and will serve as an updated data set for the 2nd DRBM Plan.

4.1.4.1 Interruption of river continuity and morphological alterations

The DRBM Plan 2009 included an assessment of barriers causing longitudinal continuity interruption for fish migration. Morphological alterations were considered as an important pressure component but not assessed on the basin-wide scale. This data gap is closed with the collection of information on morphological alterations to water bodies, which are directly linked to habitat degradation and now assessed for the first time in this chapter.

Alteration of river continuity for fish migration

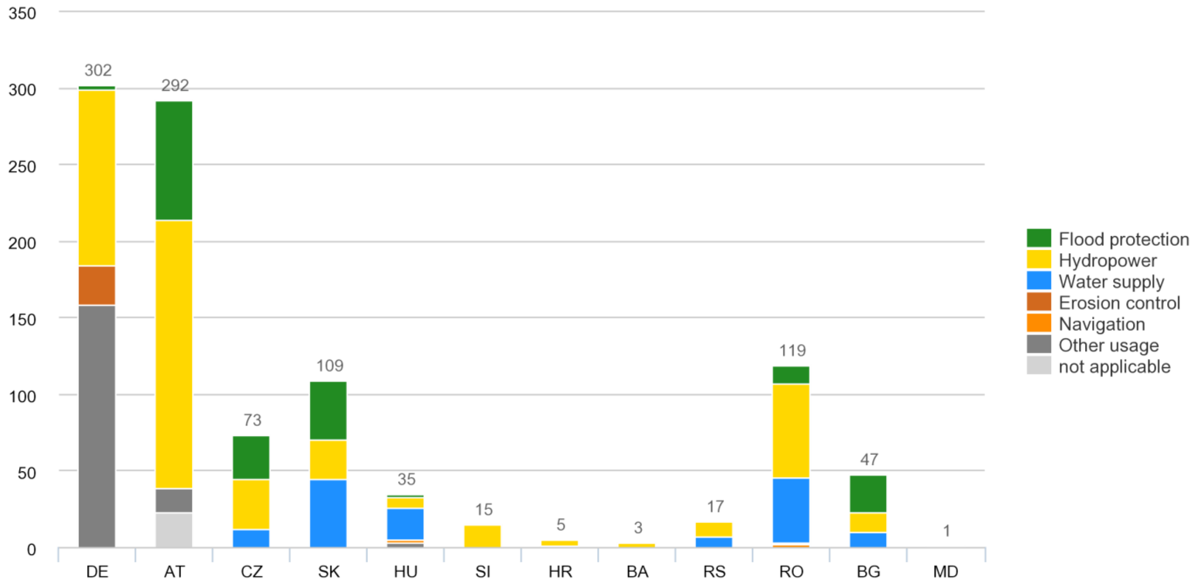
Table 19 provides information on the applied criteria for the pressures assessment on continuity interruption for fish migration in the DRBD. Compared to data which was provided for the 1st DRBM Plan in 2009, a significant number of barriers which were reported actually do not meet the criteria for the pressures assessments. This because in 2009 e.g. also river bed stabilisation structures as of some cm height were reported as barriers which are equipped with functional fish migration aids. This issue has been clarified in the updated data set which was used for the assessments in this report. Due to this reason the total number of barriers is differing from the number reported in 2009.

The key driving forces causing continuity interruption are hydropower generation (45%), flood protection (18%) and water supply (13%). More detailed information on the number of continuity interruptions and associated main uses is illustrated in Figure 21 for the different countries. In many cases barriers are not linked to a single purpose due to their multifunctional characteristics (e.g. hydropower use and navigation; hydropower use and flood protection).

Table 19: Continuity interruption for fish migration: Criteria for pressure assessment

Pressure	Provoked alteration	Criteria for pressure assessment
Alteration of river continuity	Interruption of fish migration and access to habitats	Anthropogenic interruption, rhithral >0.7m height, potamal >0.3m height, or lower in case considered as relevant on the national level[8]

Figure 21: Number of continuity interruptions and associated main uses



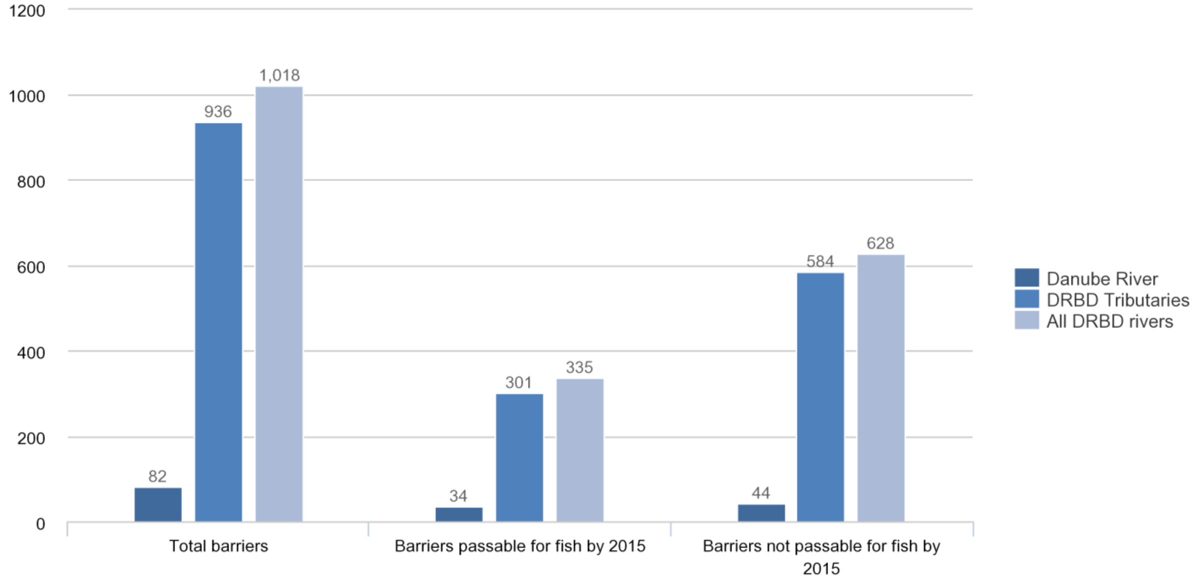
1,018 barriers are located in DRBD rivers with catchment areas >4,000 km^2 (Figure 22 and Map 10). 598 of the 1,018 continuity interruptions are dams/weirs, 296 are ramps/sills and 124 are classed as other types of interruptions. 47% of the barriers were reported to cause a water level difference of less than 5 m under average conditions, 21% cause a water level difference between 5 and 15 m, and 6% are larger dams with water level differences of more than 15 m. For the remaining barriers data on the water level difference is not available.

335 of the barriers were reported by the countries to be already equipped or to be equipped by 2015 with functional fish migration aids. 628 continuity interruptions (64%) will remain a hindrance for fish migration as of 2015 and are currently classified as significant pressures (see Figure 22). For the remaining barriers it either still needs to be determined whether fish migration is possible or they were reported to be located outside of the fish area (details see Map 10).

Out of the total 703 water bodies in the DRBD, 304 are affected by barriers for fish migration, out of which 50 are passable for fish. 246 water bodies in the DRBD are significantly altered by continuity interruptions un-passable for fish species. This is 35% of the total number of DRBD water bodies.

[8] Rhithral are the headwater sections of rivers and potamal the lowland sections.

Figure 22: Current situation on river continuity interruption for fish migration in the DRBD



For the Danube River itself, 82 barriers were identified, out of which 34 are expected to be passable for fish by 2015. Although progress on addressing this issue is made, the Austrian/German chain of hydropower dams, the Gabcikovo Dam (SK) and the Iron Gate Dams 1 & 2 (RO/RS) remain significant river and habitat continuity interruptions for the Danube River, posing problems i.e. for long and medium distance migratory fish species.

Alteration of river morphology

The EU WFD requires in Annex II the identification of significant morphological alterations to water bodies. Elements defining river morphology include

- river depth and width variation,
- structure and substrate of the river bed, and
- structure of the riparian zone.

Deterioration of the natural river morphology influences habitats of the aquatic flora and fauna and can therefore impact water ecology. Aggregated information on the alteration of river morphology was collected on the level of the water body. Since most countries have a five class system and others a three class system in place for the assessment of the morphological condition, it was agreed to provide information on the morphological alterations of water bodies in the following three classes:

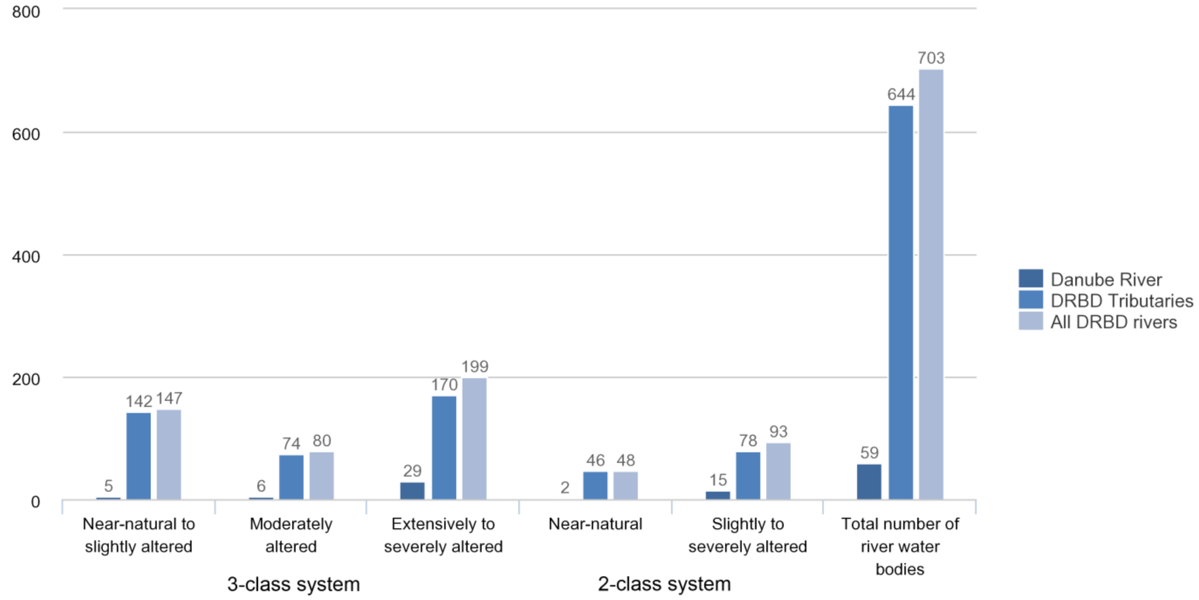
- Near-natural to slightly altered (1-2);
- Moderately altered (3);
- Extensively to severely altered (4-5).

In two countries a two class system is in place, whereas data is indicated separately according to the following classification:

- Near-natural;
- Slightly altered to severely altered.

The pressure analysis concludes that 147 out of a total 703 river water bodies are near natural to slightly altered (21%). 80 water bodies were reported to be moderately altered and 199 are extensively to severely altered (Figure 23 and Map 11). 48 water bodies reported in the 2-class system are near natural (7%) and 93 are slightly to severely altered. For the remaining water bodies no information on the classification of river morphology is yet available.

Figure 23: Morphological alteration to water bodies of the Danube River, the DRBD tributaries and all DRBD rivers



Further harmonisation efforts are required in the future towards a better comparable assessment of morphological alterations to the rivers in the DRBD.

4.1.4.2 Disconnected adjacent wetlands/floodplains and relevant measures

Wetlands/floodplains and their connection to river water bodies play an important role in the functioning of aquatic ecosystems and have a positive effect on water status. Connected wetlands/floodplains play a significant role when it comes to retention areas during flood events and may also have positive effects on the reduction of nutrients and improvement of habitats. As an integral part of the river system they are hotspots for biodiversity, also providing habitats for e.g. fish and waterfowls that use such areas for spawning, nursery and feeding grounds.

The 1st DRBM Plan from 2009 concluded that compared with the 19th Century, less than 19% of the former floodplain area (7,845 km^2 out of a once 41,605 km^2) remain in the entire DRB. This is caused in particular due to the expansion of agricultural uses and the disconnection from water bodies due to river engineering works concerning mainly flood control, navigation and hydropower generation.

The basis of the pressure analysis for the 1st DRBM Plan was the consideration that disconnected wetlands/floodplains are potential pressures to aquatic ecosystems on the basin-wide level and that the highest possible area of those which have a reconnection potential should be re-connected in order to support the achievement of the environmental objectives. Therefore, restoration efforts and measures were taken to facilitate the achievement of WFD environmental objectives.

The pressure analysis focuses on analysing the location and area of disconnected wetlands/floodplains (>500 ha or which have been identified by the Danube countries of basin-wide importance) with a definite potential for reconnection, taking into account those wetlands/floodplains which are reconnected until 2015 as part of the JPM implementation of the 1st DRBM Plan. Since for the 1st DRBM Plan partly also historical wetlands/floodplains have been reported without being considered to have a reconnection potential, the updated data set addresses now those wetlands/floodplains with a definite reconnection potential.

In total 280,527 ha of wetlands/floodplains have been identified to have a reconnection potential[9]. Out of these and as part of the JPM implementation, 89,954 ha are totally and 46,089 ha are partly reconnected where some of the required measures were already completed but further measures are planned, having positive effects on water status and flood mitigation. The remaining

[9] The assessment includes data for MD and UA reported in 2009.

wetlands/floodplains, covering an area of 144,484 ha, have a remaining potential to be re-connected to the Danube River and its tributaries in the next WFD cycles (see Figure 24 and Map 12).

The indication of no reconnection potential for wetlands/floodplains in many Danube countries (Figure 24) does not indicate that there are not wetlands/floodplains with reconnection potential or that there is no restoration taking place is these countries, since Figure 24 exclusively illustrates relevant information for the basin-wide scale for wetlands/floodplains with an area larger 500 ha.

Figure 24: Area [ha] of DRBD wetlands/floodplains (>500 ha or of basin-wide importance) which are reconnected or with reconnection potential

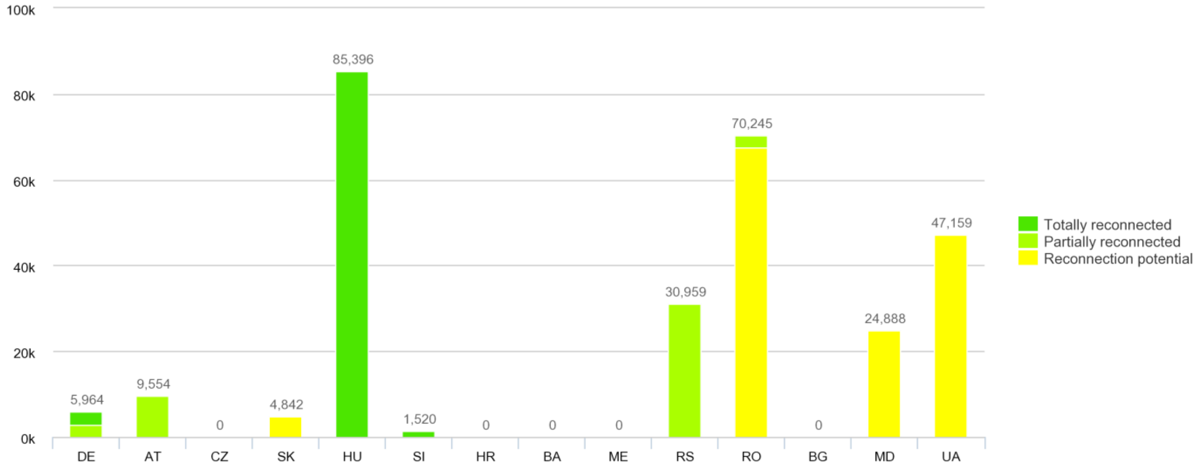


Table 20 shows the number of remaining water bodies in the DRBD (in absolute numbers and percentage) which have the potential to benefit from reconnected wetlands/floodplains or an improvement of the water regime in the future, having a positive effect on their water status. The absolute length of water bodies with restoration potential in relation to disconnected wetlands/floodplains is 2,776 km (11% of total river network).

Table 20: Number of river water bodies with wetlands/floodplains, having a reconnection potential beyond 2015 as well as relation to overall number of water bodies

	Number of WBs	WBs with reconnection potential	% with reconnection potential
Danube River	59	10	17
DRBD tributaries	644	14	2
All DRBD rivers	703	24	3

4.1.4.3 Hydrological alterations

A pressure assessment on hydrological alterations was for the first time performed for the DRBM Plan 2009. The assessment in this analysis provides updated information, taking into account the progress achieved in reducing the hydrological pressures and impacts as part from the implementation of the JPM.

The main remaining pressure types in the DRBD causing hydrological alterations are in numbers: 392 impoundments, 153 cases of water abstractions and 79 cases of hydropeaking. The provoked alterations and applied criteria used for the assessment are shown in Table 21.

Table 21: Hydrological pressure types, provoked alterations and criteria for the respective pressure/impact analysis in the DRBD

Hydrological pressure	Provoked alteration	Criteria for pressure assessment
Impoundment	Alteration/reduction in flow velocity and flow regime of the river sections caused by artificial transversal structures	Danube River: Impoundment length during low flow conditions >10 km Danube tributaries: Impoundment length during low flow conditions >1 km
Water abstraction / residual water	Alteration in quantity and dynamics of discharge/flow in water	Flow below dam <50% of mean annual minimum flow[10] in a specific time period (comparable with Q95)
Hydropeaking	Alteration of flow dynamics/discharge pattern in river and water quantity	Water level fluctuation >1 m/day or less in the case of known/observed negative effects on biology

The pressure analysis concludes that 624 hydrological alterations are located in the DRBD – 37 of them in the Danube River. Details on the distribution of hydrological alterations between the different pressure types (impoundments, water abstraction and hydropeaking) and their significance according to the ICPDR criteria (Table 21) are outlined below as well as illustrated in Map 13, 14 and 15. Table 22 shows the number of DRBD water bodies affected by hydrological alterations (in absolute numbers and percentage).

Table 22: Number of river water bodies significantly affected by hydrological alterations in relation to the overall water body number

	Total number of WBs	WBs affected by hydrological alterations	Proportion of affected WBs to total number (%)
Danube River	59	34	58
DRBD tributaries	644	215	33
All DRBD rivers	703	249	35

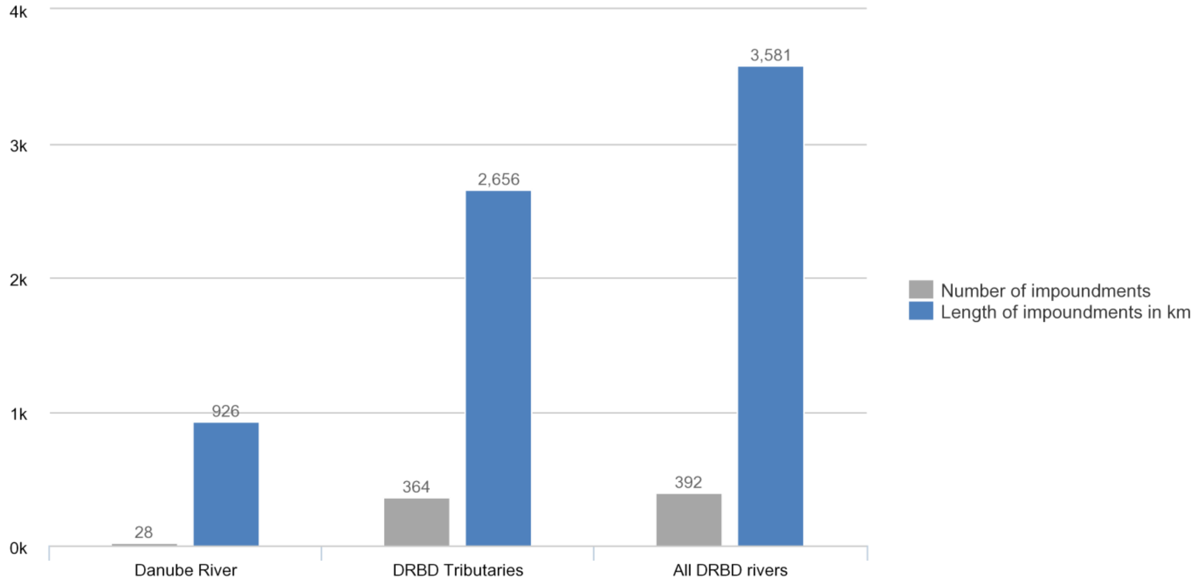
Impoundments

Impoundments are caused by barriers that - in addition to interrupting river/habitat continuity – alter the upstream flow conditions of rivers. The character of the river is changed to lake-like types due to decrease of flow velocities and eventual alteration of flow discharge. Additionally, impoundments can lead to erosion and deepening processes downstream of the impounded section, inducing a decrease of the water table and consequently, dry out of the adjacent wetlands.

The pressure analysis concludes that 392 impoundments are located in the DRBD (see Figure 25 and Map 13) affecting 225 water bodies. It can be concluded that out of 25,207 km of all rivers in the DRBD with catchment areas > 4,000 km^2, 3,581 km are affected by impoundments (14%).

[10] A pressure provoked by these uses is considered as significant when the remaining water flow below the water abstraction (e.g. below a hydropower dam) is too small to ensure the existence and development of self-sustaining aquatic populations and therefore hinders the achievement of the environmental objectives. Criteria for assessing the significance of alterations through water abstractions vary among EU countries. Respective definitions on minimum flows should be available in the national RBM Plans.

Figure 25: Number and length of impoundments in the DRBD



For the Danube River, impoundments are the key hydrological pressure type causing significant alterations. 926 km of its entire length (of 2,857 km) are impounded (representing 32% of the length) by 28 barriers. In fact, impoundments are the major hydrological pressure type for the Danube River.

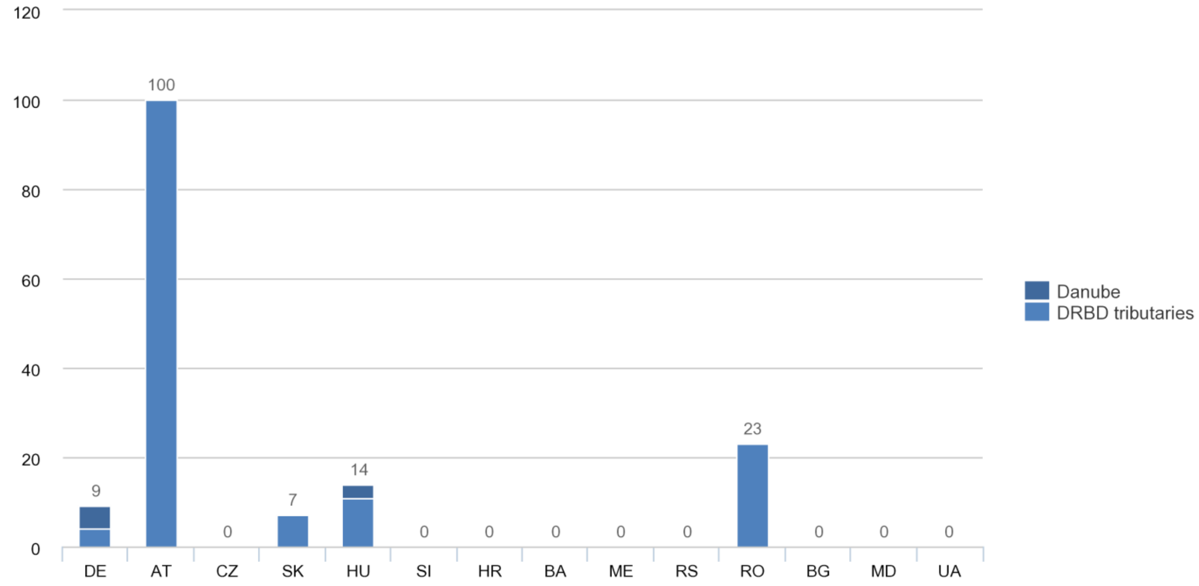
The impoundment upstream of the Iron Gate 1 Dam affects the flow of the Danube River over a length of 310 km up to Novi Sad (11% of the entire length of the Danube River) and represents a significant pressure. In the middle Danube Basin, the Gabcikovo Dam impounds for more than 17 km (less than 1% of the entire length) and the AT/DE chains of hydropower plants impound a major share of the upper Danube River (approx. 269 rkm or around 9%). However, significant free-flowing stretches are located upstream of Novi Sad to the Gabcikovo Dam and downstream of the Iron Gate 2 Dam to the Black Sea.

Water abstractions

Water abstractions can significantly reduce the flow and quantity of water and impact the water status in case where the minimum ecological flow of rivers is not guaranteed. In the DRBD, the key water uses causing significant alterations through water abstractions are mainly hydropower generation (73%), public water supply (6%), cooling purposes for electricity production (3%), agriculture, forestry and irrigation (3%) and others.

The pressure analysis concludes that in total 153 significant water abstractions are causing alterations in water flow in DRBD rivers (Figure 26 and Map 14). 110 water bodies are affected by these pressures. The Danube River itself is only impacted by alterations through water abstraction at Gabcikovo hydropower dam (bypass channel) and water abstractions in Germany as well as Hungary.

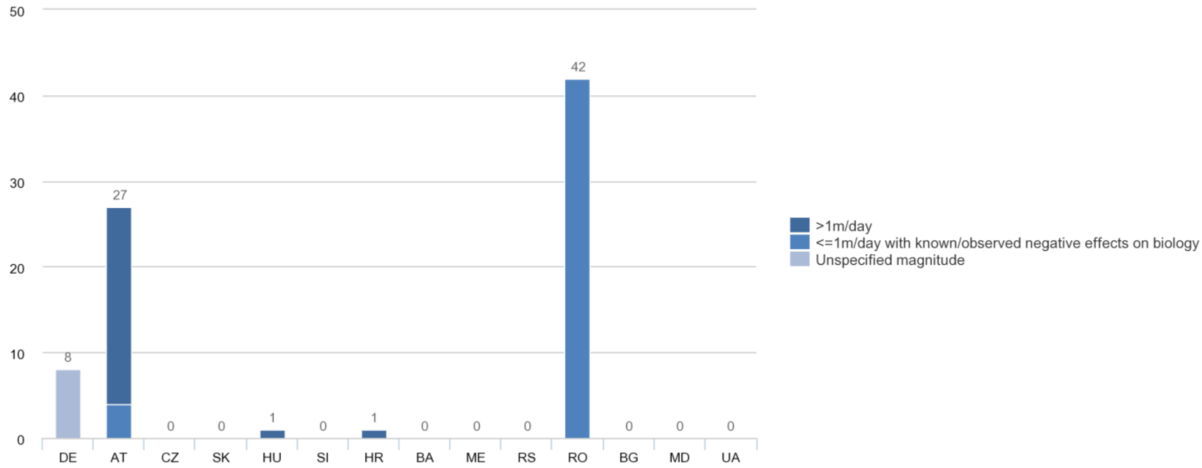
Figure 26: Number of significant water abstractions in the Danube River, DRBD tributaries and all DRBD rivers with catchment areas >4,000 km²



Hydropeaking

Hydropeaking is a pressure type that occurs in the DRBD, stemming from hydropower generation for the provision of peak electricity supply resulting in artificial water level fluctuation. Data was collected based on the ICPDR criterion (Table 21), whereas in total 79 cases of hydropeaking are causing significant water level fluctuations larger than 1 m/day below a hydropower plant or less in the case of known negative effects on biology (see Figure 27 and Map 15). Overall, 78 water bodies are affected by hydropeaking, one of them located at the Upper Danube.

Figure 27: Number of significant cases of hydropeaking in the DRBD



4.1.4.4 Future infrastructure projects

In addition to already existing hydromorphological alterations, a considerable number of future infrastructure projects (FIPs) are at different stages of planning and preparation throughout the entire DRBD. These projects, if implemented without consideration to effects on ecology, are likely to provoke impacts on water status due to hydromorphological alterations.

A list of FIPs of basin-wide importance has been compiled for the 1st DRBM Plan and was updated for this analysis for the time horizon 2021 (see Annex 3). The following criteria were applied for the data collection (Table 23):

Table 23: Criteria for the collection of future infrastructure projects for the Danube River and other DRBD rivers with catchment areas >4.000 km²

	Danube River	Other DRBD rivers with catchment areas >4.000 km²
Criteria	Strategic Environmental Assessment (SEA) and/or Environmental Impact Assessments (EIA) are performed for the project	Strategic Environmental Assessment (SEA) and/or Environmental Impact Assessments (EIA) are performed for the project
	or	**and**
	project is expected to provoke transboundary effects	project is expected to provoke transboundary effects

All FIPs (until 2021) including brief descriptions (if provided) and are compiled in Annex 3 and Map 16. The pressure analysis concludes that 51 FIPs have been reported for the DRBD. 36 of them are located in the Danube River itself. In total 36 (71%) are related to navigation; 11 (21%) to flood protection, and 4 (8%) to hydropower generation (see Map 16).

Therefore, it can be concluded that navigation and flood protection, followed by hydropower generation, are the key drivers that may provoke impacts on water bodies in the DRBD by 2021. For 21 out of all reported projects (41%), deterioration of water status is expected and therefore exemptions according to WFD Article 4.7 are required. Details are summarised in Annex 3. Information on the economic relevance of different sector, including hydropower and inland navigation, can be obtained from the economic analysis (Chapter 8).

4.1.5 Other issues

4.1.5.1 Quality and quantity aspects of sediments

The 1st DRBM Plan outlines conclusions on the way forward regarding sediment management in the DRB and respective actions to be taken for upcoming RBM cycles.

On sediment quality, the characterisation in the Danube is primarily based on the results of the Joint Danube Surveys (JDS 1 and 2). The monitoring activities discovered that while concentrations of certain substances (organochlorinated compounds) in the solid phase were at low levels, heavy metals and polycyclic aromatic hydrocarbons were occasionally found at elevated concentrations requiring further concern. This issue is investigated during JDS 3 and the results will be introduced in the 2nd DRBM Plan.

With regard to sediment quantity, the 1st DRBM Plan concluded that at the present the sediment balance of most large rivers within the DRB can be characterised as disturbed or severely altered. Therefore, attention should be given to ensuring the sediment continuum (improving existing barriers and avoiding additional interruptions). However, the availability of sufficient and reliable data on sediment transport is a prerequisite for any future decisions on sediment management in DRB. Hence, to propose appropriate measures for improving the situation, a sediment balance for the DRB has to be developed and additional investigations are needed to identify the significance of sediment transport on the Danube basin-wide scale.

In order to address the indicated issues, further data on sediments for the Danube will be gained in the frame of JDS 3, where the monitoring activities also include investigations on quality and quantity aspects of sediments. However, for obtaining a full picture a specific international project activity on sediment management is needed. Currently, work is ongoing to elaborate a project proposal in cooperation with relevant sectors (i.e. hydropower, navigation) to be submitted to an appropriate call of an adequate funding program. The results of the project will be integrated in subsequent RBM cycles.

4.1.5.2 Invasive alien species

In the 1st DRBM Plan it was highlighted that the Danube River Basin is very vulnerable to invasive species given its direct linkages with other large water bodies (Southern Invasive Corridor connecting Black Sea through the Danube - Danube/Main/Rhine Canal - Rhine with the North Sea). The Danube is exposed to an intensive colonisation of invasive species and further spreading in both north-west and south-east directions throughout the basin. Results of the JDS 2 showed that invasive alien species (IAS) have become a major concern for the Danube and that their further classification and analysis is essential for an effective river basin management.

To achieve a common consensus on how to assess the presence of the invasive species in the Danube and to decide whether the ecological status of the Danube is really significantly impacted by neozoa, the ICPDR is developing a "Guidance paper on Invasive Alien Species as a significant water management issue" for the Danube River Basin. The ICPDR Monitoring and Assessment Expert Group (MA EG) adopted a joint position that IAS should not be considered en-bloc as having a negative impact on the ecological status unless a detailed integrative evaluation would prove this.

The MA EG is collecting data on the distribution of non-indigenous species within the DRB with the intention to carry out the assessment of the level of invasiveness for the aquatic taxa. To ensure the comparability of results and avoid bias due to different methods used for taxonomic investigations, only the data from routine national monitoring and Danube surveys (JDS 1, AquaTerra and JDS 2 and JDS 3) are taken into the consideration. The JDS 2 data on macroinvertebrates were used to assess the level of biocontamination at JDS 2 sites by the BioContamination Index (SBC Index – Arbačiauskas et al. 2008) (see Map 17). The SBC assessment is derived from data on number of non-indigenous species and their abundance in comparison to a total number of species and community abundance. The index value ranges from 0 ("no" biocontamination) to 4 ("severe" biocontamination). It should be emphasized that the assessment of biological contamination, as a reflection of the level of pressure caused by the IAS, should be observed independently from the ecological status assessment.

The assessment based on calculation of the mean value of SBC for the left and right river side showed high level of biocontamination along the Danube River. Out of 75 JDS 2 sites that were assessed using the SBC Index, 52 were found to be severely contaminated (SBC=4), 11 sites were assessed as highly biocontaminated (SBC=3), seven sites were assessed as moderately biocontaminated (SBC=2), while only for 4 sites low level of biocontamination has been recorded (SBC=1). At one site (site 1, Upstream Iller) non-native species were not recorded (SBC=0). Mean values of the SBC Index ranged from 2.93 for the Lower Danube, over 3.74 for the Upper Danube to 3.86 for the Middle Danube. The more positive situation in the Lower Danube could be explained by the fact that for the Lower Danube Ponto-Caspic species are considered as native, while for the Middle and Upper Danube, species of Ponto-Caspic distribution are non-native.

The first analysis using SBC index confirmed the importance of the proper assessment of IAS in the DRB. It is necessary to upgrade this analysis using JDS 3 data and other available data to obtain a longer-term overview, to test other metrics and to expand the assessment to other biological quality elements. Such comprehensive analysis will lead to the identification of the most relevant invasive species in the DRB (black list) which is a key prerequisite for deciding on the impact of IAS on the ecological status.

4.2 Surface waters: lakes, transitional waters, coastal waters

In the DRBD, four lakes are identified as being of basin-wide importance: Neusiedlersee/Fertö-tó consisting of two water bodies (AT/HU), Lake Balaton (HU), Lake Yalpug (UA) and Lake Razim / Razelm (RO), which was originally marine water, gradually cut off from the Black Sea and has now turned into a freshwater lake.

Table 24 summarises whether significant hydromorphological alterations and/or chemical pressures are affecting the DRBD lakes (analysed as of 2013).

Table 24: Presence of significant hydromorphological alterations and chemical pressures affecting DRBD lakes

	Country	Significant hydromorphological alteration	Significant chemical pressure
Neusiedler See / Fertö-tó	AT/HU	No	No
Lake Balaton	HU	No	No
Lake Razim /Razelm	RO	No	No
Lake Yalpug	UA	No information	No information

Transitional waters are located in Romania and Ukraine within the DRBD and two transitional water bodies were reported by Romania – Lake Sinoe and the Black Sea waters from the Chilia mouth to Periboina. None of the two transitional water bodies located in Romania were reported to be under significant pressures.

With regard to the 4 coastal water bodies located in Romania none was reported to be under significant pressure.

4.3 Groundwater

This chapter summarises the significant pressures that have been identified for the 11 transboundary GWBs of basin-wide importance. An indicative overview of these pressures is presented in Table 25 whereas detailed information on the relevant pressures for each groundwater body is given in Annex 5.

Table 25 also provides an overview of the results of the risk assessment carried out in 2004 and 2013, of the status assessment made in 2009 for the 1st DRBM Plan and of the significant pressures in 2009 and the future significant pressures expected by 2021.

The basic principles and assessment of pollution sources for surface waters described in Chapter 4.1 also provide relevant background information for groundwater due to the very close interrelation between the two water categories. Specifically, synergies between groundwater and the three SWMIs of organic, nutrient and hazardous substance pollution are of importance.

Table 25: Risk assessment, status assessment and analysis of pressures for level A GWBs

GWB	Nat. part	No of monitoring sites (2012/2013) Quality	No of monitoring sites (2012/2013) Quantity	Quality: Status 2009	Quality: Status Pressure Types 2009	Quality: Risk 2004 →2015	Quality: Exemptions from 2015	Quality: Risk 2013 →2021	Quality: Risk Pressure types →2021	Quantity: Status 2009	Quantity: Status Pressure Types 2009	Quantity: Risk 2004 →2015	Quantity: Exemptions from 2015	Quantity: Risk 2013 →2021	Quantity: Risk Pressure types →2021
1	AT-1	4	3	Good	-	-	-	-	-	Good	-	-	-	-	-
	DE-1	4	4												
2	BG-2	6	6	Good	-	-	-	-	-	Good	-	-	-	-	-
	RO-2	26	1												
3	MD-3	6	23	Good	-	Risk	-	Risk	PS, DS, WA	Good	-	-	-	-	-
	RO-3	14	10			-		-	-						
4	BG-4	5	4	Good	-	-	-	-	-	Good	-	-	-	-	-
	RO-4	21	13												
5	HU-5	136	111	Poor	DS	Risk	Yes	Risk	DS	Good	-	Risk	-	-	-
	RO-5	15 / 4	78 / 3									-			
6	HU-6	27	19	Good	-	Risk	-	-	-	Good	-	-	-	-	-
	RO-6	32 / 9	115 / 8			-									
7	HU-7	149	147	Poor	DS	Risk	Yes	Risk	DS	Poor	WA	Risk	Yes	Risk	WA
	RO-7	25	16	Good	-	-	-	-	-	Good	-	-	-	-	-
	RS-7	16	39	Good*	-	Risk	Yes	-	-	Poor*	WA	Risk	Yes	Risk	WA
8	HU-8	54	106	Poor	DS	Risk	Yes	Risk	DS	Poor	WA	Risk	Yes	-	-
	SK-8	51	277	Good	-	Risk	-		PS, DS	Good	-	-	-		
9	HU-9	10	17	Good	-	Risk	-	-	-	Good	-	-	-	-	-
	SK-9	17	101			-									
10	HU-10	13	16	Good	-	-	-	-	-	Good	-	-	-	-	-
	SK-10	5	28												
11	HU-11	24	45	Good	-	Risk	-	-	-	Poor	WA	Risk	Yes	Risk	WA
	SK-11	0	0							Good			-		

The risk 2021 data for Hungarian GWBs are preliminary

* The status information is of low confidence as it is based on the risk assessment.

No of monitoring sites	**Total number of monitoring sites (quality and quantity) – Reference year 2012/2013**
Status 2009	Good / Poor
Status Pressure Types 2009	Indicates the significant pressures for not achiving **good status** in 2009. **AR** = artificial recharge, **DS** = diffuse sources, **PS** = point sources, **OP** = other significant pressures, **WA** = water abstractions.
Risk 2004→2015	Risk / - (which means 'no risk'). Risk of not achieving good status in 2015
Exemptions from 2015	Indicates whether there are exemptions for the GWB from acheving good status in 2015.
Risk 2013→2021	Risk / - (which means 'no risk'). Risk of not achieving good status in 2021
Risk Pressure types →2021	Indicates the significant pressures **for the risk** of not achieving good status in 2021. **AR** = artificial recharge, **DS** = diffuse sources, **PS** = point sources, **OP** = other significant pressures, **WA** = water abstractions.

4.3.1 Groundwater quality

Diffuse and/or point sources of pollution were reported as significant pressures causing risk of not achieving *good* groundwater chemical status in 2021 for 6 national shares which are located in 4 transboundary GWBs of basin wide importance. Seven transboundary GWBs (and in total 17 national shares) are not at risk of failing good chemical status in 2021 and therefore not subject to significant pressures on groundwater quality.

The overall assessment of significant pressures on the chemical status in 2009 identified pollution by nitrates from diffuse sources as the key factor. The major sources of the diffuse pollution were:

- agricultural activities,
- non-sewered population, and
- urban land use.

These challenges still remain causing risk of failing good chemical status in 2021 for nitrates but also for ammonium. Furthermore, in the national parts of 2 transboundary GWBs point sources of pollution are now identified as significant pressures; in particular:

- leakages from waste disposal,
- leakages from contaminated sites,
- leakages from oil industry infrastructure, as well as
- mining water discharges.

4.3.2 Groundwater quantity

The assessment of pressures on groundwater quantity of the 11 transboundary GWBs of basin-wide importance in 2009 showed that over-abstraction prevented the achievement of *good* quantitative status for three GWBs. Compared to the status assessment in 2009, three national shares which were in poor status are still at risk, one (HU-8) which was in poor status is no longer at risk and one (SK-11) which was in good status is now at risk of failing good status in 2021.

In 2013 the over-abstraction still posed a significant pressure on 4 national shares situated within two GWBs caused mainly by:

- Abstractions for agriculture
- Abstractions for public water supply
- Abstractions by industry

Nine transboundary GWBs of basin wide importance (19 national shares) are not at risk of failing good groundwater quantitative status in 2021 and therefore do not exhibit significant quantitative pressures.

5 Artificial and Heavily Modified Water Bodies

Economic development and social needs have substantially physically changed rivers and other waters e.g. for flood control, navigation, hydropower generation, water supply and other purposes. Surface waters have been used as an economic resource and canals and reservoirs have been created where no water bodies previously existed.

One of the key objectives of the WFD is to ensure that water bodies meet 'good ecological status'. However, aquatic ecosystems which are part of modified water bodies may not be able to meet this standard considering the uses connected with such water bodies. This is why the WFD allows to designate some of their surface waters as heavily modified water bodies or artificial water bodies whereby specific environmental objectives are applied. They will need to meet the 'good ecological potential' criterion for these ecosystems and 'good chemical status'. However, artificial and heavily modified water bodies will still need to achieve the same low level of chemical contamination as other water bodies. A series of conditions have to be met to designate water bodies in these categories.

5.1 Approach for the designation of Heavily Modified Water Bodies

WFD Article 5 and Annex II allows inter alia for the identification and designation of artificial and heavily modified water bodies. A surface water body is considered as artificial when created by human activity. Heavily modified water body (HMWB) means a body of surface water which as a result of physical alterations by human activity is substantially changed in character, as designated by the Member State in accordance with the provisions of Annex II.

According to those provisions, EU MS may designate a body of surface water as artificial or heavily modified, when:

- its hydromorphological characteristics have substantially changed so that good ecological status cannot be achieved and ensured;
- the changes needed to the hydromorphological characteristics to achieve good ecological status would have a significant adverse effect on the wider environment or specific uses;
- the beneficial objectives served by the artificial or modified characteristics of the water body cannot, for reasons of technical feasibility or disproportionate costs, reasonably be achieved by other means, which are a significantly better environmental option.

The designation of a water body as heavily modified or artificial means that instead of ecological status, an alternative environmental objective, namely ecological potential, has to be achieved for those water bodies, as well as good chemical status.

The DBA 2004 first provisionally identified HMWBs, and artificial water bodies (AWBs) were presented on the basis of specific basin-wide criteria. For the DRBM Plan 2009, the Danube countries reported the nationally identified artificial and heavily modified water bodies. Updated information on the designation of AWBs and HMWBs was reported by the Danube countries for the 2013 DBA.

5.1.1 Surface waters: rivers

The 1st DRBM Plan included the final HMWB designation for EU MS. The Non EU MS performed a provisional identification based on criteria outlined in the DBA 2004, whereas all water bodies have been fully considered for the designation.

For the 1st DRBM Plan (Part A), the designation of HMWBs for rivers and transitional waters was performed for:

a. The Danube River;
b. Tributaries in the DRBD >4,000 km^2.

For the Danube River, the Danube countries agreed on a harmonised procedure for the final HMWB designation (the designation for HR, RS and UA was provisional) and on specific criteria for a step by step approach.

The HMWB designations for the tributaries are based on national methods and respective reported information. However, the preconditions for the basin-wide final HMWB designation (regarding both the Danube River and tributaries >4,000 km^2) are to follow the EC HMWB CIS[11] guidance document. The Tisza Lake is a heavily modified river water body according to the definition of the EU WFD CIS Reporting Guidance Document.

5.1.2 Surface waters: lakes, transitional waters and coastal waters

The HMWB/AWB designations for coastal and lake water bodies are based on national methods and the respective reported information is summarised below.

5.2 Results of the designation of Heavily Modified and Artificial Water Bodies

5.2.1 Surface waters: rivers

Table 26 and Figure 28 provide information on the designation of DRBD rivers into Natural Water Bodies, HMWB and AWB. Out of overall 703 river water bodies in the entire DRBD (Danube River and DRBD Tributaries) a total number of 247 are designated heavily modified (230 final and 17 provisional HMWBs). These are 35% of the water bodies. This means that 11,551 rkm out of a total 25,207 rkm are heavily modified (39% final HMWBs and 3 % provisional HMWBs) due to significant physical alterations. Further, 25 water bodies are AWBs. The results are also illustrated in Map 18.

Table 26: Designated HMWBs and AWBs in the DRBD (expressed in rkm, number of water bodies and percentage)

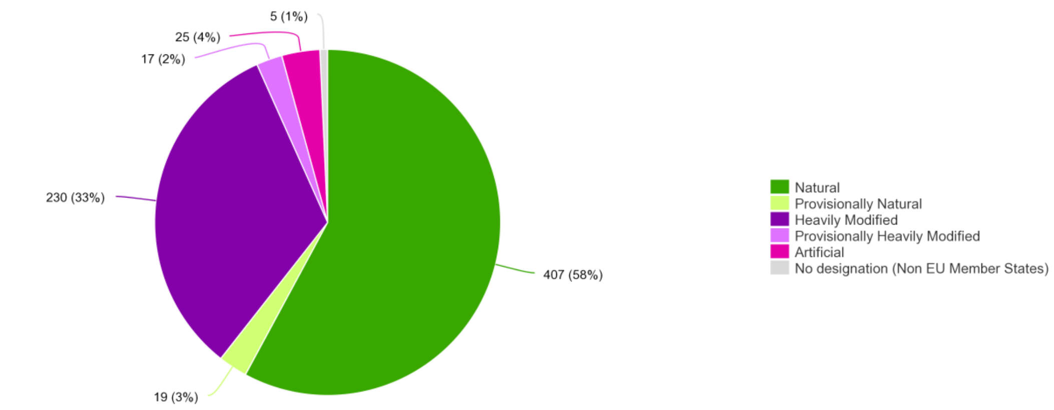
Rivers – Danube River Basin District (DRBD)		
Total number of WBs: 703	Total number of HMWBs: 247 (230 final and 17 provisional HMWB)	Proportion HMWB (number): 35%
Total WB length (km)[12]: 27,208	Total HMWB length (km): 11,551 (10,683 final and 868 provisional HMWB)	Proportion HMWB (length): 42%
The Danube River		
Total number of WBs: 59	Total number of HMWBs: 35 (33 final and 2 provisional HMWB)	Proportion HMWB (number): 59%
Total length (km): 2,857	Total HMWB length (km)[13]: 1,810 (1,764 final and 46 provisional HMWB)	Proportion HMWB (length): 63%

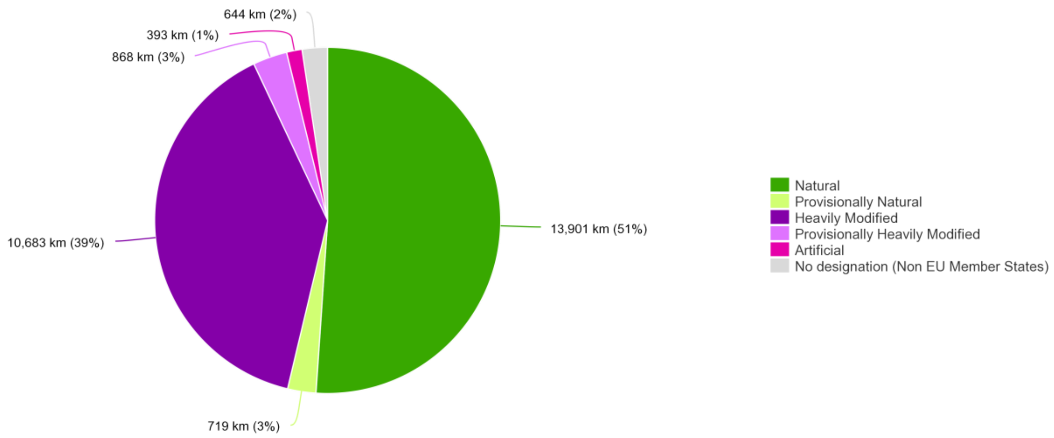
[11] EC HMWB CIS: European Commission's Common Implementation Strategy for HMWB.

[12] Including double-counting for transboundary water bodies.

[13] Double-counting of the length of transboundary water bodies was avoided for the Danube.

Figure 28: HMWBs, AWBs and natural water bodies in the DRBD, indicated in number of river water bodies and length (River km)





HMWB designation for the Danube River

Out of a total of 59 Danube River water bodies, 33 water bodies were designated as heavily modified by the EU MS. 2 were designated as provisionally heavily modified by the Non EU MS (see Table 26). Therefore, 1,810 rkm of the entire Danube River length (63%) have been designated as HMWB. No artificial water body has been designated for the Danube River itself. The results are illustrated in Map 18.

5.2.2 Surface waters: lakes, transitional waters and coastal waters

Out of 5 lake water bodies, none was designated as heavily modified or as artificial water body. Out of 2 transitional water bodies, none was designated as heavily modified or as artificial. Out of the 4 coastal water bodies, 2 were designated as heavily modified and none was identified as artificial.

The most significant canals, largely intended for navigation, are the Main-Danube Canal in DE, the Danube-Tisza-Danube Canal System in RS and the Danube-Black Sea Canal in RO.

6 Impacts and Risk Assessment

According to the provisions in Annex II 1.5 WFD an assessment is necessary on "the likelihood that surface water bodies within a river basin district will fail to meet the environmental quality objectives set for the bodies under Article 4" and that the aim of this risk assessment is to "optimise the design of both the monitoring programmes required under Article 8, and the programmes of measures required under Article 11". Also for groundwater it is mentioned in Annex II 2.1 and 2.2. that groundwater bodies need to be characterised in order to "assess the degree to which they are at risk of failing to meet the objectives for each groundwater body under Article 4".

In Annex II 1.5 it is mentioned that the risk assessment should be based on the results of the pressure and impact analysis as well as any other relevant information. Thus next to the assessment of impacts (for which the results of the monitoring campaigns as well as the status assessment from the past RBM Plan can be used), it is necessary to take into account the long-term trends (e.g. climate change) and new developments (e.g. new infrastructure but also future economic developments) for assessing if the environmental objectives will be reached by 2021. Thus if a water body is at present in good status but the economic trends show that the population will increase, urban sprawl will be growing, the agriculture will increase and intensify, there may be a risk of deterioration of good status in future and measures may need to be taken.

The situation is similar for groundwater. Besides reaching good status there can also be significant and sustained upward pollution trends. The issue with GW is also that the resilience and the response times are different, as well as the behaviour of the groundwater bodies in relation to the pressures. Nevertheless, the relationship between status and risk is conceptually the same for surface and groundwater and it has to be repeatedly addressed in each planning cycle.

6.1 Monitoring networks for surface waters and groundwater

6.1.1 Surface waters

In line with the provisions of the DRPC, the TNMN in the DRB has been in operation since 1996 (see Map 19). The major objective of the TNMN is to provide an overview of the overall status and long-term changes of surface water and, where necessary, groundwater status in a basin-wide context (with particular attention paid to the transboundary pollution load). In view of the link between the nutrient loads of the Danube and the eutrophication of the Black Sea, the monitoring of sources and pathways of nutrients in the DRB and the effects of measures taken to reduce the nutrient loads into the Black Sea are an important component of the scheme.

The TNMN laboratories have a free choice of analytical method, providing they are able to demonstrate that the method in use meets the required performance criteria. To ensure the quality of collected data, a basin-wide Analytical Quality Control (AQC) programme is regularly organized by the ICPDR.

To meet the requirements of both the WFD and the DRPC, the TNMN for surface waters consists of the following elements:

- Surveillance monitoring I: Monitoring of surface water status;
- Surveillance monitoring II: Monitoring of specific pressures;
- Operational monitoring;
- Investigative monitoring.

Surveillance monitoring II is a joint monitoring activity of all ICPDR Contracting Parties, which produces data on concentrations and loads of selected parameters in the Danube and major tributaries. Surveillance monitoring I and operational monitoring is based on collection of data on the status of surface water and groundwater bodies in the DRBD, to be published in the DRBM Plan. Investigative monitoring is primarily a national task. However, on the basin-wide level, the JDS serve the investigative monitoring as required e.g. for harmonisation of existing monitoring methodologies; filling information gaps in monitoring networks; testing new methods; or checking the impact of "new" chemical substances in different matrices. JDSs are carried out every 6 years.

6.1.2 Groundwater

The transnational groundwater management activities in the DRBD were initiated in 2002 and were triggered by the implementation of the WFD. Monitoring of the 11 transboundary GWBs of basin-wide importance has been integrated into the TNMN of the ICPDR. For groundwater monitoring under the TNMN (GW TNMN) a 6-year reporting cycle has been set, which is in line with reporting requirements under the WFD. GW TNMN includes both quantitative and chemical (quality) monitoring. It shall provide the necessary information to: assess groundwater status; identify trends in pollutant concentrations; support GWB characterisation and the validation of the risk assessment; assess whether drinking water protected area objectives are achieved and support the establishment and assessment of the programmes of measures and the effective targeting of economic resources. To select the monitoring sites, a set of criteria has been applied by the countries, such as aquifer type and characteristics (porous, karst and fissured, confined and unconfined groundwater) and depth of the GWB (for deep GWBs, the flexibility in the design of the monitoring network is very limited). The flow direction was also taken into consideration by some countries, as well as the existence of associated drinking water protected areas or ecosystems (aquatic and/or terrestrial).

The qualitative monitoring determinants of GW TNMN, which are set as mandatory by the WFD, include dissolved oxygen, pH-value, electrical conductivity, nitrates and ammonium. The measurement of temperature and set of major (trace) ions is recommended as they can be helpful to validate the Article 5 risk assessment and conceptual models. Selective determinants (e.g. heavy metals and relevant basic radionuclides) would be needed for assessing natural background concentrations. It is also recommended to monitor the water level at all chemical monitoring points in order to describe (and interpret) the physical status of the site and to help in interpreting (seasonal) variations or trends in chemical composition of groundwater. In addition to the core parameters, selective determinants will need to be monitored at specific locations, or across GWBs, where the risk assessments indicate a risk of failing to achieve WFD objectives. Transboundary water bodies shall also be monitored for those parameters that are relevant for the protection of all uses supported by groundwater.

As regards quantitative monitoring, WFD requires only the measurement of groundwater levels but the ICPDR has also recommended monitoring of spring flows; flow characteristics and/or stage levels of surface water courses during drought periods; stage levels in significant groundwater dependent wetlands and lakes and water abstraction as optional parameters.

6.2 Risk assessment for surface waters: rivers, lakes, transitional waters and coastal waters

This chapter shows the risk of failure to achieve by 2021 the WFD environmental objective for rivers, lakes, transitional waters and coastal waters. The risk analysis was made at the national level taking into account the ongoing pressures persisting from the past and the pressures which may emerge in future due to long-term trends and new developments.

6.2.1 Rivers

Figure 29 illustrates the length of the river water bodies having the risk of failure to achieve a good ecological status or ecological potential by 2021. Figure 30 shows the length of the river water bodies having the risk of failure to achieve good chemical status by 2021. Altogether 25,582 km of river water bodies were evaluated. 11,840 km of rivers will be not at risk of failure to achieve good ecological status or ecological potential (42%) and 16,192 km of rivers will be not at risk of failure to achieve good chemical status (60%).

Figure 29: Risk assessment – Ecological Status

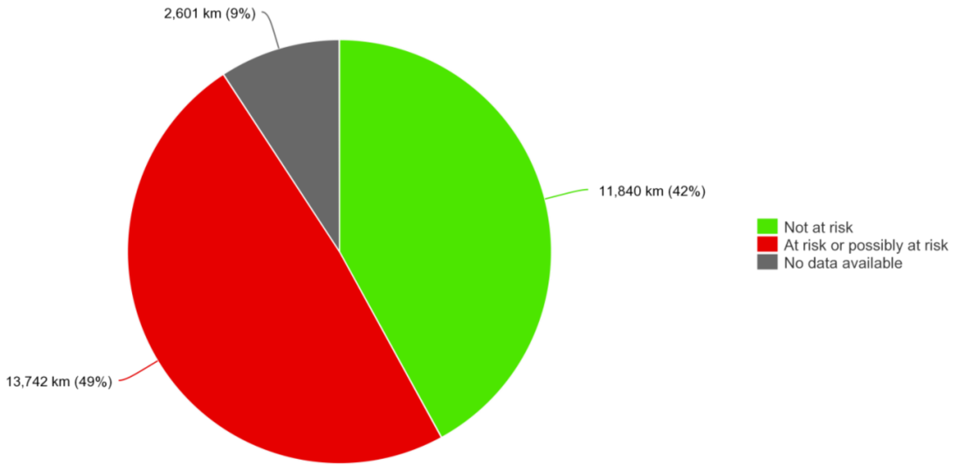
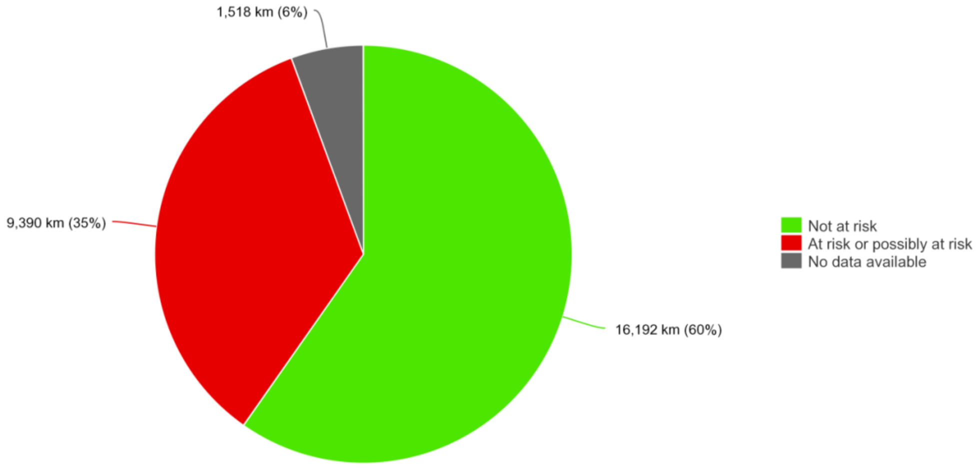


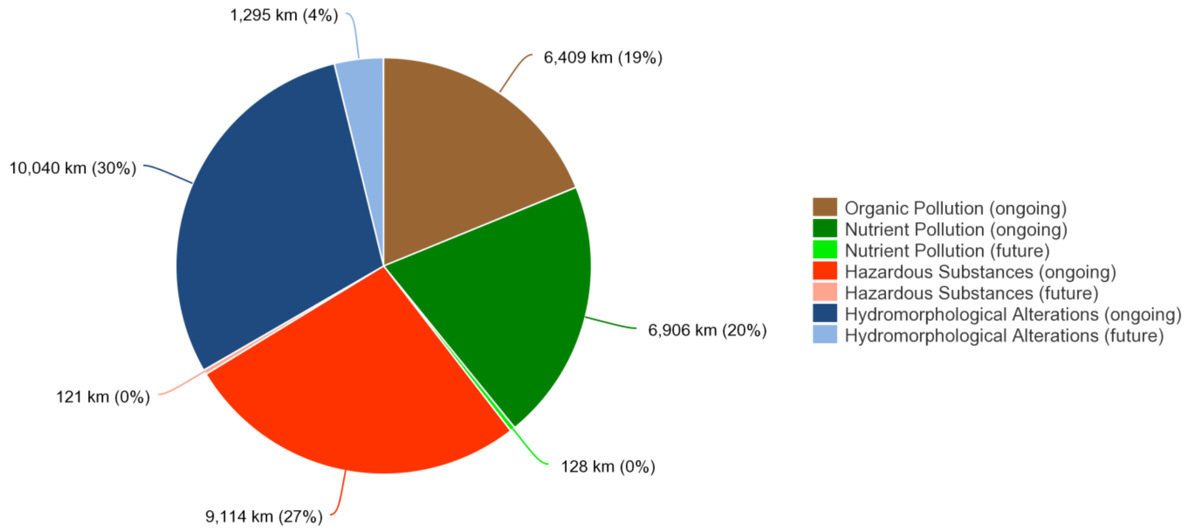
Figure 30: Risk assessment – Chemical Status



The reasons of the risk of failure to achieve a good ecological status / potential or good chemical status by 2021 expressed in terms of pressures by organic pollution, nutrient pollution, hazardous substances pollution and hydromorphological alterations are shown on Figure 31[14]. This figure distinguishes between the ongoing pressures persisting from the past and the pressures which may emerge in future due to long-term trends and new developments. Further detailed information on the different pressures can be obtained from Chapter 4.

[14] In this graph, the length in kilometres of river water bodies reported for level A (rivers with catchment size larger than 4,000km²) affected by each pressure type are summed up, so the total (100%) includes duplicated.river water bodies if they are located on border rivers or are affected by multiple pressures.

Figure 31: Risk by pressures



6.2.2 Lakes

Three lakes - consisting of four lake water bodies - were evaluated. None of them was at risk of failure to achieve a good ecological status / ecological potential and good chemical status by 2021.

6.2.3 Transitional waters

Two transitional water bodies were evaluated. Lake Sinoe and Chilia-Periboina were not at risk of failure to achieve a good ecological status / ecological potential and good chemical status by 2021.

6.2.4 Coastal waters

Altogether four coastal water bodies were evaluated. None of them was at risk of failure to achieve a good ecological status / ecological potential and good chemical status by 2021.

6.2.5 Gaps and uncertainties

The results of chemical status assessment in future can be affected by several factors. The most obvious is the change in concentrations of priority substances. As a result of implementation of the programme of measures a decreasing trend is expected but an increase in concentration of a particular substance due to a specific pollution in future cannot be excluded. There is however a number of other factors influencing the chemical status assessment caused not by changes of priority substance concentrations in water bodies but by differences in the assessment methodologies and approaches applied in the past and future.

In 2013 Directive 2013/39/EU amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy has been adopted. This directive set revised environmental quality standards with effect from 22 December 2015, with the aim of achieving good surface water chemical status in relation to those substances by 22 December 2021 by means of programmes of measures included in the 2015 river basin management plans. Directive 2013/39/EU also identified new priority substances with effect from 22 December 2018, with the aim of achieving good surface water chemical status in relation to those substances by 22 December 2027 and preventing deterioration in the chemical status of surface water bodies in relation to those substances. It is apparent that changing EQS and introducing new substances can induce negative changes in chemical status even in case when the concentrations of substances listed in 2008/105/EC would have a decreasing trend.

The other methodological reasons are highlighted in the “EC Report on the Implementation of the Water Framework Directive (2000/60/EC) - River Basin Management Plans”. This report points out that most of the Member States reported very limited failures for some of the priority substances. A large proportion of water bodies (above 40%) have not been assessed for chemical status and many monitoring programmes seem to be very limited in terms of number of substances and monitoring stations. As a consequence, the picture presented by the chemical status assessment of the first RBMPs is incomplete. This is also the case for the first DRBMP showing no data on chemical status for 21% of water bodies. Moreover, not all substances from the Directive 2008/105/EC have been assessed in all countries due to methodological problems.

The other issue highlighted in the “EC Report on the Implementation of the Water Framework Directive (2000/60/EC) - River Basin Management Plans” was that only few Member States opted to apply, according to the Article 3(2 a) of the Directive 2008/105/EC, EQSs for mercury and its compounds, hexachlorobenzene and/or hexachlorobutadiene in biota. No Member State has set more stringent EQSs for mercury in water as required by the Directive 2008/105/EC where the biota standards are not used. The lack of detection of the mercury problem in most of the Member States might be a consequence of the insufficient monitoring practices and of the fact that more stringent standards for mercury in water have not been set. This is also the case for the Danube as the issue of mercury in biota can be a chemical time bomb. In case better information will available due to better monitoring performance the status of a water body can change negatively having an adverse impact on communicating progress in the implementation of the WFD.

All those specific reasons mentioned above can lead to a quite realistic possibility of an increase of the number of water bodies not achieving good chemical status not because the programme of measures failed but as a consequence of having available more comprehensive information on polluting substances in surface waters (when compared to information that was available in 2009).

6.3 Risk Assessment for groundwater

The risk assessment made for the 11 groundwater bodies of basin-wide importance was produced at the national level and it was based on the results of the pressure and impact analysis using also any other relevant available information. In addition, it was necessary to take into account the long-term trends and new developments, which might pose a significant pressure in future.

6.3.1 Groundwater quality

Out of 11 transboundary GWBs of basin-wide importance (all 23 national parts were evaluated), a risk of failure to achieve good chemical status by 2021 was identified in 6 national shares (located in 4 different transboundary GWBs of basin wide importance). In 5 national shares the failing parameter is nitrates and in one national share the failing parameter is ammonium. Compared to the status assessment of 2009 now also 2 additional national shares (MD-3 [nitrates] and SK8 [ammonium]), which were reported as of good chemical status in 2009, exhibit risk of failing good status in 2021.

Reasons for the risk are commonly a failured general assessment of the GWB as a whole. In one national share (HU-7) groundwater also causes a failure of achieving the environmental objectives of associated aquatic ecosystems and in another national share (SK-8) environmentally and statistically significant increasing trends were detected.

Seven transboundary GWBs as a whole (and in total 17 national shares of transboundary GWBs) were not reported of being at risk of failing good chemical status in 2021, which were already reported of good chemical status in 2009. A comparison between previous status and risk results and the actual situation is given in Table 25. Detailed information is presented in Table 27.

6.3.2 Groundwater quantity

Out of 11 transboundary GWBs of basin-wide importance (all 23 national parts were evaluated), the risk of failure to achieve good quantitative status by 2021 was identified in 4 national shares (located in two transboundary GWBs). Compared to the status assessment in 2009, three national shares which were in poor status are still at risk, one (HU-8) which was in poor status is no longer at risk and one (SK-11) which was in good status is now at risk of failing good status in 2021.

Commonly reported reasons for the risk of failure in 2021 are exceedances of the available groundwater resource. In one national share (HU-11) there is a groundwater caused risk of a failure of achieving the environmental objectives of associated aquatic ecosystems in 2021, in two national shares significant damage to groundwater dependent ecosystems are at least expected and in another national share (RS-7) the use of groundwater for drinking water purposes is or might be significantly affected causing a failure of achieving good quantitative status in 2021.

Nine transboundary GWBs of basin wide importance (19 national shares) are not at risk of failing good groundwater quantitative status in 2021 and therefore do not exhibit significant quantitative pressures. Eight out of these transboundary GWBs (18 national shares) were already of good quantitative status in 2009.

A comparison between previous status and risk results and the actual situation is given in Table 25. Detailed information is presented in Table 28.

Table 27: Reasons for risk of failing Good Chemical Status in 2021 for the ICPDR GW-bodies

GWB	Name	National part	Year of assessment	"at risk"	for which parameters	Failured general assessment of GWB as a whole	Saline or other intrusions	Failured achievement of Article 4 objectives for associated surface waters	Significant damage to GW dependent terrestrial ecosystem	Art 7 drinking water protected area affected	increasing trend exceeding starting points of trend reversal
				at risk / -	*parameter*	*Yes / - / Unknown (parameter)*	*Yes / - / Unknown (parameter)*	*Yes / - / Unknown (parameter)*	*Yes / - / Unknown (parameter)*	*Yes / - / Unknown (parameter)*	*Yes / - / Unknown (parameter)*
GWB-1	Deep Groundwater Body – Thermal Water	AT-1	2013	-	-	-	-	-	-	-	-
		DE-1	2013	-	-	-	-	-	-	-	-
GWB-2	Upper Jurassic – Lower Cretaceous GWB	BG-2	2013	-	-	-	-	-	-	-	-
		RO-2	2013	-	-	-	-	-	-	-	-
GWB-3	Middle Sarmatian - Pontian GWB	MD-3	2013	at risk	nitrates	-	-	-	-	unknown	unknown
		RO-3	2013	-	-	-	-	-	-	-	-
GWB-4	Sarmatian GWB	BG-4	2013	-	-	-	-	-	-	-	-
		RO-4	2013	-	-	-	-	-	-	-	-
GWB-5	Mures / Maros	HU-5	2014	at risk	nitrates	yes	-	-	-	-	-
		RO-5	2013	at risk	nitrates	yes	-	-	-	-	-
GWB-6	Somes / Szamos	HU-6	2014	-	-	-	-	-	-	-	-
		RO-6	2013	-	-	-	-	-	-	-	-
GWB-7	Upper Pannonian – Lower Pleistocene / Vojvodina / Duna-Tisza köze deli r.	HU-7	2014	at risk	nitrates	yes	-	yes	-	-	-
		RO-7	2013	-	-	-	-	-	-	-	-
		RS-7	2013	-	-	-	-	-	-	-	-
GWB-8	Podunajska Basin, Zitny Ostrov / Szigetköz, Hanság-Rábca	HU-8	2014	at risk	nitrates	yes	-	-	-	-	-
		SK-8	2014	at risk	ammonium	yes	-	unknown	unknown	-	(NH_4, NO_3 – agriculture) (Cl, As, SO_4, TOC – industry)
GWB-9	Bodrog	HU-9	2014	-	-	-	-	-	-	-	-
		SK-9	2014	-	-	-	-	unknown	unknown	-	-
GWB-10	Slovensky kras / Aggtelek-hgs.	HU-10	2014	-	-	-	-	-	-	-	-
		SK-10	2014	-	-	-	-	unknown	unknown	-	-
GWB-11	Komarnanska Vysoka Kryha / Dunántúli-khgs. északi r.	HU-11	2014	-	-	-	-	-	-	-	-
		SK-11	2014	-	-	-	-	-	-	-	unknown

The risk data for Hungarian GWBs are preliminary

Table 28: Reasons for risk of failing Good Quantitative Status in 2021 for the ICPDR GW-bodies

GWB	**Name**	**National part**	**Year of assessment**	**"at risk"**	Exceedance of available GW resource	Failured achievement of Article 4 objectives for associated surface waters	Significant damage to GW dependent terrestrial ecosystem	Uses affected	Intrusions detected or likely to happen due to alterations of flow directions resulting from level changes
				at risk / -	*Yes / - / Unknown*	*Yes / - / Unknown*	*Yes / - / Unknown*	*Yes / - / Unknown If yes, which?*	*Yes / - / Unknown*
GWB-1	Deep Groundwater Body – Thermal Water	AT-1	2013	-	-	-	-	-	-
		DE-1	2013	-	-	-	-	-	-
GWB-2	Upper Jurassic – Lower Cretaceous GWB	BG-2	2013	-	-	-	-	-	-
		RO-2	2013	-	-	-	-	-	-
GWB-3	Middle Sarmatian - Pontian GWB	MD-3	2013	-	-	-	-	-	-
		RO-3	2013	-	-	-	-	-	-
GWB-4	Sarmatian GWB	BG-4	2013	-	-	-	-	-	-
		RO-4	2013	-	-	-	-	-	-
GWB-5	Mures / Maros	HU-5	2014	-	-	-	-	-	-
		RO-5	2013	-	-	-	-	-	-
GWB-6	Somes / Szamos	HU-6	2014	-	-	-	-	-	-
		RO-6	2013	-	-	-	-	-	-
GWB-7	Upper Pannonian – Lower Pleistocene / Vojvodina / Duna-Tisza köze deli r.	HU-7	2014	at risk	yes		yes		
		RO-7	2013	-	-	-	-	-	-
		RS-7	2013	at risk	yes	-	unknown	yes, DRW	unknown
GWB-8	Podunajska Basin, Zitny Ostrov / Szigetköz, Hanság-Rábca	HU-8	2014	-	-	-	-	-	-
		SK-8	2014	-	-	-	unknown	-	-
GWB-9	Bodrog	HU-9	2014	-	-	-	-	-	-
		SK-9	2014	-	-	-	unknown	-	-
GWB-10	Slovensky kras / Aggtelek-hgs.	HU-10	2014	-	-	-	-	-	-
		SK-10	2014	-	-	-	unknown	-	-
GWB-11	Komarnanska Vysoka Kryha / Dunántúli-khgs. északi r.	HU-11	2014	at risk	yes	yes	yes		
		SK-11	2014	at risk	unknown	-	-	unknown	-

The risk data for Hungarian GWBs are preliminary

7 Inventory of Protected Areas

Protected areas are often directly linked with surface and/or groundwater bodies and their status is therefore also depending on the management practices and status of such water bodies, and vice versa. Such areas shelter valuable habitats for flora and fauna, and can provide numerous ecosystem services.

Objectives for protected areas are also determined by the WFD in Article 4, requiring to "achieve compliance with any standards and objectives at the latest 15 years after the date of entry into force of this directive unless otherwise specified in the Community legislation under which the individual protected areas have been established".

The protected areas to be considered are listed in WFD Annex IV. Furthermore, the WFD requires to establish a "register or registers of all areas lying within each river basin district which have been designated as requiring special protection under specific Community legislation for the protection of their surface water and groundwater or for the conservation of habitats and species directly depending on water" (WFD Article 6).

At the Danube basin-wide scale, protected areas for the protection of habitats and species, nutrient sensitive areas, including areas designated as nitrates vulnerable zones, and other protected areas in Non EU MS have been compiled and are updated. Other types of protected areas according to WFD Article 6, Annex IV (e.g. areas designated for the abstraction of water intended for human consumption under Article 7 WFD, areas designated for the protection of economically significant aquatic species, or bodies of water designated as recreational waters, including areas designated as bathing waters under Directive 76/160/EEC) are not addressed at the basin-wide level but are subject to national registers.

Table 29 provides an overview on the registers of protected areas required by WFD Article 6 and Annex IV to be kept under review and up to date. The table furthermore provides information whether the register was established and is regularly reviewed at the Danube basin-wide and/or national level.

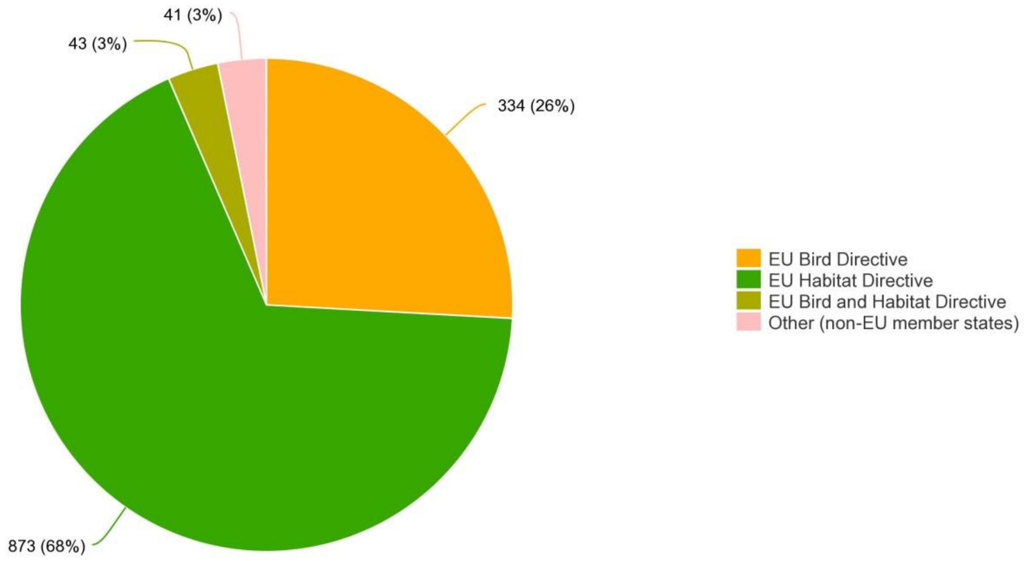
Table 29: Overview on established registers for protected areas

Type of protected area	Corresponding legislation	Register established and regularly reviewed at		Comment
		Danube basin-wide level (Part A)	National level (Part B)	
Areas designated for the abstraction of water intended for human consumption	EU Drinking Water Directive 80/778/EEC as amended by Directive 98/83/EC	-	x	-
Areas designated for the protection of economically significant aquatic species	EU Shellfish Directive 79/923/EEC and Freshwater Fish Directive 78/659/EEC	-	-	Repealed by EU WFD 2000/60/EC with effect from December 2013
Bodies of water designated as recreational waters, including areas designated as bathing waters	EU Bathing Waters Directive 76/160/EEC	-	x	Repealed by Directive 2006/7/EC
Nitrates vulnerable zones	EU Nitrates Directive 91/676/EEC	x	x	Included in 1st DRBM Plan and to be updated for 2nd DRBM Plan
Nutrient sensitive areas	EU UWWT Directive 91/271/EEC	x	x	Entire DRB is considered as a catchment area for the sensitive area under Article 5(5) of Directive 91/271/EEC
Areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection	EU Habitats Directive 92/43/EEC and EU Birds Directive 79/409/EEC	x	x	Water-relevant Natura 2000 sites
Other protected areas in Non EU Member States (e.g. Nature and Biosphere Reserves)	-	x	x	Relevant for Non EU Member States

Map 24 illustrates protected areas >500 ha designated for the protection of habitats or species where maintenance or improvement of the water status is an important factor in their protection (including Natura 2000 sites)[15]. Furthermore, the map visualises protected areas in the Non EU MS. Annex 6 includes a detailed inventory of the protected areas as illustrated in Map 24.

Figure 32 provides an overview of these protected area types for the DRBD. Out of a total of 1,255 protected areas, 873 (68%) have been designated following the EU Habitats Directive and 334 (26%) are bird protected areas (EU Birds Directive). 43 (3%) areas are protected under both the Habitat as well as Birds Directive. All of them are Natura 2000 sites designated in EU MS according to the EU WFD. 41 (3%) are protected area types reported by Non EU MS and are mainly nature reserves and Biosphere Reserves.

Figure 32: Overview on number of WFD water relevant protected areas under the EU Habitats Directive and EU Birds Directive including reported areas for Non EU MS



[15] Natura 2000 designation under the EU Directive 92/43/EEC and Directive 79/409/EEC.

8 Economic analysis

The WFD requires that river basins are also described in economic terms. This "economic analysis", which examines the economic, but also the social circumstances surrounding the use of the Danube´s water, forms a kind of foundation to base the following steps upon. This means that the planning of measures, for example, should take into account the socio-economic conditions in the basin, so as not to put the possible burden of measures disproportionally high on a single user group, or an especially vulnerable social group.

Economic principles are addressed in WFD Article 5 (and Annex III) and Article 9. A first economic analysis of water uses was carried out in 2004 for the DBA based upon the requirements of Article 5. A summary of the economic analysis of water use was included in the 1st DRBM Plan 2009 as required by WFD Article 13 and Annex VII, referring to Article 5 and Annex III. The WFD requires in Article 5 that the economic analysis shall be reviewed, and if necessary updated, at the latest 13 years after the date of entry into force of the WFD and every six years thereafter.

Furthermore, Article 9 requires that by 2010, EU MS had to take account of the principle of cost-recovery (CR), including environmental and resource costs (ERC). In addition to this direct requirement, the WFD refers implicitly to economic principles in many of its Articles.

8.1 The 2013 DBA in the context of former economic analyses in the Danube River Basin

Danube Basin Analysis 2004

The first economic analysis of the Danube River Basin (in 2004) covered three issues, complementary to the requirements for the economic analysis, based on national contributions and basin-wide assessments, with the reference year 2000:

- Assessing the economic importance of water uses;
- Projecting trends in key economic indicators and drivers up to 2015;
- Assessing current levels of recovery of costs for water services.

The assessment of the economic importance of water uses showed relatively high rates for connection to public water supply, but lower rates for connection to the public sewerage system and to wastewater treatment plants. Differences identified in the economic structure of the Danube River Basin countries (agricultural production and structure, sources and structure of electricity generation etc.) contribute to the varied importance of economic values of water among the countries.

The analysis of projected trends in key economic indicators and drivers up to 2015 showed that factors such as the level of connection rates and efficiency improvements in water supply are important in assessing future trends; but quantitative forecasts in total water supply and demand were not available in the majority of the Danube countries.

The assessment of the levels of cost recovery for water services was based on data from pricing and tariffs. As a result of differing economic, financial and institutional conditions in the Danube River Basin countries, the pricing systems also varied considerably among the countries.

Danube River Basin Management Plan 2009

The economics chapter in the 1st DRBM Plan (of 2009), which was closely linked to national WFD procedures, considered only those economic issues of relevance on the basin-wide scale and which enabled international comparison. The most important issues, the horizontal issues, i.e. issues within each Significant Water Management Issue should, as far as possible, be addressed as individual topics in the economic analysis.

For preparing the economics chapter in the 1st DRBM Plan, the information included in the DBA in 2004 was used and updated. This happened through a data collection approach, which was based on agreed templates and adapted in a way to reduce inconsistencies in data definition and collection and methodological difficulties that arose from the previous analysis in 2004.

The present version of the economic analysis is based on national contributions, namely two questionnaires treating mainly water pricing and related topics mentioned in Article 9 WFD. Hence, the present analysis updates predominantly the issues surrounding water pricing, cost recovery, and environmental and resource costs. Besides, some of the more general facts and figures have been updated as well (e.g. GDP and connection rates to sewage/water supply networks, navigation, hydropower).

An overview on the trends for some key economic indicators and drivers up to a year further in the future than 2015, ideally 2021 in line with the 2nd WFD cycle, is envisaged to be elaborated for the 2nd DRBM Plan.

Since the cost-effectiveness analysis and the cost-benefit analysis are referring to measures, these economic assessment tools are not addressed in the current update of the DBA.

8.2 Update of the economic importance of water services and water uses

According to Article 5 and Annex III of the WFD, an economic analysis of water uses had to be carried out with the aim of assessing the importance of water use for the economy and assessing the socio-economic development of the river basin; this analysis is herewith updated at the Danube River Basin level.

Table 30 presents basic socio-economic data covering all fourteen countries belonging to the ICPDR. As can be observed, a considerable difference in the GDP per capita figures exists between the Danube basin countries that shows a significant disparity in wealth. This big gap between the countries is reduced slightly when GDP per capita figures are expressed in Purchase Power Parities (PPP), as can be seen in Figure 33.

Table 30: General socio-economic indicators of Danube countries

Country	Population within the DRBD[16]	Share of population within the Danube Basin[17]	National GDP 2012[18]	GDP 2012 per capita[18]	GDP 2012 per capita[18]
	in Mio.	*in % of total population*	*in Mio. EUR*	*in EUR per capita*	*in PPP EUR per capita*
Austria	7.7	95,4% (2013)	307,003	36,400	33,300
Bosnia and Herzegovina	2.9	-	13,157.6	3,430.3	7,300 (in 2011; estimated)
Bulgaria	3.5	48,5% (in 2011)	39,668	5,400	12,100
Croatia	3.1	68.5% (in 2001)	43,904	10,300	15,600
Czech Republic	2.8	26.8% (in 2005)	152,926	14,500	20,300
Germany	9.7	41.6% (in 2010)	2,666,400	32,600	31,300
Hungary	10.0	100%	96,968	9,800	16,700
Moldova	1.1	32% (in 2011)	5,221[19]	1,466[19]	n. a.
Montenegro	0.2	28.7%	3,075	4,944[19]	7,340[20]
Romania	21.7	97.4% (estimated)	131,747	6,200	12,500
Serbia[21]	7.5	99.8%	3,147	4,335 (in 2012)	8,700 (in 2011)
Slovak Republic	5.2	96.12% (2013)	72,134 (2013)	13,330 (in 2013)	19,400
Slovenia	1.7	88% (2013)	35,319	17,200	21,400
Ukraine	2.7	-	126,863[18]	2,790[18]	n. a.

[16] ICPDR 2011: Facts and Figures Brochure.

[17] National contributions.

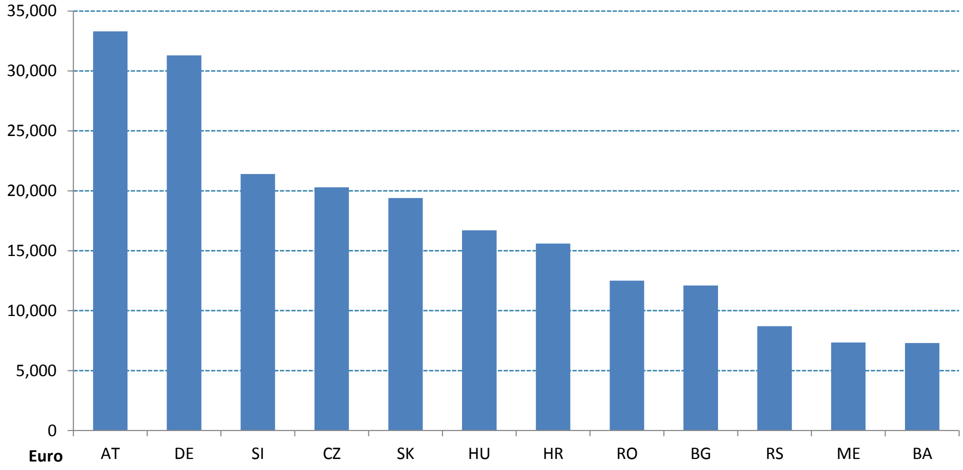
[18] eurostat.ec.europa.eu (2012 data); contributions from Danube countries.

[19] http://www.imf.org/.

[20] Data available only in International Dollars.

[21] The data from Serbia do not include any data from the Autonomous Province of Kosovo and Metohija.

Figure 33: GDP per capita (PPP) of Danube countries



Note: Some countries are not illustrated due to lack of data (Ukraine and Moldova).

8.2.1 Characteristics of water services

"Water services" means all services which provide, for households, public institutions or any economic activity (WFD Article 2 (38)):

- Abstraction, impoundment, storage, treatment & distribution of surface water or groundwater;
- Wastewater collection and treatment facilities which subsequently discharge into surface water.

Four Danube countries - Austria, Germany, Moldova and Croatia - defined water services as encompassing only water supply and wastewater collection/treatment. In the case of Croatia, it is stated that "this will probably change in the 2nd management cycle".

Seven other countries interpreted the WFD definition to encompass more than these two services. In the Czech Republic, for example, further water services (beside water supply and wastewater collection/treatment) are a) rivers and river basin management, surface water abstraction, groundwater abstraction, discharge of wastewater into surface water, discharge of wastewater into the groundwater, impoundment for the energy production, and navigation (only recreation; on Baťův kanál). At the same time, it is stated that cost recovery is only calculated for water supply and wastewater in the first cycle; in the second, CZ will include "irrigation in agriculture, water retention (in all sectors), accumulation and impoundments for the purpose of protection against flooding, production of energy (water energy, cooling)".

Slovakia defined three additional water services ("use of hydro-energy potential of watercourse, abstraction of energy water from watercourse, abstraction of surface water from watercourse"), and included these into CR calculations already in the first cycle. Serbia and Hungary defined "irrigation" as water service (Hungary also includes "other agricultural water service", such as fishponds, in the definition), whereas Romania, Slovenia and Bosnia and Herzegovina each defined a great number of water services (17 further water services in the case of Slovenia, 13 in Bosnia and Herzegovina, 8 in the case of Romania). Both Slovenia and Bosnia and Herzegovina, however, did not include these in their cost recovery assessments.

Bulgaria subdivided the water services according to the economic sectors, i.e. water supply for households, water supply for industry, water supply for agriculture, water supply for services and tourism, as well as collection and treatment of wastewater of households, collection and treatment of wastewater of industry, collection and treatment of wastewater of agriculture, and the collection and treatment of wastewater of services and tourism are each defined as individual water services. Bulgaria states that all of these are included in the calculation of CR, which, however, considers only financial costs (for more detailed information on water services, see Annex 7).

Basic information regarding water services and connection rates of the population to public water supply, public sewerage systems and wastewater treatment plants are presented in Table 31 below. The table shows the highest connection rates to public water supply mostly in the Western part of the Danube basin: Hungary and the Czech Republic (data from Germany, Austria and Slovenia not included), but some countries located in the Eastern part of the basin also show connection rates above 90% (for example, Bulgaria and Montenegro). A similar picture emerges with regard to connection rates to public sewerage systems and wastewater treatment plants - high connection rates of 90% and higher in the Western basin, and lower connection rates of 50% and below in the Eastern basin.

Table 31: Water production, wastewater services and connection rates in the Danube River Basin countries (if not indicated otherwise, the data refers to the national level)

Country	Water supply production (industry, agriculture and households from public systems)	Supply to households	Population connected to public water supply	Population connected to public sewerage system	Population connected to wastewater treatment plant
	in Mio. m³	*in Mio. m³*	*in %*	*in %*	*in %*
Austria	Available as soon as figures for the economic analysis for the 2nd national River Basin Management Plan are available.				
Bosnia and Herzegovina			60-65	46	3
Bulgaria (in 2012)	184.14 (Danube)	135.92 (Danube)	99.3	74.3	56.11
Croatia (in 2010)	281 (Danube), 502 (national level)	127	77 (Danube), 69.7 (national level)	42 (Danube), 43.6 (national level)	29 (Danube), 24 (national level)
Czech Republic	1,840.7	639.7	93.5	82.5	97.1 (of population connected to public sewerage system)
Germany	683.9	453.2	98.9	96.2	97.0
Hungary (in 2012)	598.5	341.7	94.2	74	99 (public sewerage system)
Moldova	851 (130 from GW)	118	75 (urban); 13 (rural)	75 (urban); 13 (rural)	50 (urban); 2 (rural)
Montenegro	47	0.2	97.4	64 (no of households with sewerage services)	10
Romania	2,860	550	61.3	49.1	47.1
Serbia[22] (2012)	655	324	86.6	54.6	7.5
Slovak Republic	1,047.6	302.2	83.6	60.0	58.7
Slovenia	-	-	-	-	-
Ukraine	-	-	-	-	-

Source: contributions from Danube countries. Note: National-level data is depicted in all cases except Slovakia.

In several Danube countries, the water supply networks are in poor condition due to faulty design and construction, and lack of maintenance and ineffective operation in some places. Leakage is generally high - in many cases 30–50% of the water is lost. The extent of piped drinking water supplies to households varies between urban and rural areas, with rural populations in some countries less well provided. The share of the population connected to public sewer system varies from under 10% in Moldova to over 95% in Germany.

The following two tables demonstrate the difference in the overall dimension of wastewater collection and sewage treatment that exists in the Danube river basin.

As can be seen in Table 32, in Germany and Austria the percentage of agglomerations in which wastewater is collected and treated reaches 100%; other countries in the Western part of the basin have quotas that are similarly high (the Czech Republic, Slovakia, Hungary). Further East, towards the youngest EU Member States and non-EU Member States which still have a transition period, the share of the agglomerations in which wastewater is collected and treated gets smaller. In Moldova, for

[22] The data from Serbia do not include data from the Autonomous Province of Kosovo and Metohija.

example, in only 13 out of 580 agglomerations, the wastewater is collected and treated. In the whole basin, almost 10 million people (population equivalents, to be correct) live in regions where wastewater is neither collected nor treated.

Table 32: Wastewater Collection in the Danube River Basin[23]

Country	Number of agglomerations				Population equivalent			
	Total	Collected and treated	Collected but not treated	Not collected and not treated	Total	Collected and treated	Collected but not treated	Not collected and not treated
Austria	605	605	0	0	18,703,643	18,703,643	0	0
Bosnia and Herzegovina	240	4	85	151	2,030,920	34,100	1,539,220	457,600
Bulgaria	131	24	28	79	2,815,735	2,037,359	545,765	232,611
Croatia	167	26	60	81	3,392,989	2,001,483	1,086,632	304,874
Czech Republic	237	228	9	0	2,556,296	2,535,152	21,144	0
Germany	705	705	0	0	13,080,212	13,080,212	0	0
Hungary	478	476	2		10,903,606	10,500,505	403,101	0
Moldova	190	19	10	161	845,523	254,275	48,214	543,034
Montenegro	-	-	-	-	-	-	-	-
Romania	2,390	486	196	1,708	24,580,527	12,735,280	4,833,823	7,011,424
Serbia[24]	485	33	163	289	5,467,046	876,740	3,475,236	1,115,070
Slovak Republic	343	330	13	0	4,775,114	4,713,085	62,029	0
Slovenia	138	110	17	11	1,313,345	1,177,073	95,921	40,351
Ukraine	43	25	6	12	964,524	837,276	58,300	68,948
DRBD	**6,152**	**3071**	**589**	**2,492**	**91,429,480**	**69,486,183**	**12,169,385**	**9,773,912**

The following Table 33 demonstrates the level of the treatment, and again clearly shows the difference in the level of wastewater treatment in the Danube basin. As can be seen, treatment plants with only primary treatment do not exist in the Western part of the basin anymore. At the same time, treatment plants that also remove nutrients, especially both nitrogen and phosphorous, are very common in Germany and Austria (actually, most of the treatment plants in these two countries have N and P removal), and less and less frequent towards the lower riparians and new EU Member States.

Table 33: Sewage Treatment in the Danube River Basin[25]

Country	Number of agglomerations					Population equivalent				
	Primary	Secondary	P removal	N removal	NP removal	Primary	Secondary	P removal	N removal	NP removal
Austria	0	5	82	5	513	0	20,920	1,417,223	31,100	17,234,400
Bosnia and Herzegovina	0	4	0	0	0	0	34,100	0	0	0
Bulgaria	8	11	0	0	5	75,519	556,001	0	0	1,405,839
Croatia	12	13	0	0	1	271,223	1,675,484	0	0	54,776
Czech Republic	0	112	25	21	70	0	337,340	109,800	87,560	2,000,452
Germany	0	131	45	106	423	0	446,500	199,861	438,073	11,995,778
Hungary	6	192	13	18	247	34,955	3,272,890	964,001	417,924	5,810,735
Moldova	10	9	0	0	0	108,995	145,280	0	0	0
Montenegro	-	-	-	-	-	-	-	-	-	-
Romania	207	273	0	3	3	2,292,366	8,792,969	0	1,208,615	441,330
Serbia[26]	1	31	0	0	1	57,411	719,348	0	0	99,981

[23] Source: Danube countries, data collection via ICPDR PM EG; reference year 2009, for BA 2006.

[24] The data from Serbia do not include data from the Autonomous Province of Kosovo and Metohija.

[25] Source: Danube countries, data collection via ICPDR PM EG; reference year 2009, for BA 2006.

Slovak Republic	0	301	0	8	21	0	3,614,316	0	455,472	643,297
Slovenia	0	81	0	0	29	0	848,445	0	0	328,628
Ukraine	3	22	0	0	0	81,700	755,576	0	0	0
DRBD	**247**	**1,185**	**165**	**161**	**1,313**	**2,922,169**	**21,219,169**	**2,690,885**	**2,638,744**	**40,015,216**

8.2.2 Characteristics of water uses

The WFD requires the identification of water uses: abstraction for drinking water supply, irrigation, leisure uses, industry, etc., and a characterization of the economic importance of these uses. Water use means water services together with any other activity having a significant impact on the status of water. Some countries defined more water uses as water services than others.

Hydropower generation and navigation are regarded to be water uses of basin-wide economic importance. Other water uses than these two have not been considered as economically significant on the international, transboundary level. However, more detailed analyses of water uses, which are economically significant on the national level, can be found in the national reports. This includes, for example, data on water uses connected with other forms of electricity generation, such as cooling water in thermal power plants.

The following tables provide an overview of the economic importance of water uses in the Danube basin. As can be seen, agriculture still represents important economic sectors in several Danube countries, such as Serbia, Moldova and Ukraine (around and above 10%). On the contrary, in other Danube countries, mostly in the Western part of the basin, the share of agriculture in national GDP is very low, compared to these levels - in the Czech Republic, Slovenia and Slovakia, the share is only around 2%. Industry is significant in all Danube countries, not contributing a share way below 20% to the national GDP (exceptions are Serbia and Slovenia, with figures a little below 20%). Electricity generation, on the contrary, does not exceed the 5% mark in any of the Danube countries.

Table 34: Production of main economic sectors (national level)

Country	Agriculture	Industry	Electricity Generation
	Share of GDP (in %)	Share of GDP (in %)	Share of GDP (in %)
Austria	Available as soon as figures for the economic analysis for the 2nd national River Basin Management Plan are available.		
Bosnia and Herzegovina	No information		
Bulgaria (in 2011)	4.7	26.4	n. a.
Croatia (in 2008)	6.43	16.82	2.67
Czech Republic (in 2010)[27]	2.2	39.6	n. a.
Germany	0.8 (DRB)	30.3 (DRB)	n.a.
Hungary (2012)	4.7	23	2.7
Moldova (2010)	28	39	3.4
Montenegro	No information		
Romania	4.4	20.8	0.8
Serbia[28] (2012)	10.0	17.1	3.9
Slovak Republic (in 2012)	2.11	24.69	3.59
Slovenia (2012)	2.34	18.5	2.47
Ukraine	9.82[29]	-	-

Other sources: contributions from Danube countries.

[26] The data from Serbia do not include data from the Autonomous Province of Kosovo and Metohija.

[27] http://www.czso.cz/csu/2012edicniplan.nsf/t/E5002C5A4A/$File/501312K0407.pdf

[28] The data from Serbia do not include data from the Autonomous Province of Kosovo and Metohija.

[29] ICPDR 2011: Facts and Figures Brochure.

Table 35: Hydropower generation in the Danube River Basin

Country	Installed hydropower capacity in 2010[30]	Electricity production from hydropower in 2010[31]	Share of hydropower generation[32]
	in MW	*in GWh/year*	*in % of total electricity generation*
Austria	12,469 (2008)	37,958 (2008)	56.8
Bosnia and Herzegovina	90 (2011)	1,667	18
Bulgaria	3,108	5,523	11.9
Croatia	339	1,495	31.8
Czech Republic	2,203	2,790	3.2
Germany	4,050 (2009)	19,059 (2009)	3.3
Hungary	55	188	0.5
Moldova	none	n. a. (79.1 including pumped storage)	None (6% if pumped storage is included)
Montenegro	n. a.	n. a.	n. a.
Romania	6,453	19,857.2	33.2
Serbia[33]	2,859 (2009)	10,636 (2009)	24.2
Slovak Republic	2,515 (2012)	5,125 (2013)	18.4 (2013)
Slovenia	1,188 (2011)	4,198	29.6
Ukraine	36.2	0.16	n. a.

Austria has by far the largest percentage of generated electricity based on hydropower (almost two thirds of total electricity generated). The share of hydropower is also relatively high in Croatia, Slovenia, Romania and Serbia (around 30%), and more modest in Germany (although the absolute amount of electricity produced from hydropower is high), the Slovak Republic, and the Czech Republic, where hydropower still plays an important role in the electricity system. However, in most Danube countries (with the exception of DE, HU and MD), hydropower currently represents the most important component of total renewable energy production (for more concrete information, see the Assessment Report on Hydropower Generation in the Danube Basin).

[30] Assessment Report on Hydropower Generation in the Danube Basin. AT, BG, CZ, DE, HU, MD, RS, SI and SK: data for the whole country. RO data are relevant both for the Romanian part of the Danube River Basin as well as the whole country. BA, HR and UA: data valid for the national part of the Danube River Basin only.

[31] Assessment Report on Hydropower Generation in the Danube Basin . Excluding pumped storage. AT, BG, CZ, DE, HU, MD, RS, SI and SK: data for the whole country. RO data are relevant both for the Romanian part of the Danube River Basin as well as the whole country. BA reported data for the current amount of electricity production for the national part of the Danube River Basin, while the figures for the expected amount of electricity production in the year 2020 refer to the whole country. HR and UA: data valid for the national part of the Danube River Basin only. It has to be stated that in RO, the year 2010 was an exceptional year as regards hydro-energy production, being the second highest year in the hydro- energy production history of RO.

[32] Assessment Report on Hydropower Generation in the Danube Basin and national contributions. Own calculation. Excluding pumped storage.

[33] The data from Serbia do not include data from the Autonomous Province of Kosovo and Metohija.

Table 36: The importance of inland navigation in the Danube River Basin

Country	Freight transport on the entire Danube[34]	Number of major ports
	Million tons	*Number*
Austria	10.23	8
Bosnia and Herzegovina	0.06	2
Bulgaria	8.44	11
Croatia	5.32	2
Czech Republic	none	none
Germany	6.1	6
Hungary	7.71	12
Moldova	0.15	1
Montenegro	n. a.	n. a.
Romania	17.81*	12
Serbia[35]	11.32	14
Slovak Republic	8.24	3
Slovenia	none	n. a.
Ukraine	5.68	4

*This figure includes the data related to the Danube – Black Sea channel.

The above table shows that inland navigation does not play a major role in every Danube country - it is relevant only for some Danube countries as there is no commercial inland navigation in the countries on the edges of the Danube River Basin. The countries with the highest tonnage transported on the Danube are Romania, followed by Austria and Serbia (all three countries move more than 10 million tons of cargo annually). Nevertheless, most other riparian countries also transport significant amounts.

8.3 Trend projections until 2021

In order to assess key economic drivers likely to influence pressures and thus water status up to 2015, a Baseline Scenario (BLS) has been developed in the 1st DRBM Plan from 2009. The trends established in the BLS are considered to be updated and projected further into the future (until 2021) in the 2nd DRBM Plan.

Hereby, the trend projections will follow the DPSIR approach, i.e. focusing on the most relevant drivers and pressures of socio-economic development and accompanying effects on water status (quality and quantity).

8.4 Cost recovery

In the context of the previous economic analyses (i.e. the DBA 2004 and the 1st DRBM Plan 2009), the topic of cost recovery (CR) was treated mainly in the national reports, and only briefly mentioned in either DBA and the economics chapter of the 1st DRBM Plan. However, the present updated DBA summarizes some information on CR approaches and methodologies used in the Danube countries, based on national contributions (for more detailed information, see Annex 7).

Cost recovery for specific water services is defined as the ratio between the revenues paid for a specific service and the costs of providing the service. The WFD calls for accounting related to the recovery of costs of water services and information on who pays, how much and what for.

Analysing CR approaches in general, but especially in transboundary basins with a variety of national approaches, faces several difficulties. First, the application of economic and environmental principles into price setting and the degree of application of CR vary from one to another Danube country according to the specific legal and socio-economic conditions. Second, the approaches to CR and

[34] via donau – Österreichische Wasserstraßen-Gesellschaft mbH 2013: Danube Navigation in Austria; national contributions

[35] The data from Serbia do not include data from the Autonomous Province of Kosovo and Metohija.

pricing vary inside the Danube countries as well, as often local authorities have the responsibility for setting the price and therefore determining the degree of cost recovery of certain water services. Third, the topic touches several difficult questions regarding methodologies and the understanding of, for example, ERC and "adequate cost recovery". Furthermore, a number of influencing factors are to be considered when analysing water prices, costs, or level of cost recovery in different countries with varying socio-economic structures (such as general price levels, local favourable or unfavourable conditions for water supply etc.).

Generally, all Danube countries have defined water services. The interpretation of what is to be considered a water service varies (see chapter 8.2.1 above), as well as the consequences for CR calculations. For example, the definition of a certain activity as water service does not necessarily mean that this water service is included in cost recovery calculations (this, for example, is the case in several Danube countries: a wide definitions of water services is used, but these are then not included in the CR assessment; see Chapter 8.2.1 above, or tables 2, 3 and 4 in Annex 7).

Also, the methods and underlying definitions that are relevant for calculating CR differ between Danube countries. Here, a variety of approaches can be observed: in some countries, CR is not calculated, or the information - which is sometimes difficult to obtain - is missing or unclear; often, only financial and/or operation and maintenance (O&M) costs are considered; some countries also included ERC into cost recovery calculations, although in these cases, a clear definition of ERC is missing (i.e. an underlying methodology to determine the ERC). Overall, five countries clearly state the percental level of CR of water services in a quantitative manner, two countries partly.

Regarding ERC, the current understanding and approach to defining and/or calculating them varies among the Danube countries. A full and comprehensive methodology for calculating ERC is not reported by any Danube country, due to methodological difficulties and lack of information/data. Nevertheless, a pattern can be observed that is followed by the majority of Danube countries in a slightly different way. First of all, it has to be noted that "resource costs" are often understood not as "opportunity costs" (i.e. the costs of foregone opportunity), but as the costs of the resource itself, i.e. as a form of "abstraction price/cost". Environmental costs, on the contrary, are often defined as the costs that are associated with the discharge of wastewater into water bodies, and the costs for wastewater collection and treatment (and captured and internalized through the respective charges and fees - i.e. the underlying assumption seems to be that the wastewater charges/fees adequately cover the associated environmental damages; based on this assumption, the charges/fees are then equated with the environmental costs; see below for more details).

Consequently, all Danube countries state that the principle of ERC cost recovery is applied by various forms of charges/fees, or taxes (in Bulgaria, these are not yet in place, but in the process of being established). Five countries state that in addition to charges/fees, permits which include restrictions/limitations in a way that ERC do not occur fulfil this role as well. Mitigation and/or supplementary measures seem to play a lesser role (two countries stating that mitigation/supplementary measures contribute to ERC cost recovery).

8.5 Data gaps and uncertainties

In the process of updating the Danube Basin Analysis (of 2004) and the chapter on economics included in the 1st DRBM Plan (of 2009), several gaps and uncertainties in the available data were encountered.

Foremost, there are general data gaps regarding socio-economic data in some Danube River Basin countries (but less than in the previous analysis in 2004), e.g. in Table 31 and Table 34 (i.e. regarding connection rates to public water supply and sewage/wastewater treatment services, and the socio-economic importance of agriculture, industry and electricity production). In other countries, such data will be available with the 2nd National River Basin Management Plans.

Furthermore, the accuracy of the data could be better, especially with regard to data that would be most helpful on the basin level. Often, however, national data is only available based on administrative units, which mostly do not coincide with the boundaries of the river basin. This results in a quite heterogenic feedback from Danube countries regarding specific information. E.g. in the case of hydropower, some countries reported for the year 2008, some for 2009, 2010 and 2011; some submitted data for the Danube part of the national territory, some for the whole country; some Danube countries provided average values over a period of three years. In Romania, the year 2010 was an exceptional year as regards hydro-energy production, being the second highest year in the hydro-energy production history of the country - accordingly, the figure may not represent the "usual" yearly hydropower production.

Finally, it needs to be noted the main issues the update of the Danube economic analysis dealt with – that is, water pricing, cost recovery and environmental and resource costs, are - unfortunately - not fully advanced in terms of existing approaches, data and methods in order to completely answer all the questions at hand regarding water pricing in the Danube countries. Instead, an overview of different approaches and methodologies regarding water pricing, cost recovery and ERC is provided.

8.6 Summary and conclusion

In the DBA from 2004 it was stipulated to assess the national reports (Part B of the WFD Reports 2004) in order to obtain a complete picture on national levels of cost recovery of water services in the Danube River Basin. This was regarded as an important step towards future analyses required under the WFD.

In the 1st DRBM Plan, an increase in available economic data was identified. Especially the availability of a large number of economic studies on the costs and prices of water services (including ERC) was emphasized.

Now, in the present update of the DBA, even more data has been collected, and valuable contributions were made by the Danube countries, allowing to get an overview of national approaches towards water pricing, cost recovery, and ERC.

Nevertheless, further work remains regarding methodologies and possibly harmonized approaches. This is not only due to gaps in the information available for the Danube countries, but is mainly related to the great complexity of the topic, and the many gaps and uncertainties that still exist regarding the methodologies to be applied for this topic.

9 Integration issues

9.1 Interlinkage between river basin management and flood risk management

Aware of the basin-wide relevance of flood issues, the ICPDR decided to develop its flood protection policy, which was formalised by adoption of the ICPDR Action Programme on Sustainable Flood Protection in the DRB in 2004. The Action Programme has been designed in line with the provisions of the EU Flood Directive 2007/60/EC (FD), which aims to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. The FD is based on the river basin approach and a six year cycle of planning likewise this is the case for the WFD.

The FD is to be implemented in three phases. During the first phase, a Preliminary Flood Risk Assessment (PFRA)[36] has been carried out for the DRB by December 2011 in order to identify areas of existing or foreseeable future potentially significant flood risk. During the second phase, flood hazard maps and flood risk maps are prepared by December 2013. These should identify areas prone to flooding during events with a high, medium and low probability of occurrence, including those where occurrences of floods would be considered an extreme event. The third phase requires to produce catchment-based Flood Risk Management Plans (FRMPs) by December 2015, focusing on prevention, protection and preparedness, as well as setting objectives for managing the flood risk and setting out a prioritised set of measures for achieving those objectives, thereby harmonizing with the WFD river basin management planning cycle.

The integration between the WFD and the FD offers the opportunity to adopt a new approach to optimize the mutual synergies and minimise conflicts between them. This is articulated in Article 9 of the FD, requiring that "*Member States shall take appropriate steps to coordinate the application of this Directive and that of Directive 2000/60/EC (WFD) focusing on opportunities for improving efficiency, information exchange and for achieving common synergies and benefits having regard to the environmental objectives laid down in Article 4 of Directive 2000/60/EC*".

In practical terms, there are a number of reasons why coordination is beneficial. These include:

- The overlap of legal and planning instruments in many countries;
- Planning and management under both Directives generally use the same geographical unit (i.e. the DRBD);
- Aiding the efficiency of the implementation of measures and increasing the efficient use of resources.

In order to address the different coordination requirements, the ICPDR developed in 2011 a list of issues for a coordinated implementation of the WFD and FD in the DRBD, facilitating the exchange between experts on relevant issues. Opportunities towards gaining synergies and key issues requiring coordination are clearly seen for the programmes of measures of the 2nd DRBM Plan and the 1st DFRM Plan, both due by 2015 (e.g. the reactivation of former or creation of new retention and detention capacities, addressing potential negative impacts of technical flood protection measures on water status, regulation of spatial and land use planning, prevention of accidental pollution during floods, etc.), whereas river and floodplain restoration are likely to provide the most significant direct contribution to both FD and WFD objectives.

Finally, a coordinated public consultation and communication plan[37] for both, the WFD and FD has been put in place by the ICPDR to assist with the development of the 2nd DRBM Plan and the 1st DRFM Plan for the DRBD. The document serves as a blue-print for participation on a basin-wide, outlining integrated consultation measures to be carried out.

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[36] http://www.icpdr.org/main/activities-projects/implementation-eu-floods-directive

[37] http://www.icpdr.org/main/sites/default/files/nodes/documents/ic_wd_517_-_pp_drbmp_2015-public.pdf

9.2 Inland navigation and the environment

Inland navigation can contribute to making transport more environmentally sustainable, particularly where it can act as a substitute for road transport. It can, however, also have significant influence on river ecosystems, jeopardizing the goals of the WFD.

Recognising this potential conflict, the ICPDR initiated in cooperation with the Danube Navigation Commission and the International Commission for the Protection of the Sava River Basin a cross-sectoral discussion process involving all relevant stakeholders and NGOs. This led to the "Joint Statement on Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin"[38], which was concluded in October 2007 and subsequently agreed by the Commissions involved.

The Joint Statement summarises principles and criteria for environmentally sustainable inland navigation on the Danube and its tributaries, including the maintenance of existing waterways and the development of future waterway infrastructure. Following, a "Manual on Good Practices in Sustainable Waterway Planning"[39] was developed in the frame of the EU PLATINA project, which started in 2008 and concluded in early 2012. The manual further outlines practical steps for integrated planning approaches towards sustainable solutions taking into account both, the needs of inland navigation and the environment.

A number of concrete navigation projects are in development or under implementation. Progress has been made in setting up integrated planning approaches throughout the basin and for the practical implementation of the Joint Statement principles in the frame of these projects. Noteworthy projects include: Straubing-Vilshofen (DE), Danube East of Vienna (AT), Croatia/Serbia border region, specific navigation bottlenecks along the Serbian Danube, Sava River (BA, RS, HR), Romanian/Bulgarian border stretch of the Danube, and the Romanian Danube between Calarasi and Braila.

In the frame of yearly meetings, exchange on the experiences with the application of the Joint Statement is shared amongst administrations, stakeholders and environmental groups.

9.3 Sustainable hydropower

The increased production and use of energy from renewable sources, together with energy savings and increased energy efficiency, constitute important steps towards meeting the need of reduced greenhouse gas emissions to comply with international climate protection agreements. The development of further renewable energy in line with the implementation of the EU Renewable Energy Directive 2009/28/EC[40] represents a significant driver for the development of hydropower generation in the countries of the DRB. At the same time, Danube countries are committed to the implementation of water, climate, nature and other environmental legislation.

Aware of the fact that hydropower plants offer an additional reduction potential for greenhouse gases but recognizing as well their negative impacts on the riverine ecology, the Ministers of the Danube countries asked in 2010 for the development of Guiding Principles on integrating environmental aspects in the use of hydropower in order to ensure a balanced and integrated development, dealing with the potential conflict of interest from the beginning.

The "Guiding Principles on Sustainable Hydropower Development in the Danube Basin"[41] have been elaborated in the frame of a broad participative process launched in 2011, with the involvement of representatives from administrations (energy and environment), the hydropower sector, NGOs and the scientific community. Besides providing background information on the relevant legal framework and

[38] http://www.icpdr.org/main/activities-projects/joint-statement-navigation-environment

[39] http://www.icpdr.org/main/sites/default/files/Platina_IWT%20Planning%20Manual.FINAL.Aug10.c.pdf

[40] DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

[41] http://www.icpdr.org/main/activities-projects/guiding-principles-sustainable-hydropower

statistical data, the Guiding Principles are addressing the following key elements for the sustainability of hydropower:

1) General principles and considerations (the principle of sustainability, holistic approach in the field of energy policies, weighing of public interests, etc.);
2) Technical upgrading of existing hydropower plants and ecological restoration measures;
3) Strategic planning approach for new hydropower development, and;
4) Mitigation measures.

The document is primarily addressed to public bodies and competent authorities responsible for the planning and authorization of hydropower but are also relevant for potential investors in the hydropower sector as well as NGOs and the interested public.

The Guiding Principles were adopted by the ICPDR in June 2013 and recommended for application by the Danube countries, what is planned to be further facilitated via an exchange of experiences on the application in the frame of a follow-up process.

9.4 Sturgeons in the Danube River Basin District

General background

Sturgeons represent a natural heritage for the Danube River Basin and the Black Sea. Considered as "flagship species", sturgeons constitute as "living fossils" a unique value for biodiversity but can also be of significant importance from a socio-economic point of view since healthy and properly managed stocks can sustain the income of fishermen communities and hatchery owners.

However, sturgeon stocks declined dramatically during the last century. From the six native Danube sturgeon species that partly migrated from the Black Sea upstream as far as Regensburg on the Upper Danube, one is already extinct, while the others are on the verge of extinction (see Table 37). Main pressures include the disruption of migration routes due to infrastructure projects, the loss of habitats and spawning grounds, pollution as well as overfishing of already diminishing stocks also for caviar trade.

Table 37: Overview Danube sturgeon species and their status and trend according to IUCN

Species	Also known as	Status	Trend
		According to IUCN[42]	
Acipenser gueldenstaedti	Danube sturgeon or Russian sturgeon	Critically endangered	Decreasing
Acipenser nudiventris	Ship sturgeon or Fringebarbel sturgeon	Critically endangered	Decreasing
Acipenser ruthenus	Sterlet	Vulnerable	Decreasing
Acipenser stellatus	Stellate sturgeon	Critically endangered	Decreasing
Acipenser sturio	Common sturgeon, European sturgeon, Atlantic sturgeon	Critically endangered (extinct in DRB)	Decreasing
Huso huso	Beluga sturgeon or Great sturgeon	Critically endangered	Decreasing

Although not in their natural distribution, different sturgeon species are still present within the whole Danube River Basin (in particular in the lower DRB, but with regard to the sterlet and ship sturgeon also in the middle DRB, and with regard to the sterlet in the upper DRB). Therefore, sturgeons are an issue of basin-wide concern and actions are required on the basin-wide scale.

[42] Source: http://www.iucnredlist.org/search (Accessed: 28 April 2013)

Required actions for the conservation of Danube sturgeons

Sturgeon conservation in the Danube River-Black Sea system requires a transboundary and interdisciplinary approach. A first decisive step was made in 2005 with the development of the "Action Plan for the conservation of Danube River sturgeons"[43] under the Bern Convention. Further, in 2009 the 1st DRBM Plan was adopted, which specified important key measures in the field of the ICPDR (i.e. measures for pollution reduction and the improvement of hydromorphological conditions). In addition, further measures were taken on the national level to prevent sturgeons from extinction, i.e. catchment bans in Bulgaria, Romania and Serbia, and more recently in Austria on provincial level.

The issue lately gained broad political attention in the frame of the EUSDR, with the agreed target "*To secure viable populations of Danube sturgeon species and other indigenous fish species by 2020*". Working towards the achievement of this target, the "Danube Sturgeon Task Force" (DSTF) was created in January 2012 in the frame of EUSDR Priority Area 6 (Biodiversity), where different organisations from the Danube basin (e.g. WWF, IAD, ICPDR, representatives from national research institutions, Ministries and the World Sturgeon Conservation Society) joined to work towards the issue. The DSTF aims to coordinate and foster conservation efforts in the DRB and the Black Sea by promoting actions which are outlined in the strategy and programme "Sturgeon 2020", developed by the DSTF based on the Danube Sturgeon Action Plan from 2005.

The ICPDR dedicated Danube Day 2013 to the motto "Get active for the sturgeons" in support of the ongoing process, leading to various public information and awareness raising events organised by the Danube countries throughout the basin. Furthermore, the following urgent priority actions were identified by the ICPDR:

1) Investigations on the potential feasibility to establish fish migration at the Iron Gate dams, including migration through the reservoir of Iron Gate I;
2) Monitoring and mapping of existing and historic[44] sturgeon habitats in the DRB, and;
3) Ex-situ conservation measures in support of a self-sustaining sturgeon reproduction and the natural life cycle.

A first compilation of important regions with sturgeon habitats (known and potential spawning sites, wintering sites, feeding sites) was compiled by sturgeon experts in the frame of the DSTF and is illustrated in Figure 34. Different methods were applied for this compilation, including literature review, information from fishermen on catches, presence and absence data on Young of the Year fish, bathymetric and granulometric surveys, as well as telemetry data for mature fish. However, further monitoring and mapping activities are required to obtain a comprehensive picture on the situation, allowing for more targeted conservation activities.

[43] http://www.iad.gs/docs/reports/SAP.pdf

[44] All available historic data sources are useful for the mapping of historic habitats, including specifically also data from the time period before the main river regulation works and economic development activities have been conducted.

Figure 34: Potential critical habitat for A. gueldenstaedtii, A. nudiventris, A. ruthenus, A. stellatus and H. huso as identified by various methods[45]

Planned next steps

The three priority actions identified by the ICPDR are planned to be accomplished via specific projects, whereas the ICPDR expressed support for the elaboration of respective project proposals which have to be developed and handed in under appropriate funding instruments. Beside these targeted activities, the next steps in the implementation of the WFD, i.e. the 2nd DRBM Plan and its Joint Programme of Measures, will provide the opportunity for the implementation of necessary conservation measures in support for the achievement of the agreed EUSDR target on sturgeons.

9.5 Water scarcity and drought

General issues

Attention to water scarcity and drought events in Europe has increased in the recent decade, particularly following the widespread droughts in 2003 that affected over 100 million people, a third of EU territory, and cost approximately € 8.7 billion in damage to the European economy[46].

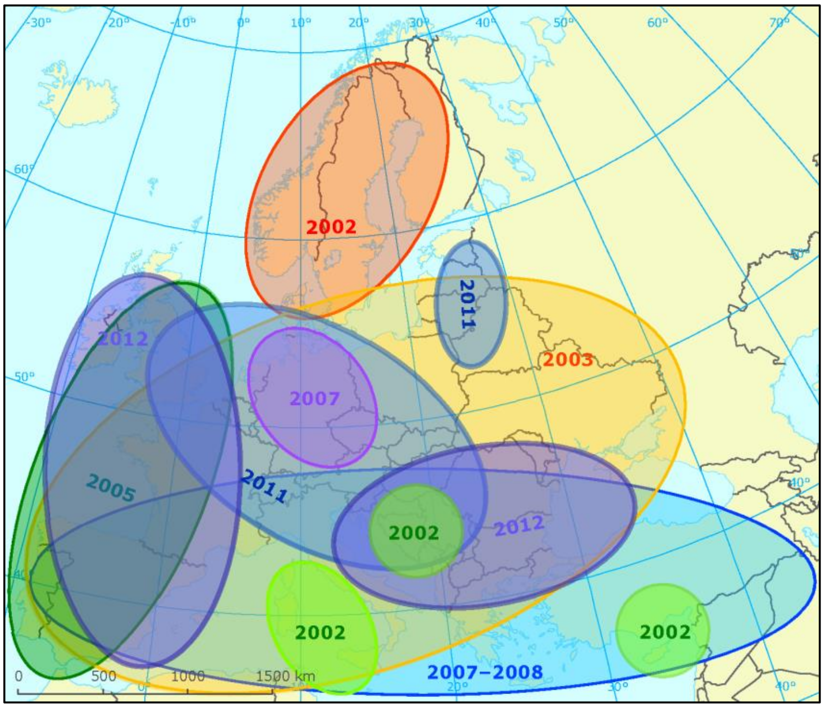
Additional water scarcity and drought events have since affected portions of Northern, Southern, and Western Europe in 2007, 2011, and 2012 (see Figure 35)[47]. These recent trends highlight the significance of growing imbalances in water supply and availability in Europe, specifically in the context of climate change.

[45] Compiled from Friedrich 2012, Guti 2006 & 2012, Lenhardt 2012, Ludwig et al. 2009, Pekarik 2012, Suciu 2012, Suciu & Guti 2012 and Vassilev 2003, partially unpublished information

[46] Communication from the Commission to the Council and the European Parliament – Addressing the challenge of water scarcity and droughts, COM(2007) 414, 18 July 2007.

[47] Communication from the Commission to the Council and the European Parliament – Report on the Review of the European Water Scarcity and Droughts Policy, COM(2012) 672 final, 14 November 2012.

Figure 35: Water scarcity and drought events in Europe in the period 2002 – 2011 (Source: ETC/ICM 2012[48])



In line with the 2007 Communication by the European Commission on Water Scarcity and Droughts, and as agreed upon by the EU Member States[49], the concepts of water scarcity and drought were developed as:

- **Water scarcity** is a man-made phenomenon. A recurrent imbalance that arises from an overuse of water resources caused by consumption being significantly higher that the natural renewable availability. Water scarcity can be aggravated by water pollution (reducing the suitability for different water uses), and during drought episodes.
- **Drought** is a natural phenomenon. A temporary, negative, and severe deviation along a significant time period and over a large region from average precipitation values (deficit in rainfall), which might lead to meteorological, agricultural, hydrological, and socioeconomic drought, based on its severity and duration.

Though there are clear similarities and differences between water scarcity and drought, the 2012 EU Gap Analysis of Water Scarcity and Droughts Policy in the EU[50] highlights the following differences:

1) Drought causes economic damage mostly in the peak spring or summer season when the irrigation demand is highest, the effects of winter drought often being less notable;
2) Water scarcity poses a permanent limit to the economic development of a region or to the ecological status of ecosystems, whereas drought poses only a time-limited (potentially significant) water shortage; and
3) Drought may occur in different water-scarce conditions, droughts under high water scarcity require specific treatment from a risk-management perspective.

[48] European Topic Centre on Inland, Coastal and Marine Waters. Available: http://www.eea.europa.eu/data-and-maps/figures/main-drought-events-in-europe

[49] INTECSA-INARSA, S.A., based on previous draft by TYPSA (2012). Working definitions for Water Scarcity and Drought Report to the European Commission.

[50] ACTeon (2012). Gap Analysis of the Water Scarcity and Droughts Policy in the EU. Available: http://ec.europa.eu/environment/water/quantity/pdf/WSDGapAnalysis.pdf

Therefore, formulating clear distinctions between these events can aid in the development of more effective River Basin Management Plans and in strengthening future water management practices.

Water scarcity and drought in the Danube River Basin

The role of water scarcity and drought in river basin management is expected to become more relevant over time also within the DRB, particularly with increased attention to climate change. Therefore, the ICPDR became active in elaborating on the relevance of the issue of water scarcity and drought, which was previously not systematically addressed on the basin-wide scale and what is in line with the following specific target agreed in the frame of the EUSDR: "*To address the challenges of water scarcity and drought based on the 2013 update of the Danube Basin Analysis and the ongoing work in the field of climate adaptation, in the Danube River Basin Management Plan to be adopted by 2015*"[51].

Based on feedback provided by the Danube countries via a specific questionnaire, it can be summarised that water scarcity and drought is not considered as a SWMI for the majority of the countries, but a number of countries consider them as a SWMI in River Basin Management Plans on national level. The main sectors which were reported to be affected by water scarcity and drought include agriculture, water supply, biodiversity, other energy production, hydropower, navigation and public health.

Water scarcity and drought was reported to be addressed by a number of Danube countries in their national River Basin Management Plans, whereas specific measures are planned or already under implementation (e.g. increase of irrigation efficiency, reduction of leakages in water distribution networks, drought mapping and forecasting, education of public on water-saving measures, market-based instruments, wastewater recycling and rain water harvesting). Further details from the assessment can be obtained from Annex 7.

Summary and outlook

It can be concluded that water scarcity and drought is not considered as an issue requiring coordination and management on the basin-wide level at this stage. This is also due to the fact that the relevance of the issue and the situation is differing between the countries and regions within the DRB. However, maintaining an exchange on the topic is considered to be beneficial, also in relation to the ongoing discussions on climate change adaptation, what should be facilitate via the exchange of best practice examples. Furthermore, a specific chapter on water scarcity and drought is planned to be devoted in the 2nd DRBM Plan, which should also reflect on the diversity of the situation within the basin.

9.6 Adaptation to climate change

Despite ambitious international climate protection objectives and activities, adaptation to climate change impacts is urgently needed. Water, together with temperature, is in the centre of the expected changes. Due to the fact that water is a cross-cutting issue with major relevance for different sectors, water is the key for taking the required adaptation steps. In the DRB, climate change is likely to cause significant impacts on water resources and can develop into a significant threat if the reduction of greenhouse gas emissions is not complemented by climate adaptation measures.

In order to take the required steps on adaptation, the ICPDR was asked in the 2010 Danube Declaration[52] to develop a Climate Adaptation Strategy for the DRB. In December 2012, the ICPDR Strategy on Adaptation to Climate Change[53] was finalised and adopted. The Strategy provides an outline of the climate change scenarios for the DRB and the expected water-related impacts. Furthermore, an overview on potential adaptation measures is provided and the required steps towards integrating adaptation into ICPDR activities and the next planning cycles are described.

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[51] EUSDR Report June 2012. Priority Area 5 - To manage Environmental Risk.

[52] Danube Declaration: http://www.icpdr.org/main/sites/default/files/Ministerial%20Declaration%20FINAL.pdf

[53] ICPDR Strategy on Adaptation to Climate Change: http://www.icpdr.org/main/activities-projects/climate-adaptation

Since adaptation to climate change is a cross-cutting issue, all relevant ICPDR Expert Groups and Task Groups were mandated to fully integrate adaptation to climate change in the planning process for the implementation of the WFD and FD in the Danube River Basin, specifically for the elaboration of the 2nd DRBM Plan and the 1st DFRM Plan. Adaptation to climate change is therefore in need to be addressed and integrated into the different SWMIs and other relevant ICPDR activities.

10 Public information and consultation

Objectives and legal framework for Public Participation

The ICPDR is committed to active public participation in its decision making. The commission believes that this facilitates broader support for policies and leads to increased efficiency in the implementation of measures. The ICPDR pursues the consultation of stakeholders in the entire cycle of ICPDR activities: from conceptualising policies, to implementing measures, to evaluating impacts. A legal framework for this is provided by the EU Water Framework Directive (Art. 14).

In practice, the ICPDR pursues public participation primarily through two avenues: (1) through the involvement of observer organisations in its ongoing work; and (2) through specific activities that are dedicated to public participation and communication. A third line of activities are ad-hoc stakeholder dialogues. These are conducted in areas that require inter-sectoral approaches, in particular inland navigation, climate change adaptation, hydropower and agriculture.

Observers to the ICPDR

Observers of the ICPDR can actively participate in all meetings of ICPDR expert groups and task groups, as well as plenary meetings (Standing Working Group and Ordinary Meetings). Observers represent a broad spectrum of water stakeholders in the Danube River Basin, covering social, cultural, economic and environmental interest groups. As of April 2014, there were 22 organisations approved as observers, all of which had the opportunity to contribute to the development of the DBA. Observers are accepted upon approval of the ICPDR and have to meet a defined set of criteria.

Public participation, communication and outreach

Under the umbrella of public participation and communication, the ICPDR pursues a range of specific activities. These include public information such as the development of technical public documents and general publications (e.g. the quarterly magazine Danube Watch); environmental education and outreach activities (e.g. the annual river festival Danube Day or the teacher's kit Danube Box); but also e.g. the public consultation activities directly related to the development of Danube River Basin Management Plans.

Public Consultation in line with Art. 14 WFD

The DBA provides the analytical basis for the Danube River Basin Management Plan. To accompany the development of the DRBMP, public consultation is done in three stages[54]: comments from the public are collected (1) on a timetable and work programme including public consultation measures; (2) on significant water management issues (SWMIs) in the river basin; and (3) the draft management plan.

Public consultation for each of these steps spans a period of six months, in which the opportunity to provide comments is actively promoted through the ICPDR network. The timetable and work programme was published for comments from 22 December 2012 to 22 June 2013; the SWMI document was published 22 December 2013 and comments are collected until 22 June 2014; the draft DRBMP will enter the public consultation phase on 22 December 2014 and will convene in summer 2015. For this last step, a stakeholder workshop and online consultation tools are planned to actively collect views from the civil society in the first half of 2015.

[54] See "WFD & EFD: Public Participation Plan". ICPDR document number: IC WD 517.

11 Summary and conclusions

The summary and conclusions focus on aspects of the implementation of the WFD at the basin-wide scale. Updated assessments will as well be performed for the 2nd DRBM Plan.

A common typology for the Danube River itself has been developed jointly by the Danube countries. Most of the national typologies of the Danube countries are based on the System B. All typologies show a good degree of coherence. On the basin-wide level, the Danube countries have agreed on general criteria as a common base for the definition of reference conditions. These have then been further developed on the national level into type-specific reference conditions.

59 water bodies have been identified on the Danube River, and 644 water bodies have been identified on the tributaries with catchments >4000km^2. Similar approaches for the delineation of water bodies in the Danube countries have been applied.

Pollution stemming from organic-, nutrient- and hazardous substances, as well as hydromorphological alterations, remain the key pressure types and Significant Water Management Issues affecting the waters of the DRBD.

With regard to organic pollution, the urban waste water sector generates about 280,000 tons of BOD and 670,000 tons of COD annual emissions (reference year: 2009/2010) into the surface water bodies of the DRBD. The direct industrial emissions of organic substances total up to approximately 50,000 tons of COD per year (reference year: 2010/2011). The significant investments in recent years on organic pollution control resulted in a considerable reduction of emissions. Despite this progress additional measures will have to be taken in the future to continue these progressive developments in the urban waste water and industrial sectors.

Concerning the recent nutrient emissions under long-term average (2000-2008) hydrological conditions, 670,000 tons of TN and 44,000 tons of TP are entering the water bodies of the DRBD per year. Although measures which are under implementation are substantially contributing to the reduction of nutrient inputs into surface and groundwater, the recent nutrient loads transported to the Black Sea are still considerably higher than those of the early 1960ies. Further efforts will be required to decrease both, point and diffuse source emissions generated in the DRBD.

On pollution from hazardous substances the Danube countries have taken important steps to fill the existing data and knowledge gaps. The on-going ICPDR investigations on priority and other hazardous substances will provide essential information on the relevance of these substances, resulting in a much clearer picture on the pollution problem than ever before. However, knowledge still needs to be further improved and the implementation of measures should be proceeded in the future to appropriately address this problem.

Apart from water pollution, hydromorphological modifications resulting from various hydro-engineering measures and water uses remain to significantly alter the natural structure of surface waters, causing impacts on the abiotic sphere as well as on the ecology.

1,018 barriers are located in the DRBD, out of which 335 were reported to be equipped with functional fish migration aids, which is inter alia a result of the currently ongoing implementation of the Joint Programme of Measures 2009. With regard to the morphological condition of water bodies, 7% were reported to be in near-natural, respectively an additional 21% in near natural to slightly altered condition – data which was for the first time collected for the DRBD. Further efforts will be required towards achieving a better harmonisation and comparability of the assessments.

On wetlands and floodplains, out of the approximately identified 280,527 ha of wetlands and floodplains with reconnection potential, 46,089 ha are in the meantime partially and 89,954 ha have been totally reconnected and the hydrological regime improved, with different positive effects i.e. on water status, flood mitigation and climate adaptation.

249 out of a total of 703, and therefore a significant number of river water bodies, is affected by hydrological alterations like impoundments, water abstractions and/or hydropeaking stemming from different water uses and infrastructure projects. The key drivers for different future infrastructure projects that may provoke hydromorphological alterations and impacts on surface water status in the future are with 71% of the projects inland navigation, 21% flood protection and 8% hydropower generation.

Altogether 25,582 km of river water bodies were evaluated in the 2013 Update of the DBA. 11,840 km of rivers are not at risk of failure to achieve good ecological status or ecological potential (42%) and 16,192 km of rivers will be not at risk of failure to achieve good chemical status (60%).

The risk of failure to achieve a good ecological status or ecological potential by 2021 is caused by organic pollution (19% of the river length), nutrient pollution (20%), hazardous substances pollution (27%) and by hydromorphological alterations (34%). Therefore, addressing these types of pressures will remain a key issue for the 2nd DRBM Plan and updated Joint Programme of Measures for the period 2015 until 2021.

Next to surface waters, groundwater is of major importance in the DRBD as well and subject to a variety of uses with the main focus on drinking water, industry, agriculture, spa and geothermal energy purposes. Pollution by nitrates from diffuse sources is the key factor affecting the chemical status of these groundwaters. The major sources of this diffuse pollution are agricultural activities, non-sewered population and urban land use. Over-abstraction poses a significant pressure on quantitative status of the groundwater bodies of basin-wide importance in the DRB. The evaluation of risk assessment for groundwater will be possible after receiving data from Hungary. This information will be provided for the 2nd DRBM Plan.

In summary, although progress in addressing existing pressures has been achieved, a significant share of Danube waters remains to be at risk of failing to achieve good status or good potential. The 2nd DRBM Plan and updated Joint Programme of Measures constitutes a key opportunity to take the next steps for a sustainable management of the Danube River Basin. One major success factor towards achieving this objective is to proceed working in close cooperation with different stakeholders and water-relevant sectors like inland navigation, hydropower, sustainable flood risk management or agriculture.