"Wastewater Management in the Danube Region: Challenges and opportunities of EU Accession"

Learning from the Experience of Implementation of the EU's Urban Waste Water Treatment Directive in EU Member Countries

Vienna WWTP on the Danube (© LBS)

Final Study Report

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ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

Office International de l'Eau

Foreword

The International Association of Water Supply Companies in the Danube River Catchment Area (IAWD) and the World Bank seek to support the rapid modernisation of the water utility sector in the Danube region through the Danube Water Program (DWP). The program entails five pillars and includes four main activities: analytical and advisory work, capacity development, knowledge sharing and competitive grants window.

Under the activity analytical and advisory work, the Umweltbundesamt (Environment Agency Austria) was entrusted in March 2017 with the execution of this study. It aims to assess the results of UWWTD implementation in the Danube Region, taking into account environmental, economic, sustainability and affordability aspects, in order to derive key conclusions and recommendations. Target countries were the following eight EU Member Countries of the Danube: *Austria, Bulgaria, Croatia, Czech Republic, Hungary, Romania, Slovakia and Slovenia*.

The specific objective of this study was to assess the key challenges and actions that countries in the Danube basin can use for wastewater management.

This study is a contribution to improving the efficiency of wastewater treatment implementation across the region by addressing three core questions with regards to the UWWTD implementation challenges:

(i) **What have been the results of UWWT Directive implementation in water quality status?**
Are we doing the right thing*, i.e. are we achieving good quality water, as defined by WFD, through harmonization with the UWWTD requirements in the region?*

(ii) **What are the key challenges for the implementation of the UWWT Directive?**
Are we doing it the right way, i.e. *are selected EU Member Countries from DRB harmonising their water sector with UWWTD requirements in the right way, notably: absorbing allocated EU funds, constructing optimally performing wastewater treatment plants, and creating sustainable/affordable mechanisms for their operation over time?*

(iii) **What are the economic results of the UWWT Directive implementation?**
Is it worth it, i*.e. what is the cost-efficiency of compliance with UWWTD?*

The quality and depth of the study findings and recommendations reflects the availability of accurate information and data that exists and could be collected from multiple sources. Some information was based on a *questionnaire on specific national issues* which was circulated to competent national and local institutions concerned with UWWTD implementation.

The study team consisted of:

- Benoît Fribourg-Blanc, Office International de l'Eau (IOWater), France*: EU UWWTD expert*
- Katharina Lenz, Umweltbundesamt, Austria: *EU water and sanitation policy expert*
- Klára Tóth, consultant, Hungary: *international* water *economist and financing expert for the Danube region*
- Philippe Bergeron, consultant, Germany: *international water economist and cost-efficiency expert.*
- Alexander Zinke Umweltbundesamt, Austria: *senior project manager and team coordinator.*

Patricia Lopez and Stjepan Gabric (World Bank – DWP) have provided valuable guidance and support throughout the preparation of the study.

Vienna, September 2017

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Acronyms

AT	Austria
BG	Bulgaria
BOT	Build, operate and transfer
BOD_5	Biochemical Oxygen Demand in 5 days
CAPEX	Capital expenditures
CIS	Common Implementation Strategy
COD	Chemical Oxygen Demand
CPR	Common Provisions Regulation for the European Structural and Investment Funds (Regulation (EU) 1303/2013)
CZ	Czech Republic
DRBD	Danube River Basin District
DRBMP	Danube River Basin Management Plan
DWP	Danube Water Program
EC	European Commission
EEA	European Environment Agency
E-PRTR	European Pollution Release and Transfer Register
ERC	Environmental and resource costs
HR	Croatia
HU	Hungary
IAS	Individual and Appropriate Systems
IAWD	International Association of Water Supply Companies in the Danube River Catchment Area
ICPDR	International Commission for the Protection of the Danube River
IED	Industrial Emission Directive (2010/75/EU)
IPPC	Integrated Pollution Prevention and Control Directive (2008/1/EC)
LAU	Local Administrative Unit
Mio	Million
MONERIS	Modelling Nutrient Emissions in River Systems
MS	Member State
O&M	Operating and maintenance
OPEX	Operating expenditures
PE	Population equivalent. The organic biodegradable load having a five-day biochemical oxygen demand (BOD_5) of 60 g of oxygen per day
RBD	River Basin District
RBMP	River Basin Management Plans
RO	Romania
SI	Slovenia

SK	Slovakia
TNMN	Trans National Monitoring Network
UWWTD	Urban Waste Water Treatment Directive (91/271/EC)
UWWTP	Urban Waste Water Treatment Plant
WFD	Water Framework Directive (2000/60/EC)
WTP	Willingness to pay
9th TA-UWWTD	9th Technical Assessment of the UWWTD Implementation

1 Executive Summary

The International Association of Water Supply Companies in the Danube River Catchment Area (IAWD) and the World Bank have launched a study on wastewater management covering the three pillars of sustainable development: biophysical, social and economic aspects.

Starting from a low starting point in many countries in the region, wastewater management was and still is one of the first priorities when addressing the water sector in the region. The main challenges include investment needs exceeding available funds, low absorption of EU funds available in transition periods negotiated for accession to EU, but also after accession, insufficient focus on cost-effectiveness, possible synergies and cost savings between the two main pieces of EU water legislation, difficulties with maintaining and operating existing wastewater systems, high financial costs possibly beyond the affordable and (lack of) availability of funds for renewal of infrastructure.

As the Danube River Basin is one of the most international in Europe and as water services are a key factor in economic development, water quality and wastewater are a core entry point for regional cooperation, EU legislation being a major driver. Significant progress has been achieved in the last ten years, but in many countries the situation is still below standard EU requirements.

Learning from the last EU assessment of wastewater management (Sept 2017), and from past studies and assessments conducted by the European Commission (EC) and the International Commission for the Protection of Danube River (ICPDR), along with other information sources and expertise that was publicly available until summer 2017, this document seeks to answer a set of key questions around wastewater management and the EU Directive on urban wastewater treatment: results of its implementation on water quality, governance, investment and affordability challenges and economic results.

On water quality (concentrations and loads of pollutants in rivers), the observed trend of the four main compounds targeted by the UWWTD (BOD_5, COD, total nitrogen and total phosphorus) is predominantly downward in most countries, reaching up to 70% for some cases.

On emissions and discharges, a downward trend significantly influenced by the UWWTD is clearly demonstrated, with important differences from source to mouth of the Danube, related a.o. to country starting point and the economic situation. However, the low level of information on wastewater collection and technologies used for its treatment and more generally on emissions and their sources apportionment make it difficult to directly assess the status of wastewater management beyond legal compliance. Improving the information system is necessary and should be done within the current frameworks: ICPDR and UWWTD data collection exercise to limit the burden and maximise use.

On impacts of UWWTD to water quality, the decreasing surface water pollution can clearly be linked to improved wastewater treatment and decreasing emissions from urban point sources. However, other existing emission sources (e.g. diffuse pollution from agriculture, pollution from industrial point sources) have also an influence on water quality. A better link between emission and water quality is necessary and should be developed in the future.

The link between the implementation of the UWWTD and the improvement of water status in surface water bodies according to the Water Framework Directive could only be shown to a limited extent in the present study. The status of surface water bodies was reported for the first time in 2009 in the context of river basin management plans under the WFD. Only when the second river basin management plans are available for the reference year 2015, changes of the status of surface water bodies will be available and can then be linked to improved wastewater treatment due to UWWTD implementation.

On all the biophysical aspects from water quality to emission, treatment and discharges, innovation plays a key role in improving the technical efficiency but also the costs of the systems. Innovative aspects include a shift towards less centralised, more local and other alternative solutions, and many ongoing research and development (R&D) projects.

On financial sustainability, the lack of comparable financial data is a major weakness for planning, analysing and reporting, which needs to be improved. The available information allows the assessment that the current situation poses a risk and a challenge. Wastewater utilities are technical infrastructures which need to be maintained in good working condition by appropriate operation and maintenance, and also to be renewed regularly, as some equipment is exposed to wear and tear. While initial investments have been high, in particular in the transition period, in many MSs assessed, the costs of operation, maintenance and reinvestment are currently not covered by service revenues. With the end of the transition period and the associated possible availability of EU funds from Transition funding instruments, other financial sources, including EU structural funds, will need to be mobilised in the near future and countries need to prepare for this development. In the case insufficient revenues are mobilised by wastewater utilities, they might not be able to undertake the necessary maintenance and renewal of infrastructure. This could possibly lead to poor quality wastewater effluent and to deterioration of water quality and ecology of the receiving aquatic environment but also to financial consequences, including fines due to non-compliance to the EU legislation.

On the economic assessment, the implementation of the Directive has so far been poorly linked to economic justifications, which may partly explain the delays in implementation and the still high level of non-compliance in some countries. No major deviation from the standard cost of wastewater management in other geographical areas is found, but the cost cannot currently be justified from an economic benefits perspective. Based on data sources explored in the study, the main source of economic benefits of the UWWTD implementation may more significantly be linked to environmental and social benefits than to health aspects. The overall economic benefits may be more pronounced than in the indicative calculated figures documented in this study. Unfortunately, as detailed further in the document, there are currently no organised and publically available quantitative and monetised datasets available in the Danube river region or elsewhere to support such a claim. A more compelling economic argument for the implementation of the UWWTD may appear when more economic benefits are qualified, quantified and monetised in the DRB and when full economic values of water related ecosystem services can be documented and accounted for.

A set of recommendations is presented based on the assessment conducted: improve the availability of biophysical and financial data; build additional wastewater infrastructure; use wastewater as a resource; rely on less centralised and less resource-intensive solutions such as nature near wastewater treatment or IAS; better address nutrient management including other economic sectors; train administration and water utilities staff; improve financial viability by focussing on key aspects such as financial framework, tariff setting, tax adaptation; develop value transfer function to anticipate and plan cost benefits of systems and speed up the development of ecosystem services valuation to support the cost benefit analyses.

2 The Danube Region: Introduction to the Water Context

2.1 Introduction

This study targets an integrated assessment of wastewater management in the Danube region by considering the three main aspects: the biophysical situation of the receiving aquatic environment, the costs of implementing wastewater management and the related social impacts in terms of its affordability and sustainability aspects. For this, together with the Water Framework Directive (2000/60/EC, WFD), the European Urban Waste Water Treatment Directive (91/271/EC, UWWTD) is the core piece of legislation to consider. In addition, the ICPDR is gathering many datasets and conducting several assessments, along with an inventory of emission is part of the mandate of the Convention. In order to complement the available sources of information, a specific questionnaire was elaborated and distributed to the national authorities of eight EU Member States of the Danube River Basin District[1] (DRBD). Detailed answers received from Austria and Romania are used in this document.

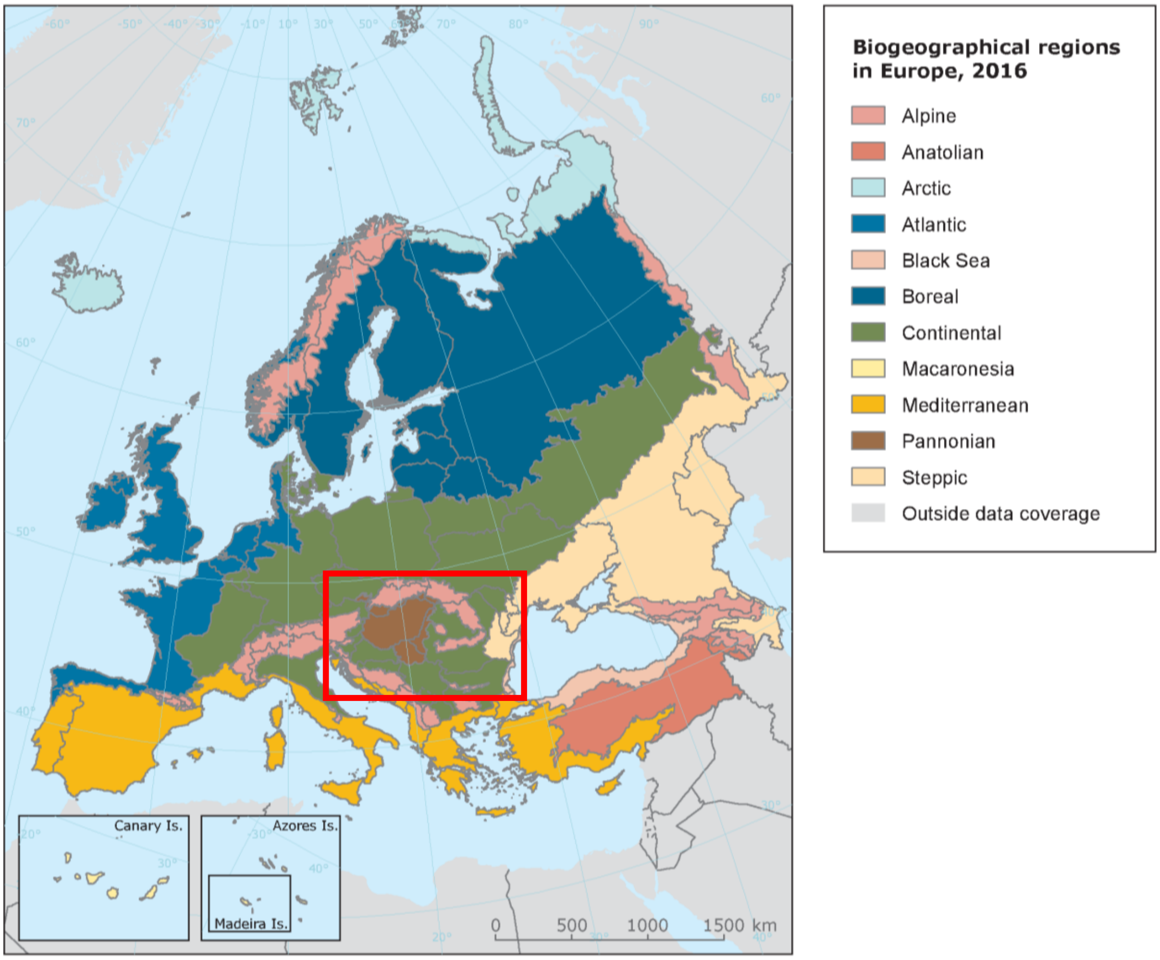
The Danube Basin extends over a total of 19 countries, which are linked by their interdependency on water resources. The current study focuses on the 16 countries which belong to central, eastern and south-eastern Europe (excluding CH, DE and PL), of which currently eight are EU Member States and, therefore, given more consideration in this study. With the exception of Austria, which entered the EU in 1995, the other countries joined the EU more recently: four (HU, CZ, SK, SI) in 2004, two in 2007 (RO, BG) and the last one in 2013 (HR). Considering wastewater management at the date of entry, and the deadlines set by the Directive for 1998 and 2005, these countries negotiated transitional periods which allow them to implement the UWWTD requirements within extended deadlines.

This introductory chapter presents the water context in the Danube region and the overall legislative framework, including past trends and the current situation regarding urban wastewater. It provides some general information necessary to understand the analyses presented in the subsequent chapters of this document.

2.2 Water context of Danube region

As “the most international” river basin in the world, the DRBD is the second largest river basin in Europe with an area of 807,827 km^2. Most of its territory belongs to three main biogeographical regions: continental, alpine and Pannonian, with the vast majority of its territory being rich in renewable water resources, even if the rainfall distribution varies greatly within the basin from 300 to 1,400 mm per year.

[1] River basin district means the area of land and sea, made up of one or more neighboring river basins together with their associated ground waters and coastal waters, which is identified under Article 3(1) of WFD as the main unit for management of river basins.



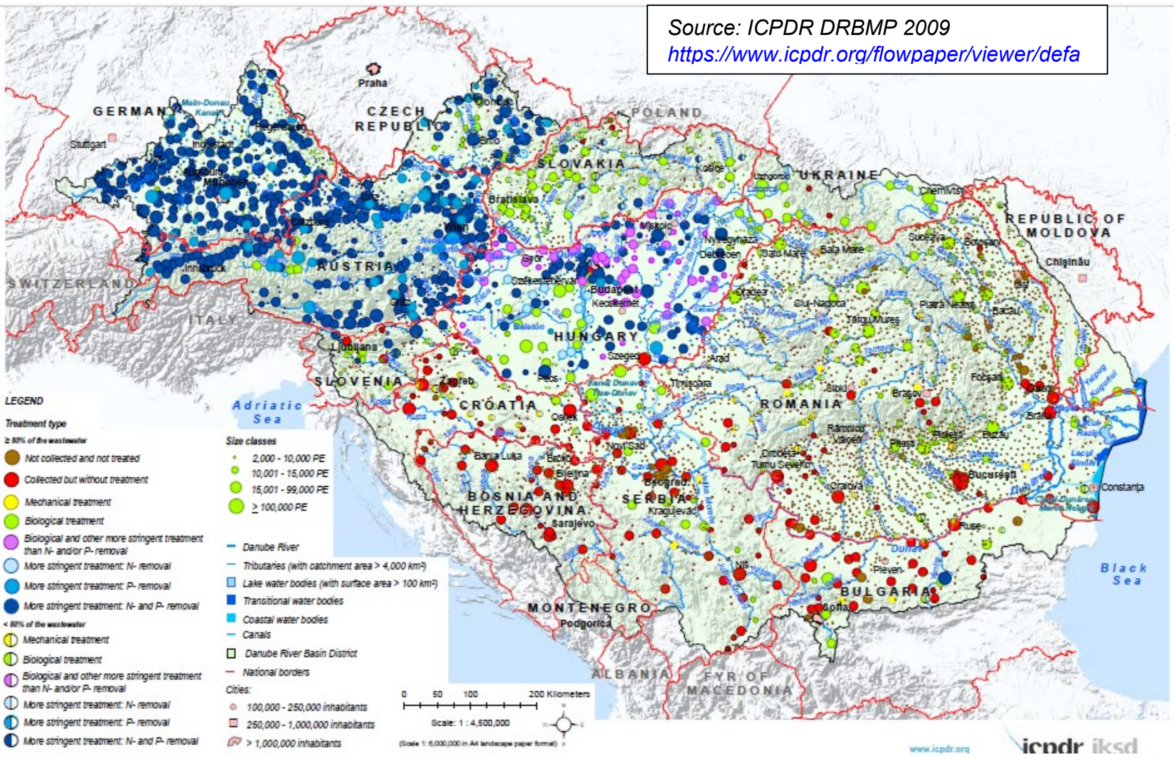
Source: EEA, 2016

Figure 2-1: The Danube River Basin and the biogeographical regions in Europe

In the DRBD a large share of drinking water is produced from groundwater (72%), but this share varies among countries from 30% in the south to 100% in the north.

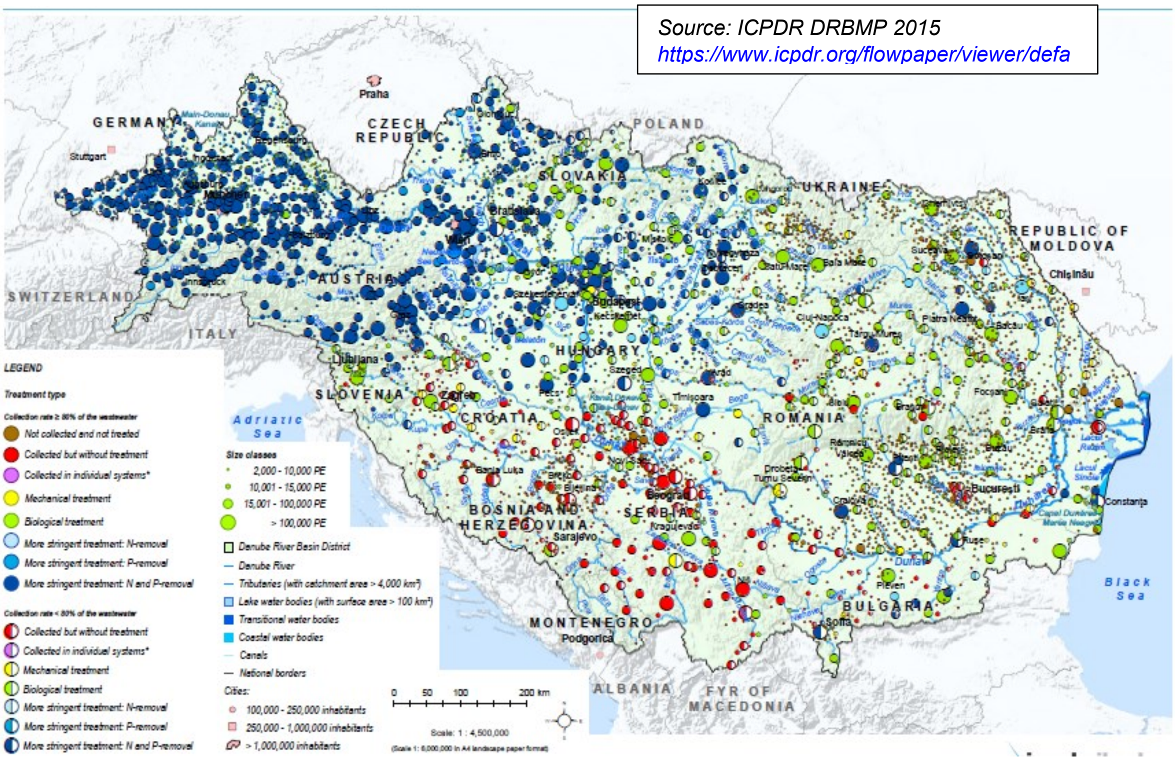
Water uses (and therefore discharges of wastewater) reflect the various economic activities of each country. This share of uses can be dominated by the domestic sector in countries with mostly settlements and service activities (Croatia), or with a higher share of industrial use when industry is the dominant sector and rainfall sufficient for agriculture (Austria, Hungary, Czech Republic or Slovakia), or with a significant share of agricultural use in case of lower rainfalls, or a more significant agriculture sector (Romania, Bulgaria). Urban population is generally larger than rural population in all countries, but the share of population in rural areas is still high (40 to 50%). In the rural areas of some of these countries, households may still lack features such as flush toilets or indoor bathrooms, leading to a low generation of wastewater. The availability of sewers and wastewater treatment can be limited in these areas. A significant share of the population is not connected to a collection/treatment system but discharge their wastewater directly into the environment.

With accession to the EU, the situation has improved and now 22% of water bodies show *good ecological status* or *potential* and 45% show *good chemical status* (WFD). Regular ICPDR reports show not only significant improvements in water quality, but also in wastewater management over the last two decades, as illustrated in the two following maps:



Source: ICPDR, 2008

Figure 2-2: Level of wastewater treatment of agglomerations ≥ 2,000 PE in DRBD for 2005-2006



Source: ICPDR, 2015

Figure 2-3: Level of wastewater treatment of agglomerations ≥ 2,000 PE in DRBD for 2011-2012

However, there is still significant pollution in surface waters, in particular due to insufficient wastewater management. Here, one of the key drivers is the population and the lack of proper wastewater management. Table 2.1 shows the share of the countries' territories within the DRB and the percentage of the DRB within the country.

	Target Countries		Share of the DRBD	Percentage of state within the DRBD	Population in million inhabitants	
					In DRBD	Outside of the DRBD
Outside study area	Germany	DE	7%	16.8%	9.4	73.3
	Poland	PL	<0,1%	0.1%	0.04	37.91
	Switzerland	CH	0.2%	4.3%	0.02	8.35
	Out of study	**Total**	**7.2%**	**_**	**9.46**	**119.56**
central, eastern and south-eastern Europe	Romania	RO	29.6%	100%	19.8	0.0
	Hungary	HU	11.5%	100%	9.8	0.0
	Austria	AT	10.0%	96%	8.3	0.3
	Slovakia	SK	5.8%	96%	5.2	0.2
	Bulgaria	BG	5.8%	43%	3.1	4.1
	Croatia	HR	4.3%	62%	2.6	1.6
	Czech Republic	CZ	2.7%	27%	2.9	7.7
	Slovenia	SI	2.0%	81%	1.8	0.4
	EU members	**Total**	**71.7%**	**-**	**53.4**	**14.3**
	Albania	AL	< 0.1	0.01	< 0.01	2.8
	Bosnia and Herzegovina	BA	4.6	74.9	2.9	1.7
	Kosovo	XK				
	Macedonia	MK	< 0.1	0.2	< 0.01	
	Moldova	MD	1.6	35.6	1.1	2.5
	Montenegro	ME	0.9	51.2	0.2	0.5
	Serbia	RS	10.2	92.3	7.5	0
	Ukraine	UA	3.8	5.4	2.7	43.2
	Non EU members	**Total**	**21.1%**	**-**	**14.4**	**50.7**

Source: DRBMP2009, World Bank, own calculation

Table 2-1: Basic Characteristics of the DRBD

The eight target EU Member States of Table 2-1 occupy around three-quarters of the DRB, whereas the largest share of the basin area belongs to Romania with about one-third of the total river basin area. Around 54 million inhabitants, i.e. 79% of the total population, of the eight target countries, are located in the DRBD.

In five of these eight countries (RO, HU, AT, SK, SI), the DRB covers an overwhelming part of the territory (80% to 100%). The Danube River Basin Management Plan (DRBMP) of these countries is therefore a reasonable source of data to assess their implementation status and their approximate UWWTD compliance costs. For the remaining three countries (CZ, HR, BG), and in particular the Czech Republic where less than one-third of the territory (27%) is located within the DRB, the DRBMP data is insufficient. Additional data such as that from the 9th Technical Assessment of UWWTD Implementation (9th TA UWWTD) recently completed by the EC services therefore needs to be considered.

The consideration of results from UWWTD reporting faces the difficulty that the UWWTD only covers agglomerations[2] (a concept different from usual administrative units) which generate pollution of above 2,000 PE (population equivalents). The definition is, however, vague and can cover different realities in different countries, which in turn can have an important influence on the financial and economic aspects of UWWTD implementation (for instance the density of population considered to include the area in the agglomeration can vary in different countries).

[2] According to the UWWTD an agglomeration represents "*an area where the population and/or economic activities are sufficiently concentrated for urban waste water to be collected and conducted to an urban waste water treatment plant or to a final discharge point*"

In general, the size (= generated load in PE) of an agglomeration should be determined taking into account:[3]

- the resident population + seasonal changes + non-resident population (e.g. tourism) and
- industrial wastewater (such as from small and medium sized enterprises and/or economic activities) being discharged into an urban wastewater collecting system or urban wastewater treatment plant and
- loads of domestic wastewater or urban wastewater from the above-mentioned sectors which should be collected by the collecting system (and/or addressed through IAS), but are not collected or do not reach the treatment plant (incomplete collecting systems, etc.)

The guidance document on the terms and definitions of the UWWTD underlines the fact that the agglomeration coincides with the sufficiently concentrated area itself and not with the de facto situation of the existing "catchment area" of a collecting system (i.e. network of sewers) within the agglomeration. However, when the collecting system is fully in place, the limits of the agglomeration under the Directive may coincide with the limits of the collecting system.

In the UWWTD reporting, the Member States can give a brief overview of their individual methodology used for the delineation of agglomerations (see Table 2-2). Taking into account the inhabitants of the Member States and the generated load of agglomerations ≥ 2,000 PE (see Table 2-1), the different national approaches to the delineation of agglomerations become evident.

EU Member State	Definition of the size (generated load) of agglomerations
Austria	Treatment capacity of UWWTP is used as an indication for the generated load of the agglomeration.
Bulgaria	The generated load is calculated.
Croatia	Total generated load of agglomeration = number of inhabitants according to official population census (2011) + industry load + tourism load (load of the maximum average week of the year)
Czech Republic	The generated load is estimated
Hungary	Calculation from settlements raw data
Slovakia	Sum of inhabitants and industry contributions expressed in PE
Slovenia	General calculation scheme (industry + inhabitants * weighting factor)
Romania	Calculation (includes resident population, economic activities, tourism, seasonal changes (connected or not), industries discharging into networks/WWTP (max average weekly loads)

Table 2-2: UWWTD MS reporting: Delineation of agglomerations and definition of size of agglomerations in the investigated Member States, as indicated by countries in 9th reporting (Spring 2016)

Agglomerations with collecting systems and treatment below this size, and all rural areas outside the agglomerations have to comply with the Directive's requirements (in general, collection with no discharge of raw wastewater and treatment with performance at the level of secondary treatment) but this kind of information/data is not collected. Essentially, this agglomeration concept covers a part of the small municipalities in particular in densely

[3] Guidance document "*Terms and Definitions of the Urban Waste Water Treatment Directive*", available at: http://ec.europa.eu/environment/water/water-urbanwaste/info/docs_en.htm

populated areas, but it misses a part of the wastewater generated in smaller villages and scattered settlements. The wastewater generated, collected and treated by these is not reported and there is therefore very little information on this. Eurostat has defined a concept of rural area but for the DRB it would represent 27.4 Mio inhabitants or 40% of the population, which seems high. On the other hand, Eurostat collects and makes available figures of population by Local Administrative Unit of level 2 (LAU2, i.e. municipalities) every ten years, the most recent for 2011 (Source: Eurostat database, extracted in June 2017). If we select only LAU2 (i.e. municipalities with less than 2,000 inhabitants), in principle not covered by UWWTD, in the eight EU MSs of DRB, we reach 10.81 Mio inhabitants (15.9%), but this is an overestimate as some municipalities are part of broader agglomerations and, thus, considered in UWWTD reporting. A more specific study in France concluded it corresponded to 7% or 4.56 Mio inhabitants, whereas by using LAU2 below 2,000 inhabitants it represents 15.9% of population, 3.6 times higher. Population density in DRB is lower than in France, it is thus probably better to consider a ratio of 2, which, if applied to the eight EU MSs, would amount to about 5 Mio inhabitants dispersed in rural areas.

For the rest of the study this will be neglected, as the lower level of equipment with basic sanitary facilities is mainly found in rural areas where domestic wastewater is generally discharged directly next to its generation into small ditches with vegetation conducting part of the purification. With progressive improvement in equipment in the future, this could become a pollution issue: if we consider that the rest of the population is connected to a correctly functioning system with a performance of 80% (easily reachable with current techniques), the above 5 Mio inhabitants discharging their wastewater untreated would represent 28% of pollution from urban wastewater.

In addition, UWWTD reporting provides very limited information on the specific technologies used for collection and treatment, which can have very different investment, operation and maintenance costs. Performance is assessed by countries based on a number of analyses with the pre-requisite that the country has implemented the necessary quality controls. Information on the wastewater generated and associated conversion to population equivalent, and information on sewer networks and their performance, including storm water overflows, are limited, but are an important component in the calculation of the final performance. The ICPDR is a key actor in DRB, regularly assessing the situation with emissions from different sources. The related documents will provide a further insight into water quality and wastewater emissions in the basin.

In the DRB, the most populated country is Romania, followed by Hungary and Austria. The lowest number of inhabitants lives in the DRB part of Slovenia. In total, 14 million people (21% of the eight countries' population) still live outside the DRBD.

According to the Terms of References (ToR), the study at hand should cover the entire territory of the eight EU Member States of the DRBD, i.e. not only the areas draining into the DRB but also other areas of the eight EU MSs which drain outside (Elbe and Odra RBD in CZ; Adriatic RBD in HR and SI; Black Sea RBD, East Aegean RBD and West Aegean RBD in BG; Vistula RBD in SK; and Rhine and Elbe RBD in AT). To avoid confusion, the entire administrative area covered by this study is referred to as the "Danube Region".

2.3 General overview of 16 countries

There are eight countries in the Danube river basin which are not EU Member States but also belong to central, eastern or south-eastern Europe: Four are EU candidate countries (Albania, Macedonia, Montenegro and Serbia) and two are potential candidates (Kosovo and Bosnia Herzegovina), which gives them incentives to improve the situation and knowledge of wastewater management. With 14.4 Mio inhabitants within the DRB (see Table 2-1), non EU members represent 17% of the population of the basin and 8.5% of the area, with Serbia accounting for half of this. Most countries in this group share the same situation, i.e. a high share of population in rural areas (30 to 50%) with basic sanitary facilities and wastewater collection, and urban areas with collection of wastewater via sewer networks discharging mostly untreated wastewater (see Annex, section 1.1 for information on individual countries). By accessing to EU, these countries will have to address wastewater treatment in urban areas, but as shown in Eurostat figures (see section 2.2), a significant share of the population living in rural area will have to be provided with collection and treatment facilities (estimated with the above assumption to be 1 Mio inhabitants).

On the other hand, eight countries are EU Member States with very different economic structures, different sizes and biogeographic conditions. Accession to the EU has obliged them to apply the "Acquis Communautaire", for which they have had access to EU funding.

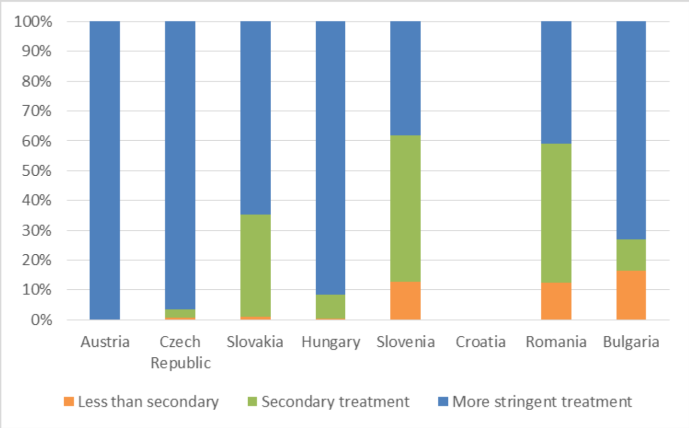
Many detailed figures on the water and sanitation sector of the various countries can be found on the Danubis website (sos.danubis.org) or in the EC UWWTD Implementation Reports: this study section will only provide a short overview to introduce the country situation.

Overall, for the eight EU Member States considered, the situation for wastewater collection and treatment for 2014 is summarised in the following table. The population is the national resident population, while the generated population equivalent (PE) takes into account population and economic activities generating wastewater in agglomerations above 2,000 PE.

Country	Population 2014 (no. of inhabitants)	Generated load (PE)	Collection		Treatment		
			Collecting systems (PE)	IAS (PE)	Discharged without treatment (PE)	Secondary treatment (PE)	More stringent treatment (PE)
AT	8,506,889	20,408,871	20,270,894	138,056	0	20,926	20,249,968
CZ	10,512,419	7,701,010	7,179,605	521,405	0	254,518	6,925,087
SK	5,415,949	4,656,291	3,870,940	766,082	19,269	1,367,790	2,503,150
HU	9,877,365	11,694,647	10,211,003	1,483,644	0	863,502	9,347,501
SI	2,061,085	1,462,223	1,244,202	91,220	126,801	770,221	473,981
HR	4,246,809	5,026,227	No data				
RO	19,947,311	20,924,781	12,680,654	138,617	8,105,510	7,504,938	5,175,716
BG	7,245,677	8,085,615	6,802,294	5,371	1,277,950	1,824,327	4,977,967
Total	**67,813,504**	**79,959,665**	**62,259,592**	**3,144,395**	**14,555,757**	**12,606,222**	**49,653,370**

Table 2-3: UWWTD situation as reported under the 9th TA-UWWTD, autumn 2017

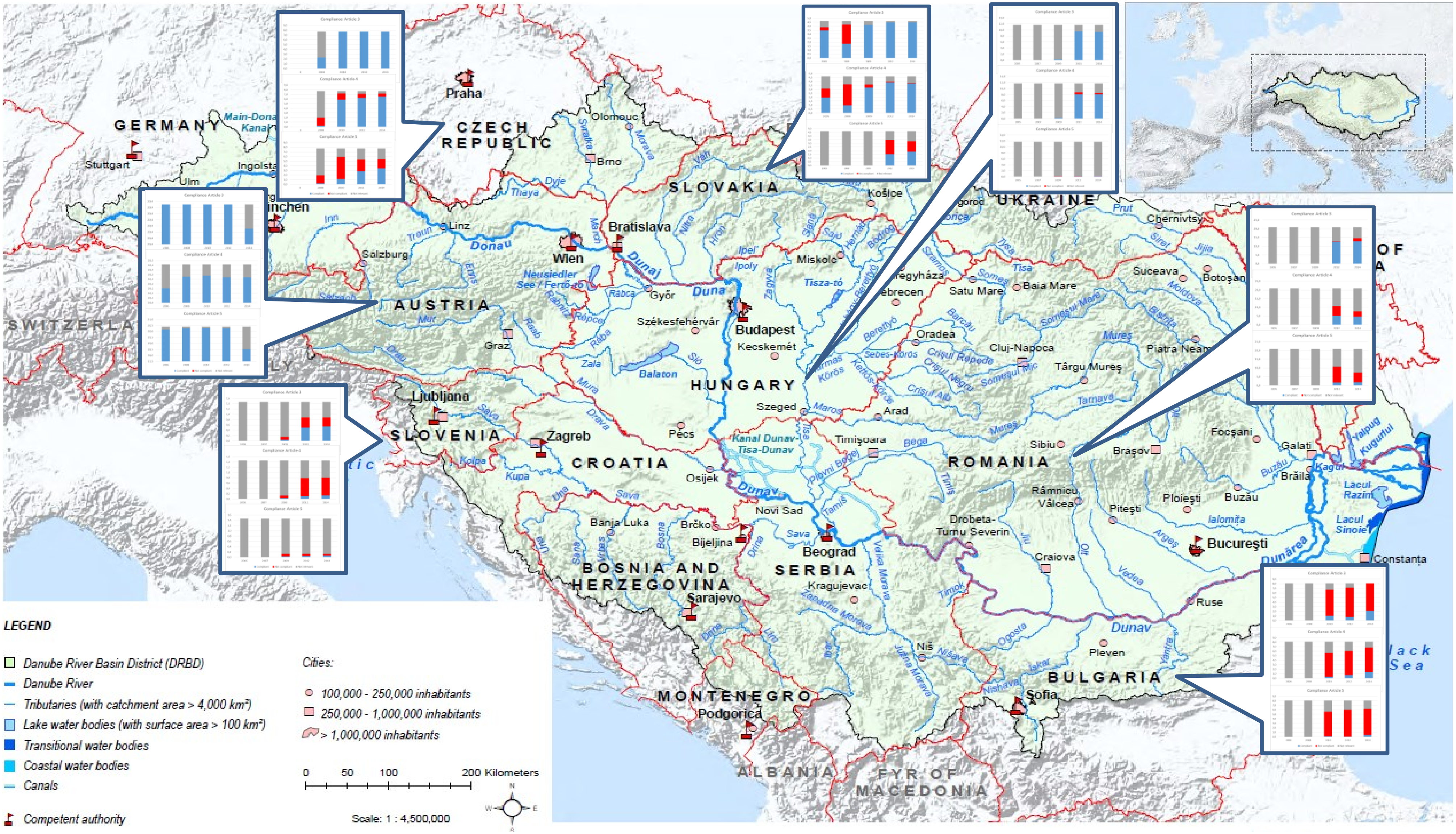
The level of collection and treatment is decreasing from source to mouth of the basin, as illustrated in Figure 2-4. Compliance follows the same pattern as illustrated in Figure 2-5.



(Source: 9th TA-UWWTD, autumn 2017)

Figure 2-4: Distribution of level of treatment of wastewater treatment plants in the eight EU Member States of DRB in 2014

Additional figures showing the evolution of wastewater collection and treatment in more detail can be found in Annex 1, section 1.2.



(Sources: country compliance from 9th TA-UWWTD, autumn 2017 & background layer ICPDR DRBMP 2009)

Figure 2-5: Compliance with article in EU8 countries of DRB in 2014

2.3.1 Austria

As the oldest member of the eight EU Member States (1995), Austria (AT) has an average income per capita of 44,000 USD (source: http://sos.danubis.org/, consulted in June 2017). In 2014 Austria had 8.4 Mio inhabitants and 632 treatment plants covered by UWWTD. Austria is an urban country (66% of population) with 2,354 municipalities and 5,400 water services and gathers a large part of its population in cities, with Vienna gathering 1.8 Mio inhabitants, but a significant share of its population also lives in rural areas.

For implementing the UWWTD, Austria decided to apply tertiary treatment (called more stringent treatment in UWWTD) for treating nitrogen and phosphorus in all treatment plants.

Austria has had a high level of wastewater treatment since 2005, with wastewater from the entire population being collected and treated, mostly collectively in wastewater treatment plants. With 100% of the population's wastewater collected and subjected to tertiary treatment, Austria now has the most advanced collection and treatment level among the eight EU MSs in the Danube River Basin.

2.3.2 Bulgaria

Being an EU member for more than ten years, Bulgaria (BG) has an average income per capita of 15,900 USD (source: http://sos.danubis.org/, consulted in June 2017). With 7.3 Mio inhabitants and 368 treatment plants covered by UWWTD in 2014, but 264 municipalities and 56 water services, Bulgaria is an urban country (73% of population) with most of the services centralised and a large part of its population in cities, with Sofia hosting 1.2 Mio inhabitants.

For UWWTD implementation, Bulgaria had a transitional period with a deadline for implementation for agglomerations >10,000 PE at 31/12/2010 and a final deadline (i.e. for agglomerations >2,000 PE) until 31/12/2014. Authorities have decided to implement the approach of individual adaptation of the treatment level, requiring tertiary treatment (called more stringent treatment in UWWTD) for nitrogen and phosphorus in agglomerations above 10,000 PE discharging into sensitive areas. The major part of its territory has been designated as sensitive.

After its accession in 2007, Bulgaria provided its first complete reporting under the UWWTD for the reference year 2010. Two additional reports were provided but progress has been slow: compliance of collection has gone from 10 to 20%, for secondary treatment from 4 to 17% and for more stringent treatment from 1 to 5%. The evolution regarding treatment is quite important, with an increase of 15% of more stringent treatment, and a decrease of treatment less than secondary treatment. However, the situation is still very difficult and the transition period is now over. In addition the estimated non-collected load is still very high (16%), with a significant decrease of 10% between 2010 and 2014.

2.3.3 Czech Republic

An EU member for almost 14 years, the Czech Republic (CZ) has an average income per capita of 27,300 USD (source: http://sos.danubis.org/, consulted in June 2017). With 10.5 Mio inhabitants and 698 treatment plants covered by UWWTD in 2014 but 6,200 municipalities and 2,400 water services, the Czech Republic is an urban country (73% of population).

For UWWTD implementation, the Czech Republic had a transitional period with a deadline for implementation for 18 agglomerations >10,000 PE at 01/05/2004, for 36 additional agglomerations >10,000 PE at 31/12/2006 and a final deadline (i.e. for agglomerations >2,000 PE) until 31/12/2010. Authorities decided to take an overall approach and apply the tertiary treatment level for all agglomerations above 10,000 PE discharging into sensitive areas, with the entire country being designated as sensitive.

After its accession to the EU in 2004, the Czech Republic provided its first reporting under the UWWTD for the reference year 2008. For this reference year, an important part of the generated load was not collected and not treated (18%), but this situation was improved in 2010 by implementing collection systems and treatment plants. The information collected has also improved, because about 7% of the generated load is now considered treated in Individual and Appropriate Systems (IAS), while this information was not reported in the past. The Czech Republic already had a collection system in place in all agglomerations and 100% compliance was reached in 2010. For secondary and more stringent treatment, progress was slower with 18% of the load still not subjected to secondary treatment and 62% not compliant by 2010. Since then, the transition period has ended. Progress with secondary treatment was relatively slow until 2014, with 9% still not compliant in 2014, while progress on more stringent treatment was faster with 27% not compliant by 2014.

2.3.4 Croatia

Being an EU member for only four years, Croatia (HR) has an average income per capita of 20,900 USD (source: http://sos.danubis.org/, consulted in June 2017). With 4.2 Mio inhabitants and 282 treatment plants covered by UWWTD in 2014 but 556 municipalities and 140 water services, Croatia is a rather rural country (42% of the population).

For implementing the UWWTD, Croatia has a transitional period with a deadline for implementation for agglomerations >15,000 PE at 31/12/2018 except for 11 coastal agglomerations, for agglomerations >10,000 PE in sensitive areas and relevant catchments and the 11 coastal agglomerations at 31/12/2020 and a final deadline (i.e. for agglomerations >2,000 PE) until 31/12/2023. Authorities have decided to apply the tertiary treatment level as an overall approach for all agglomerations above 10,000 PE discharging into sensitive areas. Almost the entire country has been designated as sensitive.

Croatia gained accession to the EU in July 2013, and for the moment the country is not required to provide any data on the situation of its wastewater sector and treatment under the UWWTD. The information from the *implementation plan for water utility sector (Hvratske Vode 2010)* is stating that 45.7% of the population are connected to a wastewater collection system but only 27% are connected to a wastewater treatment service.

2.3.5 Hungary

An EU member for almost 14 years, Hungary (HU) has an average income per capita of 22,900 USD (source: http://sos.danubis.org/, consulted in June 2017). With 9.9 Mio inhabitants and 749 treatment plants covered by UWWTD in 2014 but 3,200 municipalities and 41 water services, Hungary is an urban country (70% of population).

For UWWTD implementation, Hungary had a transitional period with a deadline for implementation for agglomerations in sensitive areas >10,000 PE at 31/12/2008, a deadline for implementation for agglomerations in normal areas >15,000 PE at 31/12/2010 and a final deadline (i.e. for agglomerations >2,000 PE) until 31/12/2015. Authorities decided that most of the territory was not sensitive and therefore as an overall approach applied the tertiary treatment level for agglomerations above 10,000 PE discharging into sensitive areas, with a very small share of its territory designated as sensitive. This will change with the next reports as the country is situated entirely within the Danube basin and has to treat N and P.

After its accession to the EU in 2004, Hungary provided its first reporting under the UWWTD for the reference year 2005. In 2005, Hungary already had a very low rate of non-treated load, and a high rate of the load reduced via secondary (70%) or tertiary (10%) treatment or IAS (20%). At the date of accession Hungary already had a collection system in place in many agglomerations and compliance is high (80%). As the country is still in a transitional period, a significant proportion of the wastewater is not subject to compliance for secondary (27%) or tertiary treatment (98%), but most of the wastewater subject to secondary treatment is compliant (4% not compliant) and the small amount subject to tertiary treatment is compliant.

2.3.6 Romania

Being an EU member for more than ten years and as the biggest country in the region, Romania (RO) has an average income per capita of 18,600 USD (source: http://sos.danubis.org/, consulted in June 2017). With 20 Mio inhabitants and 788 treatment plants covered by UWWTD in 2014 but 3,200 municipalities and 226 water services, Romania is a rural country (54% of its population lives in urban areas, which is one of the lowest shares of the region).

For implementing the UWWTD, Romania has a transitional period with deadlines linked to average performance for collection and treatment calculated at country level. (collection: 61% of load at 31/12/2010, 69% at 31/12/2013, 80% at 31/12/2015, treatment: secondary and more stringent were relevant: 51% of the load at 31/12/2010, 61% at 31/12/2013, 77% at 31/12/2015), and a deadline for individual agglomerations >10,000 PE for collection at 31/12/2013, and for treatment at 31/12/2015), and a final deadline (i.e. for agglomerations >2,000 PE) until 31/12/2018. Authorities decided to apply as an overall approach the tertiary treatment level for all agglomerations above 10,000 PE discharging into sensitive areas, with the entire country being designated as sensitive.

Romania joined the EU in 2007, but data about urban wastewater has even been available since 2005. The situation for Romania is very different from the other six EU MSs analysed here, as there is an important lack of facilities regarding urban wastewater. In 2005, less than 50% of the generated load was connected to collecting systems, and less than 30% was treated by at least secondary treatment. In 2014 the treatment situation was markedly better, with more than 50% of the generated load being subjected to at least secondary treatment and the amount of wastewater collected but not treated, estimated at 8%, had decreased significantly (20% in previous reporting). 40% are still not collected and about 30%[4] of the population has no access to basic sanitary facilities such as flush toilets or bathrooms.

The compliance assessment for Romania is calculated along specific national targets and not by agglomeration, and despite significant progress in terms of collection and treatment equipment, Romania will be far from reaching full compliance by the end of the transition period. The last reporting showed very low compliance for all aspects: collection (2.7%), secondary treatment (3.8%) and more stringent (0.9%).

2.3.7 Slovenia

EU member for 13 years and as the smallest EU country in the region, Slovenia (SI) has an average income per capita of 28,600 USD (source: http://sos.danubis.org/, consulted in June 2017). With 2 Mio inhabitants and 220 treatment plants covered by the UWWTD in 2014 and 220 municipalities with 98 water services, Slovenia is a rural country (50% of the population lives in urban areas - the lowest share of the region).

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[4] Sources: http://ec.europa.eu/eurostat/statistics-explained/index.php/Housing_conditions consulted in September 2017

For the UWWTD implementation, Slovenia had a transitional period with a deadline for implementation for agglomerations in sensitive areas >10,000 PE at 31/12/2008, a deadline for implementation for all agglomerations >15,000 PE at 31/12/2010 and a final deadline (i.e. for agglomerations >2,000 PE) until 31/12/2015. Authorities decided to apply, as an overall approach, the tertiary treatment level for all agglomerations above 10,000 PE discharging into sensitive areas, with almost the entire country being designated as sensitive.

After its accession to the EU in 2004, Slovenia provided its first reporting under the UWWTD for the reference year 2006. Difficulties due to lack of education/training for staff reporting seem to be reflected by the reduction of tertiary treatment reported between 2007 and the following reports. Overall Slovenia has mostly secondary treatment. The share of wastewater collected and not treated has slowly decreased over the eight years reported, and a significant share of wastewater was still estimated by authorities as being neither collected nor treated in 2014, while IAS was introduced in 2012. The load subject to compliance has increased but the share of the non-compliant load is of about half of the total load, with still a significant level of non-compliance for collection (23%), secondary treatment (45%) and more stringent (5%). It is therefore anticipated that the country will not reach full compliance by the end of the transition period.

2.3.8 Slovakia

Being an EU member for 13 years, Slovakia (SK) has an average income per capita of 26,100 USD (source: http://sos.danubis.org/, consulted in June 2017) With 5.4 Mio inhabitants and 356 treatment plants covered by UWWTD in 2014 and 2,900 municipalities and 17 water services, Slovakia is a rural country (54% of its population lives in urban areas).

For UWWTD implementation, Slovakia had a transitional period with deadlines linked to average performance on biodegradable load calculated at country level (83% of biodegradable load at 31/12/2004, 91% at 31/12/2008, 97% at 31/12/2012) and a deadline for all agglomerations >10,000 PE at 31/12/2010, treatment (secondary and more stringent were relevant: 51% of the load at 31/12/2010, and a final deadline (i.e. for agglomerations >2,000 PE) until 31/12/2015. Authorities decided to implement, as an overall approach, the tertiary treatment level for all agglomerations above 10,000 PE discharging into sensitive areas. Almost the entire country was designated as sensitive.

After its EU accession in 2004, Slovakia provided its first reporting under the UWWTD for the reference year 2005. Slovakia already had a collection system in place in a large part of agglomerations and full compliance on this was reached in 2009 also thanks to the use of IAS (17% of the generated load in 2014). The rate of treated wastewater is also very high, but there is still an important share of the total generated load at secondary treatment (29%).

The last reporting showed a low level (2%) of non-compliance for secondary treatment, but the level of non-compliance with regard to more stringent treatment is significant (29%) and it can be anticipated that full compliance will not be reached by the end of the transition period for more stringent treatment.

2.4 Detailed review of EU water directives

The EU legislation concerning water and water pollution has been progressively developed and implemented over the last 50 years. For the areas related to pollution and emission, three distinctive periods can be distinguished:

- a first period from 1976 to 1991[5] with a focus on pollution problems and associated properties of substances released with two main texts on dangerous substances,
- a second period from 1991 to 2000[6] with a more sectoral approach with three directives addressing urban areas, agriculture and industry,
- and finally a more recent period since 2000[7] with a more integrated approach over the entire territory with two main directives addressing inland and marine waters.

In parallel, legislation for the protection of human health has also been progressively developed to tackle drinking water production and bathing water, interacting with the legislation on pollution by requiring some minimum criteria for the water used for producing water for drinking and bathing.

EU water legislation now covers a large part of the water sector in Europe, even if some aspects are still not covered adequately. Such aspects include discharge by combined sewer overflows or rain drainage systems, which have the potential to generate significant pollution.

It defines the EU ambition regarding protection of natural waters and humans by providing a standard level of protection that every EU citizen can expect, even if countries are free to adopt stricter rules or refine their approach to adapt to national conditions and history.

Within this framework, two directives are the primary focus of the current study: the Urban Waste Water Treatment Directive (UWWTD) and the Water Framework Directive (WFD).

The **UWWTD** was adopted in 1991 with the principal aim of protecting the aquatic environment from the adverse effects of wastewater discharges from two main sectors: cities (all with a collective collection system) and the food industry (minimum 5,000 PE). The commonly recognised best way to achieve this protection is to implement wastewater collection (as defined by Article 3 of the Directive) and treatment at the level of secondary treatment (as defined by Article 4) as the considered standard for all agglomerations above 2,000 PE. This also applies to agglomerations above 10,000 PE discharging into areas designated as sensitive to eutrophication and to microbial contamination which have to implement treatment at the level of tertiary or so called “more stringent treatment” (defined by Article 5), to reduce nitrogen, phosphorus or microbial loads. For all other cases, the treatment should be “appropriate” to the receiving environment, which often means secondary. Depending on the local situation and choices, technical solutions can be very different and entail different costs: combined sewer collecting wastewater and rain water, especially in densely populated areas, or separate sewer combined with appropriate management of rainwater (harvesting, Natural Water Retention Measures…), and intensive (requiring energy, equipment and technical maintenance) or extensive treatment (less resource intensive, more natural, requires less maintenance but more space), that is often found in less densely populated areas.

The so-called “Individual and Other Appropriate Systems (IAS)” is an accepted alternative treatment method for scattered populations; or in the case of other specific biophysical conditions (slopes, natural barriers etc.); or for reasons of excessive cost. This method is suitable for very small systems and is able to treat the wastewater of a typical family house or a small set of neighbouring houses. In this case, the term “appropriate” means requiring a level of treatment equivalent to secondary treatment, i.e. a septic tank and a drainage system using soil as a purification method. Other extensive and more natural solutions (for more details see GWP CEE 2014 and WEPC 2010) are also very often used for their flexibility and resilience to changes in volume or composition of the wastewater, their robustness and

[5] DSD 76/464/EEC and daughter Directives from 1982 to 1986
[6] UWWTD (91/271/EEC), Nitrate Directive (91/676/EEC), IPPC Directive (96/61/EC) and EPER regulation
[7] WFD (200/60/EC), E-PRTR regulation, MSFD (2008/56/EC)

easier maintenance, and modularity. More stringent levels of treatment are necessary for IAS when implemented in agglomerations above 10,000 PE discharging in sensitive areas. IAS, if well designed and maintained, can be a solution for reducing the cost of implementation of UWWTD, together with solving local sanitation problems, in particular in smaller settlements, but should not be seen as a low cost solution, as it generally requires private investment by the household's owner.[8]

More specifically, the UWWTD focuses on the five main so-called macro pollutants, which are found in significant quantities in wastewaters discharged after water use by humans for their personal use at home or work, in industry and services connected to the sewer network and the food industry. These pollutants are:

- suspended solids,
- organic pollution defined by two parameters, one for easily biodegradable (biochemical oxygen demand / BOD_5) and one for the overall organic pollution (chemical oxygen demand / COD),
- nutrients defined by two parameters, one for total nitrogen (N_{tot}) and one for total phosphorus (P_{tot}), two major nutrients that impact plant growth.

The main effects of these pollutants are - in addition to microbiological impact - waste/sludge deposition in aquatic ecosystems, oxygen depletion and excessive algal growth (eutrophication), all of which pose major problems, both for the environment and for humans downstream of the discharges who intend to use water. While the target is the protection of the environment, correct implementation of the directive should enhance the use of water by humans, thereby contributing to more and better use of water.

After intensive expert debates and testing, the EC adopted the **Water Framework Directive** to overcome some major gaps found in previous legislation by providing comprehensive coverage of all inland waters and addressing water issues in a more integrated way. The WFD is repealing some past legislation and considering the implementation of the older legislation as basic measures, like the Industry Emissions (IPPC) Directive and the UWWTD. The aim of WFD is also to protect the aquatic environment, which is being accomplished by asking MSs to take appropriate measures to tackle water pollution and other pressures with the aim of achieving *good status* for all waters. Water pollution and water quality are, for the first time, to be found in a single legislative text.

The WFD has created or considered various major concepts useful for its management: a geographical organisation for the water body, the sub-basin and river basin district, and the water status for assessing water quality, the Common Implementation Strategy (CIS) for involving the countries more closely in the implementation and recovery of costs for water services.

Water status is a concept embedding the chemical status which covers only dangerous substances, and the ecological status covering physical, chemical and biological parameters along with hydro morphological conditions supporting the biology. Macro pollutants covered by the UWWTD discharged into aquatic environments and monitored in water bodies are considered under the ecological status and should reach a concentration near to natural concentrations in a water body which is considered to have *good status*.

The directive allows for exemptions which entail extended deadlines to reach the objective or less stringent objectives (less than good status), justified by specific natural conditions,

[8] Many countries classify IAS as small systems gathering and storing wastewater, which is then transported by truck to the next collective treatment plant. This solution is also accepted but from UWWTD perspective, this type of systems are considered part of the collection stage, thus covered by article 3 of the Directive and not classified as IAS.

technical or economic reasons, in particular when it would entail disproportionate cost. In such case all other measures contributing to improving the situation without excessive costs must be taken.

2.5 UWWTD Status of implementation and compliance in Europe

Every second year since 1994, the Member States of the European Union have been obliged to report the status of implementation of the UWWTD for their country. Out of the eight MSs in the study, seven countries entered the EU recently (2004, 2007 and 2013) and have specific implementation deadlines (transition periods). (see Annex 1, section 2 for more information on implementation and limits of UWWTD)

The last reporting process (the ninth) focussed on the year 2014 and the assessment of the collected datasets will be published by the European Commission in autumn 2017. This EU report considers, describes, interlinks and locates the following four main geographical features, which are logically interlinked between the source of pollution, the transportation of the pollution, its treatment and discharge into the receiving environment, with data collection being organised according to these components:

- wastewater agglomeration
- wastewater treatment plant
- wastewater discharge point
- receiving area.

In addition, it deals with the collection of wastewater, including the IAS method. This last method entails both collection and on-site treatment. However, very little information is collected on the technologies used, both at the collection and treatment levels.

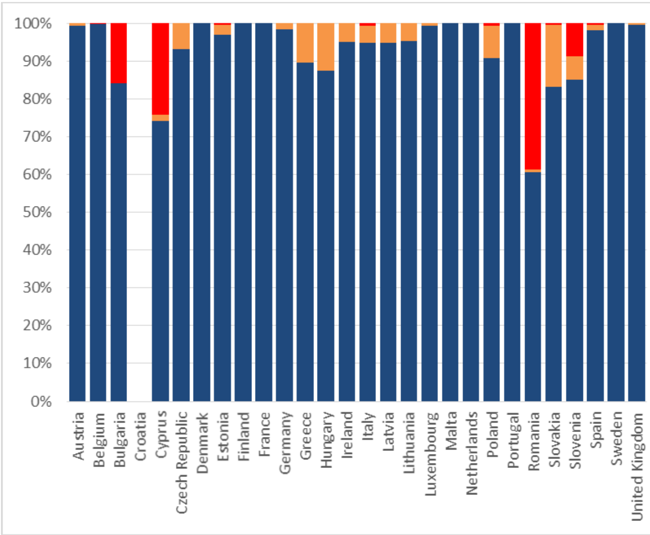
2.5.1 Wastewater generation

At a European level, wastewater production from agglomerations above 2,000 PE represents more than 600 Mio PE (498 Mio PE for EU15 and 106 Mio PE for EU13). In most cases, agglomerations are a complex source of wastewater, as they comprise not only inhabitants, but also many economic and social activities, from small and medium enterprises to industries, services, hospitals and other public services.

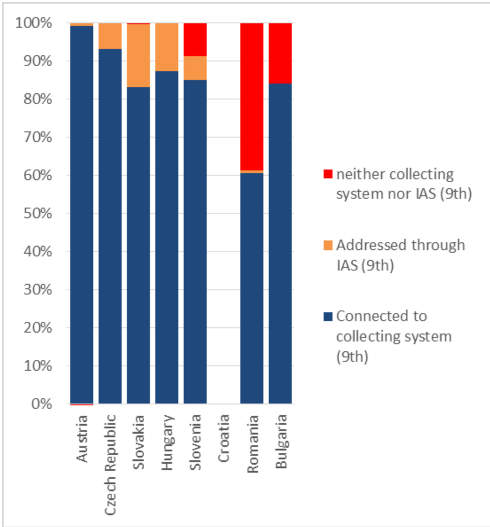
2.5.2 Collection and IAS

Figure 2-6 gives a national overview of the wastewater collection for all 28 MSs and a focus on the eight EU MSs of DRB from the upper to lower part of the basin. The majority of Member States have a high rate of collection, with a residual use of IAS. IAS are considered as responsibility of each Member State and therefore by default to provide an appropriate level of collection and treatment. Therefore, they not considered for the EU-wide data collection and reporting process. If well designed and maintained, they can provide an affordable solution with good performance (WEPC, 2010).

For collection, the majority of agglomerations are using combined sewer to collect both wastewater and rainwater, and, as raised in a recent report from the European Court of Auditors (ECA, 2015), it is common that the sewer networks are not fully water tight and can drain additional shallow groundwater. ECA raises that in the DRB this can lead to an significant amount of clean water entering the wastewater treatment plants that is disturbing the treatment process. They therefore recommend to conduct specific actions on this. In the DRB, the load discharged without collection is very low, except for Bulgaria, Romania and Slovenia but a certain degree of uncertainty remains. On the one hand because a - generally unknown - part of the wastewater can be lost by the sewer network, on the other hand because it is not always very easy to collect information on IAS, generally located on private properties, and finally because the proportion of people living in dwellings without a bath, shower or indoor flushing toilet and therefore generating a very limited amount of wastewater can be significant (31% in 2015 in Romania as reported by Eurostat). Croatia has not provided any data about collection, as it has no obligation to do so as a new MS. In the DRB the use of IAS is significant, and the information for certain parts of the population has to be improved to assess if they are effectively discharging raw wastewater.



a)



b)

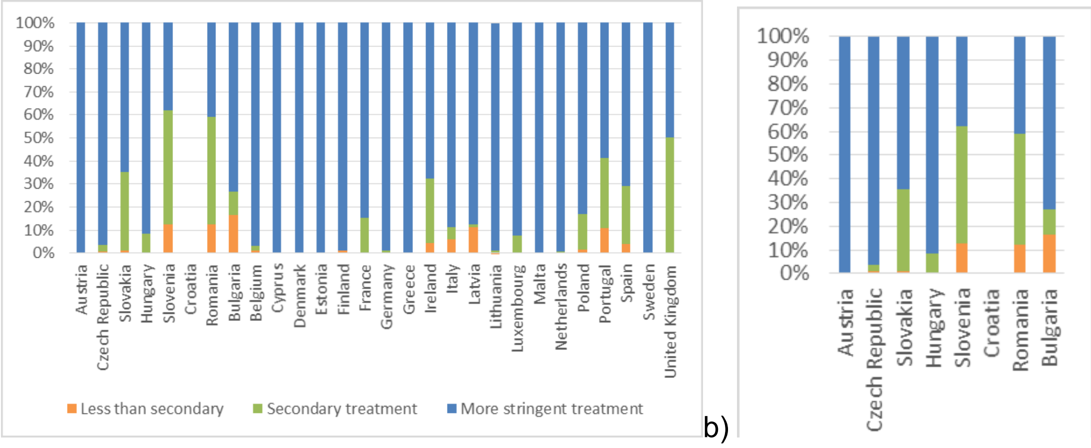
Source: 9th TA UWWTD, autumn 2017, to be published by EC

Figure 2-6: Situation of wastewater collection in percentage of the generated load for a) EU 28 & b) EU8 MSs of DRB for the reference year 2014

It should also be noted that, from an EU reporting perspective, only limited information is collected and available on losses during collection (leakages, combined sewer and combined sewer overflows etc.).

2.5.3 Wastewater treatment

Figure 2-7 shows the apportionment of the collected load between the three treatment levels for each MS and a focus on the 8 EU MSs in DRB. A significant share of the wastewater receives tertiary treatment (see also Figure 13), while some countries still discharge insufficiently treated wastewater (less than secondary) in EU 28. In DRB, a large part is still treated secondary while the Danube basin is deemed sensitive to eutrophication and thus requires more stringent treatment of nutrients. A share of the wastewater is considered insufficiently treated (less than secondary) and the location of these treatment systems show they are mostly impacting the DRB and are not concentrated along the coastlines where such treatment might be acceptable (Adriatic or Black Sea). In addition, the ECA report raises that many treatment plants are significantly oversized (28 big plants examined in 4 DRB EU MS, of which 30% receive less than 50% of the design capacity), which can have an influence on the treatment performance but also on economic and financial aspects.



Source: 9th TA UWWTD, autumn 2017, to be published by EC

Figure 2-7: wastewater treatment level in percentage of the collected load for a) the EU28 & b) EU8 MS of DRB for the reference year 2014.

2.5.4 Wastewater discharge and sensitive areas

The implementation of treatment of nutrients (microbes respectively) is necessary for discharges depending on the sensitivity of the receiving environment to eutrophication, and microbial contamination. For this purpose, the MSs have to designate sensitive areas, and catchments of sensitive areas[9], and define the relevant parameters to be treated in addition to normal treatment (secondary). In general, if a river is considered sensitive at a specific location, it is also considered sensitive downstream. It is important to note that the obligation for nutrient removal (N_{tot} and/or P_{tot}) only applies to agglomerations above 10,000 PE that discharge their wastewater into a eutrophic sensitive area and similarly for microbes in areas sensitive to microbial contamination. (see Annex 1, section 2 for detailed information on ways to define sensitive areas).

2.5.5 Compliance assessment

Compliance with the UWWTD is calculated and assessed at the level of the agglomeration and considers collection (Art. 3), secondary treatment (Art. 4) and more stringent treatment (Art. 5) and hierarchical compliance: it is not possible to be compliant for treatment and not for collection (for more details see Annex 1).

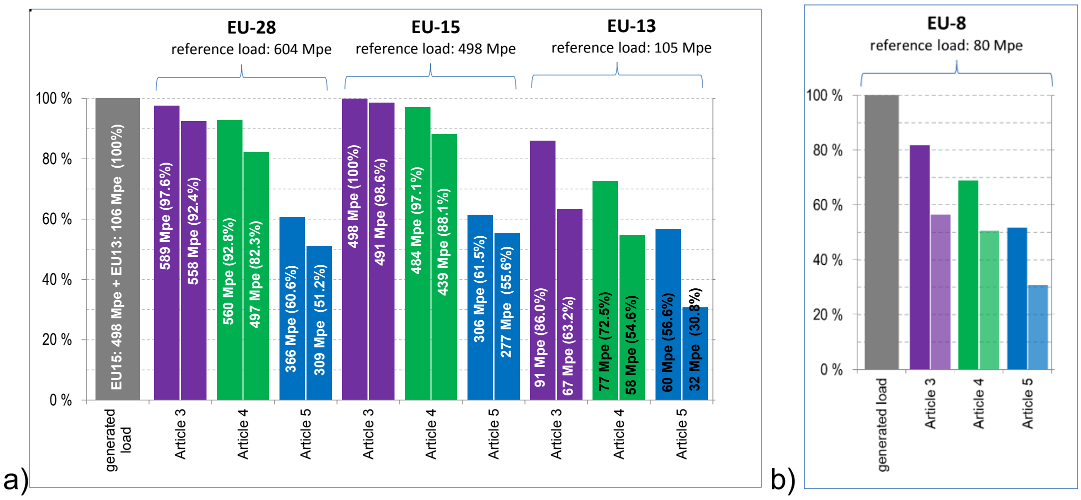
Moreover, compliance regarding collection (Art. 3) takes into account the generated load of the agglomeration, while compliance regarding secondary treatment (Art. 4) and more stringent treatment (Art. 5) takes into account the load connected to a collecting system. This difference is important as non-collected load (discharged without collection or treated by means of IAS) is considered as not-relevant regarding the treatment step (Art.4 & 5), even if it represents a significant proportion of the pollution, especially with improvement of the treatment of the collected load. (ex: with 90% performance, a wastewater treatment discharges only 10% of incoming pollution, hence if 10% of the pollution of the area is not collected, it represent the same amount as the part which is collected and treated). Although the share of wastewater collected and treated in IAS and/or transported to an UWWTP by truck is significant in single MS, this fraction of wastewater is not included in the general compliance evaluation of Art.4 and Art. 5 according to the Directive.

[9] From this point on, the term “sensitive area” will designate the sensitive area and its relevant catchment, as the requirements for those two types of receiving areas are very similar.

In DRB, a significant proportion of wastewater is not collected nor treated adequately and for wastewater entering a collective system, there is still a significant share (about 20% in each case) which is not compliant.

Compliance rules are a set of calculations comprising of a legal text that should be strictly adhered to. However, in recent years this has not always been possible. A new concept was therefore introduced: the “distance to compliance” which individually calculates each article and considers the two main components for each article: collecting system and IAS for article 3, equipment and performance for article 4 and article 5 respectively. This has the advantage of showing the remaining effort necessary by the country to achieve full compliance, both for equipment and performance. This entails different types of actions. Overall 9% of the load still need to be correctly collected, 16% needs secondary treatment and 38% needs more stringent treatment.

Figure 2-8 gives an overview of the target loads as % of generated load (solid bars) and the compliant ones (transparent bars), depending on each Article.



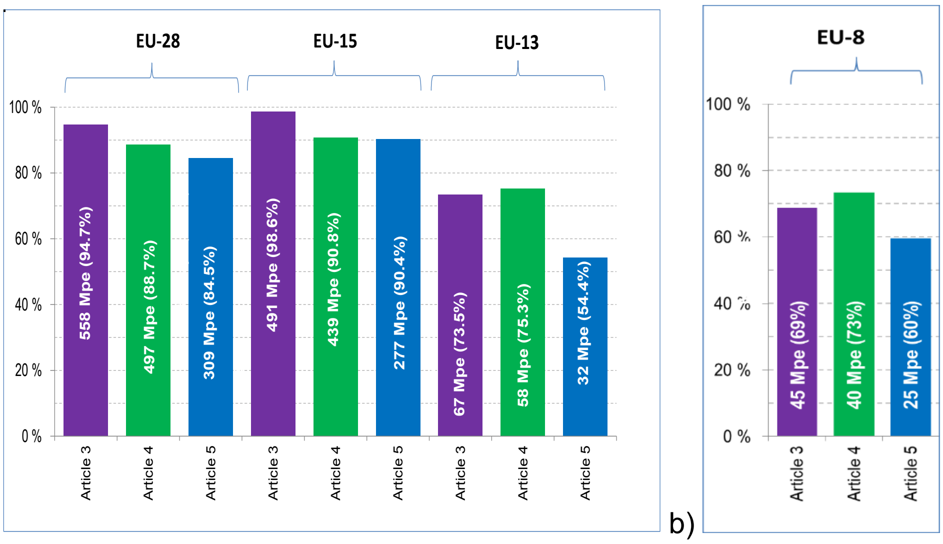
Source: 9th TA UWWTD, autumn 2017, to be published by EC

Figure 2-8: Target and compliant load rates per Article in relation to the total generated load[10]. For a) the EU28 & b) EU8 MS of DRB for the reference year 2014.

Figure 2-9 shows the same data converted to the compliance rate.

[10] Solid bars: load that should be collected and/or treated. Transparent bars: load for which the collection or treatment provided complies with the provisions in the Directive

a) b)



Source: 9th TA UWWTD, autumn 2017, to be published by EC

Figure 2-9: Average compliance rates with Article 3, Article 4 and Article 5 in relation to the total subjected wastewater load for a) the EU28 & b) EU8 MS of DRB for the reference year 2014.

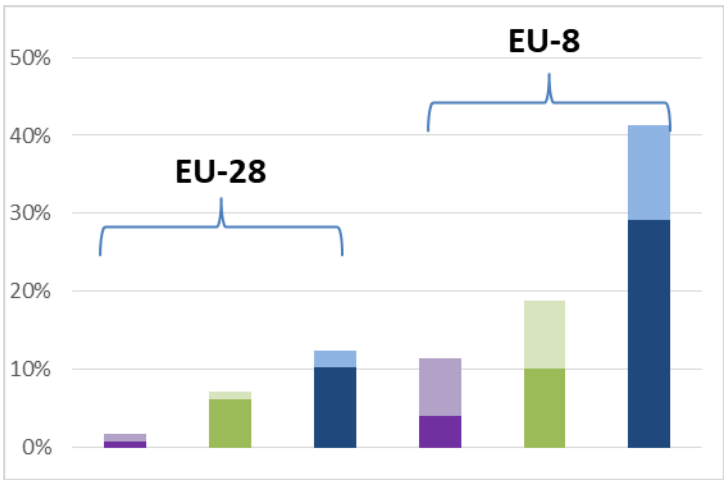


Figure 2-10

Source: 9th TA UWWTD, autumn 2017, to be published by EC

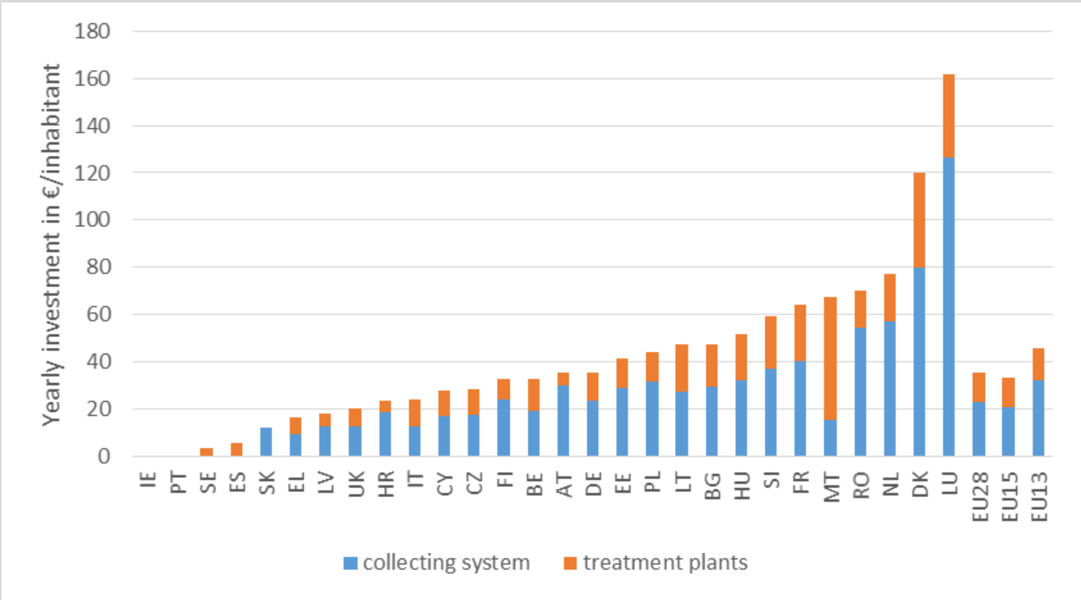
Figure 2-10: Distance to compliance for Articles 3 to 5 for the reference year 2014 for the EU28 and for the EU8 MS of the DRB (dark color: expired deadline, light color: pending deadline).

2.5.6 Investments

Under its article 17 the UWWTD requires MS to establish a programme for implementation of the Directive and to report to the EU. This does neither cover operation nor maintenance costs but only investments for renewing existing installations and for building new installations. To this end, in the last reporting, MSs also had to indicate some figures on investments. Figure 2-11 shows the current[11] yearly investment per inhabitant for each MS, indicating the differences between the investments dedicated to collection systems and the investments dedicated to treatment plants.

[11] The term "current" is used because there is not a unique period of investment reported by all the MS. The period reported can begin from 2012 to 2016, and can end at 2013 to 2023.

The mean investment for EU-13 is 48 EUR per inhabitant per year. It is less in EU-15 with an average investment of 35 EUR per inhabitant per year, with an average at the European level of 38 EUR. However, these figures need to be considered with care as some big countries have not provided the investment necessary for the renewal of infrastructures. The average value is therefore higher. Investments are mostly dedicated to collection systems, with a rate of 72% of the total investment for EU-13 and 65% for EU-15: the sewer networks, generally installed underground in streets require a lot more work and costs than treatment plants located on the surface of open ground and with a limited space.



Source: 9th TA UWWTD, autumn 2017, to be published by EC

Figure 2-11: Current yearly investments in EUR per inhabitant for each Member State (new and renewal). for a) the EU28 & b) EU8 MS of DRB for the reference year 2014.

As can be seen throughout this section, UWWTD reporting is a unique source of information on wastewater management in Europe. It presents, however, some weaknesses in capturing the complete wastewater management situation. In particular, it largely ignores the housing conditions for EU citizens, which are important in the calculation of generated load. It does not adequately cover other important aspects in the overall performance of the system, such as technical standards used for designing the systems or the importance of uncontrolled discharges including infiltration and losses, which may represent a significant proportion of the pollution released. Moreover, the link between biophysical information and costs of investment and maintenance are not well established.

3 Effects of UWWTD Implementation on Water Quality Status

This chapter addresses the question as to how water quality in the Danube region has been improving due to the implementation of the UWWTD. This means, to which extent the implementation of the UWWTD in the targeted countries is actually contributing to the achievement of “good ecological and chemical status” of surface water quality, as defined in the WFD.

3.1 Approach to assess the effects of UWWTD-implementation on water quality

The pollutants to be investigated in the current study are those which are regulated by the UWWTD and monitored in treatment plant discharges, namely BOD_5 and COD as parameters of organic pollution, and N_{tot} and P_{tot} as parameters for nutrient pollution. With regards to nutrient parameters, surface water quality monitoring also often covers ammonium (NH4-N), nitrate (NO3-N) and ortho-phosphate (PO4-P) which can also be indicative for the above.

The usual approach to investigating the influence of the UWWTD to water quality is linking emissions from wastewater generated by humans and human activities to water quality in the receiving aquatic environment (surface water quality). Loads discharged by installations and loads found in the aquatic environment are calculated and compared in order to investigate trends. This exercise is all the more complicated because not all emission sources are known and natural processes in the aquatic environment can reduce (self-purification) or increase (by-products of degradation of other pollutants) the load. The usual approach, except for very local studies, is therefore not to directly link individual loads discharged and the loads in the receiving water but to compare the multiannual trends of discharges and of loads found in aquatic environments.

A further constraint for the assessment of the UWWTD influence to surface water quality results from the fact that not only urban wastewater, which originates from agglomerations as defined under the UWWTD, contributes to the pollution of the aquatic environment but that other point and diffuse sources also have a major influence on surface water quality. The major sources emitting pollutants to surface water include point and diffuse sources (see Table 3-1).

Point sources	Diffuse sources
- wastewater from agglomerations, which is collected in sewer systems and which receives adequate or inadequate wastewater treatment - industrial and other commercial enterprises and services not connected to sewer networks - animal husbandry	- agriculture - impervious surfaces and other leakages from urban areas - transport infrastructures - atmospheric deposition - naturally covered areas

Table 3-1: Point and diffuse sources of pollution to surface waters

For organic pollution, point sources from agglomerations, industry and agriculture represent the key emitters to the aquatic environment. Due to the self-purification capacity of water bodies, the impact of organic pollution is usually a local problem and its influence along the watercourse depends strongly on many factors, such as the dilution rate and the hydraulic conditions of the recipient.

For nutrients (N_{tot} and P_{tot}), diffuse sources to the aquatic ecosystem play an important role, as already demonstrated in the 1st and the 2nd DRBMP (ICPDR, 2009; ICPDR, 2015). According to the 2nd DRBMP, agriculture (diffuse pollution) contributes approximately 42% of the N_{tot} emissions and 28% of the P_{tot} emissions to the Danube basin, whereas emissions from urban water management have a share of 25% for N_{tot} and 51% for P_{tot}. Consequently, the improvement of surface water quality cannot only be attributed to enhanced urban wastewater treatment in the Danube basin; other possible sources need to also be examined.

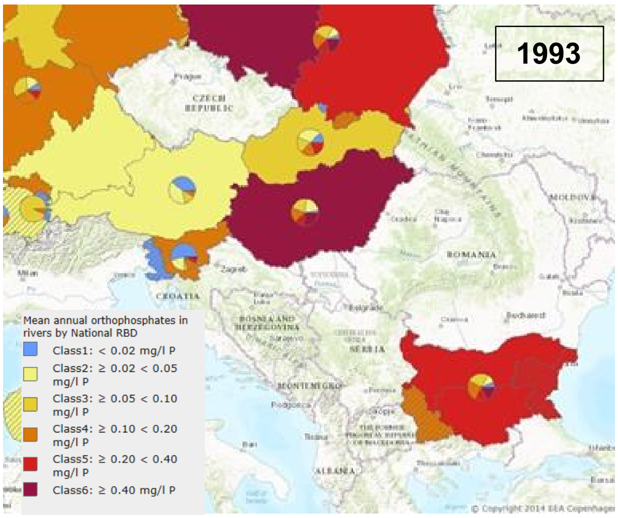
Further information that needs to be examined when assessing the influence of UWWTD-implementation on surface water quality, is the ecological status of surface water bodies, as defined under the WFD. The assessment of the 1st RBMP revealed that more than half of the 127,000 surface water bodies in Europe are reported to be in less than good ecological status or potential. The pressures affecting most surface waters are diffuse pollution (in more than 40% of Europe's water bodies in rivers and coastal waters), in particular from agriculture, causing nutrient enrichment, and hydromorphological pressures. Discharges from wastewater treatment plants, industries and the overflow of wastewater from sewage systems are significant pressures in 22% of water bodies (EEA, 2012, reference year of information 2009).

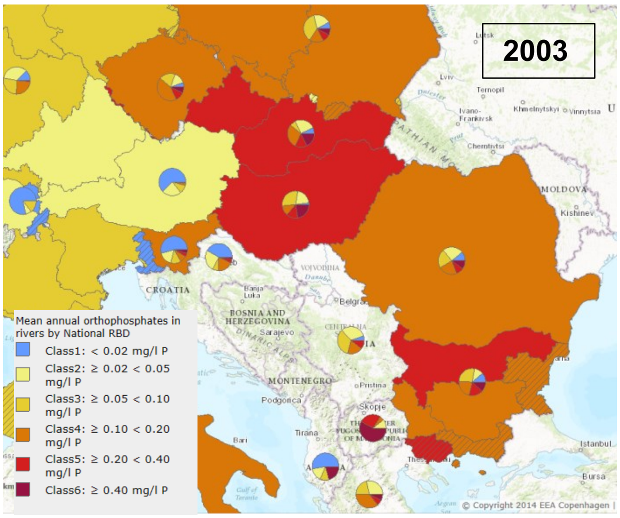
3.2 Water quality in the Danube region

The WFD requires MSs to achieve good water status, i.e. for UWWTD-relevant parameters a good ecological status. This cannot be easily translated into a surface water concentration, as it depends on the biological community of the specific part of the river considered and on the information on ecological status. However, the EEA is currently using as a proxy the median of mean annual concentrations of NH4, P_{tot} and NO3 in river water bodies as a kind of target value for reaching the good ecological status and for showing changes (see below). The median value for good ecological status considered is 0.04 mg/l P for P_{tot}, 0.05 mg/l N for NH4 and 0.6 mg/l N for NO3.

Information on water quality in the Danube region is available from the ICPDR TNMN – network and the EEA (Waterbase – Water Quality). These databases provide comprehensive information on pollutant concentrations (mg/l) at water quality monitoring stations for the last 20 years, but comprise considerably less or even no information with regards to water discharge into the rivers. Therefore, the calculation of pollutant loads in rivers was limited. A detailed explanation of the data sources and their contents is provided in Annex 2, section 2.2.

The general improvement of water quality in the Danube region regarding organic and nutrient pollution is observable in maps provided by the EEA. These maps show mean annual concentrations of selected pollutants per WFD RBD, calculated on the basis of a varying number of monitoring stations. An example of these maps is given in Figure 3-2, while further maps are given in section 2.4 of Annex 2. The long-term trend for BOD_5, NH4-N and PO4-P clearly shows that the water quality is improving over time.





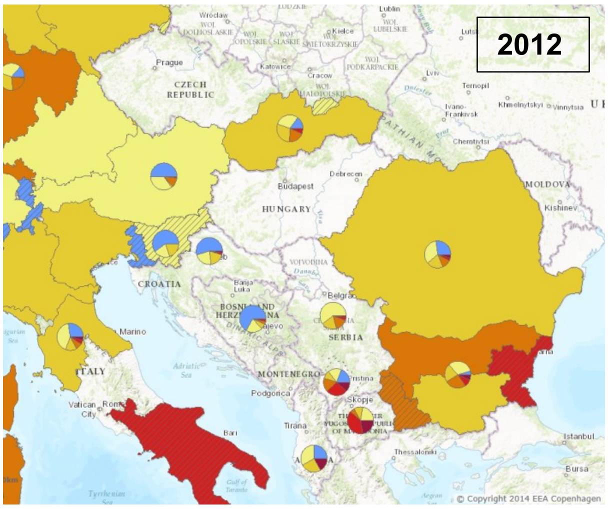
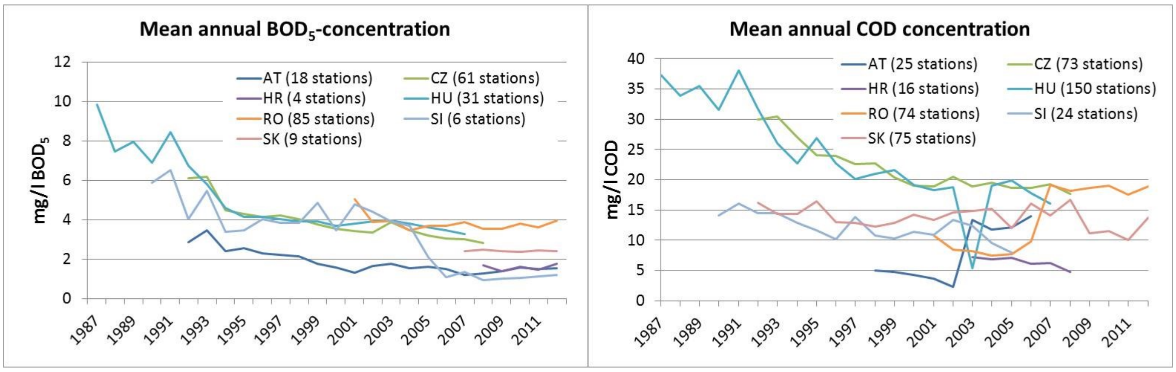


Figure 3-1: Evolution of PO4-P in rivers of the Danube basin *(Source: http://www.eea.europa.eu/data-and-maps/explore-interactive-maps/wise-soe-orthophosphate-in-rivers, extracted in September 2017)*

For the assessment of changes of mean annual concentrations of pollutants over time, these concentrations were also calculated on the basis of monitoring stations that were stable over a number of years in each country. The database allowed a reasonable evaluation for BOD_5, COD, NO3-N, P_{tot} and PO4-P, whereas for N_{tot} this assessment for N_{tot} was only possible for CZ and SK. Figure 3-3 shows the results of the investigations.



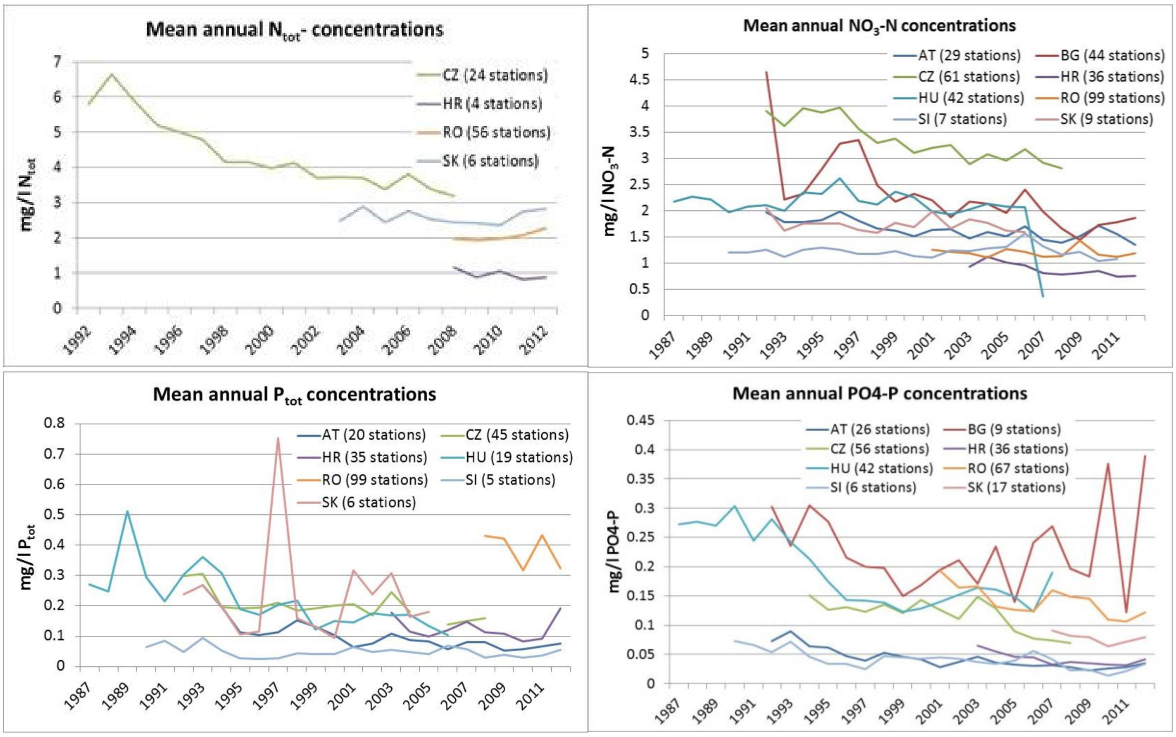


Figure 3-3: Mean annual concentrations of BOD_5, COD, N_{tot}, NO3-N, P_{tot} and PO4-P (*Source: own elaboration using EEA Waterbase data, extracted in June 2017*)

From the first to the last year of available data from stable monitoring stations per country, the mean annual BOD_5 concentrations dropped by 22% to 70%. Stable or even increasing concentrations were only observed for HR and SK, which both provided only a small number of stable monitoring stations and short time series. In five out of seven countries investigated, mean annual COD concentrations dropped by 15% to 75%. Mean annual N_{tot} concentrations decreased by 45%, whereas these remained more or less stable for SK. In contrast, NO3-N concentrations decreased in all eight countries investigated, with decreases ranging from 5% to 83%. Mean annual concentrations of P_{tot} decreased by 15% to 72% in six out of seven countries investigated; only HR recorded relatively stable concentrations and an increase in recent years. The PO4-P decreases in mean annual concentrations ranged from 12% to 54% in seven countries. Bulgaria was the only country which saw an increase, however strong fluctuations have been observed for this country in recent years.

Data from the TNMN network, the historical evolution of water quality (average concentrations and loads from years 1997-2002, 2003-2009 and 2009-2014), and also the longitudinal evolution of water quality regarding BOD_5, NH4-N, NO3-N and PO4-P is presented in Figure 3-4 to Figure 3-7.

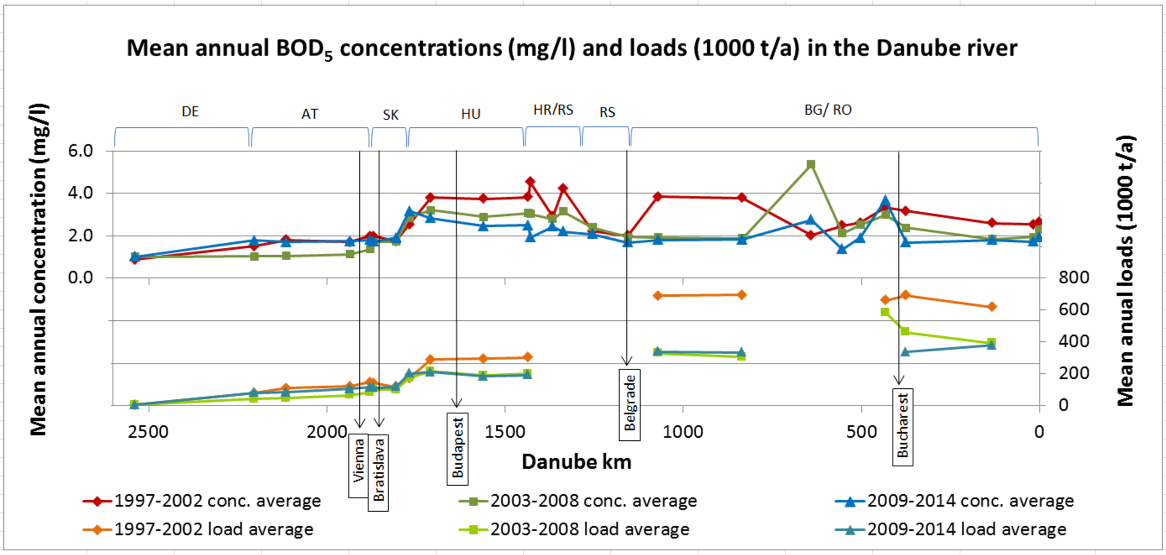


Figure 3-4: Mean annual BOD_5 concentrations and loads in the Danube river (*Source: see Fig. 3-3*)

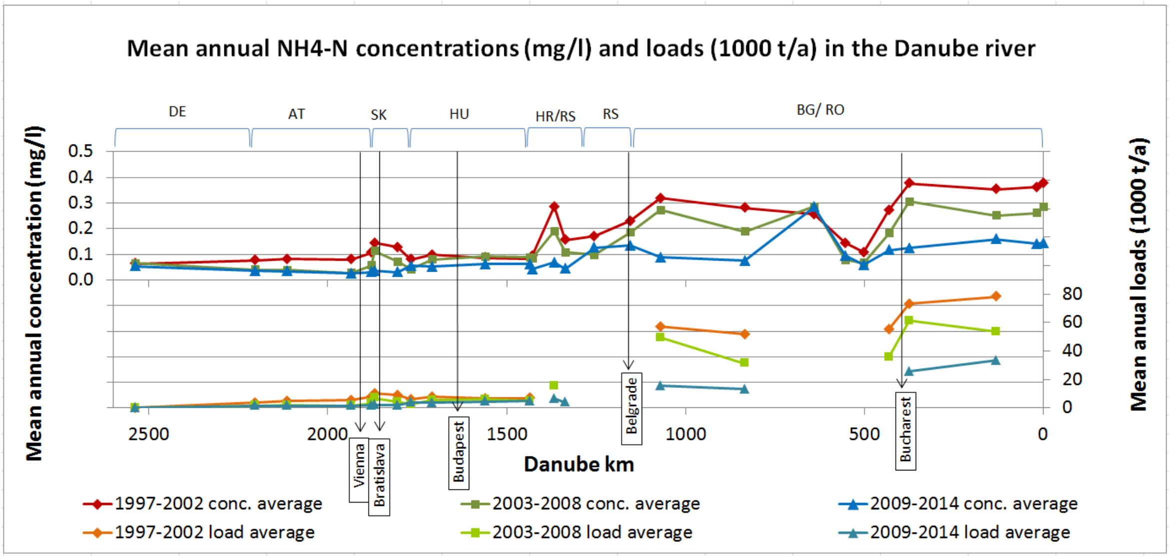


Figure 3-5: Mean annual NH4-N concentrations and loads in the Danube river (*Source: see Fig. 3-3*)

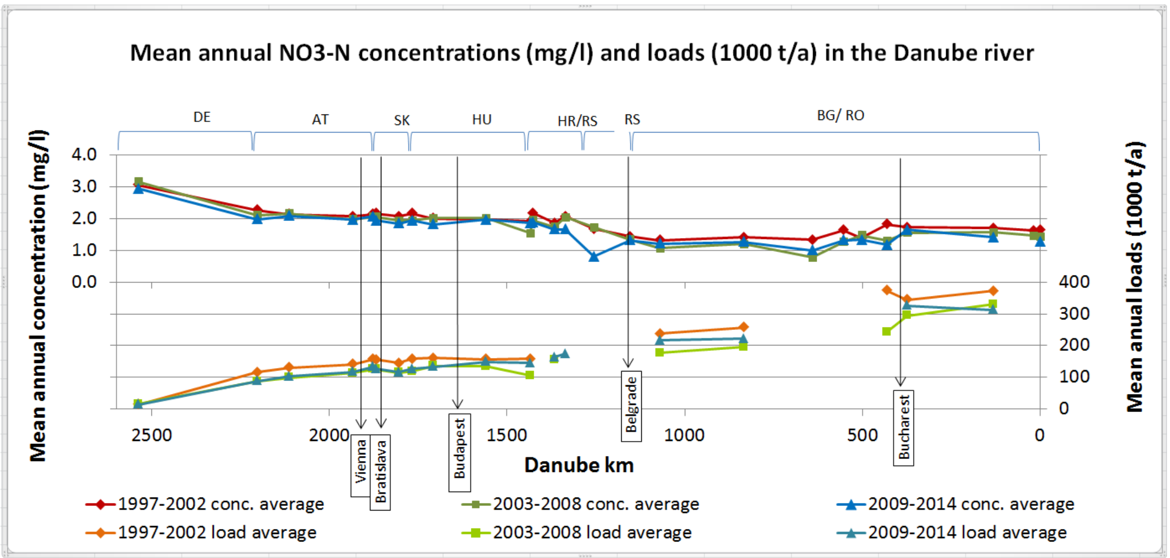


Figure 3-6: Mean annual NO3-N concentrations and loads in the Danube river (*Source: see Fig. 3-3*)

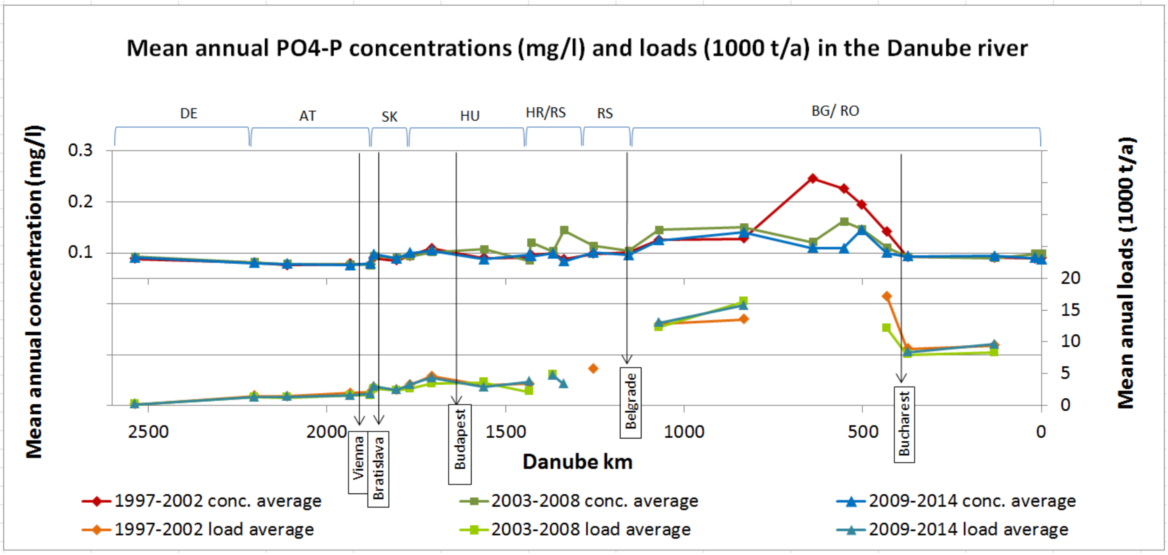


Figure 3-7: Mean annual PO4-P concentrations and loads in the Danube river (*Source: see Fig. 3-3*)

Comparing the mean annual concentrations and mean annual loads over a period of time, a positive historical development can be clearly observed for BOD_5 and NH4-N. Moreover, a slight positive trend for NO3-N is also observable. Taking into account average concentrations from all 26 observed TNMN monitoring stations in the years 1997 – 2002 and 2009 - 2014, the average concentration decreased for BOD_5 from 2.7 to 2.1 mg/l, from 0.19 to 0.08 mg/l for NH4-N, from 1.88 to 1.66 mg/l for NO3-N and from 0.06 to 0.05 mg/l for PO4-P. This trend can be clearly linked to the construction of new and the up-grading of existing UWWTPs. For instance high levels of NH4-N concentrations and loads downstream in Vienna were eliminated by the modernisation of the Viennese UWWTP in 2006.

It can be clearly seen that both available data sources on water quality in the Danube region show a consistent downward trend of the concentrations and loads of BOD_5, COD, N_{tot} and P_{tot}.

Box 2-1: Vienna's main wastewater treatment plant and its influence on surface water quality

Designed for carbon and phosphorus removal, the Viennese main wastewater treatment plant went into operation in 1980. From 2000 to 2005 the treatment plant was modernised and enlarged to an organic design capacity of 4,000,000 PE and the provision of nitrogen-removal (nitrification, denitrification). Due to this modernisation, the removal efficiencies increased for all wastewater parameters, especially for total nitrogen (N_{tot}) with an increase from 46% to 81%. Furthermore, the removal rates for BOD_5 and COD increased by more than 10%.

The modernisation of Vienna's sewage treatment plants had significant effects on the environment.

The Austrian Federal Agency for Water Management (Bundesamt für Wasserwirtschaft, BAW) stated that the water quality of the Danube river downstream the discharge of the effluent of the treatment plant had improved and achieved biological quality class II (BAW, 2007). In addition, the loads of ammonium in the Danube River decreased significantly, as can be seen in Figure 3-8.

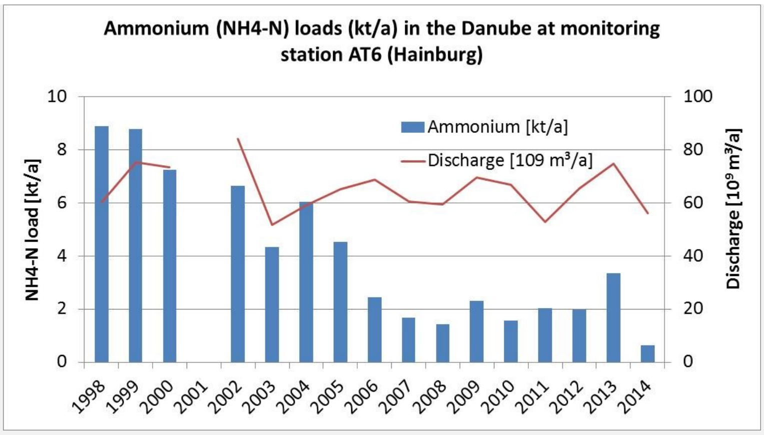
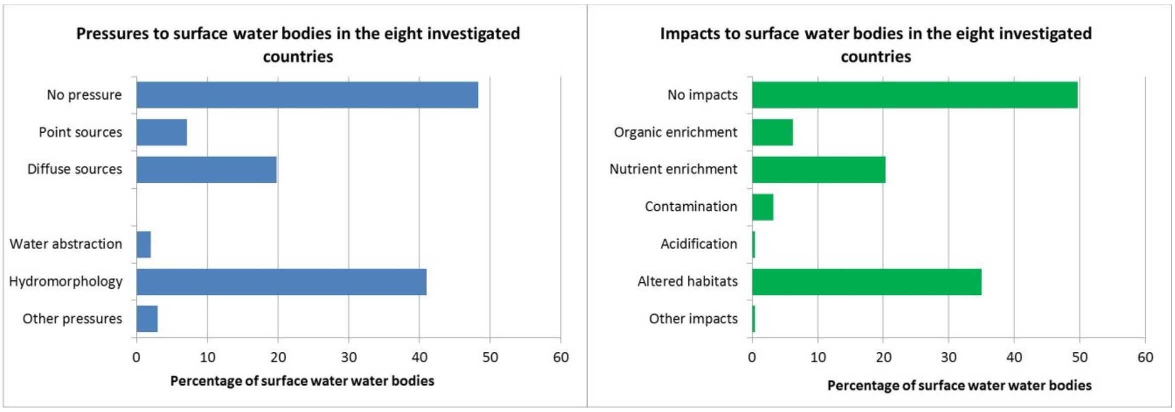


Figure 3-8: Ammonium loads in the Danube at TNMN monitoring station AT6 (Hainburg)

3.3 Status and pressures of surface water bodies according to the WFD

The ecological status of surface water bodies and the pressures and impacts in accordance with the WFD, were reported by the Member States within the context of the WFD RBMP. For the first RBMPs, which were due in 2009, data is available in the WISE WFD database. This information has already been assessed and published (EEA, 2012). For the second RBMPs, which were due in 2015, raw data is publically available, but a central database gathering datasets from all countries is not currently accessible.

In the eight countries involved in this study, 17,011 surface water bodies were reported for the first RBMP, covering all water categories: 16,353 for rivers (96%), 568 for lakes (3%), 45 for transitional waters (0.3%) and 45 for coastal waters (0.3%). As can be seen from Figure 3-9, 27% of surface water bodies in the eight countries are affected by pollution pressure, with diffuse sources being the most important (20%).



(*Source: own elaboration using EEA 2012 report*)

Figure 3-9: Proportion of total number of classified surface water bodies with significant pressures (left figure) and impacts (right figure) (total for rivers, lakes, transitional waters and coastal waters) in the eight countries investigated.

With regards to the impacts caused by pollution pressure, nutrient enrichment causing eutrophication is the most important impact affecting around 20% of the surface water bodies in the countries investigated. Organic enrichment due to pollution by oxygen-consuming substances affects around 6% of surface water bodies.

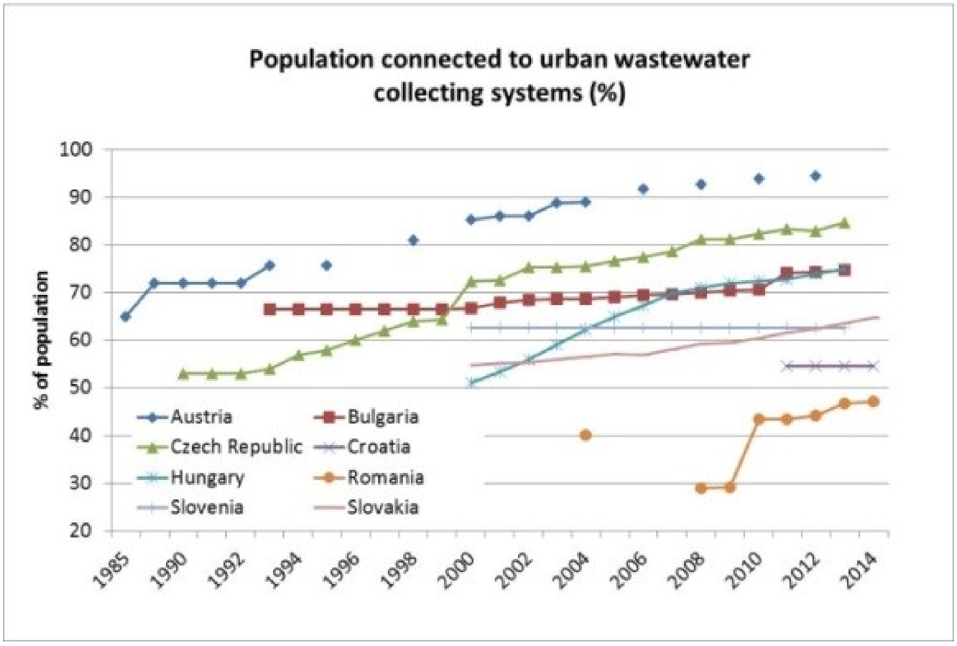
3.4 Status of implementation of the UWWTD and of wastewater treatment in the eight countries

Biennial reporting, in accordance with Art. 15 of the UWWTD, requires information on wastewater infrastructure and the performance of UWWTPs in order to assess whether the UWWTD is being timely and correctly implemented. The individual interpretation of single aspects of the UWWTD (e.g. definition of the size of agglomerations, designation of sensitive areas under UWWTD Art. 5 requiring more stringent treatment) hinders the direct comparison of implementation levels of the various different countries. When only small areas of the country are designated as sensitive areas, high compliance rates with Art. 5 are more easily achieved than in countries, which apply more stringent treatment levels throughout the entire country. 100% compliance with Art. 3 does not mean that 100% of the population are connected to sewer systems. In addition, the information provided using different reporting exercises and obligations is often inconsistent, thereby creating problems when assessing the influence of wastewater treatment on water quality. An overview of the status of UWWTD implementation is provided in Table 3-2. It should be noted, however, that the hierarchic compliance rule (see section 2.4) partially hides the detailed situation and progress made. The last assessment makes wider use of the concept of distance to compliance. This shows that for all agglomerations with expired deadlines for secondary treatment, missing equipment represents 20% of the problem and non-compliance is mostly due to poor performance. For more stringent treatment, missing equipment represents 50% of the problem. For all agglomerations with pending deadlines for secondary treatment, missing equipment represents 31% of the problem and non-compliance is mostly due to poor performance. For more stringent treatment missing equipment represents 100% of the problem.

In order to assess the influence of UWWTD implementation of surface water quality, it is therefore essential to take into account information on wastewater infrastructure, instead of information on UWWTD compliance. Information on the status of wastewater infrastructure in the countries investigated is available from the TA-UWWTD (described in chapter 1 of this report), from the DRBMP and in other data sources, e.g. by Eurostat (Figure 2-8).

Country	Application of UWWTD Art. 5	Final deadline for UWWTD implementation	Compliance status (9th UWWTD Synthesis report, reference date 2014)		
			Art. 3 (Collecting system)	Art. 4 (Secondary treatment)	Art. 5 (More stringent treatment)
Austria	Art. 5(8)+5(4)	2005	100%	100%	100%
Czech Republic	Art. 5(8)+5(2,3) for nitrogen and phosphorus	2010	100%	90%	63%
Slovakia	Art. 5(8)+5(2,3) for nitrogen and phosphorus	2015	100%	98%	57%
Hungary	Art. 5(1)+5(2,3), sensitive areas cover 7% of the national territory	2015	100%	95%	92%
Slovenia	Art. 5(1)+5(2,3), sensitive areas cover 97% of the national territory	2015	61%	17%	50%
Croatia	Art. 5(1)+5(2,3), sensitive areas cover 80% of the national territory	2023	-	-	-
Bulgaria	Art. 5(1)+5(2,3), sensitive areas cover 88% of the national territory	2014	26%	20%	7%
Romania	Art. 5(8)+5(2,3) for nitrogen and phosphorus	2018	89%	59%	25%

Table 3-2: Implementation of UWWTD in the investigated countries *(Source: own elaboration based on 9th TA UWWTD, autumn 2017, to be published by EC)*



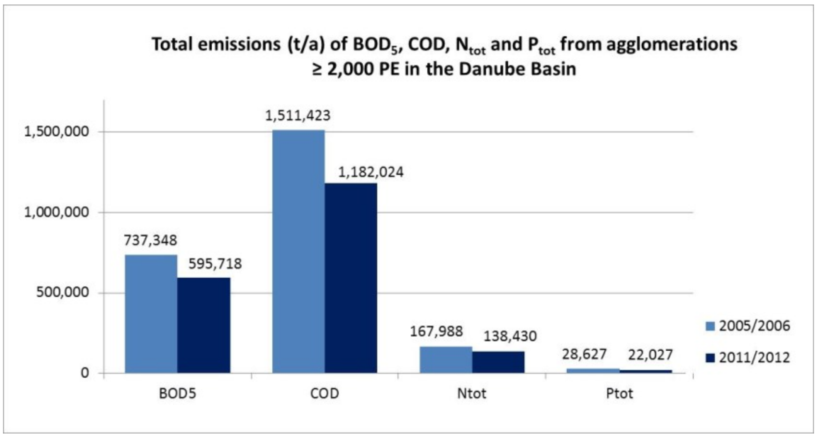
Source: own elaboration based on Eurostat data extracted in June 2017,
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_ww_con&lang=en

Figure 3-10: Population connected to urban wastewater collecting systems

3.5 Emissions from UWWTD – agglomerations

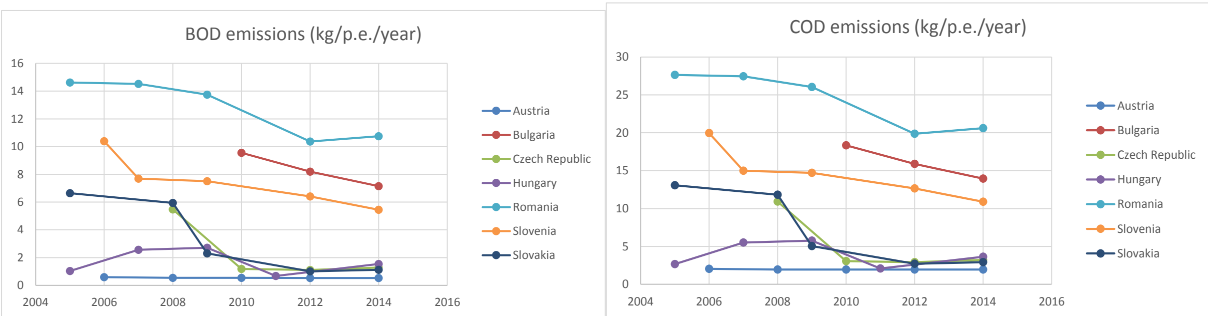
Information regarding emissions (t/a) from UWWTD-agglomerations is available from the ICPDR Urban Waste Water Inventory for the reference years 2005/2006 and 2011/2012, and was additionally calculated for all years between 2005 and 2014 by means of information provided by the Member States for the TA-UWWTD. While the ICPDR Urban Waste Water Inventory directly requests emissions from agglomerations ≥ 2,000 PE in the Danube basin, the emissions calculated from the TA-UWWTD refer to the entire country and makes broader use of individual emission coefficients, calculated on the basis of partially reported emission loads and the performance of treatment plants.

The results of the ICPDR Urban Waste Water Inventory and the TA-UWWTD resulted in identical findings. As can be seen in Figure 3-11 the total emissions (t/a) from agglomerations ≥ 2,000 PE in the Danube basin decreased between 2006 and 2012. The evolution of emissions in terms of pollution substance (kg/PE/year or g/PE/year from 2005 to 2014) can be observed in Figure 3-12 and Figure 3-13. For Croatia no data analysis was possible, as due to the country's EU-accession in 2013, this country was not yet obliged to report the full set of UWWTD data.



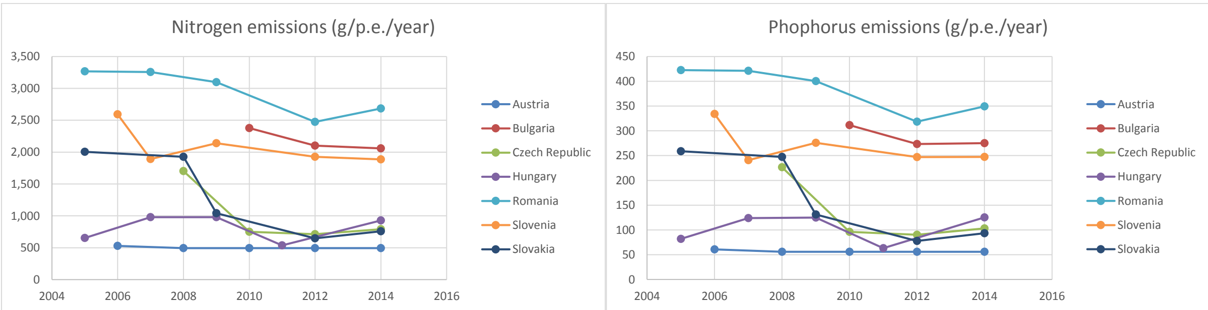
Source: DRBMP 2009, DRBMP, 2015

Figure 3-11: Total emissions (t/a) of BOD_5, COD, N_{tot} and P_{tot} from agglomerations ≥ 2,000 PE in the entire Danube Basin



Source: own elaboration based on 9th TA UWWTD, autumn 2017, to be published by EC

Figure 3-12: BOD_5 and COD emissions' evolution from 2005 to 2014 for seven MSs in to the DRB.



Source: own elaboration based on 9th TA UWWTD, autumn 2017, to be published by EC

Figure 3-13: Nitrogen and phosphorus emissions' evolution from 2005 to 2014 for seven MSs belonging to the DRB

Figure 3-12 and Figure 3-13 clearly show that four groups of MSs can be highlighted:

- **Austria**, which reached full UWWTD compliance before 2005 and implemented N and P removal on a country-wide level. The country has recorded a very low and constant rate of emission since 2006.
- The **Czech Republic, Slovakia and Hungary**, which had to reach full compliance with UWWTD in 2010 or 2015 and achieved full, or almost full, compliance with Art. 3 and Art. 4 in 2014, managed to strongly decrease their organic emissions to reach

values below 2 kg/ PE/a for BOD_5 and less than 5 kg/PE/a for COD. Results for 2014 show that emissions are stagnating.

- **Slovenia and Bulgaria**, which had to achieve UWWTD compliance in 2015 or 2014 but reported low compliance rates for collection, secondary and tertiary treatment in 2014, also decreased their organic emissions, but still had high emissions in 2014 (between 5.5 and 7 kg/PE/a for BOD5 and between 10 and 15 kg/PE/a for COD). Due to the fact that in these countries significant parts of the wastewater are still not collected, or collected but not treated, tertiary treatment is not the first priority. Consequently, the tendency towards a decrease in N_{tot} and P_{tot} is less significant, reaching values of around 2 kg/PE/a for N_{tot} and of 0.25 – 0.3 kg/PE/a for P_{tot} in 2014.
- **Romania** also managed to decrease its emissions up until 2012, with a slight increase in 2014 due to more treatment plants being included in the analysis. However, BOD_5 and COD emissions are still high (more than 10 kg/PE/a BOD_5 and more than 20 kg/PE/a COD). Romania revealed highest emissions for N_{tot} and P_{tot} compared to the other countries investigated (2.7 kg/PE/a N_{tot} and 0.35 kg/PE/a P_{tot}), a significant share of wastewater still being collected but not treated.

Taking into account the status of UWWTD implementation (see Table 3-2 and Figure 2-9 for distance to compliance), it is important to acknowledge the different deadlines for implementation agreed during negotiation for accession to the EU, which takes into account the country situation at its accession to EU (see section 2.3 for details by country). This explains why there are different groups among the EU8 MSs regarding emissions. Similar assessments were carried out for N_{tot} and P_{tot} (Figure 3-13) for BOD_5 and COD, with a less important decrease for Bulgaria, Slovenia and Romania. Tertiary treatment is not the priority for these countries, as significant amounts of wastewater are collected but not treated at all and need first to be treated at the secondary level.

3.6 Additional impacts on water quality (industrial and agricultural point sources, diffuse sources)

Information about the industrial and agricultural direct dischargers was obtained from E-PRTR (and its predecessor EPER), which contains the main industrial facilities and big pig, poultry and aquaculture installations and their discharges above certain capacity and emission thresholds. It is supplemented with data directly requested by the ICPDR for the purpose of the 1st and 2nd DRBMP from countries that do not report under E-PRTR/ EPER. These data sources are limited, as they do not cover smaller sources of emissions. However, it is assumed that the biggest share of emissions is covered. For the three pollutants, which were investigated (COD, N_{tot} P_{tot}), the industrial and agricultural direct emissions are relatively small compared to the emissions from urban wastewater. In the Danube river basin they range from 8% (reference year 2006) to 5% (reference year 2012) for the entire emission from urban and industrial point sources for COD, from 5% (reference year 2006) to 4% (reference year 2012) for N_{tot} and from 2% to 1% (reference year 2012) for P_{tot}. A detailed overview of these emissions and the contribution by each country of the Danube basin over the years is provided in section 2.7 of Annex 2.

For diffuse sources, to estimate the spatial patterns of nutrient emissions in the Danube Basin and to assess the different pathways contributing to the total emissions, the MONERIS[12] model (Venhor et al., 2011) was applied for the entire basin and for current

[12] MONERIS (**MO**delling **N**utrient **E**missions in **RI**ver **S**ystems): http://www.moneris.igb-berlin.de/index.php/homepage.html

hydrological conditions (2009 – 2012). MONERIS is applicable for sub-basins ranging from 50 to 500 km². The results were presented in the 2nd DRBMP.

According to the MONERIS calculation presented in the 2nd DRBMP, the total nitrogen emissions in the Danube river basin were 605,000 t/a for the reference period 2009-2012. In the 1st DRBMP these emissions amounted to 686,000 t/a N_{tot} (reference year 2005). As can be seen from Table 3-3, groundwater flow is responsible for the biggest share of all N_{tot} emissions (54%). Diffuse pathways account for 84% and therefore dominate figures for basin wide nitrogen emissions, whereas the pathway "point sources" amounts to only 16% of N_{tot} emissions. Agricultural sources are clearly dominating the emissions from diffuse pathways. The P_{tot} emissions in the Danube river basin are 38,500 t/a for the reference period 2009-2012, with diffuse pathways being responsible for 67% of total emissions ('soil erosion' being the dominant contributor to diffuse pathway) and the pathway "point sources" contributing 33%. In the 1st DRBMP P_{tot} emissions amounted to 58,000 t/a.

Pathway	N_{tot}		P_{tot}	
	[t/a]	[%]	[t/a]	[%]
Direct atmospheric deposition	12,309	2%	301	0.8%
Overland flow	49,678	8%	602	1.6%
Soil erosion	16,665	3%	12,169	32%
Tile drainage flow	43,694	7%	253	0.7%
Groundwater flow[1]	325,091	54%	5,472	14%
Urban runoff[2]	62,226	10%	7,129	18%
Point sources[3]	95,404	16%	12,627	33%
Total	**605,067**	**100%**	**38,553**	**100%**

[1] summed emissions via all subsurface flow components (base flow and interflow)
[2] summed emissions via urban runoff, combined sewer overflows and not connected population
[3] summed emissions from urban wastewater treatment plants, population connected to sewer systems without treatment plant and emissions from industrial direct dischargers

Source: ICPDR, 2015

Table 3-3: Point and diffuse nutrient emissions in the Danube basin according to different pathways for the reference period 2009 – 2012

Taking into account the concept of agglomerations as defined by the UWWTD, emissions from agglomerations as calculated with MONERIS cover emissions from combined sewer overflows, emissions from unconnected populations (both pathways are defined as diffuse emissions in section 'Urban Runoff') as well as emissions from urban wastewater treatment plants and from the population connected to sewer systems without treatment plants. For N_{tot}, the pathways 'urban runoff' and 'point sources' only amount to 26% of total N emissions into the Danube River Basin, which means that urban wastewater from agglomerations under the UWWTD is only partly responsible for nitrogen loads in the surface waters of the Danube basin. For P_{tot} the pathways 'urban runoff' and 'point sources' amount to 51% of the total P-emissions into the Danube River Basin, which suggests a high potential of measures addressing urban water management to reduce P emissions (example: by reducing P_{tot} concentrations in detergents and the removal of P_{tot} in wastewater treatment plants).

The spatial distribution and density of emissions and the contribution of the different pathways to total nitrogen emissions vary from country to country according to geo-climatic conditions, the intensity of agricultural land use and the status of urban wastewater management. Whereas in Germany and Slovenia N_{tot} emissions via groundwater and tile drainage are dominant, urban areas and point sources contribute around half of the total emissions in Serbia and Bosnia. Urban areas and point sources are the dominant emission pathways for P_{tot} in almost all countries.

The long-term development of nutrient emissions (both N_{tot} and P_{tot}) shows a declining trend from 2000 to 2012. For N_{tot} and $P_{tot,}$ this is partially due to a reduction of emissions from point sources and the reduction of emissions from urban areas.

In addition to emissions, river loads were calculated for the 2nd DRBMP by using MONERIS. The calculated river loads were 410,000 t/a N_{tot} and 22,000 t/a P_{tot} for the reference period 2009-2012. These numbers show that the loads emitted are retained in the river network. 32% of total N emissions are retained during the instream transport, mainly by denitrification. 42% of P_{tot} emissions do not reach the river mouth due to them settling in reservoirs and floodplains (ICPDR, 2015).

3.7 Attribution of water quality changes to UWWTD implementation

The long-term trends regarding water quality (chapter 3.2) and emissions from agglomerations as defined under the UWWTD (chapter 3.5) clearly show a downward trend in both concentrations of organic and nutrient pollution in rivers and emissions of these groups of pollutants from agglomerations. The quantification of the influence of improved wastewater treatment on improving water quality is, however, a difficult task, as wastewater from agglomerations is only partly responsible for the pollution of the aquatic environment. Natural processes also have a decisive impact on the fate of pollutants in rivers (see chapter 2.5.6). The attempt to quantify river loads for pollutants and to compare them with emission loads – calculated for the TNMN monitoring station AT1 (Jochenstein) as the 'incoming' point and RO5 (Reni) as the 'outgoing' point for the area under investigation – further underlines these difficulties (see Table 3-4).

		2006	2012
BOD_5	River load (t/a) at monitoring station AT1 (Jochenstein)	50,386	82,148
	River load (t/a) at monitoring station RO5 (Reni)	565,579	370,262
	Input into Danube river (RO5 - AT1)	515,193	288,114
	Emissions from agglomerations (t/a)[1]	478,845	256,282
	Share (%) of total emissions from agglomerations	93%	89%
N_{tot}	River load (t/a) at monitoring station AT1 (Jochenstein)	106,719	89,300
	River load (t/a) at monitoring station RO5 (Reni)	444,191	225,762
	Input into Danube river (RO5 - AT1)	337,472	136,462
	Emissions from agglomerations (t/a)	130,056	88,081
	Share (%) of total emissions from agglomerations	39%	65%

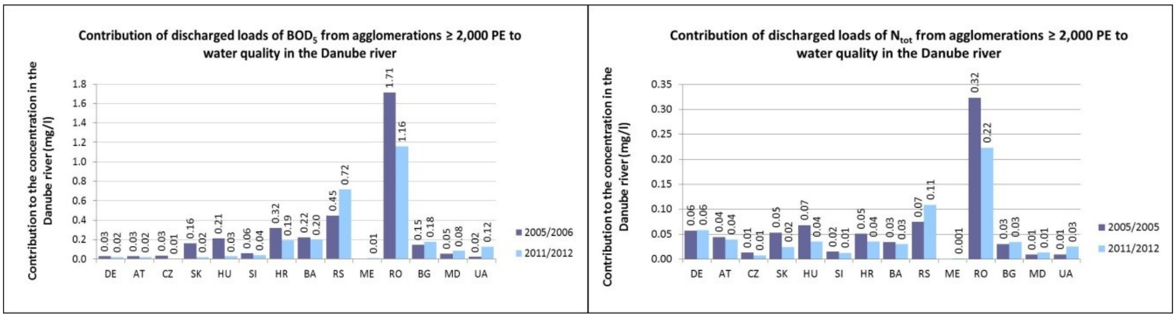
Source: ICPDR DRBMP, only emissions originating from collected wastewater were taken into account

Table 3-4: Comparison of pollutant loads (BOD_5 and N_{tot}) in the Danube river and emissions of pollutants from UWWTD agglomerations

As can be seen from Table 3-4 no clear trend can be observed with regard to the share of pollutant emissions from agglomerations in the pollutant loads into the Danube river, although both river loads and the emissions from agglomerations show a downward trend.

A further attempt to quantify the influence of improved urban wastewater treatment on river water quality is possible by relating discharged loads of pollutants (as available from the ICPDR DRBMP) to the Danube's long-term water discharge at the mouth to the Black Sea.

This assessment results in a theoretical concentration of pollutants in the Danube River resulting from urban wastewater discharges (see Figure 3-14).

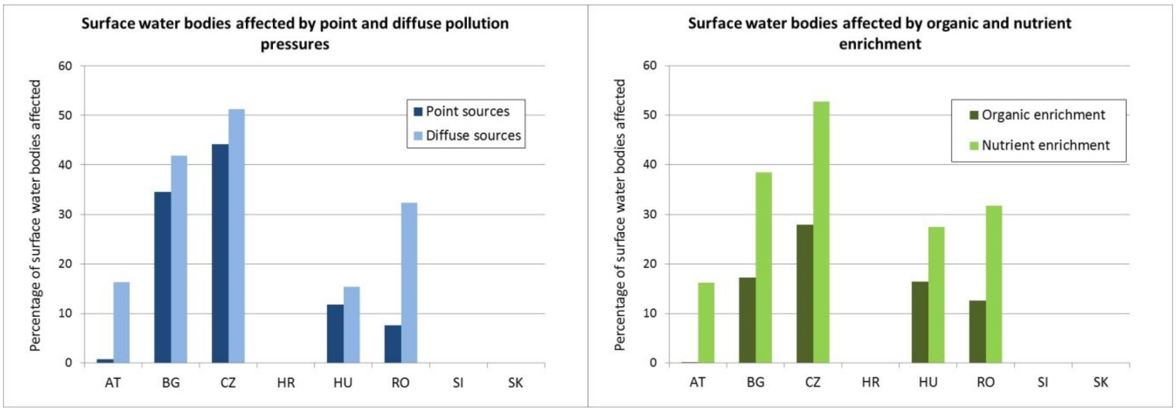


Source: own elaboration, Wastewater Management in the Danube Region: Opportunities of EU Accession, autumn 2017

Figure 3-14: Contribution of discharged loads from agglomerations ≥ 2000 PE to water quality in the Danube river

With the exception of Bulgaria, the contribution of urban wastewater discharges to pollutant concentration by EU MSs in the Danube is decreasing, with highest decreases observable in those MSs which joined the EU in 2004, 2008 and 2013. Germany and Austria were obliged to fully implement the UWWTD by 2005 and have therefore recorded only slight decreases over the years since. An increase in contributions in the non-EU MSs is obvious and is probably due to the construction of sewer systems without fully operational wastewater treatment plants, resulting in an increased transfer of wastewater discharge from soil to surface water. In Bulgaria the increase could be due to improved data quality in the reference year 2012.

The direct assessment of the influence of UWWTD implementation on the water quality of surface water bodies according to the WFD reveals several limitations, as can be seen from Figure 3-15.



Source: own elaboration using EEA 2012 report

Figure 3-15: Proportion of surface water bodies affected by point and diffuse pollution (left figure) and affected by organic and nutrient enrichment (right figure) in the eight countries investigated

While in 2008/2009 the Czech Republic was more advanced in wastewater treatment than Romania,[13] figures reported to the WFD RBMP in 2009 show that the percentage of surface water bodies affected by point source pollution was actually higher in CZ than in Romania.

3.8 Findings

The following findings concerning **dominant trends and the current status of surface water quality** are noteworthy:

- The surface water quality of the DRB has improved over the last 20 years for both, organic pollutants (BOD_5, COD) and nutrients (N_{tot}, NH4-N, NO3-N, P_{tot}, PO4-P).
- In the majority of the countries investigated, mean annual concentrations in surface waters (calculated as the average the annual concentration from these surface water monitoring stations that were continuously monitored over a number of years in a country) decreased over time. As an example, mean annual BOD_5- concentrations dropped by 22% to 70% in five out of seven countries investigated, resulting in average concentrations of 1.2 mg/l BOD_5 (SI) to 3.9 mg/l BOD_5 (RO) in 2012.
- As a second example NH4-N concentrations in 26 monitoring stations along the Danube also decreased over time. At the Romanian monitoring station Reni (Danube km 132) the average NH4-N concentration decreased from 0.35 mg/l (reference period 1997 – 2002) to 0.16 mg/l (reference period 2008 – 2014). This decrease is also clearly visible when assessing NH4-N loads at the respective monitoring stations (ranging from 78 kt/a in reference period 1997-2002 to 34 kt/a in the reference period 2008-2014).
- As detailed above, the legal requirement on water quality is to reach the good status. This requirement cannot be easily linked to specific concentrations of pollutants to be found everywhere. Data on status and pressures of surface water bodies according to the WFD was only accessible for the reference year 2009. Therefore, no trends could be analysed. In 2009 the eight countries investigated reported on 17,011 surface water bodies, of which 7% were affected by point sources and 20% by diffuse sources. Nutrient enrichment affects around 20% of surface water bodies, while organic enrichment impacts around 6% of surface water bodies.

Data collected concerning **emission loads from urban wastewater treatment, pollution from industrial sources and nutrient pollution from agriculture** reveals:

- In the period 2006 to 2012, the share of correctly treated wastewater (in terms of PE treated by secondary and tertiary treatment and IAS) in the Danube basin increased from 63% to 71% (DRBMP, 2009 and 2015).
- Emission loads for BOD_5, COD, N_{tot} and P_{tot} from urban settlements according to the UWWTD in the Danube basin decreased between 2006 and 2012. In 2012 the total emissions were 596 kt/a for BOD_5 (a decrease of 142 kt compared to 2005), 1,182 kt/a for COD (a decrease of 329 kt/a), 138 kt/a for N_{tot} (a decrease of 30 kt/a) and 22 kt/a for P_{tot} (a decrease of 6.6 kt/a).
- To improve the emission load assessment, the use of emission factors or standard values which could be applied to other similar situations is a robust solution. It needs to be based on sufficiently detailed information of the techniques deployed. The current information does not provide such information and specific data collection is needed and could be organised by ICPDR in support of the emission part of DRBMP.

[13] CZ: 80% of the generated load in PE collected and treated by secondary or more stringent treatment and around 19% not collected and not addressed via IAS, RO: 30% of the generated load in PE collected and treated by secondary or more stringent treatment and nearly 50% not collected and not addressed via IAS.

- Since 2006 all countries investigated have managed to decrease their emissions (in terms of load/PE/a) except for Austria, whose emission levels have remained constant due to the country's full implementation of the UWWTD before 2006. In 2014 the lowest emissions of pollution indicators, such as BOD_5 (below 2 kg/PE/a), were achieved by those countries which have already achieved more than 90% compliance with secondary treatment (Art. 4 of UWWTD) (AT, CZ, SK and HU). SI and BG, both of which show Art. 4 compliance rates of less than 25%, reached BOD_5-emission values of 5 kg/PE/a - 7 kg/PE/a. For RO (4% compliance rate with Art. 4) BOD_5-emissions were still over 10 kg/PE/a.
- Emissions from industrial and agricultural point sources into the aquatic environment are low in comparison with emissions from urban wastewater management. Taking into account E-PRTR, which covers the biggest share of industrial emissions, they amounted to 5% of the entire emissions from urban and industrial point sources for COD, while the share of N_{tot} and P_{tot} was below 5% in the reference year 2012.
- The MONERIS model, which was applied to the Danube basin in order to assess the different sources contributing to total nutrient emissions, revealed that a maximum of 26% of N_{tot} emissions and a maximum of 51% of P_{tot} emissions in the Danube basin originate from agglomerations and urban wastewater management (reference years 2009-2012).

Data collected concerning **the impact of UWWTD implementation to water quality** reveals the following points of interest:

- The performance of wastewater treatment plants is a core issue for assessing impact; improving performance will lead to achievement of compliance, but also increase the impact of UWWTD implementation by reducing emission and discharges into aquatic environments.
- For organic pollution the key emitters to the aquatic environment are point sources (agglomerations, industrial discharges, agricultural point sources). The implementation of the UWWTD therefore contributes significantly to the improvement of surface water quality. In countries where more than 85% of the load in the Danube basin is treated by secondary treatment (AT, CZ, SK and HU), discharges from UWWTD-agglomerations in the Danube region only contribute between 0.01 mg/l BOD_5 to 0.03 mg/l BOD_5 to BOD_5-concentrations in the Danube (reference year 2012). For SI and BG, where 60%-70% of the Danube basin's load is treated by secondary treatment, the contribution amounts to 0.04 mg/l (SI) to 0.2 mg/l BOD_5 (BG). In HR and RO, where around 45% of the load in the Danube basin is treated by secondary treatment, the BOD_5-contribution amounts to 0.2 mg/l (HR) and 1.2 mg/l (RO).
- The application of source apportionment has revealed that UWWTD agglomerations are responsible for part of the total N and total P-emissions into the Danube River Basin and that different sources are dominant in different countries in the Danube basin. The decreasing trend of NH4-N-concentrations in the Danube, however, can be clearly attributed to improved and more stringent wastewater treatment.

4 Financial Sustainability of UWWTD Implementation

This chapter addresses the following questions *Are we doing it the right way?* It addresses the question of the costs of implementing the UWWTD and how affordable and sustainable these investments are?

It also raises the question as to how great an extent are the financial costs associated with the implementation of UWWTD in the target countries sustainable, and Is the resulting sustainably operated UWWTD-compliant wastewater infrastructure affordable for its consumers?

4.1 Financial Sustainability of the Wastewater Utility Sector

Financial sustainability of UWWTD implementation depends on a number of factors. The following are particularly important for countries in the Danube Region:

- Investment and reinvestment costs
    - Collection network and WWTP
    - Individual Appropriate Systems for small settlements
- Operation and maintenance costs
- Tariffs
- Level of affordability
- Long term population forecasts and
- Available financing sources

These factors have been combined with long-term forecast scenarios to explore how financially sustainable implementation of the UWWTD may be achieved. These scenarios attempt to address the two following issues: (i) how sustainable are the current revenues and costs (investment, reinvestment and operation) of the WW sector in the eight countries in the longer term, and (ii) what the potential is for the eight countries in the Danube Region to achieve full cost recovery in the foreseeable future.

4.2 Boundaries Scenarios Developed

The two following longer-term scenarios covering the period of 2015-2040 have been developed:

- A **Business as Usual (BAU) Scenario**. This scenario considers only two off-sector elements as factors of changes:

  (i) population change and

  (ii) labour cost increase affecting O&M costs.

- **A Sustainability Orientated Pathway (SOP) Scenario**. This perhaps over-optimistic scenario tries to simulate the outcome of the financial pathway of utilities operation when tariffs are raised incrementally and rather swiftly (when necessary near the limit of the EU affordability threshold) to optimize the cost/revenue balance. In this scenario the aim of the revenue increase is to achieve:

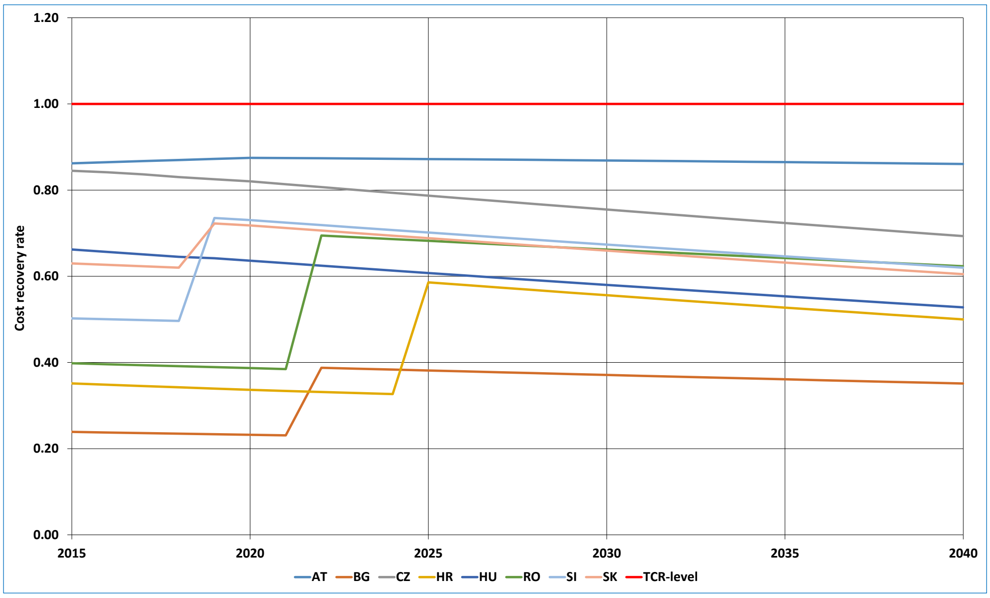
  (iii) **operational cost recovery (OCR) ratios** comparable to the current Austrian level (1.44-1.6) and

  (iv) **total cost recovery (TCR) ratios** not lower than 1. TCR is defined as not only embracing O&M costs, but also investment and reinvestment, including financial costs to be achieved as soon as possible within the affordability threshold encouraged by EU guidelines[14].

[14] EC (2014) Guide to Cost-Benefit Analysis of Investment Projects; Economic appraisal tool for Cohesion Policy 2014-2020

Assumptions are made on GDP, population, tariff, O&M and efficiency changes until 2040. Details about the assumptions and premises used in the scenarios are presented in Annex 3, paragraph 3.2. The development of TCR ratios for each of the eight countries of the study until 2040 under BAU and SOP scenarios is presented in Figure 4-1 and Figure 4-2.

The sharp increases in the graph reflect the end of new investment expenditures. AT and, to a lesser extent, CZ are essentially compliant with UWWTD. New investments are either not expected or will not be of any real significance.

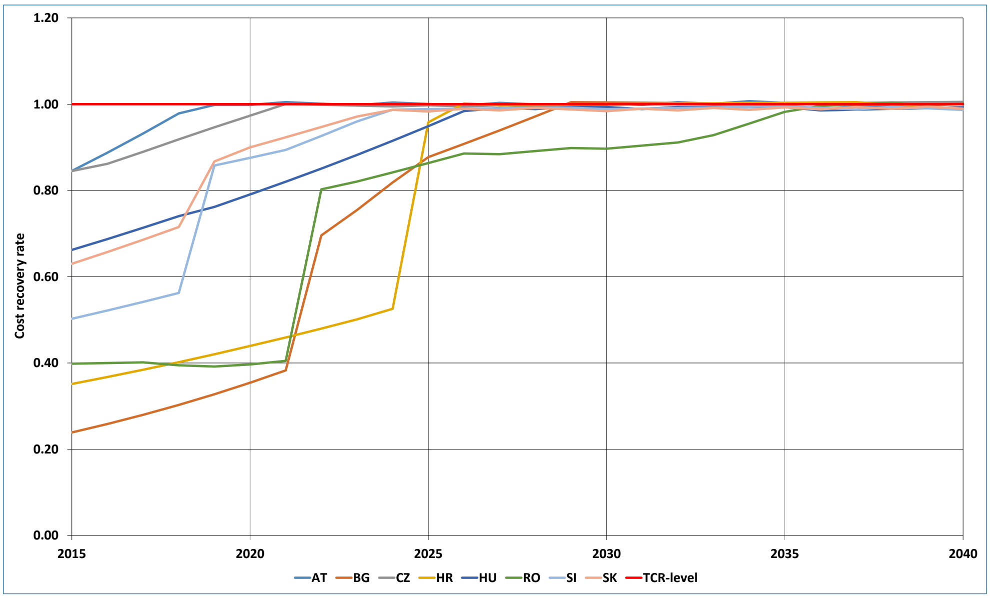


Source: SOS Report 2015, own assessment

Figure 4-1: Long-term evolution of TCR ratios in countries of the Danube Region – BAU scenario

The BAU scenario is financially unsustainable in the longer term. Key trends for TCR ratios by countries (Figure 3-2) are therefore:

- Without an increase in revenue, the TCR ratio including OPEX and CAPEX is expected to drop in all eight countries and remain significantly lower than the target level of 1;
- By 2040, the lowest TCR ratio is expected in BG (0.35) meaning that revenues cover only 35% of the total costs of sanitation;
- By the same year, TCR ratios will be becoming critical in HU and HR (0.53 and 0.54 respectively);
- The ratios for the other countries (SK, SI, RO and CZ) will remain poor (0.6-0.7);
- AT will remain well within the desired ratio level of 1 (red line in the Figure 4-1).



Source: SOS Report 2015, own assessment

Figure 4-2: Long-term evolution of TCR ratios in countries in the Danube Region – SOP scenario

The SOP scenario identifies several conditions that will allow the eight countries to achieve full cost recovery (TCR ration of 1 or higher, Figure 3-2). These are:

- TCR ratio of 1 (red line in the Figure 3-2) can be achieved within a 5 to 25 year period for all of the eight countries, with robust tariff increases remaining within the affordability threshold of wastewater services for households, and with productivity and efficiency gains by the operators;
- In AT, a 5-year long annual increase of 5% of tariff above inflation would raise the TCR ratio to the desired level of 1. As the population is expected to continue increasing, there is no risk of a shrinking customer base. The WW tariff level by 2040 is calculated to be 2.44 €/m³;
- In CZ, a 7-year annual 5 % increase in tariff above inflation and 2% thereafter would be sufficient to reach a TCR ratio of 1. As the population is expected to decrease in later years, a 1 to 2% annual tariff increase would be needed to balance the decreasing customer base taking into account reasonable efficiency gains in NRW and staff productivity. WW tariff level by 2040 would be 3.11 €/m³;
- In HR, a 12-year annual 5% increase of tariff above inflation would be needed to reach a TCR ratio of 1. As the population is expected to decrease in future years, a 1 to 2 % annual tariff increase would be needed to compensate for a shrinking customer base in spite of utilities' assumed staff productivity gains. The WW tariff level by 2040 would be 2.41 €/m³;
- In HU, a 13-year annual 5% increase in tariff over inflation would lead to the TCR ratio of 1. Considering that the efficiency gain potential is relatively limited, a 2% annual increase may be needed thereafter to compensate for population reduction. The WW tariff level by 2040 is expected to be 2.85 €/m³. Affordability constraints would occur if the EC threshold is applied;
- In RO the affordability ratio had already reached the maximum value without the assumed tariff increases at the beginning of the assessment period in 2015 (see Figure 3.10). An annual tariff increase of 3 to 4% can therefore be foreseen for the next 25 years to secure a TCR ratio of 1. If the EC affordability threshold is applied, the TCR ratio of 1 cannot be reached within the period of assessment (by 2040).

Efficiency gain potential may be high for both NRW (from 45%) and staff productivity (from 18). The WW tariff level by 2040 would be 2.09 €/m³;

- In SK, a 5% annual increase of tariff over inflation for 10 years would lead to a TCR ratio of 1. A further 2% annual increase will be needed to balance constraints appearing due to the shrinking customer base. Some efficiency improvements could materialise (NRW from 32% and staff productivity from 8). The WW tariff level would be 2.68 €/m³ by 2040. Affordability constraints would occur if the EC threshold is applied;
- In SI, the 5% an annual tariff increase would have to be implemented for the first 10 years. As the population is expected to decrease further, an annual 1 to 2%, tariff increase may be needed to compensate for the loss of customers. Some efficiency improvements could occur (NRW (from 31%). The WW tariff level by 2040 would be 2.49 €/m³;
- Finally, in BG an annual 5% increase of the tariff over inflation is necessary for 15 years. As the population is expected to decrease further, an annual 1 to 2% tariff increase may be needed to compensate for the loss of paying customers in the later years. Efficiency gains potential would be high (NRW from 60% and staff productivity from 6). Affordability constraints would occur if the EC threshold applies. In this case, a TCR ratio of 1 will not be achieved within the period of assessment. The WW tariff level would be 1.30 €/m³ by 2040.
- Should one or more of the assumptions of the modelled scenario (GDP growth, social tolerance, efficiency gains) not be met, financing gaps, especially for capital investment and reinvestment, may appear. These would need to be filled by a mix of grants, loans or bonds. The gaps can still be bridged with the help of EU grants for a limited period until perhaps 2021-2027. In the current EU programming period (2014-2020) RO plans to complete its UWWTD investments by 2018. For HR the agreed transition period ends in 2023, the SOP scenario assumes this could take up to 2027. In the SOP scenario, 2027 is assumed to be the final year of new investments with EU grants and the starting year for the inclusion of the cost of financing with the help of commercially pegged loans or bonds. According to the assumptions of the SOP scenario, access to money markets (commercial loans or national or municipal bonds) are expected to become an imperative for UWWTD capital reinvestment from 2028 onward. When loans and bonds will become necessary, legal limitations on debt ceilings for municipalities may also have to be taken into account.

Box 3.1 Case study in Slovenia – wastewater utility in Maribor financed by EBRD loan

The municipality of Maribor has implemented an UWWTD investment under PPP model (public/private partnership) partially financed by bank loans. The project involved a concession for the construction and operation of a WWTP to serve the municipality. Investors/sponsors included two French and two Austrian water companies. In 2000, the concession was granted by the Municipality of Maribor to a locally incorporated special purpose entity, Aquasystems d.o.o., wholly owned by the project sponsors. The EBRD provided debt financing to Aquasystems.

Now, Aquasystems is operating the WWTP in cooperation with the Sewage System Unit of the multi-purpose utility company of Maribor, called Nigrad d.d. As the water tariff was controlled by the central government until January 2013, Aquasystems/Nigrad d.d (like several other water utilities in the country) struggled to generate enough revenue to fully cover its O&M costs. Financial performance indicators are still positive, but it is feared that without an adequate rise of the wastewater tariff, financial performance degradation may occur. Details are presented in Annex 3.

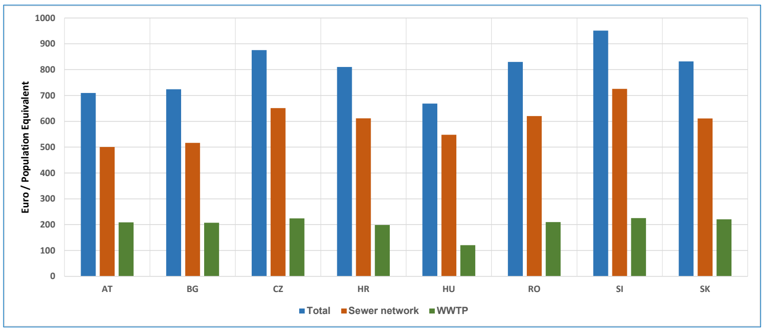
Sources: Maribor wastewater project – case study by EBRD, 2001; www.nigrad.si/kanalizacija

4.3 Investment Costs for UWWTD Compliance

Investment costs for UWWTD compliance cover primarily centralised infrastructure (network and wastewater treatment plants (WWTPs), and their reinvestments require sustainable operation. This also includes decentralised treatment systems called "Individual Appropriate Systems (IAS), which are installed in small agglomerations and settlements, where centralised infrastructures are not cost effective. Three official documents were available with quantitative data for a centralised UWWTD infrastructure developed in the Danube Region: These are the two DRBMPs (the 1st DRBMP of 2009 and the DRBMP update of 2015) and the 9th EU Technical assessment of the implementation of the UWWTD by the EC services (9th TA-UWWTD). Due to inconsistencies of the data available in these three sets of documents (see Annex 3, paragraph 3.3), best estimates were calculated based on the *distance to compliance* in PE data extracted from the 9th TA-UWWTD (cut-off date 31/12/2014). This enables the integration of the costs of infrastructure of various ages before or after accession to EU, which are not documented in the available sources mentioned earlier. It is to be noted here that at the time of EU accession, all countries had already historically constructed sewer networks and some WWTPs that should be considered as part of the overall investment picture.

A rough estimation of the total investment needs of centralised wastewater infrastructure in the eight countries for full compliance with UWWTD is around 60 Billion EUR, 43 Billion EUR of this amount have already been invested. The future new investment needed (from 2015 onward) for sewage networks and WWTPs in the target countries is therefore expected to be around 17 Billion EUR. Details per country are presented in Table 3.8 in Annex 3.

Figure 4-3 reflects the estimated specific cost per PE and per country needed to bring about UWWTD compliance. The lowest unit cost of 668 EUR/PE is found in HU and the highest cost of 951 EUR/PE is in SI. Development costs for sewer networks are about twice the cost of related WWTP development costs. HU also has the lowest specific WWTP investment costs (121 EUR/PE). The share of designated sensitive agglomerations is also the smallest in the Danube Region (see the map on Annex 1). Not surprisingly, tertiary treatment is more expensive in the smaller territories and agglomerations in HU.



Source: Own assessment

Figure 4-3: Specific investment costs of UWWTD compliance, EUR/PE

4.4 Reinvestment costs for UWWTD Compliance

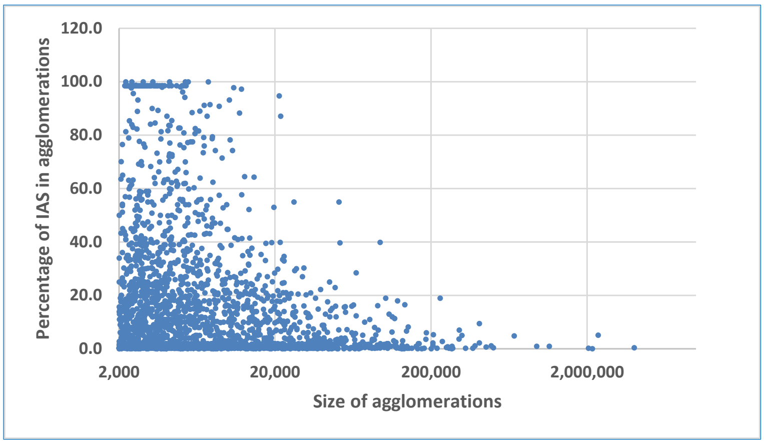
It is evident that periodic reinvestment is needed to sustain the functionality of the sanitation infrastructure to:

- keep equipment functioning at the originally designed level of service (renewal);
- adjust infrastructure to evolving technologies and to adapt to possible strengthening of EU and national urban pollution control regulation and standards (upgrade).

AT, with its mature water infrastructure, is confronting the large costs of modernising and upgrading its wastewater systems to meet rising environmental standards and to replace obsolete installations developed in earlier years. The reconstruction of the old infrastructure for some new MSs also represents a significant financial burden (HU, CZ, BG).

4.5 Individual Appropriate Systems (IAS)

A number of agglomerations between 2,000 PE and 10,000 PE in size have a significant proportion of their pollution loads treated via IAS. Although the graph in Figure 4-4 shows the percentages as an imprecise cloud, in particular for agglomerations displaying low IAS use, it signals that the lower the size of an agglomeration, the higher the proportion of pollution treated via IAS. A further observation in Figure 4-4 is that the smaller the agglomeration size (approx. smaller than 20K PE), the wider the distribution of treatment shares of IAS between 0 and 100%.



Source: 9th TA-UWWTD

Figure 4-4: Share of the IAS in agglomerations above 2,000 PE of the countries in the Danube Region

UWWTD and WFD both emphasise the necessity of appropriate wastewater treatment with the objective of advancing and achieving good (ecological) status of water bodies. This suggests that alternative lower cost technical decentralised solutions for small agglomerations and settlements are acceptable under the UWWTD. These systems should, however, warrant an equivalent level of environmental protection compared to centralised systems. Adequate operation of IAS could be supervised by local wastewater utilities managing centralised systems.

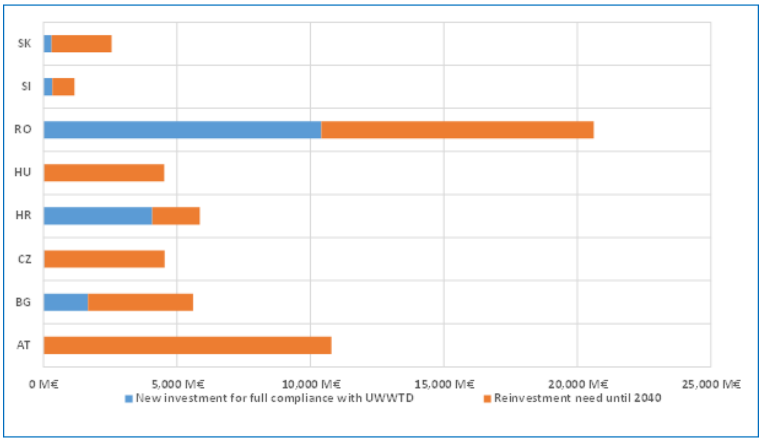
The 9th TA-UWWTD report only documents agglomerations with a size of more than 2,000 PE, disregarding settlements with a population below 2,000 inhabitants and (rural) areas outside the agglomerations. 10.8 million people are however living in these smaller human settlements and rural areas in the eight countries of the Danube region. UWWTD-compliant sanitation for these populations is not addressed in the 9th TA-UWWTD report.

4.6 Future Demand for Capital Expenditures for UWWTD Compliance

Future demand for capital expenditure is estimated to be about 56 Billion EUR for UWWTD compliance up to 2040 (see Table 3.10 in Annex 3 for details on the estimation per country). These values integrate two components

- (i) remaining new investment in non-equipped agglomerations above 2,000 PE (17 Billion EUR),
- (ii) reinvestment for older infrastructure needing renewal (39 Billion EUR).

Figure 4-5 clearly shows that infrastructure renewal and reinvestment is expected to require the mobilisation of substantial funding in excess of twice the demand for remaining new investment needed for full compliance in the Danube Region. In this context RO faces the greatest challenge needing future capital expenditure that is twice that required by AT.



Source: Own assessment

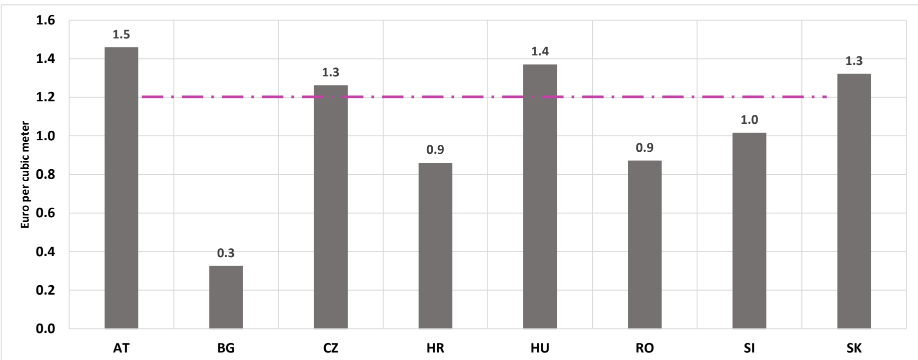
Figure 4-5: Future demand for capital investment up to 2040 in countries in the Danube Region, reference year 2015

Due to a lack of data concerning settlements below 2,000 inhabitants, the costs for their compliance with the UWWTD are not included in the amount of capital investments reflected in Figure 4-5. This might be as high as 8-10 Billion EUR in total.

4.7 Current Operating and Maintenance (O&M) Costs

Data on current operating and maintenance costs provides an indication of the performance of a water utility and its capacity to sustain efficient operation. A relentless drive toward continuous efficiency gains in operation is an important managerial objective of any wastewater utility.

The "Water and Wastewater Services in the Danube Region – A State of the Sector – Regional Report" published by the World Bank in May 2015 (from now on referred to as SOS Report 2015 in this study) estimated the average O&M costs per cubic meter of the combined water and wastewater services in the Danube Region. As the study focused solely on WW, the estimated wastewater O&M costs were set at 60% of the combined water cost documented in the above assessment. Figure 4-6 reflects the resulting specific O&M cost per country. They fluctuate around the statistical average for the Danube Region (1.1 EUR/m^3, the purple dashed line in Figure 4-6 O&M costs of four countries (AT, CZ, HU, SK) are higher than the region's average, while the others remain lower. BG (0.3 EUR/m^3) has a significantly lower figure (30% of the average), which may mean that the dataset for BG is not representative.



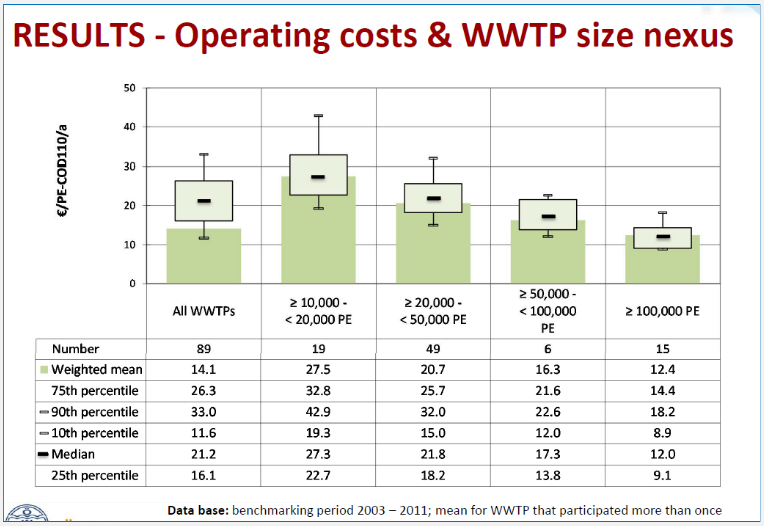
Source: SOS Report 2015; own assessment

Figure 4-6: Specific O&M costs of wastewater collection and treatment in countries of the Danube Region

Box 2 Case study in Austria – optimization of operating costs

In Austria, large efforts have been deployed to optimise the operation of WWTPs through training of operators.

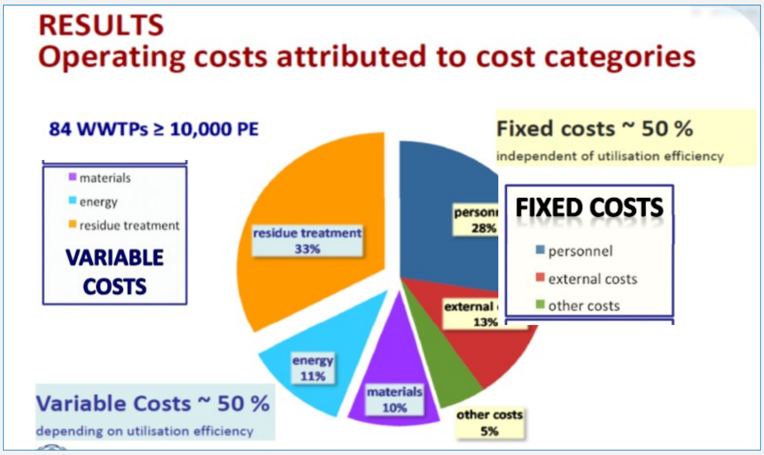
The optimisation of WWTPs in the country started in 1999 as a research project to develop performance indicators and to identify best practices as well as optimisation and cost reduction potentials. Since 2004, an internet platform allows WWTPs to participate in the benchmarking and optimisation process. Today, more than 130 WWTPs (with a size of 2,000 PE to 1,000,000 PE) participate in this process (39% of the Austrian WWTP design capacity). Some results of the benchmarking exercise for the period 2003 to 2011 as regards operating costs can be seen in Figure 4-8.



	All WWTPs	≥ 10,000 - < 20,000 PE	≥ 20,000 - < 50,000 PE	≥ 50,000 - < 100,000 PE	≥ 100,000 PE
Number	89	19	49	6	15
Weighted mean	14.1	27.5	20.7	16.3	12.4
75th percentile	26.3	32.8	25.7	21.6	14.4
90th percentile	33.0	42.9	32.0	22.6	18.2
10th percentile	11.6	19.3	15.0	12.0	8.9
Median	21.2	27.3	21.8	17.3	12.0
25th percentile	16.1	22.7	18.2	13.8	9.1

Source: benchmarking period 2003 – 2011; Schaar, Lindtner et al.

Figure 4-7: Results of operating cost versus WWTP size



Source: Schaar, Lindtner et al.

Figure 4-8: WWTP Operating Costs by Category (Schaar, Lindtner et al.)

Of particular significance in the Austrian model is the continuous training and knowledge sharing exercises organised by the Austrian Water and Waste Management Association (ÖWAV) for WWTP operators. This non-profit organization covers the entire Austrian water and waste management sector. It is considered to be an "independent counsellor" with the mandate to advance sustainable water, wastewater and waste management in the country.

Source: https://www.abwasserbenchmarking.at/home/benchmarking/benchmarking.php

The European Court of Auditors (ECA) report[15] made a comparison of costs from accounting information received for the 28 plants in four new Member States (CZ, SK, HU, RO). ECA confirmed that operating costs are influenced by the type of treatment (more stringent treatment implies a higher cost) and the size of the plant (economy of scale). The unit costs per PE documented in the ECA report range from 3 to 21 EUR. However, the comparison with AT benchmarks shows that there were significant differences amongst the plants not necessarily explainable by the two features mentioned (see Annex 3, paragraph 3.4).

4.8 Future trends in O&M costs

Future improved management of O&M costs can firm up the financial sustainability of wastewater utilities. O&M costs in the target countries can, for example, be significantly lowered by:

- (i) reducing infiltration and unaccountability for connections,
- (ii) improving staff productivity and
- (iii) boosting the energy efficiency of equipment.

In the wastewater sector, infiltration of groundwater into sewers and illegal and unrecorded connections are two major sources of inefficiencies. As no information is available regarding these inefficiencies, non-revenue water (NRW), which is often documented fairly accurately in water utilities reports, is used as a proxy for the estimation of prospective utilities efficiency gains. Reducing NRW from its current high levels (60% in BG, 45% in RO, 44% in HR) is considered to be a good proxy for estimating the operating saving potential achievable by wastewater utilities.

Staff productivity expressed as number of staff per thousand connections, reflects how productive a utility is from a human resources perspective. AT has the best staff productivity indicator (2.0) and RO the worst (18.0), followed by SK (7.7) BG (6.2) and CZ (5.2).

Efficiency gains in form of infiltration reduction and staff productivity improvement were considered for these countries in the SOP scenario (paragraph 3.2).

4.9 Tariffs and Connection Fees

Tariffs and connection fees have a direct impact on the OCR and TCR ratios of water utilities. The ECA report mentioned earlier assessed key aspects of wastewater tariffs in selected wastewater utilities. It assessed whether:

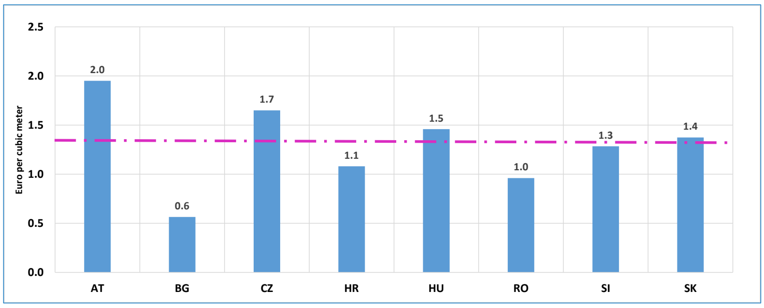
- the wastewater tariff covered the depreciation, operating and maintenance costs of the assets;
- there was room for increasing the wastewater tariff, whenever operating and maintenance costs were not sufficiently covered;
- the infrastructure owners had accumulated sufficient financial reserves to enable the replacement/renewal of infrastructure at the end of its economic life.

The report found that capital (new investment plus reinvestment) and operating costs were fully recovered by tariffs in only 11% of the cases assessed. In all the other cases, cost recovery was limited, if not marginal.

For the assessment of the UWWTD compliance, only wastewater related tariffs matter. Therefore, an assumption was made regarding the component of the wastewater element of the overall utility tariff. It was set at 60% of the combined water tariff to also take into account the fact that in many countries the wastewater tariff is often underestimated to avoid

[15] Special Report ECA 02 2015 EU-funding of urban waste water treatment plants in the Danube river basin: further efforts needed in helping Member States to achieve EU waste water policy objectives (pursuant to Article 287(4), second subparagraph, TFEU)

frightening customers and promote connection to sanitation services. When the UWWTD is completed, the sanitation share of the tariff could possibly reach 70% due to expensive tertiary treatment. Figure 4-9 reflects the average wastewater tariff per country. The tariffs fluctuate around the statistical average of the Danube Region (1.3 EUR/m^3; purple dashed line in Figure 4-9). Five countries (AT, CZ, HU, SI, SK) have an equal or higher sanitation tariff than the region's mean. A significantly lower tariff consistent with the observed O&M costs was estimated for BG (0.6 EUR/m^3. Details are presented in Annex 3, paragraph 3.5.



Source: SOS Report 2015; own assessment

Figure 4-9: Tariffs of wastewater collection and treatment in countries of the Danube Region

The wastewater tariffs for countries in the Danube Region display substantial differences. The WW services in AT (2.0 EUR/m^3) are three times more expensive than in BG (0.6 EUR/m^3). Such differences can however also be found between old MSs. For example, the wastewater tariff in Spain is 0.56 EUR/m^3 (in Catalonia: 0.72 EUR/m^3), while it is 2.53 EUR/m^3 in England and Wales and 3.50 EUR/m^3 in Scotland.

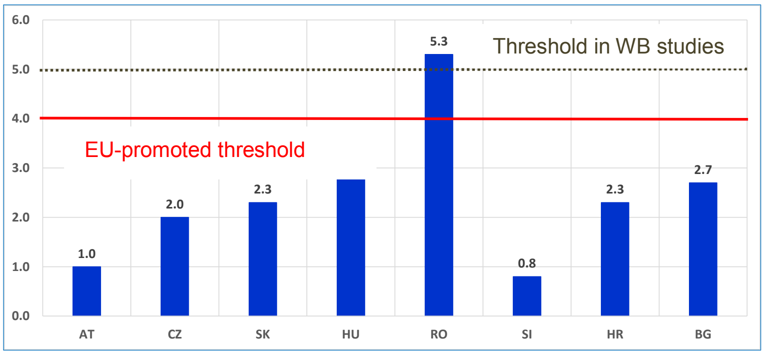
4.10 Future Tariff Prospects

Wastewater pricing policies currently only partially support full cost recovery of water services in the eight countries. WFD defines cost recovery not only in financial but also in economic terms (environmental and resource costs). Concerning financial costs, depreciation is usually only partially included in the current tariffs. Most of the countries assessed use expert judgment to estimate the cost recovery ratio of their water services in the DRBMP. Three countries (CZ, RO and SI) need further studies to be able to define cost recovery level of their WW services. In all eight countries environmental and resource costs are not entirely internalised, either due to the absence of reference values or a lack of robust methodology to define them (see chapter 5). Even in the presence of adequate methodology, the internalisation of ERC also depends on the affordability of sanitation services for consumers.

The price setting authorities in the eight countries, regardless of whether they are national or municipal, are often reluctant to approve tariff increases because of political considerations. Instead, they recommend that utilities strive for efficiency gains which can reduce their operating costs. Although this is a legitimate and desirable approach, the reality is that a substantial tariff increase to enable appropriate recovery of the depreciation cost of assets is unavoidable, especially in countries which have lower tariffs than the region's average (BG, RO and HR). This is expected to impact on poorer households, which will need governmental subsidy to allow them to pay their wastewater service bills without deteriorating the utilities' revenue collection position.

4.11 Affordability

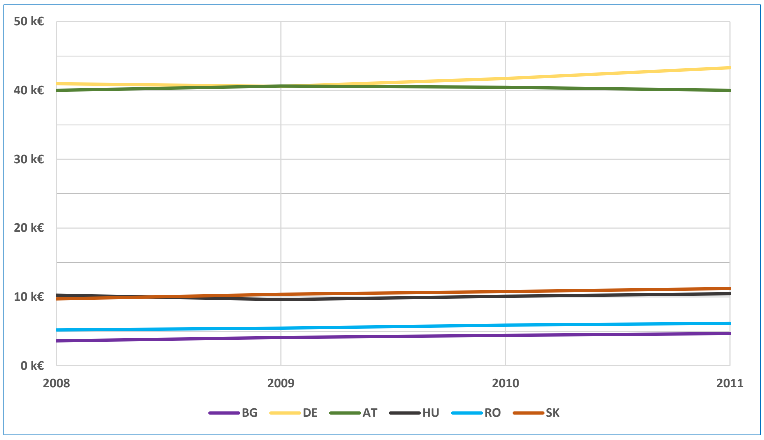
Affordability indicators in the target countries are shown in Figure 4-10. They are extracted from the SOS Report 2015 for modelling the sustainably of the WW sector. The countries are listed according to their location (upstream to downstream) on the Danube River. The worst affordability ratio of 5.3% is to be found in RO. It exceeds the 5% threshold usually applied in WB studies (brown dotted line in Figure 3-10). This suggests that some Romanian households already have difficulties in paying their water bills. Considering that the currently connected population in RO (approx. 60%) is likely to be in larger cities, which are financially better off, and that the demand for new connection will be in smaller rural communities, the country's affordability situation is expected to worsen in the coming years. The affordability indicators for other countries are currently below the EU-promoted threshold of 4% (solid red line in Figure 4-10). BG and HU, which have the closest affordability ratio to the threshold after RO, may also face difficulties when future tariff increases become necessary to cover WW services.



Source: SOS Report, 2015; own consideration

Figure 4-10: Current affordability ratios of water services in the countries of the Danube Region, in percentage

The affordability ratio is directly proportional to per capita water consumption and wastewater charges including taxes and fees, and inversely proportional to household net disposable income. Figure 4-11 presents the annual earnings per person for the selected countries of this study, based on the latest Eurostat data.



Source: own elaboration based on Eurostat data extracted in June 2017

Figure 4-11: Average annual earnings per person in selected countries of the study, in EUR

Affordability constraint is not a real concern in the "old" MSs but it is a serious challenge for a number of "new" MSs due to significantly lower household incomes. The difference in earnings between new and old MSs is significant: The income in AT/Germany is nearly four times higher than in the medium income countries (SK and HU) of the East-European region.

The income situation is even worse in RO and BG, which joined the EU in 2007. Their earnings per person only correspond to about two-thirds of the medium income countries highlighted earlier and one-sixth of AT and Germany. Further information on affordability analysis is presented in Annex 3, paragraph 3.6.

4.12 Impact of Demographic Trends

Demographic trends may have a negative impact on the financial viability of water and wastewater utilities in the Danube Region. A significant overall population decrease has been observed in the Danube Region over the last decade. During the 2005-2015 period, 2 to 2.5 million people left these regions. While four countries covered by this study enjoyed population growth (AT, SK, CZ, SI), the other four (RO, HU, BG, HR) experienced a continuous shrinking of the population.

A declining population results in a diminishing number of customers for the water service provider. Operating and maintaining existing infrastructure based on a contracting revenue base is always problematic because sunken fixed asset maintenance costs cannot be significantly reduced to balance lower revenues.

According to a Eurostat forecast, the general demographic trends for the previous decade are expected to continue until 2020. During this period, four countries will have a positive population change: AT, CZ, SI and SK. Thereafter, from 2020 to 2080, the European demographic forecast anticipates a population growth only in AT. All other seven countries may well face a decline in the number of inhabitants.

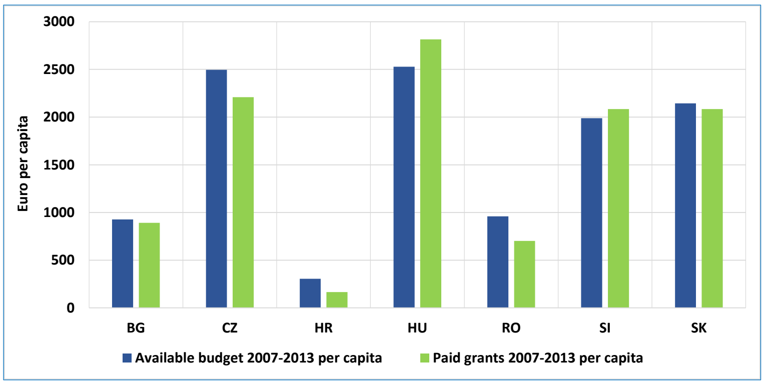
At the same time, decreasing population numbers could possibly have a positive environmental impact. Shrinking number of inhabitants means lower pollution load and lower pressure on the water environment.

Overall, the demographic downward trend may provide the opportunity to encourage the development of extensive, low cost, nature-near WWTP systems which have lower investment costs and less fixed operation costs.[16] See also Annex 3, paragraph 3.6.2.

4.13 European Sources of Financing for UWWTD Investment

During the period of 2000-2020, a significant part of the financing of wastewater infrastructure investment came, and will continue to come, from the EU in all seven countries of the Danube Region, except AT. Figure 4-12 summarises the budgets and EU grants received by the countries of the study during the period of 2007-2013 (not only for the implementation of the UWWTD).

[16] See GWP CEE 2014: Natural Technologies of Wastewater Treatment; WEPC 2010: Sustainable and cost-effective wastewater systems for rural and peri-urban communities up to 10,000 PE



Source: EU funds in CEE - Progress report 2007-2015 by KPMG, 2016

Figure 4-12: Available EU budget vs paid grants per capita in the period 2007-2013 in the Danube Region

The robustness of the absorption capacity for EU funds by the seven countries for the implementation of UWWTD investments could not be quantitatively assessed in this study. The countries reported different figures in different documents. Obviously, the countries may not have a transparent and complete database for their total UWWTD investment needs and funding sources.

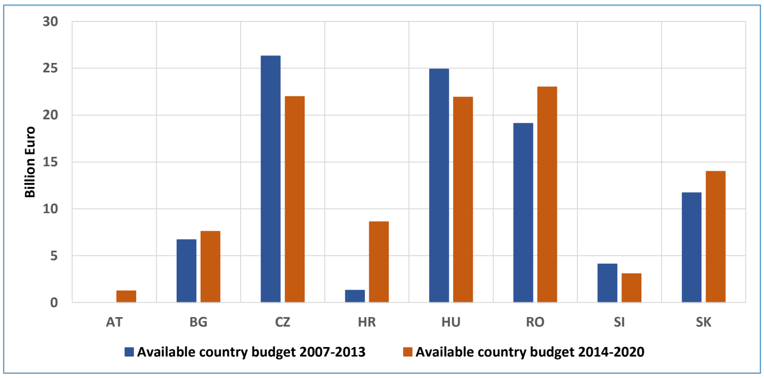
The EU has been co-financing UWWTD investments since 2000 in the Danube Region. It is estimated that by the time full compliance with UWWTD is achieved, around 15 Billion EUR worth of grants will have been disbursed in the seven countries for UWWTD investment. In the period 2000-2006 about 2.5 Billion EUR, in the 2007-2013 period about 5 Billion EUR, and until by the time full compliance across all countries of the study another 6-7 Billion EUR more will have come from EU grants.

As in previous EU programming periods, every European region is, in principle, currently (2014-2020) eligible to benefit from European Structural and Investment (ESI) Funds for their UWWTD investments. A number of changes in the ESI Fund policy framework are likely to have significant consequences to the countries in the Danube Region.

The level of support still depends on each region's position in relation to the average GDP per capita of the EU-27. For cohesion policy, the CPR[17] now distinguishes between three categories (i) less developed regions; (ii) transition regions; (iii) more developed regions.

Figure 4-13 reflects the available total budget for countries in the Danube Region in the two EU programming period of 2007-2013 and 2014-2020. Between the two periods the budget available for CZ, HU and SI was reduced by an amount of 8 Billion EUR, while other countries (BG, HR, RO, SK) enjoyed an increase of 14 Billion EUR in line with CPR categories. Details about the budget and the list of regions by categories are presented in Annex 3, paragraph 3.7.

[17] Common Provisions Regulation for the European Structural and Investment Funds (Regulation (EU) 1303/2013, hereafter referred to as CPR.



Source: EU funds in CEE - Progress report 2007-2015 by KPMG, 2016; ESI Funds 2014-2020 - EC

Figure 4-13: Available EU budget in the period 2007-2013 vs 2014-2020 of the countries in the Danube Region

If it is assumed that EU grant transfers may become phased out after 2027, it would leave some countries without appropriate financial resources to complete and renew their UWWTD-related capital investments. Then, different more onerous sources of financing may need to be considered and mobilized when planning future investments, such as loans instead of grants.

The seven cohesion countries in the Danube region assessed in the 9th TA-UWWTD report declared that sources of funding for infrastructure investment came exclusively from the Cohesion Fund (CF) and the European Regional Development fund (ERDF). Other sources of financing such as International Funding Initiative (IFI) loans from the European Investment Bank (EIB) or The European Bank for Reconstruction and Development (EBRD) are not mentioned due to the prevailing high EU grant co-financing rate applied in most of the approved investments. A few examples of loan financing did however occur during the EU pre-accession period, see Maribor case study in Annex 3.

4.14 Findings

Concerning the existing **financing mechanisms** and national programmes for the implementation of UWWTD, along with the funding of wastewater infrastructure construction in the eight countries of the study, the following main findings are particularly noteworthy:

- National programmes and strategies for implementation of UWWTD infrastructure are mostly enabled via legislation. AT also makes reference to the national river basin management plan and its associated Programme of Measures (POM), which cover UWWTD investment as a basic measure. These documents specify financing sources regarding capital costs (investments or reinvestments), although no clear quantitative data has been provided.
- The ECA report from 2015 concluded that the available funds (2007-2013) combined with low disbursement were insufficient to meet the national UWWTD deadlines for wastewater infrastructure completion. The report also noted that the funds were absorbed slowly and that the achievement of the national operational programmes did not allow for reconciliation with the targets of the UWWTD implementation plan.
- In the EU programme period 2014-2020, substantial EU grant funds remain available for countries with pending deadlines up to their full compliance (RO, HR). The overall available budget of European Structural and Investment (ESI) funds for these two countries are 11 Billion EUR higher than the previous programming period. However, it is anticipated that these funds will not cover the demand to reach full compliance with the UWWTD especially for RO.

- EU funds available for countries whose deadlines have expired and have not yet achieved compliance are significantly lower (CZ, HU, SI in total have 8 Billion EUR less EU grant budget available than in the preceding EU programming period).
- An additional pressure for national authorities comes from periodic assessments and checks carried out by EC services, which can sometime result in court cases[18].

In the target countries, **sources of financing** for capital investments, which comply with the UWWTD, are essentially EU. National grants are structured as follows:

- In AT, only national public funds are used for UWWTD capital investments. This represents 20.5% of the project value, the remaining amount is financed by local stakeholders and beneficiaries.
- In the other seven countries, EU grant co-financing plays a decisive role, typically 50-80%. This generous support is supplemented by equity provided by the municipality or the service provider and is between 20-50%.
- Despite the crucial importance of EU grants for UWWTD investments, there is no consistent, up-to-date or transparent information on fund utilisation by the new MSs.
- The speed of implementation of UWWTD investments depends heavily on the administrative and management capacity of the countries at national and local level.

The **investment costs** associated with implementation of the UWWTD in the eight countries of the Danube Region are estimated to be around 66 Billion EUR. Out of this, a total of 49 Billion EUR has already been invested, partially before accession to the EU. Future new investment (from 2015 onward) needed to achieve full compliance is expected to be around 17 Billion EUR. In addition, it is anticipated that a sum of 1.6 to 2 Billion EUR will be required annually for regular reinvestment in infrastructure. The overall investment could possibly need to be raised by 8-10 Billion EUR of investment to cover small rural settlements with populations below 2,000 inhabitants. This would amount to between 74 to 76 Billion EUR of total investment costs for sustaining UWWTD implementation and 25 to 27 Billion EUR of new investment in the eight countries in the Danube Region.

Operation and maintenance costs are essentially financed from tariff revenues with either no or minimal subsidies provided by national or local governments. According to the World Bank SOS Report 2015, two countries do not entirely cover their UWWTD related O&M costs with tariff revenues. Their operation cost recovery (OCR) ratios are estimated to be below 1 (HR 0.97 and HU 0.89).

In general, with the exception of AT, **current tariffs** in the study countries do not provide for full cost recovery of wastewater services (including depreciation for future investment and reinvestment) and are therefore not sustainable. The cost of wastewater is currently well below the desired total cost recovery (TCR) ratio of 1 (0.24-0.86).

Two scenarios have been developed for modelling the long-term **financial sustainability** of tariffs until the year 2040. A *Business As Usual* (BAU) scenario and a *Sustainability Orientated Pathways* (SOP) scenario.

- The results of the BAU scenario found that financial sustainability, which is already weak, would continue to deteriorate in most countries in the Danube Region. By 2040, the typical TCR would be around 0.5-0.7 for six countries and for BG even lower (0.3). AT is expected to have a better ratio of 0.9.
- The optimistic SOP scenario recommends tariff increases within the boundary of EU-recommended affordability thresholds. This would lead to significant operational efficiency gains. In the longer term, TCR ratios can achieve the targeted value of 1

[18] See http://ec.europa.eu/environment/water/water-urbanwaste/implementation/caselaw_en.htm

within a variable timeframe depending on the country in question: AT within 5 years and RO after 25 years.

- Tariff increases required for the SOP scenario will not be easy to implement. They may even be impossible to implement for political reasons and the population may not accept frequent and drastic price increases. Consequently, UWWTD asset depreciation costs may not be fully recovered by the tariff. Financing gaps of various sizes are expected to appear in each country. In the absence of sufficient national and European grants, a need for market-based loans or bonds will arise. Debt ceilings constraints may then have to be taken into account.

User charges in the eight countries are currently mostly **affordable**, but financially unsustainable for the utilities concerned. An affordability assessment, based on the average household incomes of the various countries, indicates that poorer households will be adversely affected. This is in spite of the fact that in some countries there is a lack of even the most basic sanitation systems (up to 30% of households with no flush toilet or indoor bathroom). These families will need access to either state or municipal subsidies to cover their water/wastewater costs in order to concur with the cost recovery requirement for wastewater services and the polluter pays principles.

5 Economic Assessment of the UWWTD implementation

This chapter addresses the questions *Is it worth it?* It addresses the as to which extent the costs associated with the implementation of full compliance with the UWWTD in the target countries (investment, O&M and reinvestment) are justified?

Will the economic benefits to the countries and regions resulting from compliance with the directive justify the costs incurred?

5.1 Economic assessment according to EU UWWTD and EU WFD

The UWWTD does not specifically address the economic aspects of implementing the directive. Article 17 merely mentions the need ”*to establish a programme for the implementation of the Directive*” and to provide “*an update every two years giving information on the programme”* with ”*The methods and formats to be adopted for reporting on the national programmes”* determined by a Committee representing the European Commission and the Member States.

The economic aspects of UWWTD come into play through the Water Framework Directive (WFD). WFD promotes the application of sound economic principles, methods and instruments for supporting the achievement of the *good ecological status* objectives in Europe. Albeit very important, UWWTD investment is a subset of the types of measures to be implemented under the WFD.

Economic aspects appear in several WFD articles:

- Article 4: use of cost-benefit analysis (CBA) for exemptions and disproportionate cost decisions;
- Article 5: economic analysis of water use and scenario development;
- Article 9: application of the cost-recovery principle, including environmental and resource cost through water pricing; and
- Article 11 and Annex III: Cost-Effectiveness Analysis (CEA) for selecting measures.

Annex 4.A provides a list of guidance documentation developed between the years 2000 and 2012 by EC services to support the Member States and River Basin Authorities in their efforts to document CBA and CEA under the WFD.

The reality regarding information provided by Member States regarding the economic assessment of measures implemented under the WFD (therefore including UWWTD investment) is sobering. Although the majority of Member States have started the process of assessing the costs and benefits of WFD, most of these are unfortunately still at an early stage, including the commissioning of first studies and/or the development of tools. Only a few Member States (United Kingdom, Netherlands, France) are sufficiently advanced in the assessment process to have produced first results and estimates of costs and/or benefits of the WFD at national or regional level. For all the others MSs, no clear picture has emerged as to which extent they have begun to make any serious economic analysis regarding WFD implementation.

No information has found that allows for the extraction of information concerning UWWTD-specific costs and benefits. Reports and data, when available, are not transparent regarding UWWTD-related values. They provide only a very vague and undefined broad order of magnitude of costs and benefits. This means that this study has had exploit other sources of data. This is essentially the data reflected in the DRBMPs under the ICPDR and the EU dataset from the 9th TA-UWWTD made by EC services in line with the article 17 of the UWWTD.

The Guide on Cost-Benefit Analyses of major projects for the EU programme periods 2007-2013 and 2014-2020 provides methodological support to assess the benefits of the UWWTD investment projects. However, the quantification and monetization of these benefits in principle necessary to develop the CBA analysis in the feasibility studies of investment do not cover several benefits which may be significant.

5.2 Current economic consideration of UWWTD in ICPDR countries

For the ICPDR and the national agencies managing the Danube River, the economic focus of attention has so far been solely geared toward Environmental and Resources Costs (ERC) that are recovered through charges for water uses. Wider environmental costs and benefits are neither considered nor documented.

As shown in the Annex 4.B the costs documented in ICPDR's RBMP for the riparian countries are limited to water abstraction charges, which are considered to represent resource costs, wastewater treatment and discharge into water bodies; thereby reflecting environmental costs. These charges vary for the countries between 0.018 and 0.3 EUR/ m^3, which may be below the real economic costs.

According to the draft guidelines for assessing the recovery of ERC in the context of the Water Framework Directive from March 2015, the Environmental Costs (EC) are the costs of damage that water uses impose on the environment and ecosystems and on those who use the environment (e.g. reduction in the ecological quality of aquatic ecosystems or salinisation and degradation of productive soils). The Resource Costs (RC) are the costs of foregone opportunities that other uses suffer due to the depletion of the resource beyond its natural rate of recharge or recovery (e.g. water pollution). ERC cost can be estimated via two main, mutually non-exclusive, approaches: the 'cost based' or the 'benefit based' approach. The cost-based approach relies on the calculation of the costs of measures required to protect the environment. The benefit-based approach is based on the estimation of the loss of welfare due to environmental damage or the increase in welfare if environmental damage is avoided. The economic value of the environmental damage (avoided with the help of existing pollution abatement and mitigation measures) can be estimated by using direct and indirect economic valuation methods, or revealed preference methods (see chapter 4.5).

Box 5.1 provides an overview of the pros and cons of the cost-based and benefit-based methods to estimate ERC in any river basin.

Box 5.1: Pros and Cons of cost-based and benefit based methods to estimate ERC

	Cost-based approach	Benefit-based approach
Pros:	• Cost-based approaches are generally less intensive in terms of data and resource requirements • Cost data is usually more readily available	• Benefit-based approaches attempt to derive an estimate of the actual benefits created by the achievement of environmental objectives. • Benefit-based methods can account for non-use values. From a theoretical perspective, it is assumed that they are closer to providing the values of EC. • Benefit-based approaches provide information on

	than benefit data • A transparent and defensible method when based on market data.	how the general public perceives the current status of water resources, depending on how well it is informed about water issues, and how relevant water quality improvements are perceived to be. • The results of the benefit-based approach can also be used in cost-benefit assessments for justifying exemptions.
Cons:	• There are uncertainties as to how close the results of the cost-based approach are to real ERC values. • If the measures selected are not the most cost-effective measures for achieving GS, then the cost-based approach can lead to overestimates. • The cost-based approach does not provide information on users' preferences.	• Benefit-based approaches require a sound assessment of the beneficiaries (who, how many, where...). The aggregated benefits estimated are sensitive to the definition of the population benefiting from specific ecosystem services or having a non-use value. • Many people, including policy-makers, economists, and stakeholder representatives, question the methods and the validity of the results obtained via benefit-based approaches. • GS is defined on the basis of a series of technical parameters that can differ from the way individuals assess and perceive "good" water status. • The Benefit-based approach is relatively resource and time intensive if based on primary data collection (surveys). This explains why benefit-transfer is sometime chosen because it requires fewer resources. However, it adds uncertainty.

Source: Draft guidance on assessing ERC - Drafting Group ECO2 - Common Implementation Strategy, Working Group 2B, 2015.

5.3 Economic cost effectiveness of UWWTD implementation

In accordance with the WFD, Member States are required to undertake a Cost Effectiveness Analysis (CEA) in order to make judgements about the best combination of measures needed to achieve the directive's objectives. This is also valid for UWWTD investments.

Strictly speaking, the cost effectiveness of the UWWTD is the extent to which the UWWTD implementation programme can achieve its results at a lower cost compared to alternatives. Within the frame of this study, it is not possible to compare such alternatives.

The approach has therefore been to estimate the total costs of UWWTD implementation. This is then divided by the quantity of intended effects in order to document benchmark data that can be compared either between the target countries themselves or with data from similar programmes in other countries. For UWWTD, the main effect considered is the pollution removed from surface water bodies. This is estimated in terms of removed load (tons) of BOD, COD, Total N and Total P as well as in the volume of wastewater before discharge (m^3) and the PE benefiting from UWWTD investment.

Table 5-1 summarizes these findings. Detail of the calculation, assumptions and more detailed values are shown in Annex 4-C.

Countries Total Cost EUR/ pollution removed	AT	BG	CZ	HR	HU	RO	SI	SK
EUR/ton BOD (2000-2014)	4,740	8,293	6,809	5,123	8,806	36,606	26,815	8,704
EUR/ton BOD (2015-2040)	1,860	1,152	2,724	3,842	1,960	2,498	3,565	2,227
EUR/ton BOD (2000-2040)	2,844	2,126	3,962	3,892	3,378	3,904	5,992	3,687

EUR/ton COD (2000-2014)	2,748	4,787	4,052	3,018	5,555	20,470	17,311	5,439
EUR/ton COD (2015-2040)	1,078	668	1,621	2,264	1,241	1,457	2,139	1,357
EUR/ton COD (2000-2040)	1,649	1,232	2,358	2,293	2,137	2,272	3,622	2,260
EUR/ton Total N (2000-2014)	20,863	35,243	34,065	29,006	107,508	159,401	236,615	42,933
EUR/ton Total N (2015-2040)	8,185	5,217	13,633	21,753	24,019	12,920	20,180	10,633
EUR/ton Total N (2000-2040)	12,518	9,544	19,825	22,035	41,369	20,037	35,236	17,734
EUR/ton Total P (2000-2014)	40,391	68,276	67,892	39,483	206,134	317,711	444,021	99,120
EUR/ton Total P (2015-2040)	15,847	10,025	27,174	29,610	47,043	24,478	31,349	22,974
EUR/ton Total P (2000-2040)	24,236	18,359	39,514	29,993	80,663	38,053	55,401	38,867
EUR/ m^3 (2000- 2014)	3.98	1.69	1.94	1.02	2.27	1.93	1.84	1.90
EUR/ m^3 (2015- 2040)	1.53	0.50	0.75	1.55	0.85	0.95	0.87	0.70
EUR/ m^3 (2000- 2040)	2.35	0.80	1.10	1.51	1.28	1.15	1.16	1.06
EUR/ PE, year (2000-2014)	97	170	138	96	171	706	525	175
EUR/ PE, year (2015-2040)	38	23	55	77	38	50	72	45
EUR/ PE, year (2000-2040)	58	43	80	78	66	78	120	74

Table 5-1: Cost of treatment of various UWWTD pollutants for the period 2000-2040

The values of the above table yield in average 75 EUR/PE BOD, year, 76 EUR/PE COD, year, 35 EUR/PE TN, year and 14 EUR/PE TP, year. These values are similar to numbers found in a recent (2015) USEPA report which reflects the annual cost of treating TN and TP in WWTPs in the USA.

Type of cost	WWTP with Nitrogen Removal (residual concentration in effluent 0,6-1,4 mg/l TN)	WWTP with Phosphor removal (residual concentration in effluent < 1,0 mg/l TP)
Capital Cost	1.27 to 3.58 USD (2012)/ gpd 41 to 116 EUR/ PE, year	0.03 to 22.17 USD (2012) gpd 1 to 720 EUR/ PE, year
O&M Cost	0,05 to 0.092 USD (2012)/ gpd 0,162 to 3 EUR/ PE, year	0.01 to 2.33 USD (2012) gpd 0,324 to 76 EUR/ PE, year

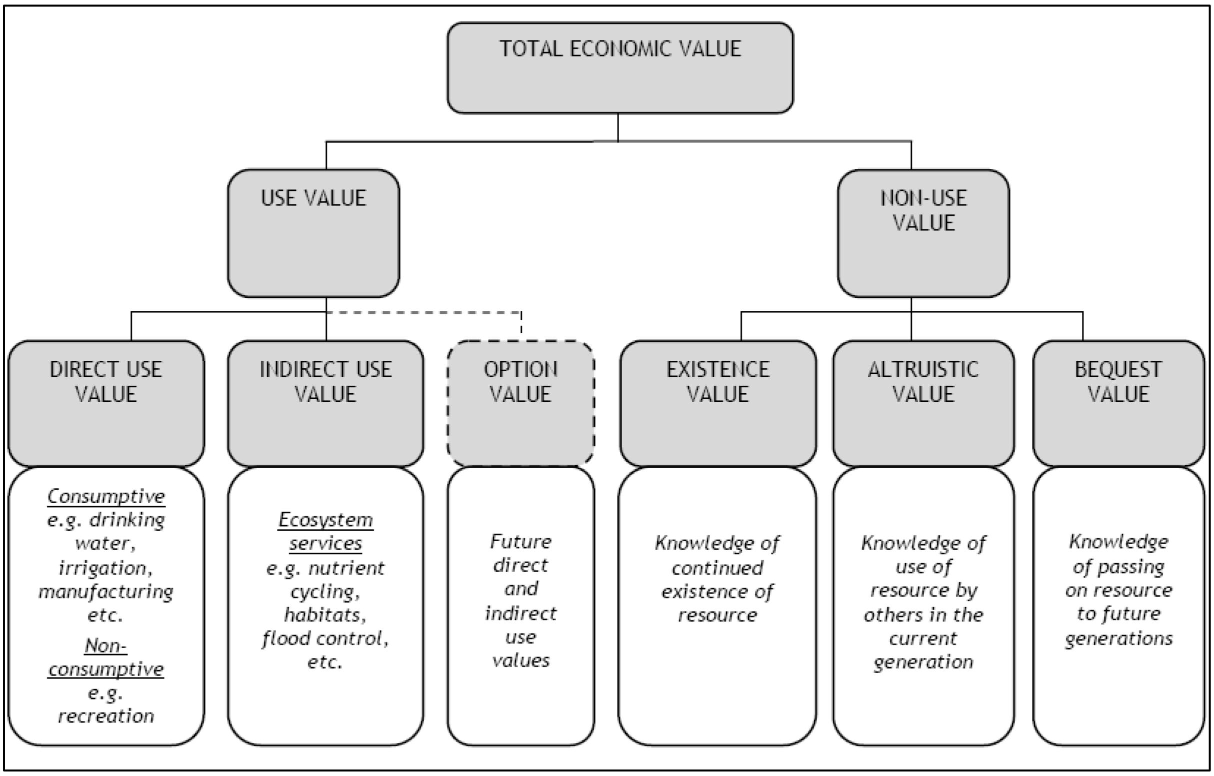
1 m^3/d= 264,17 gpd; 1, 22 USD = 1 EUR; 1 PE= 8,8 g TN and 1,5 g TP and 150 l/day; 1 m^3day= 6,66 PE

Source: "Compilation of cost data associated with the impact and control of Nutrient pollution, May 2015"

Table 5-2: Annual costs of N & P removal in USA (2015)

5.4 Economic values of good surface water quality

The economic value of water can have several sources (i) direct uses made of it, (ii) indirect uses made of it, (iii) preferences for future reserved uses, and (iv) reasons that are independent of use, including ensuring a sustainable water environment for others to use. All these value components can be summed up to represent the total economic value of water, as shown in Figure 5-1:



Source: Scoping Study on the Economic (or Non-Market) Valuation Issues and the Implementation of the WFD, EFTEC – Final Report, 2010

Figure 5-1: Water and Total Economic Value

According to the EFTEC report from which the box above has been extracted, the different water values can be summarized as follows:

Use value involves some interaction with the resource, either directly or indirectly:

- Direct use value: use of water in either a consumptive manner, such as household water supply, or in a non-consumptive manner, such as for recreation (e.g. angling);
- Indirect use value: the role of water in providing or supporting key ecosystem services, such as nutrient cycling, habitat provision, climate regulation, etc.;
- Option value: not associated with the current use of water but with the benefit of making use of water resources in the future.

Non-use value is associated with benefits derived simply from the knowledge that the natural resources and aspects of the natural environment are maintained (i.e. it is not associated with any use of a resource). Non-use value can be attributed to three motivations:

- Altruistic value: derived from knowing that contemporaries can enjoy the goods and services related to natural resources;

- Bequest value: associated with the knowledge that natural resources will be passed on to future generations;
- Existence value: derived simply from the satisfaction of knowing that a natural resource continues to exist, regardless of use made of it by oneself or others now or in the future.

5.5 Economic valuation techniques and methodology applied

Water as an environmental resource represents a 'non-market' good or service. In order to estimate its economic value, including impact on its quality such as pollution and environmental degradation, non-market valuation methods are required. Three main approaches are used to estimate the economic value of water. They distinguish themselves by the type of economic data used or generated to measure the economic value. This includes:

(i) **Market price method:** This is used whenever price signals from traded good or services associated with competitive markets can be accessed. However, whilst there are markets for water and wastewater services, prices are not determined in competitive markets. In addition, water provides many more services than those directly consumed by household, agriculture and industrial sectors, such as the indirect use values and potential non-use values described in Figure 5-1. Therefore, using the price of water is not sufficient to estimate its total economic value.

(ii) **Revealed preference method:** Water characteristics (availability, quality and quantity) may affect demand for other goods and services that are traded in markets (property price near water bodies or with good access to water supply, water recreation services, etc.). These prices can be used as proxy to estimate the economic value of water based on the relationship between the water characteristics and the related demand for market priced goods or services. Specific methods include hedonic pricing, travel cost models and more.

(iii) **Stated preference method:** This is applied in the absence of market-based price and consumer behaviour data. These methods use questionnaires as means of creating hypothetical markets and asking a representative sample of survey respondents to trade-off money – i.e. state their willingness to pay (WTP) - for goods and services as they would in 'real-world' markets. The most commonly applied methods are contingent valuation and choice experiments.

(iv) **Economic value transfer method:** This method estimates economic values by transferring existing value estimates from studies already completed to new policy locations. The approach has the advantage of avoiding the need for extensive and detailed surveys and statistical evaluation required under the three preceding groups of methods, especially if the target location is a large domain such as a river or a river basin. For economists, the application of the economic value transfer method is considered economically robust when limit conditions are met: (i) costs from the original study site must be methodologically valid; (ii) the population in the original study and the new policy site must be similar; (iii) the difference between pre-policy and post-policy water characteristics must be similar across the study and policy site.

Tools available to overcome these difficulties include (i) unit benefit transfer, which involves multiplying a mean unit value (per household or per hectare) from a similar site by the quantity of the good/ service at the site being assessed); (ii) adjusted unit benefit transfer, which is similar to unit benefit transfer, but is adjusted for site characteristics (e.g. income, population levels, etc.); (iii) value function transfer, which uses a value or demand function from one site considering various parameters (e.g. population, average income) and applying parameters for a new site to obtain new site specific value; and (iv) meta-analytic function transfer, whereby values or demand functions from several sites are combined and applied with local site parameters (White et al, 2011)). As a whole, all the latter techniques outlined remain difficult to apply with sufficient economic robustness, when targeting large regional or national areas such as a river basin or a country.

In this short study with limited resources, the unit benefit transfer methodology, combined with some estimation of the willingness to pay for good water quality extracted from past studies, has been retained as an acceptable option to derive countrywide estimation of the economic value of achieving compliance with UWWTD requirements in the Danube region. The estimated values gained may not be economically robust but they provide indicative ranges and orders of magnitude of what the economic benefits of UWWTD compliance could be for the Danube riparian countries.

5.6 Estimation of economic benefits of UWWTD compliance in the Danube Region

The economic assessment of UWWTD implementation considers both the economic costs of the implementation of the UWWTD as well as the economic benefits to the concerned population derived from good water quality and water bodies. On the cost side, the following costs have been taken into account: investment, reinvestment and O&M costs of wastewater collection and treatment system required under the UWWTD Articles 3, 4 and 5. Administrative costs, along with environmental and resources charges and costs, have been ignored in this first approximation due to the absence of country data on which to base such costs. On the benefit side, health and environmental and social benefits have been taken into account based on the willingness to pay (WTP) for good drinking water quality (health benefits) and for good water resource quality for environmental and social purposes (environmental and social benefits). Environmental benefits in this study are probably underestimated. As an example the monetization of ecosystem services are not included, although these benefits may be significant. Absence of any data and numbers on many potential benefits made it impossible in this study to approximate values that would be reasonably credible. Even the estimation of benefits that are monetized are only conservative guess estimates that are based on the judgement of the authors but lack economic robustness.

Table 5-3 summarises an exemplary valuation of WTP for good drinking water quality (see more examples in Annex 4-D) and Table 5-4 reflects the WTP value range of health-related benefits considered for this study estimation.

Source	Location	Effect Valued	Value
Vasquez et al. (2009)	Parral, Mexico	Households are willing to pay from 1.8% to 7.55% of reported household income above their current water bill for safe and reliable drinking water services	1.8 % - 7.55% of current water bill
Beaumais et al. (2010)	Mexico, Korea & Italy	The median willingness to pay for better tap water quality in Mexico, Korea and Italy was estimated at 10.1%, 6.4% and 8.8% of the median water bill.	10.1%, 6.4% and 8.8% of the median water bill.

Source: EU Benefit Assessment Manual for Policy Makers: Assessment of Social and Economic Benefits of Enhanced Environmental Protection in the ENPI countries (2011)

Table 5-3: Exemplary valuation of WTP for good drinking water quality

Country	Lower Specific WTP Value	Lower value of Yearly Health Economic Benefits Mio EUR	Maximal WTP Value	Higher value of Yearly Health Economic Benefits Mio EUR
Austria	1.5 % of water bill	15	9 % of water bill	90
Bulgaria	1.5 % of water bill	3	9 % of water bill	16
Czech Republic	1.5 % of water bill	9	9 % of water bill	54
Croatia	1.5 % of water bill	5	9 % of water bill	32
Hungary	1.5 % of water bill	8	9 % of water bill	51
Romania	1.5 % of water bill	15	9 % of water bill	89
Slovenia	1.5 % of water bill	2	9 % of water bill	11
Slovakia	1.5 % of water bill	4	9 % of water bill	26

Source: Own considerations

Table 5-4: Willingness to pay (WTP) value range of health-related economic benefits of UWWTD implementation

For the environmental benefits, Table 5-5 summarises some exemplary valuation of environmental benefits extracted from the "EnValue" database (see Annex 4-D for details).

EnValue Database (NSW, Australia)								
Source	**Country, Location**	**Valuation Method**	**Value Documented**	**Unit**	**Currency**	**Year**	**Value**	**EUR equivalent** (2017 April exchange rate)
Mitchell & Carson (1981) in Kneese (1984)	USA	Contingent Valuation Method	WTP for improved water quality from: (1) Non-bootable to swimmable	USD per household p.a.	USD	1981	225	209.56
			(2) Non-bootable to swimmable		USD	1981	152	141.57
			3) Bootable to fishable		USD	1981	42	39.12
			(4) Fishable to swimmable		USD	1981	31	28.87
Heiberg & Hem (1987) in Barde & Pearce (1991)	Norway, Kristiansand Fjord,	Contingent Valuation Method	WTP for improved water quality: (1) Locally, per household p.a.	NKR per household p.a.	NOK	1989	411	44.82
			(2) Locally, per taxpayer as a single payment	NKR per taxpayer as a single payment	NOK	1989	924	100.77
			(3) Nationally, per taxpayer as a single payment	NKR per taxpayer as a single payment	NOK	1989	635	69.25

EnValue Database (NSW, Australia)								
Source	**Country, Location**	**Valuation Method**	**Value Documented**	**Unit**	**Currency**	**Year**	**Value**	**EUR equivalent** (2017 April exchange rate)
Loomis (1987) in Young (1991)	USA, Mono Lake	Contingent Valuation Method	WTP for protection of the lake's ecosystem	USD per household	USD	1985	12.85	11.97
Sinden (1990b)	Australia, Victoria	Travel Cost Method	WTP for recreation at 24 sites along a river system: (1) Day visits	AUD per household p.a.	AUD	1989	22	15.73
			2) Camping visits		AUD	1989	37	26.45

1 EUR = 1.0737 USD 1 EUR = 9.1685 NOK 1 EUR = 1.3988 AUD

Source: EnValue Database (NSW, Australia)

Table 5-5: Exemplary valuation of water costs/ benefits extracted from the "EnValue" database

Table 5-6 reflects the WTP values used in this study assessment: The values are indicative. They have been selected based on expert judgement considering available data from other projects mentioned above and under the Annex 4-D. They have no claim of economic robustness under the benefit transfer approach:

Country	Lower WTP Value	Higher WTP Value
Austria	40 EUR/ person, year	180 EUR/ person, year
Bulgaria	40 EUR/ person, year	120 EUR/ person, year
Czech Republic	40 EUR/ person, year	120 EUR/ person, year
Croatia	40 EUR/ person, year	120 EUR/ person, year
Hungary	40 EUR/ person, year	120 EUR/ person, year
Romania	40 EUR/ person, year	120 EUR/ person, year
Slovenia	40 EUR/ person, year	120 EUR/ person, year
Slovakia	40 EUR/ person, year	120 EUR/ person, year

Source: Own considerations

Table 5-6: Range of willingness to pay (WTP) values for environmental/ social benefits of full UWWTD implementation

The economic costs estimation has undergone some simplification regarding the elimination of economic distortion, due to the absence of country data on which to base corrections. This includes the removal of taxes, subsidies and transfer payments. Future costs have been discounted using the discount rates according to the Annex III to EC guidelines regarding the implementation regulations on the application form and CBA methodology, for the programming period 2014-2020.

Figure 5-2 reflects the estimated cost and benefits. For most countries, the overall cost of implementing UWWTD is between the lower and higher range of the estimated benefits. Depending on how economic benefits are valued (lower or higher estimates), the implementation of UWWTD may or may not be justified in economic terms.

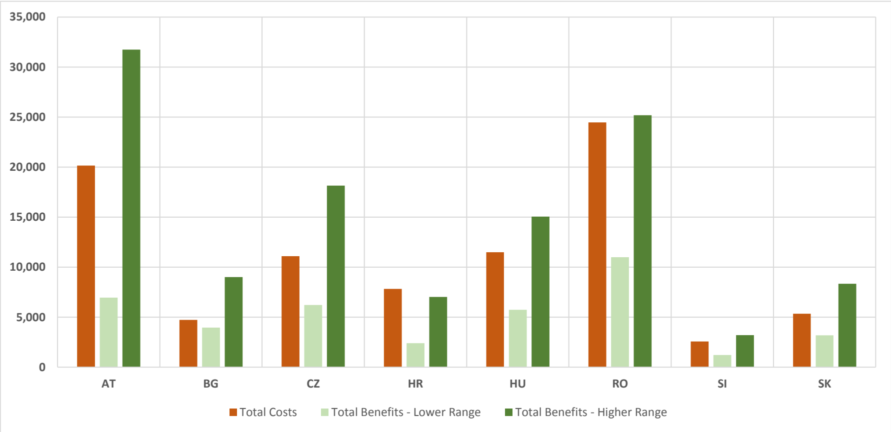


Figure 5-2: UWWTD related costs and benefits discounted (2015) per country for the period 2015-2040, Mio EUR

Table 5-7 provides the corresponding estimated economic indicators of UWWTD implementation in terms of economic ENPV[19] values and associated EIRR[20], B/C[21] for the lower and higher range of estimated benefits:

Indicators	Economic indicators at country level (2015-2040)							
	AT	BG	CZ	HR	HU	RO	SI	SK
ENPV (Lower Range)	-13,194	-775	-4,879	-5,434	-5,763	-13,476	-1,345	-2,162
ENPV (Higher Range)	11,598	4,277	7,053	-809	3,555	716	643	2,985
EIRR (Lower Range)								
EIRR (Higher Range)	n/a	34%	194%	-2%	33%	6%	18%	39%
B/C (Higher Range)	1.58	1.90	1.64	0.90	1.31	1.03	1.25	1.56

Table 5-7: Economic Indicators of the implementation of the UWWTD for the period 2015-2040

The corresponding data for the entire period 2000-2040 is shown in Figure 5-3 and in Table 5-8.

[19] The Economic Net Present Value (ENPV) corresponds to the discounted aggregated value of the economic costs and benefits of the investment made over the assessment period.
[20] The Economic Internal Rate of Return (EIRR) corresponds to the discount rate that yields an ENPV of zero. If positive, it is an indicator that the investment generates an economic surplus for the beneficiary population of the Danube region.
[21] The Benefit / Cost (B/C) ratio compares discounted cost and benefits over the assessment period. If it is above 1, the investment generate an economic surplus to the concerned society.

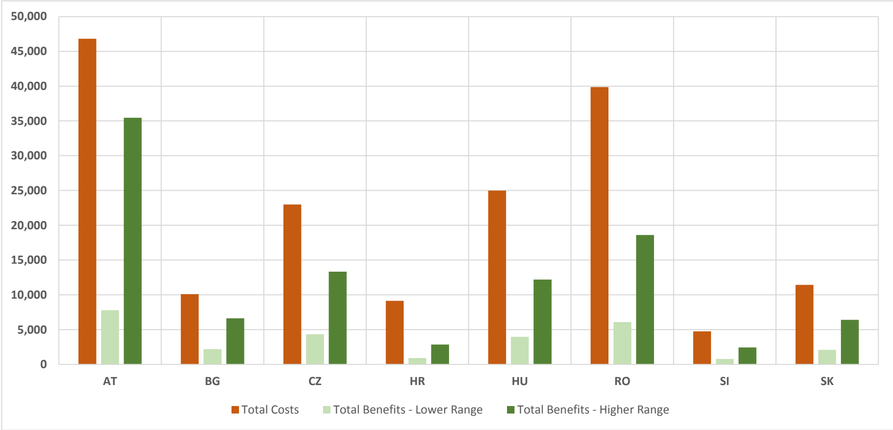


Figure 5-3: UWWTD related costs and benefits discounted (2015) per country in the period 2000-2040, Mio EUR

Indicators	Economic indicators at country level (2000-2040)							
	AT	BG	CZ	HR	HU	RO	SI	SK
ENPV (Lower Range)	-39,033	-7,915	-18,653	-8,232	-21,024	-33,793	-3,961	-9,339
ENPV (Higher Range)	-11,357	-3,476	-9,672	-6,306	-12,801	-21,274	-2,307	-5,023
EIRR (Higher Range)	3%	10%	6%	*	2%	3%	3%	5%
B/C (Higher Range)	0.76	0.66	0.58	0.31	0.49	0.47	0.52	0.56

Table 5-8: Economic Indicators of the implementation of the UWWTD for period 2000-2040

** No sensible value calculated, as HR joined the EU some ten years later than the other countries*

No significant economic surplus is apparent for the whole of the period 2000-2040, even when considering the higher range of estimated economic benefits. The ENPV remains slightly negative and the EIRR is only marginally positive (2 to 3 %) for most countries.

5.7 Findings

The main costs elements used in the assessment included investment, reinvestment, cost of capital and O&M costs estimated from EU reports. Administration costs were found to be poorly documented and difficult to extract from country accounts. On the plus side, the main components monetised are based on literature figures concerning health, environmental and social benefits. These implicitly include the potential improvement of the health of people due to good sanitation conditions, and an increase in the number of tourists and the revenue generated by recreational activity due to improved environmental conditions.

Economic activities generated by the construction of WW facilities, such as the number of jobs and added-value in terms of GDP growth, have not been quantified due to the absence of quantitative or monetised figures and data on which to base such an estimation.

Based on assessed evidence issued from available literature, studies and official reports from the EU the ICPDR and others, there is no compelling economic case for full compliance with the directive. There is also no compelling evidence that full compliance leads to sufficiently defensible economic benefits to the country or region that justify the costs incurred (slightly negative ENPV and marginally positive EIRR in Table 5-8 above).

The economic arguments to justify the implementation of UWWTD are currently tenuous in the eight countries of the Danube region. The absence of robust literature data or studies on the economic benefits of health, environmental and social aspects of UWWTD implementation in the Danube region makes it difficult at this point of time to justify the implementation of the UWWTD on purely monetized economic ground. This is not to say that the implementation of the UWWTD has no significant positive economic impact for the region. Imagine the Danube river economic situation today without all the investments made to control urban water pollution along the river. The difficulty is that there is a dearth of quantitative and monetized data and studies concerning various types of economic benefits. The full value of ecosystem services is possibly higher than currently embedded in the documented figures. The estimation of ecosystem services benefits in EU countries is still in its infancy and no set of meaningful data are currently available.

A more compelling economic argument for the implementation of the UWWTD may appear when more economic benefits are qualified, quantified and monetised in the DRB and when the full economic value of water related ecosystem services can be assessed and accounted for. In order to be able to build a more robust economic assessment of the benefits of the implementation of the UWWTD, more financially and economically relevant datasets need to be developed and monitored at both country and river basin level. This is one avenue for action recommended in the concluding chapter.

6 Conclusions and Recommendations

6.1 Conclusions

6.1.1 Impact of UWWTD implementation to surface water quality

As regards the impacts of UWWTD-implementation to surface water quality, the following conclusions can be drawn:

- Comprehensive information concerning surface water quality in the Danube region is available for the last 20 years. Data concerning urban wastewater treatment and emissions originating from agglomerations, according to the UWWTD, is only available at a comparable level from 2005/2006 onwards on a biennial basis. Data on the status and pressures of surface water bodies according to the WFD is accessible from a central database for the reference year 2009, with an up-date of information for the reference date 2015 expected to be available in 2018. The existence of the up-dated WFD-database will allow the investigation of trends relating to the status of surface water bodies and the link to improved wastewater treatment due to UWWTD-implementation in the near future.
- The status of surface water quality with regard to organic pollution and nutrients has improved over the last 20 year. For nearly all substances investigated, mean annual average concentrations as well as mean annual loads have been decreasing over the years.
- The UWWTD implementation and compliance assessment has shown some limitations in assessing the real situation as regards wastewater management and key issues to tackle. This has been partly addressed with the introduction of the distance to compliance concept which shows a significant part of the non-compliance is due to lack of performance of the treatment in place. Further investigations are needed to identify the main reasons for this: lack of adequate on-site monitoring system, lack of education, missing equipment, inadequate dimensioning of the system… Beyond the compliance assessment, technical data on the types of collecting and treatment systems implemented, their operation, maintenance and renewal are necessary to fine tune the assessment of the systems' performance and to link them with the financial data. The data collection process is now mature enough to allow an extension towards such data which are also relevant for national authorities. A joint exercise involving all countries to define the minimum necessary dataset, as was already implemented for collecting financial data for Article 17 of UWWTD, is certainly the most efficient approach.
- The proportion of correctly treated wastewater in the DRB is increasing. At the same time emissions of organic pollutants and nutrients from agglomerations are decreasing.
- The key emitters of organic pollution into the aquatic environment are point sources. Because emissions from agglomerations represent the majority of point sources (compared to industrial and agricultural point sources), the implementation of the UWWTD is significantly contributing to improved surface water quality.
- With regard to nutrient pollution source apportionment, MONERIS has revealed that, among point sources, urban wastewater management is partially responsible for the discharge of Ntot and Ptot emissions into the Danube. The implementation of the UWWTD is contributing to the improvement of surface water quality.
- However, other emission sources, in particular diffuse sources, have a major role in the emission and discharge of nutrients into the aquatic environment and also need to

be considered in the assessment of impacts on surface water quality. Agriculture has a prominent role in this by using a large share of the soil in the basin.

- The EU is currently promoting green infrastructure, in particular in the water field with Natural Water Retention Measures, which will lead to an adapted management of rainwater in the city. This is expected to have also an influence and to help improve wastewater management, as most agglomerations are using combined sewer, so this will reduce the amount of rainwater entering the sewer networks.

6.1.2 Financial Sustainability of UWWTD Implementation

The following aspects are important for the financial sustainability of the implementation of UWWTD in the Danube Region:

- High-quality financial planning, analysis and reporting on the implementation of UWWTD should be based on officially endorsed, reliable and comparable financial data across the Danube countries. The essential datasets are the total and annual investment and reinvestment costs, annual operation and maintenance costs, tariffs and collected, treated and billed WW quantities, as well as the total collected revenue of the wastewater services. Funding sources, total and annual EU co-financing amounts, subsidies from central and local governments, as well as own equity contribution by the service providers are also crucial. According to the study findings, these data are not systematically available in all Danube countries in an uniform and transparent way. The assessment of the achievement of the objectives of the WFD can only be documented credibly if technical data are supported by robust financial information.
- Monitoring of the financial sustainability of wastewater services is crucial to water quality in receiving waters. The expensive wastewater infrastructure created so far – and that which is still being developed in the countries along the Danube in order to achieve full compliance – has resulted in a noticeable improvement in the Danube's water quality. This positive impact can only be preserved and further enhanced if service quality levels are sustained. This requires the costs of operation, maintenance and renewal to be covered by the revenues of the service providers in the long term. As long as system operation and reinvestment are not financially sustainable, there is very real risk of a decline in service quality and a deterioration of the quality of discharges into receiving waters. Inadequate full financial sustainability of UWWTD investment will lead to a deteriorating water quality in the Danube River.
- Most of the agglomerations of the seven countries have already received or will still receive significant EU-grant support for UWWTD investments.. Some future funding gaps are anticipated between revenues and the costs of wastewater utilities. Other financial sources need to be mobilised.
- The main obstacle to high-quality planning, analysis and reporting on the implementation of UWWTD is the lack of adequate, reliable and comparable technical and financial data within the Danube countries. These data should refer to the coherent and complete time span across all countries and be approved by national authorities. As a first step, it seems meaningful to collect and organise such a database which should include primarily the data discussed or estimated in chapters 3 and 4 of this study. The objectives of the WFD can only be realised if the technical data are supported by robust financial information.

6.1.3 Economic Assessment of the UWWTD implementation

The following points are of significance:

- The eight target countries in the Danube region have so far given little thought and made minimum effort to justify the implementation of the UWWTD from an economic perspective at the national macro level. Justification was limited to the CBA developed for individual investment projects. The prevailing driver for investment seems to be the need for regulatory compliance under the EU directives. The lack of economic justification may explain some delay of implementation observed in several countries.
- The cost / benefit of ecosystem services are currently not being adequately addressed and assessed in the Danube region, although they may represent the most significant source of economic value to justify UWWTD implementation. The economic benefits of water-related ecosystem services have been defined as (i) regulating services, (ii) provisioning services with no commercial value, (iii) provisioning services with commercial value, and (iv) cultural services. Realistically, they are only vaguely quantified due to the novelty of the international R&D development efforts carried out so far in this context. Currently documented economic benefits of ecosystem services found in the literature may be widely underestimated.
- According to the literature data reviewed, the environmental and social benefits of good water quality are at a larger order of magnitude than health benefits (multiplier between 10 to 30).
- The estimation of the economic effectiveness of the costs of UWWTD implementation in the eight countries of this study seems to be comparable to corresponding costs in other developed countries. The study yields costs in the range of 75 EUR/PE BOD, year, 76 EUR/PE COD, year, 35 EUR/PE TN, year and 14 EUR/PE TP, year. These values are similar to numbers found in a recent (2015) USEPA report, which reflects the annual costs of treating Total Nitrogen and Total Phosphorus in WWTP in the USA.

6.2 Recommendations

The following recommendations can be drawn from the assessment developed in this study:

6.2.1 Impact of UWWTD implementation to water quality

- A key prerequisite for assessing the influence of UWWTD implementation on surface water quality is the availability of a **consistent and comprehensive database** for wastewater infrastructure, emissions from UWWTPs, surface water quality and water discharge. For wastewater infrastructure and water quality this is already the case, while for emissions, the situation needs to be improved. Consistent data on water flow at EU level, with a satisfactory level of detail, is not yet available. This is impeding the calculation of river loads of pollutants along the hydrosystem crossing with emissions from different sources. Hence, the available data collections should be complemented with a **database on water discharge** (see section 3.2). Recent efforts towards water accounts seem to be heading in this direction.
- **Data models** (MONERIS, PEGASE and others), which assess the different pollutant pathways into the aquatic environment, need to be set up and applied in the countries' river basins in order to **better quantify individual pressures** (diffuse sources, such as agriculture, versus point sources like UWWTP).
- With regard to wastewater management, wastewater is largely collected in urban areas but not treated everywhere. Beyond the implementation of dedicated treatment

systems with secondary and more stringent treatment, which is often under progressive implementation, it is recommended that organic and nutrient pollution is further reduced by specific attention to leakages and combined sewer overflows and to specific local conditions, in particular in touristic areas where the wastewater volume can vary a lot and be significant in some periods. For smaller urban areas, statistics on household equipment should be used to anticipate the volumes and customise the approach: advice on low technical and resilient collective systems or optionally for IAS. Priority needs to be given to the biggest agglomerations (above 10,000 PE) with the view that the improvement of large emission sources will reveal and make the share of emissions from smaller sources more important in the final balance. Long term planning will be required to achieve these objectives.

- MONERIS evaluations have shown that urban wastewater management is only partially responsible for nutrient input into the aquatic environment. The following measures therefore need to be implemented in the participating countries:
  - a reduction of nitrogen (and phosphorus) pollution of ground and surface waters by **better management of nutrients** in agriculture (animal manure and fertilisers) through the implementation of the EU Nitrates Directive;
  - ensuring sustainable agricultural production and soil nutrient balances (nitrogen, phosphorus) and further reduction of diffuse nutrient pollution by the implementation of basic and cost-efficient supplementary **agri-environmental measures** linked to the EU Common Agricultural Policy;
  - **a further decrease in phosphorus emissions** by implementation of the EU regulation on phosphate-free detergents and a reduction of phosphates in detergent products;
  - the use of **emission inventories** and regular reviews or similar tools to follow progress in pollution emission.

6.2.2 Financial Sustainability of UWWTD Implementation

- Several countries are failing to fulfil the infrastructural requirements of UWWTD due to limited **administrative capacity and resources for investment**. This is compounded by low tariff application. This constraint need to be addressed at both country and EU level;
- Financing gaps between tariff revenues and total costs of wastewater services already exist in several countries of the study and are expected to widen further in new EU MSs with increasing advancement toward full UWWTD compliance. Should EU grants for UWWTD investment cease around 2027, the financing gap for remaining investment and reinvestment will only be bridgeable with commercial loans. This will require governments to facilitate the **establishment of financially viable water utilities**;
- Promoting **greater public transparency** of the wastewater service needs, costs, systems performance and of their impact to the environment. This could be achieved through publication of data and reports, which allow better comparison of service costs and quality between utilities, improve confidence of customers in the services provided and their acceptance for tariff increase when needed.
- Reforms need to be launched as soon as possible in each new MS to **enable water utilities / municipalities to become creditworthy**. The financial position of operators / owners ought to be characterised by transparency, accountability and autonomy. It is only after these qualities become prevalent, that finance from the national or international financial market will be mobilizable by wastewater utilities.
- The regulatory and legal framework for **water / wastewater tariff setting needs to be modernised and strengthened**, so that a reasonable TCR ratio for wastewater services can be achieved by water utilities, while remaining affordable for users;

- **The tax system in some countries may need to be upgraded** to ensure that taxes do not unduly burden water / wastewater utilities, which are providing an essential social and economic service.
- A key experience of the study is the lack of availability of accurate data. Given the high cost of UWWTD implementation, the relatively low cost of information systems, and the risk of failing sustainability of compliance in the longer term, it would be appropriate to set up and permanently update a comprehensive, coherent and transparent **database** at national level which then could be used for the national assessments and provide further data to other levels like ICPDR, EU or others. A coordinated approach between all countries would help to limit the burden and extend the possible use of such database.

6.2.3 Economic Assessment of the UWWTD implementation

The following actions should be considered in the countries of the Danube region to improve the capacity to document the economic values of the implementation of the UWWTD:

- Developing of **national databases linking water quality to economic costs and benefits** (see Annex 4.E for a model database matrix).
- Creating and keeping country and RB based datasets for costs and benefits values updated, focusing on a limited number of the most significant elements. These include i.a. (i) irrigated agriculture, (ii) tourism and recreation, (iii) commercial fishing, (iv) property values, (v) human health, (vi) drinking water investment costs.
- **Developing value transfer functions** applicable within a river basin: This allows the transformation of economic values from one site to others that have some common features. The value transfer approach is a useful tool that has been indicatively applied in this study. Developed with greater economic rigour and robustness, it would allow the estimation of reasonably credible economic values within a river basin, without having to rely on extremely resources-intensive economic valuation techniques such as the stated or revealed preference methods. Developing such functions could help reduce the risks of error and uncertainty of expressed costs and benefits within a river basin. Functions could be developed at various level such as (i) unit value transfer datasets, (ii) adjusted unit value datasets functions integrating new site characteristics such as income, population concerned, etc., (iii) value transfer function integrating various parameters (population, average income, etc.), and (iv) meta-analytic function transfer that documents values or demand functions extracted from several site studies that can be applied to new sites parameters.
- Speeding up R&D and the application of **estimating the economic values of ecosystem service benefits**. Eco-system services are the benefits that people obtain from protecting the ecosystems. Improving the water quality of water resources through forceful implementation of the UWWTD can create or sustain the welfare and livelihoods of the population concerned. According to the widely used classification developed by the Millennium Ecosystem Assessment (2005), the main eco-system services can be categorised in four groups: (i) provisioning services, (ii) regulating services, (iii) cultural services, and (iv) supporting services.

The following recommendations may be appropriate for the **EU candidate countries**:

- The implementation of the UWWTD represents a substantial investment and needs to be **planned well in advance** and staged in time to be able to mobilise financial resources at the lowest costs.
- WWTPs are an expensive investment, even more so when advanced treatments required under UWWTD guidelines become necessary in **sensitive areas**. Candidate countries should invest in science-based studies (to define areas to be officially

declared as sensitive areas) early and well in advance of accession negotiations with EC services.

- Engineered concrete-based WWTP solutions at primary, secondary and tertiary level tend to have considerable O&M costs. Recent R&D across the EU has demonstrated that extensive **“nature near” ecological WWTP solutions** (constructed wetlands or lagoons) have significantly lower O&M costs. They can also enhance pollution reduction. In certain cases, such solutions can even be practical for agglomerations above 2000 PE, if the discharged wastewater is compliant with the UWWTD. Such systems may also integrate crops or woodland elements that generate revenues and thus further reduce WWTP costs.

6.3 Further investigations proposed

6.3.1 Provide the most recent picture of water quality in the DRB by using data reported under WFD:

- Information on the ecological status of surface water bodies, as well as the pressures and impacts, in accordance with the WFD, are available in the WISE WFD database for the 1st RBMP (reference year 2009). The respective datasets for the 2nd RBMP (reference year 2015) are currently being compiled and will be made publically available in a central database. As soon as these datasets are publically available, the ecological status of surface water bodies reported in the 1st and the 2nd RBMP can be compared and related to the latest developments regarding UWWTD-implementation.

6.3.2 Explore the available information on wastewater collection and treatment techniques, including IAS in the DRB:

- Identify key techniques employed and their strengths and weaknesses concerning net discharge and pollution along with potential management issues.
- Identify key technical guidance for wastewater infrastructures dimensioning used in the region (French water guide; ATV *Abwassertechnische Vereinigung - Association for Technical Wastewater Management*, and others), to ascertain whether this has an impact on the size of infrastructures, which may partially explain poor performance.
- Propose a data collection factsheet to organize specific gathering/sharing of a common DRB dataset to improve comparability throughout the basin, and feed national information platform or a regular DRB overview.

6.3.3 Address priority substances as an emerging issue linked to wastewater discharges:

- Beyond the parameters covered by UWWTD, wastewater contains a wide set of polluting substances. Some *priority substances* identified under EU legislation are requiring further attention. While industrial emissions and substances embedded in products are covered by other EU legislation, domestic wastewater can contain priority substances stemming from the use of (domestic) products. Long term emission data models for priority substances (similar to nutrient emission models, like MONERIS) should be introduced and developed in the Danube region.

6.3.4 Address the issue of inadequate creditworthiness of water utilities to enable market based funding sources for the future in the Danube region:

- Assessment of the financial sustainability situation of representative wastewater utilities (best and worse in class in each country).

- Identification of underlying causes for weak sustainability (tariff setting, tariff level, customers' affordability limit, regulatory requirement imposed on utilities (taxes, etc.)
- Recommendations for alternative ways and means to improve the financial sustainability of wastewater utilities (legal, regulatory, institutional, technical, etc.)

6.3.5 Provide guidance and support for countries in the Danube region:

- How to better document the overall cost of implementing UWWTD (investment, O&M, administrative costs) and
- How to build a database for the most significant economic, environmental and social costs and benefits of UWWTD implementation.

6.3.6 Develop and document - qualitatively, quantitatively and in monetized terms - standards for UWWTD-related economic benefits:

- These standards could be systematically applied in CBA studies, which are attached to project feasibility studies in order to justify an economic return of UWWTD investments.

7 Literature

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