"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

Annex to Final Study Report

30 September 2017

Satellite map of Piatra Neamt WWTP (105,000 inhab.), Romania © 2017, Google

Activated sludge basin of Veliko Tarnovo WWTP (> 50.000 inhab.), Bulgaria © Nicolas Jeanmaire, OIEau

ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

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1.1 General overview of the 16 countries

1.1.1 Short information on ALB, FYROM, MNE, RS, BiH, Kos, UA and MLD

For the eight countries belonging to central, eastern and south-eastern Europe, the situation in terms of urban population and wastewater management is detailed below:

In Albania 55% of the population live in urban areas and more than 84% have wastewater collection, whereas the rural population has a very low collection level (13%). Wastewater treatment is very limited with only 13% of the population connected to four treatment plants.

In Bosnia and Herzegovina 39% of the population live in urban areas and even the largest agglomerations have no treatment plants. Only eight treatment plants have been reported to Eurostat.

In Kosovo 39% of the population live in urban areas and 53% of the population have wastewater collection but only 1% is treated in two treatment plants.

In Macedonia 57% of the population live in urban areas and 86% of the population have wastewater collection but only 13% is treated in nine treatment plants.

In Moldova 45% of the population live in urban areas but only 50% have wastewater collection with a big difference between the capital (80%) and the other cities and only 5% in rural areas. On average 38% of the population are connected to sewers and 124 treatment plants and 24% of the population have wastewater treatment.

In Montenegro 64% of the population live in urban areas and the wastewater of 43% of the population is collected. The wastewater of only 18% of the population is treated in four treatment plants.

In Serbia 55% of the population live in urban areas but 27% live in small agglomerations with no treatment plants. Wastewater of most of the larger cities is discharged without treatment. There exist only 50 wastewater treatment plants.

Ukraine is a large country with 69% of the population living in urban areas, with 73% of wastewater collected and 37% treated in 3,093 plants. These are mostly in bad condition with 87% needing a complete overhaul.

1.1.2 Detailed overview of AT, CZ, SK, HU, SI, HR, RO, BG

For the eight EU Member States of central, eastern and south-eastern Europe the trends in wastewater treatment as reported by the countries and commented on in the main document are illustrated for each country in the following:

Austria

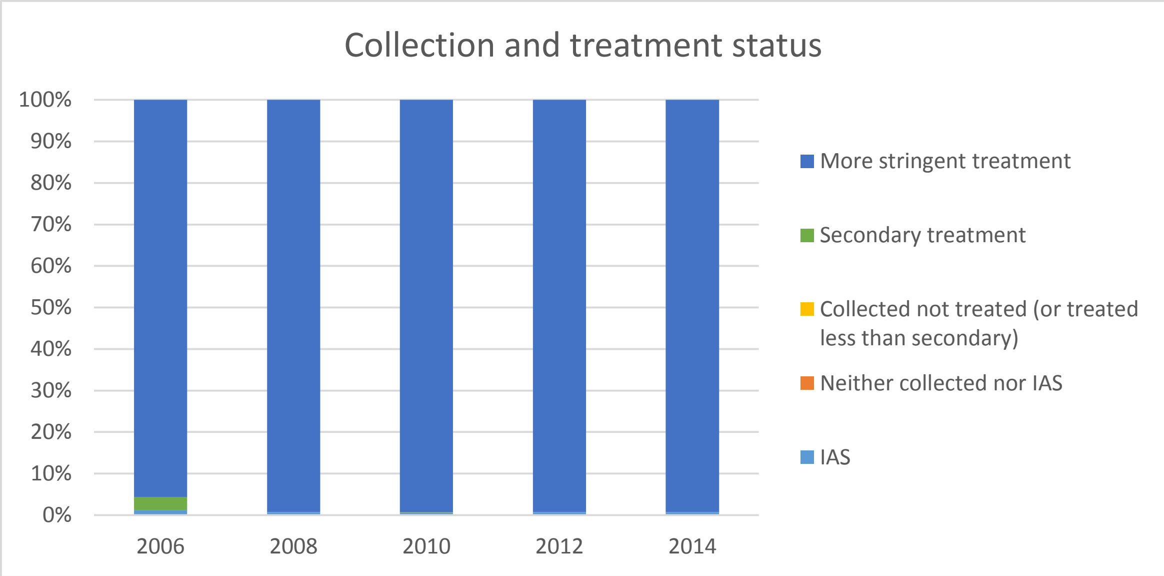


Figure 1-1: Load destination in percentage, based on the total generated load in Austria (Source: EU implementation reports).

Bulgaria

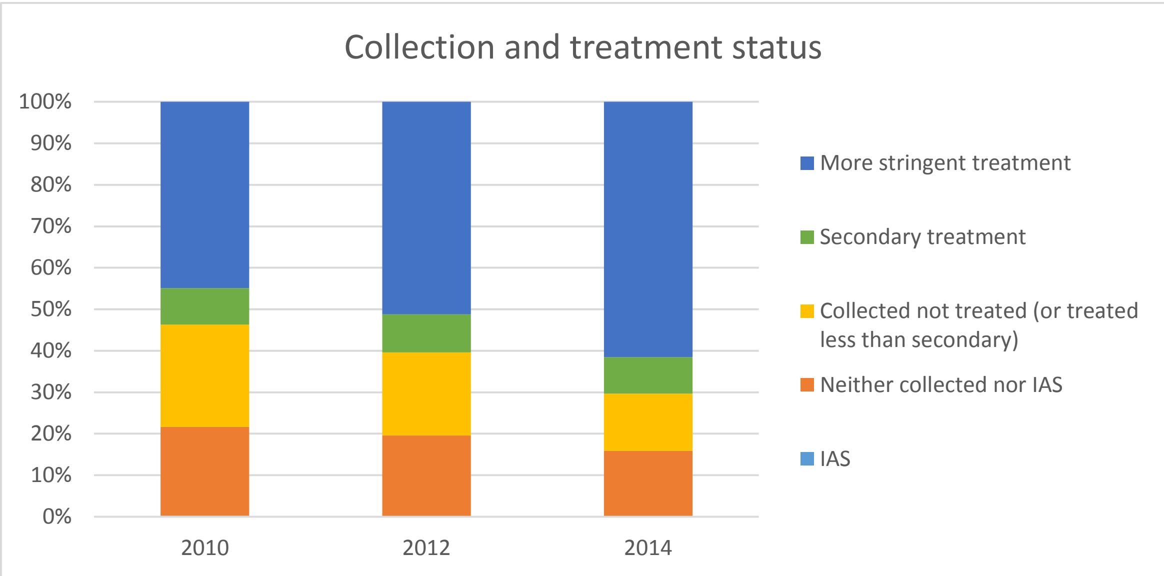


Figure 1-2: Load destination in percentage, based on the total generated load in Bulgaria (Source: EU implementation reports).

Czech Republic

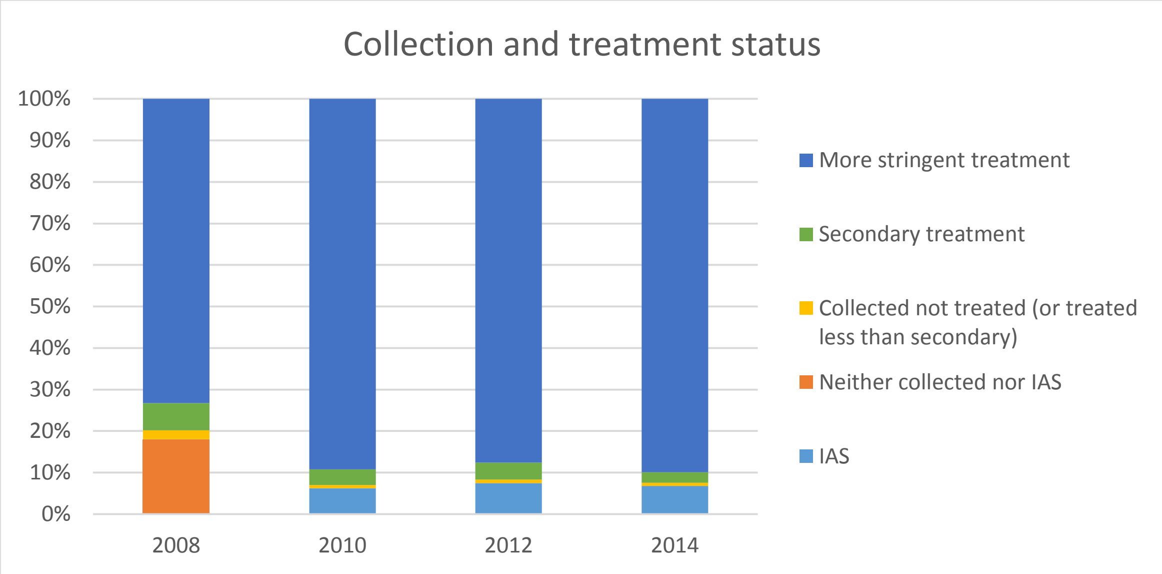


Figure 1-3: Load destination in percentage, based on the total generated load in the Czech Republic (Source: EU implementation reports).

Croatia

Croatia joined the EU in July 2013, and currently the country is not required to provide any data on the situation of its wastewater sector and treatment under the UWWTD, therefore no trend can be presented.

Hungary

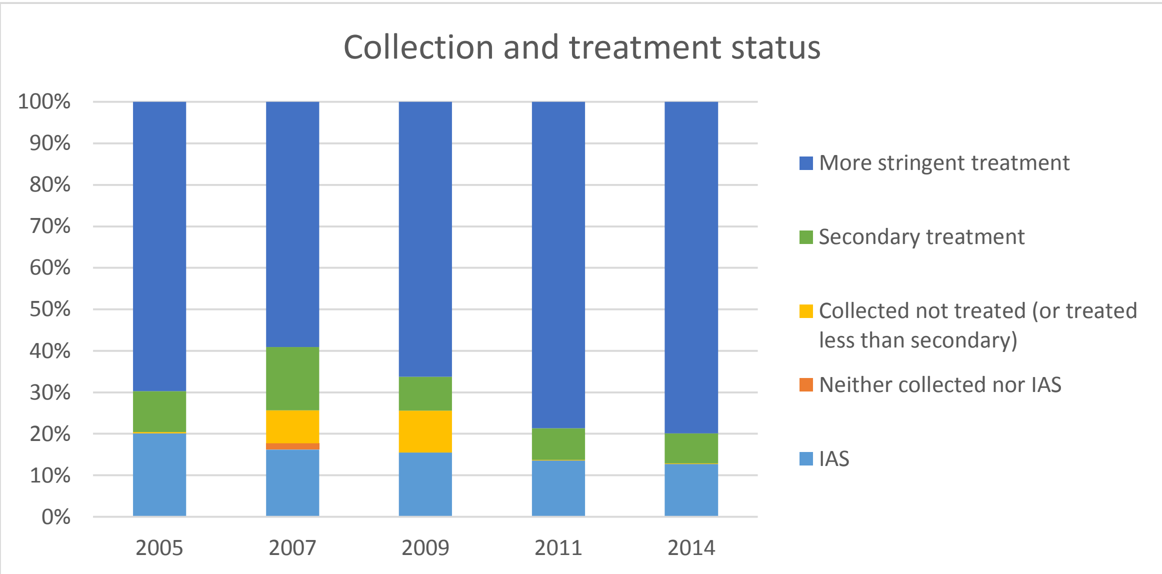


Figure 1-4: Load destination in percentage, based on the total generated load in Hungary (Source: EU implementation reports).

Romania

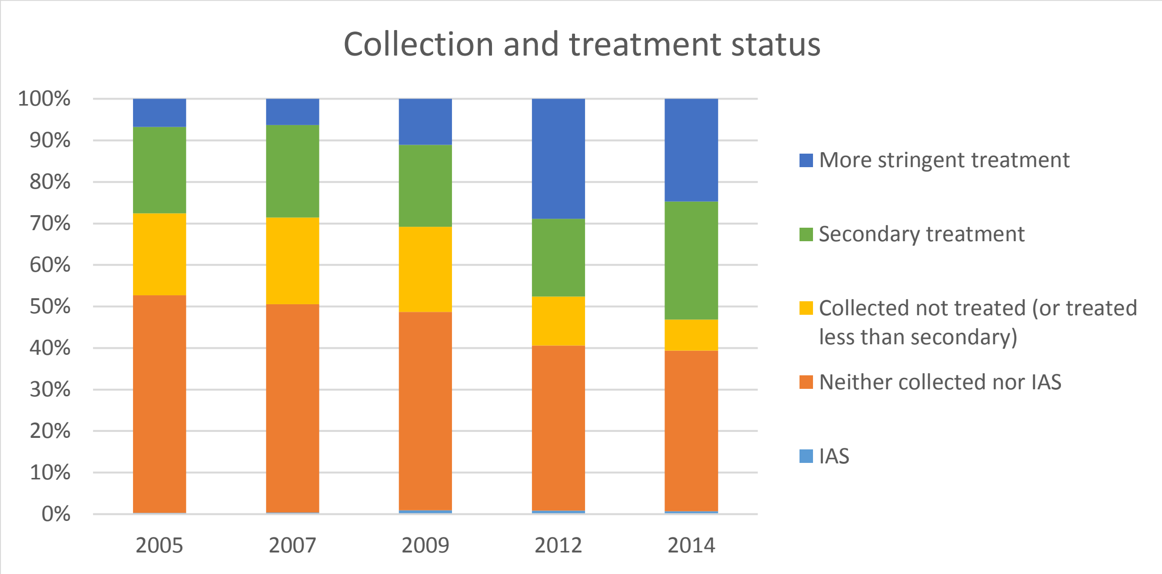


Figure 1-5: Load destination in percentage, based on the total generated load in Romania (Source: EU implementation reports).

Slovenia

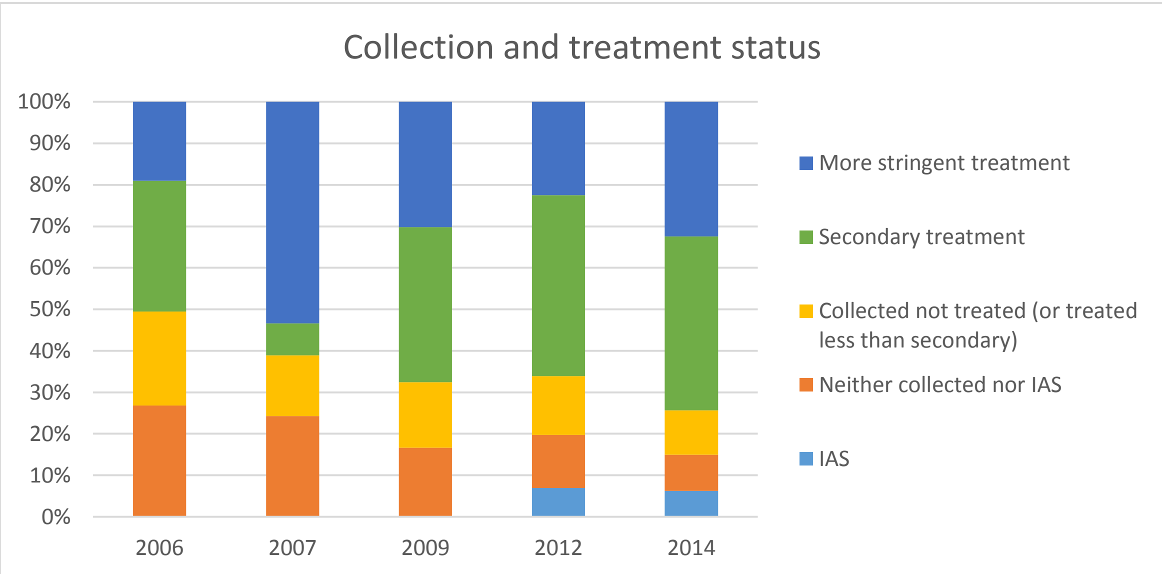


Figure 1-6: Load destination in percentage, based on the total generated load in Slovenia (Source: EU implementation reports).

Slovakia

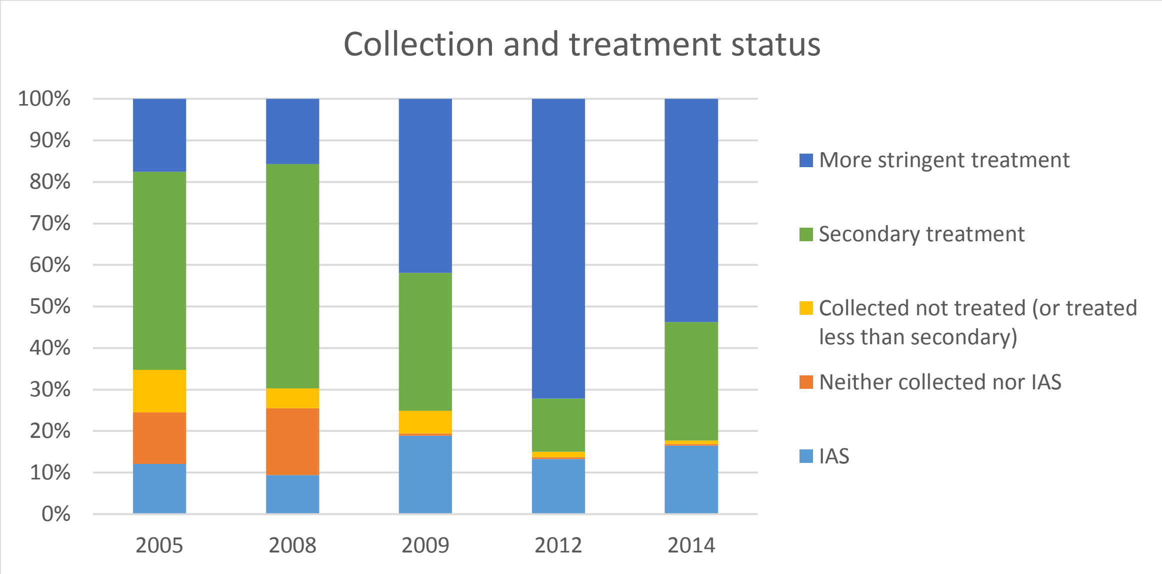


Figure 1-7: Load destination in percentage, based on the total generated load in Slovakia (Source: EU implementation reports).

1.2 UWWTD Status of implementation and compliance in Europe

This part provides additional details on the status of UWWTD implementation in the EU Member States in the Danube River Basin covered by the current study.

Every second year since 1994, EU Member States have been obliged to report the status of implementation of the UWWTD for their country. This report covers a detailed description of the situation by agglomeration (under Article 15), a summary of the situation for the country (under Article 16) and the investment planned for the future (under Article 17). For the detailed situation report, Member States have to report a standardised dataset describing the situation of urban wastewater collection and treatment. All datasets are analysed by the European Commission in order to obtain national and European overviews of the urban wastewater situation. The situation is assessed with regard to compliance on the level of treatment and the performance as reported by countries, within the UWWTD deadlines and considering the various thresholds and specific local conditions, in particular sensitive areas requiring more stringent treatment. Out of the eight Member States in the study seven joined the EU recently and therefore have specific implementation deadlines (transitional periods).

Note: Implementation report analyses are based on a limited set of data with e.g. no information on the specific technologies used for treatment and little and non-mandatory information on wastewater loads. Data regarding treatment installations and their performance rely on the prerequisite that the country has implemented the necessary quality controls to ensure good quality monitoring. Information on the generated wastewater and associated conversion to Population Equivalent (PE), and information on sewer networks and their performance including storm water overflows is limited, whereas they are an important component in the calculation of the final performance. They are also highly relevant for a complete overview of the wastewater discharges into the aquatic environment.

The implementation report targets rather the question whether the requirements of the Directive are fulfilled than the protection of the aquatic environment from the adverse effects of wastewater discharge which is the primary objective of the Directive. The implementation report is published three to four years after the data was originally produced due to the processes of data collection and validation. To tackle this, the EU has developed a new approach to make data available more rapidly and ease the assessment: the UWWTD Structured Implementation and Information Framework.

In addition, some requirements set out by the Directive are very restrictive like for instance less than 1% loss during transport to consider the collection system compliant. This pushes, countries to over-interpret the rules to avoid being mostly non- compliant.

The last reporting process (the 9^{th}) took place from January to June 2016, the reference year of the reported data being 2014. The assessment was conducted in autumn, and the final draft report was presented to MS representatives in May 2017 and ready for publication by the European Commission in September 2017.

The UWWTD addresses urban wastewater either directly produced by humans for their everyday care or by the food industry, or produced by activities generating similar wastewater like services. All other wastewater is to be either pre-treated before discharge in the sewer or treated separately.

Population Equivalent (PE) is a standard indicator representing the pollution of one inhabitant per day. It is used to define wastewater quantities collected and treated, which are then are used to define the size of sewers and treatment plants. In section 1.2, the large cities cited have treatment plants treating on average far more PE than the number of inhabitants. This means that the individual sizes of agglomerations represent both the inhabitants of the area and the economic activity discharging their wastewater in the sewer. In general, the larger the city, the larger is the share of wastewater generated by economic activities.

Wastewater discharge and sensitive areas

For the designation of sensitive areas, Member States have two options:

- they can designate individual sensitive areas and their relevant catchments using Article 5(1) of the Directive (e.g. Croatia, Hungary, Bulgaria, Slovenia, Slovakia[1]);
- they can avoid this designation by considering the whole country as one sensitive area based on Article 5(8) of the Directive (e.g. Austria, Romania, Czech Republic).

For each sensitive area (regardless of whether Article 5(1) or Article 5(8) of the Directive has been applied for designation) the MS can choose how compliance to Directive requirements regarding the agglomerations relevant to Article 5 (i.e. agglomerations above 10,000 PE discharging their wastewaters into a sensitive area) is achieved:

- for each agglomeration individually, by checking the installations and their performances. This is the most common way to proceed, using Article 5(2) and Article 5(3) (known as Article 5(2,3)) of the Directive (e.g. applies in the Danube region to Hungary, Slovenia, Slovakia, Romania, Czech Republic, and Bulgaria);
- skip the individual compliance assessment if the N_{tot} and/or P_{tot} removal rate is sufficient[2] on the sensitive area level, and all the relevant agglomerations will be

[1] Slovakia is a particular case as it used Article 5(1) to designate its whole territory as one sensitive area.

considered compliant[3] (e.g. Austria). This can be done using Article 5(4) of the Directive.

Application of Article 5(4) is specific to each sensitive area. A MS can apply Article 5(4) for some of its sensitive areas and Article 5(2,3) for the others (there is no such example in the DRB).

Figure 10 shows the different existing areas and their locations. Almost 76% of the territory of the European Union has been designated as sensitive area or catchment of sensitive area or Art. 5(8) is applied.

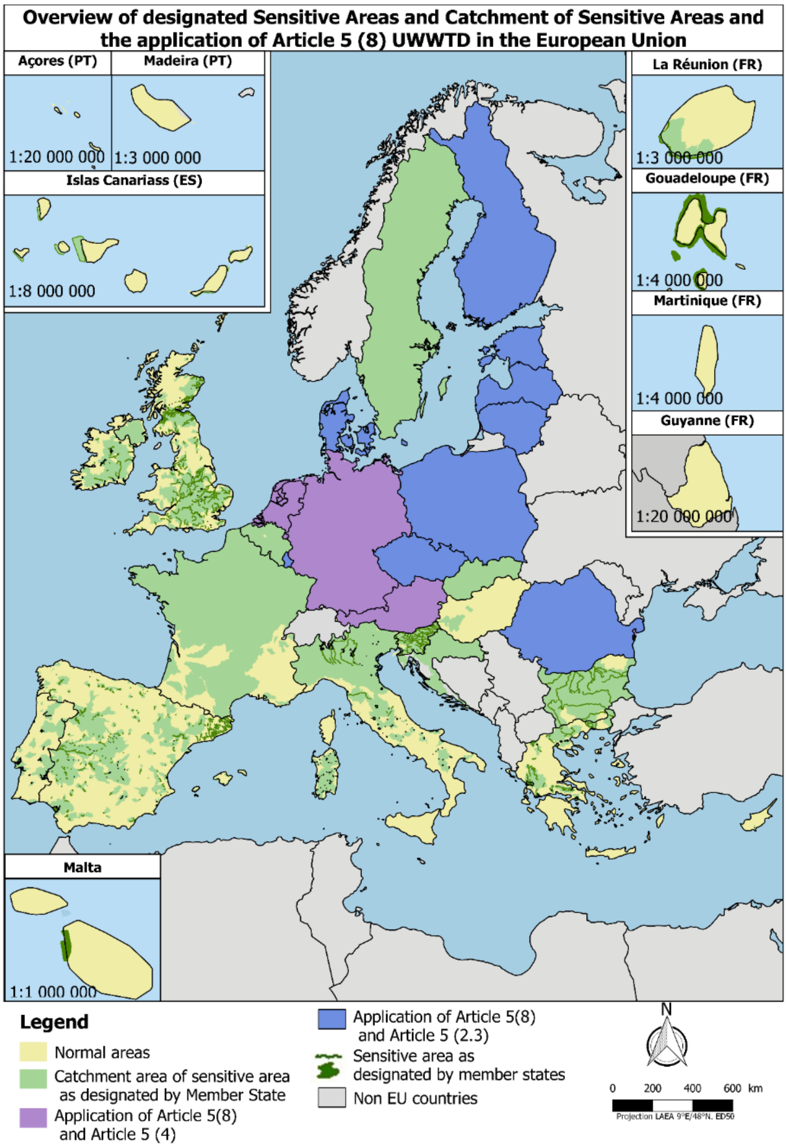


Figure 1-8: Overview of sensitive areas and catchments of sensitive areas and the application of Article 5(8) of the UWWTD in EU-28 as reported by EU Member States (Source: 9th implementation report, to be published).

[2] A "sufficient" removal rate in a sensitive area applying Art 5 (4) is achieved if the reduction of the overall load entering all urban waste water treatment plants in that area is at least 75 % for total phosphorus and at least 75 % for total nitrogen.

To cope with the progressive enlargement of the EU, and as the three main Articles (3, 4 and 5) of the Directive define the collection and treatment, some agglomerations can benefit from extended deadlines to implement the requirements of the Directive. These agglomerations will be considered as not relevant regarding a specific Article, as long as the deadline is still pending.

As a consequence some Articles of the Directive are not relevant for individual agglomerations either because of pending transition deadlines or because the agglomeration does not qualify for the application of single Articles (i.e. agglomerations below 10,000 PE are not relevant regarding Article 5).

Compliance assessment

As stated in the main report, Compliance assessment is done at the agglomeration level, considering collection (Art. 3), secondary treatment (Art. 4) and tertiary treatment (Art. 5). In addition hierarchic compliance is required: it is not possible to be compliant for treatment and not for collection.

This means that the whole agglomeration will be not compliant, even if part of the load is collected/ treated in line with the Directive. However, it is accepted if a small part of the load does not fulfil the requirements of the Directive if this does not exceed 2% (in some cases 1%) of the agglomeration's load and represents less than 2,000 PE.

The different requirements regarding the compliance assessment lead to the establishment of different "target loads" (i.e. load relevant to an Article) depending on the Article, and as a consequence to different compliance rates. In Figure 4 of the report percentages are related to the generated load, and therefore do not represent a "compliance rate", as they are not based on the target load.

It can be noticed that the percentage of the target load for Article 5 is quite the same for EU15 (61.5%) and EU13 (56.6%), while the difference is quite important for Article 3 (100% for EU15 and 86% for EU13) and Article 4 (97% for EU15 and 72.5% for EU13). This situation can be explained by the fact that the deadlines regarding agglomerations above 10,000 PE. have already expired, while for smaller agglomerations, there are still pending deadlines. This difference highlights the fact that Europe focuses its efforts on the largest agglomerations, in order to efficiently reduce the pressures on the receiving water bodies.

In the long-term, and after deadline expiration, the percentage of the target load for EU13 should meet that of EU15. Indeed, the EU15 group has very few agglomerations under pending deadline, and has a stable situation regarding the implementation of the Directive, the last deadline having expired more than ten years ago, in 2005.

It can be noted that the compliance rates regarding the EU13 group are similar for Articles 3 and 4, but quite lower for Article 5. To achieve compliance with Art. 5 is more difficult than compliance with Art. 4,, especially in terms of performance of the existing installations.

It is important to note that PT, SE, ES and UK do not report the investments related to the renewal of existing infrastructures which is necessary to stay in compliance with the Directive. Hence, investments of these Member States and of the EU15 are under-estimated.

2. Annex 2: Effects of UWWTD implementation on water quality status

2.1 Introduction

This chapter addresses the question *"What have been the results of UWWT Directive implementation in water quality status?"*

It attempts to provide answers to the following sub-sections:

1) **Sub-question 1:** *What are the dominant trends and what has been the current status of surface water quality in the Danube River Basin over the past 25 years*[4]*? This study is focused on quality of surface water, or the "receiving water bodies", and not on groundwater quality.*

2) **Sub-question 2:** *Does the existing data enable us to calculate emissions and river loads related to WWTPs and their changes over time? What is the impact of wastewater treatment on river water quality? With how much confidence and at what scale can we attribute changes in water quality in countries and in sub-basins to the construction and operation of wastewater treatment plants in compliance with UWWTD? How much can we say the UWWTD has worked in moving the needle towards the overarching environmental objectives of the WFD?*

3) **Sub-question 3:** *What is the current level of implementation of the UWWTD (in EU Member Countries in the DRB, available in the 8th report of implementation of the UWWD)? In cases where faster rates of implementation have occurred, what has been the impact on water quality? On-time implementation is defined as the implementation of the harmonization schedule in the manner and in the timeframe in which it was agreed. Faster and slower implementation are defined as the extent to which a country exceeds or deviates from its own established harmonization schedule.*

4) **Sub-question 4:** *To what extent can changes in surface water quality be attributed to urban wastewater treatment as opposed to reduced industrial pollution or decreased nutrient pollution from agriculture? Do the data on emissions enable us to estimate source apportionment?*

5) **Sub-question 5:** *What are the lessons learnt regarding the UWWTD impact on water quality?*

2.2 Data sources for this study

For the assessment of the dominant trends and the current status of surface water quality in the Danube region over the past 25 years, the databases and publications of the ICPDR, the

[4] The UWWTD dates from 1991 in its earliest version, Council Directive 91/271/EEC (21 May 1991), although it has since been amended a few times (notably in 1998 and in 2014), so 25 years is an appropriate timeframe for a retrospective review.

EEA and the EC (DG ENV and Eurostat) are of main importance. Further information can also be obtained from regular reporting under the UWWTD[5], the WFD and the E-PRTR[6].

Data on **water quality aspects** is available from the following data sources:

- ICPDR Trans National Monitoring Network (TNMN)[7]: Since 1996 the ICPDR is operating this network which aims at providing a well-balanced overall view of pollution and long-term trends in water quality and pollution loads in the major rivers in the Danube River Basin. While the TNMN-database[8] contains detailed information as regards concentrations (e.g. in mg/l) of pollutants at monitoring stations, information on hydrometric data (water discharge) is more scarce and not available for all relevant monitoring stations. Therefore, the calculation of river loads (t/a) is not possible for all monitoring stations.
- EEA Waterbase - Water quality[9]: covers information on the status and quality of Europe's rivers, lakes, groundwater bodies and transitional, coastal and marine waters at the EU-level. For the time period from 1960 to date this database contains time series of nutrients, organic matter, hazardous substances and other chemicals in rivers, lakes and groundwater, as well as data on biological quality elements such as phytobenthos and macroinvertebrates in rivers and lakes. Hydrometric data (information on water discharge) is not included in this database.

Data on the **status of urban wastewater infrastructure**, the **level of UWWTD-implementation** and **emissions from urban settlements/agglomerations**, is available from the following data sources:

- ICPDR Urban Waste Water Inventory: covers emissions (t/a) of BOD_5, COD, N_{tot} and P_{tot} from agglomerations ≥ 2,000 PE in the Danube region (data available for the reference years 2005/2006 and 2011/2012 and presented in the 1st and 2nd DRBMP);
- UWWTD reporting under Art. 15 (TA-UWWTD): covers information about agglomerations ≥ 2,000 PE in EU28 Member States and UWWTPs serving these agglomerations. Data on emissions is provided on voluntary basis and therefore only available for some of agglomerations;
- Eurostat: Data on connection rates to sewer system and urban wastewater treatment plants for the last 25 years.

Data on **other sources of emissions to surface waters, like e.g. industrial point sources or diffuse sources** is available from the following data sources:

- E-PRTR: contains the main industrial and agricultural facilities as well as UWWTPs > 100,000 PE and their discharges above certain capacity and emission thresholds. For the DRBMP the ICPDR additionally requested information on industrial and agricultural discharges from countries, which are not reporting under E-PRTR;

5 https://www.eea.europa.eu/data-and-maps/data/waterbase-uwwtd-urban-waste-water-treatment-directive-4

6 http://prtr.ec.europa.eu/#/home, database available at: https://www.eea.europa.eu/data-and-maps/data/member-states-reporting-art-7-under-the-european-pollutant-release-and-transfer-register-e-prtr-regulation-13

7 http://www.icpdr.org/main/activities-projects/tnmn-transnational-monitoring-network

8 TNMN database available at: http://www.icpdr.org/wq-db/

9 http://www.eea.europa.eu/data-and-maps/data/waterbase-water-quality/

- Diffuse emissions: data is obtained by use of models (like e.g. MONERIS). For the Danube Basin an assessment of the share of diffuse pollution to the pollution load in rivers was elaborated for and published in the 1st and 2nd DRBM.

2.3 TNMN-database

Based on information from the TNMN-database Figure 2-1 to Figure 2-7 show the annual mean concentrations (mg/l) of BOD_5, COD_{Cr}, N_{tot} (as sum of NH_4-N, NO_3-N and NO_2-N), NH_4-N, NO_3-N and P_{tot} along the Danube River for the years 1996 to 2014. An overview of the observed monitoring sites is given in Table 2-1.

Country code	New TNMN code	Name of site	River km
AT	AT1	Jochenstein	2,204
AT	AT5	Enghagen	2,113
AT	AT3	Wien Nussdorf	1,935
AT	AT6	Hainburg	1,879
SK	SK1	Bratislava	1,869
SK	SK2	Medvedov	1,806
HU	HU1	Medvedov	1,806
HU	HU2	Komarom	1,768
HU	HU3	Szob	1,708
HU	HU4	Dunafoldvar	1,560
HU	HU5	Hercegszanto	1,435
HR	HR1	Batina	1,429
HR	HR2	Borovo	1,337
RO	RO1	Bazias	1,071
RO	RO2	Pristol/ Novo Selo	834
BG	BG1	Novo Selo Harbour/Pristol	834
BG	BG2	Bajkal	641
BG	BG3	Svishtov	554
BG	BG4	Upstream Russe	503
RO	RO3	Dunare - upstream Arge	432
RO	RO4	Chiciu	375
BG	BG5	Silistra/Chiciu	375
RO	RO5	Reni	132
RO	RO6	Vilkova-Chilia arm	18
RO	RO7	Sulina arm	0
RO	RO8	Sf Gheorghe arm	0

Table 2-1: TNMN monitoring sites investigated for the current project

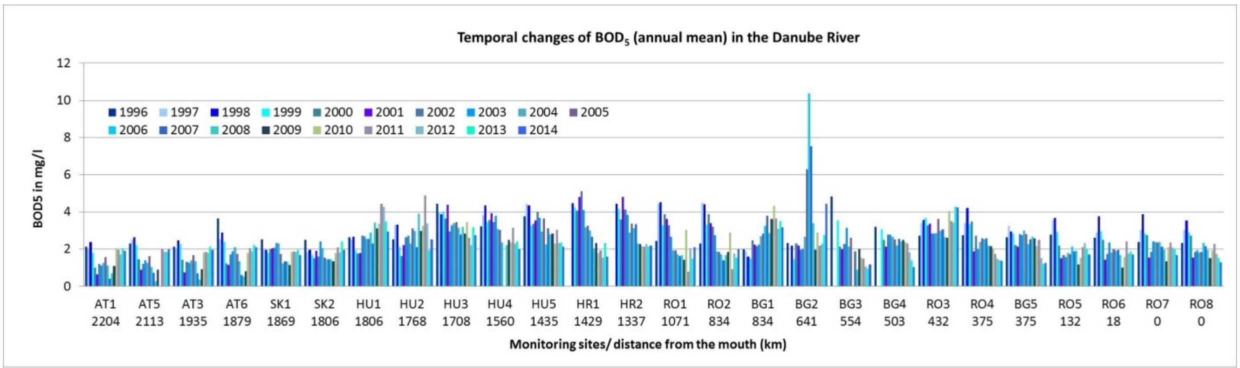


Figure 2-1: Temporal changes of BOD_5 in the Danube River (TNMN database)

For BOD_5 a decreasing trend of annual mean concentrations can be observed over years at nearly all or most monitoring stations of Hungary, Croatia, Bulgaria and Romania. In Austria and Slovakia mean annual concentrations have been slightly rising from 2010 onwards. When comparing mean annual BOD_5-concentrations for the years 2010 – 2014 in Austria (upper Danube) and Romania (monitoring stations RO5 – RO8, lower Danube) it becomes evident that the concentrations are nearly stable although they are elevated in the middle part of the Danube. This could be explained by the increasing discharge in the Danube and the natural processes in the river ecosystem (self-purification processes). Organic content is also influenced by natural organic substances released by plants (forest areas) and by growth of aquatic vegetation (algae) and it is a usual situation that lower parts of rivers have higher concentrations of BOD_5 and COD.

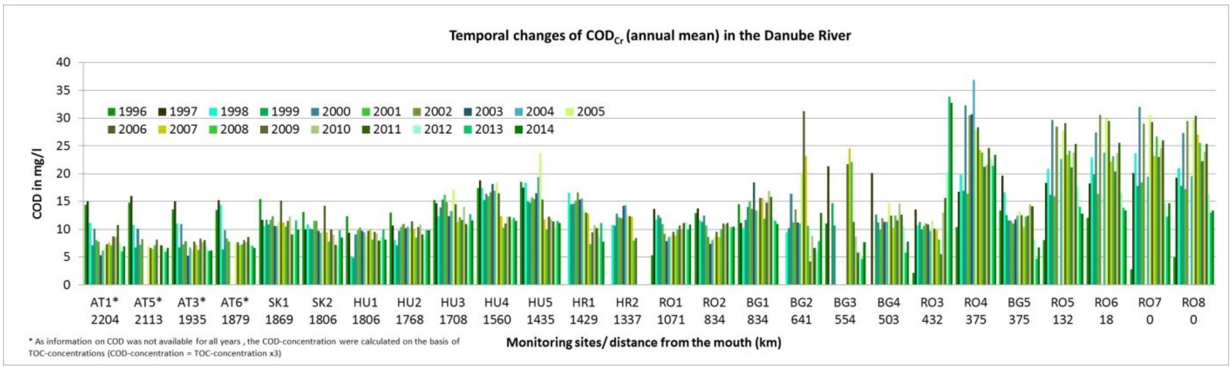


Figure 2-2: Temporal changes of COD in the Danube River (TNMN database)

For COD a decreasing trend of annual mean concentrations can be observed over years at nearly all monitoring stations of all investigated countries. The mean annual concentrations are increasing along the Danube River, which could be due to increasing COD-emissions from agglomerations and industrial point sources. In Austria mean annual COD-concentrations decreased from 1997/1998 over the following years. In Hungary a significant decrease can be observed for the monitoring stations HU4 and HU5 from the years 2004/2005 onwards.

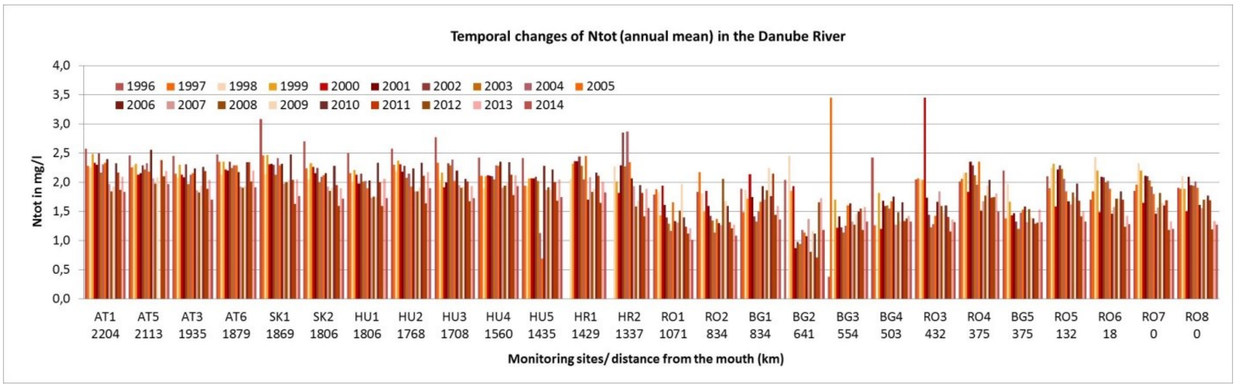


Figure 2-3: Temporal changes of N_{tot} (as sum of NH_4-N, NO_3-N and NO_2-N) in the Danube River

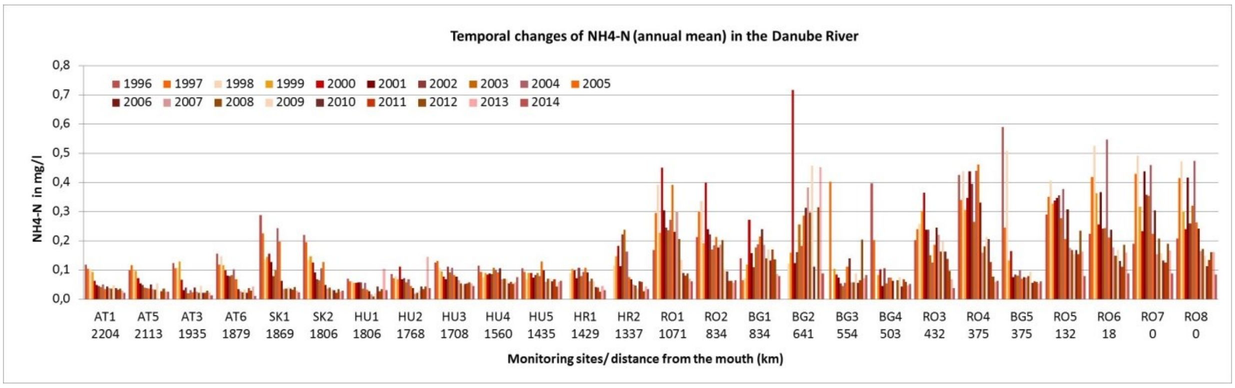


Figure 2-4: Temporal changes of NH_4-N in the Danube river

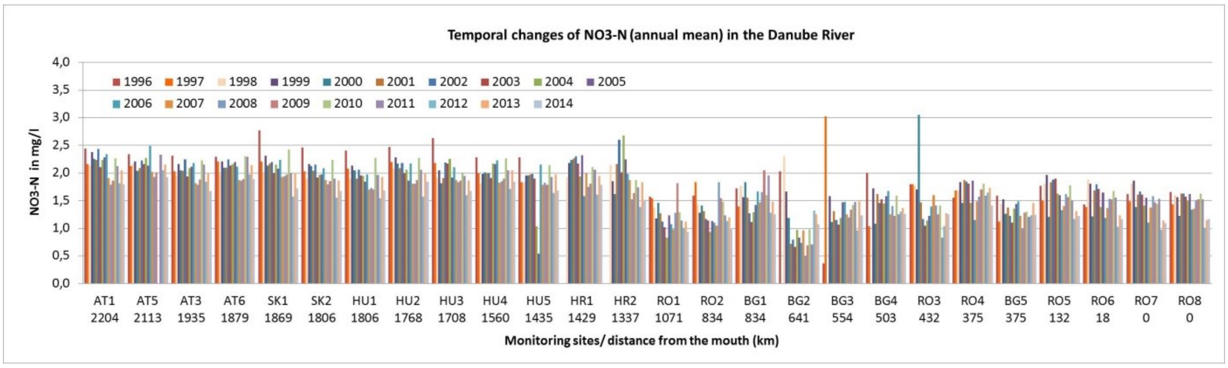


Figure 2-5: Temporal changes of NO_3-N in the Danube River

Information about the parameter N_{tot} was not available for all monitoring stations observed, therefore, this parameter was calculated as the sum of NH_4-N, NO_3-N and NO_2-N. Accordingly, the mean annual concentrations of N_{tot} reflect the trend of mainly NO_3-N, which represents the biggest share of the cumulative parameter. In Austria, Slovakia, Hungary and Croatia the mean annual concentrations of both, NH_4-N and NO_3-N have been constantly decreasing over time at most monitoring stations, whereas for Romania and Bulgaria this decrease seems to have happened predominantly in the last years observed (from 2012 onwards). Along the Danube River NO_3-N concentrations are decreasing. This effect is at least partly due to natural processes in rivers. On the contrary, NH_4-N concentrations show an increasing tendency. The reason could be decreased dissolved oxygen levels due to higher wastewater discharges from incorrectly treated urban wastewater. Reduced NO_3-N concentrations in the lower part of the Danube could be explained by higher rates of denitrification, where nitrate is reduced and ultimately produces molecular nitrogen and higher consumption by vegetation in the river and in associated ecosystems.

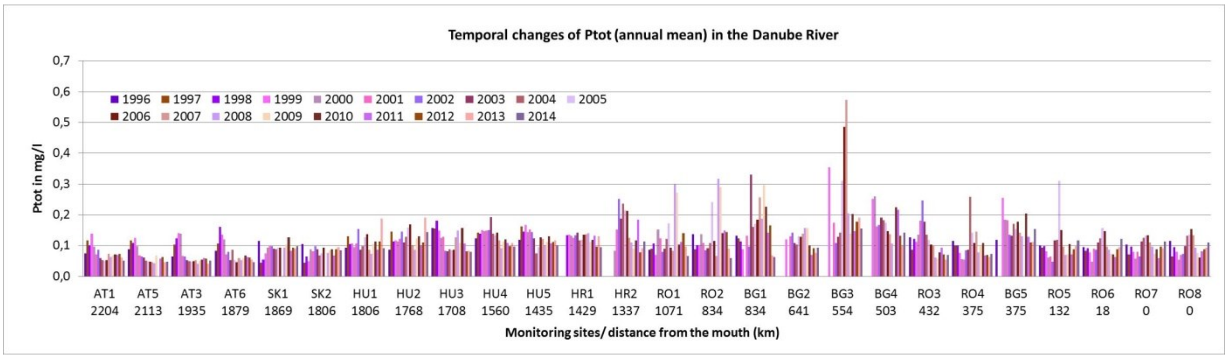


Figure 2-6: Temporal changes of P_{tot} in the Danube River

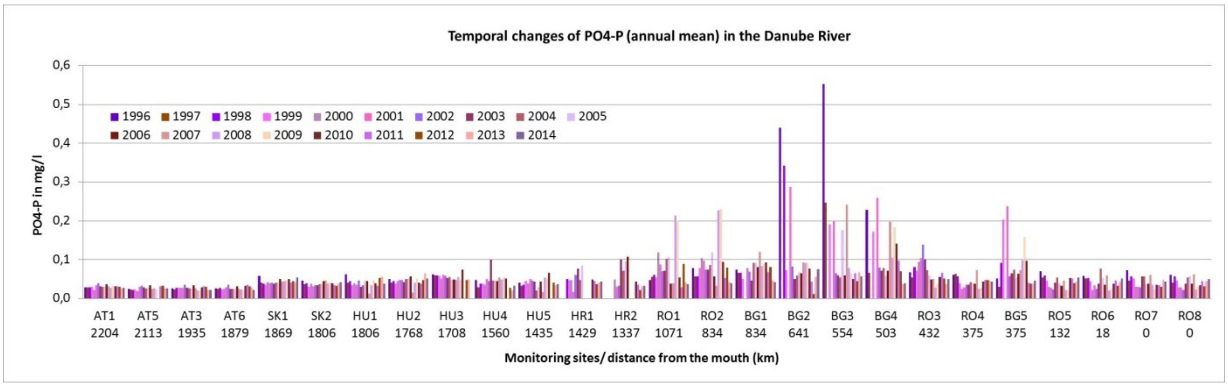


Figure 2-7: Temporal changes of PO_4-P in the Danube River

For P_{tot} the mean annual concentrations along the Danube River are slightly increasing. A strong decrease at all Austrian monitoring stations could be investigated over time which might be due to the fact, that the Austrian legislation for urban wastewater (1st First wastewater emission regulation for communal wastewater", BGBl. Nr. 210/1996) introduced the mandatory removal of phosphorus in wastewater treatment plants and that the agri-environmental program ÖPUL was launched in the year 2000 to address diffuse nutrient losses (BMLFUW, 2000). For Slovakia the mean annual P_{tot}-concentrations were stable over time, whereas monitoring stations in Hungary and Croatia show a decreasing tendency over years. For Bulgaria and Romania no clear trend could be observed, some monitoring stations revealed decreasing annual mean concentrations over years, whereas other monitoring stations did not.

The link between improved wastewater phosphorus removal and decline of P_{tot}-concentrations in European rivers has already been demonstrated (Neal et al., 2010, Räike et al., 2003). The situation of no clear trends for mean P_{tot}-concentrations could be explained by findings from Zoboli et al. (2014). In this study, patterns of changes in the concentration of total phosphorus at different flow levels from 1991 to 2013 in the Austrian Danube were statistically analysed and related to point and diffuse emissions, as well as to extreme hydrological events. It could be shown that the reduction of point source emissions achieved in the 1990s was well translated into decreasing P_{tot} baseflow concentrations during the same period, but did not induce any changes of concentration at higher flow levels. A sharp and long-lasting decline in P_{tot}-concentrations, affecting all flow levels, took place after a major flood in 2002. Such a decline was still visible during another flood in 2013, which recorded lower P_{tot}-concentrations than then preceding one. The results of the study suggest that as a result of floods, the river system experienced a significant depletion of its in-stream phosphorus stock and a reduced mobilisation of P_{tot}-rich sediments afterwards. This hypothesis was corroborated by the decoupling of peak phosphorus loads from peak maximum discharges after 2002. From the TNMN database the explicit influence of the implementation of the UWWTD cannot be easily identified at all monitoring stations along the Danube River. Urban wastewater treatment is responsible for only part of the nutrient load in the river, and natural processes like floods may considerably influence nutrient concentrations in the course of the river.

However, taking into account that all investigated countries except AT (EU accession 1995) and HR (EU accession 2013) joined the European Union in the years 2004 or 2007 and started implementing the UWWTD hereafter, the decreasing trend of the investigated pollutants over years is - at least partly – due to the implementation of the UWWTD.

Due to few data on discharge in the TNMN-database annual loads of BOD_5, COD, N_{tot} and P_{tot} could only be calculated for 17 of the 26 monitoring stations investigated (Figure 2-8 to Figure 2-11). As has already been shown for mean average concentrations, loads decrease over time at most of the monitoring stations. Loads along the Danube River are increasing, which is due to the progressively increasing drainage area downstream with larger volumes of water but also increasing mean annual concentrations in the course of the Danube (see chapter 3.2 of the main document) and increasing water discharges.

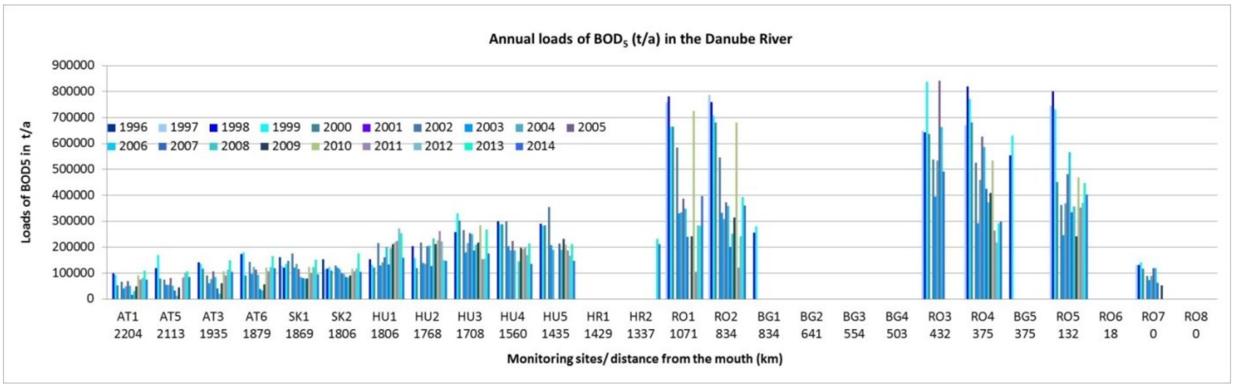


Figure 2-8: Annual loads of BOD_5 (in t/a) at different TNMN-monitoring stations along the Danube

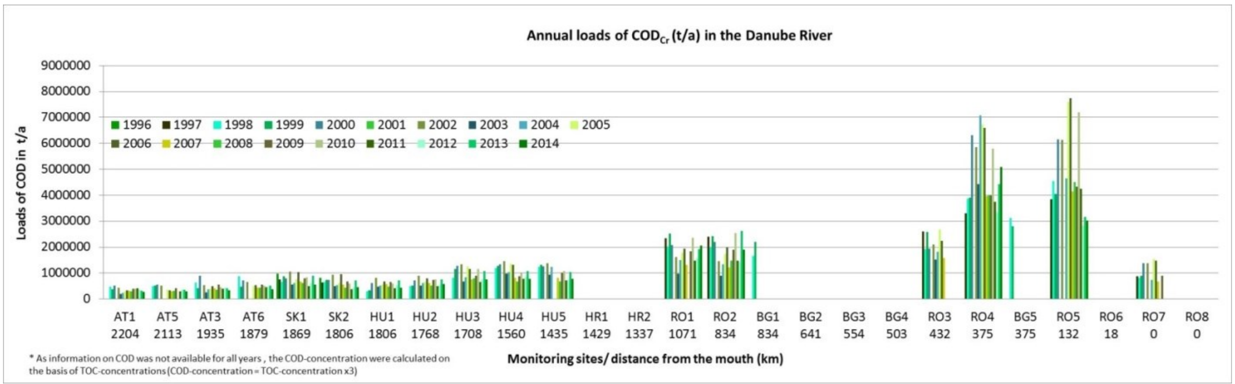


Figure 2-9: Annual loads of COD (in t/a) at different TNMN-monitoring stations along the Danube River

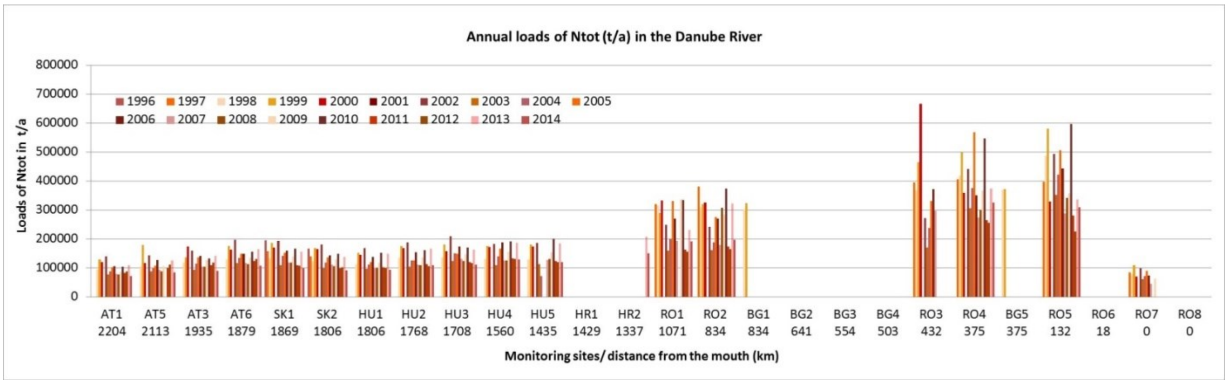


Figure 2-10: Annual loads of N_{tot} (in t/a) at different TNMN-monitoring stations along the Danube River

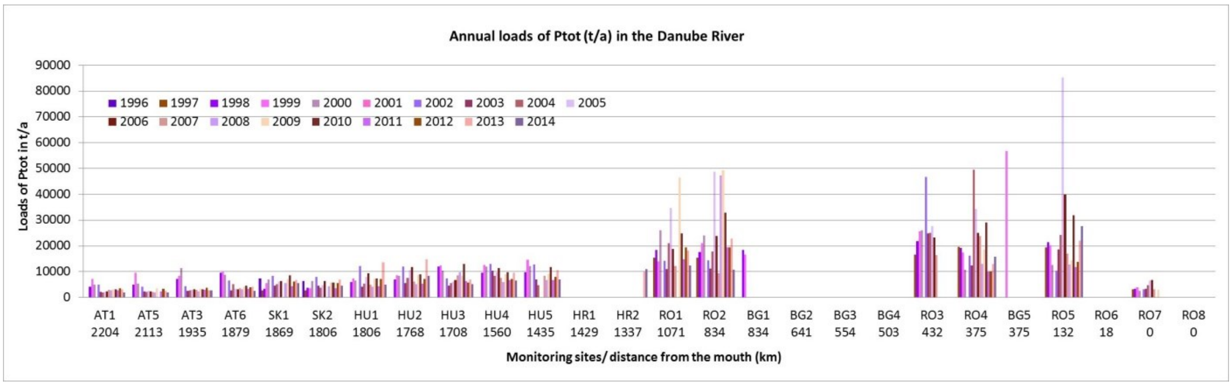


Figure 2-11: Annual loads of P_{tot} (in t/a) at different TNMN-monitoring stations along the Danube River

In order to roughly relate river loads and emission loads from urban wastewater management loads were calculated for the TNMN-monitoring station AT1 (Jochenstein) as 'incoming' point of the investigated area and RO5 (Reni) as 'outgoing' point of the investigated area. Although the monitoring station RO5 (Reni) is not directly located at the mouth of the Danube to the Black Sea, it is only 100 km away and presents a monitoring station with comprehensive data on pollutant concentrations and water discharge. The difference of the pollutant load from both monitoring stations was then compared with the emissions from UWWTD-agglomerations, as calculated for the 1st and the 2nd DRBMP (reference years 2006 and 2012) for the purpose of estimating the share of emissions from agglomerations in the total emissions into the river system. Regarding the emissions from agglomerations, only emissions originating from collected wastewater were taken into account, as the non-collected wastewater does not directly enter surface waters.

	2006	2012
BOD_5 load (t/a) at AT1 (Jochenstein)	50,386	82,148
BOD_5 load (t/a) at RO5 (Reni)	565,579	370,262
BOD_5 emission into Danube River (RO5 - AT1)	515,193	288,114
BOD_5 emissions from agglomerations (t/a)	478,845	256,282
% of total emissions from agglomerations	93%	89%
COD load (t/a) at AT1 (Jochenstein)	325,659	356,504
COD load (t/a) at RO5 (Reni)	7,733,848	2,816,791
COD emission into Danube River (RO5 - AT1)	7,408,189	2,460,286
COD emissions from agglomerations (t/a)	1,037,713	551,796
% of total emissions from agglomerations	14%	22%
N_{tot} load (t/a) at AT1 (Jochenstein)	106.719	89.300
N_{tot} load (t/a) at RO5 (Reni)	444.191	225.762
N_{tot} emission into Danube River (RO5 - AT1)	337.472	136.462
N_{tot} emissions from agglomerations (t/a)	130.056	88.081
% of total emissions from agglomerations	39%	65%
P_{tot} load (t/a) at AT1 (Jochenstein)	2.312	3.517
P_{tot} load (t/a) at RO5 (Reni)	39.891	13.858
P_{tot} emission into Danube River (RO5 - AT1)	37.579	10.342
P_{tot} emissions from agglomerations (t/a)	21.850	12.402
% of total emissions from agglomerations	58%	120%

Table 2-2: Comparison of pollutant loads in the Danube River and emissions of pollutants from UWWTD – agglomerations

As can be seen from Table 2-2 no clear trend can be observed for the share of pollutant emissions from agglomerations in the pollutant loads discharged into the Danube River. For P_{tot} the loads originating from agglomerations in the reference year 2012 were even higher than the difference of P_{tot}-loads at the monitoring stations AT1 (Jochenstein) and RO5 (Reni). The low correlation can be explained by different reasons, like self-purification processes of the river, degradation processes of pollutants, influence of floods and other hydrometric parameters or retention in the river system. Also the results of MONERIS showed that the emissions from agglomerations cannot directly be attributed to the pollutant loads in the river system.

2.4 EEA-database

Based on Waterbase-Water quality the EEA publishes information on water quality aspects, like e.g. mean annual BOD_5-, NH4-N- and PO4-P-concentrations in rivers or macrophytes and phytoplankton in lakes for a time period from 1993 to present on its website. An example of these publications (for BOD_5) is given in Figure 2-12.

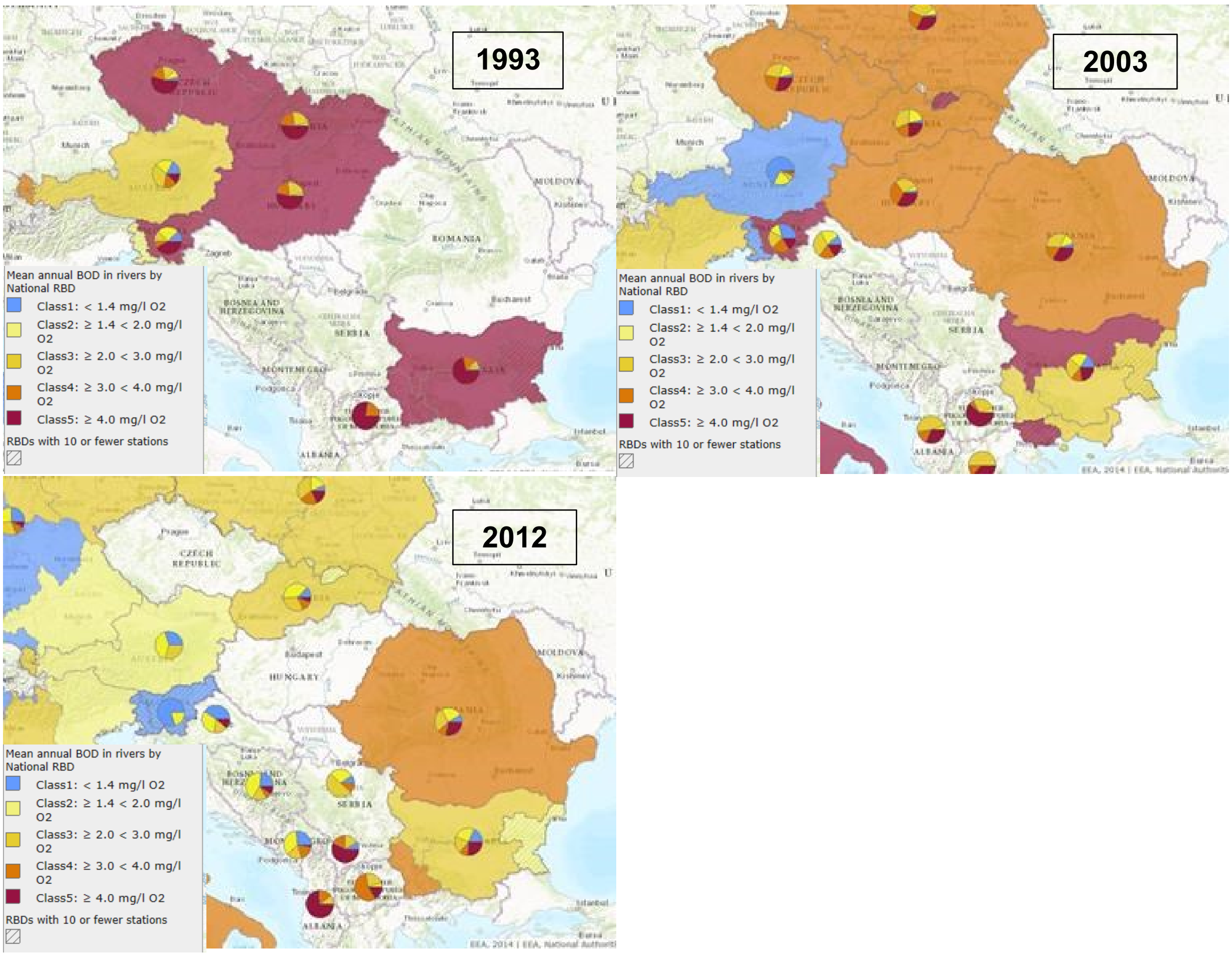


Figure 2-12: Evolution of BOD_5 in European rivers (http://www.eea.europa.eu/data-and-maps/explore-interactive-maps/wise-soe-bod-in-rivers)

Due to modifications of the monitoring system (e.g. based on the implementation of the WFD) the assessment of the mean annual concentrations as published by the EEA is based on a differing number of monitoring stations (e.g. in Austria 118 monitoring stations were sampled for BOD_5-concentrations in 1993, compared to 148 in 2003 and 60 in 2012). For the assessment of long-term trends it is however important, to consider a consistent set of monitoring stations over years. Therefore, the current report evaluated long-term mean annual concentrations for BOD_5, COD, N_{tot}, NO3-N, P_{tot} and PO4-P in rivers on the basis of data from only those monitoring stations that were consistently monitored over several years in the EEA Waterbase_Rivers_v14 (data available until reference year 2012). For each country and for each nutrient the stations with the longest shared time series where selected in order to be able to calculate the mean annual concentration over each country. For this step only annual data was selected. In some cases, for instance for BOD_5 in Slovakia, the amount of years analysed was reduced to improve the number of stations. For BOD_5, COD and P_{tot} BG is not represented in the graphs, due to very few stations with more than two years of data. For N_{tot}, sufficient data was only available for CZ, HR, RO and SK and for NH_4-N only for AT, BG, SI and SK.

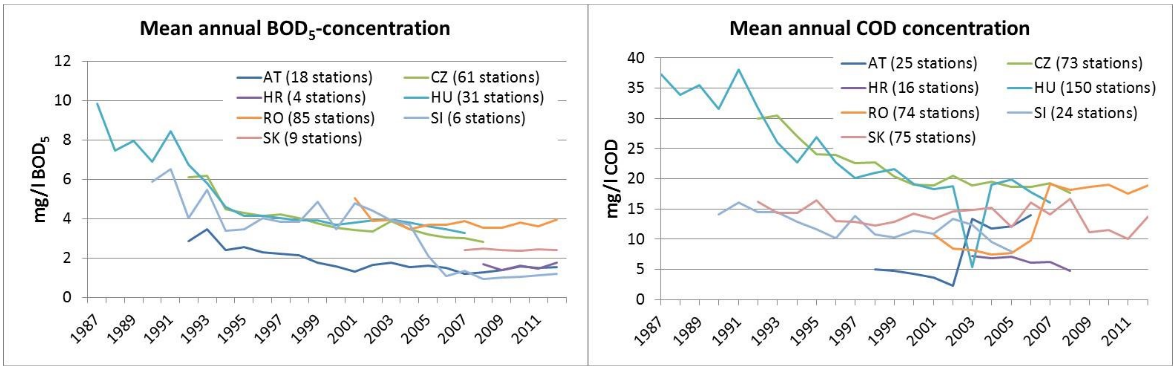


Figure 2-13: Mean annual BOD_5 and COD concentrations for AT, CZ, HR, HU, RO, SI and SK

For organic pollution (BOD_5 and COD), the long-term average annual concentration shows a decrease in BOD_5 concentrations in all investigated countries and of COD concentrations in nearly all investigated countries. As regards BOD_5, the time series for Croatia and Slovakia cover only five and six years, respectively, and the BOD_5-concentrations are fairly constant. Clear stepwise decreases can be seen for Hungary in 1994 and for Slovenia in 2005. The results from the EEA-database are in good accordance with the decreasing trend of mean annual concentrations at the investigated monitoring stations of the TNMN-network and are also in similar concentration ranges for Austria, Slovakia, Hungary and Croatia. For Romania, mean annual concentrations in the Danube are lower than the mean annual concentration for the entire country.

Mean annual COD concentrations in the Czech Republic, Croatia, Hungary, Romania and Slovenia are decreasing during the monitored time frame. In Austria and Romania COD concentrations show a stepwise increase in 2002 (AT) and 2007 (RO). In Slovakia the concentration of COD remains fairly constant. As for BOD_5 the results from the EEA-database are consistent with the decreasing trend of mean annual concentrations at the investigated monitoring stations of the TNMN-network, except for Austria, where a decreasing trend could be investigated at the four observed monitoring stations. For Romania an increase of mean annual concentrations was observed at three of the investigated monitoring stations. In general the mean annual concentrations calculated for the entire countries and the single monitoring stations are consistent.

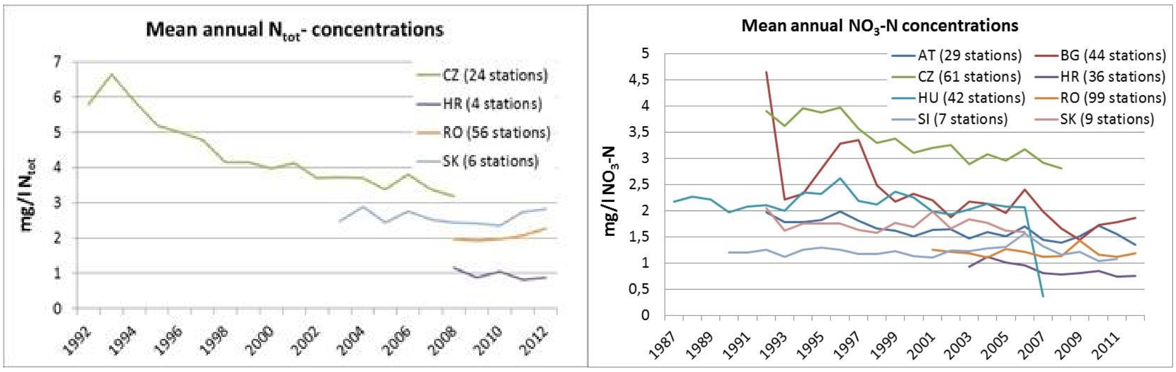


Figure 2-14: Mean annual concentrations of N_{tot}, NH_4-N and NO_3-N for the countries in the project

It is important to consider that in this period a clear focus was made on nutrients in the EU legislation with the Nitrates Directive and all efforts in livestock manure management, and the policy on phosphate free detergents, in addition to the UWWTD, which has led to a decrease in the discharge or release of N and P in most EU Member States.

Figure 2-14 shows that the mean annual N_{tot}-concentrations are clearly steadily decreasing in the Czech Republic, whereas for Slovakia the N_{tot}- concentrations remain almost constant which can certainly be linked to a lower share of tertiary treatment in Slovakia. The time series for Romania and Croatia were short but also reveal more or less constant concentrations. For Slovakia, these results differ from the TNMN-data from monitoring stations in the Danube River, where mean annual N_{tot}-concentrations are decreasing over time. For Croatia and Romania the N_{tot}-concentrations are in the same range as observed in the TNMN-monitoring.

Information about mean annual NH_4-N- concentrations from consistent monitoring stations covered only a short time period and did therefore not a allow serious interpretation of data. For NO_3-N the mean annual concentrations showed a decreasing trend over years for Austria, Bulgaria, the Czech Republic and Croatia, whereas the trends for Slovakia, Hungary, Slovenia and Romania were rather stable or only slightly decreasing. In contrast, the NO_3-N mean annual concentrations in nearly all TNMN-stations along the Danube River showed a decrease of NO_3-N-concentrations. The mean annual concentrations observed at the TNMN-monitoring stations and in the EEA-database are within the same concentration range. Only for Bulgaria the mean annual concentrations differed before 2008 and for Croatia, mean annual concentrations in the Danube are higher than those calculated for the entire country.

Figure 2-15 shows that the mean annual P_{tot} concentrations are decreasing in Austria, the Czech Republic, Hungary and Croatia, whereas they are rather stable over time (at a very low level) in Slovenia. For Slovakia and Romania the data revealed strong variations. Mean annual P_{tot} concentrations were in the same concentration ranges for all investigated countries at the TNMN-monitoring stations and in the EEA-database except for Romania, for which data from the EEA-database revealed higher concentration ranges.

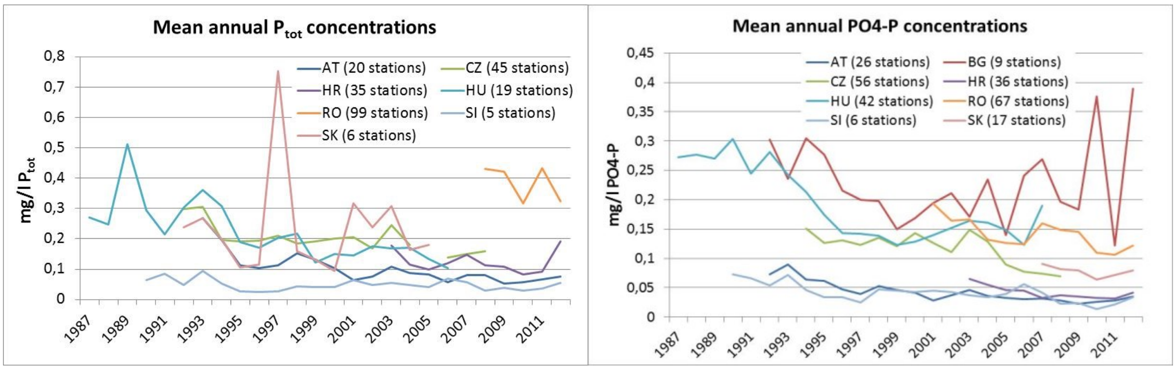


Figure 2-15: Mean annual concentrations of P_{tot} and PO_4-P for the countries in the project

For PO_4-P which is closely linked to discharges by humans, the mean annual concentrations showed a decreasing trend over years for all investigated countries except for Bulgaria, where the mean annual concentrations revealed strong variations and no interpretable trend. Mean annual PO_4-P concentrations were in the same concentration ranges for Austria, Slovakia and Croatia at the TNMN-monitoring stations and in the EEA-database. For Hungary, Bulgaria and Romania mean annual PO_4-P concentrations at TNMN-monitoring stations were lower than the mean annual concentrations calculated from EEA-data.

2.5 ICPDR Urban Waste Water Inventory (as presented in the DRBMP)

This chapter gives an overview of the wastewater load (PE) from agglomerations ≥ 2,000 PE in the Danube basin as reported for the 1st and the 2nd DRBMP and the share of wastewater load receiving different stages of collection and treatment. The chapter also focuses on emissions of BOD_5, COD, N_{tot} and P_{tot} in the reference years 2005/2006 (1st DRBMP) and 2011/2012 (2nd DRBMP) and the share of these emissions from different stages of collection and treatment.

For the DRBMP, the ICPDR collected information about the share of wastewater load in different collection and treatment stages and data about emissions directly from the countries. For the 1st DRBMP this data collection followed the principles of reporting under the UWWTD to the European Commission; for the 2nd DRBMP most of the data for EU Member States could be directly obtained from the UWWTD database and only emitted loads from UWWTPs (which is not an obligatory parameter under UWWTD-reporting) were completed by the countries.

Data on wastewater treatment collected for the purpose of the UWWTD comprises information about installations in place and the performance of these installations. This means that UWWTD-reporting requests monitoring results of BOD_5, COD, N_{tot} and P_{tot} at the level of UWWTPs, in order to investigate whether the installed wastewater treatment works properly. Data evaluation for the DRBMP did not consider monitoring results, but only the installations in place.

According to the 2nd DRBMP there are 5,705 agglomerations with a size of 2,000 PE or more in the Danube Basin, which generate a wastewater load of nearly 88 million PE (reference year 2011/2012). In the 1st DRBMP there were 6,224 agglomerations with a size of 2,000 PE or more and a generated load of nearly 95 million PE (reference year 2005/2006) (see Figure 2-16). The decrease of number and generated load is due to a review of number and size of agglomerations in single countries. Major changes were observed for Austria (decrease of generated load of 5.1 Mio PE), with a decrease due to a change of the calculation method of the generated load[10] and Romania (decrease of the generated load of 5 Mio PE).

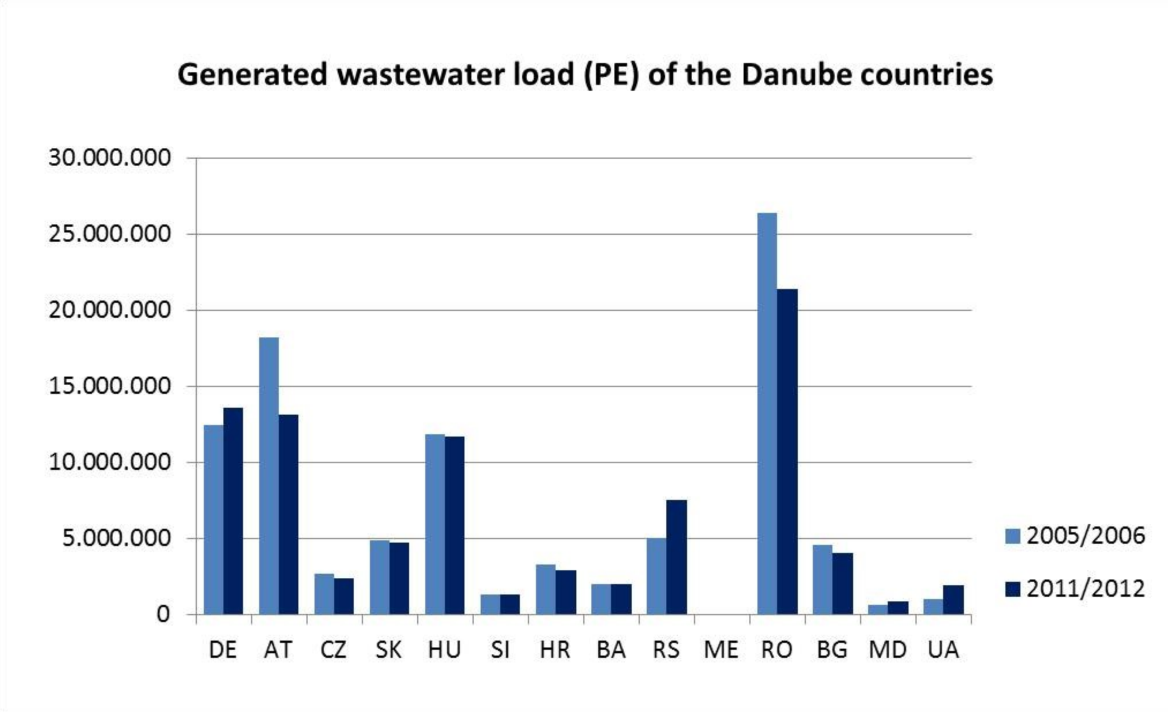


Figure 2-16: Generated wastewater load in the Danube countries in 2005/2006 and 2011/2012 (ICPDR, 2009; ICPDR, 2015)

In the reference year 2011/2012 almost half (45%) of the generated total wastewater load originates from agglomerations with a size of more than 100,000 PE (although this group contributes only 2% to the total number of agglomerations). This indicates the necessity to apply appropriate treatment technologies in these large agglomerations.

Figure 2-17 gives an overview of the share of the collection and treatment stages in the generated load in the 1st and the 2nd DRBMP. In 2011/2012 approximately half of the generated load was collected and treated in wastewater treatment plants with N- and/ or P-removal, which represents is an increase compared to the year 2005/2006. At the same time the fraction of wastewater load, which is not collected in collecting systems and the fraction of wastewater which is collected, but not treated, decreased. Overall, while more and better treatment was implemented during the period (from 63 to 70% treated correctly, i.e. secondary and tertiary treatment and IAS), a significant proportion is still collected and not treated or not treated adequately (11%) and a significant proportion is not collected and not treated at all. Moreover, these figures do not include smaller settlements where no information is provided. As the 11% of the load, which is collected and not treated or not

[10] For the 1st DRBM as well as for reporting under the UWWTD Austria considered the organic design capacity (PE) of urban wastewater treatment plants (UWWTPs) as indicator for the generated load originating from agglomerations ≥ 2,000 PE. For reporting under the 2nd DRBM Austria took into account the actual load entering UWWTPs as indicator for the generated load, which led to a reduction of 5.1 Mio. PE. As the entire generated load is treated in UWWTPs and as the emitted loads were reported for all UWWTPs of Austria for the 1st and the 2nd DRBMP, the decrease of generated load does not influence emissions.

treated adequately, produce the majority of surface water emissions, substantial improvements can be achieved by applying adequate treatment.

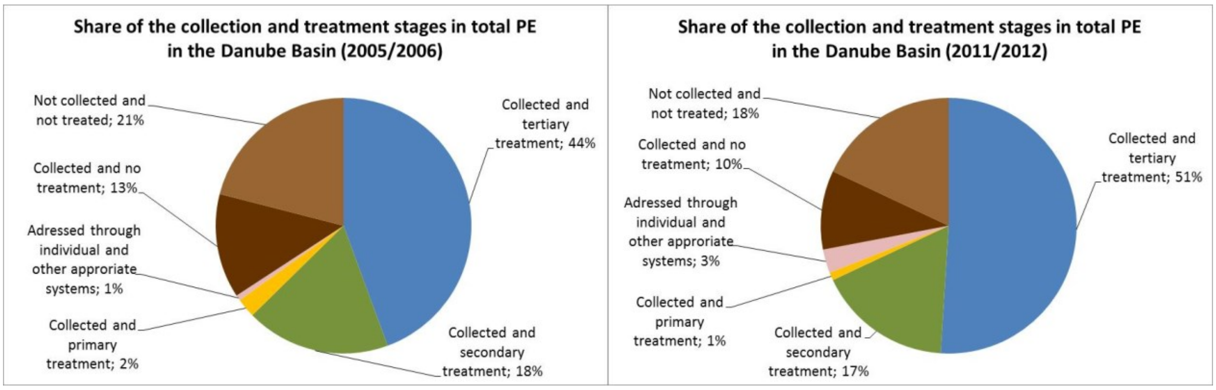


Figure 2-17: Share of the collection and treatment stages of agglomerations in the Danube Basin in the reference years 2005/2006 and 2011/2012 (ICPDR, 2009; ICPDR, 2015)

An overview of country contributions to the basin-wide generated loads and the proportion of the treatment and collection stages in the reference years 2005/2006 and 2011/2012 can be seen in Figure 2-18. Wastewater collection and treatment are highly advanced in the upstream countries, at good condition in several countries of the middle-basin, whereas a significant proportion of the wastewater load still lacks wastewater collection and/ or treatment in downstream countries.

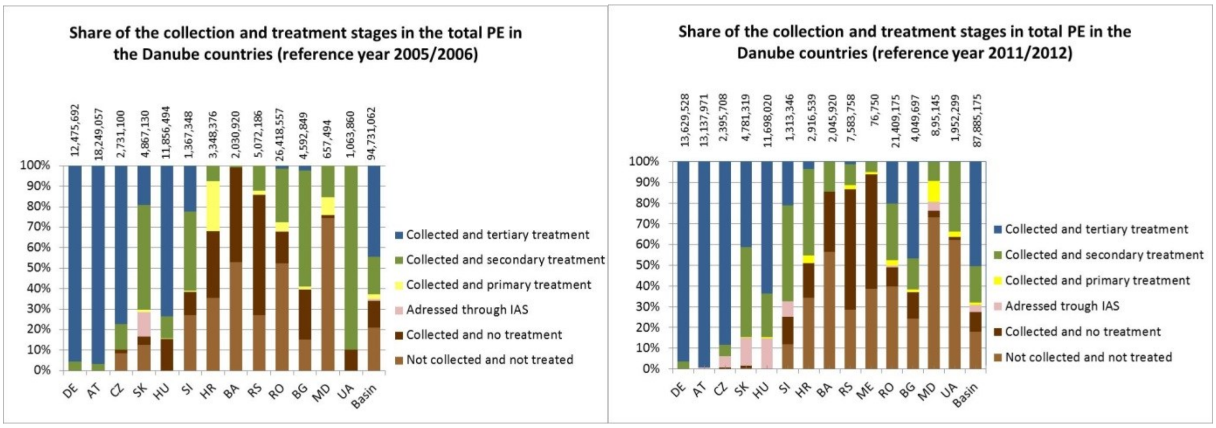


Figure 2-18: Share of the collection and treatment stages in total PE in the Danube countries in the reference years 2005/2006 and 2011/2012

For the analysis of emissions from urban wastewater treatment, the DRBMP focuses on the presentation of emitted loads discharged into surface waters, as these loads directly influence the quality of the Danube River. Therefore, the 2[nd] DRBMP only presents emissions from the urban wastewater fraction, which is collected in collecting systems and treated in an UWWTP or discharged without treatment. Individual and appropriate systems, where the wastewater is brought to an UWWTP by trucks were taken into account as well. Urban wastewater loads from agglomerations, which are not collected in collecting systems, do usually not enter the main surface waters directly, but are discharged in small ditches where self-purification partly occurs with the help of aquatic vegetation and/or infiltrate groundwater after soil passage, either directly or with an intermediate individual treatment (fully functioning

IAS or partial with septic tank, and/or infiltration drainage). Without further control, these pathways however pose a sanitation problem by disseminating diseases and fecal bacteria.

The purpose of the current report, which focuses on water quality, is to provide an overview of all emissions from agglomerations which means also emissions from the wastewater load that is not collected in collecting systems. Consequently, the purpose of this report strongly differs from the purpose of the assessments of the 2nd DRBMP.

As can be seen from Figure 2-19 the total emissions of BOD_5, COD, N_{tot} and P_{tot} from agglomerations ≥ 2,000 PE in the Danube Basin decreased considerably from 2005/2006 to 2011/2012. An overview of the total emissions per country of the project is given in Figure 2-20. While the total emissions are decreasing in nearly all of the countries investigated in the current project (except for a slight increase in Bulgaria), the emissions from countries from the rest of the basin reveal an increase. One of the reasons for this increase might originate from Serbia, which reported a higher generated load from agglomerations ≥ 2,000 PE in 2011/2012 compared to the generated load reported for 2005/2006 and close to 90% of the generated load collected and not treated or not collected in 2005/2006 and close to 100% of the generated load collected and not treated or not collected in 2011/2012. The decrease of emissions in the countries investigated in the project is due to the implementation of better treatment levels. The implementation of the UWWTD promotes the comprehensive installation of secondary and more stringent wastewater treatment for urban wastewater until 2014/2015 (end of transitional period for UWWTD-compliance in Bulgaria, Slovakia, Hungary and Slovenia), 2018 (end of transitional period for UWWTD-compliance in Romania) and 2023 (end of transitional period for UWWTD-compliance in Croatia).

Figure 2-20 also shows the share of emissions from the eight countries in the project (AT, CZ, SK, HU, SI, HR, RO, BG) in relation to the emissions from the rest of the Danube Basin in the reference years 2005/2006 and 2011/2012. While in 2005/2006 the eight countries of the current project contributed between 71% and 78% of the emissions of BOD_5, COD, N_{tot} and P_{tot} into the Danube Basin, they only contributed 58% - 64% of the emissions in the reference years 2011/2012.

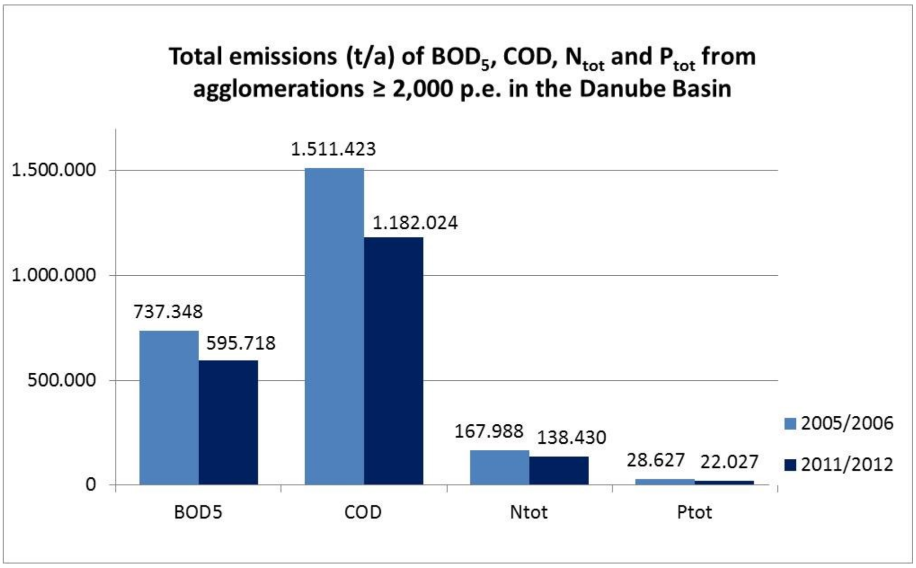


Figure 2-19: Total emissions (t/a) of BOD_5, COD, N_{tot} and P_{tot} from agglomerations ≥ 2,000 PE in the Danube Basin

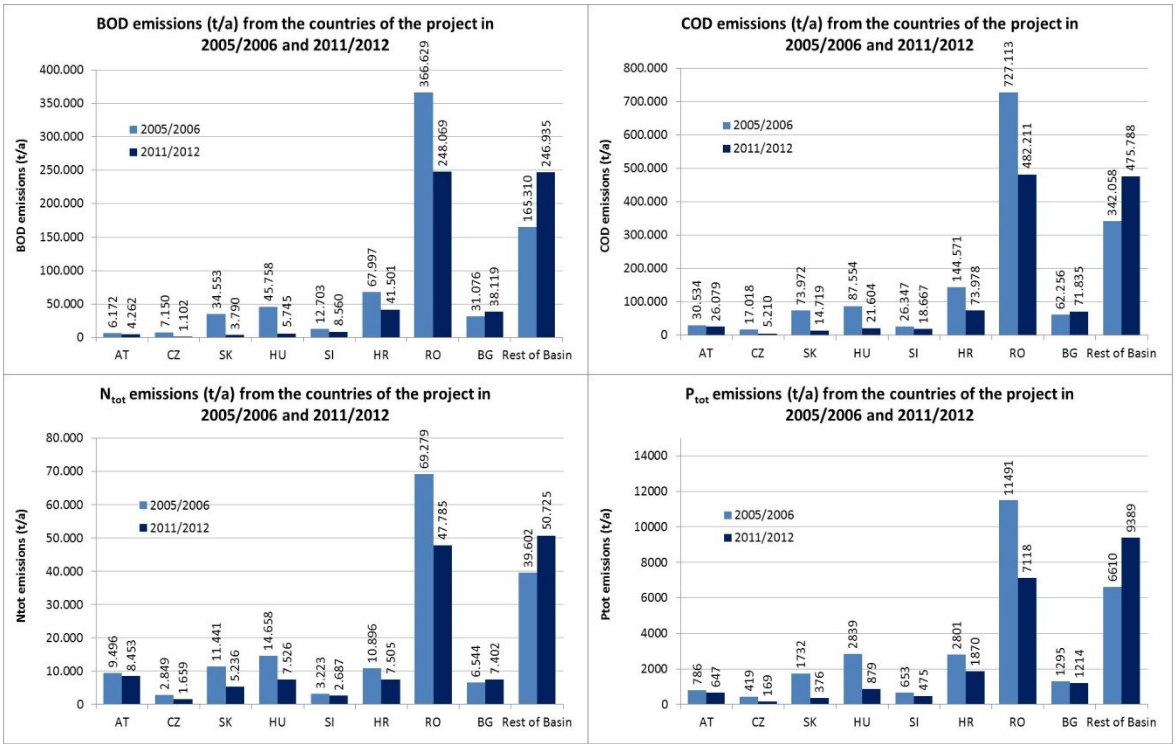
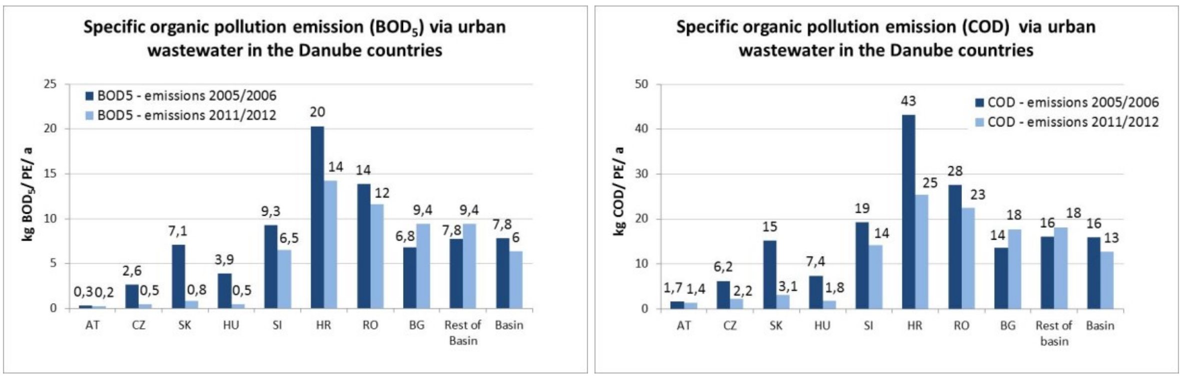


Figure 2-20: Total organic and nutrient pollution emission from agglomerations≥ 2,000 PE in the Danube countries

Total emissions (t/a) of organic and nutrient pollution were also related to the wastewater load (in PE) in order to calculate specific emissions for the reference years 2005/2006 and 2011/2012 (see Figure 2-21). Except for Bulgaria all investigated countries revealed decreasing specific emissions for BOD_5, COD, N_{tot} and P_{tot}, while for the rest of the basin the specific emissions slightly increased. The highest specific emissions in the investigated countries, as regards organic pollution, were observed for Croatia and Romania. As regards N_{tot}-emissions, highest specific emission values were observed for Slovenia, Croatia and Romania; for P_{tot}-emissions Slovenia and Croatia had the highest specific emissions.



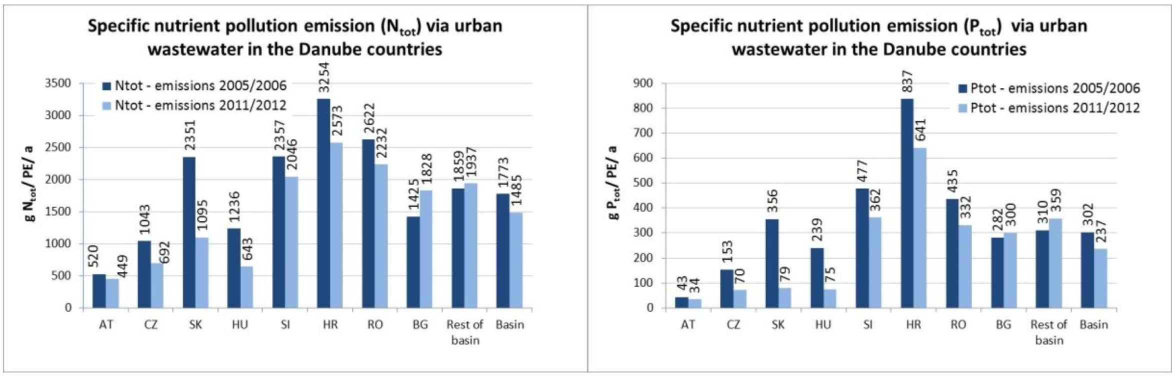


Figure 2-21: Specific organic and nutrient pollution from agglomerations ≥2,000 PE in DRB countries

Table 2-3 and Figure 2-22 give an overview of the share of different wastewater collection and treatment stages in the total emissions in the Danube Basin. Highest fractions of the load of pollutants originate from wastewater, which is not collected in collecting systems, but these emissions do not pose a direct threat to surface waters, as they usually percolate into the ground. However, Figure 2-22 clearly shows, that the construction of collecting systems for these wastewater loads needs to be accompanied by the simultaneous construction of wastewater treatment plants in order to prevent damage to the receiving waters. Significant fractions of the load collected in collecting systems originate from wastewater, which is collected in collecting systems, but not treated, whereas relatively small fractions of loads are emitted from agglomerations treated by tertiary treatment - despite the large fraction of wastewater load (in PE) addressed through this treatment. This situation can be explained by the high removal efficiencies of tertiary treatment (around 90%).

Type of treatment	PE	BOD (t/a)	COD (t/a)	N_{tot} (t/a)	P_{tot} (t/a)
Tertiary treatment (NP removal)	39,782,835	31,000	118,203	30,105	2,502
Tertiary treatment (P removal)	2,171,779			4,226	385
Tertiary treatment (N removal)	2,450,930			3,330	525
Secondary treatment	15,212,530	50,413	108,538	23,175	3,692
Primary treatment	1,110,746	10,720	21,533	2,286	430
Collected but not treated	8,313,329	164,149	303,522	24,959	4,868
Not collected	15,896,548	339,436	630,228	57,905	10,535
Addressed through IAS	2,946,478	-	-	-	-
Total collected	69,042,149	256,282	551,796	88,081	12,402
Total	**87,885,175**	**595,718**	**1,182,024**	**138,430**	**22,027**

Table 2-3: Share of organic and nutrient pollution from different collection and treatment stages in the Danube Basin (reference year 2011/2012)

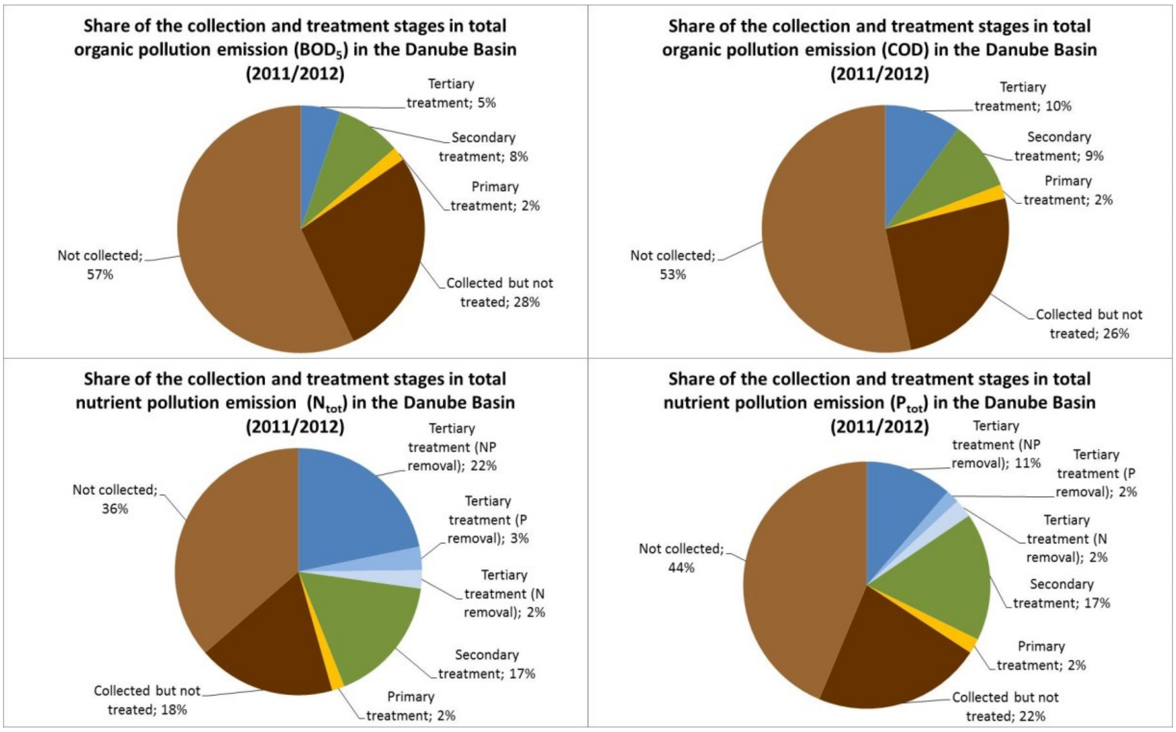


Figure 2-22: Share of the collection and treatment stages in the total organic/ nutrient pollution emission via urban wastewater in the Danube Basin (reference year 2011/2012)

2.6 UWWTD reporting under Art. 15 (TA-UWWTD)

Information about urban wastewater treatment installations, performance and voluntarily reported incoming and discharged loads of BOD_5, COD, N_{tot} and P_{tot} from the UWWTD Synthesis Reports (5th to 9th TA-UWWTD)[11] was used to estimate the emissions of the main pollutants in the eight EU Member States belonging to the Danube River Basin. Emissions were calculated at the national level, without taking into account the catchment of the Danube River.

This exercise was elaborated in order to calculate emissions from agglomerations ≥ 2,000 PE for those years, which are not covered by the ICPDR Urban Waste Water Inventory and to additionally consider the treatment performance of UWWTP. This aspect was not taken into account in the ICPDR Urban Waste Water Inventory.

The datasets of the 9th UWWTD-reporting were used to calculate removal rates for each parameter (BOD_5, COD, N_{tot} and P_{tot}) depending on the treatment type of a wastewater treatment plant and its performance. Yearly pollutant production per PE was also calculated for each parameter. The removal rates and pollutant production per PE were then used, together with the national information provided in the previous UWWTD Synthesis Reports, to estimate the national emissions regarding each parameter and its evolution over time.

[11] The reports before the 5th reporting are not relevant as only Austria is described. All other MS belong to the EU13 group: the first dataset was produced during the 5th reporting.

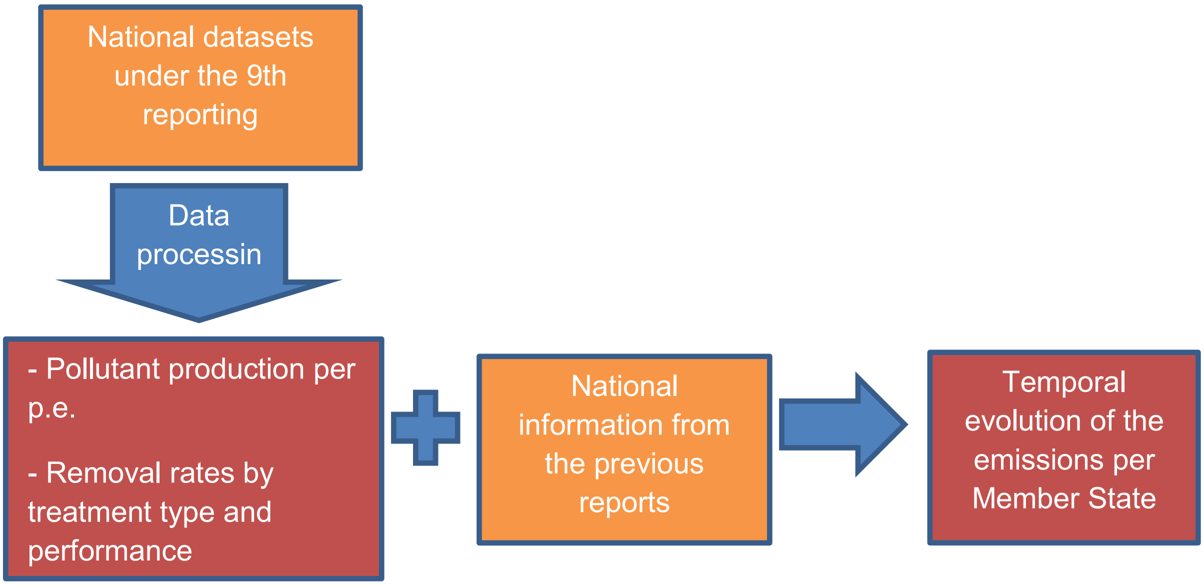


Figure 2-23: Description of the methodology's steps to estimate pollutant emissions in the MS belonging to the Danube River Basin

In the national reports summarised in the UWWTD Synthesis Reports, there is a chapter called "installation in place". It contains information about the distribution of the generated load through the different wastewater facilities. Table 2-4 gives an example of the table that describes the Hungarian situation for the reference year 2009 (7th UWWTD Synthesis Report):

HU (reference date: 2009/12/31)	**agglomerations**		**wastewater load**	
whole territory	**number**	**[%]**	**p. e.**	**[%]**
HU total	496	100.0	12,927,619	100.0
collecting system in place	492	99.2	10,930,214	84.5
secondary treatment				
installation in place	484	97.6	9,618,622	74.4
monitoring results meet requirements for discharge	377	76.0	9,174,477	70.9
more stringent treatment				
installation in place	409	82.5	8,563,597	66.2
monitoring results meet requirements for discharge	320	64.5	6,819,537	52.7

Table 2-4: Table from the 7th report of the UWWTD describing the Hungarian situation regarding wastewater facilities

This table presents the total generated load, the collected load, but also information about the treatment applied to this collected load. Information about monitoring results, which allows the evaluation of the performance of the facilities, is also available.

On the other hand there are the datasets provided by the MS under the 9th reporting of the Directive. In the structure of the dataset, it is possible to report the amount of pollutants entering and leaving each WWTP, in tonnes per year (t/a). This data is not compulsory, but some countries such as RO, HU and SI provided it for the year 2014 for the majority of UWWTPs.

Using the data provided by those three MS, it is possible to calculate removal rates and pollutant production, as it can be seen in Table 2-5 below.

	Pollutant production	Removal rates			
		Secondary treatment		More stringent treatment	
		Good performance	Bad performance	Good performance	Bad performance
	(g/p.e./day)	(%)	(%)	(%)	(%)
BOD	50.7	87.34	51.71	97.10	86.71
COD	94.9	84.31	49.13	94.35	84.52
N	10.5	54.50	28.56	87.03	64.28
P	1.4	54.80	29.73	88.66	60.86

Table 2-5: Estimation of pollutant production and removal rates depending on the treatment type and its performance

For each parameter, it was possible to calculate the average removal rate depending on the treatment type and its performance. The performance was determined to fit with the table "installation in place" presented previously. Average removal rates were then applied to the specific loads described in Table 2-4.

The data provided in Table 2-5 can be compared with the removal rates provided in the DRBMP report produced by the ICPDR (Table 2-6). The removal rates are quite close for BOD_5 and COD, for installations with good monitoring results. For N_{tot} and P_{tot} the removal rates calculated on the basis of the 9th UWWTD report are much higher than those presented in the DRBMP report for secondary treatment (55% of removal in Table 2 and 20 to 30% of removal for Table 2-6.

No treatment	Generated loads are reported as discharged ones.
Primary treatment	BOD_5 reduction: 30% COD reduction: 30% N_{tot} reduction: 10% P_{tot} reduction: 10%
Secondary treatment	BOD_5 reduction: 90% COD reduction: 80% N_{tot} reduction: 20% P_{tot} reduction: 30%
More stringent treatment	BOD5 reduction: 95% COD reduction: 90% N_{tot} reduction: 80% P_{tot} reduction: 90%

Table 2-6: Average removal rates for the main macro-pollutants depending on the treatment (Source: DRBMP report)

Limitations of the applied methodology

1) Croatia is absent from this analysis. As Croatia is a new MS of the EU, it did not provide the relevant data during the previous UWWTD reportings.

2) Absence of information about primary treatment in the previous reports: The consequence is that wastewater with primary treatment will be considered as not treated. This will lead to a slight overestimation of the emissions, as the removal for primary treatment plants will be considered zero, but primary treatment has generally low rates of removal, the standard value being a minimum of 20% on BOD.

3) Limited information about parameter removal: As explained before, only three of the eight MS belonging to the Danube River Basin provided information about entering and discharged loads of pollutants, but they represent a significant share (46.7%) of the population of the eight investigated countries. This may lead to a biased estimation of the removal rate. However, the number of WWTP covered is still sufficient to have reliable values, which can be used together with the data provided in the national reports (402 Treatment Plants for BOD, 403 for COD, 319 for N and 300 for P).

4) High variability of the removal rate in case of bad performance: For several WWTPs considered as failing to comply with the Directive's requirements in terms of performance, the removal rates can vary from 0% to 90%. In this case the average removal rate is not representative for all WWTPs, as the standard deviation is very high.

5) Separate approach to evaluate secondary and more stringent treatment: As can be seen from **Table 2-4** the load treated more stringently represents 8.6 Mio PE, whereas the load treated with secondary treatment represents 9.6 Mio PE, with a generated load of 12.9 Mio PE

The table must then be read as follows: 9.6 Mio PE are treated with secondary treatment, and among those 9.6 Mio PE, 8.6 Mio PE are also treated with more stringent treatment.

This is not a problem if only treatment installations are considered, as a more stringent treatment means automatically a secondary treatment upstream: to know the amount of the load treated only secondarily (without more stringent treatment) all we have to do is a subtraction (the secondary treated load minus the more stringent treated load). However, when we want to introduce performances, it is impossible to know the amount of the load treated only secondarily and with bad performances (as shown by the schema above).

In order to avoid this issue, the following procedure was applied:

- Calculation of the load treated only with secondary treatment.
- Calculation of the rate of non-performing secondary treatment installations based on the total secondary treatment installations.
- Application of this calculated rate to the load treated only with secondary treatment, in order to estimate the "load treated only with secondary treatment and with bad performances"
- The load treated only with secondary treatment can then be deduced by complementarity

This approach has the advantage to stay close to the performance described in the national reports. However, it can be expected that such an approach will lead to underestimate the emissions, as secondary treatment installations without more stringent treatment may be more exposed to bad monitoring results.

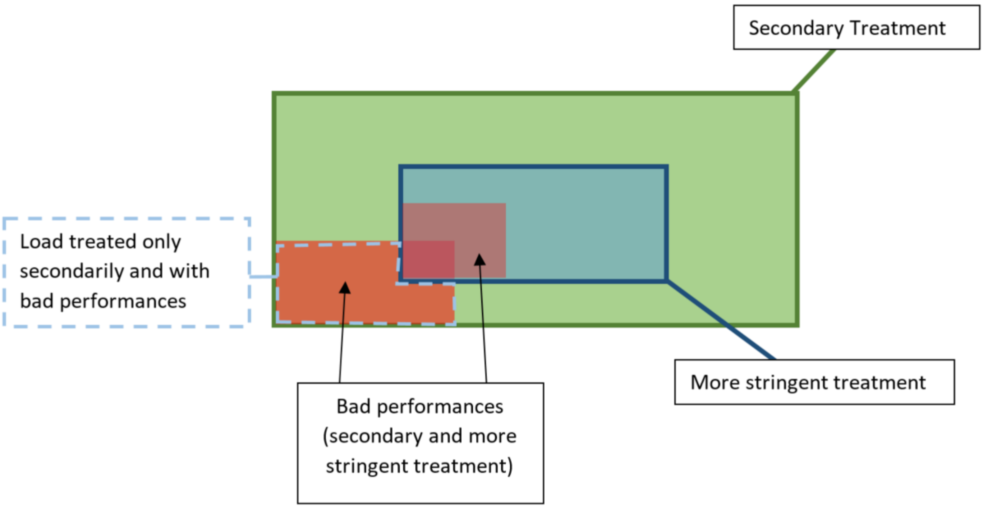


Figure 2-24: Description of the shared loads depending on the treatment and the performances.

<u>The advantages of the applied methodology can be summarised as follows:</u>

- The results provided by the ICPDR for 2012 are very close to the results produced from the UWWTD Synthesis Reports;
- It is the best way to obtain an overview of the evolution of wastewater treatment in MS belonging to the Danube River Basin as starting with the 5th Implementation Report all UWWTD implementation reports are considered. ;It takes into account the performance of the treatment and not only the installation in place, which gives the possibility to understand the impact of both installation and performance on the emissions;
- Removal rates and pollutant production are calculated based on local examples, situated in the Danube River Basin, which is much more relevant than using parameters from literature.

The evolution of emissions was estimated for the seven MS of the Danube River Basin for the four main parameters, from 2005 to 2014. Because of missing data, it was not possible to present a complete trend for Bulgaria and the Czech Republic. As explained before, it was not possible to estimate the emissions before 2005, as the majority of the MS had no obligation to report any data under the UWWTD before this date.

Emissions are expressed in kg/PE/year for BOD and COD (respectively g/PE/year for nitrogen and phosphorus) in order to be able to compare the situation in the seven MS. It is possible to obtain the total emissions of a MS by multiplying the emissions per PE by the total generated load of the MS.

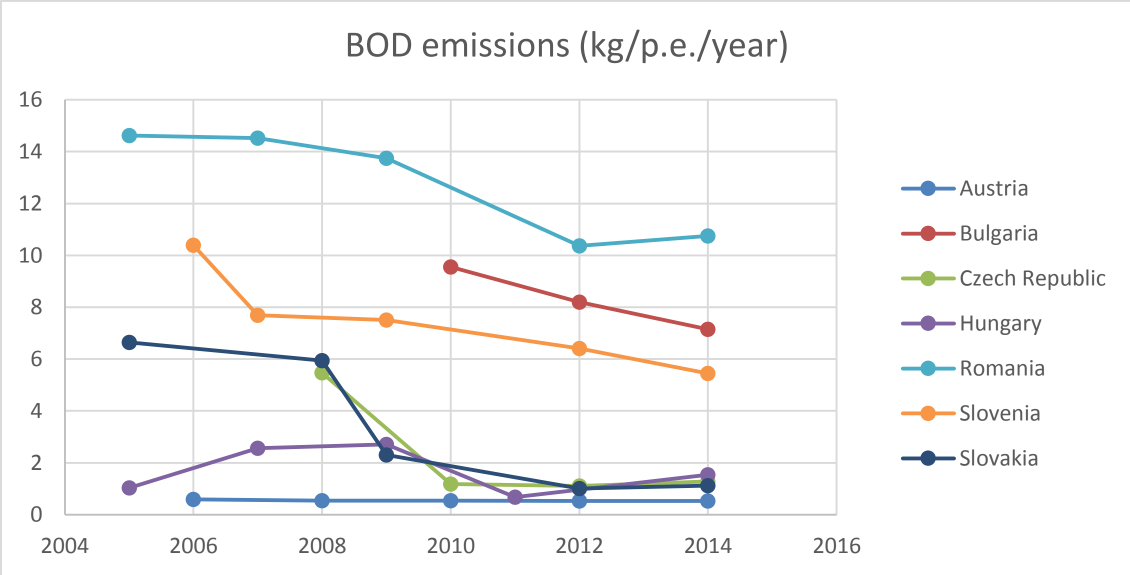


Figure 2-25: Evolution of BOD emissions from 2005 to 2014 for 7 MS belonging to the Danube River Basin (source: EU implementation reports).

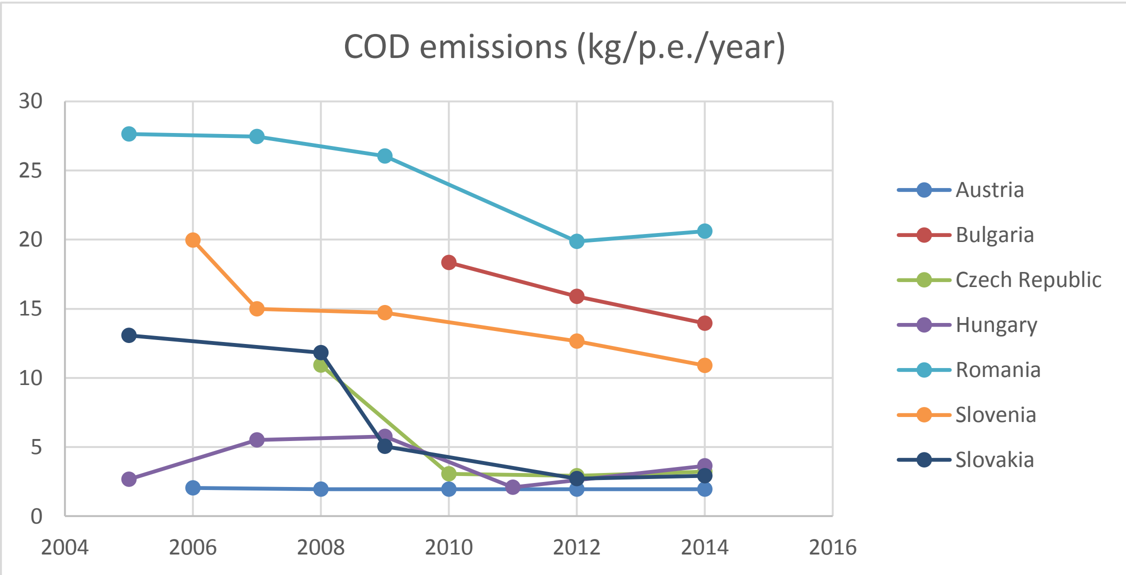


Figure 2-26: Evolution of COD emissions from 2005 to 2014 for seven MS belonging to the Danube River Basin (source: EU implementation reports).

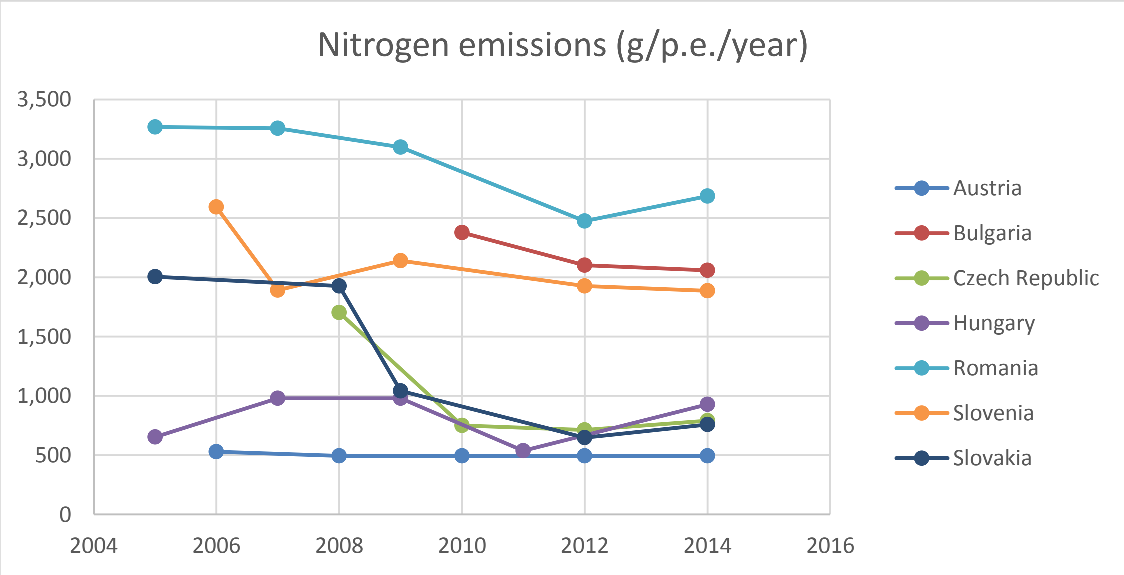


Figure 2-27: Evolution of nitrogen emissions from 2005 to 2014 for seven MS belonging to the Danube River Basin (source: EU implementation reports).

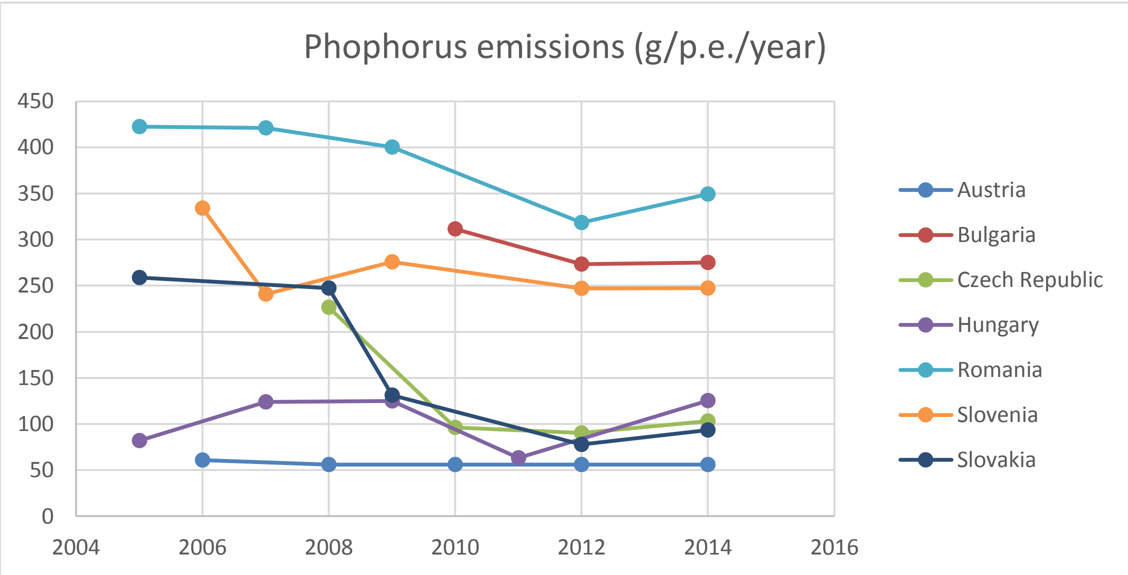


Figure 2-28: Evolution of phosphorus emissions from 2005 to 2014 for seven MS belonging to the Danube River Basin (source: EU implementation reports).

The emissions for BOD_5 and COD seem to follow the same evolution. This can be explained by the values in Table 2-5 where removal rates are very similar for BOD and COD, whatever the treatment or the performance was, but is also explained by the process to treat these parameters which is exactly the same. This same remark can also be done for nitrogen and phosphorus.

The last remark about the results will be the stagnation, and in some cases the increase, of the emissions between 2011-2012 and 2014, for all parameters, especially for Nitrogen and Phosphorus. This phenomenon can mainly be explained by a methodology change in the assessment of the performing treatment plants and the non-performing ones. Indeed for the 9^{th} reporting, the MS were asked to report the performances for all the treatment levels available on a treatment plant, even if this treatment level is not compulsory regarding the Directive (e.g. an agglomeration below 10,000 PE with more stringent treatment). As a consequence all treatment plants without data on performance were considered as non-performing, even if the treatment level was not compulsory. This leads to an increase regarding the estimated emissions.

Analysis:

<u>BOD and COD</u>:

By analysing Figure 2-25 and Figure 2-26, four groups of MS can be highlighted:

- MS that managed to decrease their organic emissions, but still have a high emission per PE in 2014: Bulgaria and Slovenia;
- MS that managed to decrease their organic emissions, with a stagnation for the reference year 2014, and a low emission per PE (below 2kg per PE and per year for BOD): Czech Republic, Slovakia and Hungary (the evolution for Hungary needs to be investigated, as 2 increases in the emissions are present);
- Austria, which reached full compliance before 2005, and then has a very low and constant rate of emission since 2006;
- Romania, which managed to decrease its emissions until 2012, but emissions went up between 2012 and 2014. Moreover, the emission rate still very high (more than 10 kg/PE/year for BOD).

The difference between Austria and the six other MS can be explained by the fact that Austria had to comply with the Directive much earlier than the other MS. However, it is important to understand why there are different groups among the EU13 MS. It is also important to note that not all the MS belonging to the EU13 begin with the same situation at their accession to the EU.

<u>Nitrogen and Phosphorus</u>:

The same assessments can be made for nitrogen and phosphorus as for BOD 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 and not treated.

2.7 Industrial and agricultural direct dischargers (E-PRTR – data supplemented by information from the DRBMP)

For the current report information about the industrial and agricultural direct dischargers were obtained from E-PRTR (and its predecessor EPER), which contains the main industrial facilities and their discharges above certain capacity and emission thresholds, and 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. In order to have a homogenous database with information provided in the ICPDR Urban Waste Water Inventories, data requests in E-PRTR and EPER were done for the reference years 2006 and 2012. However, it is important to point out that this data source (both EPER and E-PRTR) is limited as they cover only the biggest point sources above certain thresholds.

The following figure gives an overview of direct releases of COD, N_{tot} and P_{tot} from industrial and agricultural point sources, that exceed capacity and emission thresholds (under E-PRTR: 50 t/a TOC, 50 t/a N_{tot}, 5 t/a P_{tot}). Data were obtained directly from the E-PRTR- (reference year 2007 – 2014) and the EPER- (reference year 2001 and 2004) database (from the version available at the end of June 2017) and from information collected by the ICPDR for the DRBMP (total emissions in the Danube Basin in the reference year 2006, emissions per country for reference year 2012). Data on COD-emissions were calculated on basis of the loads of total organic carbon (TOC) reported under E-PRTR and EPER. Sector 5.f (urban wastewater treatment plants with a capacity of 100,000 PE and more) was excluded from the data evaluation.

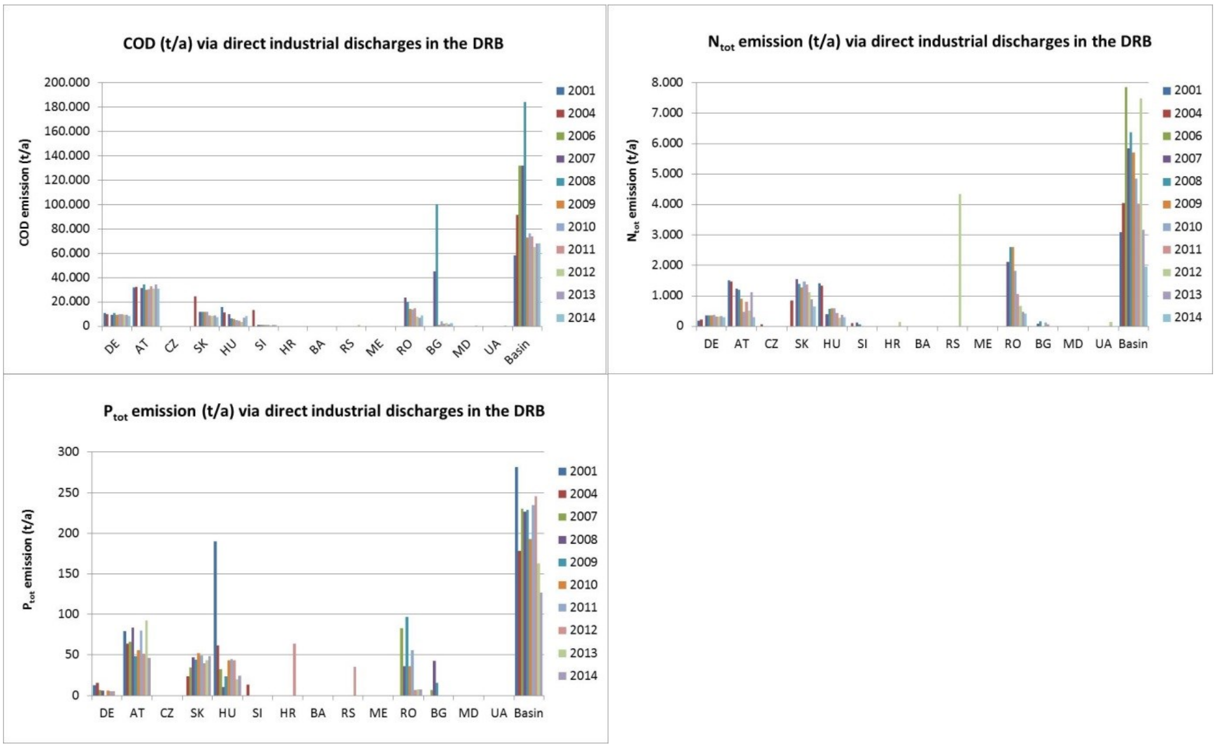


Figure 2-29: Total COD-, N_{tot}- and P_{tot}- discharges from industrial and agricultural direct dischargers into the Danube River Basin for the reference years 2001 – 2014 as reported under EPER and E-PRTR and the DRBMPs

The total emissions in the reference year 2012 as presented in Figure 2-29 slightly vary from the results provided in the 2nd DRBMP (due to up-dates of the E-PRTR database since the data evaluation for the 2nd DRBMP). For the reference year 2012 total emissions of COD amounted to 65,000 t/a, with the paper and wood processing sector (36%) and the waste and industrial wastewater management sector (32%) contributing the highest share of emissions. In 2006 the total COD-emissions amounted to 132,000 t/a, from 2001 to 2014 the emissions in the entire basin varied between 58,200 t/a and 184,500 t/a, with the eight countries in the project contributing between 81% and 94% of the total emissions.

For N_{tot} total emissions in the reference year 2012 amounted to 7,480 t/a, with the chemical industry having the highest importance as regards the share of emissions (46%) followed by the energy sector (40%). In 2006 the total N_{tot} emissions were 7,860 t/a, from 2001 to 2014 the emissions in the entire basin varied between 2,000 t/a and 7,900 t/a, with the eight countries in the project usually contributing between 85% and 94%. In the reference year

2012 Serbia reported very high N_{tot} emissions (4,000 t/a) and therefore, the share of N_{tot}-emissions in the basin from the eight countries in the project was lower (36%) in this year.

As regards P_{tot} total emissions in the reference year 2012 amounted to 246 t/a, with the food production (36%) and energy sector (22%) having the highest importance as regards the share of emissions. In 2006 the total P_{tot} emissions were 454 t/a, from 2001 to 2014 the emissions in the entire basin varied between 127 t/a and 454 t/a, with the eight countries in the project usually contributing between 84% and 100%.

For all three investigated pollutants the reported industrial emissions are relatively small compared to the emissions from urban wastewater. 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}. The share from these sources is very limited but it does not comprise all smaller sources of emission.

2.8 Diffuse sources (as presented in the DRBMP)

To estimate the spatial patterns of nutrient emissions in the Danube basin and 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 hydrological conditions (2009 – 2012). The results were presented in the 2nd DRBMP. MONERIS is a semi-empirical, conceptual model for the quantification of nutrient emissions from point and diffuse sources in river catchments. It allows the identification of the sources and pathways of nutrient emissions into river systems as well as the analysis of transport and retention of nutrients in river systems.

According to the MONERIS calculation presented in the 2nd DRBMP the total nitrogen emissions in the Danube River Basin are 605,000 t/a for the reference period 2009 – 2012. In the 1st DRBMP these emissions amounted to 686,000 t/a N_{tot}. As can be seen from Table 2-7 groundwater flow is responsible for the biggest share of all N_{tot} emissions (54%). Diffuse sources account for 84% and therefore dominate the basin wide nitrogen emissions, whereas point sources amount to only 16% of N_{tot} emissions. The P_{tot} emissions in the Danube River Basin are 38,500 t/a for the reference period 2009 – 2012, with diffuse sources being responsible for 67% of total emissions (and 'soil erosion' being the dominant part within diffuse sources) and 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%**

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

[1] sum of emissions via all subsurface flow components (base flow and interflow)

[2] sum of emissions via urban runoff, combined sewer overflows and not connected population

[3] sum of emissions from urban wastewater treatment plants, population connected to sewer systems without treatment plant and industrial direct dischargers

Table 2-7: Point and diffuse nutrient emissions of the Danube River Basin according to the different pathways for the reference period 2009 – 2012 (ICPDR, 2015)

Taking into account the concept of agglomerations as defined under the UWWTD, emissions from agglomerations cover the emissions from combined sewer overflows, emissions from not connected population (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 the 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 River 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 the urban water management to reduce P emissions (example: reducing P_{tot} concentrations in detergents, removal of P_{tot} in wastewater treatment plants).

The spatial distribution of emissions and the contribution of the different pathways to the total nitrogen emissions in the countries vary according to geo-climatic conditions, the intensity of agricultural land use and the status of urban wastewater management. Whereas in Germany or Slovenia N_{tot}-emissions via groundwater and tile drainage dominate, urban areas and point sources contribute around half of the total emissions in Serbia or Bosnia. For P_{tot} urban areas and point sources are the dominating emission pathways for 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 partly due to a reduction of emissions from point sources and for P_{tot} additionally due to reduction of emissions from urban areas.

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

2.9 Literature

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3. Annex 3: Financial Sustainability of UWWTD Implementation

3.1 Introduction

This chapter addresses the question "*Are we doing it the right way?*" and "*What are the costs of implementing the UWWTD and how affordable and sustainable are those investments?*"

It attempts to provide of answers to the following sub-questions:

1) **Sub-question 1:** *What are the existing financing mechanisms at the disposal of selected EU Members States (MS) for the construction (capital costs) and operation (O&M) of wastewater management infrastructure? To what extent are the originally allocated funds sufficient to achieve agreed UWWTD objectives? How do the initial estimations compare with actual compliance costs?*

2) **Sub-question 2:** *What funding sources, other than EU funds, have been used for capital investments in order to comply with the UWWTD?*

3) **Sub-Question 3:** *What are the overall costs (financial and economic) associated with implementing the UWWTD at basin MS country level?*

4) **Sub-Question 4:** *How are utilities in selected countries financing the operation and maintenance of wastewater infrastructure built to comply with the UWWTD? To what extent has this financing come from increased tariff levels to the public? Have national or local governments put in place mechanisms to subsidise the operation and maintenance of WWTP?*

5) **Sub-Question 5:** *Are current tariff levels considering the cost of asset depreciation? In other words, are WWTPs built in compliance with the UWWTD fully financially sustainable?*

6) **Sub-Question 6:** *What are good examples of fully sustainable operated WW systems, and how have they achieved this outcome?*

7) **Sub-Question 7:** *How much existing tariffs provide for full cost recovery tariff levels (which cover full costs of operating and maintaining water and sewerage infrastructure as well as WWT infrastructure)?*

8) **Sub-Question 8:** *How affordable are user charges (connection costs and tariffs) in DRB MS? What affordability projections and tariff commitments were initially made? How do these compare with the situation today?*

3.2 Financial Sustainability of Wastewater Utility Sector

According to Brikké (2002), sustainability in the water utility sector is primarily based on service quality. A water service is considered to be sustainable when it:

- ✓ is functioning and being used;
- ✓ is able to deliver an appropriate level of benefits (quality, quantity, continuity, healthy) to all the levels of customers, including the poorest;
- ✓ continues to function over a prolonged period, (which goes beyond the lifespan of the original equipment);
- ✓ has an institutionalised management;
- ✓ has operation, maintenance, administrative and replacement costs that are covered at local level;

- ✓ can be operated and maintained at local level with limited but feasible external support; and
- ✓ does not affect the environment negatively.

Financial sustainability of a water utility sector can simply be defined as the availability of sufficient revenue for the service providers to meet utility sectoral obligations. These obligations include provision of water services in sufficient quantities and acceptable quality at affordable prices to all customers, while recovering operating and maintenance (O&M) costs and the costs of capital investments required to maintain and sustain the service in the longer term.

3.2.1 Determining Factors

Financial sustainability depends on a number of factors. In this study the following are of particularly importance:

- Investment and reinvestment costs:
    - Collection network and wastewater treatment plant (WWTP);
    - Individual appropriate systems for small settlements;
- Operation and maintenance costs;
- Tariffs;
- Affordability for customers;
- Long-term population forecasts, and
- Available financing sources.

These factors have been combined into long-term forecast scenarios to explore how a 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 is the potential is for the eight countries of the Danube Region to achieve full cost recovery in the foreseeable future.

3.2.2 Long-term Scenarios

To address the two issues mentioned above, two national cash-flows scenarios for the wastewater sector have been developed for each of the eight countries in the study. The analysis covers the period from 2015 to 2040. These scenarios integrate (i) investment, (ii) reinvestment, including the cost of financing (iii) O&M costs, and (iv) tariff revenues of the utilities. Costs and revenues are expressed in real terms (with no inflation impact taken into consideration) on the basis of 2015.

Two boundary scenarios have been developed:

- A **Business As Usual (BAU) Scenario**. This scenario considers only two off-sector elements as factors of change: (i) population change and (ii) labour cost increases affecting O&M costs.
- A **Sustainability Orientated Pathway (SOP) Scenario**. This over-optimistic scenario attempts to simulate the outcome of financial operation when tariff increases compatible with EU affordability rules are applied. In this scenario the aim of the revenue increase is to achieve (i) operational cost recovery (OCR) ratios comparable to the current Austrian level (1.44-1.6) and (ii) total cost recovery (TCR) ratios not

lower than 1. TCR was defined as embracing not only 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[13].

Table 3.1 and Table 3.2 summarise the key assumptions used in the development of the two scenarios.

Country	GDP	Population	Tariff	O&M	Efficiency
Austria	1.5% DRBMP trend	Increase, EUROSTAT	Unchanged (increase by inflation)	Increase by 1% labour cost	Unchanged
Bulgaria	4-3-2% EC forecast	Decrease, EUROSTAT	Unchanged (increase by inflation)	Increase by 1% labour cost	Unchanged
Czech Republic	4.5-2.6-3% EC forecast	Decrease, EUROSTAT	Unchanged (increase by inflation)	Increase by 1% labour cost	Unchanged
Croatia	2.8-3.1-3% EC forecast	Decrease, EUROSTAT	Unchanged (increase by inflation)	Increase by 1% labour cost	Unchanged
Hungary	3.1-2.9-3% DRBMP trend	Decrease, EUROSTAT	Unchanged (increase by inflation)	Increase by 1% labour cost	Unchanged
Romania	3.9-4.9-4% EC forecast	Decrease, EUROSTAT	Unchanged (increase by inflation)	Increase by 1% labour cost	Unchanged
Slovenia	2.9-2.5-3% EC forecast	Decrease, EUROSTAT	Unchanged (increase by inflation)	Increase by 1% labour cost	Unchanged
Slovakia	3.8-3.6-3% EC forecast	Decrease, EUROSTAT	Unchanged (increase by inflation)	Increase by 1% labour cost	Unchanged

Source: EC economic forecasts, Eurostat, DRBMP; Own assessment

Table 3.1: Assumptions used for the development of the BAU scenario 2015-2040, annual changes

Country	GDP	Population	Tariff	O&M	Efficiency
Austria	1.5% DRBMP trend	Increase, EUROSTAT	Increase above inflation, 4-year 5%	Increase by 1% labour cost	Unchanged
Bulgaria	4-3-2% EC forecast	Decrease, EUROSTAT	Increase above inflation, 14-year 5%; 1-2% afterwards. Affordability constraints if EC threshold is applied.	Labour cost 3% increase	12-year cost 3% savings: NRW and labour productivity
Czech Republic	4.5-2.6-3% EC forecast	Decrease, EUROSTAT	Increase above inflation, 7-year 5%; 1-2% afterwards	Labour cost 3% increase	7-year 0.5% cost savings: NRW and labour productivity
Croatia	2.8-3.1-3% EC forecast	Decrease, EUROSTAT	Increase above inflation, 10-year 5%; 1-2% afterwards	Labour cost 3% increase	25-year 2.5% cost savings on NRW
Hungary	3.1-2.9-3% DRBMP trend	Decrease, EUROSTAT	Increase above inflation, 10-year 5%; 1-2% afterwards	Labour cost 2% increase	Unchanged
Romania	3.9-4.9-4% EC forecast	Decrease, EUROSTAT	Delayed increase after 6 years. Increase by 4% up to 2040.	Labour cost 2% increase after 10 years.	10-year 5% cost savings NRW and 15-year 10% labour productivity

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

Country	GDP	Population	Tariff	O&M	Efficiency
			Affordability constraints if EC threshold is applied.		
Slovenia	2.9-2.5-3% EC forecast	Decrease, EUROSTAT	Increase above inflation, 10-year 5%; 1-2% afterwards	Labour cost 3% increase	8-year 0.5% cost savings NRW and labour productivity
Slovakia	3.8-3.6-3% EC forecast	Decrease, EUROSTAT	Increase above inflation, 10-year 5%; 1-2% afterwards	Labour cost 3% increase	7-year 4% cost savings NRW and 15-year 4% labour productivity

Source: EC economic forecasts of EUROSTAT, DRBMP; Own assessment

Table 3.2: Assumptions used for the development of the SOP scenario 2015-2040, annual changes

The following longer-term assumptions and elements were embedded in the scenarios.

- Evolution of revenues:
    - ✓ Number of inhabitants in line with the forecast of the Statistical Office of the European Communities (EUROSTAT) up to 2040;
    - ✓ Per capita water consumption trends;
    - ✓ Tariff increase (not higher than 5% tariff increase annually to stay reasonably realistic);
    - ✓ Collection efficiency of billed revenues;
    - ✓ Affordability ratio to set the upper limit of tariff increases at the total affordability rate of maximum 5% of combined water and wastewater expenditures. Affordability was also checked at a rate of 4% promoted by EC.
- Evolution of O&M costs
    - ✓ Efficiency-boosting measures (NRW as proxy for infiltration to be reduced to 25%, staff productivity reduced to 4 staff per 1,000 connections);
    - ✓ Cost increase as a result of real wage growth in new EU MSs;
    - ✓ Operating cost coverage ratio as proxy for the O&M cost trend. When this ratio dips below 1, the service becomes unsustainable.
- Evolution of capital costs
    - ✓ Significant amount of new investment costs were considered in RO and HR up to full compliance with UWWTD starting in 2015 with annual increment split linearly until 2020-2026 as appropriate;
    - ✓ Various residual amounts of new investments in other MSs, with the exception of AT which is already fully equipped;
    - ✓ Staged reinvestment costs compatible with the life expectancy of infrastructure for all eight target countries;
    - ✓ Costs for financing arising as a consequence of an hypothetical termination of EU-funding after 2027.
- GDP growth projection per country based on
    - ✓ DRBMP 2015 projection for countries with consistent data (AT, SK, HU);
    - ✓ EC Economic forecast 2017 winter for the other countries (BG, CZ, HR, RO, SI).

The period of projection was considered to be 2015-2040 for all eight target countries.
In the BAU scenario, no tariff increase is considered necessary. Changing factors are the overall number of inhabitants according to the EUROSTAT forecast and water utility real wages convergence to the EU15-level of 1% per year.

In the SOP scenario, wastewater tariff increase is sped up while staying within or below (i) a maximum annual increase of 5 % for wastewater tariff and (ii) a maximum affordability threshold of 3% for the wastewater segment and 60% of water expenditure (in critical cases, when the water expenditures of households is calculated to reach the preceding affordability ceiling, a lower, EU-promoted threshold of 2.4% was then considered).

Each of the two scenarios is documented with the help of two key indicators:

- The evolution of the ‘operational cost recovery (OCR) ratio’, calculated as billed revenue per operating expenditures;
- The evolution of the “total cost recovery (TCR) ratio”, calculated as total revenues [operating expenditures + capital expenditures].

Table 3.3 summarises the main indicators under the SOP scenario at the beginning and end of the assessment period.

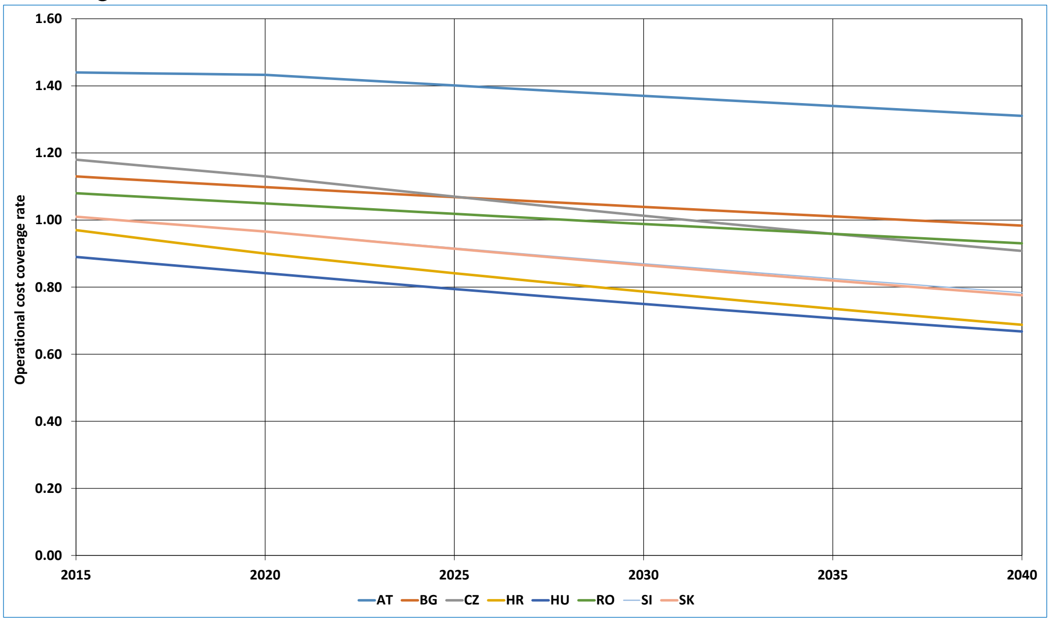
Target countries	Operating Cost Recovery Ratio		Total Cost Recovery Ratio	
	2015	2040	2015	2040
Austria	1.44	1.52	0.86	1.00
Bulgaria	1.13	2.51	0.24	1.00
Czech Republic	1.18	1.21	0.84	1.00
Croatia	0.97	1.25	0.39	1.00
Hungary	0.89	1.22	0.66	1.00
Romania	1.08	1.69	0.40	1.00
Slovenia	1.00	1.24	0.50	1.00
Slovakia	1.01	1.26	0.63	1.00

Source: Own calculation

Table 3.3: Estimation of OCR and TCR ratios under the SOP scenario

As shown in Table 3.3, the SOP scenario leads to reasonable financial sustainability, albeit with the help of serious and repeated tariff increases, which may not please policy makers and politicians.

The long-term projection of the above indicators under BAU and the SOP scenarios is reflected in Figures 3.1 to 3.4.

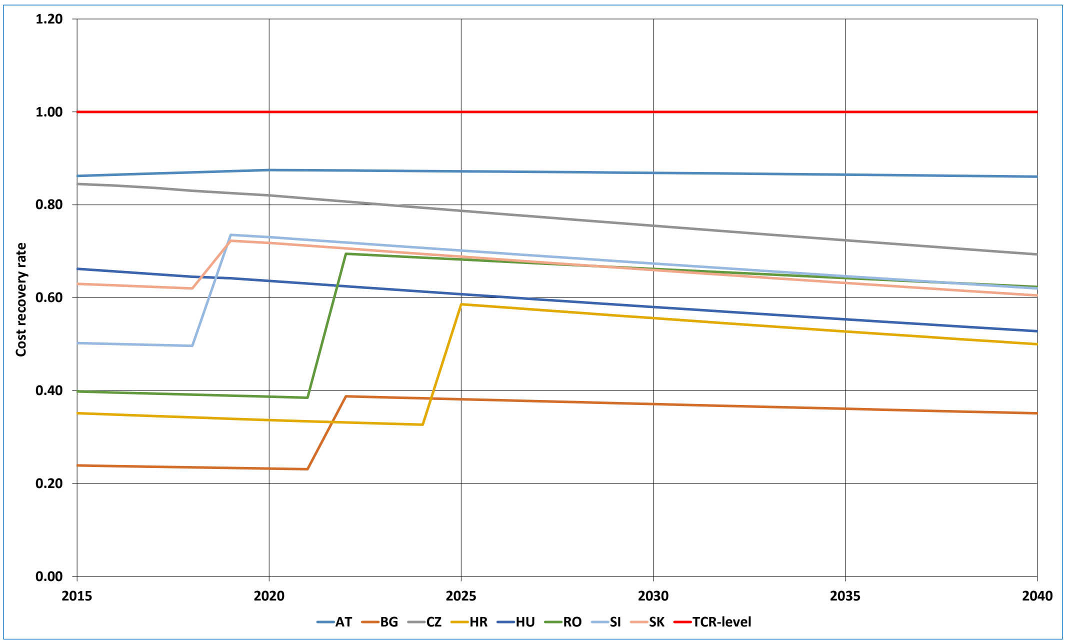


Source: SOS Report 2015; Own assessment

Figure 3.1: Long-term evolution of OCR ratios in countries in the Danube region – BAU Scenario

The SOP scenario identifies several conditions that allow the eight countries to achieve full cost recovery (TCR ratio of 1 or higher, Figure 3.4). These are:

- Without revenue increase, the OCR ratio for the sanitation sector is expected to decrease in all eight countries below cost covering O&M requirements, except for AT;
- By 2040, the lowest OCR ratios are expected in countries with the largest population decline: HU, HR, SI and SK. These countries will not be able to cover their O&M costs throughout the assessment period, so the wastewater services become unsustainable;
- Other countries run into operational loss from 2027-2031 onward (RO, CZ, and BG). For BG, there is possibly an error in the declared operational revenue and cost data, as they are significantly lower than in other countries in the region. The initial operation cost coverage ratio (1.13) is good but may be incompatible with serious efficiency problems also reported (high (60%) NRW and low staff productivity (above 7));
- AT continues to cover its operating expenditures (OPEX) albeit with a decreasing level of OCR ratio.



Source: SOS Report 2015, Own assessment

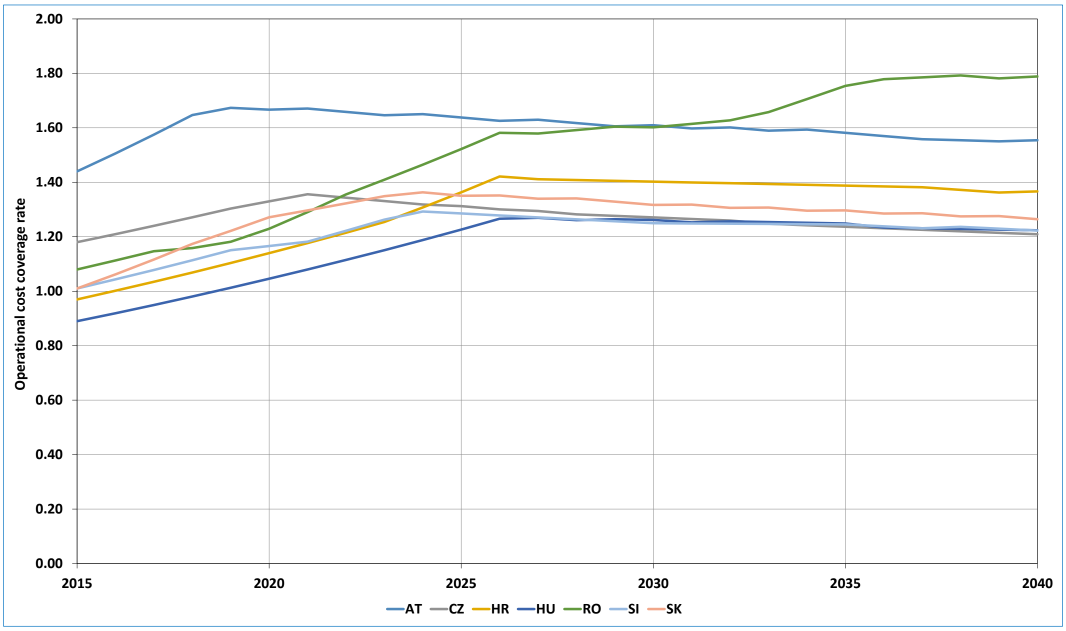
Figure 3.2: Long-term evolution of TCR ratios in countries in the Danube region – BAU scenario

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

The key findings regarding the long-term trends of TCR ratios under BAU scenario (Figure 3.2) are:

- without revenue increase, the TCR ratio, which includes OPEX and capital expenditures (CAPEX), is expected to decrease in all eight countries and remains 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 overall costs of sanitation services;

- By the same year the TCR ratios will become 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);
- Even in AT the TCR ratio remains well below the desired level of 1 (red line in Figure 3.2).

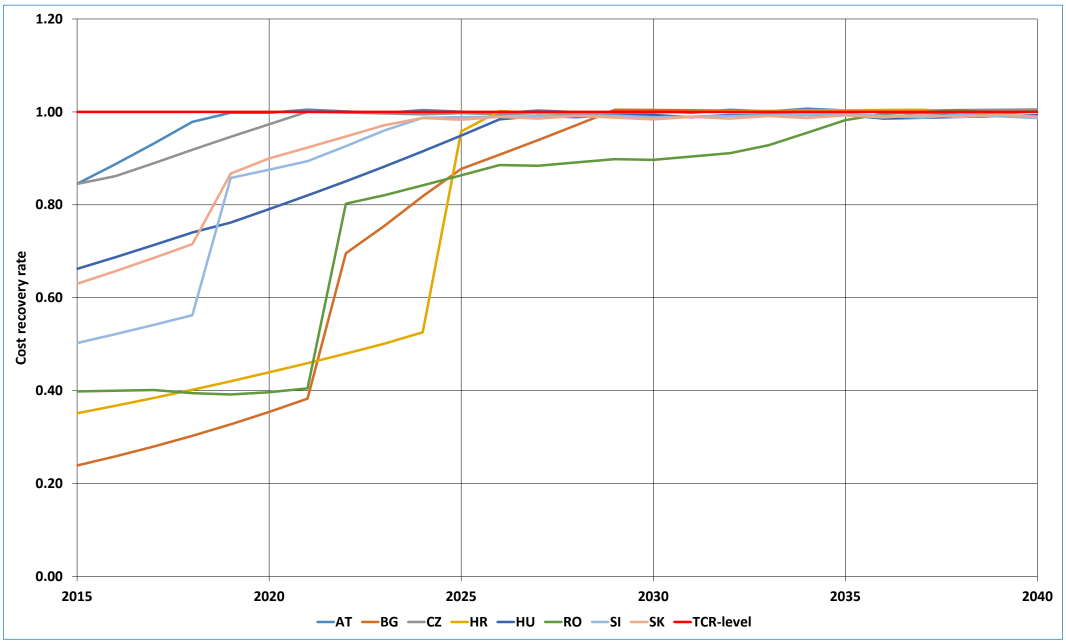


Source: SOS Report 2015, own assessment

Figure 3.3: Long-term evolution of OCR ratios in countries of the Danube region – SOP scenario

The main findings regarding the long-term trends of OCR ratios under SOP scenario (Figure 3.3) include:

- an adequate OCR ratio can be achieved with the help of a mix of significant incremental tariff increases and complementary efficiency improvements in all Danube region countries;
- the best ratios are expected in RO and AT (1.5 and 1.7). Most of the countries are expected to reach OCR in the range of 1.2 to 1.3 by 2040;
- the relatively high values expected in RO are linked to the good current operational cost coverage ratio reported in that country. With low staff productivity presently pegged at 18, it is unclear in what way the country can justify an operational cost recovery ratio above 1 (1.08);
- BG is excluded from the chart as its OCR ratio jumps to the unlikely value of 2.5, when the revenues are raised to cover CAPEX by 2040. There is possibly some data incoherence in the underlying dataset extracted from available reports on which the scenarios are based.



Source: SOS Report 2015, own assessment

Figure 3.4: Long-term evolution of TCR ratios by countries of the Danube region – SOP scenario

The SOP scenario identifies several conditions that allow the eight countries to achieve full cost recovery (TCR ratio of 1 or higher, Figure 3.4). These are:

- ✓ A TCR ratio of 1 (red line in Figure 3.4) can be achieved within a 5 to 25 years period for all of the eight countries with robust tariff increases remaining within the 3% affordability threshold of wastewater services, and with productivity and efficiency gains by the operators;
- ✓ In AT, a 5-year long annual 5% increase of tariff above inflation would raise the TCR ratio to the desired level of 1. As the population is expected to continue to increase, there is no risk of a shrinking customer base. The WW tariff level by 2040 is calculated to be 2.44 €/m^3;
- ✓ In CZ, a 7-year annual 5 % increase of tariff over 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 €/m^3;
- ✓ In HR, a 12-year annual 5% increase of tariff over inflation would be needed to reach a TCR ratio of 1. As the population is expected to decrease in the future years, a 1 to 2 % annual tariff increases would be needed to compensate for the shrinking customer base. This is in spite of assumed utilities' staff productivity gains. The WW tariff level by 2040 would be 2.41 €/m^3;
- ✓ In HU, a 13-year annual 5% increase of tariff over inflation would lead to a 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 €/m^3. Affordability constraints will appear if the EC threshold is applied;
- ✓ In RO the affordability ratio has already reached the maximum value without the assumed tariff increases at the beginning of the assessment period in 2015 (see Figure 3.10). A 3 to 4% annual tariff increase can therefore be expected to continue for 25 years to secure a TCR ratio of 1. If the EC affordability threshold is applied, a

TCR ratio of 1 cannot be reached within the period of assessment (until 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 €/m^3;

- ✓ In SK, a 5% annual increase of tariff over inflation over a period of 10 years would lead to a TCR ratio of 1. A further 2% annual increase will be needed to balance constraints appearing due to a shrinking customer base. Some efficiency improvements could occur (NRW from 32% and staff productivity from 8). The WW tariff level by 2040 would be 2.68 €/m^3. Affordability constraints would appear if the EC threshold is applied;
- ✓ In SI, the 5% annual tariff increase would be necessary 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 loss of customers. Some efficiency improvements could appear (NRW (from 31%). The WW tariff level by 2040 would be 2.49 €/m^3;
- ✓ Finally, in BG an annual 5% tariff increase over inflation is necessary over a 15-year period. 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 later years. The potential for efficiency gains would be high (NRW from 60% and staff productivity from 6). Affordability constraints would occur if the EC threshold is applied. In this case, a TCR ratio of 1 cannot be achieved within the period of assessment. The WW tariff level by 2040 would be 1.30 €/m^3.

The SOP scenarios highlighted above are based on certain tariff increase assumptions that may or may not materialise:

- It assumes a continued GDP growth until 2040 along the trend predicted between now and 2018. In the case of a slowdown of economic growth, household incomes may stop expanding. The affordability threshold recommended by the EU and applied in the scenario may then prevent the modelled tariff increases from occurring (RO, BG, HU, SK).
- Affordability constraints can also affect the modelled tariff increase, when poorer residents are connected to the wastewater network in smaller settlements, especially in RO and BG.

Intermediary scenarios between the two calculated extremes presented above would all yield lower cost recovery ratios, especially with regard to TCR. Some financing gaps particularly for capital investments or reinvestment may then appear. These gaps 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 possibly limited period until 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, but the SOP scenario continues until 2027. In the SOP scenario, 2027 was hypothetically assumed to be the end year for new investments co-financed with EU grants, and the starting year for the inclusion of the cost of financing with the help of commercially pegged loans or bonds. The SOP scenario predicts that access to money markets (commercial loans or national or municipal bonds) will become an imperative for UWWTD capital reinvestment from 2028 onward.

As commercial loans or bonds are only provided to creditworthy organisations, it is of the utmost importance that water and wastewater utilities and related municipalities start early to build up their credit ratings and creditworthiness to enable them access to money markets (loans and bonds) for their UWWTD related capital investments and reinvestments.. In the case loans and bonds are becoming necessary, legal limitations on debt ceiling for municipalities will have to be taken into account.

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

The project involved a concession for the construction and operation of a wastewater treatment plant to serve the municipality of Maribor, the second largest city in Slovenia with a population of 110,000. Investors/sponsors included, in addition to two French enterprises Suez Lyonnaise des Eaux SA (SLDE) and Degremont, two Austrian water companies: Aquanet GmbH and Styrcon GmbH. The composition of the sponsor group was designed to maximise the strengths required for the project and represented by international corporations with wide experience in the water sector and infrastructure project development in the region. The concession was granted by the Municipality of Maribor to a locally incorporated special purpose entity, Aquasystems d.o.o. which is wholly owned by the project sponsors. The EBRD provided financing to Aquasystems, for a total amount of 28.1 MEUR.

The construction took place between 2000 and 2004, and the operating period will run until 2024. The total cost (development, financing, construction) was 43.5 M EUR, and was financed with the Slovenian party's equity (24%) and commercial debt (76%) from EBRD and syndicated banks. In parallel, the Municipality benefitted from a 6.5 M EUR grant from the EU's Large Scale Infrastructure Facility (LSIF) for the construction of the main collector.

Aquasystems is not entitled to collect service charges directly from consumers in Maribor, instead it is paid by the Municipality for performance-based construction and operation services. In the event of a shortage of funds from tariff revenues collected, the Municipality is obliged to pay the concession fees out of its available financial resources.

Aquasystems has in turn entered into a fixed-price turnkey construction contract with SLDE and Degremont, and into a technical assistance and know-how licence agreements with SLDE (thus ensuring that it has sufficient technical resources available from the sponsors at all times to perform its concession agreement obligations).

The term of the concession is 22 years from the scheduled acceptance of the construction of the first phase of the facility. The agreement is divided into separate construction and operational periods to split risks and facilitate the concessionaire's ability to manage them. The construction period was split into three phases, representing the progressive level of treatment of the constructed facility (mechanical pre-treatment during phase one; biological treatment for pollution removal during phase two; and advanced biological treatment for the removal of nitrogen and phosphorous compounds during phase three). The phasing of the construction into three treatment steps with different treatment performance criteria was a challenge for this transaction. The approach was to make the implementation of each phase dependent, as far as possible, from objective measurable performance criteria and procedures to avoid the need of renegotiation at the end of each phase. The construction period included starting and closure dates as well as target performance acceptance criteria for each phase.

The tariff was structured to meet the project's funding and commercial requirements. It was kept flexible enough to accommodate contingent investment requirements. This was accomplished by breaking the tariff into three distinct components: a capital charge, an operation charge and a tax pass-through charge. The capital charge provided for the recovery of costs for the design, construction and start-up of the facility. The operation charge consisted of a fixed monthly component, and a variable, cash-inflow related component, based on a fixed rate of EUR/m^3 of influent. These two elements were subjected to escalation based on annual inflation. The tax pass-through charge was designed to enable the concessionaire to recover Slovenian taxes, including, inter alia, sales tax and VAT. Other taxes, including profit and income taxes, were not reimbursable.

***Experience of the past 15 years**:*

Aquasystems is now operating in cooperation with the Sewage System Unit of the multi-purpose utility company of Maribor, called Nigrad d.d as shown in the published price list for 2017. With water tariffs controlled by the central government until January 2013, water utilities in SI struggled to generate adequate revenues to cover their costs. According to the Decree on Methodology for pricing (Official Gazette of the Republic of Slovenia, No. 87/2012, 109/2012), new tariff structure and approval process has been introduced. The current water tariff comprises a fixed charge for service availability, which is set depending on the meter's diameter, and a volume charge proportionate to water consumption. This tariff structure is uniform for all categories of water users (households, businesses). According to Nigrad d.d.'s Price List 2017, the sanitation price regarding Aquasystems services is €1.3056/m^3, which has not been changed since 2010. According to the Study elaborated by Nigrad d.d for the price proposal 2016, published on the website, service prices have remained unchanged since 2004. The financial performance indicators of the Sewage System Unit are positive, or show some negligible yield due to cost savings of maintenance works that has not been carried out. The Nigrad Study provides a list of uncompleted maintenance works between

2013 and 2015 comparing performed and planned maintenance requirements (e.g. the annual cleaning of sewers 14-23%; camera inspections of sewer pipes 11-12%; cleaning of pumping stations 17-157%; manual cleaning of nets and other discharge facilities 40-273%; pest control 66-100%; sand waste 25-27%). The Nigrad Study emphasises that in recent years, some of the costs of implementing public services have increased significantly. Taking into account the level of services provided by the company to users and the related costs, price adjustment is indispensable. We did not find evidence that Nigrad's price proposal (Reference number: DT-) has been approved.

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

3.3 Investment Costs for UWWTD Compliance

UWWTD investment costs primarily cover centralised infrastructure (network and wastewater treatment plants (WWTP)) and the reinvestment needed for sustainable operation. This also includes decentralised systems called Individual Appropriate Systems (IAS), which are installed in small agglomerations and settlements where centralised infrastructures are not cost-effective.

3.3.1 Investment Costs of Sewer Networks and WWTPs

Several data sources were explored and assessed to determine the investment costs of UWWTD implementation to arrive at reasonably complete and coherent values for the study.

3.3.1.1 Data Sources

Three official documents were available with quantitative data for the centralised infrastructure developed in the Danube region. These are the two Danube River Basin Management Plans (DRBMPs; the 1st DRBMP of 2009 and the DRBMP update of 2015) and the 9th EU Technical assessment[14] of the implementation of the UWWTD by the EC services (9th TA-UWWTD).

The paragraphs below review successively the data available in the DRBMPs and the EU 9th TA-UWWTD. They are complemented and validated by data collected from a questionnaire sent to relevant representatives of competent authorities in each of the eight countries.

Two main complementary investment groups were compiled: (i) past investments made to date (considering 2014 to be aligned with the reference data of the recently completed 9th TA-UWWTD) and (ii) the future investments necessary to achieve full compliance with the articles of the UWWTD, in particular Article 3 (sewerage), Article 4 (secondary treatment) and Article 5 (advanced, more stringent treatment).

Data from the DRBMPs

The estimation of the investment needed under the UWWTD as reflected in the DRBMPs is shown in Table 3.4.

[14] 9th Technical assessment of the implementation of Council Directive concerning Urban Waste Water Treatment (91/271/EEC) - European Commission Directorate General Environment September 2017

Target Countries	1st DRBMP 2009	DRBMP Update 2015	
	"2005-2015 Implementation of UWWTD – Costs"	Annex 11 "2009-2015 EA Investment cost for water supply and wastewater"	Annex 12 "2016-2021 Implementation progress of UWWTD - Costs"
Austria	Full compliance, no new investment costs expected	3,200	Full compliance reached; ongoing costs for maintenance and reinvestments
Bulgaria	352	1,600	352
Czech Republic	1,315	822	Full compliance reached by 2016, but delayed; ongoing costs for maintenance and reinvestments
Croatia	1,950	650	1,885
Hungary	3,100	1,887	2,405 (excluded, as refers to years 2013-2015)
Romania	13,400	12,700	13,400
Slovenia	884	1,021	884
Slovakia	1,604	985	-
Danube Region	**22,605**	**22,865**	**16,521**

Sources: DRBMP2009, DRBMP2015

Table 3.4: Investment Cost of Compliance with UWWTD reflected in DRBMPs, M EUR

Data shown in Table 3.4 highlight that despite the sizeable investments already made in connection with the UWWTD, additional investments are needed to achieve compliance. With the exception of AT, all other EU MSs, targets of this study have experienced delays in the implementation of the UWWTD, mostly due to financial constraints. For the RO and HR, the need for new infrastructure remains substantial. For the others the demand is small. This means that a number of both large and smaller agglomerations (as defined in the UWWTD) in the Danube region countries currently remain non-compliant with the Directive as indicated by the DRBMPs.

Data from 9th TA-UWWTD

The latest progress report of the UWWTD implementation is the 9th TA-UWWTD and covers the period 2013-2014. The stated annual investments for the Danube region countries are summarised in Table 3.5.

Target Countries	Yearly investments (new and renewals) M EUR		
	Past	Current	Future planned
Austria	308	329	334
Bulgaria	340	340	364
Czech Republic	300	301	304
Croatia	98	323	323
Hungary	510	462	462
Romania	1,391	1,774	906
Slovenia	123	209	50
Slovakia	67	188	202
Danube Region	**3,137**	**3,926**	**2,945**

Source: 9th TA-UWWTD

Table 3.5: UWWTD Annual Investment data under the 9th Technical Assessment

Cost data provided by the MSs under the 9th TA-UWWTD do not clearly mention the investment period covered for the reported investment values (past and future). For some countries, data only refers to a few years of the last EU programme period, while for others the data refers to the entire timespan from the date of accession. Some countries do not even mention which years of past or future investment they are referring to. Some reported costs include not only new investment, but also expenditure on reinvestments. Consequently, this investment data is not really fit for purpose to serve as a base dataset for the estimation of the total cost of compliance with the UWWTD.

Data from complementary questionnaires
The questionnaire delivered to each of the eight countries attempted to collect data covering the total historical UWWTD investment costs of each country including investment developed before and since accession.

Three countries (AT, RO and SK) provided answers to the questionnaire. Only Slovakia answered the question "How does the ex-ante cost estimation for investment compare with ex-post disbursed amounts toward UWWTD compliance", indicating ca. 10% underestimation of investment needs (2,588 vs. 2,909 MEUR), which is an indicator of good quality infrastructure planning, monitoring and reporting for this country. Investment costs reported through questionnaires from countries are presented in Table 3.6. Data collection through these questionnaires brought only few results and is therefore insufficient for a thorough analysis of UWWTD implementation.

Target Countries	Investment costs, M EUR		Source of information, remarks
	2000-2015	2016-2021	
Austria	45,500	387.65	Data from year 1959; and in 2016 (only reinvestment).
Bulgaria			Data collection has been stopped due to ongoing EC enquiry on UWWTD implementation
Czech Republic			Result of data collection was not delivered.
Croatia			Result of data collection was not delivered.
Hungary	1,775	865	HU authorities officially stated that DRBMP and HU RBMP update 2015 are the data sources for 2007-2015; Costs for 2000-2006 are not specified
Romania	1,897; 4,965	541; 7,671	In period 2022-2027 for agglomerations <2000; 4,071 M EUR. RO reports different data in various reports.
Slovenia			Result of data collection was not delivered, except the case study of Maribor.
Slovakia	2,225.6	683	Investment plan prepared in 2004: 2,588 M EUR

Source: Country Questionnaires and communications

Table 3.6: Summary of total investment costs of compliance with UWWTD via questionnaires

3.3.1.2 Best Estimates Based on Population Equivalent Data

In order to consolidate the data documented in the previous paragraphs into a coherent and complete picture of the investment costs for UWWTD implementation in the Danube region, an estimation was attempted. This was based on a standard cost function developed for DG Environment using the Population Equivalent (PE) information from the dataset of the 9th TA-UWWTD.

The estimation, which takes into account the distance to compliance for each UWWTD agglomeration as defined and documented in the 9th TA-UWWTD, enables the integration of the cost of infrastructure at various stages before or after accession to EU, which are not documented in the available information sources mentioned earlier. At the time of EU accession, all countries had already historically constructed sewer networks and some WWTPs that should be part of the overall investment picture.

The approach taken uses a uniform method for all countries based on the estimated distance to compliance of each agglomeration in terms of pollution abatement extracted from the 9th TA-UWWTD. The cost functions link the investment costs to pollution load, expressed in PE processed for four groups of agglomerations of various sizes: (2,000 to 9,999; 10,000 to 49,999; 50,000 to 99,999 and above 100,000 PE).

The indicative initial status of UWWTD infrastructure coverage at the year of EU accession is also taken into account using the data summarised in Table 3.7.

Target Countries	Year of accession to EU	WW Collection coverage %	WWTP coverage %
Austria	1995	76	100
Bulgaria	2007	70	42
Czech Republic	2004	78	94
Croatia	2013	62	43
Hungary	2004	40	96
Romania	2007	43	28
Slovenia	2004	74	34
Slovakia	2004	55	68

Source: Country pages, National surveys – SOS 2015

Table 3.7: Indicative sanitation coverage in the countries in the year of accession

According to the 9th TA-UWWTD and datasets, each country's wastewater agglomerations can be divided into two major groups:

- agglomerations, which are compliant with UWWTD with wastewater collection and treatment installations in place. This means, the performance of the installations are disregarded, and
- agglomerations non-compliant groups with infrastructure to be built in the future.

The first group represents historical investments up to 9th TA-UWWTD cut-off date (31/12/2014), while the second group represents future investment needs (from 1/1/2015 onward).

The results of the investment cost assessment are summarised in Table 3.8. A rough estimation of the investment needs for centralised wastewater infrastructure in the eight countries of the Danube region for full compliance with UWWTD is around 60 Billion EUR, out of which 43 Billion EUR have already been invested. Future new investment needs (from 2015 onward) for sewage network and WWTP are expected to be around 17 Billion EUR. As HR was not requested to report in the 9th TA-UWWTD, no data is available regarding installations already in place. Consequently the total amount of estimated Croatian investment is dealt with in this assessment under future investment.

Target Countries	Total Pollution load, PE	Historical investment costs, M EUR		Future investment costs, M EUR		Total investment cost for full compliance, M EUR
		Sewer network	WWTP	Sewer network	WWTP	
Austria	20,270,894	10,150	4,238	-	-	14,388
Bulgaria	8,080,245	3,370	810	804	865	5,849
Czech Republic	7,179,593	4,675	1,590	-	21	6,286
Croatia	5,026,227	0	0	3,074	999	4,073
Hungary	10,210,998	5,592	1,221	-	12	6,825
Romania	20,786,160	5,852	990	7,037	3,373	17,252
Slovenia	1,371,002	883	87	112	222	1,304
Slovakia	3,890,209	2,360	578	17	281	3,236
Danube Region	**76,815,328**	**32,882**	**9,514**	**11,044**	**5,773**	**59,213**

Source: 9th TA-UWWTD; own assessment

Table 3.8: Calculated total investment costs needed for compliance with UWWTD (centralised systems); reference year 2015

The investment cost numbers here are significantly higher than the values reflected in preceding paragraphs. Table 3.9 reflects the estimated corresponding specific cost per PE and per country needed to implement 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. Sewer network development costs are about twice as expensive as related WWTP development costs. HU also has the lowest specific WWTP investment costs (121 EUR/PE). Its share of designated sensitive agglomerations is also the smallest in the Danube region (see the map in Figure 1-8 in Chapter 1 of this Annex). Not surprisingly, more expensive tertiary treatment applies to a considerably smaller territory and a smaller number of agglomerations.

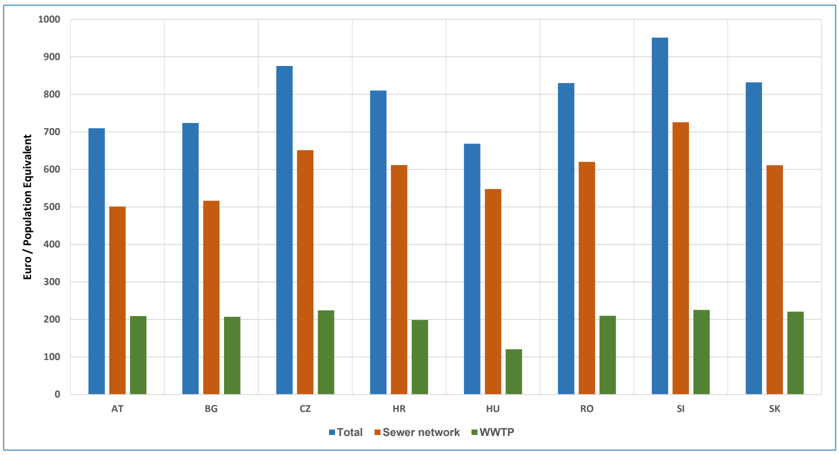
Target Countries	Total Investment Cost per PE			Country Population Density	Share of rural* population in country %
	Total	Sewer network	WWTP		
Austria	710	501	209	103	34
Bulgaria	724	517	207	65	26
Czech Republic	876	652	224	134	27
Croatia	810	611	199	74	41
Hungary	668	547	121	106	29
Romania	830	620	210	86	45
Slovenia	951	726	225	102	50
Slovakia	832	611	221	111	46
Average Danube Region	**771**	**572**	**199**	**94**	**37**

*Source: Own calculations, *World Bank database on rural population per countries*

Table 3.9: Specific investment cost per PE to achieve UWWTD compliance in the Danube region

A predictable link between specific costs and population density is noticeable in this table. This relates to the density of urbanisation, along with the number and size of agglomerations above 2,000 PE in each country. The denser the population and urbanisation of a country and the larger the size of the agglomerations in a country, the lower the specific investment costs.

Specific investment cost per PE for compliance with UWWTD is split into sewer cost and WWTP cost. The sum of these two costs is reflected in Figure 3.5.



Source: own assessment

Figure 3.5: Specific investment costs of UWWTD compliance, EUR/PE

3.3.2 Reinvestment Costs

The sustainability of the functionality of a centralised wastewater infrastructure system requires periodic significant reinvestment to

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

These additional capital costs need to be covered by the owner of the infrastructure. These costs do not appear immediately after construction of the infrastructure, but start to occur five to ten years later. Their financial recovery through inclusion in the tariff needs to start early to build the financial reserves needed when physical demand for replacement arises.

Austria, with its mature water infrastructure, will be the first to confront the substantial costs of modernising and upgrading its wastewater systems to meet rising environmental standards and to replace obsolete installations developed in the earlier years. The rehabilitation of the old infrastructure for some new MSs also causes substantial financial burden (see Table 3.7).

Various complex methods and assumptions are described in the literature to assess the reinvestment needs of wastewater infrastructure. All require details about the type of infrastructure, the technologies applied, the sophistication of the equipment and its life expectancy. In the absence of such details, a simple and straightforward approach is to estimate reinvestment as a single percentage of the initial investment costs. For this assessment, the annual reinvestment requirements for a sewer network have been defined as 2% of the initial investment value (life expectancy of 50 years) and 5% for the WWTP (life expectancy of 20 years). Arguments in favour of such a relative short lifespan are the increasing proportion of electronic and IT equipment in WWTP investment, along with the growing use of smart technologies, which require replacement every three to five years. Table 3.10 shows the magnitude of the issue of replacing and upgrading wastewater collection and treatment infrastructure in the countries of the study. It reflects reinvestment needs starting with the reference year 2015 progressing onward for 25 years based on the calculated investment cost figures highlighted in Table 3.8 earlier.

Target Countries	Reinvestment need on historical installations, M EUR		Reinvestment need on future installations, M EUR		Total annual reinvestment need, M EUR	Total Initial Investment values, M EUR
	Sewer network	WWTP	Sewer network	WWTP		
Austria	203	212	0	0	415	14,388
Bulgaria	67	41	16	43	167	5,849
Czech Republic	94	80	0	1	174	6,286
Croatia	0	0	61	19	81	3,459
Hungary	112	61	0	1	173	6,825
Romania	117	50	141	169	476	17,252
Slovenia	18	4	2	11	35	1,304
Slovakia	47	29	0	14	90	3,236
Danube Region	**658**	**476**	**221**	**258**	**1,613**	**58,599**

Source: 9th TA-UWWTD; Own assessment

Table 3.10: Calculated Reinvestment Need for Sustained Compliance with UWWTD

AT, which is a fully equipped “old“ EU MS, will experience substantial demand for infrastructure renewal to maintain current standards. In other countries, as shown in Table 3.7, the current coverage of sewer network was the highest (78%) in CZ and the lowest (34%) in SI. For WWTP infrastructure, the corresponding figures are for the best performing country (excluding AT), again CZ with 94% urban population coverage. The lowest proportion of wastewater treatment facilities is registered in RO (28%). As CZ was already significantly better equipped at the date of accession, it is expected that the country will face (after AT) a large demand for funds to renew and upgrade its UWWTD infrastructure to sustain its environmental efficiency. Some other new MSs (e.g. HU) are also struggling to find financing sources to carry out restoration of its old sewerage systems.

In 2015, a Special Report from the European Court of Auditors (ECA) on the EU-funding of urban WWTPs in the Danube River Basin was issued, targeting 28 newly built WWTPs in four countries (CZ, SK, HU and RO). The report concluded that, based on current revenue trends, financial reserves accumulated by utilities managing WWTPs would be insufficient to implement the renewal of their UWWTD infrastructure. In only 12 (43%) of the 28 WWTPs assessed, had adequate reserves been built by the owners to finance renewal and reinvestment. Interestingly, according to the report, the organisational structure of the owning/operating utilities plays a significant role. When the owner is a single non-commercial entity (municipality), and there is no legal requirement to ensure separate accounting for the management of water-related services, income and expenditure are often merged with income and expenditure from other municipality activities. The capacity of building reserve for reinvestment is then weak.

When the owner and the operator of the infrastructure are financially separate entities and the operator is required to manage and report on the systems according to commercial accounting principles, the capacity to build reserve for reinvestment becomes more robust. In all the cases assessed by ECA, the operating companies – which often also manage the drinking water supply – were able to build some operational surplus that could contribute to the financing of the renewal of the infrastructure.

This is, however, warranted only when these reserves are not withdrawn by the owners of the operating companies in the form of dividends or taxes. Nine of the 28 operating companies (32%) assessed were requested to pay out dividends to the owners in the period 2010 to 2012. In CZ, a legal provision stipulated that profit should be reasonable. In 2013, the law provided a formula for the calculation of this reasonable profit. In SK, the surplus is capped per cubic meter sold. In HU, water utilities' surplus have been subjected to a 31% sectoral "energy supplier tax", and 9% "profit tax". This has severely reduced the capacity of water utilities to build reserve for reinvestment.

3.3.3 Individual and Other Appropriate Systems

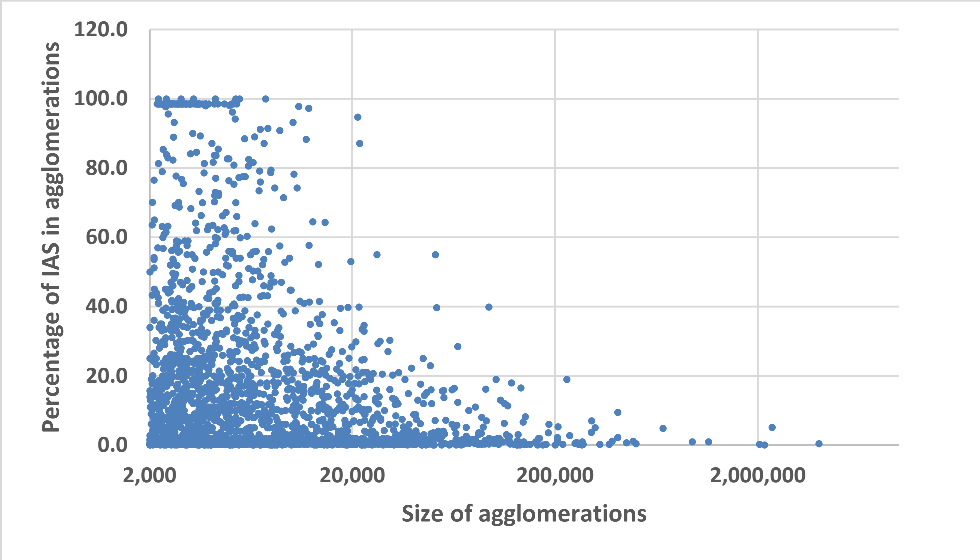
Household based decentralised on-site systems are referred to as Individual Appropriate Systems (IAS) by both the UWWTD and this study. Smaller agglomerations often use such systems when these become more cost-effective than a centralised wastewater infrastructure due to the diminishing benefit of economy of scale. "Appropriate" treatment can mean a range of solutions. Several extensive WWTPs are described in the "*Guide – Extensive wastewater treatment process adapted to small and medium sized communities – Implementation of Council Directive 91/271/EEC of May 1991*[15]"

A classification of systems is also documented in the guidance paper "*Sustainable and cost-effective wastewater systems for rural and peri-urban communities up to 10,000 population equivalents*[16]". This paper describes three centralised and one decentralised system.

An IAS is an integrated part of a property or house in the target countries. While the benefits have a public dimension, the ownership, along with the full cost of installation and operation remains private. The strength of the solution is that wastewater is collected, thereby minimising risks of health hazards. The weakness is that environmentally sound and complete collection, treatment and disposal might often not be adequately covered.

Figure 3.6 presents the percentage of IAS found in the agglomerations in the seven target countries of the Danube region (HR is not requested to report in 9th TA-UWWTD). Many agglomerations between 2,000 and 10,000 PE in size can have a significant proportion of their pollution loads treated via IAS. Figure 3.6 presents the proportions of IAS in the agglomerations of the Danube Region. Although the graph shows the percentages as an imprecise cloud, in particular for agglomerations displaying low IAS use, it shows that the smaller the size of an agglomeration, the more pollution that is treated by IAS. A further interpretation of the figure reveals that the smaller the size of the agglomeration (smaller than 20K PE), the wider the distribution of the share of IAS (ranging between 0 and 100%). Table 3.11 completes the picture by documenting the share of the pollution load treated by IAS. The average share of IAS across the agglomerations (above 2,000 PE) in the Danube region is about 4%. The proportion of the pollution load treated by IAS does not exceed 10% even for smaller agglomerations. The declining trend of the role of IAS by the increasing size of agglomerations is also clearly documented.

[15] http://ec.europa.eu/environment/water/water-urbanwaste/info/pdf/waterguide_en.pdf
[16] http://www.wecf.eu/download/2010/03/guidancepaperengl.pdf page 11



Source: 9th TA-UWWTD

Figure 3.6: Proportion of IAS in agglomerations above 2,000 PE in the countries of the Danube region

Size of agglomeration, PE	Generated pollution load, PE	Pollution load collected via IAS, PE	Share of pollution load collected via IAS (%)
2,000-10,000	13,883,989	1,330,940	10%
10,001-50,000	17,625,404	958,457	5%
50,001-100,000	8,166,581	281,467	3%
Above 100,001	35,257,464	573,585	2%
Danube Region	**74,933,438**	**3,144,449**	**4%**

Source: 9th TA-UWWTD

Table 3.11: Pollution load addressed via IAS in the Danube region, 2014

According to data available in the 9th TA-UWWTD most of the countries apply IAS to complement their centralised wastewater systems in rural and peri-urban areas with a lower population density. According to the spirit and the letter of the UWWTD, IAS can be applied as an exception, and should provide for the same level of environmental protection as centralised systems. Table 3.12 reflects the estimated investment value of IAS implemented for agglomerations above 2,000 PE extracted from the datasets of the 9th TA-UWWTD. While the above mentioned guides are explicit about IAS technologies they do not provide any up-to-date investment figures for such solutions.

A current reference on IAS costs in France can be found in the table developed by the Agence de l'Eau: Rhône, Méditerranée, Corse reflected on the website:
https://www.eaurmc.fr/lobservatoire-des-couts/assainissement/assainissement-non-collectif.html .
The table presents the cost of a septic tank for a standard family house with five rooms (dining and living rooms plus three bedrooms), discharging into subterranean drains in the garden. With total average investment values of 7,000 € including taxes, this seems a relatively high figure for application in the East European countries. Another expert estimate from France indicates an investment cost of 5,000 EUR/house (1,500-2,000 EUR/PE). For this study, the lower estimate of 1,500 EUR/PE has been retained for the new MSs, and 2,000 EUR/PE for AT. Based on these assumptions, the overall historical investment costs

for IAS were assessed to be about 6 billion EUR in the Danube region. Although some MSs have deployed public services to control whether IASs are functioning according to set environmental standards, no evidence has been found regarding environmental protection achieved through IAS application.

Target Countries	Share of wastewater collected by IAS	Total PE collected by IAS	Total PE generated in the country	IAS investment in agglomerations above 2,000 PE, (EUR)	Unit investment costs (EUR/PE)
Austria	1.0%	138,056	20, 408,950	276,112,000	2,000
Bulgaria	0.0%	5,370	8,085,615	10,740,000	1,500
Czech Republic	7.0%	521,417	7,701,010	1,042,834,000	1,500
Croatia*					
Hungary	13.0%	1,483,649	11,694,647	2,967,298,000	1,500
Romania	1.0%	138,621	20,924,781	277,242,000	1,500
Slovenia	6.0%	91,221	1,462,223	182,442,000	1,500
Slovakia	16.5%	766,082	4,656,291	1,532,164,000	1,500
Danube Region	**4.0%**	**3,144,449**	**74,933,438**	**6,288,832,000**	

*Source: 9th TA-UWWTD, Own calculations; *HR is not requested to report in the 9th TA-UWWTD*

Table 3.12: Proportion of IAS and the estimated investment costs for IAS per country (status 2015)

Three countries (BG, AT, RO) have a lower than average proportion of IAS in their wastewater management infrastructure mix. Other countries apply these solutions more widely (6-17%). Some changes have emerged compared to the 8th TA-UWWTD[17]. The EC noted in this report that some countries (HU, SK) had relatively high rate of application of IAS solutions (above 20%).

The UWWTD and the 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 the wastewater utility managing the centralised systems.

The 9th TA-UWWTD report only documents agglomerations with a size of above 2000 PE, disregarding settlements with population below 2,000 inhabitants. 10.8 million inhabitants live in these smaller settlements and rural areas in the eight countries of the Danube Region. The largest number of such inhabitants is in CZ (2.8 M), while in BG, SK, HU and AT 1.6 to 1.8 M people lives in such areas. In RO, 1 M live in settlements with a population of less than 2,000 people, while in HR and SI this applies to just a few hundred thousand people.

UWWTD-compliant sanitation for this population is not addressed in the 9th TA-UWWTD report.

[17] https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/1-2016-105-EN-F1-1.PDF pg. 5

3.3.4 Total Investment Costs

Table 3.13 summarises the estimated total capital investment needed to achieve compliance with the UWWTD in the Danube region. These costs cover the centralised and decentralised (IAS) systems and further differentials before and after 2015.

Target Countries	Total investment for compliance with UWWTD	Past Investment - centralised system before 2015	Past investment - decentralised system before 2015	Future new investment, from 2015 up to full compliance
Austria	14,664	14,388	276	0
Bulgaria	5,860	4,180	11	1,669
Czech Republic	7,329	6,265	1,043	21
Croatia	4,073	0	0	4,073
Hungary	9,792	6,813	2,967	12
Romania	17,529	6,842	277	10,410
Slovenia	1,486	970	182	334
Slovakia	4,768	2,938	1,532	298
Danube Region	**65,501**	**42,396**	**6,288**	**16,817**

Source: Own assessment

Table 3.13: Estimated total investment costs needed to achieve compliance with the UWWTD in agglomerations above 2,000 PE, M EUR

According to Table 3.13 the total investment needs for UWWTD implementation and full compliance in the eight countries of the study is around 66 Billion EUR. Out of this, 60 Billion EUR is anticipated to be required for centralised systems and 6 Billion EUR for decentralised IAS systems. Around 75% of the overall investment expenditure has already been implemented. The remaining 25%, or about 17 Billion EUR, represents new investment needed up to full compliance with UWWTD in the coming years.

3.3.5 Future Demand for Capital Expenditures

As highlighted earlier, implementation delays toward full compliance have occurred in five out of eight countries in the Danube region. These five countries are already facing expired compliance deadlines, as highlighted in Chapter 1. Pending deadlines still exist for RO (2018) and HR (2023). At the current rate of annual investment spending, it is doubtful whether these two countries will be able to achieve compliance by the defined deadlines.

As shown in Table 3.14, a rough estimation of future capital investment needs in all countries in the Danube region, a residual demand of about 56 Billion EUR is needed to fulfil and sustain UWWTD compliance up to 2040. These values integrate two components (i) new remaining investment in non-equipped agglomeration above 2,000 PE (17 Billion EUR), (ii) reinvestment for older infrastructure calling for renewal (39 Billion EUR).

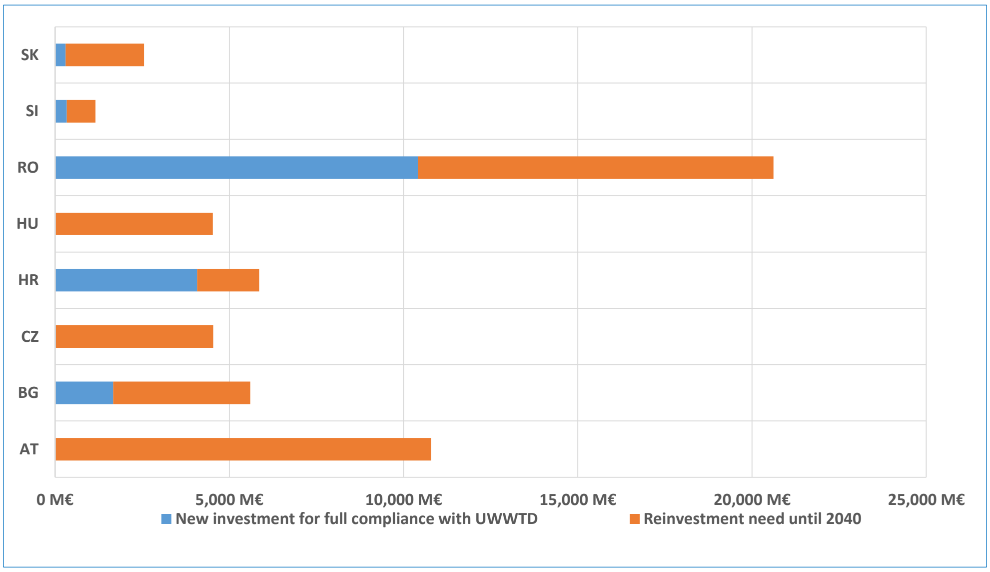
Target Countries	Future new investment, up to full compliance	Reinvestment after full compliance until 2040	Total capital expenditure until 2040
Austria	0	10,787	10,787
Bulgaria	1,669	3,933	5,602
Czech Republic	21	4,518	4,539
Croatia	4,073	1,783	5,856
Hungary	12	4,511	4,523
Romania	10,410	10,208	20,618
Slovenia	334	826	1,160
Slovakia	298	2,252	2,550
Danube Region	**16,817**	**38,818**	**55,635**

Source: Own calculation

Table 3.14: Estimated future demand for capital investment up to 2040, MEUR (reference year 2015)

Due to a lack of data on the specifics of the settlements below 2,000 inhabitants, their costs for UWWTD-compliant sanitation are not included in the capital investments reflected in Table 3.14 and Figure 3.7, however it could be as high as 8 to 10 Billion EUR. These amounts are to be added to the assessed future investment costs of UWWTD harmonisation.

Figure 3.7 clearly indicates that infrastructure renewal and reinvestment is expected to require the mobilisation of large funding in excess of twice the demand for remaining new investment up to full compliance in the Danube region. In this context, RO faces the greatest challenge with a future capital expenditure need which is twice that of the AT.

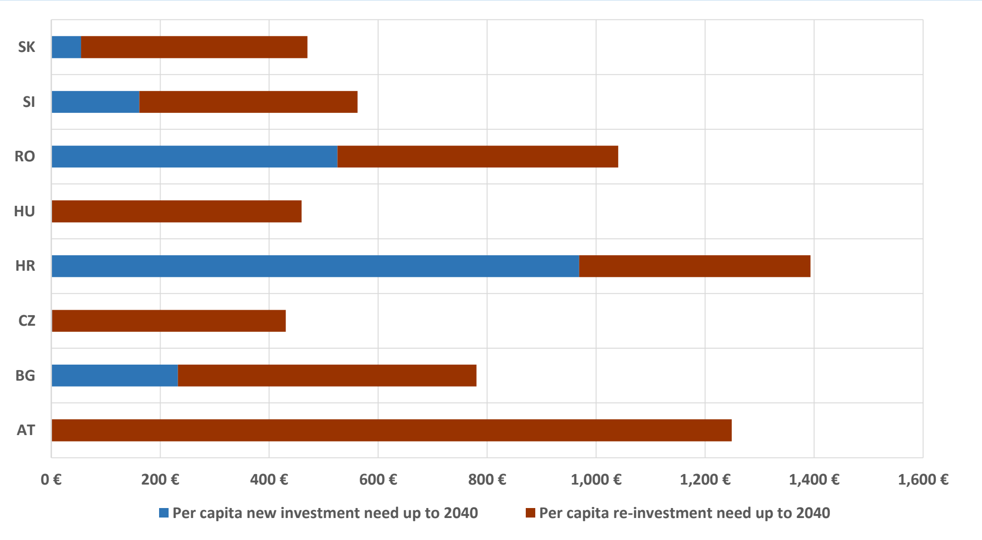


Source: own assessment

Figure 3.7 Future demand for capital investment up to 2040 in countries of the Danube region, reference year 2015

Figure 3.8 presents the estimated future capital investment data for the next 20 years in relation to the number of inhabitants in the year 2015.

Up until 2040, the largest amount of capital expenditure per inhabitants to achieve and sustain UWWTD compliance is expected to be in HR, AT and RO. In contrast, it is anticipated that CZ, HU and SK will spend less than half per capita than the highest spending countries on sustaining compliance for their wastewater sectors. However, HU may well be required to increase WWTP investments in sensitive areas as pointed out in this Annex 1, paragraph 1.2. map in Figure 1.8.



Source: own assessment

Figure 3.8: Future per capita capital investment needs up to 2040 in countries in the Danube region, reference year 2015

3.4 Operation and Maintenance Costs

Wastewater networks and WWTPs are reliant on equipment, especially pumps, blowers and other machinery (e.g. sludge treatment), that are subject to heavy wear and tear and therefore need to be maintained and refurbished periodically in order to stay operational. These replaceable items are accounted as annual maintenance costs. They are different from reinvestment and renewal costs (see paragraph 3.3.2 above), which cover the replacement of large infrastructure components (e.g. pumping station, civil works, sewer replacement), which are accounted as capital expenditures.

These mechanical installations are also heavy users of electricity and it is important for this equipment to stay abreast of technological development to remain functional and energy efficient.

The performance of a water utility is best defined by its capacity to sustain efficient operation and to cover its O&M costs. A relentless drive toward continuous efficiency gains in operation is an important and necessary managerial objective of any performing water and wastewater utility.
The paragraphs below address a few fundamental efficiency factors affecting the O&M costs of wastewater utilities in the Danube region.

3.4.1 Efficiency Factors for Wastewater Utilities

The ”Water and Wastewater Services in the Danube Region – A State of the Sector – Regional Report” from May 2015 published by the World Bank (hereafter referred to as SOS Report 2015 in this study) highlights several key indicators of water utility performance. Two are particularly useful in documenting the operational performance of water utilities: the non-revenue water (NRW) and the staff productivity per 1,000 connections.
NRW represents water which is abstracted, treated and distributed but is neither accounted nor charged to customers. It encompasses physical leakage as well as “economic” losses through illegal or unrecorded connections and other similar factors. The abstraction, treatment and distribution of water into a network system consumes a large amount of energy. When water is lost before reaching customers, it becomes a waste of economic resources. The high rate of NRW still prevailing in many water systems in some countries of the study is a symptom of inefficient operations. Reducing NRW from its current high levels (60% in BG, 45% in RO and 44% in HR) can substantially reduce operating costs for utilities.

This study addresses the wastewater segment of the water service sector in which infiltration of groundwater into sewers and illegal and unrecorded connections are the main sources of water related inefficiencies. As no information is available regarding these inefficiencies, NRW, which is better documented quantitatively in water utilities reports, has been retained as proxy in this study for the estimation of the prospects for water related efficiency gains in WW utilities.

An example of the similarity between infiltration in sewer and NRW in water supply networks is documented in the ECA report. At one WWTP in RO, the hydraulic capacity utilisation was estimated to be in the range of 60 to 85% with half (50%) of the water reaching the WWTP estimated being groundwater infiltration in sewers, which does not need treatment. This is within the average range for NRW in RO (45%) according to SOS Report 2015 (which is almost the same as the 50% infiltration value range).

Staff productivity expressed as number of staff per thousand connections, reflects how productive a utility is from a human resources perspective in managing and maintaining its physical infrastructure. Data is available for water utilities but not well documented, particularly for wastewater service providers. As many water service providers are also wastewater utilities, in the eight countries of the study, the data documented in national water utilities reports was considered in this study to also be representative for the wastewater utility sector.

Table 3.15 reflects the estimated two indicators of operational efficiency introduced above and is extracted from the SOS Report 2015. The figures represent the estimated national average and compare the operating cost recovery (OCR) ratio estimated for the respective countries. High NRW (above 25%) means unjustifiably high energy costs, and low productivity (above 4 staff/1,000 connections) means high labour costs.

Based on the data presented, no clear link is evident between utility efficiency and the size of utilities that economy of scale would predict. Table 3.14 conversely reflects some degree of relationship between NRW, staff productivity and operating cost coverage. The best scores of both indicators are for AT and the CZ. BG has the worse rating. Strangely, the operating cost coverage for BG is as good as for CZ, which could mean that the dataset for BG may possibly not be accurate. An operating cost coverage below 1, and probably comparable to those observed in HU or HR is more plausible.

Target Countries	Number of water utilities in the country	Average number of population served *[inhabitants]*	Non-revenue water [%]	Staff productivity		Operating cost coverage *[billed revenue/ operating expense]*
				Number of employees /1,000 connections	Number of employees /1,000 inhabitants served	
Austria	5,465	1,395	16	2.0	0.4	1.44
Bulgaria	56	128,437	60	6.2	1.2	1.13
Czech Republic	2,438	4,057	22	5.2	0.8	1.18
Croatia	140	24,605	44	3.0	-	0.97
Hungary	41	226,912	24	3.5	1.7	0.89
Romania	226	54,679	45	18.0	-	1.08
Slovenia	98	18,502	31	-	-	1.00
Slovakia	17	277,074	32	7.7	1.2	1.01

Source: SOS Report, 2015

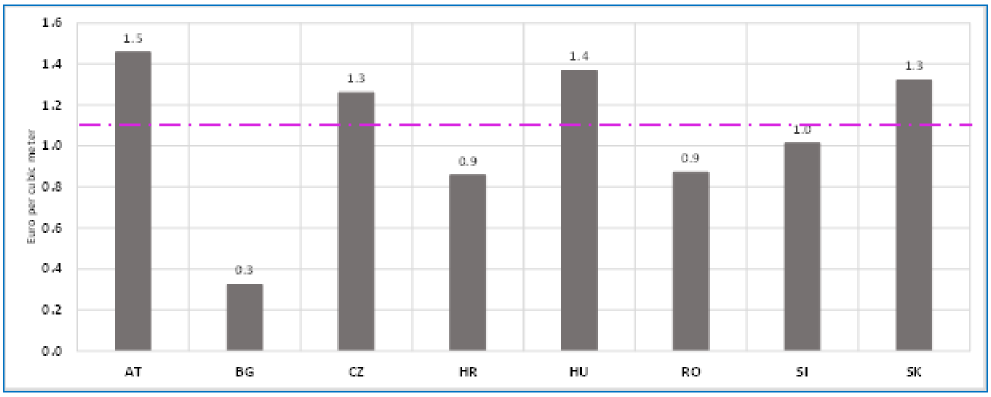
Table 3.15: Selected performance indicators in the target countries of Danube region

Another frequent cause of inefficiency identified by the ECA report is the mismatch between the designed & built capacity and the real inflow to WWTPs. It found that nine out of the 28 plants examined (32%) were operating at less than 50% of their design capacity. A further nine plants (32%) were operating at between 51 and 60% of their capacity. This seemed to be a particularly serious issue in RO, where eight out of 12 plants assessed were operating at less than 50% of their capacity. The ECA report concluded that investing in WWTPs that have significant excess capacity is not an efficient use of scarce financial resources at either European or national level.

The over-dimensioning of WW infrastructure in some countries of the study may be partially linked to the reliance on design standards promoted by the German Association for Waste Water ("*Abwassertechnische Vereinigung*" or ATV), which tends to be on the extra safe side of hydraulic infrastructure and equipment dimensioning. Some country specific adjustment of these standards to optimise the fit to the hydrological and technical context of each country may be appropriate in order to rationalise the costs of the designed infrastructure.

3.4.2 Current Operating and Maintenance Costs

Data on current operating and maintenance costs provide an indication of the performance of a water utility. The SOS Report 2015 mentioned earlier estimated the average O&M costs per cubic meter of the combined water and wastewater services in the Danube Region. As the study focused only on WW, the estimated wastewater O&M costs were set at 60% of the combined water costs documented in the above assessment. It needs to be noted that after full implementation of the UWWTD these costs can be as high as 70%. Figure 3.9 reflects the resulting specific O&M costs per country. They fluctuate around the statistical average of the Danube Region (1.1 EUR/m^3, the purple dashed line in Figure 3.9). O&M costs for 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 possibly not representative.



Source: SOS Report 2015; own assessment

Figure 3.9 Specific O&M costs per cubic meter of wastewater collection and treatment in countries of the Danube Region

The level of operating costs[18] per PE served is another indicator of the operational efficiency of a utility and its managed assets. The ECA report referred to an earlier made comparison of costs based on the utilities accounting information received for the 28 plants. ECA recognises that operating costs are influenced by the type of treatment (more stringent treatment implies a higher cost) and by the size of the plant through economy of scale. However, the comparison shows that there were significant differences amongst the plants not necessarily explainable by the two features mentioned. The diversity of operational costs are characterised as follows:

- Maximum unit cost: 20.5 €/PE
- Minimum unit cost: 3 €/PE
- Median unit cost: 10 €/PE
- First quartile: 3-6 €/PE (7 plants)
- Second quartile: 6-10 €/PE (6 plants)
- Third quartile: 10-14 €/PE (6 plants)
- Fourth quartile: 14-20 €/PE (7 plants)

The comparison of the above operational costs with the Austrian benchmark data highlighted in Box 3.2 below allows for the following comments:

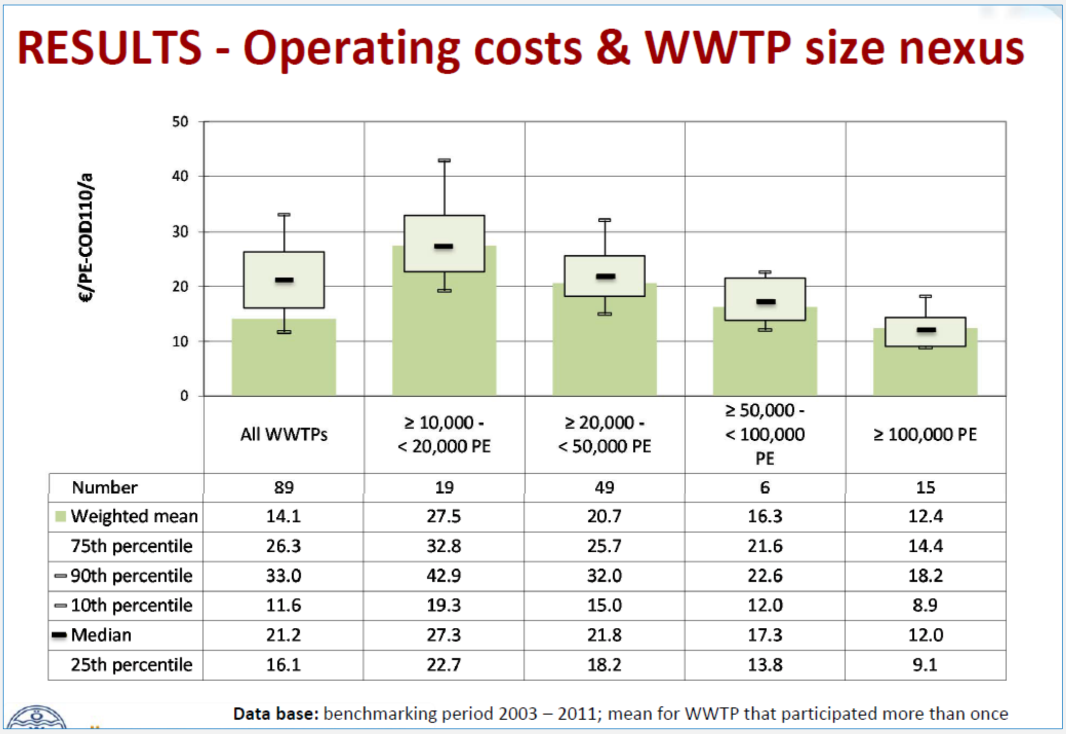
- The costs of the first quartile (7 plants) seem unrealistically low, being 20% of AT data;
- Plants of the third and fourth quartiles (13 plants) work with comparable unit costs as AT's WWTPs;
- The maximum AT unit costs are occasionally double (33-43 EUR/PE) the maximum value found in the ECA study of 20.5 EUR/PE can be explained by the significantly lower labour costs in new MSs.

Box 3.2 Case study in Austria – optimisation of operating costs

In Austria, major efforts have been deployed to optimise the operation of WWTPs through the 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 the process (39% of the Austrian WWTP design capacity). Some results of the

[18] Sum of the following costs: labour cost, cost for materials (including cost for chemicals), energy cost, sludge transport and disposal cost and other sundry costs. In the category of 'other costs' only the outsourced maintenance costs and costs for outsourced laboratory analysis were considered. Depreciation cost was not included for example.

benchmarking exercise for the period 2003 to 2011 regarding operating costs can be seen in Figures 3.9 and 3.10.



	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

Figure 3.9: Results of operating cost versus WWTP size (benchmarking period 2003 – 2011 (Schaar, Lindtner & Others)

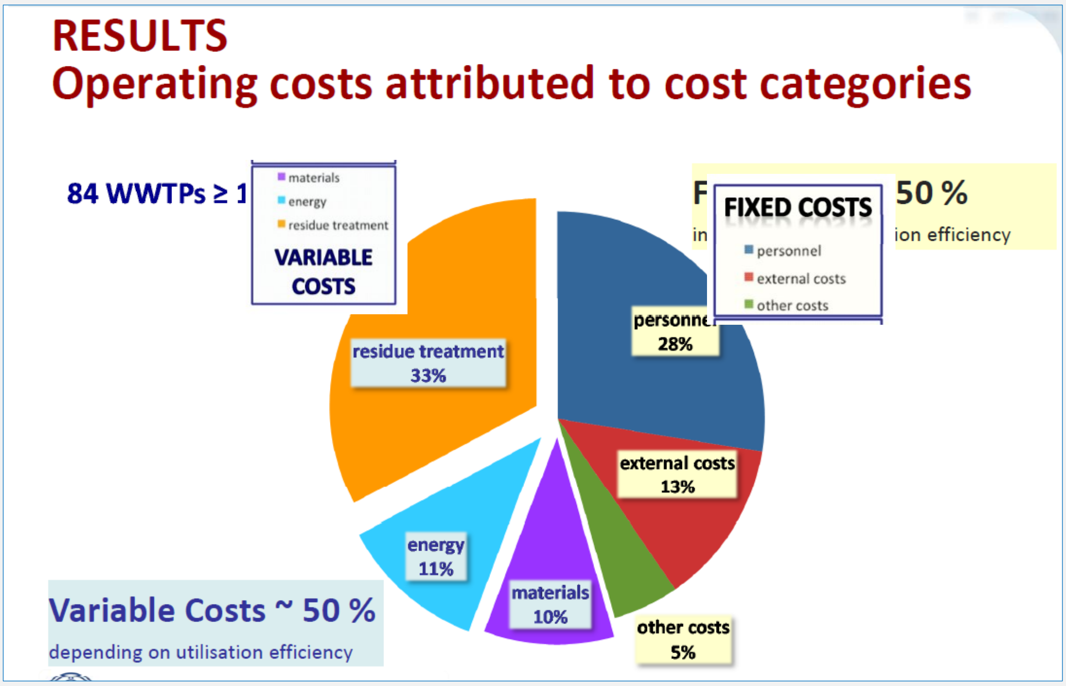


Figure 3.10: WWTP Operating Costs by Category (Schaar, Lindtner, and others)

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 organisation covers the entire Austrian water and waste management sector. It is considered an "independent counsellor" with a mandate to advance sustainable water, wastewater and waste management in the country.

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

3.4.3 Future Trends in Operating and Maintenance Costs

Operating efficiency improvement at wastewater utilities is an important source of opportunity for improving the financial sustainability of water utilities. WWTP's O&M costs in the target countries can be significantly lowered by (i) reducing infiltration and unaccounted for connections, (ii) improving staff productivity and (iii) boosting the energy efficiency of equipment. Although this is expected to be partially offset by real wage increases for staff, efficiency gains in operation remains a serious avenue to the improvement of the OCR ratio for wastewater utilities.

Table 3.16 summarises possible future efficiency gains in the two indicators explored earlier (infiltration and unaccounted for connection (NRW as a proxy) and staff productivity). Staff productivity indicators in some countries are already quite reasonable (AU, CZ, HU, HR) and above the good practice figures highlighted earlier. For these countries no efficiency gains reserves were considered in the scenarios exploring the future capacity of the utilities to cover their costs (Paragraph 3.2.2). For other countries (BG, CZ, HR, RO, SI and SK) infiltration reduction gains are assumed as medium or high reserves.

Target Countries	Infiltration reduction and unaccounted for connections	Staff productivity increase
Austria	No significant reserve	No significant reserve
Bulgaria	High reserve	High reserve
Czech Republic	Medium reserve	No significant reserve
Croatia	Medium reserve	No significant reserve
Hungary	No significant reserve	No significant reserve
Romania	High reserve	High reserve
Slovenia	Medium reserve	No data
Slovakia	Medium reserve	Medium reserve

Source: own assessment

Table 3.16: Possible annual water utilities efficiency gains in countries of the Danube Region

Overall, it seems that efficiency gains in O&M costs hold substantial reserves that can be exploited to improve the financial sustainably of the wastewater utilities. A good way to capture these benefits is to introduce or strengthen the utilities benchmarking process as practiced in AT.

3.5 Tariffs and Connection Fees

Water utilities collect revenues from two sources; from tariffs for services consumed and through one off payments such as for connection fees to a sewer or for the collection and treatment of sludge from septic tanks from non-centralised wastewater systems. All these are regulated either at EU level or national or local level.

3.5.1 Statutory Requirement

Article 9 of the Water Framework Directive (WFD) requested Member States to ensure that adequate contributions from water users to the recovery of the costs of water services, including environmental costs of wastewater collection and treatment, were implemented by 2010. This principle is in practice applied through wastewater tariff systems.

Water cannot be transported over large distances, at affordable costs. Consequently, water services are often local or regional and often represent a natural monopoly[19] for the service provider. To avoid the risk of monopolistic water pricing behaviour by system operators, water service pricing is regulated by public institutions through tariff structures and tariff polices anchored in national legislation.

The WFD requires EU MSs to set wastewater tariffs in line with “the polluter pays” principle, but with due consideration to social, environmental and economic effects, and to ensure that water services remain affordable.

Although any tariff increase is always politically loaded and unwanted by local politicians, it is always desirable to strive to establish wastewater tariffs that cover service costs. This is aligned with the polluter-pays-principle, which states that polluters (those discharging wastewater such as households and industrial or commercial installations) are responsible for the pollution they discharge and should therefore bear the costs of alleviating this pollution by means of wastewater collection and treatment systems.

In practice, it is rare to find water tariffs that enable “full cost recovery” of services. Full cost recovery means in principle full coverage through water prices of (i) the capital invested, (ii) the required reinvestment and renewal and (iii) the recurrent O&M costs of the water services (iv) environmental costs. The concept of Sustainable Cost Recovery (SCR) promoted by the OECD, takes the view that it is important for tariffs to at least cover O&M costs of services since, without this basic cash flow, it is impossible for the operator to deliver sustainable levels of service.

The EC guidance for cost-benefit analysis of water infrastructure projects instruct that water tariffs should cover at least O&M costs, and preferably a significant part of the depreciation charge applied on assets.
The depreciation factor should be increased during the period of analysis to eventually achieve the full recovery of these costs, depending on the affordability level for consumers. In other words, there is a strict requirement for the sustainable operation of the infrastructure to be established. Depreciation here is seen as a proxy of the cost needed to renew the infrastructure to sustain environmentally efficient operation.

For the EU programme period 2014–2020, respect for the cost recovery principle of water services has been made mandatory. This is promoted through an ex-ante conditionality imposed in national programmes using EU grants for the development of water and wastewater projects. The approval of national operational programmes for the 2014–2020 period in the WW sector was contingent to the ‘*existence of an adequate contribution of the different water uses to the recovery of the costs of water services […]*’ with the definition of what is an ‘*adequate*’ contribution remaining at the discretion of the Member States.

3.5.2 Current Wastewater Tariffs

Various sources of information are available regarding current wastewater tariffs in the Danube Region. These include (i) the ECA report (covering four countries), (ii) the DRBMP, which cover around 72% of the territory of the eight countries and (iii) the SOS Report 2015, which fully covers the eight countries of the study. Unfortunately, none of these reports

[19] A natural monopoly is a monopoly in an industry in which it is most efficient (involving the lowest long-run average marginal cost) for production to be permanently concentrated in a single firm rather than contested competitively.

considers the wastewater elements of water tariffs separately. The available data essentially bundles water supply and sanitation tariffs together.

The ECA report mentioned earlier examined the wastewater tariffs in four countries (CZ, SK, HU and RO) and 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 their respective economic lives.

The 28 cases of the four countries assessed compared the tariff income with the cost data of the water service operators and/or infrastructure owners. The ECA found that capital (investment plus reinvestment) and operational costs were fully recovered in only three cases (11%). In all the other cases, cost recovery was only partial, if not marginal.

The ECA report also noted that in several countries, except possibly in RO, specific legal/fiscal provisions limited the capacity of utilities to recover costs:

- in the CZ and SK depreciation costs relating to the portion of the assets that were financed by grants (EU or national) are completely or partially ignored;
- in HU, a reduction of water tariffs was enforced by law in 2013, and in SK restrictions regarding tariff increases were imposed.

The ECA report highlighted the risk that revenue restrictions could encourage plant operators not to implement necessary maintenance in order to maintain short-term profitability, thereby endangering the longer-term operational sustainability of the WWTPs.
The case study in SI (Box 3.1 above) provides a numerical example of uncompleted maintenance jobs, as a consequence of cutting costs to meet the utility's profitability target.

The most consistent and comprehensive information covering the eight countries of the study, was found in the SOS Report 2015. The report reflects on an estimation of combined water supply and sanitation tariff data in a number of Danube countries including those targeted by this study.

For the assessment of UWWTD compliance, only wastewater related tariffs are relevant. It is known that operational water supply costs are usually significantly lower than wastewater collection and treatment costs. For the purpose of this assessment, the estimated wastewater tariff was set at 60% of the combined water tariff to match the expected real cost of the wastewater services. When the UWWTD is finally completed, the sanitation share of the tariff could possibly reach 70% due to expensive tertiary treatment.

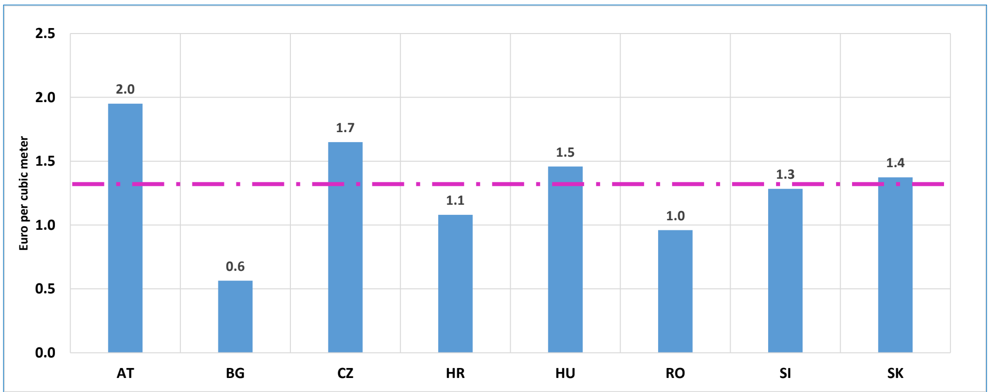
Table 3.17 summarises average national wastewater tariff estimations issued by the SOS Report 2015 that were integrated into the financial sustainability scenarios.

Target Countries	Water and sanitation services combined*		Sanitation service alone (assessed)**	
	Average tariff [EUR/m^3]	Average O&M cost [EUR/m^3]	Average tariff [EUR/m^3]	Average O&M cost [EUR/m^3]
Austria	3.25	2.43	1.95	1.46
Bulgaria	0.94	0.54	0.56	0.32
Czech Republic	2.75	2.10	1.65	1.26
Croatia	1.80	1.43	1.08	0.86
Hungary	2.43	2.28	1.46	1.37
Romania	1.60	1.45	0.96	0.87
Slovenia	2.14	1.69	1.28	1.01
Slovakia	2.29	2.20	1.37	1.32

*Source: *SOS Report, 2015, **Own calculation*

Table 3.17: Selected data characterising water revenues in the target countries

Figure 3.12 below shows the wastewater tariffs of the target countries adjusted to the UWWTD compliance analysis. The tariffs fluctuate around the statistical average of the Danube Region (1.3 EUR/m^3; purple dashed line in Figure 3.12). Five countries (AT, CZ, HU, SI, SK) have equal or higher sanitation tariffs than the region's means. A significantly lower tariff, consistent with the observed O&M costs, has been estimated for BG (0.6 EUR/m^3).



Source: SOS Report 2015; own assessment

Figure 3.12 Tariffs for wastewater collection and treatment in countries in the Danube Region

Box 3.3 Wastewater tariffs in selected old Member States

Average sewage and wastewater treatment tariffs in selected MSs in years 2011-2012:
England and Wales average: Standing charge: 75.3 EUR/year and volumetric charge: 160.3 cents/m^3. Southern Water (2017): Standing charge 27.2 EUR/year and volumetric 2.53 EUR/m^3
Scotland: 3.50 EUR/m^3
Netherlands: 2.97 EUR/m^3
France: EUR 1.54 EUR/m^3 (in 2009)
Germany: 2.36 EUR/m^3
Spain: 0.56 EUR/m^3; Catalonia: 0.72 EUR/m^3

Source: EEA Assessment of cost recovery through water pricing

In brief it can be summarised that:

- sanitation tariffs are diverse in both the old and new MSs;
- examples of low tariffs can be found in both groups of countries: BG and Spain 0.56 and 0.72 EUR/m^3;
- examples of high tariffs can also be found across the EU MSs: 1.95 EUR/m^3 in the Danube region (AT), and 2.97-3.50 EUR/m^3 (NL and Scotland) and in old MSs;

- sanitation tariffs tend to be higher in the old MSs than in the Danube region. This can be explained by the differential of costs and household incomes between these two groups.

3.5.3 Cost Recovery through Tariffs

The current state of cost recovery of wastewater services is reported by the countries in the DRBMP in line the WFD. According to Article 9, the price of water services should recover not only financial, but also environmental and resource costs. The situation of cost recovery (CR) of wastewater services in the eight countries of the study is summarised in Table 3.18. Cost recovery can be assessed at various scales (e.g. utility; river basin; national) and consider different aggregations of costs (e.g.: O&M lone; O&M plus overhead costs; O&M plus overhead costs plus depreciation of fixed assets; O&M plus overhead costs plus depreciation of fixed assets plus environmental and resource cost). The WFD encourages the recovering of costs of water services in the widest sense possible (all financial, environmental and resource costs) and at the river basin level.

Target Countries	Prices and costs for water services available [Y/N/partly]	Levels of CR stated [Y/N/partly]	Clear methodology for calculating CR [Y/N/partly]
Austria	Y (total costs and total revenues of water)	Y	Y (based on expert judgment)
Bulgaria	Y (for all water services)	Y	Y
Czech Republic	Y (abstraction, water supply and wastewater)	Partly (all O&M costs are fully covered, when including also subsidies on investment, we would not reach 100% of the cost recovery)	N
Croatia	Partly (water supply for households and industry)	Y	Y (methodology and CR calculation will be included in 2nd National RBMP)
Hungary	Yes for public water supply, for waste water collection, agricultural water service, damming and storage of water for energy production	Y	Y
Romania	Partly (water supply for households and industry)	N	N (only O&M costs considered; no figures provided)
Slovenia	Y	Partly (additional assessments are in progress)	Partly (only financial costs and internalised part of environmental and resource costs considered, additional assessments are in progress)
Slovakia	Y	Y	Partly (only financial costs, including depreciation and internalised part of environmental and resource costs are considered).

Source: DRBMP Update 2015, Annex 11

Table 3.18: Sanitation Cost Recovery in Countries of the Danube Region according to DRBMP 2015

Most of the countries are currently using expert judgment to estimate the cost recovery ratio of their water services. The level of cost recovery is, however, not quantified in the DRBMP. Three countries (CZ, RO and SI) need further efforts to quantitatively document their national level of cost recovery for WW services.

The methodology for cost recovery assessment needs to be refined, consolidated and harmonised in all Member States in order to clarify which costs under which conditions and at what values need to be internalised. Costs requiring particular attention because they are poorly defined include (i) asset depreciation (ii) environmental costs and (iii) resource costs.

3.5.4 Price Elasticity of Wastewater Services

One aim of the water pricing policy stated in the WFD is to rationalise the use of water resources, and to facilitate conservation. One often anticipated consequence of increasing water tariffs is a reduction in water consumption and as a consequence also wastewater discharge. This economic phenomenon, known as price elasticity of demand, measures the responsiveness of demand to changes in tariff for the wastewater services. When the per capita water consumption drops well below 100 litres per day, the price elasticity of water demand can be seen as being operational in the Danube region.

Table 3.19 reflects the average water and sanitation tariffs and the specific costs of operating the services. These are based on volume consumed and discharged, together with indicators of water consumption and rates of revenue collection in the eight countries in the Danube region.

Target Countries	Average water and wastewater tariff [EUR/m^3]	Average O&M cost of water services [EUR/m^3]	Operating cost coverage ratio 2015	Billing collection rate, [cash income/billed revenue] [%]	Residential water consumption [litres/capita/day]
Austria	3.25	2.43	1.44	105	140
Bulgaria	0.94	0.54	1.13	72	100
Czech Republic	2.75	2.10	1.18	95	87
Croatia	1.80	1.43	0.97	90	113
Hungary	2.43	2.28	0.89	94	94
Romania	1.60	1.45	1.08	112	136
Slovenia	2.14	1.69	1.00	97	114
Slovakia	2.29	2.20	1.01	116	81

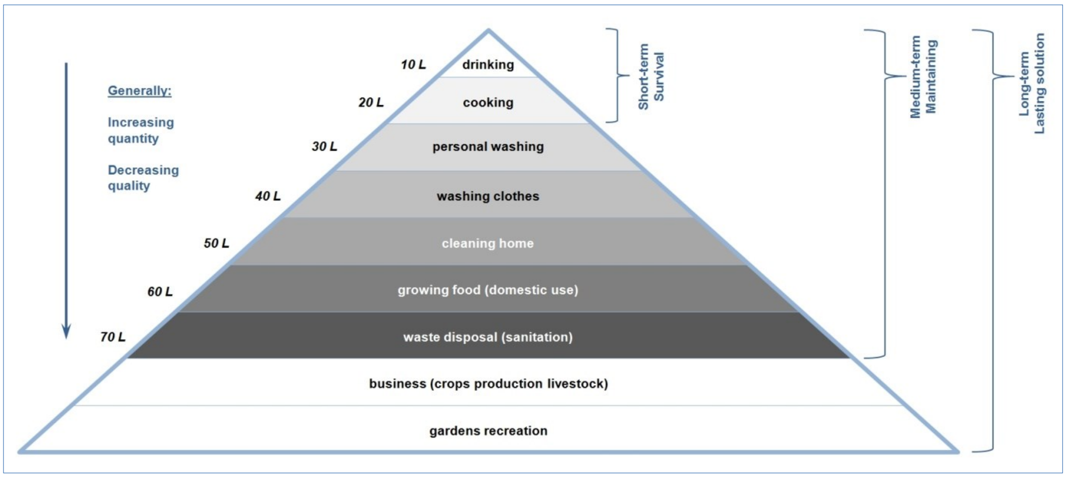
Source: SOS Report, 2015

Table 3.19: Selected data on water prices, costs and consumption in the target countries

Although no clear quantitative linkages can be identified between high water tariffs and low water consumption, the price elasticity of water services is qualitatively apparent in the table. In the Danube region, three countries – SK, CZ and HU – all have higher water tariffs and also lower water consumption. The current residential water consumption in these countries is below the Danube region's average of 122 l/c/d, and moving closer to the target of the "waste-free", "average rational water consumption" of 70 l/c/d suggested by the WHO[20]. Interestingly, low revenue collection ratios can be observed at relatively low tariffs (BG, HR), suggesting that payment discipline does not always correlates with the tariff level.

[20] According to the WHO, people use water in a wide range of activities. Some are more important than others. Clearly, having a few litres of water to drink a day is more vital than washing clothes. People also need to wash to prevent skin diseases and to meet physiological needs. Each additional use has health and other benefits, but with decreasing priority.

A hierarchy and minimum amount of water requirements as proposed by the WHO are presented in Figure 3.11.



Source: WHO

Figure 3.13: Hierarchy of water requirements (inspired by Abraham Maslow's hierarchy of needs)

While reduced water abstraction, consumption and discharge can have a positive consequence in environmental terms, it may also exacerbate revenue contraction, which can have a significant detrimental effect on water utilities' finances. Moreover, smaller volumes of wastewater discharged do not necessary mean a smaller quantity of pollutant being released. Utilities need to adapt their tariff structures to these emerging circumstances. The weight of the fixed component in a two-tier tariff system can, for example, be increased to compensate for shrinking volumetric discharge.
Innovative tariff structures need to be explored to balance revenues with desirable water consumption savings and the need to maintain sustainably expensive infrastructures for the declining population that they serve.

3.5.5 Connection Fees

No survey has been found in the Danube region countries concerning prevailing connection fees to centralised water and wastewater systems.

The relatively high costs of connection to a sewer system can be an obstacle for some households. To facilitate acceptance, some utilities spread the connection charges over several years, or recover them through tariff surcharges. There is a growing consensus that subsidies are better used to reduce connection charges than to keep consumption charges at a lower level. Cross-subsidies within the utility can also be used to temporarily support the connection of poorer households with the tariff applied to the wealthier sections of the population, which have higher water consumption supporting services and connections than in poorer areas.

The connection fee can be a significant dimension of affordability, especially for poorer households, and a survey to assess the importance of this issue would be beneficial. Special attention should then be paid to the sources of finance for network connection fees (bank loans with subsidised interest rate to population, utilities spreading the costs over several years etc.) especially for poorer households that need to be connected in the future in RO and BG.

3.5.6 Future Trends in Tariffs and Connection Fees

Water service pricing policies in the eight countries only partially fulfil the requirement stipulated in the WFD regarding the need for full cost recovery of water services, not only in financial terms, but also in economic terms (environmental and resource costs). Financial expenditure and depreciation costs are usually only partially included in the current tariffs. Environmental and resource costs (ERC) are even less internalised due to an absence of reference values and a lack of robust methodology to define such reference values (see Chapter 4). Even in the presence of an 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 as to whether they are local (municipality) or a central (regulator, ministry) body are often reluctant to approve tariff increase proposals due to political considerations. They instead recommend introducing efficiency measures that can reduce operating costs. Although this is a legitimate approach, the reality is that a substantial tariff increase cannot be avoided to enable decent cost recovery of depreciation, especially in countries that have lower tariffs than the region's average.

When poorer households need support, it should preferably be in the form of well-targeted subsidies from the state or municipal budgets or from cross subsidisation between groups of customers within a utility, which do not lower the revenues needed by the utility to recover its costs. Keeping the tariff excessively low for all will compromise the "polluter pays" principle.

3.6 Affordability of Wastewater Services

Water utilities' revenues are strictly limited by the ability of consumers to pay for the services. At the same time, the utility's consumer base is not constant, and can be impacted by long term demographic changes that need to be integrated into the strategy of the wastewater sector.

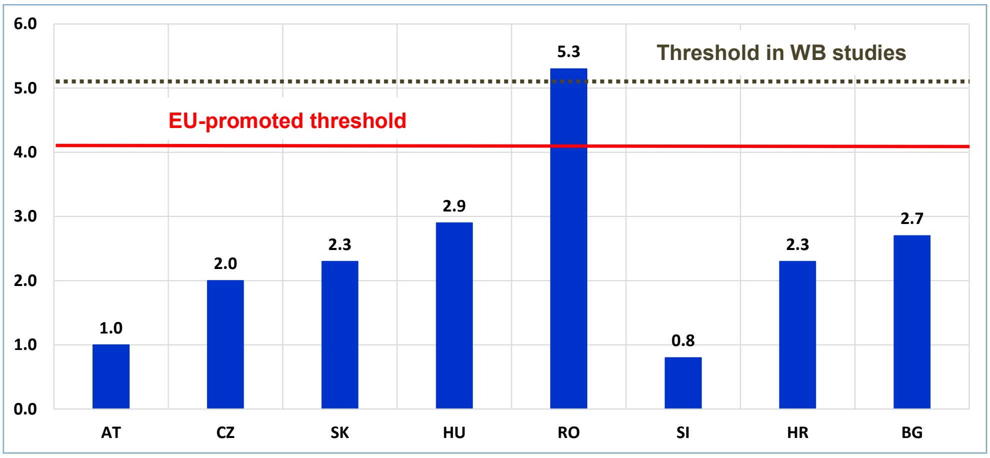
3.6.1 Affordability Assessment

Affordability of water services can be interpreted as the price that a consumer is able to pay without jeopardising its ability to meet other important basic needs. Affordability of water services therefore depends on both the water tariff and households' income and expenditures. Different approaches are available in the literature on measuring affordability. One common method, however, is to calculate the "affordability rate" by taking the crude ratio between the expenditure on a given utility service provider and a household's total disposable income.

There is no universal benchmark for a water services affordability rate and each country can itself decide and document what constitutes an affordable threshold for water supply and sanitation services. In World Bank studies, 3 to 5% of total (monthly or annual) household income is typical. EU guidance documents promote 4% of disposable household income. Using these thresholds, the affordability of water prices can be measured with the help of macro- or micro-affordability indicators.

A macro-affordability analysis relies on official national statistical information of households' income and expenditure. Current statistical data based affordability ratios in the countries in the Danube region are shown in Figure 3.12, and were_published in the SOS Report 2015. The countries are listed from upstream to downstream along the flow of the Danube River.

The worst affordability ratio, 5.3%, is observed in RO. This suggests that households may already have problems with paying water bills, as the ratio is even less favourable than the maximum applied in WB studies (brown dotted line in Figure 3.14). However, the bill collection ratio is unusually high (112%) according to the referred SOS 2015 Study. This ratio shows that 12% more revenue is collected than billed, which may express some inconsistency with the affordability ratio being the least affordable in the region. Considering that the currently connected population in RO (approx. 60%) is likely to be in larger cities and financially better off, and that the demand for new connection is smaller in rural communities, the affordability situation is anticipated to worsen in the coming years in this country. The affordability indicators for other countries are currently below the EU-promoted threshold of 4% (solid red line in Figure 3.14). BG and HU have the closest affordability ratio to the threshold after RO and may also face difficulties when future tariff increases become necessary to cover wastewater services.



Source: SOS Report, 2015

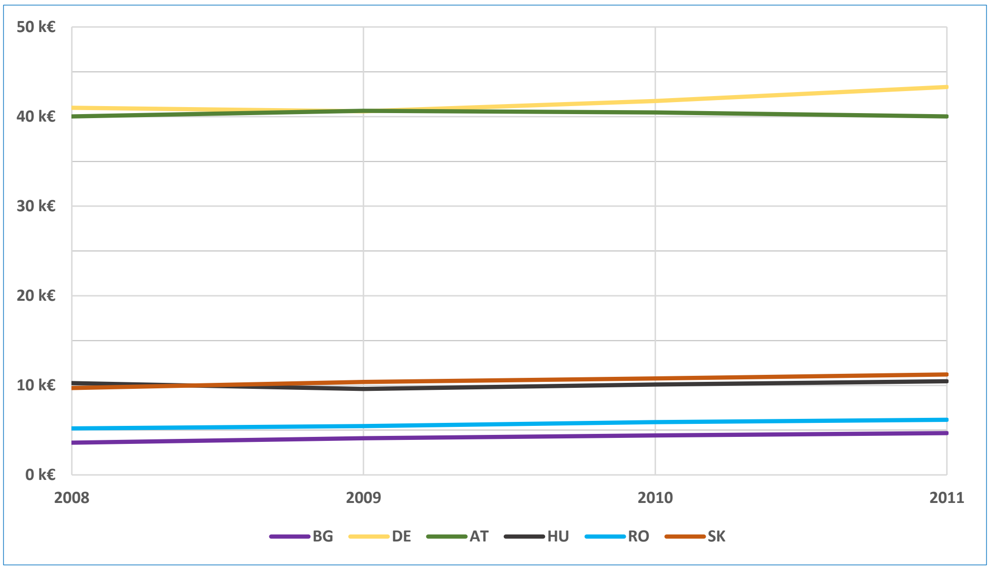
Figure 3.14: Current affordability ratios in the target countries of the Danube Region (%)

A micro-affordability assessment is developed at water utility level. It expresses the upper limit of water charges that a local household can afford for water and wastewater services. Serving a large number of the population with low affordability can affect the capacity of a water utility to cover its O&M, investment and reinvestment cost obligations.

The micro-affordability relies on the following formula:

$$\text{Affordability ratio} = \frac{\text{Water Consumption * Tariffs + VAT + Environmental Charges}}{\text{Household's Net Income}} < \begin{array}{l} 5\% \\ \text{or } 4\% \end{array}$$

The affordability ratio is directly proportional to the per capita water consumption and water & sanitation tariffs including taxes and charges, and inversely proportional to household net income. Figure 3.15 demonstrates the annual earnings per person for the selected countries of this study based on EUROSTAT data. As no household level data is registered by EUROSTAT, this study relied on annual earnings per person to show income differences. In the first approximation, the unemployment situation for each of the assessed countries is not considered to be significantly different.

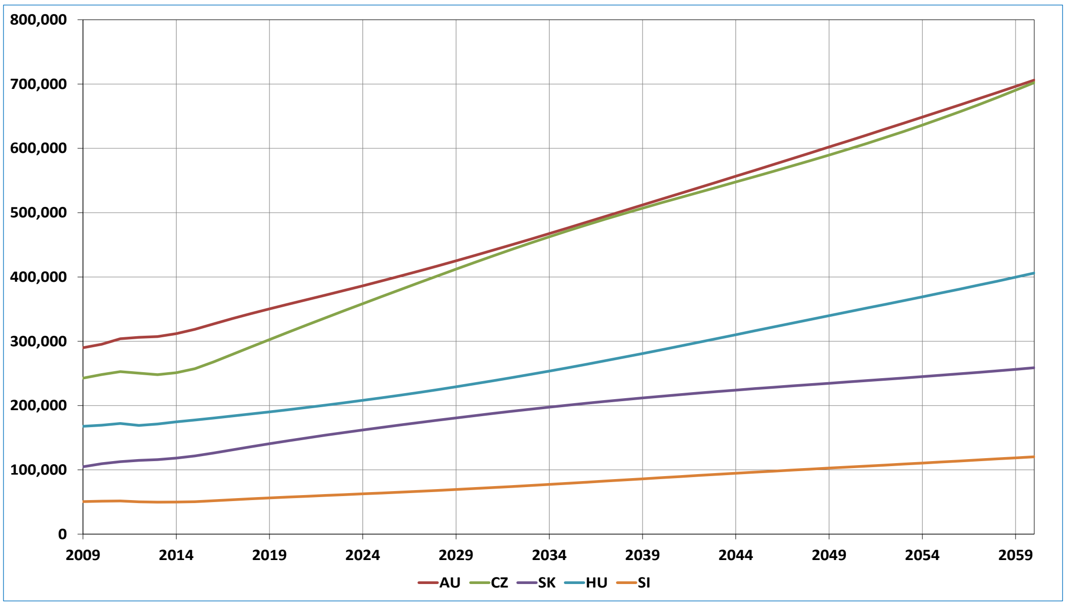


Source: EUROSTAT 2017, http://ec.europa.eu/eurostat/tgm/table.do?tab=table&plugin=1&language=en&pcode=tps00175, OECD for AT;

Figure 3.15: Average annual earnings per person in selected countries of the study

In the light of income differences presented in Figure 3.15, the affordability constraint is not a real concern in the "old" MSs (EU15), but it is a serious challenge for a number of "new" MSs due to constrained household incomes there. 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-third of the medium income countries highlighted earlier and one-sixth of AT and Germany.

Assuming that household earnings will rise in line with the per capita GDP in the Danube region, Figure 3.14 reflects expected household income based on the long-term per capita GDP forecast published by OECD and the population forecast published by EUROSTAT.



Source: OECD GDP forecast / EUROSTAT population forecast

Figure 3.16: Long-term per capita GDP forecast in USD at purchasing power standard

Based on micro-affordability data in Figure 3.16, it is possible to estimate the macro-affordability ratio of an average household consuming around six (6) m^3/month. This is reflected in Table 3.20, which expresses future an anticipated affordability ratio using 3% of the household earnings as an affordability threshold for the wastewater management expenditure share of the combined water price.

Target Countries	Water and Wastewater tariff affordability ratio [%] In 2015	Wastewater tariff affordability ratio [%] In 2015	Wastewater tariff affordability ratio [%] In 2025	Wastewater tariff affordability ratio [%] In 2040
Austria	1.0	0.6	0.66	0.57
Bulgaria	2.7	1.6	2.56	2.69
Czech Republic	2.0	1.2	1.56	1.39
Croatia	2.3	1.4	1.91	1.31
Hungary	2.9	1.7	2.69	2.07
Romania	5.3	3.2	2.99	3.01
Slovenia	0.8	0.5	0.69	0.57
Slovakia	2.3	1.4	2.40	1.91

Source: SOS Report 2015; own calculation

Table 3.20: Average affordability ratios in the future for the eight target countries

The mitigation of the affordability constraints expressed in the table above can be addressed through several avenues. The most significant include:

- Tariffs and O&M costs
  - ✓ rationalise the cost of wastewater services (both capital and operational expenditures),
  - ✓ seek innovative tariff structures (in Canada water tariff setting combines aspects of affordability, conservation, and economic development);
- Rationalisation of water consumption
  - ✓ awareness raising campaigns for conservation and water-saving measures - education;
  - ✓ promotion of low cost, high water saving devices (shower heads, tap heads) including free distribution to water consumers wherever it can be justified. Experience in France shows that the cost of water saving tap heads (around 3 to 4 EUR) can save up to 50% of the water used in kitchen and bathroom equipment;
- Value Added Tax
  - ✓ standard reasonable VAT rate: a VAT rate in the range of 27% (HU) often represents one percentage point of the affordability ratio (3 to 5% of incomes);
- Households' income
  - ✓ increase household incomes as a result of GDP growth measures;
  - ✓ develop transparent and well-targeted subsidy schemes for the poorest.

In summary, it can be stated that countries need to design water pricing policies that take better into account the anticipated affordability constraints experienced by poorer households. Limited capacity to pay for water and wastewater services by poorer households should not be ignored by keeping the tariff low. This endangers the utilities' financial viability and should be acknowledged officially and mitigated via targeted subsidies schemes.

3.6.2 Demographic Trends in the Danube region

Past demographic trends are presented in Table 3.21, comparing changes in population in the DRBD and the Danube region from 2005 to 2015.

Target Countries	Population in DRBD			Population in Danube Region		
	2005	2015	Change %	2005	2015	Change %
Austria	7.9	8.3	4.80%	8.2	8.6	4.99%
Bulgaria	3.4	3.1	-2.68%	7.7	7.2	-6.28%
Croatia	3.1	2.6	-3.32%	4.4	4.2	-5.37%
Czech Republic	2.8	2.9	0.90%	10.2	10.5	3.28%
Hungary	10.2	9.8	-3.50%	10.2	9.8	-3.50%
Romania	21.6	19.8	-8.26%	21.6	19.8	-8.26%
Slovenia	1.6	1.8	2.56%	2.0	2.1	3.15%
Slovakia	5.2	5.2	0.91%	5.3	5.4	0.95%
Total	**55.8**	**53.4**	**-2.60%**	**69.7**	**67.7**	**-2.32%**

Source: 1st DRBMP2009; World Bank

Table 3.21: Changes of population in the Danube River Basin District and the Danube region in the period 2005-2015, million inhabitants

Over the last decade, a significant overall population decrease has been observed in the Danube River Basin District and the Danube region. During this period, between two and two and a half million people left the region. Four countries covered by this study enjoyed population growth (AT, SK, CZ, SI), while the other four (RO, HU, BG, HR) suffered continuing shrinking population.

In the context of this study, a declining population results in a diminishing number of customers for the water service providers. Operating and maintaining existing infrastructure based on a contracting revenue base is always problematic because sunk infrastructure maintenance costs cannot be significantly reduced to balance lower revenues.

Future demographic trends are presented in Table 3.22, which is based on data from EUROSTAT. According to these statistics, the general tendency of the previous decade is expected to continue until 2020. During that period, four countries will have positive population changes: AT, CZ, SI, and SK. Thereafter, for the period 2020 to 2080, the Eurostat forecast anticipates that only AT will experience population growth. All the other seven countries will face a possible decline in the number of inhabitants.

Target Countries	2015	2020	2040	2060	2070	2080
Austria	8,576,261	9,005,487	10,087,623	10,230,993	10,171,555	10,072,112
Bulgaria	7,202,198	6,954,254	5,933,535	5,225,824	4,871,873	4,593,415
Czech Republic	10,538,275	10,652,407	10,552,301	10,307,640	9,983,111	9,777,734
Croatia	4,225,316	4,091,559	3,819,863	3,533,771	3,401,757	3,276,481
Hungary	9,855,571	9,789,630	9,471,313	9,119,692	8,883,760	8,691,906
Romania	19,870,647	19,259,049	17,069,777	15,698,753	15,015,303	14,530,142
Slovenia	2,062,874	2,075,778	2,066,086	2,000,454	1,956,522	1,938,449
Slovakia	5,421,349	5,458,718	5,373,043	5,114,570	4,908,905	4,714,770

Source: EUROSTAT

Table 3.22: Forecast of population change in the Danube region in 2015-2080

At the same time, decreasing populations may have positive environmental impacts. Shrinking number of inhabitants means lower pollution loads and less pressure on the water environment.

This demographic downward trend may be an opportunity for smaller agglomerations to explore WWTP solutions which do not necessitate the use of heavy duty equipment which has high energy operating costs and require periodic maintenance and renewal. Extensive nature near solutions such as constructed wetlands can be deployed modularly. Such solutions perform efficiently, even when operating well below design capacity and have a long economic life and low maintenance costs.[21]

3.7 European Sources of Financing of Wastewater Infrastructure Investments

During the current EU programming period 2014-2020, the European Regional Development Fund (ERDF) and Cohesion Fund (CF) grants have been the primary funding source for new wastewater infrastructure investments to comply with the UWWTD. However, from the next period onward (2021-2027) these sources are expected to be significantly reduced, thereby forcing water utilities to rely more on commercial debt financing through loans or bonds for their capital investments. As a result, it is of the utmost importance that tariffs and revenues for water utilities are set at an appropriate level which is compatible with future commercial funding sources.

3.7.1 EU Grants Role for Capital Expenditures

Since 2004, a substantial amount of EU grants have been mobilised to address the major financing needs of the water and sanitation sector in “new” EU MSs. Following the financial crisis of 2008, the EC and the EU MSs had to reorganise their budgets to address issues of financial stability and the need to reduce systemic risks in their operations. Budget reforms invariably lead to expenditure cuts, including to the various subsidies so far provided in the water and sanitation sector.

Despite the importance of EU co-financing in facilitating the implementation of the UWWTD, no comprehensive overview of the size of the EU grants allocated to UWWTD investment in the seven countries (AT is excepted) has yet been collected and documented.

A progress Report for the timespan 2007-2015 from KPMG “EU funds in Central and Eastern Europe” presents an overview of the progress achieved during the implementation of EU funds in the previous programming period (2007-2013).

The European countries summarise their seven-year development plans in National Strategic Regional Framework Programmes, which combine sectoral operational programmes (OP) agreed with European Commission. Financial closure is due within two years of the end of the programming period. The UWWTD implementation is typically financed by environmental SOP in each country.

The programming period 2007-2013 was officially closed at the end of 2015. By that time, the utilisation of all assigned allocations had to be controlled and approved by the EC and all payment applications for the final balance of each OP submitted. Only then can an OP be considered to be closed. Table 3.23 presents general information on EU fund disbursement in countries of the Danube region.

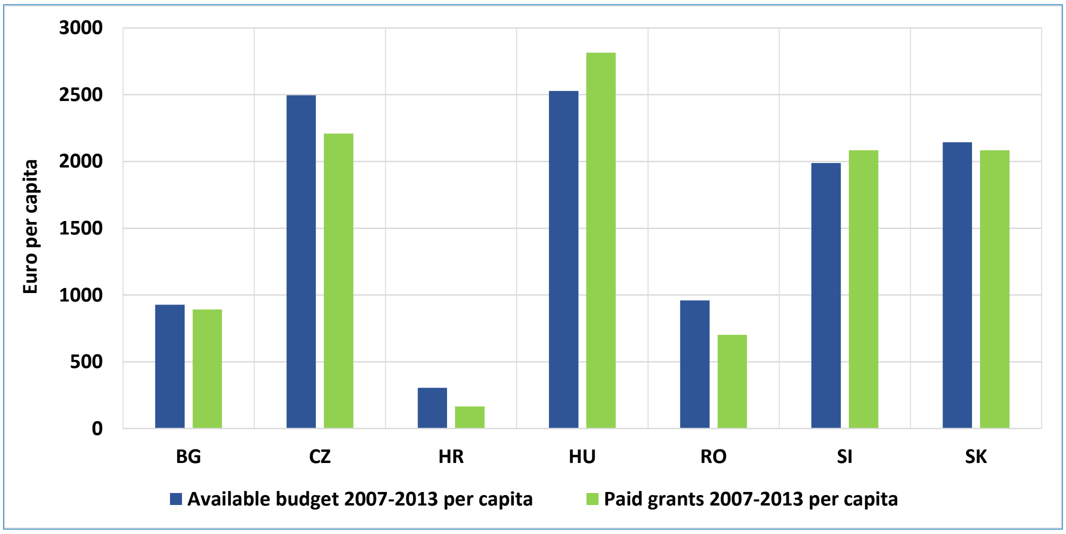
[21] See GWP CEE 2014: Natural Technologies of Wastewater Treatment; WEPC 2010: Sustainable and cost-effective wastewater systems for rural and peri-urban communities up to 10,000 PE

Target Countries	Available budget, bn EUR	Available budget per capita, EUR	Contracted grants, bn EUR	Paid grants, bn EUR	Contracting ratio, %	Payment ratio, %
Bulgaria	6.7	926.9	7.0	6.4	105	95
Czech Republic	26.3	2,495.9	27.0	23.3	103	89
Croatia	1.3	305.5	1.5	0.7	117	57
Hungary	24.9	2,528.6	29.2	27.7	117	111
Romania	19.1	959.5	22.1	13.9	116	73
Slovenia	4.1	1,987.8	4.4	4.3	107	105
Slovakia	11.7	2,144.4	14.2	11.3	122	97
Total	94.1	1,621.2	105.4	87.6	112	90

Source: EU funds in CEE-Progress report 2007-2014 by KPMG

Table 3.23: EU-fund disbursement in Danube region countries in the programming period 2007-2015

All countries over-contracted their EU budget in order to mitigate the financial risk of not utilising the available budget. An important factor in determining the efficiency of EU fund management and disbursement is the gap between the contracted and paid grants. The smaller the gap between these two factors, the more efficient the national absorption capacity for EU funds is. HR in Table 3.23 is an exception, having joined the EU in 2013. It had a significantly shorter period to allocate, contract and disburse funds. SI is the leader of the group with two percentage point (pp) difference. HU also achieved good results with a 6pp deviation. The biggest variances are in SK (25pp) and RO (43pp). Figure 3.17 summarises these indicators in per capita available and paid grants for the period 2007-2013.



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

Figure 3.17: Available budget vs. paid grants per inhabitants in period 2007-2013 in Danube Region countries

Although the dataset for Table 3.23 does not strictly reflect the EU grants allocated and disbursed for UWWTD implementation, it gives an overview of the difficulty experienced by the seven countries in using EU-grant funding. The following comments are appropriate:

- fundamental weaknesses in public procurement procedures (lack of transparency, frequent irregularities in BG, SK, RO);

- a lack of mechanisms to fund equity contributions of the beneficiaries of the projects (RO);
- providing funding for projects which cannot be completed by the end of 2015 (BG, HR, RO);
- weak public administration structure and a fluctuation in qualified staff;
- overcomplicated grant schemes and public procurement procedures which required large volumes of documentation;
- slow responsiveness, knowledge and information exchange and transfer;
- the Croatian experience confirms that implementation efficiency depends less on funding the investment costs (or set standards), and more on integrating EU implementation procedures into existing administrative & management mechanisms.

In the ECA report mentioned earlier, one conclusion was that while ERDF/CF spending during the 2007-2013 programme period played a key role in bringing forward wastewater collection and treatment, these amounts were insufficient to meet the national UWWTD deadlines for wastewater infrastructure.

Robust data on the absorption capacity for EU funds by the seven countries of the study for the implementation of UWWTD investments could not be assessed. The countries reported different figures in different documents. Obviously, the countries do not have a transparent, and complete database for total UWWTD investment and their funding sources. Table 3.24 attempts to synthesise the available information on EU co-financing through various programming periods. Data gaps were replaced by consultant estimates.

- From the year 2000 onward, the seven countries have received an increasing amount of co-financing EU funds to implement UWWTD. Up until 2020, a total of about 15 billion EUR is expected to be allocated and transfered;
- In the current programming period (2014-2020) RO, HR and BG are expected to continue to receive substantial EU funds, as their sanitation infrasturcture is still below UWWTD-compliance requirements.

Target Countries	2000-2006 ISPA, ERDF	2007-2015 CF, ERDF	2014-2020 Budgets CF, ERDF	Total EU contribution
Bulgaria	246	1,122	1,000	2,368
Czech Republic	397	229	0	626
Croatia*	21	200	1,100*	1,321
Hungary	493	410	900	1,803
Romania	1,044	2,382	3,810*	7,236
Slovenia	117	351	250	718
Slovakia	259	546	200	1,005
Total Danube Region	**2,577**	**5,240**	**7,260**	**15,077**

*Source: DG Regio Report; Questionnaires; RBMPs; SOS Report 2015; expert esitmate; *Partially disbursed after 2020*

Table 3.24: EU funds to co-finance of investments in wastewater infrastructure in the period 2000–2020, MEUR

The determination of the EU co-financing ratio for a project during the programming period 2007-2013 is stipulated in the Council Regulation 1083/2006 for the EU structural funds ERDF, ESF and CF. For countries in the Danube Region the maximum grant ratio was 85% of the eligible expenditure. According to the regulation, revenue-generating projects such as wastewater projects, the net revenue of the project over the assessment period must be deducted from the investment costs to arrive at the figure for eligible expenditure.

An exemplary financing structure in Romania for a wastewater project would entail: 65% from EU-funds, 23% from national budget, 9% from local governments, and 3% from utilities. In Hungary the effective EU co-financing rate is often nearer to the maximum 85%, and the remaining amount is financed by national and local governments.

DG Regio has published major projects' details of the period 2007-2013 on the website: http://ec.europa.eu/regional_policy/en/projects/major/

Typical EU co-financing rates for major WW projects are: BG 76%, CZ 72%, RO 67%, HU 85%, SI 56% and SK 59%.

The EU co-financing rates from structural and the cohesion funds for certain MSs having financial difficulties during the global financial crisis of 2008-2009 were increased from 2010 to the end of the programming period. In the Danube region two countries (HU and RO) enjoyed a 10% increase over the maximal co-financing rate of 85%.

It needs to be repeated that despite the high cost of UWWTD implementation across new MSs, and the crucial importance of the EU grant co-financing of UWWTD investments, there is neither consistent nor complete transparent information on the utilisation of EU-funds to monitor UWWTD investments. Effectiveness of EU-fund allocation and disbursement overwhelmingly depends on the administrative and management capacities of the governments concerned. The co-financing capacity of countries seems to have so far played only a subordinated role.

As in previous EU programming periods, every European region (in statistical terms) 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[22] now distinguishes between three categories of regions. These three are:

- less developed regions: those whose GDP per capita is less than 75% of the average GDP of the EU-27;
- transition regions, whose GDP per capita is between 75% and 90% of the average GDP of the EU-27. This category has replaced the phasing-in and phasing-out mechanisms applied in the previous funding period;
- more developed regions with a GDP per capita above 90 % of the average GDP of the EU27.

The target countries of the study categories and the particular regions eligible for EU grant support are presented in Table 3.25.

Target countries	**Eligible regions**
	(i) Less developed regions
BG	Severozapaden, Severen tsentralen, Severoiztochen, Yugoiztochen, Yugozapaden, Yuzhen tsentralen
CZ	Střední Čechy, Jihozápad, Severozápad, Severovýchod, Jihovýchod, Střední Morava, Moravskoslezsko
HR	Jadranska Hrvatska, Kontinentalna Hrvatska
HU	Közép-Dunántúl, Nyugat-Dunántúl, Dél-Dunántúl, Észak-Magyarország,

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

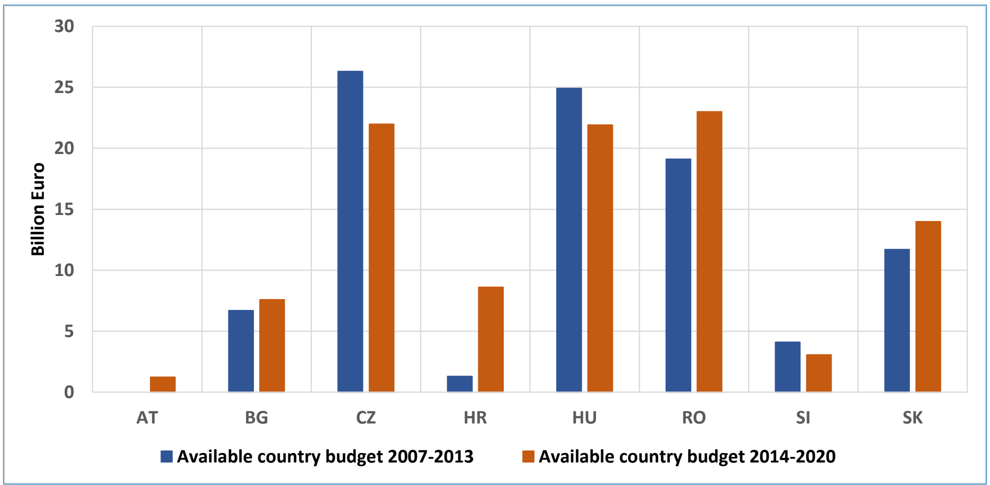
	Észak-Alföld, Dél-Alföld
RO	Nord-Vest, Centru, Nord-Est, Sud-Est, Sud–Muntenia, Sud-Vest Oltenia, Vest
SI	Vzhodna Slovenija
SK	Západné Slovensko, Stredné Slovensko, Východné Slovensko
	(ii) Transition regions
AT	Burgenland
	(iii) **More developed regions**
AT	Niederösterreich, Wien, Kärnten, Steiermark, Oberösterreich, Salzburg, Tirol, Vorarlberg
CZ	Praha
HU	Közép-Magyarország
RO	Bucureşti–Ilfov
SI	Zahodna Slovenija
SK	Bratislavský kraj

Source: ESI Funds 2014-2020 - EC

Table 3.25: Regions eligible for support from ESI funds in period 2014–2020 in the seven target countries of the study

Regularly updated information on the European Structural and Investment Funds Regulations are available on the Inforegio website: http://ec.europa.eu/regional_policy/fr/information/legislation/regulations

Figure 3.18 reflects the available total budget for countries in the Danube Region in the two EU programming periods of 2007-2013 and 2014-2020. Between the two periods the budget available for CZ, HU and SI was lowered by an amount of 8 Billion EUR, while other countries (BG, HR, RO, SK) enjoyed an increase of 14 Billion EUR in line with the CPR categories.



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

Figure 3.18 Available EU budget in the period 2007-2013 and 2014-2020 for countries in the Danube Region

EU grant transfers are hypothetically assumed in the SOP scenario to be phased out in the foreseeable future, leaving some countries without appropriate financial sources to sustain their wastewater infrastructure. This financing gap will need to be replaced by market-based financial sources. These financial sources will only be available to creditworthy organisations. Creditworthiness requires three conditions to be satisfied: (i) credibility (transparency), (ii) accountability and (iii) autonomy. In the coming decade, it will become of the utmost importance that water utilities and the agglomerations they serve become more creditworthy in order to be able to leverage commercial finance. In this case, legal restriction and debt ceilings imposed on municipalities will have to be taken into account.

3.7.2 Cost of Financing Wastewater Infrastructure Development in the Long Term

The current long-term cost of the capital benchmark for the ECB (EURIBOR), which represents the “marginal lending facility for the ECB”, is 0.25%. The LIBOR is no longer referred to, due to ongoing Brexit negotiations. In the future this extremely low rate is expected to raise. Assuming a 10% commercial interest rate on 50% of planned reinvestment costs, the cost of financing up to 2040 represents ca. 1.5 Billion EUR for the eight countries in the Danube region. The highest financing cost can be anticipated for AT with 500 M EUR and the lowest 30 M EUR for SI.

4. Annex 4.A: Water Economic Guidance Documents for EU WFD

1) WISE- WATER INFORMATION SYSTEM FOR EUROPE - Water Notes on the Implementation of the Water Framework Directive, Produced by DG Environment) Water Note 5 - Economics in Water Policy - The value of Europe's waters
http://ec.europa.eu/environment/water/participation/pdf/waternotes/water_note5_economics.pdf

2) COMMON IMPLEMENTATION STRATEGY FOR THE WATER FRAMEWORK DIRECTIVE (2000/60/EC) - Guidance document No 1 Economics and the environment -The implementation challenge of the Water Framework Directive, 2003
http://ec.europa.eu/environment/water/water-framework/economics/pdf/Guidance%201%20-%20Economics%20-%20WATECO.pdf

3) Common Implementation Strategy - Working Group 2B: Drafting Group ECO1 - Information Sheet on Assessment of the Recovery of Costs for Water Services for the 2004 River Basin Characterisation Report (Art 9), 2004
http://ec.europa.eu/environment/water/water-framework/economics/pdf/Information_Sheet_ECO1_Cost_Recovery.pdf

4) COMMISSION STAFF WORKING DOCUMENT- Accompanying document to the COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL - 'Towards Sustainable Water Management in the European Union' - First stage in the implementation of the Water Framework Directive 2000/60/EC, 2007
http://ec.europa.eu/environment/archives/water/implrep2007/pdf/sec_2007_0362_en.pdf

5) CEA Drafting Group - Cost Effectiveness Analysis document Cost Effectiveness Analysis document, 2006
http://ec.europa.eu/environment/water/water-framework/economics/pdf/2006_CEA_final_policy_summary.pdf

6) COMMON IMPLEMENTATION STRATEGY FOR THE WATER FRAMEWORK DIRECTIVE (2000/60/EC) - Technical Report - 2009 – 027 - Guidance Document No. 20 - GUIDANCE DOCUMENT ON EXEMPTIONS TO THE ENVIRONMENTAL OBJECTIVES, 2009
http://ec.europa.eu/environment/water/water-framework/economics/pdf/Guidance_document%2020.pdf

7) European Commission Directorate-General Environment - Defining Water Framework Directive and pre-Water Framework Directive measures Final report - March 2010
http://ec.europa.eu/environment/water/water-framework/economics/pdf/Defining%20pre-WFD%20and%20WFD%20measures.pdf

8) Costs and Benefits associated with the implementation of the Water Framework Directive, with a special focus on agriculture: Final Report
http://ec.europa.eu/environment/water/water-framework/economics/pdf/framework_directive_economic_benefits.pdf

9) European Commission - Managing Scarce Water Resources - Implementing the Pricing Policies of the Water Framework Directive, Final Report, June 2010
http://ec.europa.eu/environment/water/water-framework/economics/pdf/pricing_policies.pdf

10) Scoping Study on the Economic (or Non-Market) Valuation Issues and the Implementation of the Water Framework Directive, EFTEC, September 2010
http://ec.europa.eu/environment/water/water-framework/economics/pdf/Scoping%20Study.pdf

11) Workshop: CIS-Workshop on WFD-economics – Taking stock and looking ahead - 19-20 October 2010
http://ec.europa.eu/environment/water/water-framework/economics/pdf/WFD-economics-workshop-outcome.pdf

12) Working Group F on Floods - Thematic Workshop “Floods and Economics: appraising, prioritising and financing flood risk management measures and instruments” 25-26 October 2010
http://ec.europa.eu/environment/water/water-framework/economics/pdf/WGF11-3-BE-Floods_and_economics_workshop.pdf

13) A Floods Working Group (CIS) Resource document Flood Risk Management, Economics and Decision Making Support, October 2012
http://ec.europa.eu/environment/water/water-framework/economics/pdf/WGF%20Resource%20document%20Flood%20Risk%20Management.pdf

14) Comparative study of pressures and measures in the major river basin management plans in the EU Task 4 b: Costs & Benefits of WFD implementation, Final Report, September 2012
http://ec.europa.eu/environment/archives/water/implrep2007/pdf/EU%20pressures%20and%20measures_task_4b_Guidance%20note_final%20version.pdf

15) Guide to Cost-Benefit Analysis of Major projects 2007-2013
http://ec.europa.eu/regional_policy/sources/docgener/guides/cost/guide2008_en.pdf

16) EC (2014). Guide to Cost-Benefit Analysis of Investment Projects; Economic appraisal tool for Cohesion Policy 2014-2020
http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf

5. Annex 4.B: Current approach for environmental and resources costs in the DRBMP

For the national agencies managing the Danube River and the ICPDR, the current focus regarding Environmental and Resources Costs and benefits (ERC) is oriented solely towards costs that can be recovered through charges to customers. The costs documented are the costs imposed by the MS for the use of the water in the form of charges for water abstraction (resources cost) or for wastewater collection and treatment and discharge into water bodies (environmental costs).

Country	ERC estimations available [Y/N/Partly]	Clear methodology for calculating ERC [Y/N/Partly]	Clear methodology for cross subsidies [Y/N/Partly]
AT	N AT is "on the way" to find a method to isolate/separate the ERC in (company) cost accounting systems, to make them visible and do get a better basis for calculations	Partly (expert judgment involved)	N
BG	ERC are quantified (2008-2012)	Y (Methodology is developed)	N
CZ	Y	Partly The calculation of EC in CZ is based on the costs of renewal and saved costs. It determines the costs that would be necessary for compensation of impacts of water management services on environment, respectively for the compensation of the impacts disturbing the state of surface and GW from the quantitative, qualitative and hydro-morphological point of view.	N (Subsidies do not play a role in CZ)
HR	Partly ERC are partly quantified, only the internalised parts are quantified.	Partly (cost-based approach) Assessment of ERC is ongoing.	N
HU	Partly ERC are partly quantified, only the internalised parts are quantified. ERC were assessed in 2006-2007 based on the 2005 data for wastewater and drinking water. Considering the international experience, we chose the cost-based approach, so we consider the cost of the remaining measures needed in order to achieve "good status" as EC.	Y EC calculation methodology is clear (cost based methodology), but the cost of measures is missing The Water Load Fee (WLF) and water resource fee is internalized of (a part of the) external environmental costs The rate of the water load fee is defined by the product of: 1) the total amount of the annual discharge of the contaminant measured in kilograms, 2) multiplied by a specific rate per pollutant, 3) a measure of area sensitivity and 4) sludge disposal factors. (For more details, see the DBA2013). Water resource fee (abstraction fee) is depend on the water resource type and water uses (and some another element)	N There are subsidies for covering a part of the financial cost for households when the service costs are extremely high, or the costs are above a certain threshold.
RO			
SI	Partly ERC are partly quantified, only the internalized parts are quantified, additional assessments are in progress.	Partly (assessment of ERC are in progress)	N
SK	N No "full estimations of ERC for single water services"; only the "internalized parts are quantified"4.	Partly For the estimation of EC, the cost-based approach is used which involves the costs for certain	Partly (subsidies play little role)

		groups of measures. The evaluation of RC is also based on a cost-based approach (e.g. construction of long-distance pipelines to areas failing to achieve good quantitative status of GWBs). As regulatory measures and restrictions have not been applied, the RC which appear due to non-coverage of water requirements of specific sectors (foregone costs approach), is not current.	

Source: DRBMP update 2015, Annex 11.

Table 4.1: ERC considered by the ICPDR and riparian countries administrations

While the assumption for these charges should correspond to the associated resource or environmental damages caused by water pollution, the values currently applied shown in Table 4.2 may not be representative of these countries genuine water resources and the environmental cost of forgone benefits due to incomplete compliance with UWWTD requirements.

Countries	**Water service**	**Environmental cost** **[€/m³, €/?, not assessed]**	**Resource cost** **[€/m³, €/?, not assessed]**	**Payment for environmental* cost recovery** **[€/m³, no payment]**	**Payment for resource* cost Recovery** **[€/m³, no payment]**
AT	Waste water treatment	ERC are considered in the recovery of the costs of waste water services; they are not quantified individually		ERC are considered in the recovery of the costs of waste water services; they are not quantified individually	
BG	Public collection of wastewater	13,260,866.23 € (in 2012) (Costs for removal of damages, caused by diffuse pollution from settlements without sewage system)	No identified resource costs	Recovery through prices of public collection of waste water Price for collection of waste water: 0.09 €/ m³	N
	Public treatment of wastewater	€27,240,608.85 (in 2012) (1.Costs for removal of damages, caused by point pollution of waste water from households and industry /building of WWTPs 2. Costs for removal of damages, caused by diffuse pollution	No identified resource costs	Recovery through prices of treatment of waste water Price for treatment of waste water: 0.14 €/m³	N
CZ	Wastewater treatment	ERC are in the form of charges for pollution and volume of discharged wastewater.		No separate payment exists. ERC recovery costs are internalized.	
HR	Wastewater service	Water protection fee: 0.38 €/m³ for households (for industry depends on level of pollution); Development fee introduced on local level and vary from 0–0.53 €/m³ ERC are partly internalized through water price (in form of water fees). Assessment of ERC is ongoing.		0.4 €/m³ For purpose of this study rough estimation has been made, based on Annual Financial Plan of Hrvatske Vode (National Agency for water Management)	
HU	Wastewater collection and treatment for	EC were assessed in 2006-2007 based on the 2005	Not assessed. We want to establish a kind	0.018 €/m³	No payment

Countries	Water service	Environmental cost [€/m^3, €/?, not assessed]	Resource cost [€/m^3, €/?, not assessed]	Payment for environmental* cost recovery [€/m^3, no payment]	Payment for resource* cost Recovery [€/m^3, no payment]
	households industry public	data. EC are partly internalised in the water load fee and this is covered by the water price	of mechanism, which can determine the resource cost utilizing market procedures, not just by administrative (legislative) measures.		
RO	Wastewater treatment (includes sewerage)	0.3 €/m^3	-	0.3 €/m^3	-
SI[1]	Wastewater collection and treatment for households	not assessed (only internalied part was assessed, additional assessments are in progress)	-	Environmental tax: 26.4125 €/ unit load	-
SK	Collection and treatment of wastewater	Environmental cost in the form of charges for discharge of wastewater is internalized in the price for the collection and treatment of wastewater (EUR/m3)	Not assessed	No separate payment, only the internalized one	No payment

*Source: DRBMP update 2015, Annex 11. 1Data for Slovenia updated according to the draft of 2nd RBMP 2015-2021 *Data is from 1st analysis (2005-2006)*

Table 4.2: Assessment and recovery of ERC in the Danube region

6. Annex 4.C: Cost Efficiency of UWWTD implementation

In order to express the cost effectiveness of the implementation of UWWTD, an attempt has been made to express the so-called "Levelled Cost" (LC) of the implementation of the UWWTD for the eight countries in the Danube region.

The LC expresses the present value of the cost of collecting and treating wastewater under the UWWTD during the lifespan of implementation, investment needed to comply with the UWWTD. The LC can be related to the m^3 of wastewater treated or the tons of pollution (BOD, COD, N and P) removed.

Tables 4.3 and 4.4 provide an overview of the underlying assumptions applied in the calculation for each country in the Danube region.

Future costs are discounted for using the EU recommended social discount rate for projects co-financed under EU programmes. According to Annex III regarding the implementation regulation on application form and CBA methodology for the programming period 2014-2020, the European Commission recommends that a social discount rate of 5 % is used for major projects in cohesion countries and 3 % for the other Member States. In accordance with the recommendations of EU guidance documentation, the social discount rate applied in this economic assessment was set at 3% for AT, and at 5% for all the other countries of the study. Quantities are undiscounted in the calculation of the LCs and aggregated over the assessment period.

The following calculation assumptions apply:

- ✓ Yearly treatment costs starts at the year of accession;
- ✓ Total cost of collection and treatment (investment, reinvestment, O&M) are discounted starting from 2015 onward (first future year after the 9^{th} Technical Assessment milestone year);
- ✓ Earlier costs (2014 and earlier) are not discounted. They represent sunk past cost.

Country	Year of Accession	IAS agglomerations				Secondary Treatment Agglomerations			More stringent treatment agglomerations		
		PE treated at Accession year	PE treated at year of 9th TA-UWWTD	PE treated at full compliance year	Year/deadline of full compliance	PE treated at Accession year	PE treated at year of 9th TA-UWWTD	PE treated at full compliance year	PE treated at Accession year	PE treated at year of 9th TA-UWWTD	Final deadline of the transitional period / Deadline of full compliance with Art. 5.
Austria	1995	138,056	138,056	138,056	2005	1,325,395	1,750,852	1,750,852	14,019,701	18,520,080	2005
Bulgaria	2007	1,000	5,370	5,370	2014 / 2020	81,619	163,237	1,016,131	2,076,851	3,759,697	2014 / 2020
Czech Republic	2004	300,000	521,417	521,417	2010/2017	1,252,126	1,683,795	1,707,755	4,011,988	5,406,486	2010/2017
Croatia	2013	Not reported	Not reported	Not reported	2023 / 2027	509,691	Not reported	1,911,819	830,301	Not reported	2023 / 2027
Hungary	2004	300,000	1,483,649	1,483,649	2015 / 2019	3,840,005	8,350,537	10,000,013	81,019	194,518	2015 / 2019
Romania	2007	100,000	138,621	138,621	2018 / 2021	180,780	449,779	6,365,507	409,547	4,592,858	2018 / 2021
Slovenia	2004	50,000	91,221	91,221	2015 / 2019	125,884	303,614	500,334	19,177	76,221	2015 / 2019
Slovakia	2004	500,000	766,082	766,082	2015 /2019	221,146	540,803	591,300	1,233,802	1,993,489	2015 / 2019
Total		**1,389,056**	**3,144,416**	**3,144,416**		**7,536,646**	**13,242,617**	**22,244,859**	**22,682,386**	**34,543,349**	

Source: 9th TA-UWWTD; own considerations

Table 4.3: Assumptions for economic assessment of cost efficiency of UWWTD implementation for the period 2000-2014

Country	Year of Accession	IAS Agglomerations				Secondary Treatment Agglomerations				More stringent treatment Agglomerations			
		PE treated at Accession year	PE treated at year of 9th TA-UWWTD	PE treated at full compliance year	Year/deadline of full compliance	PE treated at Accession year	PE treated at year of 9th TA-UWWTD	PE treated at full compliance year	Final deadline of the transitional period / Deadline of full compliance with Art. 4.	PE treated at Accession year	PE treated at year of 9th TA-UWWTD	PE treated at full compliance year	Final deadline of the transitional period / Deadline of full compliance with Art. 5.
Austria	1995	138,056	138,056	138,056	2005	1,325,395	1,750,852	1,750,852	2005	14,019,701	18,520,080	18,520,080	2005
Bulgaria	2007	1,000	5,370	5,370	2014/2020	81,619	163,237	1,016,131	2014 / 2020	2,076,851	3,759,697	7,064,119	2014/2020
Czech Republic	2004	300,000	521,417	521,417	2010/2017	1,252,126	1,683,795	1,707,755	2010/2017	4,011,988	5,406,486	5,471,887	2010/2017
Croatia	2013	0	0	0	2023/2027	509,691	0	1,911,819	2023 / 2027	830,301	0	3,114,408	2023/2027
Hungary	2004	300,000	1,483,649	1,483,649	2015/2019	3,840,005	8,350,537	10,000,013	2015 / 2019	81,019	194,518	210,988	2015/2019
Romania	2007	100,000	138,621	138,621	2018/2021	180,780	449,779	6,365,507	2018 / 2021	409,547	4,592,858	14,420,664	2018/2021
Slovenia	2004	50,000	91,221	91,221	2015/2019	125,884	303,614	500,334	2015 / 2019	19,177	76,221	870,676	2015/2019
Slovakia	2004	500,000	766,082	766,082	2015/2019	221,146	540,803	591,300	2015 /2019	1,233,802	1,993,489	3,298,936	2015/2019
Total		**1,389,056**	**3,144,416**	**3,144,416**		**7,536,646**	**13,242,617**	**22,244,859**		**22,682,386**	**34,543,349**	**52,971,758**	

Source: 9th TA-UWWTD; own considerations

Table 4.4: Assumptions for economic assessment of cost efficiency of UWWTD implementation for the period 2000-2040

Tables 4.5 and 4.6 reflect the resulting LCs per country of four key UWWTD pollutants (BOD, COD, N & P) for the period 2000-2014 (the past) and 2000-2040 (the entire period between EU accession and full compliance) in EUR/ton removed through the applied collection systems and wastewater treatments.

Countries Total Cost EUR/ ton removed	AT	BG	CZ	HR	HU	RO	SI	SK
BOD (2000-2014)	4,740	8,293	6,809	5,123	8,806	36,606	26,815	8,704
BOD (2015-2040)	1,860	1,152	2,724	3,842	1,960	2,498	3,565	2,227
BOD (2000-2040)	2,844	2,126	3,962	3,892	3,378	3,904	5,992	3,687
COD (2000-2014)	2,748	4,787	4,052	3,018	5,555	20,470	17,311	5,439
COD (2015-2040)	1,078	668	1,621	2,264	1,241	1,457	2,139	1,357
COD (2000-2040)	1,649	1,232	2,358	2,293	2,137	2,272	3,622	2,260

Table 4.5: Cost of treatment of various UWWTD pollutants for period 2000-2014-2040 (EUR/ton)

Countries Total Cost EUR/ ton removed	AT	BG	CZ	HR	HU	RO	SI	SK
Total N (2000-2014)	20,863	35,243	34,065	29,006	107,508	159,401	236,615	42,933
Total N (2015-2040)	8,185	5,217	13,633	21,753	24,019	12,920	20,180	10,633
Total N (2000-2040)	12,518	9,544	19,825	22,035	41,369	20,037	35,236	17,734
Total P (2000-2014)	40,391	68,276	67,892	39,483	206,134	317,711	444,021	99,120
Total P (2015-2040)	15,847	10,025	27,174	29,610	47,043	24,478	31,349	22,974
Total P (2000-2040)	24,236	18,359	39,514	29,993	80,663	38,053	55,401	38,867

Table 4.6: Cost of treatment of various UWWTD pollutants for period 2000-2014-2040 (EUR/ton)

Important simplification assumptions applied include:

- ✓ PEs complying with the UWWTD requirement have been increased linearly between the three years with available dat; these are (i) accession year, (ii) 9th Technical Assessment Report year 2015 and (iii) estimated final year of full compliance. After full compliance year, PEs served by UWWTD are considered to be constant.
- ✓ PEs considered as being compliant at accession are as defined in Tables 4.3 & 4.4: Wastewater collection and treatment coverage in the year of accession.
- ✓ Pollution load reduction for given types of treatment is based on ICPDR data as shown in table 4.7 below.

Tables 4.5 and 4.6 underline the importance and impact of the investment made in sewer and WWTP as key cost factor for the beneficiaries. Between 2000 and 2014, new EU member countries invested heavily first in sewers and then progressively in WWTPs. The overall cost per pollution removed over the period 2000 – 2014 due to those heavy investments was particularly high. The tables show that the overall costs balance themselves in most countries during the latter implementation period due to the lower need for new investment.

The high specific values for some countries such as Hungary can be explained through the conjunction of several factors:

- ✓ Hungary has, among the eight target countries, the smallest group of agglomerations located in sensitive areas. Only secondary treatment applies in many areas. This leads to lower amounts of N and P being removed and higher specific costs for infrastructure (sewer and WWTP). This is particularly noticeable for the period 2000-2014. Around two-third of investment values account for the cost of collection during that period.
- ✓ The bulk of new investment in HU was concentrated in the period of 2000-2014 (ca. 80%). Only minor investment took place from 2015 onwards (see assumptions in table 2).

- ✓ In Slovenia, the high specific values of N and P removal observed in the period 2000-2014, was due to the limited investment made in that period in WWTPs. In this period only less than 10% of treatment plants were operating (see assumptions in table 2).

As a whole, the values of the above tables 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 that reflects the annual cost of treating TN and TP in WWTP in the USA (Table 6).

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 4.7: Annual costs of N & P removal in USA (2015)

Table 4.8 presents the corresponding LC per m^3 collected and treated per country. The following assumptions apply here:

- ✓ The volume of wastewater being collected and treated is estimated to be 150 l/PE, day.
- ✓ Costs included cover investment, reinvestment, the cost of capital and annual operation for wastewater collection and treatment.
- ✓ Treatment costs also start at the year of accession.
- ✓ Country population of year 2015.

Countries Total Cost EUR/ m^3 treated	AT	BG	CZ	HR	HU	RO	SI	SK
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

Table 4.8: Cost of UWWTD collection and treatment per volume treated (EUR/m^3)

Finally, Table 4.9 reflects the levelled cost per Population Equivalent (PE) and year as a gauge for the assessment of the affordability of wastewater services under the UWWTD.

Countries Total Cost EUR/ PE, year	AT	BG	CZ	HR	HU	RO	SI	SK
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 4.9: Cost of UWWTD collection and treatment per PE & year (EUR/PE, year)

Countries Cost per inhabitant	AT	BG	CZ	HR	HU	RO	SI	SK
Total cost/ inhabitant (2000-2040)	5,420	1,407	2,180	2,178	2,539	2,012	2,306	2,108
Capital cost/inhabitant (2000-2040)	3,168	1,132	925	1,138	1,054	1,078	890	907
O&M cost/inhabitant (2000-2040)	2,252	276	1,256	1,040	1,486	934	1,416	1,201

Table 4.10: Total cost of UWWTD implementation, discounted to 2015 (EUR/inhabitant)

Table 4.11: UWWTD PE Pollution Load Reduction according to ICPDR Guidance

Incoming Pollution	Unit	Austria	Bulgaria	Croatia	Czech Rep.	Hungary	Romania	Slovakia	Slovenia
Volume	l/ day,PE	150	150	150	150	150	150	150	150
BOD	g/ day, PE	60	60	60	60	60	60	60	60
COD	g/ day, PE	110	110	110	110	110	110	110	110
N	g/ day, PE	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
P	g/ day, PE	1.5	1.5	2.05	1.5	1.5	1.5	1.5	1.9
Reduction IAS		Austria	Bulgaria	Croatia	Czech Rep.	Hungary	Romania	Slovakia	Slovenia
BOD	%	90%	90%	90%	90%	90%	90%	90%	90%
COD	%	60%	60%	60%	60%	60%	60%	60%	60%
N	%	55%	55%	55%	55%	55%	55%	55%	55%
P	%	10%	10%	10%	10%	10%	10%	10%	10%
Emission after IAS									
BOD	g/ day, PE	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
COD	g/ day, PE	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00
N	g/ day, PE	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96
P	g/ day, PE	1.35	1.35	1.85	1.35	1.35	1.35	1.35	1.71
Eliminated after IAS									
BOD	g/ day, PE	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00
COD	g/ day, PE	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00
N	g/ day, PE	4.84	4.84	4.84	4.84	4.84	4.84	4.84	4.84
P	g/ day, PE	0.15	0.15	0.21	0.15	0.15	0.15	0.15	0.19
Reduction 1st Treatment		Austria	Bulgaria	Croatia	Czech Rep.	Hungary	Romania	Slovakia	Slovenia
BOD	%	30%	30%	30%	30%	30%	30%	30%	30%
COD	%	30%	30%	30%	30%	30%	30%	30%	30%
N	%	10%	10%	10%	10%	10%	10%	10%	10%
P	%	10%	10%	10%	10%	10%	10%	10%	10%
Emission after 1st Treatment									
BOD	g/ day, PE	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00
COD	g/ day, PE	77.00	77.00	77.00	77.00	77.00	77.00	77.00	77.00
N	g/ day, PE	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92
P	g/ day, PE	1.35	1.35	1.85	1.35	1.35	1.35	1.35	1.71
Eliminated after 1st Treatment									
BOD	g/ day, PE	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
COD	g/ day, PE	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00
N	g/ day, PE	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
P	g/ day, PE	0.15	0.15	0.21	0.15	0.15	0.15	0.15	0.19
Reduction 2nd Treatment		Austria	Bulgaria	Croatia	Czech Rep.	Hungary	Romania	Slovakia	Slovenia
BOD	%	90%	90%	90%	90%	90%	90%	90%	90%
COD	%	80%	80%	80%	80%	80%	80%	80%	80%
N	%	20%	20%	20%	20%	20%	20%	20%	20%
P	%	30%	30%	30%	30%	30%	30%	30%	30%
Emission after 2nd Treatment									
BOD	g/ day, PE	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
COD	g/ day, PE	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00
N	g/ day, PE	7.04	7.04	7.04	7.04	7.04	7.04	7.04	7.04
P	g/ day, PE	1.05	1.05	1.44	1.05	1.05	1.05	1.05	1.33
Eliminated after 2nd Treatment									
BOD	g/ day, PE	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00
COD	g/ day, PE	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00
N	g/ day, PE	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76
P	g/ day, PE	0.45	0.45	0.62	0.45	0.45	0.45	0.45	0.57
Additional Removal 1st to 2nd Treatment									
BOD	g/ day, PE	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00
COD	g/ day, PE	55.00	55.00	55.00	55.00	55.00	55.00	55.00	55.00
N	g/ day, PE	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
P	g/ day, PE	0.30	0.30	0.41	0.30	0.30	0.30	0.30	0.38

Reduction 3rd Treatment		Austria	Bulgaria	Croatia	Czech Rep.	Hungary	Romania	Slovakia	Slovenia
BOD	%	95%	95%	95%	95%	95%	95%	95%	95%
COD	%	90%	90%	90%	90%	90%	90%	90%	90%
N	%	80%	80%	80%	80%	80%	80%	80%	80%
P	%	90%	90%	90%	90%	90%	90%	90%	90%
Emission after 3rd Treatment									
BOD	g/ day, PE	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
COD	g/ day, PE	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
N	g/ day, PE	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76
P	g/ day, PE	0.15	0.15	0.21	0.15	0.15	0.15	0.15	0.19
Elimination after 3rd Treatment									
BOD	g/ day, PE	57.00	57.00	57.00	57.00	57.00	57.00	57.00	57.00
COD	g/ day, PE	99.00	99.00	99.00	99.00	99.00	99.00	99.00	99.00
N	g/ day, PE	7.04	7.04	7.04	7.04	7.04	7.04	7.04	7.04
P	g/ day, PE	1.35	1.35	1.85	1.35	1.35	1.35	1.35	1.71
Additional Removal 2nd to 3rd Treatment									
BOD	g/ day, PE	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000
COD	g/ day, PE	11.000	11.000	11.000	11.000	11.000	11.000	11.000	11.000
N	g/ day, PE	5.280	5.280	5.280	5.280	5.280	5.280	5.280	5.280
P	g/ day, PE	0.900	0.900	1.230	0.900	0.900	0.900	0.900	1.140

Multiplier PE/ year	Unit	Austria	Bulgaria	Croatia	Czech Rep.	Hungary	Romania	Slovakia	Slovenia
volume	m3/year, PE	54.75	54.75	54.75	54.75	54.75	54.75	54.75	54.75
Pollution Removal IAS System	Unit	Austria	Bulgaria	Croatia	Czech Rep.	Hungary	Romania	Slovakia	Slovenia
BOD	Kg/year, PE	19.71	19.71	19.71	19.71	19.71	19.71	19.71	19.71
COD	Kg/year, PE	24.09	24.09	24.09	24.09	24.09	24.09	24.09	24.09
N	Kg/year, PE	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77
P	Kg/year, PE	0.05	0.05	0.07	0.05	0.05	0.05	0.05	0.07
Pollution Removal 1st Treatment	Unit	Austria	Bulgaria	Croatia	Czech Rep.	Hungary	Romania	Slovakia	Slovenia
BOD	Kg/year, PE	6.57	6.57	6.57	6.57	6.57	6.57	6.57	6.57
COD	Kg/year, PE	12.05	12.05	12.05	12.05	12.05	12.05	12.05	12.05
N	Kg/year, PE	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
P	Kg/year, PE	0.05	0.05	0.07	0.05	0.05	0.05	0.05	0.07
Pollution Removal 2nd Treatment	Unit	Austria	Bulgaria	Croatia	Czech Rep.	Hungary	Romania	Slovakia	Slovenia
BOD	Kg/year, PE	19.71	19.71	19.71	19.71	19.71	19.71	19.71	19.71
COD	Kg/year, PE	32.12	32.12	32.12	32.12	32.12	32.12	32.12	32.12
N	Kg/year, PE	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
P	Kg/year, PE	0.16	0.16	0.22	0.16	0.16	0.16	0.16	0.21
Pollution Removal 3rd Treatment	Unit	Austria	Bulgaria	Croatia	Czech Rep.	Hungary	Romania	Slovakia	Slovenia
BOD	Kg/year, PE	20.81	20.81	20.81	20.81	20.81	20.81	20.81	20.81
COD	Kg/year, PE	36.14	36.14	36.14	36.14	36.14	36.14	36.14	36.14
N	Kg/year, PE	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57
P	Kg/year, PE	0.49	0.49	0.67	0.49	0.49	0.49	0.49	0.62

7. Annex 4.D: Economic Assessment of UWWTD Implementation

7.1 Methodology applied for economic assessment

7.1.1 Economic Costs

Economic costs relate to wastewater services, which are provided to households, public institutions and all economic activities. Within the framework of the UWWTD, these services cover wastewater management: (i) waste-water collection and (ii) treatment facilities which subsequently discharge into surface water including sludge treatment and disposal.

The following key cost elements have been included in the assessment so far available: (i) capital costs (comprising new investment, existing assets depreciation and costs of capital when available), (ii) operating & maintenance costs, and (iii) administrative costs in particular water resources management costs for the management of River basin in line with the WFD (when available).

Costs have been estimated and documented in real terms not adjusted for inflation. In addition, future costs (from 2015 onward) were discounted over the assessment period assumed to be 25 years in line with the rates defined in the EU guide to “”*Cost-Benefit Analysis of Investment Projects; Economic appraisal tool for Cohesion Policy 2014-2020; EC; December 2014*””.

7.1.2 Economic Benefits

Benefits considered were essentially environmental and resources benefits (avoided costs) of full compliance.

To arrive at quantitative numbers for a rough estimation of the economic benefits of full UWWTD compliance, data from international literature studies were considered as source of quantitative information in conjunction with the economic value transfer approach.

In an ”economic value transfer” approach, cost estimates from existing literature case studies can be spatially and/or temporally transferred to a new policy context. The challenge is to win access to adequate quantitative and monetised data that is reasonably similar and transferable from a case study to the target Danube region. A number of conditions should apply for a value transfer approach to be economically valid. Costs from the original study site must be theoretically and methodologically valid. The population in the original study and the new policy site must be similar. The difference between pre-policy and post-policy water quality (or quantity) levels must be similar across study and policy site. The study and policy sites must be similar in terms of environmental characteristics, and the distribution of property rights and other institutions must be similar across sites.

For a macro-level economic assessment of the Danube region as a whole, such matching conditions with other regions are unlikely to be met. Consequently, no scientifically robust application of the ”economic value transfer” concept was considered. Instead, the unit value transfer approach was taken. In such an approach, mean unit values per person from other sites are multiplied by the number of people benefiting in the Danube region. The methodology applied has no pretention of economic robustness. On the other hand, estimates gained can provide indicative ranges of the order of magnitude as to what the economic benefits of UWWTD compliance may be for the Danube riparian countries and an indication as to to which extend the costs of implementing the UWWTD generates benefit surpluses for the countries of the Danube region.

7.2 Estimation of the economic costs of the implementation of the UWWTD

To estimate the economic cost of the UWWTD, the financial costs and revenues for UWWTD implementation, as documented in chapter 3, have been retained.

Two different complementary elements were considered here: (i) the past cost of implementation up to the 9th TA-UWWTD, which has just been completed and covers the period up to the year 2014; and (ii) the future remaining costs expected to be needed to fulfil full compliance of the articles 3, 4 and 5 of the UWWTD from 2015 onwards.

7.2.1 Past costs up to the 9th EU TA-UWWTD

Table 4.12 summarises the estimated financial costs of the implementation of the UWWTD up to the 9th TA-UWWTD. These costs, expressed as annual real costs, include (i) investment costs (assuming a linear investment over the years since accession), (ii) O&M costs and (iii) administrative costs (so far only available from RO).

Country	Annual Investment and Renewal costs up to the 9th EU assessment.	Yearly O&M costs up to the 9th EU assessment	Yearly Administrative costs
Austria	308	619	
Bulgaria	340	92	
Czech Republic	300	439	
Croatia	98	231	
Hungary	510	513	
Romania	1,391	966	219
Slovenia	123	104	
Slovakia	67	250	

Source: 9th TA-UWWTD; Questionnaires; Own Calculation

Table 4.12: Past Financial Costs of implementation of UWWTD up to 2014 (M EUR) (cost basis 2015)

7.2.2 Future costs to attain full compliance

Table 4.13 summarises the additional estimated yearly UWWTD investment costs up to full compliance. For the future, besides new investment needed to achieve compliance, re-investment costs have been introduced to cater for the expected renewal costs of infrastructure at the end of its economic life.

According to EU guidelines on cost-benefit analyses of project, taxes and subsidies are transfer payments that do not represent real economic costs or benefits for society as they merely involve a transfer of control over certain resources from one group in society to another.

Country	New Investment costs up to compliance	Yearly reinvestment to stay compliant	Yearly O&M costs to stay compliant	Yearly Administrative costs
Austria	0	415	684	
Bulgaria	238	108	71	
Czech Republic	1	173	562	
Croatia	346	81	276	
Hungary	1	174	625	
Romania	1,487	476	656	182
Slovenia	84	35	124	
Slovakia	75	90	254	

Source: 9th TA-UWWTD; Questionnaires; Own Calculation

Table 4.13: Future Financial Costs of implementation of UWWTD from 2015 onward, M EUR (Cost basis 2015)

Some general rules in principle apply to correct such distortions:

- prices for input and output must be considered net of VAT;
- prices for input should be considered net of direct and indirect taxes;
- prices (e.g. tariffs) used as a proxy for the value of outputs should be considered net of any subsidy and other transfer granted by a public entity.

Due to absence of country level information on which to base such an economic correction, fiscal adjustment has not been applied to financial costs in this assessment.

7.3 Estimation of economic benefits of UWWTD implementation

Table 4.14 summarises how the economic benefits categories highlighted in earlier paragraphs are considered to derive an estimation of the economic benefits of the full implementation of the UWWTD.

Benefits Categories	Underlying Causes	Quantitative Value	Money Unit Value	Embedded Other Benefits
Health related Benefits	✓ Connection to sewage networks to warrant access to safe drinking water supply	Population not connected to sewage networks and WWTP according to UWWTD 9th Assessment	WTP for improved access to safe water supply on a per capita or household basis or as % of Water Bill	Health, Economic, Social,
Environmental Benefits	✓ Connection to sewage network ✓ Directive compliant WWTPs	Population impacted by non-compliance with Articles 3, 4 or 5 of UWWTD	WTP for access to clean river water (for recreation, tourism etc.) on a per capita or household basis or as % of Water Bill	Health, Economic, Social
Social Benefits	✓ Good surface water quality	Population impacted by non-compliance with Articles 3, 4 or 5 of UWWTD	WTP for access to clean river water (for recreation, tourism etc.) on a per capita or household basis	Environmental, Economic.
Economic Benefits	✓ Good water resources quality	Water extracted from water bodies	WTP for good water quality per volume of water used	Environmental, Health, Social

Table 4.14: Factors considered estimating the economic benefits of UWWTD full compliance

The paragraphs below provides the underlying literature review explored to define a range of economic benefit values to be applied to the countries in Danube region for this study.

7.3.1 Health Related Benefits

According to the EU Benefit Assessment Manual for Policy Makers regarding the assessment of Social and Economic Benefits of Enhanced Environmental Protection in the ENPI countries from September 2011, the following unit values are mentioned for the assessment of water related health costs (see Table 4.15).

Type of measures	Money unit value	Unit value for references year (2008)
1) Non-access to safe water supply	Mortality; Morbidity (diarrheal illness)	VSL in the range of €0.15-5-1.5 million (PPP12 adjusted) depending on country income level. Valued in terms of cases of chronic bronchitis-equivalents in the range €0.03-0.27 million (PPP adjusted), depending on country income level. EU-27 average reference values € 2,050/admission € 58/consultation € 140/day € 90/day € 42/day € 1.3/day € 42/day WTP to avoid a case of diarrhoea in the range of €18-172 (PPP adjusted), depending on country income level
2) No connection to sewage network	Mortality Morbidity (diarrheal illness)	As part of access to safe water supply

Table 4.15: Unit values used for economic assessment in and around EU countries

Unfortunately, it was not possible at macro level to access data or to estimate the number and quality of water borne illnesses currently occurring in the target countries due to sewage pollution. As a proxy the health benefits of the UWWTD implementation were approximated based on a household's willingness to pay (WTP) for an improved water supply system under the assumption that the WTP for an improved water supply system could be considered equivalent to the cost of the incidence of water borne illnesses in concerned households. Table 4.16 reflects some exemplary valuation of the WTP for a good drinking water supply system.

Source	Location	Effect Valued	Value
Edwards (1988)	Cape Cod, Massachusetts, USA	WTP for provision of potable groundwater for personal use and use by future generations, which is, treated to the government health safety limits.	EUR 619.7 – 3,090.4 / household, year
Hanley (1989)	East Anglia, UK	WTP to benefit from a guaranteed reduction in the nitrate levels of the drinking water supplies to 50mg/l.	EUR 25.2 / household , year
Jordan and Edwards (1993)	USA	WTP to guarantee clean drinking water from groundwater sources.	EUR 845 – 1,135.7 / household , year
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 4.16: Exemplary valuation of WTP for good drinking water quality

The values vary greatly from 620 to 3,000 EUR equivalent/ household, year for two studies made in the USA. Other studies are noteworthy and show the cost of a poor water supply due to polluted water resources as a willingness to pay an additional price as a percentage of the household water bill (in the table provided between 1.8 to 10 % of the median water bill).

The value of a willingness to pay (WTP) is affected by the level of income in the country. In the absence of more precise data from the countries in the Danube region the health benefits of this study were estimated to be within a range of two values (lower and upper values) of the WTP of households for improved water supply systems quality. These lower and upper values were defined as a percentage of a household's water bill for UWWTD agglomerations in the target countries not yet equipped with sewer systems at the time of the 9th TA-UWWTD.

Table 4.17 provides the selected WTP value range considered in the monetised estimation of the health benefits of full implementation of the UWWTD in the target countries.

Country	Lower Specific WTP Value	Lower value of Yearly Health Economic Benefits M EUR	Maximal WTP Value	Higher value of Yearly Health Economic Benefits M 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 consideration

Table 4.17: WTP value range of health related economic benefits of UWWTD implementation

7.3.2 Environment and Social Benefits

A report by the Irish consulting company Goodbody Economic Consultants from August 2008 reviewed the international availability of data on Water Resource/ Environment Benefit Values. It identified four significant environmental valuation databases that form a repository for environmental valuation studies that have been conducted over the years. These are (i) the Environmental Valuation Reference Inventory (EVRI) by Environment Canada http://www.evri.ca, (ii) Envalue by the Australian NSW EPA, (http://www.environment.nsw.gov.au/envalueapp/), (iii) the Ecosystem Services Database (ESD) by the UK Department for Environment, Food & Rural Affairs Ministry (https://www.gov.uk/guidance/ecosystems-services) and (iv) the Review of Externality Data (RED) (www.isis-it.net/red/) funded under the 5th EU FWP (Fifth Framework Programme).

Out of these four databases, the EVRI and the EnValue are the most useful in the Danube region. They contain a number of valuation documents linked to the water environment. ESD has comprehensive documents on valuation methodology, but little example and case studies. RED does not cover yet the water sector.

Tables 4.18 and 4.19 summarise WTP valuation data for the environmental and social benefits of good water resources quality issued from the EnValue and EVRI databases.

EnValue Database (NSW, Australia)								
Source	**Country, Location**	**Valuation Method**	**Value Documented**	**Unit**	**Currency**	**Year**	**Value**	**EUR equivalent (2017 April exchange rate)**
Water Research Centre et al (1989) in Barde & Pearce (1991)	UK	Contingent Valuation Method	WTP for improved water quality from bootable to fishable through improvements in the sewerage system	GBP per household p.a. (increase in water rates)	GBP	1987	6	6.96
Sutherland (1982)	USA	Travel Cost Method	Total WTP for improved water quality from fishable to swimmable	USD millions p.a.	USD	1979	377.2	351.31
Sutherland & Walsh (1985)	USA Flathead River, Montana,	Contingent Valuation Method	WTP to protect water quality: (1) Recreation value (swimmable water quality)	USD per household p.a.	USD	1981	7.37	6.86
			(2) Option value		USD	1981	10.71	9.97
			(3) Existence value		USD	1981	19.88	18.52
			(4) Bequest value		USD	1981	26.37	24.56
			(5) Total		USD	1981	64.16	59.76
Steinnes (1992)	USA Minnesota,	Hedonic Price Method	Impact of water quality on lakeshore land values	USD per lot per cm below the surface a secchi disk can be observed	USD	1987	206	191.86
Oster (1977)	USA, Merrimack River Basin,	Contingent Valuation Method	WTP for improved water quality from non-bootable, non-fishable and non-swimmable to bootable, fishable and swimmable	USD per person p.a.	USD	1973	12	11.18
Navrud (1988b) in Barde & Pearce (1991)	Norway, Inner Oslo Fjord,	Contingent Valuation Method	WTP for improved water quality	NKR per household p.a. (for 10 years)	NKR	1986	612	66.74
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
Mendelsohn, Hellerstein, Huguenin, Unsworth & Brazee (1992)	USA, New Bedford, Massachusetts,	Hedonic Price Method	Decrease in house prices from reductions in water quality: (1) Swimmable to fishable	USD per household p.a.	USD	1989	7,000.0	6519.51
			(2) Swimmable to bootable		USD	1989	9,000.0	8382.23
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
Harris (1984)	New Zealand, Waikoto Basin,	Contingent Valuation Method	WTP to maintain the improvement in water quality generated by legislation affecting discharges by industrial users	NZD per person p.a.	NZD	1983	16	10.45
Greenley, Walsh & Young (1982)	USA, South Platte River Basin	Contingent Valuation Method	WTP to preserve water quality from pollution from a mining development: Users: (1) Recreation value	USD per household p.a.	USD	1976	57	53.09
			(2) Option value		USD	1976	22	20.49
			3) Existence value		USD	1976	34	31.67
			4) Bequest value Non-users		USD	1976	33	30.73
			5) Existence value		USD	1976	25	23.28
			(6) Bequest value		USD	1976	17	15.83
Georgiou, Langford, Bateman and Turner (1998)	UK, Great Yarmouth Beach and Lowestoft Beach, East Anglia	Contingent Valuation Method	WTP per respondent per year to ensure that bathing water at Great Yarmouth Beach passed the European Community (EC) standard	GBP per respondent per year	GBP	1995	12.64	14.67
Georgiou, Langford, Bateman and Turner (1998)	UK, Great Yarmouth Beach and Lowestoft Beach, East Anglia	Contingent Valuation Method	WTP per respondent per year to ensure that bathing water at Lowestoft Beach did not fall below the EC standard	GBP per respondent per year	GBP	1995	14.32	16.62
Dwyer Leslie (1991)	Australia, Sydney	Contingent Valuation Method	WTP of households to indefinitely preserve water quality	AUD per household p.a.	AUD	1990	51.37	36.72
Harris & Meister (1983)	New Zealand, Lake Tutira	Travel Cost Method	Total WTP for recreation	NZD p.a.	NZD	1980	83,349.0	54462.23
Lant and Roberts (1990)	USA, Mid-west cornbelt, Illinois and Iowa	Contingent Valuation Method	WTP for recreation benefits and intrinsic benefits of river quality improvement. Mean annual bids per household for recreation for river quality improvements - poor to fair	USD per household per year (increase in state sales tax)	USD	1987	30.5	28.41
			Mean annual bids per household for recreation for river quality improvements - fair to good		USD	1987	37.1	34.55
			Mean annual bids per household for recreation for river quality improvements - good to excellent		USD	1987	41.51	38.66
			Mean annual bids per household for intrinsic values for river quality improvements - poor to fair		USD	1987	37.61	35.03
			Mean annual bids per household for intrinsic values for river quality improvements - fair to good		USD	1987	47.16	43.92
			Mean annual bids per household for intrinsic values for river quality improvements - good to excellent		USD	1987	43.22	40.25
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 = 0.8918 GBP 1 EUR = 9.1685 NOK 1 EUR = 1.3988 AUD 1 EUR = 1.5304 NZD 1 EUR = 1.432 CAD

Source: EnValue Database (NSW, Australia)

Table 4.18: Exemplary valuation of water costs/ benefits extracted from the ”EnValue” database

EVRI Database Study	Location	Effect valued	EUR Values or (EUR equivalent)
Bliem, M., M. Getzner and P. Rodiga-Laßnig 2014	River Danube from Vienna to the Slovak Republic boarder (approx. 50 km)	WTP Improved water quality From moderate to good	EUR 27.66 – 44.49/ household , year (in water bill)
		WTP Improved water quality from moderate to very good	EUR 59.85 – 78.34/ household, year (in water bill)
Chegrani, P. 2010	French Rivers	WTP Fishing	EUR 25 - 42 / day, person
		WTP Walking	EUR 14.1 – 17/ visit
		WTP Kayak	EUR 6.4 - 15/ day, person
		WTP Boating	EUR 64 – 444 / week
		WTP Fishing and walking	EUR 2,40 EUR/ visit, household
Whitehead, J.C. (2005)	USA , North Carolina	WTP Improved water quality total Value	USD 24.77 – 75,73/ year, person (EUR 23.07 – 70,53/ year, person)
		WTP improved water quality Non-use Value	USD 6.56 – 62.48/ year, person (EUR 6.11 – 58.19/ year, person)
		WTP improved water quality Use Value	USD 5.15 – 32.58/ year, person (EUR 4,80 - 30.34/ year, person)
Chegrani, P. (2007)	River Gardon, France	WTP walking (users)	EUR 35.2/ household
		WTP Fishing (users)	EUR 35.2 / household
		WTP Kayak	EUR 14.1 / household
		WTP Bathing	EUR 14.1 / household
		WTP Visit (non user)	EUR 29.7 / household
Genius, M., E. Hatzaki, E. M. Kouromichelaki, G. Kouvakis, S. Nikiforaki and K. P. Tsagarakis (2008)	Crete, Greece	WTP for improved drinking water supply	% 13.29 – 22.04 Water bill
Polyzou, E., N. Jones, K. I. Evangelinos and C. P. Halvadakis (2011)	Lesvos Island, Greece	WTP for improved drinking water supply	EUR 10.38 / 2 months
Hokby, S. and T. Soderqvist (2003)	Stockholm region; Laholm Bay Sweden	WTP for reduced nitrogen load in Baltic sea	1% increase in income would result in a 0.6% to 1.3% increase in demand for eutrophication reduction. A 1% increase in the price of eutrophication reduction would result in a 1.6% to 2.1% decrease in demand for nitrogen reduction.
Lienhoop, N. and F. Messner (2009)	Germany, Lusatia Region	WTP for non-use and recreational benefits of a post-mining lake	EUR 18.96 – 30.49/ household, year
(2007)	International assessment	Provisioning services (int. USD/ha/year, Inland water	USD 408 (EUR 380)
de Groot, R., L. Brander, S. van der Ploeg, R. Costanza, F. Bernard, L. Braat, M. Christie, N. Crossman, A. Ghermandi, L. Hein, S. Hussain, P. Kumar, A. McVittie, R. Portela, L. C. Rodriguez, P. ten Brink and P. van Beukering (2012)	"Global Estimates of the Value of Ecosystems and their Services in Monetary Units"	Provisioning services (int. USD/ha/year, Rivers and lakes	USD 1808 (EUR 1684)
		Regulating and habitat services (USD/ha/year, Rivers , Lakes)	USD 187 (EUR 174)
		Cultural services Value (USD/ha/year, Rivers , Lakes)	USD 2166 (EUR 2017)
		Recreation (USD/ha/year, Rivers, Lakes)	USD 2166 (EUR 2017)
		Total Economic Value (USD /ha/year, Rivers , Lakes)	USD 4267 (EUR 3974)
		Total Economic value (USD /ha/year, Rivers, Lakes)	USD 1446 – 7757 (EUR 1347 – 7225)
Deronzier, P. et S. Terra (2006)	Valorisation of the River Loir, France	WTP Fishing	EUR 11 – 13.4 / day
		WTP Walking	EUR 14.1 – 17/ visit
		WTP Kayak	EUR 6.4 - 10.4/ day. person
		Improvement of water quality (Users)	EUR 31 - 40 user/ year
		Riparian people	EUR 20 – 30 person/ year
Beaumais, O., A. Briand, K. Millock and C. Nauges (2011)	Italy	WTP for Better Tap Water Quality	EUR7.81 – 30.28 / water bill 200 EUR
Johnson, E. K., D. Moran and A. J. A. Vinten (2007)	UK, Irvine Beach, Ayrshire, Scotland	WTP for reduction in faecal loading in the Irvine catcment (25 %)	GBP 51000 / year (EUR 59178 / year)
		WTP for reduction in faecal loading in the Irvine catcment (50 %)	GBP 1802000 / year (EUR 2090972 / year)
		WTP for reduction in faecal loading in the Irvine catcment (75 %)	GBP 3798000 / year (EUR 4407055 / year)
Krantzberg, G. (2006)	Canada, Ontario Lake Basin	Annual Value of Recreational boating	CAD 2.2 billion (EUR 1,54 billion)
		Annual value for beaches	CAD 200-250 million (EUR 140- 175 million)
Rinaudo, J., L. Maton and S. Aulong (2007)	France ,River Basin Seine Normandie	Benefit Total/ Cost Total for specific areas of the river basin	1 % - 82%
		Bathing and Boating	EUR 25- 28 million/ year
		Water treatment saving	EUR 127 million over 50 years
Perni, A., J. Martinez-Paz and F. Martinez-Carrasco (2012)	Spain, Region of Murca, Segura River riverside	WTP River water quality improvement up to Quality I (maintaining ecological flow)	EUR 47.21-54.24 / year, person
		WTP River water quality improvement up to Quality II level (good quality for fishing and swimming)	EUR 50.68-65.37 / year, person
Bateman,I.J., M.A. Cole, S. Georgiou and D.J. Hadley (2006)	UK, River Tame passing through the city of Birmingham	WTP for small water improvement	GBP 6.14 – 9.05/ household, year (EUR 7.12 – 10.50/ household, year)
		WTP for medium water quality improvement	GBP 9.83 – 14.33/ household, year (EUR 11.41 – 16.63/ household, year)
		WTP for large water quality improvement	GBP 15.13 – 21.48/ household, year (EUR 17.56 – 24.92/ household, year)

1 EUR = 1.0737 USD. 1 EUR = 0.8618 GBP 1 EUR = 1,432 CAD (April 2017)

Source: EVRI Database

Table 4.19: Exemplary valuation of water costs/benefits extracted from the ”EVRI” database

The estimation of the environmental and social benefits in the study followed a similar approach as for the health related benefits. In the absence of country data allowing the application of the value transfer approach with sufficient robustness, a range of indicative environmental and social benefits values were defined based on the datasets documented above. Table 4.20 provides the selected WTP value range considered in the monetised estimation of the environmental / social benefits of a fully implemented UWWTD in the target countries of this study.

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 consideration

Table 4.20: WTP values range for environmental/ social benefits of full UWWTD implementation

The figures apply to populations impacted by non-compliance with the Articles 3, 4 or 5 of UWWTD. As the water quality of the surface water bodies in the Danube region remains essentially and overwhelmingly below the level of good ecological status, the entire population of the Danube region has been retained as a multiplier for the application of the unit value transfer for environmental and social benefit estimation.

The WTP value for Austria was set higher to cater for the reality that annual earnings per person in Austria are currently around four times the comparable earnings in other countries (see Chapter 3). Table 4.21 reflects the estimated yearly benefits of complete UWWTD accrued to each target countries of the study.

Country	Population Benefiting, M inhabitants (2015)	Yearly Environmental Benefits (lower range) M EUR	Yearly Environmental Benefits (higher range) M EUR
Austria	8.6	346	1,555
Bulgaria	7.2	287	828
Czech Republic	10.6	422	1,267
Croatia	4.2	162	485
Hungary	9.8	392	1,176
Romania	19.8	793	2,283
Slovenia	2.2	83	249
Slovakia	5.4	217	653

Table 4.21: Estimated yearly environmental/ social benefits of compliance with UWWTD

7.3.3 Other Economic Benefits

Other economic benefits concerns economic development opportunities and industrial productivity gains for riparian economic operators due to the high quality of river water. Industrial water is mostly an input in a production process, such as cooling, condensation, washing, and moving materials. Water may also be incorporated into products. Industrial water users are concerned about the quality of the water and may be negatively impacted by specific raw water quality parameters such as total suspended solids, dissolved oxygen level, temperature, salinity, water clarity or water quantity.

A study by the US government of Agriculture on Evaluating Benefits and Costs of Changes in Water Quality by Jessica Koteen, Susan J. Alexander, and John B. Loomi from 2002 provides an indicative table highlighting the value of access to good water quality for different types of industry (see Table 4.22 below).

Source	Valuation method	USD / acre-foot (1998 USD)	EUR / 1000 m^3	Industry
Young and Gray 1972	Indeterminate	99.77	75.33	Chemical industry
Young and Gray 1972	Indeterminate	125.27	94.59	Paper manufacturing
Young and Gray 1972	Indeterminate	31.04	23.44	Minerals industry
Russell 1970	Change in production costs	146.33	110.49	Beet sugar processing
Kollar and others 1976	Change in production costs	259.40	195.86	Cotton textile finishing
Kane and Ostantowski 1980	Change in production costs	637.42	481.28	Low estimate, meat packing industry
Kane and Ostantowski 1980	Change in production costs	889.07	671.29	High estimate, meat packing industry
Average of above examples		313.00	236.00	

1 acre-foot = 1233,48 m^3

Source: US Government "Evaluating Benefits and Costs of Changes in Water Quality by Jessica Koteen, Susan J. Alexander, and John B. Loomi"" 2002

Table 4.22: Value of good resource water quality for industry

The water quality parameters, which were relevant for the estimated valuation, are unclear in the table above. In addition, it is unclear which quantity of water and which water uses would need to be taken into account in the estimation of related economic benefits (avoided costs) in the Danube region countries. Consequently, the data can only be considered as anecdotal and inadequate to be used for any kind of quantitative economic assessment as part of this study.

7.3.4 Indicators of the Economic Benefits of Compliance with UWWTD

Indicators of the economic value of the implementation of the UWWTD considered in this study include (i) the Economic Net Present Value (ENPV) of the economic costs and benefits of deploying investment to satisfy the UWWTD and operating them sustainably, (ii) the Economic Internal Rate of Return (EIRR) of the implementation of the UWWTD, and (iii) the Benefits/ Costs Ratio of the costs of the UWWTD investment.

The ENPV correspond to the discounted aggregated value of the economic costs and benefits of the investment made over the assessment period.

The EIRR is the discount rate that yields an ENPV of zero. If positive, it is an indicator that the investment has generated an economic surplus for the beneficiary populations of the Danube region.

The B/C ratio compares discounted costs and benefits over the assessment period. If it is above 1, the investments generate an economic surplus to the concerned societies.

The tables and graphs below show for each target country of the study the PV of the economic costs and benefits of the implementation of the UWWTD.

In the analysis presented below, three assessment periods were considered: (i) the period covering past investments between the years 2000 to 2014, (ii) the future investment period considered necessary to complete the fulfilment of UWWTD compliance, estimated to be the period from 2015 to 2040 and (ii) the entire period considered necessary to implement and comply with the UWWTD (years 2000 to 2040).

The two assessments were developed in real terms using for future costs the discount rate prescribed by the EC services as a social discount rate in public investment benefiting from grants from the EU.
According to Annex III to the Implementing Regulation on application form and CBA methodology, for the programming period 2014-2020, the European Commission recommends that a social discount rate 5 % is to be used for major projects in cohesion countries and 3 % for the other Member States. Member States may establish a benchmark for the SDR which is different from 5% or 3 %, on the condition that: (i) justification is provided for this reference on the basis of an economic growth forecast and other parameters; (ii) their consistent application is ensured across similar projects in the same country, region or sector. The Commission encourages MSs to provide their own benchmarks for the SDR in their guidance documents, possibly at the start of operational programmes and then to apply them consistently in the project appraisal at national level. According to the current EU guidance documentation, the social discount rate for AT is 3%, and 5% for all the other countries of the study. These figures have been retained for the economic assessment made in this study.

7.3.5 ENPV and EIRR of UWWTD implementation

Table 4.23 provides the calculated discounted cash flows of key cost elements per country over the period 2015-2040. It is assumed that they correspond with the implementation period until full compliance after the milestone year of the 9th Technical Assessment. Table 4.24 provides the corresponding NPV values aggregated for the eight countries and the resulting EIRR, B/C.

Cash flow elements	Discounted Cash Flows (2015-2040) M EUR							
	AT	BG	CZ	HR	HU	RO	SI	SK
New Investment	0	1,380	1	3,145	11	8,605	296	264
Reinvestment	7,417	2,061	2,498	741	2,501	5,051	461	1,250
O&M Costs	12,362	1,215	8,486	3,903	8,889	10,598	1,790	3,784
Cost of capital	371	72	117	37	94	204	19	49
Tariff Revenues	19,475	2,822	10,780	4,661	10,139	14,720	2,149	4,760
Administrative costs						182		
Health Benefits (lower range)	297	42	162	70	152	221	32	71
Health Benefits (Higher range)	1,782	219	935	404	818	1,012	172	378
ERC Benefits (Lower Range)	6,659	3,910	6,061	2,322	5,580	10,763	1,188	3,113
ERC Benefits (Higher Range)	29,967	8,786	17,220	6,613	14,231	24,164	3,036	7,954

Table 4.23: UWWTD related discounted cash flows (2015) per country in period 2015-2040

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 4.24: Economic Indicators of the implementation of the UWWTD of period 2015-2040

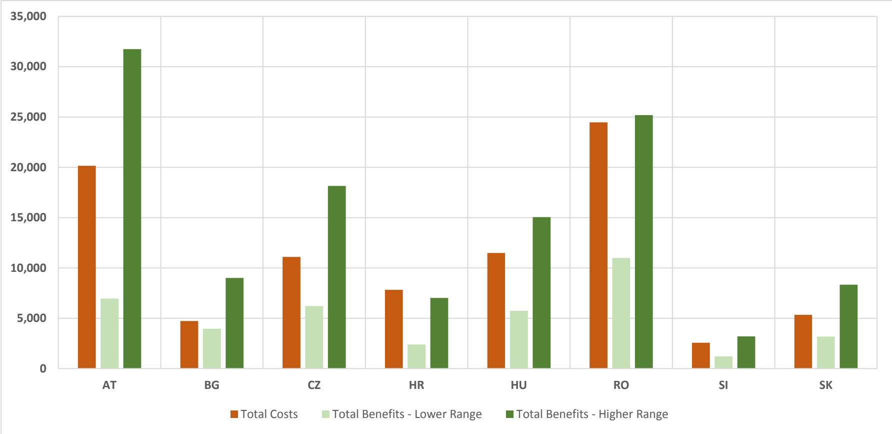


Figure 4.1 UWWTD related costs and benefits discounted (2015) per country in period 2015-2040, M EUR

Tables 4.25 and 4.26 provide similar data for the period 2000- 2014 and Tables 4.27 and 4.28 for the period 2000-2040.

Cash flow elements	PV Cash Flows (2000-2014) M EUR							
	AT	BG	CZ	HR	HU	RO	SI	SK
Investment	14,388	4,180	6,265	0	6,813	6,842	970	2,938
Reinvestment	5,186	432	952	0	951	666	121	419
O&M Costs	7,092	764	4,755	467	5,734	7,903	1,132	2,728
Cost of funding	0	0	0	0	0	0	0	0
Tariff Revenues	12,196	863	5,611	453	5,103	8,535	1,143	2,755
Administrative costs								
Health Benefits (lower range)	153	6	42	3	38	64	9	21
Health Benefits (Higher range)	919	39	253	20	230	384	51	124
ERC Benefits (Lower Range)	4,155	1,180	2,286	170	2,201	3,243	447	1,186
ERC Benefits (Higher Range)	18,698	3,541	6,858	510	6,602	5,299	1,342	3,557

Table 4.25: UWWTD related cash flows 2000-2014

Indicators	Economic indicators at country level (2000-2014)							
	AT	BG	CZ	HR	HU	RO	SI	SK
ENPV (Lower Range)	-22,358	-4188	-9,644	-294	-11,259	-12,104	-1,767	-4,878
ENPV (Higher Range)	-7,050	-1795	-4,862	63	-6,666	-5,299	-830	-2,403
EIRR (Higher Range)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
B/C (Higher Range)	0.74	0.67	0.59	1.13	0.51	0.66	0.63	0.60

Table 4.26: Economic Indicators of the implementation of the UWWTD for the period 2000-2014

Cash flow elements	PV Cash Flows (2000-2040) M EUR							
	AT	BG	CZ	HR	HU	RO	SI	SK
New Investment	14,388	5,560	6,266	3,145	6,824	15,447	1,266	3,202
Reinvestment	12,603	2,492	3,367	1,602	3,453	5,717	552	1,668
O&M Costs	19,455	1,979	13,241	4,370	14,623	18,501	2,921	6,512
Cost of funding	371	72	117	37	94	204	19	49
Tariff Revenues	22,404	1,853	8,629	2,466	8,051	16,787	1,748	4,001
Administrative costs								
Health Benefits (lower range)	309	21	102	27	94	121	19	44
Health Benefits (Higher range)	1,823	128	609	165	563	727	117	263
ERC Benefits (Lower Range)	7,475	2,166	4,237	894	3,877	5,956	778	2,049
ERC Benefits (Higher Range)	33,637	6,498	12,710	2,683	11,630	17,869	2,335	6,146

Table 4.27: UWWTD related discounted cash flows (2015) per country in the period 2000-2040

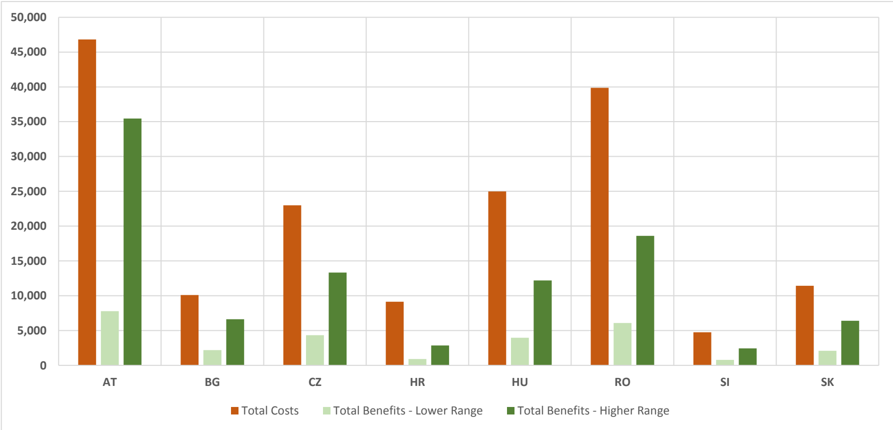


Figure 4.2 UWWTD related costs and benefits discounted (2015) per country in the period 2000-2040, M EUR

	Economic indicators at country level (2000-2040)							
Indicators	**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%	-308%	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 4.28: Economic indicators of the implementation of the UWWTD for the period 2000-2040

8. Annex 4.E: Example of a matrix for a national database linking water quality to costs and benefits

In the absence of quantified and monetised estimations of the economic costs or benefits of inland water quality, it is always possible to design a dataset that incorporates key aspects and the impact of water quality, which can be used to guide policy makers.

One approach could be to compile national datasets for the costs and benefits of water quality protection. This need not necessarily be expressed in monetary terms, but to express the relevant attributes of good water quality in other key units still relevant for policy makers. The effort would be centred on organising and compiling data that exists in different metrics, while avoiding the difficult task of transferring all benefits and costs into a common numerical measurement system such as EUR or local currencies. The framework would offer a summary matrix that presents different types of information – biological, ecological, infrastructural, economic and social. Initially, there may not be much data regarding the economic benefits of protecting aquatic uses and other water quality characteristics in the target countries. However, the framework matrix could be progressively and systematically populated and enriched with data from (i) national statistics, (ii) studies and projects addressing surface water quality issues in the target countries and the DRB, and (iii) cost benefit assessment due at the time of feasibility studies of infrastructural projects, so that more comprehensive information becomes available. Table 4.29 provides a simplified matrix example of how such a matrix database could be developed and compiled.

Attributes	Unit	Benefits	Costs
Biological and Physical			
Percent of streams satisfying water quality standards	%	Bodies meetings standards	Bodies not meeting standards
Percent of reservoirs satisfying water quality standards	%	Bodies meetings standards	Bodies not meeting standards
Percent of estuaries satisfying water quality standards	%	Bodies meetings standards	Bodies not meeting standards
Percent of coastal waters satisfying water quality stand.	%	Bodies meetings standards	Bodies not meeting standards
Ecological Attributes			
River lengths with good ecological status	km or %	Increased lengths	Decreased lengths
Wetland areas	km^2 or %	Increased surfaces	Decreased surfaces
Ecologically protected river banks lengths against erosion	km or %	Increased lengths	Decreased lengths
Protected ecological species	#	Increased ecological population	Decreased ecological population
Protected water related habitats	#	Increased areas	Decreased areas
Water infrastructure			
Water supply infrastructure	M EUR/ y	Water supply sale	Investment costs, O&M costs
Wastewater management infrastructure	M EUR/ year	Wastewater management revenues	Investment costs, O&M costs
Population served with compliant UWWTD infrastructure	pop. or %	Compliant population	Non-compliant population
Economic development activities			
Sustainably irrigated agriculture areas	km^2 or %	Increased surface	Decreased surface
Professional inland fish and shellfish production	tons/ year	Increased fish production & income	Decreased fish production & income
Industrial development requiring water access	jobs/ year	New jobs created	Jobs eliminated
River beds and banks extractive activities	tons/ year	Sustainable quantities extracted	Unsustainable quantities extracted
Social Attributes			
River banks and shorelines recreation and tourism	M EUR/ year	Annual income increase	Annual income decrease
Sport fishing and boating activities	M EUR/ y	Annual income increase	Annual income decrease
Near water bodies and waterfront properties price change	EUR/m^2 or ha	Annual increase	Annual decrease

Table 4.29: Tentative matrix to establish economic costs and benefits of good surface water quality

The availability of such a dataset, which is systematically compiled and publicly reported at country level on a yearly basis by a relevant agency (perhaps the national river basin authority), would enable a better understanding of the impact of UWWTD investment on river water quality in a country without providing strict and completely monetised figures. A dataset, comparing data over a number of years, submitted to policy makers during the budget policy decision-making process would be a useful guidance for action.