
Wastewater Management in the Danube River Basin

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1. Introduction

As one of the most international river basins in the world, the Danube River Basin (DRB) is of transboundary significance and transnational cooperation plays a crucial role in the management of its water resources. The 19 countries in the basin are very heterogeneous in terms of both, natural features and socio-economic factors, yet they share a common European aspiration and a joint commitment to sustainably manage and develop the region. In the DRB, water quality management and environmental protection, including the treatment of wastewater, have been a natural opportunity for regional cooperation and knowledge transfer under the auspices of the ICPDR.

The ambitious requirements of the European Union (EU)'s water policy, particularly those of the Water Framework Directive (WFD) and the Urban Wastewater Treatment Directive (UWWTD) oblige EU Member States (MS) to construct adequate wastewater collection and treatment facilities, to maintain their technical performance and to ensure cost-recovery. These obligations require MS to make substantial investments in the wastewater sector, to ensure sufficient management and operational capacity and to introduce appropriate prices for the wastewater services. Some 90 million Population Equivalents (PE) in the DRB generate more than 10 million m³ of wastewater each day. This significant amount of wastewater needs to be appropriately collected and treated before being discharged into the recipient water bodies to minimise soil and water pollution and health risk. The basin-wide ultimate water management objective set by the Danube countries is to achieve zero discharge of untreated wastewater into the waters of the DRB. On the other hand, wastewater represents significant resources of energy, water and nutrients that could be at least partly exploited (preferably at local scale) so that the linear energy and material flows are gradually transferred to closed loops as much as possible towards a sustainable resource management.

1.1 Policy context

The key water legislation on managing wastewater infrastructure across the EU is the UWWTD¹. The UWWTD is driven by water quality protection and precautionary aspects and specifically focuses on wastewater collection (mainly by sewer) and treatment (mainly with centralized) system development. EU MS are obliged to establish sewer systems and treatment plants at least with secondary (biological) treatment or equivalent other treatment at all agglomerations² with a generated load higher than 2,000 PE. This had to be finished by 2005 in the EU MS, although the new EU MS had a shifted transition period to fulfil the requirements (e.g. by 2018), whilst Croatia as the youngest EU MS has a transition period ending by 2023. EU MS must report their activities in the wastewater sector to the European Commission (EC) that makes them transparent to the public. Non-EU MS also intend to make efforts to achieve significant improvements. They are or will be constructing a specific number of sewer systems and urban wastewater treatment plants (UWWTPs) according to their national strategic plans. Furthermore, the UWWTD requires more stringent removal technology than secondary treatment for agglomerations discharging into sensitive areas, i.e. water bodies that are eutrophic, sensitive to eutrophication or subject to drinking water abstraction purposes and at risk of high nitrate concentration. There are two options for satisfying the requirements, either all treatment plants with a load higher than 10,000 PE have to be equipped with tertiary treatment (nutrient removal with

¹ Council Directive 91/271/EEC concerning urban wastewater treatment.

² Agglomeration means an area where the population and/or economic activities are sufficiently concentrated for urban wastewater to be collected and conducted to an urban wastewater treatment plant or to a final discharge point.

specified effluent concentrations or minimum removal rates) or a reduction of at least 75% in the overall load of phosphorus and nitrogen entering all UWWTPs has to be achieved. Moreover, all agglomerations in the catchment area of a sensitive area shall meet the more stringent technology requirement. Countries may also opt for applying the more stringent technologies in their entire territory instead of identifying sensitive areas. Old EU MS had to establish nutrient removal technology by 1998, new EU MS obtained longer implementation periods.

Introduction of appropriate treatment at agglomerations with PE less than 2,000 is also required at those agglomerations where sewer systems exist. In addition, the UWWTD also states that individual and other appropriate systems (IAS) as exceptions shall be used to locally collect (and treat) wastewater if constructing a wastewater collection system is economically not feasible or did not result in environmental benefit. However, IAS must provide the same environmental protection as the required collection and treatment systems would deliver.

The UWWTD encourages wastewater and sludge reuse whenever appropriate and obliges MS to regulate and authorize wastewater and sludge disposals. With regard to industrial wastewater, those industrial facilities, which are above 4,000 PE and not connected to UWWTPs must respect certain requirements for discharging industrial wastewater established in respective EU and national regulations. Wastewater of industrial facilities connected to sewer system shall be pre-treated. Pollution from stormwater overflows must be limited.

In the context of the WFD³, which came into force in 2000, the UWWTD measures are considered as mandatory basic measures and the sensitive areas as protected areas, which have their own specific objectives and standards to comply with. In this respect, UWWTD measures need to be implemented regardless of the status of the receiving water bodies. However, countries may need to go beyond the UWWTD obligations if achieving good status of a given water body requires more ambitious interventions (combined approach). Importantly, the WFD stipulates the principle of cost recovery and adequate water pricing for wastewater services acting as an incentive for the sustainable use of water resources.

1.2 Overview of wastewater management in the DRB

Measure implementation focused on controlling pollution from urban settlements was first intensified in the upstream Danube countries (Germany, Austria) in the 1990s when the UWWTD came into force. The ambitious provisions of the Directive were further reinforced and even strengthened by the WFD after 2000. Furthermore, the EU enlargement around the mid-2000s resulted in accession for additional 6 Danube countries – followed by Croatia in 2013 - requiring substantial investments and modernization in water and wastewater management and the related economic sectors including higher environmental ambitions. While joining the EU paid off in terms of wastewater infrastructure development by providing significant funds and knowledge transfer for the new EU countries, non-EU countries are facing challenges with financing, constructing and operating sewer systems and wastewater treatment facilities. Although pollutant emissions via wastewater discharges have been reduced also in these countries by constructing and renovating a certain number of wastewater collection systems and UWWTPs, these countries need to significantly improve their wastewater infrastructure and the related services. For the old EU MS, investment needs are shifted to proper maintenance and rehabilitation of the existing infrastructure.

Until about twenty years ago, in many DRB countries water supply and sanitation services, more specifically wastewater collection and treatment facilities, were state-owned and state-run by a few large, regional companies. Since the fall of the iron curtain and the political changes that came along, the ownership and management structure of the wastewater infrastructure have been fragmented. Many of the infrastructure facilities are owned by local governments/authorities and operated by

³ Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.

municipality or private companies usually in the form of concession. Yet, local administration and utilities often lack appropriate management skills and the financial means to construct, operate and maintain a good wastewater infrastructure and to ensure compliance with wastewater collection, treatment and discharge standards.

Implementation of the UWWTD in the DRB has a strong regional perspective and transboundary aspect. Since the Black Sea was significantly suffering from eutrophication, the receiving coastal areas have been designated by Romania in 2007 as a sensitive area under the UWWTD. As a consequence, more stringent treatment technology than secondary treatment is needed at least at the medium-sized and large treatment plants (>10,000 PE) in the EU MS of the entire DRB, being the relevant catchment area of the Black Sea northwest shelf. More stringent technology has been strongly suggested for the non-EU MS as well in order to ensure a consistent development strategy in wastewater sector (daNUbs project⁴, DRBMP Update-2015⁵).

According to the recent reporting (reference year: 2016) of the Danube countries on the status of wastewater collection and treatment, there are ca. 5,600 agglomerations with PE more than 2,000 in the DRB. These agglomerations generate an overall wastewater load of about 86 million PE. Table 1 provides an overview of the distribution of the agglomerations and their PE according to size classes.

Table 1: Distribution of agglomerations and population equivalents in the DRB according to size classes (reference year: 2016)

Size classes (PE)	Agglomerations		Population Equivalents (PE)	
	number	%	number	%
2,000 – 10,000	4,369	78	17.6 Mio	21
10,000 - 100,000	1,149	20	31.3 Mio	36
> 100,000	111	2	36.8 Mio	43
Total	5,629		85.7 Mio	

Only 13% of the total generated load (Figure 1, last column) arise from households without connection to sewer systems or adequate individual local treatment facility. An additional 7% can be linked to collection systems without treatment, whilst 8% of the total loads are dealt with individual and local systems (i.e. standardized⁶ watertight storage tanks, septic tanks with infiltration fields, small domestic treatment plants, small treatment units), out of which 4% represent IAS. The majority (72%) of the loads is conveyed via sewers to UWWTPs. Only one percent of the loads are subject to solely primary treatment, whilst quite a large proportion is transported to either secondary (9%) or tertiary (62%) phases.

The technological level of the wastewater infrastructure (collection and treatment type) and the connection rate to advanced technologies have decreasing gradient in the DRB from upstream to downstream (Figure 1). Collection and treatment of wastewater are in a highly advanced status in the upstream countries (nutrient removal is mainly in place at agglomerations above 10,000 PE, secondary treatment is available at agglomerations between 2,000 and 10,000 PE), at good conditions in some of

⁴ IWAG (2005). Nutrient Management in the Danube Basin and its Impact on the Black Sea (daNUbs). Final Report, Institute for Water Quality and Waste Management, Vienna University of Technology, Vienna, Austria.

⁵ ICPDR (2015). The Danube River Basin District Management Plan – Update 2015 (DRBMP – Update 2015). Final Report, International Commission for the Protection of the Danube River, Vienna, Austria, <http://www.icpdr.org/main/activities-projects/river-basin-management-plan-update-2015>.

⁶ National standards in compliance with the European Standard EN 12566: Small wastewater treatment systems for up to 50 PT, European Committee for Standardization (CEN).

the countries in the middle-basin (nutrient removal is still needed at certain agglomerations above 10,000 PE, small agglomerations are lagging behind) whilst significant proportions of the generated loads are not collected or collected but not treated in the downstream states indicating substantial investment needs.

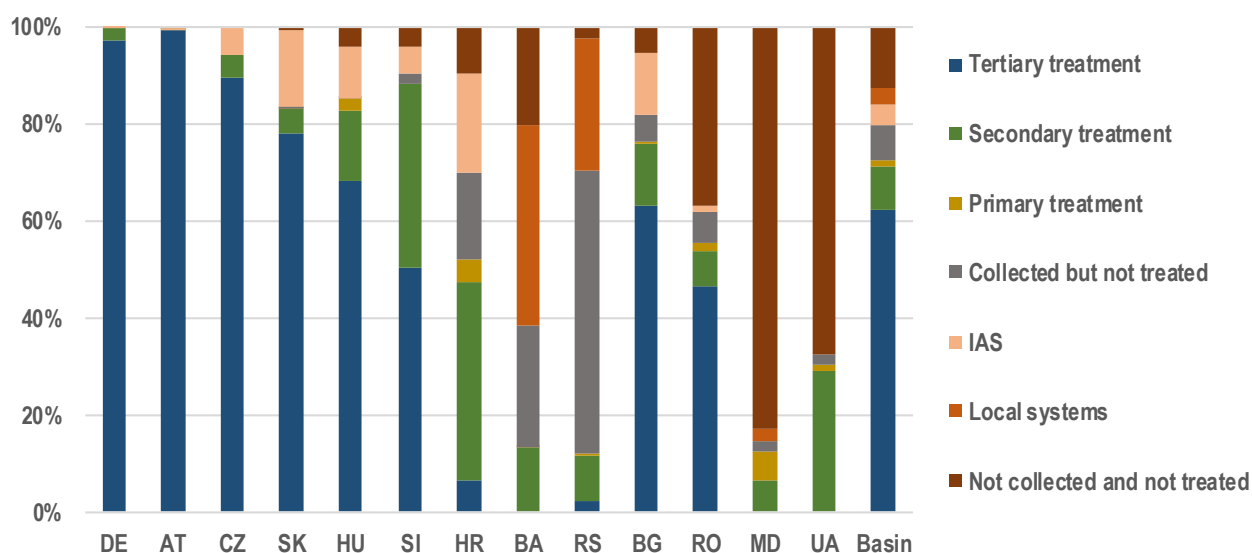


Figure 1: Share of the collection and treatment stages in the total population equivalents at agglomerations above 2,000 PE in the Danube countries (reference year: 2016)

With respect to the UWWTD implementation requirements, about 68 million PE at ca. 1,250 agglomerations above 10,000 PE have to have tertiary treatment in place, whereas at least secondary treatment has to be provided for about 18 million PE at ca. 4,350 agglomerations below 10,000 PE. Table 2 shows the current situation of wastewater treatment according to treatment types and size classes. Introduction of tertiary treatment is lagging behind for ca. 18 million PE, whereas treatment plants with secondary treatment need to be provided for ca. 9 million PE. At the basin-wide level, appropriate wastewater services are available for ca. 59 million PE, whilst wastewater treatment for 27 million PE needs either basin infrastructural development or further improvement.

Table 2: Distribution of population equivalents in the DRB according to treatment types (reference year:2016)

Treatment type	Agglomerations < 10,000 PE, i.e. 17.6 Mio PE in DRB*		Agglomerations > 10,000 PE, i.e. 68.1 Mio PE in DRB**	
	number	%	number	%
Secondary	1.6 Mio	9	6.1 Mio	9
Tertiary	5.2 Mio	30	48.2 Mio	71
IAS	1.4 Mio	8	2.4 Mio	3
Deficit / missing	9.4 Mio	53	17.5 Mio	26
Remark	* obligatory secondary treatment according to the UWWTD (or exceptionally IAS)		** obligatory tertiary treatment according to the UWWTD (or exceptionally IAS)	

In total, more than 3,800 centralized collection and treatment facilities are in place, more than half of them is a treatment plant with nutrient removal technology and about 20% are equipped with biological treatment. However, another 20% of the existing sewer and treatment systems are lacking an adequate treatment plant and having almost no or very limited pollutant removal capacity.

Progress in measure implementation

In the last twelve years, Danube countries have invested more than **€22 billion in wastewater infrastructure** in line with the requirements of the UWWTD and the WFD. Since 2006, almost **5,000 municipalities and almost 40 million PE** have had collecting and treatment facilities constructed or upgraded, with over 2,200 more planned or currently in progress to improve the services for 25 million people. During the same time period, the percentage of municipalities and industrial facilities (bigger than 2,000 PE) connected to a sewer system and UWWTP or adequate individual treatment facilities also increased substantially (to 80% at the DRB level), demonstrating a **significant improvement of wastewater services** in the DRB.

Since 2006, over **1,000 municipalities and more than 25 million PE** have had treatment plants with nutrient removal technology either constructed or extended in compliance with the UWWTD and WFD requirements. More than **€10 billion have been invested** for these projects. Besides this, almost 600 more are planned or in progress by the end of 2018 to serve an additional 12 million PE. During the same time period, the percentage of people connected to nutrient removal in mid-sized and big settlements has increased by a significant 25% and reached almost 75%. Moreover, since 2006, about 20 UWWTPs have added specific technologies such as UV-treatment or activated carbon filters to **remove hazardous pollutants** from wastewater.

Water quality impacts

At the river basin scale, the **urban wastewater** sector generates about **160,000 tons per year of BOD, 395,000 tons per year of COD, 68,000 tons TN per year and 9,000 tons TP per year** discharges into the surface water bodies of the DRB (reference year: 2016). More than 60% of the BOD emissions and about 30% of the nutrient emissions released into surface waters via urban wastewater stem from agglomerations with **existing sewer systems but without treatment**. Taking into account that these agglomerations represent only 7% of the total PE of the basin, implementation of measures for a relatively small proportion of the agglomerations can result in substantial progress.

Comparing the actual figures of the wastewater sector to those of the DRBMP 2009 and DRBMP-Update 2015, a **noticeable reduction in organic pollution has occurred** according to the reported data. The recently reported emissions are significantly lower than those of the DRBMP 2009 (2005/2006) and the DRBMP-Update 2015 (2011/2012) thanks to the infrastructural development in the new and non-EU MS. The BOD discharges declined by 64% and 31%, the COD discharge reduction rates are 58% and 21%. As with organic pollution, **a significant decrease is apparent regarding the nutrient emissions** in the DRB. The recently reported emissions from UWWTPs are significantly lower in comparison to those of the DRBMP 2009 and DRBMP-Update 2015, the TN and TP discharges decreased by 41% and 14% (TN) and 57% and 21% (TP), respectively.

The improvements in urban wastewater management have **significantly decreased** organic nutrient and hazardous substances pollution of the water bodies of the DRB, resulting in much cleaner and healthier waters for the environment and for people to enjoy.

1.3 Rationale of the ICPDR recommendation paper

Despite the huge investments made in the wastewater infrastructure sector, managing wastewater remains an important challenge for most of the countries in the DRB. The UWWTD and the WFD mandate significantly higher levels of collection and treatment than it is currently the case in many Danube countries. These obligations require additional substantial investments supported by implementation programs. The new infrastructure that is being built or needs to be constructed creates

financial, technical and management strains for national and local authorities, utilities and service providers in the region.

The ICPDR is committed to support Danube countries to overcome the challenges they are facing. This paper communicates the overall challenges, specific needs and potential solutions related to wastewater management in the DRB. Moreover, it aims at highlighting certain aspects of the current legislation from technical perspective that have been emerging in the Danube countries and might be useful for the on-going UWWTD revision process at the EU level. It also provides several recommendations and potential actions for national policy making to improve wastewater management.

2. Challenges, issues and needs

2.1 EU-policy

According to the conclusions of the 10th Implementation Report⁷ of the UWWTD (reference year: 2016), collection and treatment of urban wastewater in the EU has improved, providing an essential step on the way to achieving the objectives of the WFD. However, financing and planning remain the main challenges the wastewater sector is facing. The total investment need (estimated by the EU MS) that is necessary to ensure compliance with UWWTD is almost 230 billion EUR. The current level of investments in many EU MS is too low to reach and maintain compliance with the Directive in the long term. EU MS need to improve planning of investments, including plans for the renewal of wastewater infrastructure.

In 2020 the EC launched the impact assessment for the potential revision of the UWWTD, starting with publishing a roadmap and conducting an evaluation⁸ to scrutinize whether the existing legislation reached its objectives and still serves its purpose. The revision of the Directive aims at addressing those areas of improvement that were identified in the evaluation and aligning the Directive with the ambitious strategic targets of the European Green Deal⁹.

The evaluation concluded the following key messages:

- The UWWTD has been successful in reducing water emissions of the targeted pollutants from urban point sources. This has clearly improved the quality of EU water bodies, contributed to ensuring that the EU's bathing water sites are safe and reduced water pollution by a number of non-targeted chemicals.
- Despite overall high levels of compliance, the implementation process was significantly delayed in some MS, while a few MS are still lagging behind. The remaining loads from urban sources come largely from non-compliant agglomerations.
- The main barriers to implementation are the insufficient prioritization of the necessary investments due to problems stemming from governance arrangements at central, regional and local level and the lack of resources and administrative capacity. At the same time, MS do not invest sufficiently in the renewal of infrastructure.

⁷ Tenth report on the implementation status and programmes for implementation (as required by Article 17 of Council Directive 91/271/EEC, concerning urban waste water treatment), COM (2020) 492 final.

⁸ Commission Staff Working Document - Executive Summary of the Evaluation of the Council Directive 91/271/EEC of 21 May 1991, concerning urban waste-water treatment, SWD(2019) 701 final.

⁹ https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en.

- Whereas households are usually charged through the water bill, full cost recovery has not been achieved in the majority of the MS. In some MS the low-income households may face affordability issues if full recovery is implemented.
- The Directive's effectiveness is due to the overall clarity of the Directive and the simplicity of its requirements allowing for straightforward enforcement.
- The Directive has not optimally addressed some important pressures in relation to wastewater leading to remaining loads that could be avoided. These loads come from storm water overflows, urban runoff, mal-functioning individual or other appropriate systems and small agglomerations (< 2,000 PE) or non-connected dwellings not completely covered by the Directive.
- MS seem to apply the criteria for identifying 'sensitive areas' differently, especially in the context of eutrophication and nutrient management.
- Even with very conservative assessments of benefits, the benefits for users and stakeholders outweigh the implementation costs (capital, operational, administrative).
- The Directive is internally coherent overall. The UWWTD works overall in synergy with other EU water law and contributes strongly to achieving the objectives of the Water Framework Directive, the Bathing Water Directive and the Drinking Water Directive. However, there may be some scope for improving the coherence of the UWWTD and climate and energy policies.
- The UWWTD is still relevant and needs to be continued as inappropriately treated or untreated urban wastewater is still one of the main reasons why EU waters fail to achieve at least good status under the WFD.
- There is growing evidence of contaminants of emerging concern in water bodies, as an increasingly important issue. Overall, the treatment required under the UWWTD reduces such pollutants of wastewater to some extent but does not target them directly.
- With regard to circular economy potential, the UWWTD contains limited provisions on wastewater and sludge reuse, recovery of valuable components or energy optimization.
- It is wide recognized among stakeholders that the Directive is still needed, it has added value at EU level and withdrawing it would have negative impacts.

In its recent study¹⁰, the World Bank analysed the wastewater management situation in the DRB since the early 1990s, highlighting the challenges that the EU MS and candidate countries face related to the UWWTD implementation, considering environmental, economic, sustainability, and affordability aspects. The review focuses on seven new member states: Bulgaria, Croatia, the Czech Republic, Hungary, Romania, Slovakia and Slovenia and includes Austria as an older member state mostly for comparative purposes. The main findings of the study are the following:

- As a result of wastewater management efforts over the past 15 years, all countries of the DRB have witnessed major improvements in levels of wastewater treatment but in many countries the implementation falls behind the planned schedule, leading to non-compliance issues. The continuous improvement of surface water quality in the DRB can be only partly attributed to the implementation of the UWWTD, other EU legislation and socio-economic impacts are also major contributors.
- A total amount of 42.5 billion EUR has been invested so far by the investigated countries to implement the UWWTD. An additional 57 billion EUR will be needed to reach and maintain full compliance until 2040 (17 billion EUR for non-compliant agglomerations, 40 billion EUR for old infrastructure renewal). These amounts indicate that the new EU MS need to mobilize significant additional funds on the top of the EU funding.

¹⁰ <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/558511544813043874/is-the-uwtd-implementation-delivering-results-for-the-people-the-economy-and-the-environment-of-the-danube-region-a-wastewater-management-assessment-based-on-the-world-banks-engagement>.

- The lack of technical and institutional capacity represents a major bottleneck for UWWTD implementation and managing the related investment projects. Most new EU members have not managed to conduct the necessary institutional reforms or adjustments to prepare for an exceptionally large infrastructure investment cycle, resulting in low absorption of available funds and delays in UWWTD compliance.
- Operation and maintenance costs in the Danube region are essentially financed through tariff revenues with either no or minimal subsidies provided by national or local governments. With the exception of Austria, the current tariffs in the studied countries are not sufficient for achieving total cost recovery. Bringing wastewater management in compliance with the UWWTD would significantly increase operation and maintenance costs of utilities, triggering wastewater tariff increases and affordability issues for the bottom 40 percent of the population in many countries.
- Based on a simple cost-benefit analysis carried out in the framework of the study, there is no clear evidence for economic justification for achieving the UWWTD implementation at full compliance. Therefore, the UWWTD is to be seen as an important water legislation providing a harmonized and unified strong environmental protection rather than as a measure that yields a positive cost-benefit ratio by itself.

2.2 National issues raised by the Danube countries

A highly heterogeneous picture emerges when examining the implementation of the UWWTD and the management of the wastewater sector in the DRB. Different challenges can be observed in countries with enhanced wastewater treatment status in comparison to those where certain fundamental issues still need to be addressed and the implementation is lagging behind or has not even started yet. In addition, problems need to be addressed at both, national and local level involving all actors (national and local administration, utility operators).

2.2.1 “Very old” EU MS (DE, AT)

- Maintenance and reconstruction/restoration of technical installations (sewage system, wastewater treatment) in order to ensure long-term operability and to maintain the high-quality standards of wastewater treatment.
- Adaptation of wastewater treatment according to industrial requirements, demographic changes (especially in rural areas), climate change and water scarcity.
- Implementation of phosphorus elimination measures not only for large wastewater treatment plants but also for smaller ones, in order to achieve the objectives of the WFD.
- Implementation of the fourth treatment stage for removal of anthropogenic trace substances and micro pollutants at selected UWWTPs, as further concentration reduction of many of these compounds is not possible in a conventional sewage treatment plant.
- Water retention in urban areas via on-site infiltration to the soil zone to reduce the amount of rainwater to be collected and treated.
- Improvement of sewage sludge management (e.g. recovery of phosphorus).
- Reuse of treated wastewater in agriculture (circular economy).

2.2.2 “Old” EU MS (CZ, SK, HU, SI, BG, RO)

- Establishment of long-term planning strategies for renovation of old wastewater infrastructure along with a reconstruction program (prerequisite: knowledge on operational costs and financial resources)
- Management of storm water overflows and urban runoff via separate rain sewers via improved knowledge, not only about water volumes, but also about runoff pollution characteristics and mitigation measures.

- Elaboration of a sewage sludge management strategy, which includes treatment technology development and a support program for implementation.
- Promotion of the reuse of treated wastewater (technology, disposal, legislative background).
- Investments for the construction of sewers and UWWTPs for smaller agglomerations, in particular smaller than 2,000 PE (including potential new financial instruments, revision of regulatory background).
- Reducing pollution at source (not only at the discharge points), i.e. a comprehensive management is of major importance.
- Promotion of individual systems, provided that the institutional and legislative background and the management conditions have been elaborated.
- Coordination of all institutions with responsibilities in the wastewater management sector in order to ensure funding sources and prioritisation of measures.
- Support of local administrations in technical/operational aspects in order to implement technical measures in an optimal and cost-efficient way.
- Capacity building and build-up of competence in operation and maintenance of wastewater treatment plants.

2.2.3 New EU MS and non-EU MS (HR, BA, RS, ME, MD, UA)

- Re-organization of the water sector (consolidation of water utility areas and companies).
- Establishment of an enabling regulatory and administrative framework and capacity development to solve the following problems:
 - unclear or overlapping responsibilities between institutions, insufficient coordination,
 - deficits in administrative and technical capacities at all level;
 - deficits in capacity for operation and maintenance of existing infrastructure at local level (public companies);
 - lack of money / funding for constructing and operation of wastewater collection and treatment systems;
 - affordability issues and unrealistic water price for improved services;
 - absence of planning and constructing capacity resulting in implementation delay;
 - inefficient public procurement procedures;
 - demographic changes (depopulation of rural areas);
 - outdated standards for infrastructure elements and treatment technology;
 - no adequate collection and treatment facilities provided for rural areas.

3. Aspects for the UWWTD revision

From technical point of view¹¹ - without prejudice to the competence of the MS - the ICPDR welcomes and supports the launched revision of the UWWTD. While maintaining the simplicity of the Directive, keeping its environmental ambitions high and further respecting the fairness (equitable sharing of responsibilities and harmonized application of measures for the common benefit), precautionary (reasonable application of highest technological level) and solidarity (no transfer of pollution to downstream water bodies and countries) principles are highly favoured, there are certain aspects where improvements and revision of the current legislation could be considered:

¹¹ Results of the discussions of the ICPDR Pressures and Measures Expert Group.

- Bearing in mind the dimensions of the wastewater management investment projects, more realistic implementation conditions and transitional periods should be set in order to ensure that compliance is not lagging behind. This concerns in particular the UWWTD implementation in new MS but also potential revisions in old EU MS.
- UWWTD should be better interlinked with the WFD, the Marine Strategy Framework Directive (MSFD)¹², the Nitrates Directive¹³, the Industrial Emission Directive (IED)¹⁴, the Sewage Sludge Directive¹⁵ and the Water Reuse Regulation¹⁶:
 - UWWTD should explicitly regulate the situations where measures have to go beyond the basic requirements of the UWWTD to meet the objectives of the WFD.
 - With regard to the MSFD, the entire terrestrial basin of a coastal water should be defined as sensitive area catchment if the given coastal water body/bodies is/are eutrophic or sensitive to eutrophication.
 - The delineation of the UWWTD sensitive area catchments and the Nitrate Vulnerable Zones of the Nitrates Directive should be coherently defined and implemented in order to ensure that the concerned sectors (wastewater and agriculture) are managed in a consistent way to reduce nutrient pollution.
 - Regarding the industrial wastewater discharges, the regulation of the direct dischargers should be explicitly linked to the IED and the permit conditions on emission limit values and Best Available Techniques. For those installations which are out of scope of the IED and for those which are discharging into public sewer and UWWTPs, minimum standards for treatment before discharging into water bodies and for pre-treatment before discharging into sewer should be included.
 - In the context of circular economy and the Green Deal, quality provisions and quantity targets for wastewater reuse and sewage sludge management should be given, in line with the provisions of the Sewage Sludge Directive and the Water Reuse Regulation.
- For the identified sensitive areas, flexible nutrient removal/outflow targets should be considered. Minimum standards for nutrient removal should be respected everywhere in a sensitive area and in its relevant catchment area but stricter provisions should be defined at hot-spots (e.g. to meet WFD good ecological status, large cities).
- Regulations of the use of IAS should be reconsidered. Clear definition on the use and management of IAS is needed, including the possible technologies, criteria for compliance and justification, licensing, monitoring and registration requirements. In case of appropriate technologies, soil should also be considered as a possible recipient of treated wastewater.
- Appropriate legislation is required for small rural settlements below 2,000 PE. Alternative technical solutions (small scale and individual technologies, nature-based solutions) instead of sewer network and centralization should be offered unless meeting the WFD requirements would need constructing a centralized treatment plant. The same could be considered as an exemption even for rural agglomerations above 2,000 PE in case centralized solutions would not bring significant benefits but high costs or would not be feasible and alternative methods could offer more cost-efficient and affordable options (e.g. scattered rural dwellings).

¹² Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

¹³ Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources.

¹⁴ Directive 2010/75/EU of the European Parliament and the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control).

¹⁵ Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture.

¹⁶ COM(2018) 337 Proposal for a Regulation of the European Parliament and of the Council on minimum requirements for water reuse.

- Requirements for the operation of storm water overflows and separated rainwater canals, the related technical specifications and pollution retention measures should be defined.
- Targeted management should be introduced for emerging chemicals. Regulation should be pathway and/or source-oriented rather than substance-oriented (households, industries, special commercial or public places). Similarly to nutrients, a flexible regulation could be introduced requiring minimum standards at each UWWTP and more stringent treatment at hot-spots and for water bodies at risk (large cities, agglomerations with specific industries, failing WFD requirements, drinking/bathing water resources). These measures should be gradually implemented, prioritizing emission hot-spots and water bodies at risk. In addition, it should be considered to trace back chemical pollution to the sources and to extent the polluter pays principle to the industrial and commercial companies, whose products and their chemical content end up (at least partly) in the urban wastewater. The contribution of these producers to the cost recovery of the wastewater services would strengthen the financial sustainability and could motivate them to phase out certain chemicals. Specific potential recommendations on managing chemicals of emerging concern for the UWWTD revision are provided by the joint NORMAN-Water Europe position paper¹⁷.
- Energy optimization and energy-neutral or -positive technologies should be recommended wherever possible.

4. Recommendations for the Danube countries

The ICPDR further recommends several strategic actions to be taken in the Danube countries towards sustainable wastewater management:

- Countries should carefully prepare the national UWWTD implementation programmes along with a financial plan concerning the necessary investments, project time schedules, potential funding sources and the way of funding and the equity contributions. For non-EU MS it is crucial to develop a long-term strategic financial plan on the capital investments needed for the UWWTD compliance well before the EU accession. Accession countries should negotiate an appropriate implementation deadline taking into account the economic, institutional and affordability challenges.
- Countries need to prioritize the investment projects, starting with those with the highest environmental and societal benefits at the least costs, target pollution hot-spots and significantly contribute to reach WFD objectives.
- Countries need to ensure that the necessary technical and institutional capacity is available at both, national and local level so that the investment projects can be smoothly implemented.
 - At the administrative level there is a high demand for qualified experts dealing with wastewater management related project development and implementation. In some cases, the countries are not able to submit a bankable project proposal or the preparation and contracting phase is slow due to administrative burdens. For better absorbing available funds, people with proper organizational and strategic skills at the central and local administration are crucial.
 - Moreover, at the level of water authorities, the regulation and control over the implementation issues are important aspects that need appropriate knowledge. The

¹⁷ <https://www.norman-network.net/?q=node/342>.

planned investments need to be fully correlated with and justified by the implementation programmes.

- Danube countries should establish close coordination and efficient information exchange between the administration and regulatory bodies, financing institutions and utilities with clear roles and responsibilities. It may be necessary to consolidate or restructure the wastewater sector (geographic coverage, operating companies) in order to provide high-quality services.
- At local administration and utility level, a thorough and careful planning of operational and maintenance costs and ensuring sustainable financing of services are highly important.
 - Choosing the most feasible technological variant should be based on financial considerations besides the required technical quality environmental performance. Detailed knowledge on operational and maintenance costs including asset depreciation and future reinvestments is essential to ensure and strengthen financial viability of the utilities. If system operation and reinvestment are not financially sustainable, there is a risk of decline in service quality and status deterioration of the receiving waters.
- Full cost-recovery of wastewater services (including service provision costs and depreciation) should be ensured by setting appropriate tariffs.
 - The UWWTD implementation requires substantial investments, which result in an increase of the operating expenses. This necessarily leads to tariff increases, which may trigger affordability issues for the low-income population. Affordability challenges have to be addressed through targeted social subsidies for the poorest population and by providing subsidized access to basic sanitation services for vulnerable society groups.
- Well-developed national trainings targeting the operation and maintenance of wastewater infrastructure are crucial to ensure not only a qualified workforce but also efficient and sustainable wastewater treatment.
 - Countries are encouraged to develop national wastewater management training programs and curricula, making use of the on-going capacity building programs developed by the International Association of Water Service Companies in the Danube River Catchment Area (IAWD) for the Danube region. The Danube Learning Partnership (D-LeaP)¹⁸ is designed as a regional, integrated and sustainable capacity building initiative and provides a comprehensive curriculum to the staff of water and wastewater utilities located in the Danube region.
- All Danube countries are advised to make efforts to modernize the wastewater infrastructure and services, to establish a strategy for infrastructure renovation and to secure sufficient financing and knowledge in order to maintain and increase long-term efficiency. Countries should make use of the technological innovations, smart devices, digital technologies and automatized techniques for enhancing and upgrading their wastewater databases, on-site monitoring systems, operational and control mechanisms and analytical laboratories.
- Wastewater should be considered as a resource rather than polluted water to be discharged after treatment. Countries are encouraged to explore the innovative technologies and alternative options, which can help closing the water, energy and nutrient flux cycles at the local scale towards a sustainable resource management. This may also improve the financial sustainability of the services. In case of new plants, these aspects should be considered already in the design phase.
 - Countries should elaborate sludge management strategies to make use of the large amount of produced sewage sludge for energy production, phosphorus recovery or agricultural fertilization (direct application or composting) rather than dumping or eliminating it as waste. This should be accompanied by the development of an enabling policy and financial framework, transparent database, studies on costs and impacts and a public consultation process.

¹⁸ <https://www.iawd.at/eng/about/d-leap/>.

- In the climate change context, water reuse (along with quality standards) and energy efficient plants should be promoted.
- Countries need to establish an appropriate legal, administrative, financial and regulatory framework for service provision at small agglomerations and for applying IAS. Countries should discover the potential of decentralized systems and nature-based solutions with low operational requirements and costs, which may offer a more suitable cost-effective alternative to be considered.
 - Rural wastewater management is often a forgotten challenge and is overshadowed by the large-scale centralized investment projects. While investment priorities are usually set to mid-sized and large agglomerations, construction projects and service provision are often lagging behind in small agglomerations and rural communities below 2,000 PE where lack of management and technical capacity and affordability issues may further hinder measure implementation and which are often facing demographic issues.
- Countries should support organizing workshops, demonstration events, trainings and exchange on technical measures related to alternative solutions and emerging issues, such as sludge management options, energy optimization methods, technologies to remove emerging chemicals and small scale and nature-based treatment facilities.
- Countries are encouraged to conduct specific investigations on the emerging chemicals in urban wastewater and the potential removal rates of the conventional treatment technologies for certain indicator compounds. The fourth treatment stage to target micropollutants should be introduced gradually, first targeting emission hot-spots and water bodies at risk.
- Countries should be aware that management of urban runoff is of growing relevance, especially in the climate change context.
 - Rainwater infiltration and water retention should be supported by maintaining urban green areas, applying pervious surfaces and establishing infiltration ponds in order to reduce runoff and the accompanied pollution. Pollution from combined sewer overflows should be controlled at least by retention ponds or vegetative filters before discharges wherever possible. Similar measures might be considered to treat polluted urban runoff. Specific investigations might be needed to understand the hydraulic and water quality characteristics of the runoff events.

5. Wastewater management initiative

To help Danube countries to cope with the challenges of achieving sustainable wastewater management, the ICPDR, in close cooperation with the World Bank and its Danube Water Program¹⁹ and with support of the Priority Area 4 (Water Quality) of EU Strategy for the Danube Region²⁰, launched a wastewater management initiative. It aims to provide interested and committed government and utility representatives from the Danube region with the appropriate knowledge and experience to support modernization efforts and future optimal development of the wastewater management sector, along with achieving compliance with the UWWTD provisions. It also guides and supports Danube countries by offering and promoting capacity building programs and information exchange events in

¹⁹ <https://www.iawd.at/dwp>.

²⁰ <https://waterquality.danube-region.eu/>.

wastewater management. Moreover, it facilitates proper dialogue among the international financing institutes, national and local administration bodies and utilities.

One specific objective of the initiative is to provide regional knowledge exchange opportunities on topics relevant to the national wastewater management sectors and implications for necessary actions to reach UWWTD compliance. Although different international and regional wastewater programs are already in place, there is still a need for a coordinated, basin-wide activity that is focused on those aspects of wastewater management, which are very important but were left out of focus up to now.

This regional level wastewater management activity is particularly targeted to:

- a) financial sustainability of wastewater management (present and future),
- b) rural and small-scale wastewater management,
- c) sewage sludge management,
- d) contaminants of emerging concern.

While the geographic focus is intended to be on countries of the DRB (both EU and non-EU MS), the initiative will also bring in relevant knowledge and expertise from outside the region.