



# **BEYOND UTILITY REACH?**

## **HOW TO CLOSE THE RURAL ACCESS GAP TO WASTEWATER TREATMENT AND SANITATION SERVICES**

# **RURAL WASTEWATER TREATMENT WORKSHOP**

**JANUARY 19-20, 2021**

# I. CONTENTS

<b>I. Contents</b>	<b>2</b>
<b>II. Session overview</b>	<b>3</b>
<b>III. The Organizers</b>	<b>4</b>
1. World Bank Danube Water Program.....	4
2. International Commission for the Protection of the Danube River (ICPDR) .....	4
<b>IV. The Participants</b>	<b>5</b>
<b>V. Workshop Paper</b>	<b>6</b>
<b>Executive Summary</b>	<b>7</b>
<b>Overall status of sanitation and wastewater management</b>	<b>8</b>
<b>EU legislation and practice relevant for rural wastewater management</b>	<b>10</b>
Relevance of EU regulations for the Danube region.....	10
EU legislation on urban wastewater treatment .....	11
Relevance of the UWWTD for rural wastewater management .....	13
Importance of rural wastewater treatment .....	14
<b>National legislation in and practice of rural wastewater management</b>	<b>16</b>
Legal requirements for small WWTPs .....	16
Design guidelines and norms for small WWTPs .....	17
Management and monitoring of small WWTPs .....	18
<b>Challenges of rural wastewater management in the Danube River Basin</b>	<b>19</b>
General aspects of rural wastewater management.....	19
Legal aspects.....	20
Technology selection .....	21
Models for operation and monitoring of small WWTPs.....	24
Financing rural wastewater management.....	25
<b>Summary</b>	<b>26</b>
<b>Conclusions and recommendations</b>	<b>28</b>
<b>List of Tables</b>	<b>30</b>
<b>List of Figures</b>	<b>30</b>
<b>Acknowledgements</b>	<b>31</b>
<b>References</b>	<b>31</b>
<b>VI. Live Poll and Survey Results</b>	<b>34</b>
<b>VII. Q&amp;A Summary</b>	<b>36</b>

## II. SESSION OVERVIEW

Tuesday, 19 January	
13:30	<b>Start of Day 1 - Welcome and introduction</b>
13:40	<b>Session 1: Setting the scene – policy context and regional analytical work in field of rural wastewater management</b> Presentation of status overview, existing EU framework and requirements, findings and recommendations from advisory and analytical works on the topic of rural wastewater
15:00	<i>Break</i>
15:15	<b>Session 2: The enabling environment - approaches to wastewater management at national level (legal, financial, regulatory)</b> Presentation of rural wastewater management experiences from individual countries, including policy and regulatory-related challenges
16:30	<i>End of Day 1</i>

Wednesday, 20 January	
13:30	<b>Start of Day 2</b>
13:30	<b>Session 3: Good practices at municipal level</b> Showcasing examples of good practices in the development of rural wastewater projects/systems at municipal level from different countries
14:45	<i>Break</i>
15:00	<b>Session 4: Technical solutions and developments in rural wastewater management</b> Review of experience in the implementation of different technical solutions, including small scale, compact, low-cost and nature-based technologies
16:15	<b>Session 5: Wrap-up and closing</b> Key take-away messages from the event
16:45	<i>End of Day 2</i>

## III. THE ORGANIZERS

### 1. World Bank Danube Water Program

The World Bank / IAWD Danube Water Program supports **smart policies, strong utilities and sustainable water and wastewater services** in the Danube region by partnering with regional, national and local stakeholders, promoting an informed policy dialogue around the sector's challenges and strengthening the technical and managerial capacity of the sector's utilities and institutions.

Governments and water professionals in the Danube region face a double challenge of meeting their citizens' demand for universal, good quality, efficient, and financially sound or - in one word - sustainable water and wastewater services, while catching up to the environmental requirements of the European Union *acquis communautaire*. To address this double challenge, the World Bank and the International Association of Water Service Companies in the Danube River Catchment Area (IAWD) have partnered in the frame of the Danube Water Program, with a 13 million Euro, three-phased financing from the Government of Austria.

#### What has the Program achieved?

The Danube Water Program was formally launched in May 2013 in partnership with line ministries, regulators, waterworks associations, and local government representatives of a dozen countries in South-East Europe. Since the launch of the Program, knowledge exchanges among more than a thousand sector professionals and policy makers in the region and beyond has taken place. In 2015 a State of the Sector report was launched (SoS 2015), and updated in 2018 (SoS 2018), which are flagship products of the Danube Water Program, next to additional analytical pieces exploring status and trends in wastewater management, rural water supply and sanitation and agglomeration of utilities. Capacity building programs benefiting over 170 utilities have been undertaken under the region wide Danube Learning Partnership (D-LeaP) involving cooperation with all the national water utility associations. Numerous local initiatives worth more than € 1,000,000 through competitive grants have been supported.

[www.danube-water-program.org](http://www.danube-water-program.org)

[www.iawd.at](http://www.iawd.at)

### 2. International Commission for the Protection of the Danube River (ICPDR)

The International Commission for the Protection of the Danube River (ICPDR) works to ensure the sustainable and equitable use of waters in the Danube River Basin. The work of the ICPDR is based on the Danube River Protection Convention (DRPC), the major legal instrument for cooperation and transboundary water management in the Danube River Basin.

The ICPDR addresses the entire Danube River Basin, comprising 19 countries, making it the most international river basin in the world. Including more than 300 tributaries and connected groundwater resources too, this makes the ICPDR one of the largest and most active international river basin management commissions in the world.

In 2000, the ICPDR contracting parties nominated the ICPDR as the platform for the implementation of all transboundary aspects of the EU Water Framework Directive (WFD) and development of the International Danube River Basin Management Plans.

#### The goals of the ICPDR

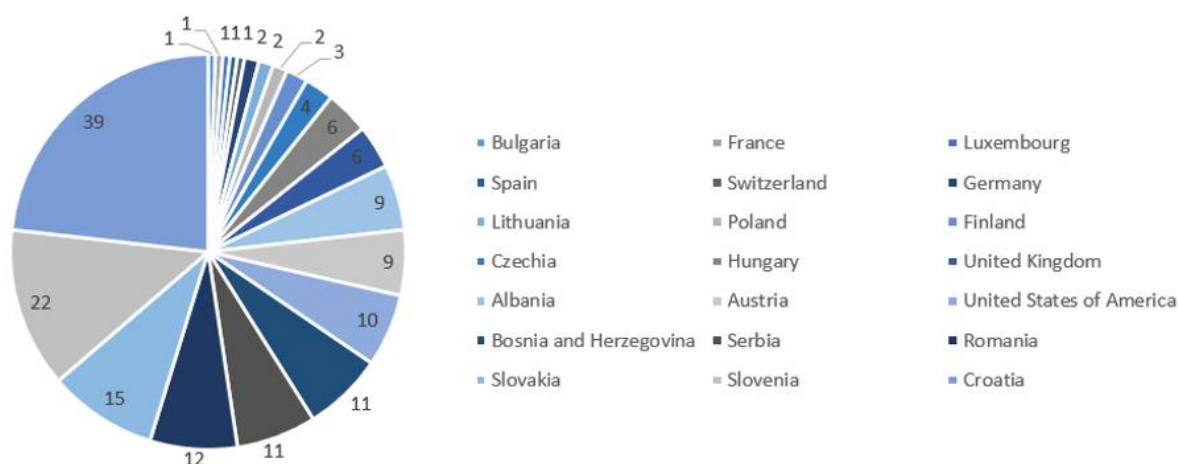
Three key elements of the ICPDR's management plans provide the three pillars of action that are needed for the Danube to achieve: i) a Cleaner Danube – this means reducing pollution from settlements, industry and agriculture; ii) a Healthier Danube – this means protecting rivers as ecosystems that provide a living environment for aquatic animals and plants, as well as services for people such as drinking water and recreation; and iii) a Safer Danube – this means a safer environment for people to live without the fear of major flood damage.

[www.icpdr.org](http://www.icpdr.org)



## IV. THE PARTICIPANTS

Overall, the Rural Wastewater Treatment Workshop drew an audience of 168 from 21 countries. The majority of participants joined from Croatia (39), followed by Slovenia (22), Slovakia (15), Romania (12), Serbia (11), Bosnia and Herzegovina (11), and others.



Results from a post workshop survey, with 34 respondents, showed the majority of participants joined from Public Agencies (23.5%); Utilities/Utility associations (20.6%); followed by academia (17.6%); and consultancy companies (14.7%).



## V. WORKSHOP PAPER

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### Table of Contents

<b>EXECUTIVE SUMMARY .....</b>	<b>7</b>
<b>1. OVERALL STATUS OF SANITATION AND WASTEWATER MANAGEMENT .....</b>	<b>8</b>
<b>2. EU LEGISLATION AND PRACTICE RELEVANT FOR RURAL WASTEWATER MANAGEMENT .....</b>	<b>10</b>
2.1. Relevance of EU regulations for the Danube region.....	10
2.2. EU legislation on urban wastewater treatment.....	11
2.3. Relevance of the UWWTD for rural wastewater management.....	13
2.4. Importance of rural wastewater treatment.....	14
<b>3. NATIONAL LEGISLATION IN AND PRACTICE OF RURAL WASTEWATER MANAGEMENT .....</b>	<b>16</b>
3.1. Legal requirements for small WWTPs.....	16
3.2. Design guidelines and norms for small WWTPs.....	17
3.3. Management and monitoring of small WWTPs.....	18
<b>4. CHALLENGES OF RURAL WASTEWATER MANAGEMENT IN THE DANUBE RIVER BASIN.....</b>	<b>19</b>
4.1. General aspects of rural wastewater management.....	19
4.2. Legal aspects.....	20
4.3. Technology selection.....	21
4.4. Models for operation and monitoring of small WWTPs .....	24
4.5. Financing rural wastewater management.....	25
<b>5. SUMMARY.....</b>	<b>26</b>
<b>6. CONCLUSIONS AND RECOMMENDATIONS.....</b>	<b>28</b>
<b>ACKNOWLEDGEMENTS .....</b>	<b>31</b>
<b>REFERENCES .....</b>	<b>31</b>
<b>LIST OF TABLES.....</b>	<b>30</b>
<b>LIST OF FIGURES.....</b>	<b>30</b>

## Executive Summary

Rural wastewater management is a challenge in all countries of the Danube region. The UN Sustainable Development Goal 6 (SDG 6) on "*Clean Water and Sanitation*" specifically addresses the topic of wastewater management by Target 6.2. (achieve access to safely managed sanitation systems for all) and Target 6.3. (improve water quality by reducing pollution).

Most countries in the Danube basin are either EU Member States, Candidate Countries or Potential Candidates, thus the EU legislation forms the basis. For Moldova and Ukraine, the EU legislation also is a benchmark, as water quality goals should be achieved for the whole basin.

The EU Urban Wastewater Treatment Directive (UWWTD) regulates the treatment of wastewater from agglomerations larger than 2'000 population equivalent (PE). For agglomerations smaller than 2'000 PE, the UWWTD does not give clear guidance, just that an "appropriate treatment" shall be foreseen so that after discharge receiving waters can meet the relevant quality objectives. For small WWTPs, most countries only apply discharge limits for organic matter (BOD<sub>5</sub> and/or COD) as well as total suspended solids (TSS) which are in general less stringent than the limits of the UWWTD for WWTPs > 2'000 PE.

According to the UWWTD, wastewater treatment plans (WWTPs) below 2'000 PE or IAS (individual or other appropriate systems) in the EU legislation should be seen as an exception and connection to centralised systems is favoured. However, there is a very large number of agglomerations smaller than 2'000 PE in the Danube region (alone in Serbia there are > 4'000 small settlements) and a large number of small WWTPs already exists.

Technologies that are simple and robust and that have low operation and maintenance requirements and costs are most suitable for rural areas. A number of studies show that natural treatment technologies such as treatment wetlands are a good option especially for rural areas. Treatment wetlands achieve the same if not better treatment performance when compared to technical solutions. Country specific or regional design guidelines that allow reaching country specific discharge limits are required to increase acceptance at institutional and administrative levels and facilitate implementation.

Technology is not the main issue, the lack of capacity in rural areas for operation, monitoring and maintenance of WWTPs is a critical issue for the implementation of the systems. Training of owners/operator of small WWTPs is key, first in order to ensure the required operation, monitoring and maintenance work, and second since it would be challenging for authorities to regularly monitor the performance of all small WWTPs due to the high number of these systems. Hence, small WWTPs play an important role for the overall treatment of wastewater and to improve water quality specifically of small receiving waters and groundwater in rural areas. In that context, specific service models such as wastewater cooperatives and larger utilities being responsible for small WWTPs have been shown successful.

Clear guidance and requirements stemming from EU legislation regarding rural wastewater management would facilitate the development and implementation of national action plans. The currently ongoing revision of the UWWTD should be taken as chance to include clear guidance on rural wastewater management. Financing rural wastewater management, in addition to the financial obligations for larger agglomerations, poses a significant challenge for Danube countries. Thus, clear financing strategies and financial support for the countries would facilitate the development and implementation of national action plans to improve access to wastewater treatment and sanitation services of the often-neglected rural population. Such strategies and action plans would, however, next to the investment costs which are often supported in the form of subsidies, also require to address the issue of ensuring the coverage of costs for operation, monitoring and maintenance.

In summary, the importance of rural wastewater management is often still neglected in the Danube countries. Thus, a policy framework for enabling and supporting rural wastewater management would facilitate the development of new service models for rural wastewater management, to be supplemented by financing solutions for both investments and operation of systems to be established. Only then, long-term functioning of the systems and service delivery for the rural population can be achieved and sustained.

## 1. Overall status of sanitation and wastewater management

The UN Sustainable Development Goal 6 (SDG 6) on "*Clean Water and Sanitation*" aims to ensure availability and sustainable management of water and sanitation for all (UN, 2015). Access to water and sanitation is recognized by the United Nations as human rights, reflecting the fundamental nature of these basic services in every person's life (UN Water, 2021).

Within SDG 6, sanitation and wastewater treatment are specifically covered in Targets 6.2. and 6.3.:

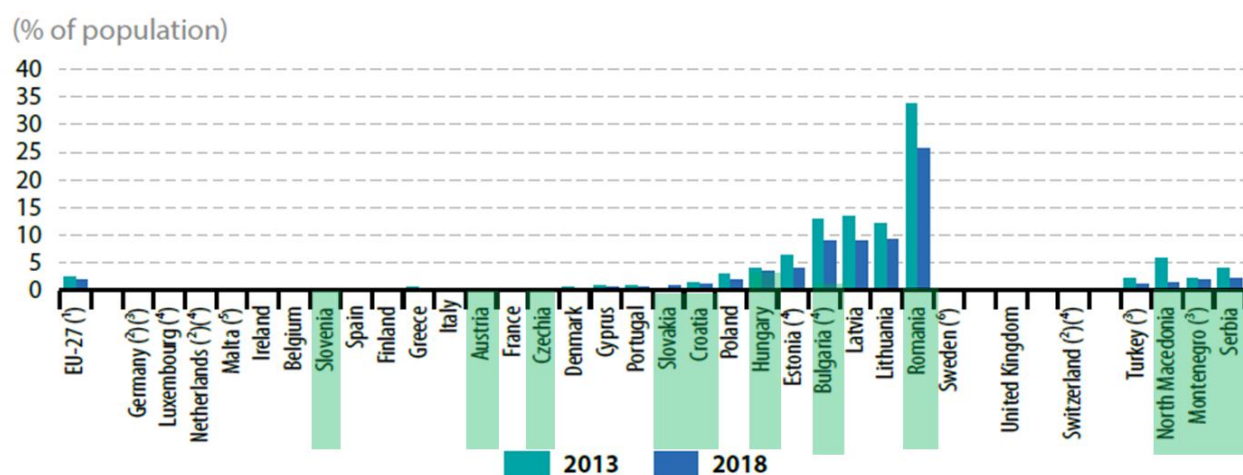
- Target 6.2.: By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.
- Target 6.3.: By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.

The SDG 6 Synthesis Report on Water and Sanitation (UN-Water, 2018) clearly demonstrates that achieving Targets 6.2. and 6.3. lacks behind achieving Targets 6.1. (achieve universal and equitable access to safe and affordable drinking water for all).

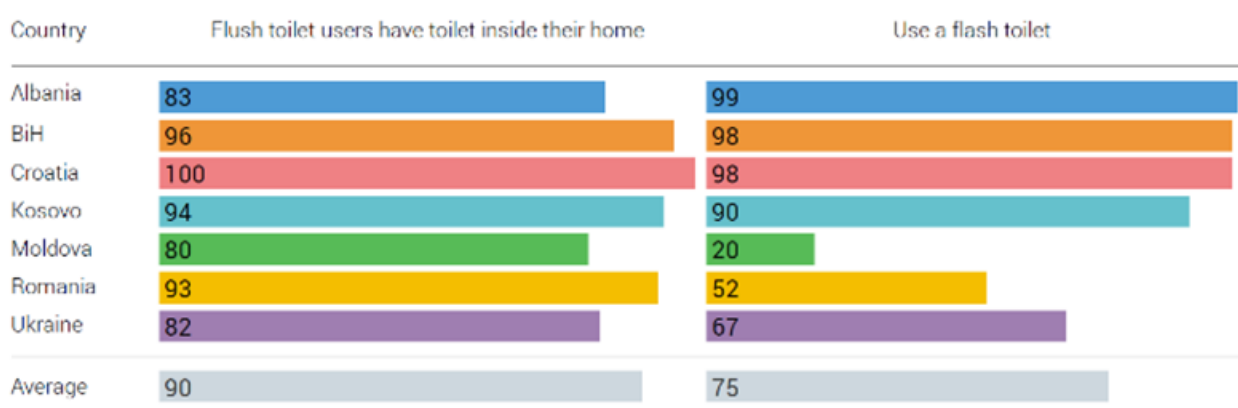
Target 6.2. asks for safely managed sanitation systems, i.e. a private improved facility where faecal wastes are safely disposed on site or transported and treated off-site and additionally, have a handwashing facility with soap and water (UN Water, 2018). Lack of access to safe, sufficient and affordable water, sanitation and hygiene facilities has a devastating effect on the health, dignity and prosperity of billions of people. The achievement of Target 6.2. is measured by indicator 6.2.1, i.e. by the proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water. In the Danube region, about 22 million people remain without access to flush toilets (World Bank Group, 2018).

Figure 1 shows the population having neither a bath, nor a shower, nor indoor flushing toilet in their household for EU Member States and selected other European countries, Figure 2 the availability of flush toilets in seven Danube region countries. Although the numbers are decreasing, still a high number of the population in several Danube countries is lacking sanitation services.





**Figure 1:** Population having neither a bath, nor a shower, nor indoor flushing toilet in their household, by country, 2013 and 2018, countries in the Danube region are marked in green (adapted from Eurostat, 2020).

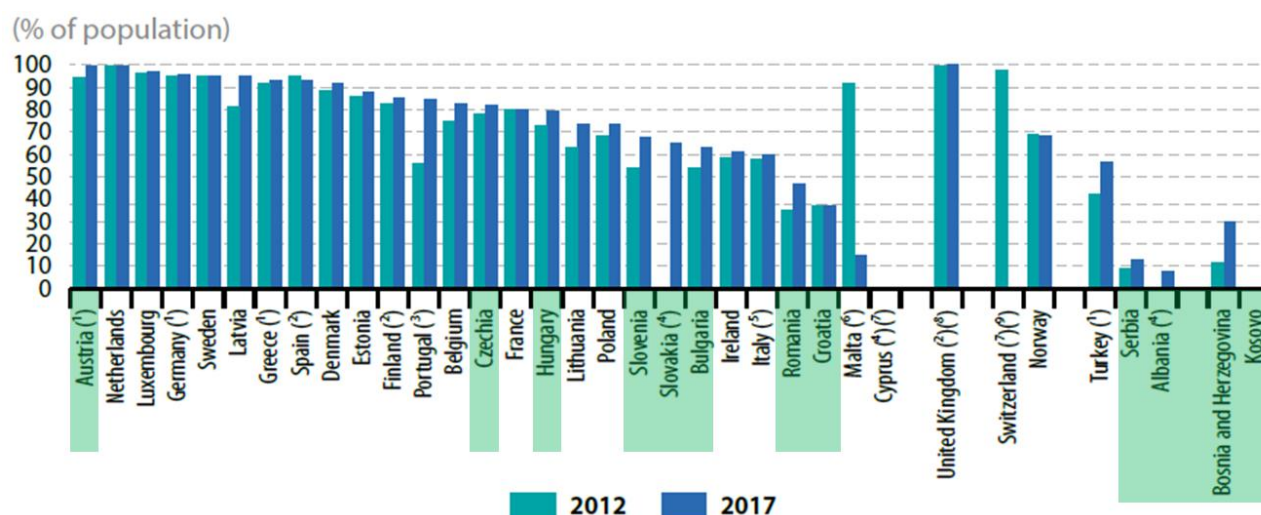


**Figure 2:** Share of flush toilet users with indoor toilet, and share of households using a flush toilet in seven countries in the Danube region (World Bank Group, 2018).

Collected but untreated or poorly treated faecal sludge and wastewaters release organic substances, nutrients and hazardous substances (e.g. pathogens, micropollutants with acute or chronic toxicity, persistent substances, carcinogenic, mutagenic or teratogen chemicals, endocrine disrupt substances) in considerable amounts into surface and groundwater bodies. Urban and rural developments, connected to the sewer systems and to wastewater treatment plants with inappropriate treatment technology, are the most important contributors of surface water contamination via point sources. The achievement of Target 6.3. is measured by two indicators:

- Indicator 6.3.1: Proportion of wastewater safely treated
- Indicator 6.3.2: Proportion of bodies of water with good ambient water quality

Figure 3 show the population connected to at least secondary wastewater treatment for EU Member States and selected other European countries. Secondary treatment requires that wastewater from urban or other sources is treated by a process generally involving biological treatment with a secondary settlement or other process that removes organic material and reduces its biochemical oxygen demand in 5 days (BOD<sub>5</sub>) by at least 70 % and chemical oxygen demand (COD) by at least 75 % (Eurostat, 2020). The population connected to at least secondary wastewater treatment is increasing in most Danube region countries, however, there is still a high proportion of wastewater that is not adequately treated in many countries.



**Figure 3:** Population connected to at least secondary wastewater treatment, by country, 2012 and 2017; countries in the Danube region are marked in green (adapted from Eurostat, 2020).

## 2. EU legislation and practice relevant for rural wastewater management

### 2.1 Relevance of EU regulations for the Danube region

Water management across the EU must respond to a number of legislative acts which lead to concrete actions and investments in the Member States. All these actions and investments are aimed at improving the quality of the waters and improving service delivery for the population.

The Danube region comprises EU Member States (Figure 4), Candidate Countries (Albania, Montenegro, North Macedonia, Serbia), Potential Candidates (Bosnia and Herzegovina, Kosovo) as well as EU neighbourhood countries (Moldova, Ukraine) (EC, 2021). Within the Danube region, countries are committed, including Non-EU Member States, to ensure appropriate level of treatment of wastewater to achieve the water quality goals of the Danube River Basin and receiving seas. Thus, the EU regulations regarding wastewater treatment is the benchmark also for the Non-EU Member States in the Danube region.



**Figure 4:** EU Member States in the Danube region (adapted from EC, 2021).

## 2.2 EU legislation on urban wastewater treatment

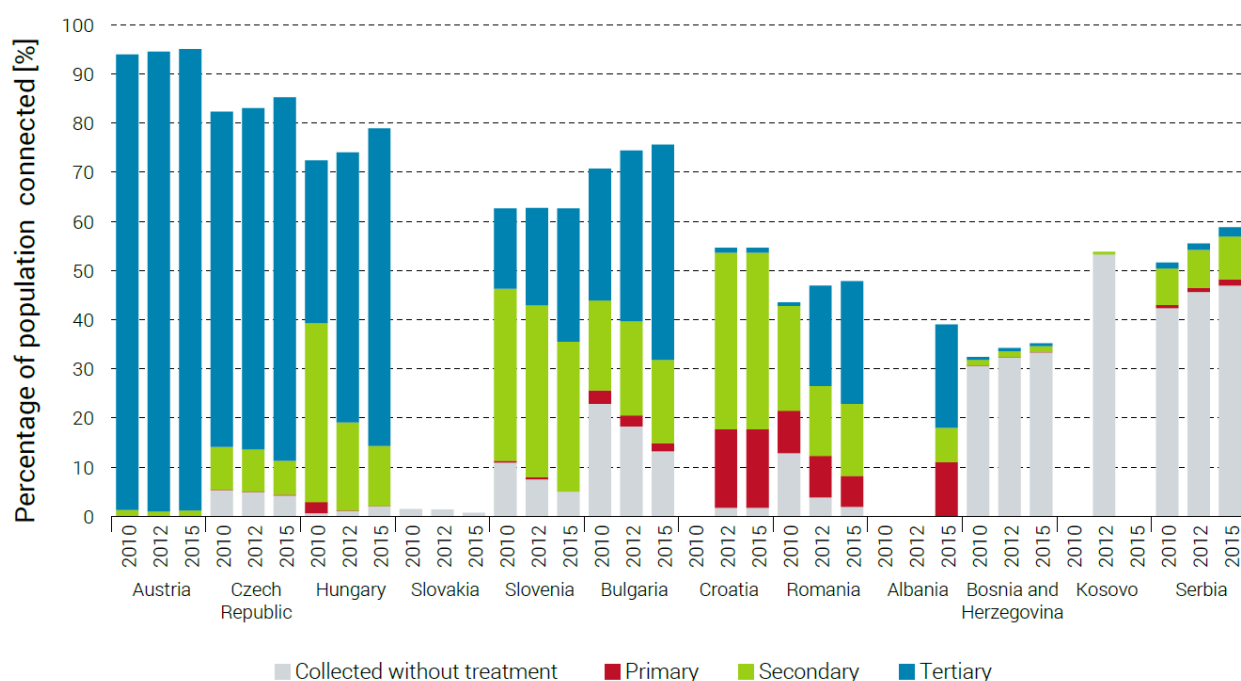
The EU Urban Wastewater Treatment Directive (UWWTD, 1991, i.e. the Directive 91/271/EEC) regulates the treatment of wastewater from agglomerations larger than 2'000 PE. According to Article 2(4), 'agglomeration' means *"an area where the population and/or economic activities are sufficiently concentrated for urban wastewater to be collected and conducted to an urban wastewater treatment plant or to a final discharge point"*.

Fulfilment of the UWWTD requires that member states ensure that urban wastewater

- is collected in all agglomerations larger than 2'000 PE (UWWTD Article 3)
- is treated according to the requirements given in the UWWTD (UWWTD Article 4), and
- is more stringently treated in sensitive areas (UWWTD Article 5).

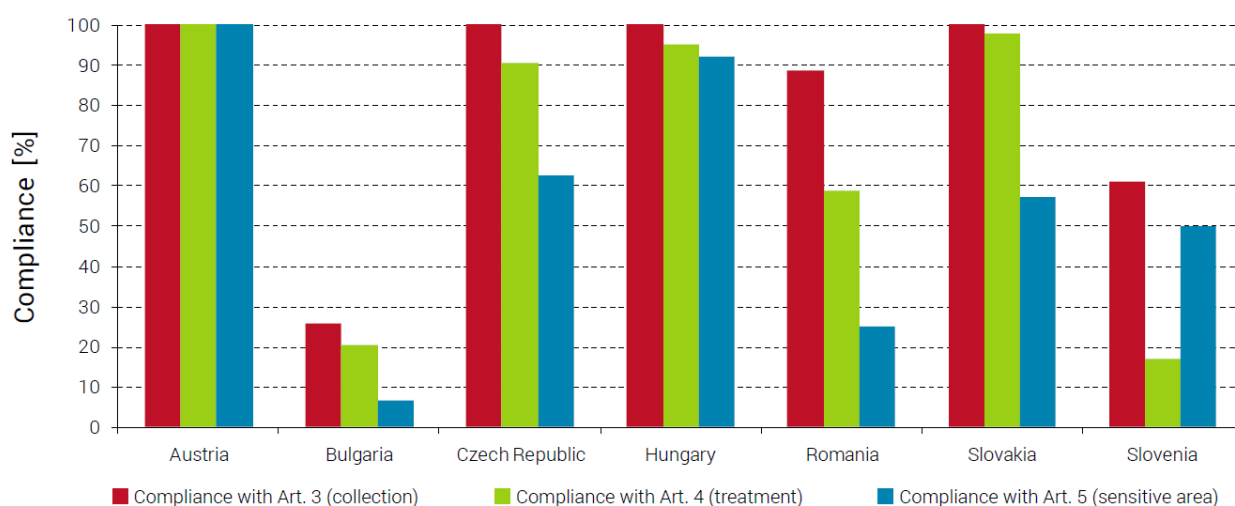
General required treatment levels for WWTPs larger than 2'000 PE as well as more stringent treatment levels for sensitive areas are defined in the annex of the UWWTD.

Figure 5 shows the share of population connected to sewage collection systems of varying treatment levels in 12 countries of the Danube region. At basin scale, more than 60% of the organic emissions into surface water via urban wastewater stem from agglomerations with existing sewer systems but without treatment. For nutrients, these figures are 30% (nitrogen) and 40% (phosphorus). Considering that these agglomerations represent only 10% of the total PE of the basin, implementation of wastewater treatment for a relatively small proportion of the agglomerations can result in substantial progress. The pollutant discharges of the new EU Member States and the non-EU Member States are substantially influenced by untreated wastewater releases (Danube Region Strategy, 2016).

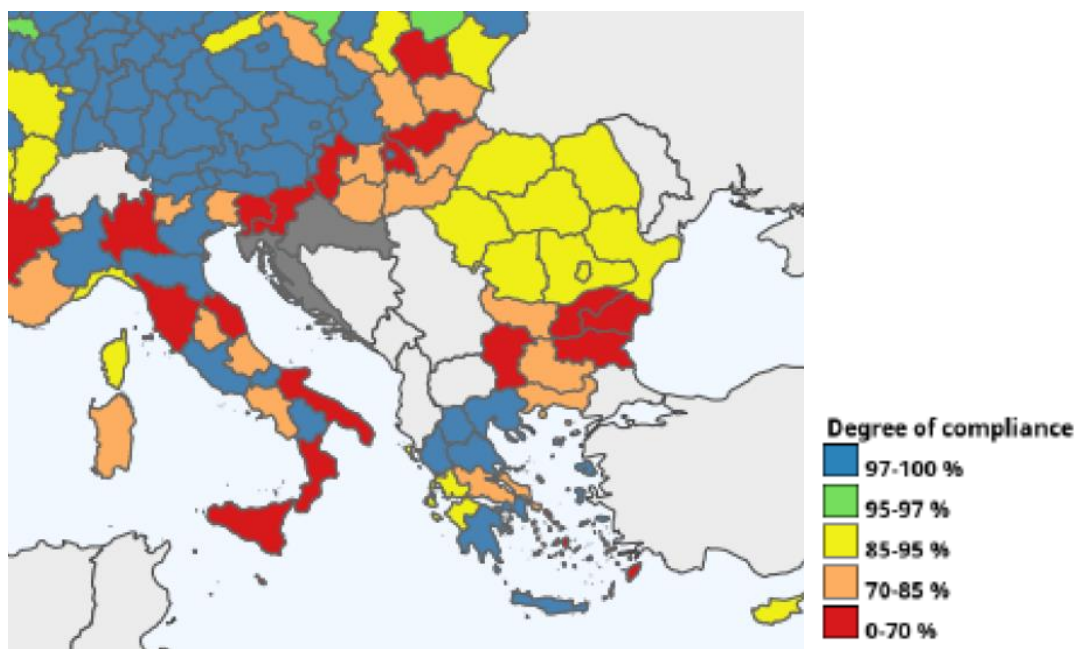


**Figure 5:** Share of population connected to sewage collection systems of varying treatment levels in the Danube region in 2010, 2012 and 2015 (World Bank Group, 2019).

Figure 6 the share compliance with UWWTD Articles 3, 4 and 5, respectively, in EU Member States in the DRB. Figure 7 shows the compliance with Article 4 (treatment) of the UWWTD in Danube EU member states at regional level. The level of connection and treatment compliance varies significantly in the DRB whereby upstream states generally show higher rates compared to downstream states. Data on Non-EU Member States are not reported in the EU reports.



**Figure 6:** Share of compliance with UWWTD Articles 3, 4 and 5 in EU Member States in the DRB (World Bank Group, 2019).



**Figure 7:** Map of compliance with Article 4 (treatment) of the UWWTD at regional level in 2016; Croatia not subject to compliance due to ongoing transition period until 2023 (adapted from EC, 2020a).

### 2.3 Relevance of the UWWTD for rural wastewater management

The UWWTD does not give general criteria for agglomerations smaller than 2'000 PE. Article 3(1) states that *"where the establishment of a collecting system is not justified either:*

- a) because it would produce no environmental benefit or*
- b) because it would involve excessive cost,*

*individual systems or other appropriate systems which achieve the same level of environmental protection shall be used."*

Additionally, Article 7 states that *"Member States shall ensure that ... urban wastewater entering collecting systems shall before discharge be subject to appropriate treatment as defined in Article 2(9) in the following cases:*

- for discharges to fresh-water and estuaries from agglomerations of less than 2'000 PE,*
- for discharges to coastal waters from agglomerations of less than 10'000 PE"*

Article 2(9) defines "appropriate treatment" as *"means treatment of urban waste water by any process and/or disposal system which after discharge allows the receiving waters to meet the relevant quality objective"*.

Thus, appropriate treatment for agglomerations of less than 2'000 PE discharging to fresh-water and estuaries should have been achieved by 31 December 2005 according to the Directive, whereas later deadlines apply for EU Member States joining the EU in 2007 and thereafter.

The term IAS (individual or other appropriate systems) is used to describe this smaller WWTPs in the EU legislation. According to the UWWTD, IAS should be the exceptional solution and the connection to a collection system should be prevailed. The justification of IAS instead of collecting system shall be based on cost-benefit analysis, IAS are thus required to be a much cheaper option (avoidance of excessive costs) and IAS to deliver equivalent protection (e.g. depending on agglomeration size, area sensitivity, type of receiving body).

According to the *"Guidance on the correct interpretation of UWWTD"* (EC, 2007), IAS are considered a compliant approach under the following conditions:



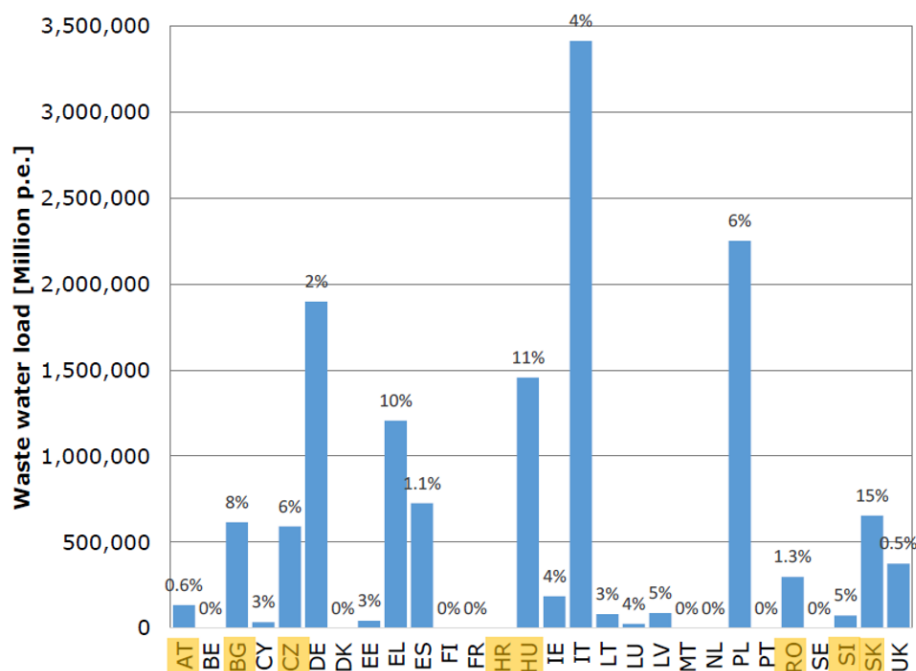
- Requirements for design, construction and maintenance of IAS to ensure same level of environmental protection as a collecting system
- IAS can be used only after a case-by-case assessment and justification concerning:
  - Absence of environmental benefit from having a collecting system, or
  - collecting system would involve excessive costs at the time being.

The implementation of the EU UWWTD is monitored regularly, i.e. EU Member States report data every two years. The latest report from 2020 (EC, 2020a) presents the assessment of the UWWTD implementation based on the 2016 data. Besides the regular monitoring, the EC started a process for evaluating the effectiveness of the UWWTD (EC, 2019). Based on this evaluation report, the revision of the UWWTD is discussed, whereby 20 points have been listed as potential revisions raised for discussion (EC, 2020b). Currently a survey under EU Member States regarding these potential revisions is carried out. The following two revision points have strong relevance for rural areas:

- Smaller agglomerations:
  - decrease threshold of agglomeration from 2000 to 1000, 500 or 200 PE.
  - EU fixed approach to define agglomerations of PE per ha.
- Individual or other Appropriate Systems (IAS)
  - Control of design and functioning: EU standards for IAS design (linked to Construction Products Regulation) combined with maintenance instructions.
  - Monitoring: Impose to Member States inspection strategies for regular monitoring and maintenance + Mandatory registration of individual and other appropriate systems.
  - Reporting: Requirement for Member States to establish a national database of IAS (location, technology, contract etc.) and report to EC when in excess of 2% in an agglomeration.

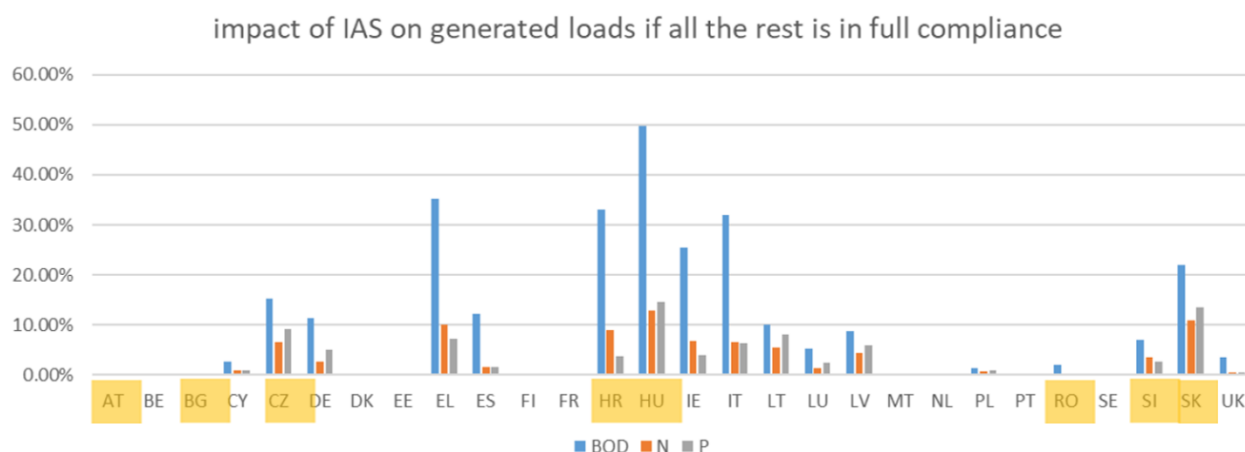
## 2.4 Importance of rural wastewater treatment

Figure 8 shows the wastewater load connected to IAS per EU Member State in 2016. The highest load of EU Member States in the DRB comes from Hungary with more than 1.4 million PE, followed by Slovakia with about 600'000 PE and Bulgaria and Czech Republic with more than 500'000 PE



**Figure 8:** Wastewater load in PE connected to IAS per EU Member State in 2016, EU Member States in the Danube region are marked in orange (adapted from EC, 2020a).

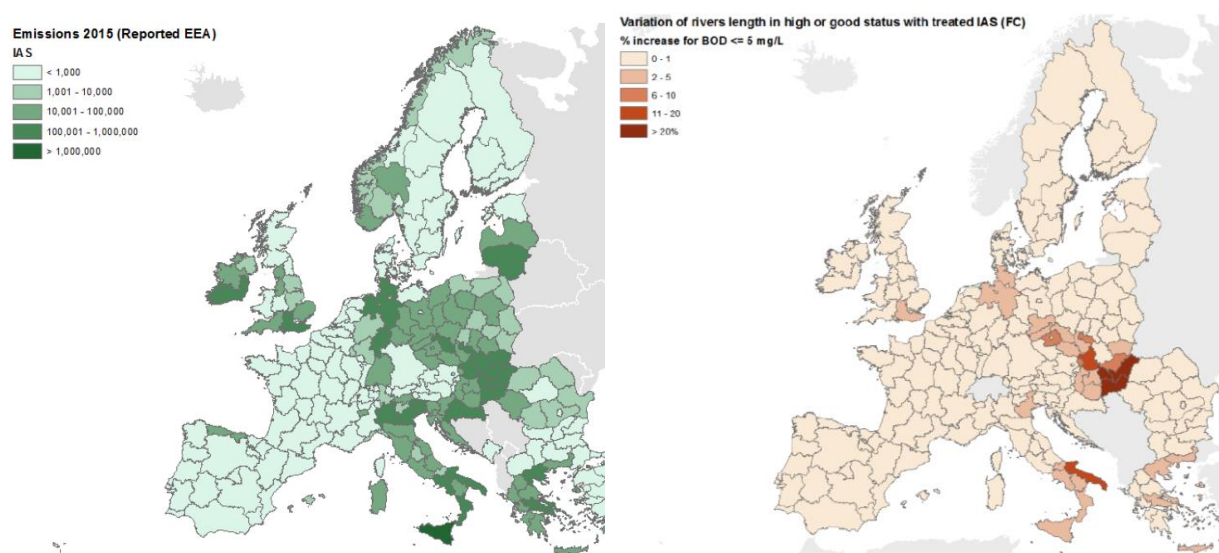
Pistocchi et al. (2019) investigated the influence of the IAS to the receiving water quality. Figure 9 shows the increase of BOD<sub>5</sub>, N and P in streams assuming that all agglomerations would be at full compliance and all IAS correspond to only primary treatment instead secondary treatment. The highest impact from only primary on receiving water quality in the DRB countries was found for Hungary, Croatia and Slovakia. As receiving waters in rural areas are often small, untreated or only partially treated wastewater from small settlements can have a significant impact on receiving water quality. Secondary treatment as minimum requirement for IAS can significantly improve receiving water quality.



**Figure 9:** Potential load assuming IAS correspond to a primary treatment, as a percentage of the total load under full compliance, for BOD<sub>5</sub>, N and P from wastewater, EU Member States in the DRB are marked in orange (adapted from Pistocchi et al., 2019).

Figure 10 shows the spatial distribution of emissions (in PE) from IAS and improvement of river water quality in terms of BOD<sub>5</sub> if all IAS treat the wastewater according to the UWWTD

requirements. According to Pistocchi et al. (2019), the impact of IAS in terms of BOD<sub>5</sub> is potentially significant, but lower than for coliforms, with certain regions increasing the length of the stream network below good status thresholds by up to more than 20% (Figure 10, right).



**Figure 10:** Spatial distribution of emissions (in PE) from IAS (left) and improvement of river water quality in terms of BOD<sub>5</sub> if all IAS treat the wastewater according to the UWWTD requirements (right: %-age of increase of river length with good water quality) (Pistocchi et al., 2019).

These general studies on EU level show that untreated or only partially treated wastewater from rural areas can have significant effects on receiving water quality. This is especially true for rural areas with small and/or sensitive receiving waters, suggesting to have secondary treatment of collected wastewaters as the minimum requirement.

### 3. National legislation in and practice of rural wastewater management

#### 3.1 Legal requirements for small WWTPs

In general, most EU Member States in the Danube region apply for WWTPs < 2'000 PE only discharge limits for organic matter in terms of BOD<sub>5</sub> and/or COD as well as for TSS discharge limits (Table 1). Usually the discharge limits for small WWTPs less than 2'000 PE are higher than the UWWTD requirements for larger 2'000 PE (i.e. 15 mg BOD<sub>5</sub>/l, 125 mg COD, and 35 mg TSS/l). In the Czech Republic, for WWTPs between 500-2'000 PE also a limit for ammonium nitrogen (NH<sub>4</sub>-N) applies. In Austria and Romania NH<sub>4</sub>-N discharge limits apply for all small WWTPs. For most countries, the authorities may set specific limit values based on water protection targets linked to other legislation, i.e. the EU Water Framework Directive.

**Table 1:** Comparison of main discharge limits for WWTPs < 2'000 PE in selected Danube region countries.

Country	Design size (PE)	Parameter				
		BOD <sub>5</sub> (mg/l)	COD (mg/l)	TSS (mg/l)	NH <sub>4</sub> -N (mg/l)	TP (mg/l)
Austria	≤ 50	25	90	-	10 <sup>1</sup>	-
	51-500	25	75	-	5 <sup>1</sup>	-
	501-5'000	20	75	-	5 <sup>1</sup>	1 <sup>2</sup>
Croatia	≤ 2'000	25	125	35	-	-
Czech Republic	< 500	40	150	50	-	-
	500-2'000	30	125	40	20	-
Hungary	< 600	80	300	100	- <sup>3</sup>	- <sup>3</sup>
	600-2'000	50	200	75	- <sup>3</sup>	- <sup>3</sup>
Romania <sup>4</sup>	≤ 2'000	20	125	60	15	2
Serbia	≤ 600	80	-	100	-	-
	601-2'000	50	-	75	-	-
Slovakia	≤ 50	40	-	-	-	-
	51-2'000	30	135	30	-	-
Slovenia	< 50	-	200	-	-	-
	50-2'000	30	150	-	-	-
Ukraine <sup>4</sup>	≤ 2'000	15	80	15	0.39	-
UWWTD	> 2'000	25	125	35	-	- <sup>5</sup>

<sup>1</sup> NH<sub>4</sub>-N discharge limits are linked to wastewater effluent temperature, i.e. 12°C for WWTPs < 5'000 PE; <sup>2</sup> for WWTPs > 1'000 PE; <sup>3</sup> the authority may set a specific limit value based on water protection interest; <sup>4</sup> according Bodík et al. (2012); <sup>5</sup> for WWTPs > 10'000 PE.

Candidate Countries and Potential Candidates usually have adjusted already their legislation towards the UWWTD and thus have already similar requirements as EU Member States (see e.g. Serbia in Table 1). Albania is currently on the way to adopt their wastewater regulation to be in line with the EU regulations.

However, in Bosnia and Herzegovina no specific regulation is in place for agglomerations smaller than 2000 PE and a relatively significant share of the population rely on self-provision of water and sanitation services. Most small communities (< 2'000 people) do not have WWTPs or no specific investments have been implemented for small settlements (Danube Region Strategy, 2016).

Legal requirements for Ukraine (Table 1, reported by Bodík et al., 2012) are the most stringent for small plants, being even stricter than for large plants in the EU. Discharge limits of < 0.4 mg NH<sub>4</sub>-N/l are almost impossible to fulfil for smaller WWTPs of any technology.

The regulation of most countries in the Danube region provides for WWTPs less than 2'000 PE only discharge limits for organic matter (in terms of BOD<sub>5</sub> and/or COD) and for solids (in terms of TSS). In most countries, requirements for WWTPs less than 2'000 PE are less stringent compared to the EU regulation for WWTPs larger than 2'000 PE, in only few countries requirements are more stringent.

### 3.2 Design guidelines and norms for small WWTPs

In most countries, no specific design guidelines or norms exist or have to be applied. The requirements are defined through effluent quality that needs to be consistently achieved. Usually

a permit has to be given to each WWTP, whereby authorities can decide on more stringent discharge requirements for sensitive receiving water bodies.

In several countries, the ISO EN 12556 standards for WWTPs less than 50 PE is used. The certification procedure for compact technical WWTPs (ISO EN 12556-3) requires testing for organic matter removal and thus cannot be applied in countries where  $\text{NH}_4\text{-N}$  discharge limits are existing. In many countries of the region for WWTPs up to 2'000 PE the German DWA guidelines (DWA-A 131, 2016, and DWA-A 226, 2009) for activated sludge plants are applied.

Austria has specific design guidelines for small WWTPs less than 50 PE, i.e. Ö-NORM B 2502-1 (2012) for technical plants and Ö-NORM B 2505 (2009) for treatment wetlands. If small WWTPs are designed according to these design standards, the process for getting the permission for operating the WWTP is simplified (Langergraber et al., 2018).

### 3.3 Management and monitoring of small WWTPs

In general, monitoring intervals and parameters to be monitored are given in the permits of the individual WWTP. In all countries, required monitoring of small WWTPs is less frequent and requires less parameters to be analysed compared to larger WWTPs.

In Austria, self-monitoring below 50 PE usually includes weekly routine checks if the WWTP is working properly and monthly sampling and analysis of the following parameters: temperature and pH of effluent, effluent concentration of ammonia nitrogen and settleable solids, and (if applicable) the sludge volume. All results gained from self-monitoring as well as operational and maintenance work have to be documented in an operations diary. Besides self-monitoring, external monitoring is requested. External monitoring has to be carried out in specified intervals (e.g. once per year or every two year). In some federal states, the period of the external monitoring will be extended, e.g. from two to three years, if owners of WWTPs successfully complete the training course for operators. During external monitoring, effluent samples are analysed and the operations diary including the data gained from self-monitoring is checked and evaluated. Reports from external monitoring are sent to the local authorities for evaluation. To get the permission several local authorities request that owners have a contract for operation and maintenance with a company and/or that owners of WWTPs take part in the training course for operators. Once the 1.5 days training course is passed successfully, the authorities may increase the interval for the external monitoring (Langergraber et al., 2018).

One main objective of the trainings for operators of small WWTPs is that the likelihood that these plants are also operated well increases if owners/operators are trained. This is required because these small WWTPs are less often monitored and evaluated.

The Austrian Wastewater and Waste Association ÖWAV is responsible for the training of operators of wastewater treatment plants. In most countries of the Danube region, waterworks and wastewater associations offer trainings among their services (World Bank Group, 2019), however, up to now not specifically for small WWTPs. In that context it is pointed out that under the Danube Learning Partnership (D-LeaP) and the Regional Capacity Development Network (RCDN), capacity development offerings for the water supply and sanitation sector exist (e.g. on performance indicator data collection and benchmarking, asset management, energy efficiency, etc.), however these are mainly targeted towards larger utilities. The existing cooperation networks may provide an opportunity to also develop and offer capacity development activities targeted at small rural wastewater utilities in the future. A short summary on the situation in relation to policy-making and sector institutions, service provisions and service coverage is given for Serbia, Bosnia and Herzegovina, Montenegro, Moldova and Ukraine in **Error! Not a valid bookmark self-reference..**



**Table 2:** Summary on policy-making and sector institutions, service provisions and service coverage for wastewater in Serbia, Bosnia and Herzegovina, Montenegro, Moldova and Ukraine (adapted from Danube Region Strategy, 2016).

	Policy-making and sector institutions	Service provisions	Service coverage
<b>RS</b>	Five main ministries constitute the national institutional framework of the water sector, with no clear line ministry and often overlapping mandates.	Local governments are responsible for water and wastewater service provision through 152 public utility companies. In rural areas, inhabitants rely on self-provision.	Only 11% of the population is connected to wastewater treatment. Effluents are treated mostly below UWWTD standards, resulting in significant environmental and public health hazards. Most small communities (<2,000 people) do not have public wastewater collection and treatment plants.
<b>BIH</b>	The sector is controlled and regulated at different administrative levels. Despite the existence of two clear line ministries, some overlaps can be noted.	Local governments are responsible for water and sanitation services and provide them through 142 public utility companies. 42% of the population relies on self-provision.	Only 3% of the population is connected to wastewater treatment plants.
<b>ME</b>	The sector is controlled and regulated by several ministries, with one clear line ministry. Local water and wastewater service providers are regulated and controlled by five national institutions.	Municipalities provide water and wastewater services to their population. Local governments are responsible for water and wastewater services and provide them through 22 public utility companies. 24% of the population rely on self-provision	Only 18% of all wastewater produced is effectively treated, mostly below the Urban Waste Water Treatment Directive standards, resulting in significant environmental and public health hazards. However, the situation in urban and rural areas is markedly disparate.
<b>MD</b>	Several ministries and agencies regulate the water sector.	Municipal utilities are in charge of water provision. Currently, 52 municipally owned operators provide water and sanitation services to 43% of the population mainly located in urban areas. The rest of the population (57%) relies on self-provision	There are significant coverage differences between urban and rural areas. In urban areas, 50% of the population is connected to a public collective sanitation system (rates from 30% to > 90%). According to various estimates, only 1% to 5 % of rural population is connected to the wastewater collection system, and practically, no rural wastewater is treated. Eleven percent of inhabitants in rural villages use unimproved sanitation solutions.
<b>UA</b>	Several ministries and agencies control the water sector at the national level, with no clear line ministry and mandate overlaps. There is a lack of distribution of responsibilities among the administrative authority levels	Local self-governments are the owners of water and wastewater infrastructure. 35% of the population relies on self-provision.	Only 37% of the population, most of which live in urban areas, is connected to a wastewater treatment. Only over a third of the wastewater collected is effectively treated, resulting in a large volume of untreated wastewater being directly discharged into the environment, causing pollution and health hazards

In the Danube region there is a large demand regarding training of WWTP operators in general and more specifically for operators/owners of small WWTPs. National water and wastewater associations should be involved in setting up training schemes. Experience from e.g. Austria shows that training of operators improves the functioning of all WWTPs. Due to the importance of rural wastewater management, there is specific need for trainings for operators/owners of small WWTPs in the Danube region.

## 4. Challenges of rural wastewater management in the Danube River Basin

### 4.1 General aspects of rural wastewater management

In general, only a small proportion of the wastewater load is generated in rural areas, however, a high number of small WWTPs is required to treat this load. E.g. in Austria, from in total 29'400 WWTPs 97.8 % are smaller than 2'000 PE (27'500 WWTPs or 93.4 % are even smaller than

50 PE), however, they only treat 3.3 % of Austria's wastewater load (Langergraber, 2018; ÖWAV, 2019). Additionally, rural areas in many Danube region countries are the poorest regions in the respective countries. Increased pressures on existing wastewater infrastructure may result from migration away from rural areas. This leads to the reduction in the size of agglomerations and the reduction in the wastewater generated and this in turn can lead to over-dimensioned plants (Wood et al., 2019). Serbia has more than 4'200 settlements with less than 2'000 population, most of them with decreasing population (Marjanović, 2021).

For selecting the right wastewater treatment technology, one has to consider that small WWTPs are characterised by highly fluctuating wastewater flows as well as high concentrations of the wastewater constituents with high fluctuations. Additionally, only few trained personals are available to operate these plants in rural areas.

This results in the following general requirements for small WWTPs:

- simplicity of the technology,
- simplicity of operation and maintenance,
- high robustness, high stability, and large reactor volume, to buffer the high fluctuations of flow and concentrations, and
- low sludge production.

However, choosing the right technology is not the main issue. Every technology requires proper operation, monitoring and maintenance to ensure effective treatment of wastewater. Capacity for operating small WWTPs is a key factor for the long-term functioning of the systems.

In reality, these systems are often operated by untrained or undertrained individuals who lack specialised knowledge and have limited awareness on the requirements of water and sanitation services. Due to the sheer number of such systems, their location (on private properties or in remote areas) it is often challenging for the competent authorities to access and inspect these (Wood et al., 2019).

## 4.2 Legal aspects

For agglomerations smaller than 2'000 PE, the UWWTD does not give clear guidance, just that an "appropriate treatment" shall be foreseen for collected wastewaters so that after discharge receiving waters can meet the relevant quality objectives. The term IAS (individual or other appropriate systems) is used to describe this smaller WWTPs in the EU legislation. However, the UWWTD sees the use of IAS as an exception and connection to centralised systems is favoured. IAS should only be implemented, in the case of collection would result in excessive costs and is they can ensure the same level of environmental protection as a collecting system.

The evaluation study of the UWWTD (EC, 2019) made some general comments/suggestions regarding the relevance of rural wastewater management:

1. Small agglomerations and non-connected dwellings are a factor in not reaching good status under the WFD. The impact of small agglomerations and non-connected dwellings and their discharges depends on local conditions such as the discharge point and the type and size of the receiving water body. It is expected that in many small agglomerations substantial use of IAS is made.
2. The UWWTD is not clear on how costs and benefits need to be assessed in order to ascertain whether IAS could be used, what 'sufficiently concentrated' means in the context of agglomerations or how Member States need to monitor the effectiveness of IAS use.
3. At technical level, the ISO EN 12566 standard prescribes rules for IAS used for up to 50 PE. Not all technologies described in this standard treat the wastewater to the same level.

Few Member States adopted stricter standards for IAS to address their concerns about having a negative environmental impact on small receiving waters in rural areas.

Overall, there is a need for a policy framework that enables and supports rural wastewater management. In particular, further clarity provided by EU regulations on requirements for rural wastewater management on a national level may be beneficial. This clarification is specifically required for agglomerations less than 2'000 PE and includes e.g. the definition of agglomeration, requirements of use of IAS, the adequate treatment levels for IAS. Clarity in the EU regulations would support Danube region countries to develop national legislation and plans for implementing rural wastewater management.

EU or national legislation may also be more supportive and acknowledge the need for small WWTPs in rural areas with low population densities and scattered small settlements. Small WWTPs are essential for increasing the coverage with wastewater treatment.

Building and/or strengthening the institutional and legal framework and local implementation capacities for rural wastewater management was recommended for a number of Danube region countries (World Bank Group, 2018). These was specifically recommended for the following topics: rural sanitation along the entire sanitation service chain (reported in general for Albania, Croatia, Kosovo, Moldova, Romania, Ukraine) and faecal sludge management (reported for Bosnia and Herzegovina, Croatia, Kosovo, Moldova, Romania, Ukraine).

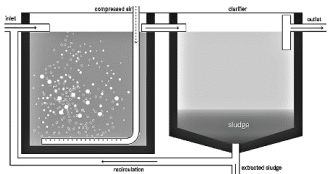
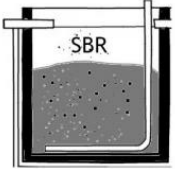
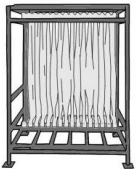
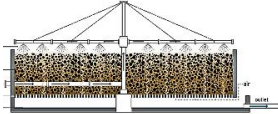
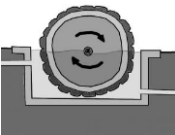
### 4.3 Technology selection

A high number of technical solutions are available for rural wastewater management. These technologies can be classified as follows:

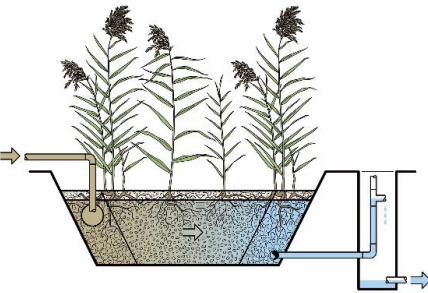
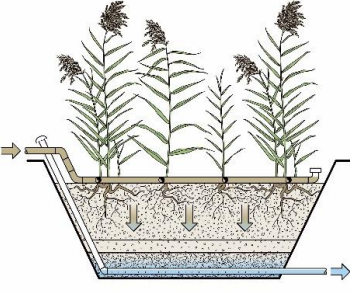
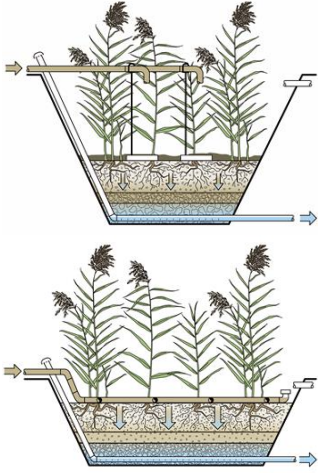
- On-site collection with off-site treatment
  - Cesspits (with transport to next WWTP or faecal sludge treatment unit)
- Soil as recipient of treated (or partially treated or untreated) wastewater
  - Soak pits, leach fields, etc.
- Solutions with less than secondary treatment
  - Septic tanks, etc.
- Solutions with at least secondary treatment
  - Technological solutions with suspended biomass (e.g. conventional activated sludge plants, SBR – Sequencing Batch Reactor, MBR – Membrane BioReactor)
  - Technological solutions with fixed biomass (e.g. Trickling filter, RBC – Rotating biological contactor, filtration systems)
  - Nature-based solutions (e.g. treatment wetlands)

In the following tables, main technologies with at least secondary treatment usually applied in rural wastewater management are briefly described. Table 3 describes technological solutions often applied for small WWTPs. In Table 4 the main types of treatment wetlands applicable for secondary treatment of wastewater, the fourth main type, Free Water Surface wetlands, is usually applied as polishing stage.

**Table 3:** Technological solutions with at least secondary treatment often used for small WWTPs (schematics taken from the SSWM Toolbox, SSWM, 2021).

Technological solutions	Short description
<b>Conventional activated sludge (CAS)</b> 	<ul style="list-style-type: none"> <li>– Biological treatment &amp; secondary clarification in two separated reactors</li> <li>– Continuous flow of wastewater to and from the CAS</li> <li>– Less operational flexibility</li> <li>– Excess sludge has to be managed</li> </ul>
<b>Sequencing Batch Reactor (SBR)</b> 	<ul style="list-style-type: none"> <li>– Equalization, primary clarification, biological treatment &amp; secondary clarification in one single reactor</li> <li>– Effluent is released in batches, i.e. this might cause hydraulic stress for small receiving waters</li> <li>– Operational flexibility but more complex control is required for larger units</li> <li>– Higher level of operation and maintenance required</li> <li>– Excess sludge has to be managed</li> </ul>
<b>Membrane Bio-Reactor (MBR)</b> 	<ul style="list-style-type: none"> <li>– Secondary clarifiers and tertiary filtration processes are eliminated, thereby reducing plant footprint.</li> <li>– High-quality treated effluent, also for reuse in irrigation</li> <li>– However, higher operating costs due to membranes and need of chemical flocculants to produce settling of biosolids</li> <li>– Lower excess sludge production</li> </ul>
<b>Trickling filter</b> 	<ul style="list-style-type: none"> <li>– Fixed-bed, biological reactor that operates under (mostly) aerobic conditions. Pre-settled wastewater is continuously 'trickled' or sprayed over the filter</li> <li>– Can be operated at a range of organic and hydraulic loading rates</li> <li>– Primary treatment and treatment of excess sludge required</li> </ul>
<b>Rotating biological contactor (RBC)</b> 	<ul style="list-style-type: none"> <li>– Fixed-bed reactors consisting of stacks of rotating disks mounted on a horizontal shaft. They are partially submerged and rotated as wastewater flows through</li> <li>– Low operational and maintenance requirements</li> <li>– Less operational flexibility but high process stability, resistant to shock hydraulic or organic loading</li> </ul>

**Table 4:** Treatment wetland main types used for secondary treatment of wastewater (adapted from Dotro et al., 2017).

TW type	Short description
<b>Horizontal flow (HF) wetland</b> 	<ul style="list-style-type: none"> <li>– Wastewater flows horizontally through a sand or gravel-based filter whereby the water level is kept below the surface.</li> <li>– Due to the water-saturated condition mainly anaerobic degradation processes occur.</li> <li>– Effective primary treatment is required to remove particulate matter to prevent clogging of the filter.</li> <li>– Emergent plants (macrophytes) are used.</li> <li>– Are used for secondary or tertiary treatment.</li> <li>– Area requirement: <math>\leq 4\text{-}10 \text{ m}^2/\text{PE}</math></li> </ul>
<b>Vertical flow (VF) wetland</b> 	<ul style="list-style-type: none"> <li>– Wastewater is intermittently loaded on the surface of the filter and percolates vertically through the filter.</li> <li>– During two loadings air re-enters the pores and aerates the filter so that mainly aerobic degradation processes occur.</li> <li>– Effective primary treatment is required to remove particulate matter to prevent clogging of the filter.</li> <li>– Emergent macrophytes are used.</li> <li>– Area requirement: <math>\leq 2\text{-}5 \text{ m}^2/\text{PE}</math></li> </ul>
<b>French VF wetland</b> 	<ul style="list-style-type: none"> <li>– Are VF wetlands for treating screened wastewater.</li> <li>– Two stages of VF wetlands operate in series and in parallel.</li> <li>– Provide integrated sludge and wastewater treatment in a single step.</li> <li>– No primary treatment unit is required.</li> <li>– Area requirement: <math>\leq 1.5\text{-}2.5 \text{ m}^2/\text{PE}</math></li> </ul>

It is generally agreed that technologies that are simple and robust and that have low operation and maintenance requirements and costs are most suitable for rural areas. Design standards for small WWTPs that allow reaching country specific discharge limits facilitate their implementation.

On-site collection in water-tight cesspits with transport to next to off-site treatment is generally the most expensive solution. On-site treatment is usually the cheaper option.

The discharge levels for WWTPs < 2'000 PE in the various Danube region countries (Table 1) define which technologies can be applied. Most countries require at least secondary treatment, i.e. biological treatment with a secondary settlement or other process that removes organic



material by at least 70 % and 75 % for BOD<sub>5</sub> and COD, respectively. In the case of NH<sub>4</sub>-N discharge limits, the technology selected needs to be capable of biological treatment including nitrification.

Solutions with less than secondary treatment and with soil as recipient for untreated wastewater might be applied in selected regions if there is no threat of pollution of surface water and groundwater, respectively. If such technologies can be applied depends on the national legislation in the Danube region countries.

Several studies suggest that nature-based solutions such as treatment wetlands shall be favoured for wastewater treatment facilities with secondary treatment. Pistocchi et al. (2020) present a study focussing on wastewater treatment in Danube region countries. In a feasibility study, various wastewater treatment solutions for three Slovenian villages (with population of 220, 300 to 820, respectively) have been designed and evaluated against costs, social acceptability, technical issues and ecosystem services by experts and stakeholders. The considered technologies included technical solutions, treatment wetlands, enhanced treatment wetlands and solutions with reuse and resource-utilisation in mind. It has to be noted that not all technologies investigated result in the same treatment level. The outcomes of the study suggest that there are considerable advantages of nature-based solutions, i.e. treatment wetlands, for wastewater treatment in rural areas and small agglomerations, throughout the Danube region countries. Treatment wetlands offer significantly higher cost-effectiveness than more “technological” and centralized solutions, particularly because it can significantly reduce the O&M costs compared to technical solutions.

It is generally known that treatment wetlands if properly designed and constructed can achieve the same if not better treatment levels as technical solutions such as activated sludge plants. Treatment wetlands have significantly lower O&M costs and can achieve required level of pollution reduction with smaller per PE costs (Umweltbundesamt and IOW, 2017). There is also a high level of knowledge regarding implementation and performance of treatment wetlands at the expert and scientific levels in central and eastern European (CEE) countries. However, the transfer into practice is insufficient, and there is low awareness and recognition of treatment wetlands at the institutional and administrative levels (Bodík et al., 2012; Istenič et al., 2016).

#### 4.4 Models for operation and monitoring of small WWTPs

Technology is not the main issue, the lack of capacity in rural areas for operation, monitoring and maintenance of WWTPs is a critical issue for the implementation of the systems. All technologies need proper operation, monitoring and maintenance to function. Even the simplest technology fails if it is not properly operated and maintained.

Several models to support operation, monitoring and maintenance have shown to be successful for rural areas:

##### 1. Training of owners/operators of small WWTPs:

Training for owners/operators of small WWTPs has one main objective: the likelihood that the plant is also operated well increases if owners/operators are trained and thus understand why operation, monitoring and maintenance is important. In Austria, a training for owners/operators of small WWTPs ( $\leq 50$  PE) lasts 1.5 days and authorities provide incentives to owners/operators such as increased intervals for the required external monitoring (Langergraber et al., 2018).

A study on the performance of small WWTPs in Upper Austria – a federal state in which a high percentage of owners/operators of small WWTPs is trained – showed that all technologies comply with the required threshold values independent of the age of the plant.

Proper operation, monitoring and maintenance by trained persons seems to be key fact for well-functioning small WWTPs (Langergraber, 2021).

## 2. Wastewater cooperatives

Cooperatives is a service model that is quite popular in Austria and few other European countries. Water and wastewater cooperatives are bodies governed by public law, membership comprises the users of the services that share a common property, e.g. the WWTP. Cooperatives are self-determined and self-organised. Within their membership they have to organise operation, monitoring and maintenance of the assets. Financing of cooperatives is by connection fees, basic and consumption charge as well as subsidies (Aichlseder and Wesely, 2021).

In Austria, about 3'400 cooperatives (for water and wastewater) exist. Cooperative solutions are predominant rural areas, rural communities, villages, remote settlements in usually non-economical strong areas. Most of the 260 wastewater cooperatives in Upper Austria are rather small, i.e. they have less than 30 members (Aichlseder and Wesely, 2021).

To support these small cooperatives, regional umbrella organisations (at federal state level in Austria) were created with aim to be a one-stop-shop of consulting, supporting and representing to the members of the cooperatives. Additionally, the umbrella organisations provide educational programmes (for chair persons, cashiers, controllers, water managers, etc.), offer a group third-party insurance and maintain a library of FAQs (Aichlseder and Wesely, 2021).

## 3. Larger utilities operate small WWTPs

Small WWTPs can be also operated by larger utilities. The utility responsible for the central WWTP of an agglomeration can be also in charge of operation, monitoring and maintenance of smaller plants in remote settlements in the same or neighbouring municipalities. The policy of some municipalities is to provide all persons the same service despite if they are living in the agglomeration or in a small settlement. In such cases all persons in the municipality pay the same connection fees and consumption charges. The staff of the central WWTP is taking care of the WWTPs of small settlements.

This service can also be offered by regional or national service providers. Águas de Portugal (AdP), a 100% state owned company, operates about 1'000 WWTPs in Portugal whereby 70 % of the plants are below 2'000 PE. AdP also implemented a high number of the WWTPs by themselves and developed a standard design for WWTPs < 2'000 PE to optimise project, tendering and construction time and costs. Standardisation allowed OPEX optimization and internal benchmarking (Nuno, 2021).

## 4.5 Financing rural wastewater management

In general, financing rural wastewater management poses a significant challenge for Danube region countries. All decentralised solutions need a certain degree of external support because, on the one hand, there is the very high number of WWTPs required and, on the other hand, rural areas are economically often less favoured compared to urban areas.

Financial support from the EU or from other sources for the implementation of rural wastewater management would allow to progress in rural service delivery. Regional differences in Danube region countries require national action plans. Clear EU legislation regarding rural wastewater management would facilitate the development of coherent national legislation and national action plans.

External support is often provided in forms of subsidies. For example, in Austria, subsidies for wastewater infrastructure are provided on national as well as on federal state level. The national

subsidy depends on the income of the inhabitants and the specific investment costs of wastewater infrastructure in the respective municipality. Based on these criteria, the national agency handling the subsidies (Kommunalkredit Public Consulting) applies municipality-dependent subsidies between 10 and 40 % of the investment costs. For WWTPs  $\leq 50$  PE the procedure is simplified and a fixed amount per PE is applied as subsidy. Subsidies are also given for reinvestments in the wastewater infrastructure. Similar procedures and rules are applied for subsidies from the federal states. Anyway, owners of the wastewater infrastructure have to apply for subsidies before the implementation starts.

In general, subsidies are available only for investment costs, generally no subsidies are available for operation, monitoring and maintenance of the plants.

## 5. Summary

Access to water and sanitation is a human right that is recognized by the United Nations. The UN Sustainable Development Goal 6 (SDG 6) on "*Clean Water and Sanitation*" specifically addresses the topic of wastewater management by Target 6.2. (achieve access to safely managed sanitation systems for all) and Target 6.3. (improve water quality by reducing pollution).

In the Danube region, the EU legislation provides a key basis as countries in the region are either EU Member States, Candidate Countries, Potential Candidates or associated countries.

The Urban Wastewater Treatment Directive (UWWTD) regulates the treatment of wastewater from agglomerations larger than 2'000 population. Candidate Countries and Potential Candidates already have or are on the way to implement the UWWTD in national legislations. In general, the fulfilment of the requirements of the UWWTD (in term of collection and treatment) is less advanced in Candidate Countries and Potential Candidates compared to Member States, however, also in Member States the grade of fulfilment varies significantly.

For agglomerations smaller than 2'000 PE, the UWWTD does not give clear guidance, just that an "appropriate treatment" shall be foreseen so that after discharge of the treated wastewater, receiving waters can meet the relevant quality objectives. The term IAS (individual or other appropriate systems) is used to describe this smaller WWTPs in the EU legislation. However, the UWWTD sees the use of IAS more as an exception and connection to centralised systems is the favoured solution. IAS should only be implemented, in the case of collection would result in excessive costs and is they can ensure the same level of environmental protection as a collecting system. The UWWTD is not clear on how the costs and benefits need to be assessed for evaluating the applicability of IAS: In general, guidance provided at EU level would facilitate the developing coherent national legislation and action plans for rural wastewater management.

The number of small agglomerations is significant in all countries of the Danube region. Small agglomerations and non-connected dwellings might be a factor in not reaching good status of receiving waters if collected wastewater is not treated. Solutions for the treatment of wastewater from small sites is thus an issue to achieve environmental protection targets. Too high discharge limits for small WWTPs might pose environmental problems, as IAS – according to the UWWTD – should result in the same level of environmental protection as a collecting system.

For small WWTPs  $< 2'000$  PE, most countries in the Danube region only apply organic matter (BOD<sub>5</sub> and/or COD) as well as TSS discharge limits which are in general less stringent than the limits of the UWWTD for WWTPs  $> 2'000$  PE. However, set targets may require at least secondary treatment of domestic wastewater also for small systems. Technologies that provide only primary treatment (e.g. septic tanks) and application of raw wastewater on soil might be allowed in specific cases if there is no threat of pollution of surface and groundwater, respectively. In some countries (e.g. Austria, Czech Republic, Romania) also discharge limits for ammonium

nitrogen ( $\text{NH}_4\text{-N}$ ) are set and discharge limits for small plants can be also more stringent than the UWWTD requirements for larger plants.

In principle, a large number of technologies is available that can be applied for small WWTPs. Technologies that are simple, have a robust treatment performance and have low operation and maintenance requirements and costs are more suitable for rural areas. Design standards that allow reaching country specific discharge limits facilitate their implementation.

A number of studies show that natural treatment technologies such as treatment wetlands are a good option especially for rural areas. Treatment wetlands already have been applied in most countries of the Danube region in various sizes. If properly designed, constructed and operated, treatment wetlands achieve the same if not better treatment levels when compared to technical solutions.

In most Danube region countries, a significant level of knowledge regarding implementation and performance of treatment wetlands at the expert and scientific level is available. However, transfer into practice is sometimes insufficient due to a lack of awareness and recognition at institutional and administrative levels. Design guidelines usually facilitate implementation of technologies. Country specific or regional design guidelines for treatment wetlands would be thus beneficial in the Danube region.

Technology is not the main issue, the lack of capacity in rural areas for operation, monitoring and maintenance of WWTPs is a critical issue for the implementation of the systems. Monitoring the performance of small WWTPs by authorities is in general much less advanced for small WWTPs in all countries when compared to larger WWTPs. This is mainly caused by the high number of these systems as well as the fact that they are often not easily accessible as they are on private properties. Thus, training of owners and operators of small WWTPs is considered as essential for ensuring proper operation, monitoring and maintenance. Experience shows that trained persons more likely take better care of their WWTP, i.e. they take better care of the required operation, monitoring and maintenance work. In most Danube region countries, the national and local waterworks and wastewater associations would be well placed for offering such training programs (such as the ÖWAV in Austria).

Additionally, specific service models have been shown successful in rural areas. These include wastewater cooperatives in which all users of the services share the common property. Cooperatives are self-determined and self-organised, i.e. within the membership they organise the operation, monitoring and maintenance of the assets. To support these small cooperatives in technical, administrative, legal and other aspects, examples for regional umbrella organisations have been shown to be successful. A precondition of this model is, that cooperatives need to be established as legal entity in the legislation. Another service model could be that larger utilities take care of rural wastewater management, i.e. they are in charge for implantation as well as operation of small WWTPs in a municipality, a specific region or even the whole country.

Rural wastewater management requires external support in terms of investment and operation. Often, this support is provided in the forms of subsidies. However, subsidies are available only for investment costs, generally no subsidies are available for operation, monitoring and maintenance of the plants.

Clear EU and coherent national legislation regarding rural wastewater management would facilitate the development of national action plans and implementation. Financing rural wastewater management is a significant challenge in and for Danube region countries. Thus, financial support would facilitate the implementation of national action plans.

## 6. Conclusions and recommendations

The presentations and discussions during the event suggest the following main conclusions and recommendations for rural wastewater management in the Danube region:

### 1. General

- Although untreated or inappropriately treated wastewater from rural developments is a significant contributor of surface water contamination via point sources, the importance of rural wastewater management is still widely neglected. Small WWTPs play an important role for the overall treatment of wastewater and to improve water quality specifically of small receiving waters and groundwater in rural areas.
- Rural wastewater management is a challenge in most of the countries of the Danube region. A clear policy framework for enabling and supporting rural wastewater management is lacking.
- Most countries in the Danube region are either EU Member States, Candidate, Potential Candidate or associated countries, thus the EU legislation forms a key basis. Further clarity of EU legislations for agglomerations less than 2'000 PE (e.g. definition of agglomeration, use of IAS, adequate treatment levels for IAS) would facilitate coherent action at national level. The currently ongoing revision of the UWWTD should be taken as chance to include clear guidance on rural wastewater management.

### 2. Technologies

- Local communities should be able to operate the systems, i.e. technologies that are simple and robust and that have low operation and maintenance requirements and costs are required.
- However, every technology requires operation, monitoring and maintenance. If a technology is not operated and maintained well, even the simplest technology will fail. Only if operation, monitoring and maintenance is ensured, wastewater treatment systems will function over a long time.
- Experience shows that treatment wetlands - if properly designed, constructed & operated - can achieve the same (if not a better) treatment level as technical solutions. Treatment wetland have lower operation and maintenance requirements compared to technological solutions.
- Design guides for treatment wetlands in the Danube region are lacking and would facilitate their implementation. Although in most countries experience on treatment wetlands is available on expert level, design guides would facilitate increasing acceptance at institutional and administrative levels.

### 3. Implementation

- Financing rural wastewater management poses a significant challenge for Danube region countries. Thus, clear financing strategies and financial support for the countries would facilitate the development and implementation of national action plans to improve access to wastewater treatment and sanitation services of the rural population.
- Regional differences regarding affordability and social aspects need to be considered when developing action plans. For rural communities, financial support is required. Besides investment costs which are often supported in the form of subsidies, also coverage of costs for operation, monitoring and maintenance needs to be considered.



#### 4. Operation, monitoring and maintenance & capacity building

- Operation, monitoring and maintenance of the implemented system has to be planned from the start of a project. This includes the definition of responsibilities for supervision at regional and/or country level.
- Usually subsidies are only available for the implementation of the system. Operation, monitoring and maintenance is never subsidised. A policy framework for enabling and supporting the development of new service models for rural wastewater management, to be supplemented by financing solutions for both investments and operation of systems should be established.
- Experience from other countries can help to develop suitable models for operation, monitoring and maintenance for the Danube region, e.g. wastewater cooperatives with regional umbrella organisations and/or larger utilities that take over the operation and monitoring of small WWTPs.
- For operation, monitoring and maintenance, training of owners/operators is key because the likelihood that the plant is properly operated increases if owners/operators are trained and thus understand why operation, monitoring and maintenance is important. National or regional training facilities showcasing different wastewater treatment technologies and allowing hands-on training of operators should be established. Special tailor-made trainings should also be offered to decision-makers such as community leaders and authorities.

## List of Tables

Table 1: Comparison of main discharge limits for WWTPs < 2'000 PE in selected Danube region countries.....	17
Table 2: Summary on policy-making and sector institutions, service provisions and service coverage for wastewater in Serbia, Bosnia and Herzegovina, Montenegro, Moldova and Ukraine (adapted from Danube Region Strategy, 2016).....	18
Table 3: Technological solutions with at least secondary treatment often used for small WWTPs (schematics taken from the SSWM Toolbox, SSWM, 2021).....	22
Table 4: Treatment wetland main types used for secondary treatment of wastewater (adapted from Dotro et al., 2017).....	23

## List of Figures

Figure 1: Population having neither a bath, nor a shower, nor indoor flushing toilet in their household, by country, 2013 and 2018, countries in the Danube region are marked in green (adapted from Eurostat, 2020).....	9
Figure 2: Share of flush toilet users with indoor toilet, and share of households using a flush toilet in seven countries in the Danube region (World Bank Group, 2018). ....	9
Figure 3: Population connected to at least secondary wastewater treatment, by country, 2012 and 2017; countries in the Danube region are marked in green (adapted from Eurostat, 2020). ....	10
Figure 4: EU Member States in the Danube region (adapted from EC, 2021).....	11
Figure 5: Share of population connected to sewage collection systems of varying treatment levels in the Danube region in 2010, 2012 and 2015 (World Bank Group, 2019). ....	12
Figure 6: Share of compliance with UWWTD Articles 3, 4 and 5 in EU Member States in the DRB (World Bank Group, 2019).....	12
Figure 7: Map of compliance with Article 4 (treatment) of the UWWTD at regional level in 2016; Croatia not subject to compliance due to ongoing transition period until 2023 (adapted from EC, 2020a). ....	13
Figure 8: Wastewater load in PE connected to IAS per EU Member State in 2016, EU Member States in the Danube region are marked in orange (adapted from EC, 2020a).....	15
Figure 9: Potential load assuming IAS correspond to a primary treatment, as a percentage of the total load under full compliance, for BOD <sub>5</sub> , N and P from wastewater, EU Member States in the DRB are marked in orange (adapted from Pistocchi et al., 2019).....	15
Figure 10: Spatial distribution of emissions (in PE) from IAS (left) and improvement of river water quality in terms of BOD <sub>5</sub> if all IAS treat the wastewater according to the UWWTD requirements (right: %-age of increase of river length with good water quality) (Pistocchi et al., 2019).....	16

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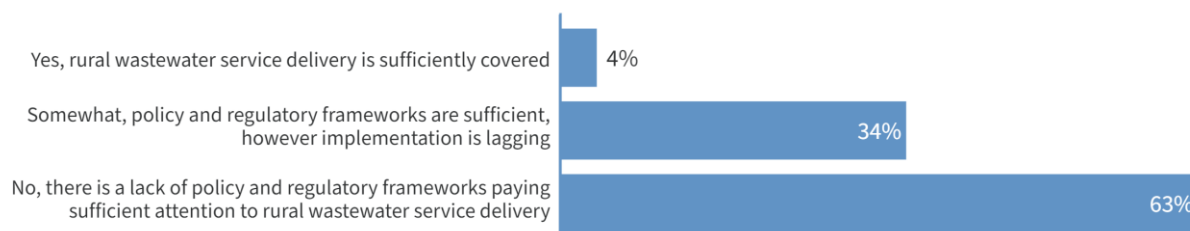
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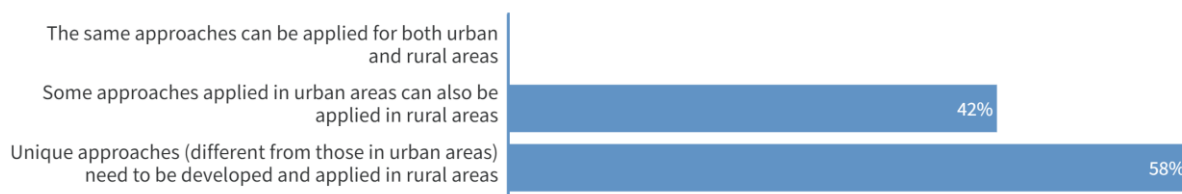
## VI. LIVE POLL AND SURVEY RESULTS

During the opening and closing panels of the workshop, participants were asked to participate in a live poll. The questions and results are shown below.

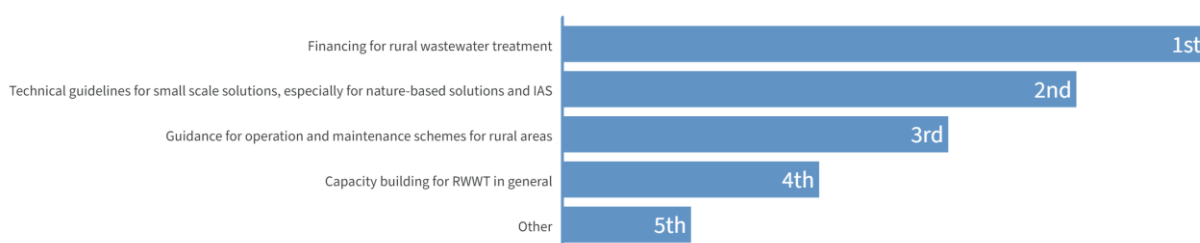
**Do you think that rural wastewater service delivery receives sufficient attention under the existing policy and regulatory framework?**



**To what extent do you think there is a difference in terms of the necessary approaches and solutions for service delivery in rural areas compared to urban areas (policy, regulatory, financial, technical)?**



**Please rank the following potential areas for further support and follow up actions - You can rank by moving answers up and down (priority items at top)**



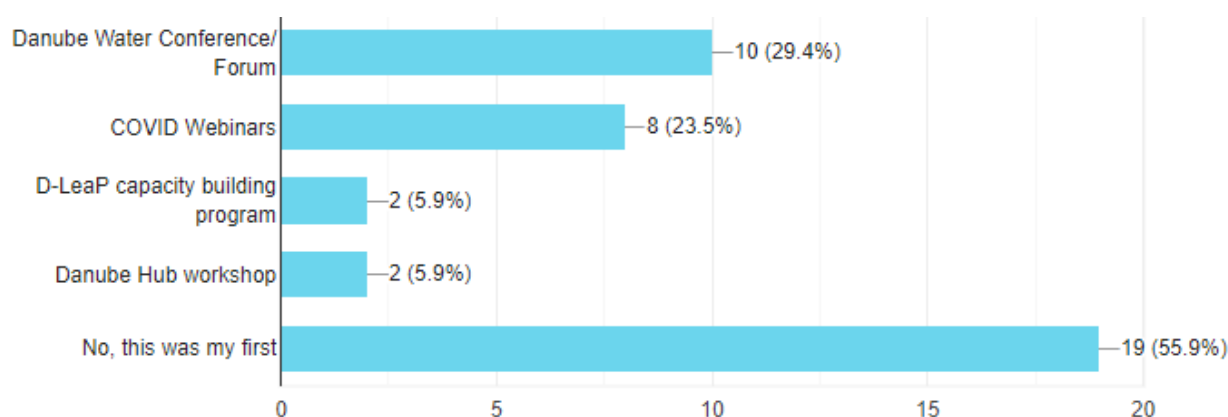
**In 1 word, what are your main take-aways from the event?**



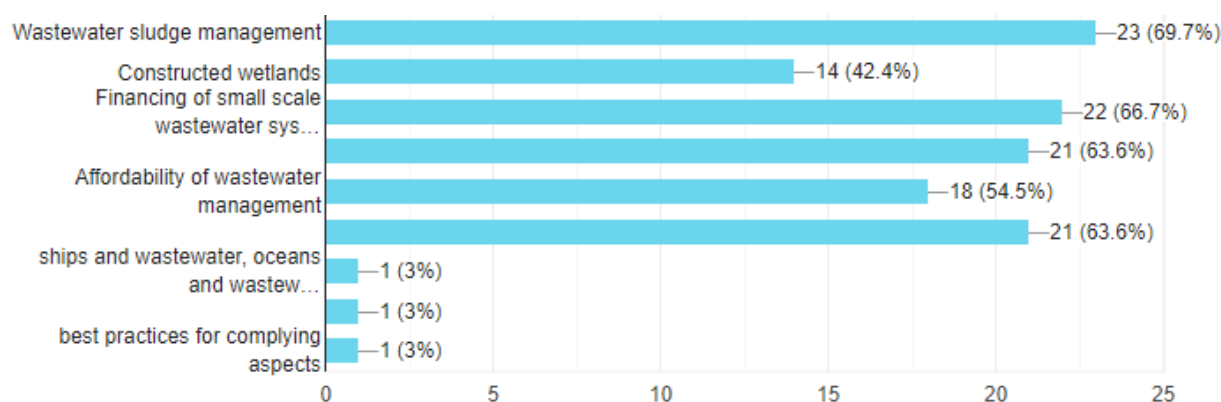
Finally, when asked, **“What other topics should be considered for potential further support and follow-up activities,”** answers were varied, including: Best practices; meter reading techniques; communication and terminology in the context of the UWWTD; small scale industrial waste water; water quality/pollution; sludge management; public relations, communication and education; enabling environment – institutions and legislation; rural integrated water resources management (beyond waste water); nutrient recycling and recovery; management models, technologies, and operation and maintenance; nature based solutions; and financing RWWT.

Results from a post workshop survey, with 34 respondents, revealed the following:

**1. The RWWT Workshop was the first Danube Water Program event attended by the majority of participants (56%).**



**2. When asked “which of the following topics would you like to see covered in future events?”, there appeared to be high demand to cover: (i) wastewater sludge management; (ii) financing of small scale wastewater systems; (iii) wastewater treatment, and water reuse; and (iv) challenges of operating small scale WWTP.**



## VII. Q&A SUMMARY

During the two day workshop, a lively Questions and Answers session took place using the Q&A function of Zoom. While some questions were answered live, several written responses were provided. Some sample questions that arose are provided below.

### Day 1 – January 19, 2021

1. **Isn't the access to sanitation more a problem of water supply? If you have water supply in the household, you are likely to have flush toilet also?**
  - a. You are absolutely right, piped indoor water access is directly related to access to flush toilets in some of the countries in the Danube.
2. **What about the compliance requirements for IAS? It seems it is needed a unitary approach at EU and regional level.**
  - a. IAS are still seen as an exception and connection to a centralized WWTP is favored. Also, the application of IAS (when / which treatment level is required) is not clearly defined. This calls for a better guidance in the EU legislation.
3. **What is the area of agglomeration just the settlement itself or also the surrounding area between agglomerations? Should all the territory of the country be covered by agglomerations or not?**
  - a. No, the idea isn't to define the whole territory as 'Agglomeration' - that' would be excessive - again it is a question of balancing costs vs potential benefits...
  - b. In Austria, an agglomeration acc. to UWWTD has been defined as the catchment of a WWTP
4. **"Centralized is profitable and decentralized is not." Profitable for whom? The users or the operators?**
  - a. We have to find a good balance between centralized and decentralized, that's why we need to discuss the concept of 'Agglomeration'
5. **In most of the countries UWWTP is introduced firstly for large agglomerations than smaller ones. What is your experience, was this good decision, or it should have been done in parallel?**
  - a. In parallel would be the best solution for the environment. Unfortunately, Countries have limited financial resources. Then, prioritization of larger agglomerations seems reasonable to reduce the pollution load as fast as possible.
6. **Why is PE planned to be fixed to ha?**
  - a. We mentioned eh/ha as an example of approaching the 'density' of population - but the metric isn't yet fixed.
7. **What is the EU time schedule for finalization of impact assessment of UWWTD? And the prognosis for changing UWWTD?**
  - a. We intend to finalize the IA this year and come with a proposal in early 2022.
8. **Why is EU against IAS, on what grounds?**
  - a. IAS continues to be part of the solution I would think, not just an "exception"
  - b. EC is not against IAS; however, we want to make sure that those IAS that are used are well functioning, monitored and maintained. Another point to consider is how to incentivize connections where there is already a collection system in place.
9. **When referring to IAS, can you elaborate on the different approaches - for example are there any experiences that you can share related to a hybrid solution of non-collective sanitation facilities for 20 households, as opposed to 20 separate IAS?**

- a. it can be a combination of a small DEWAT (like those mentioned in the presentation of Gunter Langergraber) combined with on-site sanitation solutions at the household level, especially if the density of the village or hamlet is very low; even such DEWAT management and emptying services could all be part of the mandate of the service provider; for example in south Africa (Durban) and Malaysia utilities provide such diverse services (regardless of the technology solution).

**10. IF EU eliminates IAS what are we talking about**

- a. Sorry if I was not clear but it is not our intention to eliminate IAS, they are justified in specific circumstances - we just would like to make sure that they are working as well as possible.
- b. Acc. to my understanding, EU wants IAS to be applied where it makes sense.

**11. Who is in charge in Austria for controlling the small WW plants? And how is assessed the compliance with permits?**

- a. The regional water authorities.

**12. In Austria: do you have financial systems (co-financing) also for individual systems or the costs go completely to the individual user?**

- a. Austria has subsidies

**13. In Austria and other European countries, does the effluent, after individual treatment (old septic tanks) have to be laboratory tested to approve that the treated water is a good quality, and how often? Is that determined in water permit for every IAS? And what about the new individual treatment systems < 50p.e.?**

- a. In AT the effluent of small WWTPs has to be laboratory tested. The requirements are defined in the individual water permit.

**Day 2 – January 20, 2021**

**1. Do you have information for us regarding ground water quality in Serbia (including hygiene aspects)? To which extent is it deteriorated by WW application on soil?**

- a. Absolutely. In most areas of Serbia, we do not have groundwater quality problems traceable to septic tanks. Obviously, you have to consider geology and soils in making the decision. IN RS nitrate is not a problem in any of the delineated water bodies.

**2. The additional significant costs for operation, maintenance, and transport of waste waters from IAS should be taken into consideration. In many cases the cost for IAS is more expensive than centralized systems (depending on density of population)**

- a. Why should you transport treated wastewater for additional treatment? The average cost of emptying sludge is in the region of 150 euros per household annually
- b. We've compared the IAS O&M costs and your comment is only applicable to watertight tanks,
- c. Ok, the conclusion might be that in Serbia it will be used only the IAS with infiltration in soil?
- d. No evidence of widespread impacts on groundwater bodies. In some locations close to settlements > 5000 PE there are localized effects, but overall groundwater body status remains good. Better monitoring is needed to confirm this.
- e. Sounds interesting. But I think, as it is also the question of ground water level, type of soil, humidity of soil, geological conditions between the soil and ground water and the amount of spread water to defined area in defined time (for plants watering f.e. etc.). It is necessary as treated water would not "penetrate" to the ground water directly and immediately. And another warning. Treated WW does not just consist of organic carbons, but some rest of medicaments, hormones are present there etc.
- f. If IAS are more expensive than connection to a centralized WWTP depends on the local situation.

3. **A good point: technology is not a problem. The management is area where we need to focus. What does it tell us? Reality is that water managers feel more comfortable to address technologies. Management is outside of their comfort zone.**
  - a. You are absolutely right. This is what needs to change and legal framework to enable the change has to be provided.
4. **With this cooperative method in Austria, do you have water loss and how do you manage this. What is the appropriate percentage of loss per year?**
  - a. The cooperatives, like also communities and companies, have to check the sewers every 5 years, the very small every 10 years by an external company.
5. **Why do you treat proper septic tanks with 2 to 3 months retention as primary treatment only? Surely in 3 months there are some anaerobic effects with denitrification taking place and organics being degraded by anaerobic processes**
  - a. Stand-alone septic tanks do not reach the level of treatment usually required to be classified as secondary treatment (I know there are several definitions for secondary treatment, I am using the one used e.g. in Austria).
6. **Interesting to see 0 violations above thresholds for soil systems as and SBRs which is not the case with other systems. Can you comment?**
  - a. Zero violations have been by soil filters and MBR (not SBR). "Soil filtration" systems are actually similar to sand filters; however, it is a closed system without infiltration in the subsurface. I did not mention specifically because of the low number and thus this maybe not so representative.
7. **Are there pilots/case studies for source separation in such small agglomerations in Austria?**
  - a. Actually, only very few, e.g. separate collection of grey water and reuse the treated greywater with rainwater can be found, very few examples of solution with urine separation.
8. **I saw that you treat (old) septic tanks as a primary treatment?**
  - a. Stand-alone septic tanks do not reach the level of treatment usually required to be classified as secondary treatment (I know there are several definitions for secondary treatment, I am using the one we use e.g. in Austria)
9. **Regarding wetland treatment, what is your experience in regard to capacity degradation in relation to the environmental temperature? Is this technology applicable in the areas where winter temperatures drop below -15°C?**
  - a. The largest TW for treating wastewater as a main-stage is in Moldova (very low temperatures in winter) and has design capacity of 20'000 PE"
  - b. Yes, for use, the plants + snow cover provides an excellent insulation layer for operation in winter.
10. **Why don't we talk about using biogas plants and algae technology in secondary wastewater treatment?**
  - a. High rate algae ponds can also provide secondary treatment but are not so robust as treatment wetlands plus more skilled workers for maintenance are needed. On the other hand, they produce algae biomass which is interesting for reuse.
  - b. UASBR and anaerobic/facultative/maturation ponds could also be discussed
11. **A comment on CWs. I worked in an accredited lab as a sampler and I have seen many CWs and many other types of WWTPs. Currently I maintain 9 WWTPs (trickling filters, MBBR, SBR, rotating biodisks, etc.). Each with its own problems and challenges, but all have something in common that affects them: suspended solids in the inflow. And this is the most important thing for CW, but many times underestimated. Without good solids separation before biological stage, you can forget good performance, especially for CW.**



- a. Especially for horizontal flow CW which are sensitive to TSS. Therefore, proper design and maintenance are crucial. Vertical flow CW with intermitted loadings are less sensitive to TSS.
- b. Exactly. The only time I saw problems with CW was because of bad maintenance of primary settling tank
- c. Emptying the primary sludge is the most important O&M activity for both HF and VF wetlands