WORKSHOP ON SEWAGE SLUDGE MANAGEMENT IN THE DANUBE REGION FOR A GREENER EU

WORKSHOP REPORT

August 2021

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1. Summary workshop data

Workshop title:	Workshop on Sewage Sludge Management in the Danube Region for a Greener EU – an EU Green Week Partner Event
Date:	10 June 2021
Venue:	online space
Organising body:	EU Strategy for the Danube Region, Priority Area 4 – Water quality
Partners:	
	International Commission for the Protection of the Danube River (ICPDR)
	International Sava River Basin Commission (ISRBC)
	Danube Water Programme (DWP) – World Bank
	Danube Strategy Point (DSP)
Number of registrations:	103
Number of participants:	84
Number of presentations:	13

2. Executive summary

Recognizing the development of waste water treatment in the Danube Region and consequently the growing need for sewage sludge treatment and recovery, the EU Strategy for the Danube Region, Priority Area Water Quality (EUSDR PA4), supported by the Hungarian Ministry of Foreign Affairs and Trade initiated in 2020 the elaboration of a preparatory study on sewage sludge treatment and recovery in the Danube Region. The study was carried out by TRENECON Consulting and Planning Ltd, finalized in March 2021 and its content was consulted with countries of the Danube Region within the framework of the Steering Group of EUSDR PA4. In the study, an overview is provided on the information available on the Danube countries' sludge management, the best practices and difficulties and the study provides recommendations for future steps to be taken.

In light of the conclusions from the above sludge management study, the EUSDR Priority Area Water Quality with cooperation of the International Commission of the Protection of the Danube River (ICPDR), the Danube Water Programme (DWP) and the International Sava River Basin Commission (ISRBC) organised a stakeholder workshop on Sludge management in the Danube Region for a greener EU on 10 June 2021 with the assistance of the Danube Strategy Point (DSP) providing operational support, ensuring visibility of the forum and adding to professional quality of panel discussions and presentations. The workshop was organized as a Green Week Partner Event.

The EU Green Week as the largest annual environmental event organised by the Directorate General for Environment dedicated to zero pollution set the framework for this partner event on sewage sludge management. The international workshop on sewage sludge management organised by EUSDR PA4 in the virtual space was attended by over 80 experts, registered from 17 countries: representatives of national and international bodies and policy makers from a wide range of countries including non-Danube Basin countries as well. The workshop is considered a stage of the initiation aiming at discussing sludge management issues in the Danube Region and sharing practices, understanding potentials, which was started with the elaboration of a study on sewage sludge treatment and recovery in the Danube Region.

The main objective of the event was to initiate meaningful discussions on the issues and potentials of sewage sludge management in the Danube Region. The state-of-play, technology and policy aspects, future potentials, including, among others, the issues of treatment, pollution control, agricultural application, energy source were addressed with a view to promoting sustainability, establishment of the circular economy.

The workshop was organised around 5 sessions starting with welcoming notes from the EUSDR PA4 HU coordinator and the international partners, WB, ICPDR and ISRBC. During the sessions participants could get an overview of the current state of wastewater, sewage sludge management in the Danube Region, various policy approaches, technology solutions and best practices in terms of treatment and use of sludge. The keynote speech

was delivered by two representatives of DG Environment on the ongoing revision of relevant EU directives.

Altogether 13 presentations inviting considerable interest were delivered. National water agencies representatives presented the legal environment and regulatory issues in their respective countries while technology companies introduced successful projects and results ranging from producing biomethane to nutrient recovery. Each session was concluded either with an audience poll or a discussion panel to share ideas and draw conclusions. Participants were very actively involved in the discussions, readily identified preferences or priorities, and share their views at the roundtable discussion on legislation. Key messages to policy makers were identified with the active involvement of the attendees.

The workshop came quite timely due to the ongoing public consultation related to sewage sludge. It proved that the issue of sludge is specifically important as it has high energy content and contains several materials, notably phosphorus, that are important input materials for the chemical industry and agriculture. It is truly relevant considering the European Green Deal. The presenters showed that the situation related to sewage sludge management is varying across the Danube Region. In some countries advanced waste water treatment and sludge management practices exist while in others still the establishment of the waste water treatment facilities is the main challenge. The discussion shall continue in the upcoming period, as key messages for policy makers were identified:

Key messages:

- Expanding wastewater treatment in Danube region results in ever increasing sludge volumes which represents a serious challenge for utility sector and industry.
- Not only the volumes are growing considerably but the pollutant content of sludge is an issue to be addressed; source control is encouraged for the circular economy and to avoid cross-media pollution.
- Availability of data on sludge production, national or regional alike remain an issue, with data often outdated and not reliable. Data gaps are particularly serious when it comes to pollutants presence in sludge, sludge quantities and sludge treatment methods.
- Sludge management solutions applied drastically differ across countries ranging from use in agriculture to incineration depending on technology advancement, general perception, legal framework, etc.
- It is acknowledged that there is no tailor-made solution, but a mix of treatment solutions can be the most appropriate aligned with national, local particularities.
- The acceptance of different treatment technologies by stakeholders and the public is a key which require a common understanding on how we consider sludge and technological improvement in addition to ongoing communication.
- Better integration of regulations, policies on waste, water and sludge management in line with the green deal initiative could result in a more efficient legislation promoting achievement of common goals. A revision/update of EU Sewage Sludge Directive could play an important part in achieving this objective.
- A common understanding of sludge as a product/resource that has its role in circular economy should be adopted to tackle the complex challenges of sludge management in holistic manner.

- Better coordination, cooperation of responsible authorities and relevant stakeholders are prerequisites of efficient and responsible sludge management. Knowledge sharing, exchange of information, and transboundary co-operations could promote positive approach to sludge issue and help with technology advancement.
- With technologies getting more and more sophisticated and improvement driven by costly innovation, the social aspects and service affordability should be taken into consideration.

It has been concluded that there was a strong need for further strengthening the regulations related to sludge management at EU level to ensure safe use of sludge and to minimize disposal. It was pointed out that discussion with policy makers is imperative to exploit full potential of sludge management for the circular economy by creating a favourable legal environment and getting to a common understanding by setting an approved direction in sludge management. Pollution control at source has been considered as a key issue by most of the participants.

3. Objectives and organizing partners

Objectives

The general aim of the workshop was to discuss the situation of sewage sludge management in the Danube Region. Specifically, the workshop was planned to start and facilitate discussion on sewage sludge management in the Danube Region and pave the way towards more in-depth policy and technological dialogue on this issue.

Primary target group for the event: national sewage sludge experts and interested stakeholders in the Danube Region and in Europe, policy makers, water and sludge managers and thematic coordinators.

Organizing partners

The workshop was organised by the following institutions:

- **EU Strategy for the Danube Region, Priority Area 4 – Water quality**
  https://waterquality.danube-region.eu/
- **International Commission for the Protection of the Danube River (ICPDR)**
  www.icpdr.org
- **International Sava River Basin Commission (ISRBC)**
  https://www.savacommission.org/
- **World Bank Danube Water Programme (DWP)**
  https://www.danube-water-program.org/

Technical assistance to the workshop: Danube Strategy Point (DSP)
https://danube-region.eu/contact/danube-strategy-point/

4. Preceding activities

The sewage sludge preparatory study

Recognizing the significance of the issue of sludge management, the EU Strategy for the Danube Region, Priority Area 4 (EUSDR PA4 – to restore and maintain the quality of waters) initiated the elaboration of a preparatory study to on sewage sludge treatment and recovery in the Danube Region.

The study concluded that there is a clear difference between the upstream, central and downstream countries along the Danube: in the highly developed upstream areas sewage system coverage is at reasonable level, treatment produces large quantities of sludge; in the central region waste water treatment has been developed steadily over the last decade, and sludge quantities have grown; and in the downstream countries waste water treatment recently gained impetus. Financial feasibility related to waste water and sludge management in areas with small and scattered settlements remains an issue in the central and downstream countries.

The quality of sludge also changed in parallel to the advancement of sewage system. New materials occur in sludge in growing quantities that are those of growing concern, namely micropollutants, plastics and pharmaceuticals. These compounds are not monitored regularly and put burden on the further recovery of the various sludge products.

At the same time many central and downstream countries of the Danube Region use treated and composted sludge in their agricultural sectors.

The quantity of sludge slowly increases in the upstream countries due to the increasing water use and the further development of sewerage systems. In the downstream countries, at the same time, the quantity of sludge increases rapidly as new sewage systems are installed in large agglomerations. Sludge management of the downstream countries is at its early phase. The growing pollution level of sludge is receiving growing attention and environmental standards are becoming stricter.

The sewage and sludge management of small settlements, especially those with scattered spatial distribution, is receiving growing attention. Policy or legislative documents are available in a number of countries, their orientation and detailedness greatly differ.
Specific, Danube Basin oriented forecasts for sludge production and planned management methods do not exist. The lack of such forecasts suggests that there is a considerable knowledge gap on the Danube Region level.

The current workshop was based on the findings of the preparatory study.

For more details on the initiation of the workshop see Annex 1: Concept Note

Related activities of the partner organisations

International Commission for the Protection of the Danube River (ICPDR)

ICPDR has coordinated several activities and managed various projects on water quality and wastewater management since its establishment. As the international organisation being in charge of transboundary water management, ICPDR develops River Basin Management Plans for the Danube River Basin, in which wastewater management has received primary attention. The organisation also managed targeted wastewater management activities, partly within the framework of its current wastewater initiative focusing on capacity building events. Recently ICPDR has co-organised a workshop on rural wastewater management in partnership with the World Bank. ICPDR is currently developing a recommendation paper on wastewater management.

International Sava River Basin Commission (ISRBC)

The activities of the ISRBC also cover a wide range of activities among which the preparation of the River Basin Management Plan is of primarily importance. The document gives a comprehensive picture on waste water management of the region, as the insufficient waste water treatment is the largest polluter of waters in large areas of the Sava basin.

Danube Water Programme (DWP)

The DWP focuses on the development of water service provision; thus waste water treatment and sewage management are obviously in the forefront of its activities. The programme is a joint effort of World Bank and IAWD has run several years now and provides assistance to water utility sector in the region in the wide range of topics with objective to achieve better and more efficient provision of water related services in the southeaster European region.

5. Setting and participants

Workshop settings

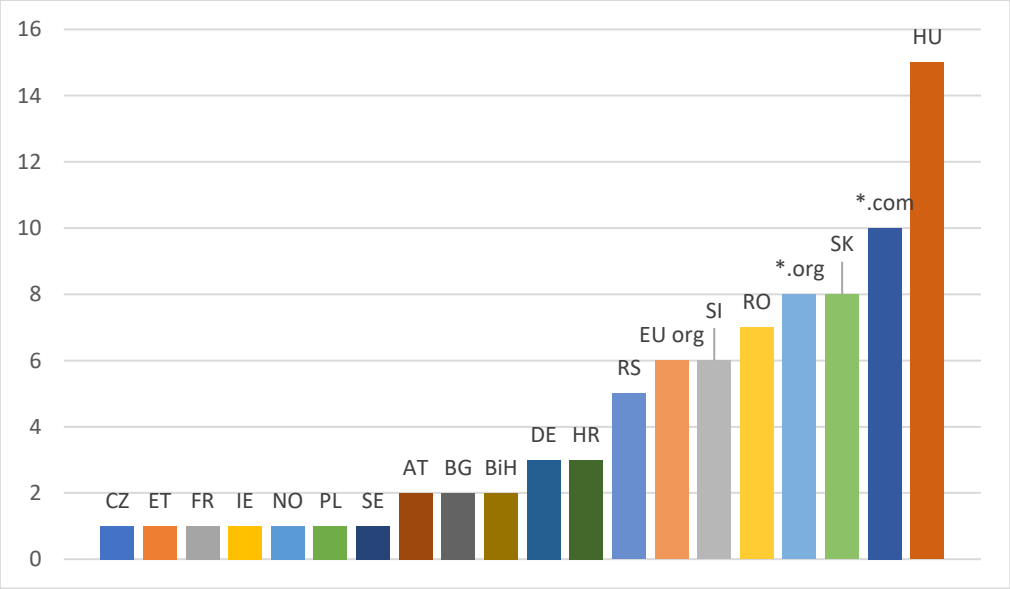
The workshop was organised in the virtual space due to the pandemic situation. The technical background was provided by the Danube Strategy Point. The workshop was organised through the Zoom software.

Participants

The total number of participants was 84, and there were 103 registrations after the call (81% of the registered participated) from 17 countries. The participants covered all the Danube Basin countries except for Ukraine and Moldova. Besides the Danube Basin countries, invited speakers from many other European countries, such as Ireland, Norway, Spain, Sweden, participated, and a number of participants arrived from non-Danube Basin countries as well, (e.g. Lithuania and Albania). Hungary and Slovakia (the co-ordinating countries of the Priority Area) were represented in the largest number including national water management bodies, the line ministries, educational organisations, and enterprises.

Besides the representatives of national bodies working for better water management international organisations also participated, such has the European Investment Bank (EIB), World Bank (WB), Global Water Partnership – Central and Eastern Europe (GWP-CEE).

The below figure shows the breakdown of participants according to their country of origin/organisation as indicated in their email attributes.



1. Figure: Number of participants per country of origin / organisation

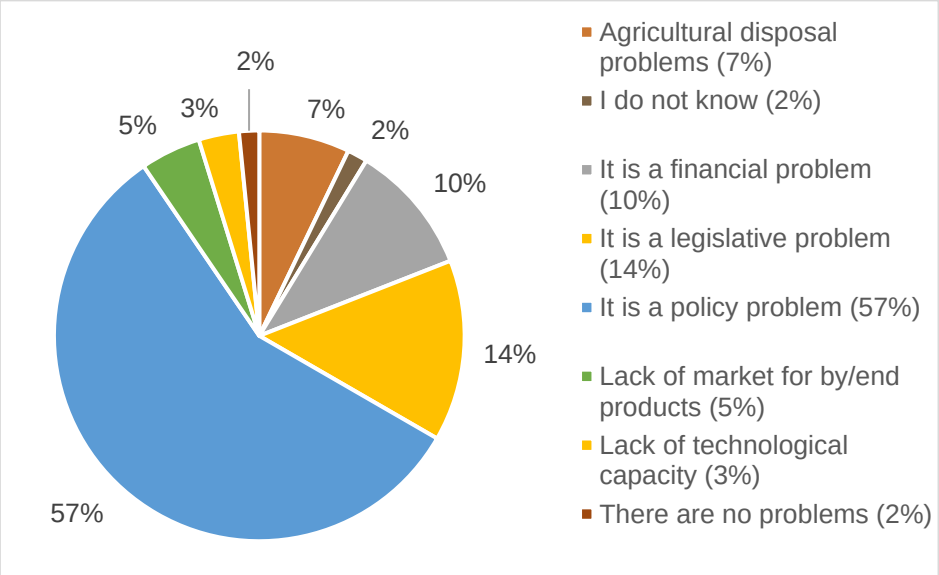
Note: “*.com” and “*.org” stand for the email address attributes as in “gmail.com” or as in those of international organisations such as “icpdr.org” thus the nationality of participants registering with such addresses cannot be defined.

6. Presentations and discussions

Session 1: Welcome Notes

Organizing partners, EUSDR PA4, World Bank, ICPDR and Sava Commission welcomed the participants and outlined reasons for organizing the workshop and their main expectations.

Audience Poll question: What is the main problem related to sewage sludge management in your country? **It is a policy problem: 57%**



2. Figure: Relevance of sewage sludge management problems

Session 2: Setting the Scene

Keynote speech 1: Evaluation of Sewage Sludge Directive

Sylvie Grajales, European Commission – DG Environment

The overall objective of Directive 86/278/EEC is to encourage the correct use of sewage sludge in agriculture and regulate its use in order to prevent harmful effects on soil, vegetation, animals and humans. It sets the rules of use including sampling, analysis and recording to ensure nutrient requirements and to maintain quality of soil and water. The presentation highlighted the political, strategic context, interrelations with the European

Green Deal as the framework. Participants got an insight of sewage sludge re-use by member states or destination for comparison. It was concluded based on 2014 evaluation of the directive that the SSD was effective in achieving the objectives, induced technical development and discourage disposal. On the other hand, it failed to fully match the EU circular economy ambitions, it falls behind the expectations in terms of regulation of pollutants in sludge or coherence with Urban Wastewater Treatment Directive. The presentation concluded that on-going evaluation of the SSD is needed through standard criteria and with stakeholder consultations. An evaluation report is foreseen in the spring 2022 that lays the ground for future impact assessment and a legislative proposal.

Keynote speech 2: Revision of the Urban Waste Water Treatment Directive

Nele Rosenstock, European Commission – DG Environment

First the approach to the impact assessment was presented to the participants stressing the need for stakeholder consultations. The 2016 and full-compliance status were considered the baselines and data collection included information from member states and literature review supplemented with modelling assumptions. The analysis used quantification and modelling by JRC. It has been revealed that the main problems encompass the unused potential of resource recovery, relatively high contribution to GHG emissions, energy use, while there is unused production potential too. For resource recovery, a number of policy measures with the objective of integration into circular economy shall be introduced. Also, energy and climate neutrality of the sector can be achieved through a combination of policy measures. To this end a roadmap was defined and conference with DE as well as technical workshops held in 2020, while public consultations are ongoing, and efforts will be concluded with a stakeholder conference in October 2021. The presenter highlighted that stakeholder views, including of the Danube countries are welcomed in the frame of ongoing open public consultation.

Presentation 1: Wastewater management in the Danube River Basin

Ádám Kovács, ICPDR

The International Commission for the Protection of the Danube River (ICPDR) is a transboundary organization coordinating water management in the Danube River Basin (DRB) including wastewater management issues. Thanks to the massive investments of the Danube countries in the wastewater infrastructure, the organic, nutrient and hazardous substance emissions of surface waters stemming from agglomerations have considerably been reduced in the Danube River Basin since 2005, along with an increasing sludge production. There has been a shift to more advanced technologies in many countries, Danube states invested in the wastewater sector a total of ca. 40 billion EUR by 2016. The treatment level varies greatly from country to country, 75% (65 million PE) is provided with adequate treatment while basic infrastructural development and nutrient removal is required for 9,5 million and 11.5 million PE, respectively. The estimated total investment costs that are still required to achieve the targeted level of urban wastewater treatment by 2040 amount to 57 billion EUR. In addition, a range of issues also needs to be addressed especially in new and non-EU member states, including capacity building, appropriate regulatory conditions, ensuring operational costs, water pricing or restructuring water sector. In the old EU member states maintenance of the existing infrastructure and addressing emerging issues (e.g. sludge, emerging substances) are of high importance. The ICPDR helps Danube countries in their efforts towards achieving sustainable

wastewater management by supporting capacity building programs and releasing a recommendation paper on wastewater management.

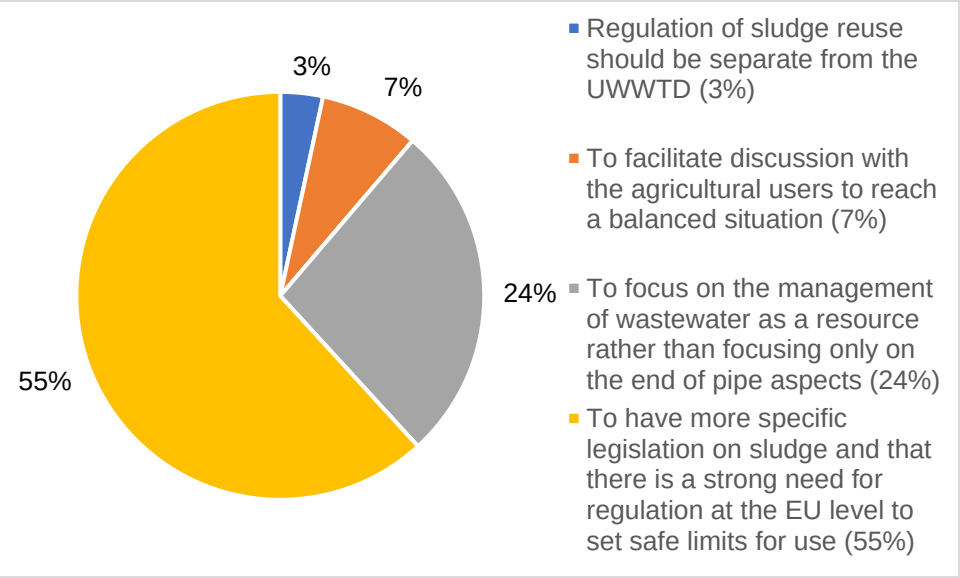
Presentation 2: Preparatory study on sewage sludge management in the Danube region

Attila Fürstand, Trenecon Kft.

The study initiated by PA4 of the EU Strategy of the Danube Region was conducted by the Trenecon Consulting and Planning Ltd. The study aimed at the foundation of discussion on communal and agricultural sewage sludge management in the Danube Region, specifically focusing on whether it is possible to develop a common strategy for sludge management on the Danube Region level. It was concluded in the study, and presented at the workshop, that there are considerable problems and changes in relation to sludge management as well as sound policy formulation both national and international level. Firstly, it was highlighted that there fundamental changes going on European policy level regarding sludge management in relation to the Green Deal and the ongoing reform of various directives. Secondly, the data available on international level on sludge management are unsuitable for sound policy formulation, and thirdly, the differing social economic and environmental assets of the Danube Region call for different solutions for sludge management. It was concluded that although a common vision is possible to be developed on the Danube Basin level, specific actions can be defined only after the improvement of data reliability and detailedness, the establishment of the related EU policies and directives and considering the fundamentally differing socio-economic environments of the Danube Basin countries.

Audience Poll question: What would be your key messages to policy makers? What would you consider important? (multiply answers possible)

To have more specific legislation on sludge: 55%



3. Figure: Support of selected key messages for policy makers

Session 3: Policy

Presentation 1: Legislation and experience in Germany

Andrea Roskosch, Wastewater Technology Research

Historical figures of sewage sludge disposal in Germany show a considerable increase of thermal use and a steadily decreasing agricultural use. Today, some 75% of sewage sludge is incinerated in Germany. Introduced in 2017, the new German sewage sludge ordinance set some new limit values, imposes restrictions and requirements with regard to the use of sewage sludge in agriculture, landscaping, forests and gardens and provides for P-recycling, recovery in treatment and recovery technology. Depending on population equivalent values the possibility of agricultural use will be limited and P-recovery is regulated with different time horizons. However, P-recycling is mandatory for economic and ecology considerations when phosphorous content of sludge exceeds 2% of dry mass and also to reduce soil contamination. The statutory framework in coherence with the fertilizer law requires application of different technologies to recover phosphorous and to produce P-products in wastewater treatment or sewage sludge treatment. In comparison, while WWT plant is cost effective, thermal sewage sludge treatment destroys all organic material offers better P-recovery. Therefore, promotion of P-recovery and encouraging acceptance of P-recovery products and installation of incineration plants to ensure sewage sludge treatment, and potential ban on agricultural use are some actions to be considered.

Presentation 2: Legislation and experience in Slovakia

Katarína Kozáková, Water Research Institute

Earlier sewage sludge could be directly applied to soil, however, Act No 188/2003 produced a shift in favour of composting (some 60% was composted) and since 2015 no sludge has been applied directly to soil. The fertilizer Act No. 136/2000 regulates the production and application of composts. Since 2014 the share of composted sludge reduced to about 50% as energy recovery got into the forefront. The composition of sewage sludge application changed considerably over the past decade. Annually, an average of 22% of sludge is used for energy recovery regulated by Act no. 79/2015 on waste and Act No. 39/2013 on integrated prevention and control of environmental pollution. The same legislation applies to landfilling of sludge (5% of the annual production). Sludge can also be used in recultivation, as a landfill cover layer amounting to 12-18% in the last 5 years. It is claimed that all application methods are duly regulated in Slovakia with the exception of a group of thermal methods like pyrolysis, wet oxidation or gasification.

Presentation 3: Challenges of the sludge management in Romania

Georghe Constantin, Ministry of Environment, Waters and Forests

Disposal, incineration, storage, use of wastewater and sewage sludge are regulated by several government decisions and ministerial orders in Romania. Provisions are aimed among others to reduce negative environmental impacts, in particular pollution of air, soil, surface and groundwaters. Sludge can be used for remediation, rehabilitation of polluted sites provided hazardous material content is under specified threshold values. Similarly, application of sludge to agricultural land the concentration of heavy metals needs to be analysed and monitored. To regulate agricultural use of sludge an act is being drafted. It

sets the obligations of both producers and users of sewage sludge as well as defines the tasks of the competent authorities and sanctions to be applied in case of no-compliance. The draft law regulates transport of sludge in closed tanks, requires monitoring of affected land, and provides for restrictive conditions regarding chemical materials, pathogens. The national strategy for sludge management – finalized in 2013 but never officially approved – calls for improving the institutional and reporting system and providing guidance to sludge producers and users. It is claimed the main challenge of sludge management is the increasing volume of sewage sludge in urban wastewater treatment plants versus the reduced possibilities of disposal or co-incineration and resistance to its use in agriculture or forestry.

Presentation 4: Legislation and experience in Sweden

Agneta Thor Leander, VA SYD Water & Wastewater Regional Association

The Swedish experience was showcased to demonstrate an example from the Baltic Region: In Sweden there is a strong commitment to make use of the resources, nutrients in wastewater or sewage sludge. The priority endeavor is prevention, control at source which is considered the basis for circular economy. Recycling of organic matter and nutrients on farmland (i.e. agricultural use) amounts to 39% of total sludge produced, 60% is for land reclamation and only 1% is incinerated – disposal is not allowed in Sweden. Agricultural use is encouraged and supported by the REVAQ certification system designed to regulate the application of wastewater sludge for sustainable agriculture. This ensures reintroduction of nutrients to land in compliance with environmental regulations. The system was developed with the involvement of the Federation of Swedish Farmers, Swedish Food Federation, Swedish EPA, and the Water & Wastewater Association. Now 50% of the population is served by REVAQ certified VVTPs. The certification system sets strict “product” criteria for plants certified, gives guidelines for improvement with respect to components, metals, ensures reliable information on composition to stakeholders, traceability in GIS maps. Mapping, monitoring and reduction of organic substances, metals via control at source are considered prerequisites of long-term sustainability.

Policy roundtable discussion after Session 3

A roundtable discussion on legislation efforts, issues and different national challenges concluded Session 3 moderated by Mr. Balázs Horváth. Speakers from Slovenia, Romania, the EU and World Bank expressed their thoughts on general approach to sludge management, regulatory framework and concerns to be tackled.

In Slovenia, legal harmonisation in general has been implemented since accession, while the regulatory framework of sludge management still needs be developed and the relevant national strategy is lacking. Sludge is currently exported, however P recovery and mono-incineration of sludge are considered to be desirable. In Romania, there are concerns of using sludge, and strict regulations are in place to prevent pollutants, pathogens from getting into the environment. On the other hand, it is also excepted, that sludge can be considered a product or a source of nutrients, P that should be recovered. Incineration of sludge raises concerns of air-pollution. In fact, a clear approach across the Danube Region would be needed to identify the preferred option to treat or use sludge. The fundamental ambition of the EU (DG ENV) in harmony with the initiative of circular economy is to prevent waste at source, avoid pollution of any kind achieving zero pollution at the end of the chain. It is a tricky issue whether to consider sludge a waste or source, so prioritising waste stream

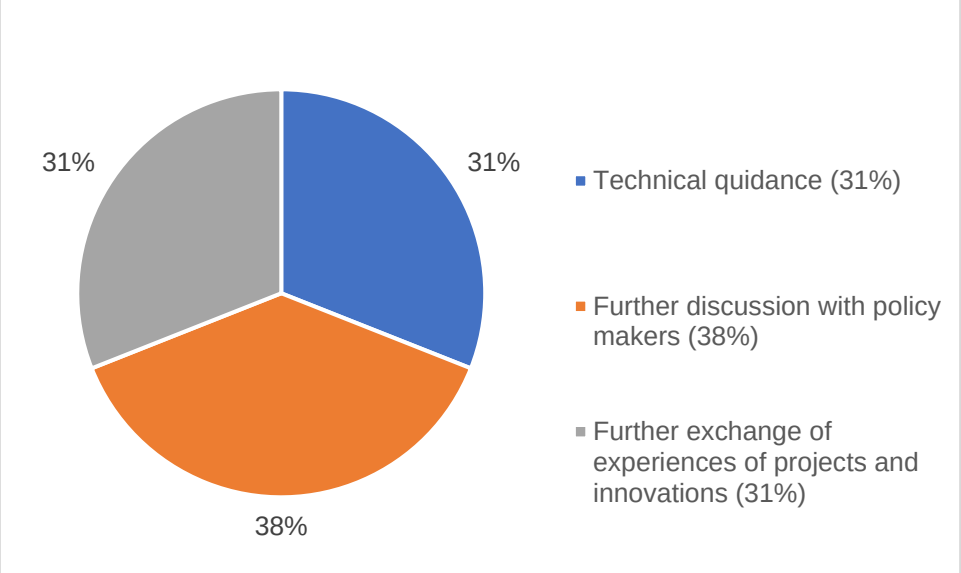
across the EU is a challenge that need be addressed. It is agreed that the level of advancement of wastewater, sludge treatment legislation and practices vary greatly, and sludge management strategies are so different from country to country (ranging from complete banning to spreading sludge on agricultural land) that in revising the sludge directive there is need for substantial input which is to be achieved in the course of impact assessment. Also, sludge management, application of sludge is a very complex issue where the big picture including energy efficiency, GHG emission, effects on food, agricultural production shall be considered when revising the directive, working on legal alignment. Similar concerns were emphasised by the speaker from the World Bank, stressing lack of common approach across the EU regarding sludge management, and clear lack of integration between wastewater treatment and sludge treatment in terms of legal framework and technology wise. It was pointed out that a streamlined approach for safety among others shall be adopted. It is a major concern looking at the complexity of the issue that no generally accepted direction can be identified, approaches are very diverse. On the other hand, technically wastewater treatment cannot be separated from sludge management, so in legislation the obvious interrelations need to be addressed and understood.

In terms of resource recovery, one must be aware of the costs i.e., using sludge for energy or P recovery cannot be competitive. Unless a very efficient technology is developed, the costs far exceed the gains and shall be borne by users, taxpayers. Affordability is an issue, and it is a growing concern of the poorer part of the population that need to be supported by setting up some kind of social support scheme. Adding to that, introduction of innovative technology, new investments necessarily increase costs. It is admitted also, that today investments in wastewater/sludge treatment are high and direct benefits are relatively low.

Participants agreed that lack of data and poor reliability of information at national level constitute difficulties in adopting a common approach, developing fitting legislation with the ultimate goal of protecting human health and the environment. Acceptability of sludge as a product or source by the public can only be strengthened if data on quantities and content (nutrients and pollutants, pathogens residues alike) are available and authentically support application of sludge. The complexity, the interrelation of problems and national differences raise the questions: can sludge management commonly regulated at EU level, and can or should it be covered separately by a single directive? In fact, clear separation of relevant responsibilities, scopes of authority is a challenge in most countries.

Audience Poll question: Please indicate which of the following potential areas should be tackled first for follow up actions.

Further exchange of experiences: 38%



4. Figure: Support of selected follow-up actions

Session 4: Technology & Best Practices

Keynote speech: Mitigation of hazardous substances in sewage sludge: SLUDGEFFECT project

Hans Peter H. Arp, Norwegian Geotechnical Institute, Norwegian University of Science and Technology

The technology keynote presentation pointed to that comparison of sludge management in Norway with that in the EU reveals that the ratio of sludge applied in agriculture is considerably higher in Norway accounting for 82% as opposed to 50% in the EU while a mere 1% is incinerated which is a fraction of the EU value (28%). Mono-incineration and co-combustion have been increasing in many countries (Germany targeting 70%) while other thermal treatments are rarely applied (pyrolysis, gasification). The SLUDGEFFECT research and innovation project aimed at developing ways to reduce hazardous substances of sewage sludge and harmful presence of e-waste plastic for achieving circular economy. It is a novel research conducted by an interdisciplinary team of researchers in collaboration with a wide range of stakeholders in Norway on how thermal treatments can be optimized for removing hazardous substances in sludge and e-waste plastic while producing useful raw materials. The presentation gave an overview of contaminants' different reactions to sludge incineration. Work packages of the project, stages and specific objectives of research work are presented in a flow-chart. It is investigated how incineration, dry pyrolysis and HTC can remove selected substances and it is claimed that a consistent framework for life cycle, sustainability analysis shall be established. Results are integrated with user feedback to support implementation in a circular economy. It is a mission of the project to predict the impacts (chemical risk and LCA) of shifting to thermal treatments in Norway and how to get zero chemical pollution and climate emissions. There are different views of the future of thermal treatment of sludge (incineration or pyrolysis), however it is concluded that

the best solution is local depending on contaminants in the sludge and new thermal technologies can bring benefits. The most important in sludge management is the control at source, preventing pollution. It is also claimed that biosolids (pyrolyzed biosolids) have a role in agriculture and land reclamation and also incineration or co-combustions in many cases is the best option.

Presentation 1: VALUE: Waste to Value for small/medium WWTP's
András Deli, UTB Envirotec Zrt.

The Hungarian company offering wastewater technologies and organic waste solutions developed a sludge treatment process and facility with a compact design to overcome current problems of extensive sludge disposal, like high costs, CO2 footprint, WWTP capacity and to turn sludge into valuable materials. Under the project, partly funded from GINOP, an operational plant was commissioned at the North-Pest WWTP in Budapest, where the carefully controlled Aerotherm process with membrane filtration produces readily biodegradable C-source (VFA) and liquid fertilizer (NPK) from the thickened sludge. In addition, the output sludge quantity to be dewatered and disposed is largely reduced. The production balance proves that value is created, costs are saved which explains that the next plant is planned to be installed soon in Kecskemét at the city's WWTP.

Presentation 2: Sewage sludge in agriculture – an Irish perspective
Aoife Kyne, Irish Water (UISCE)

The Sewage Sludge Directive has been transposed into Irish law. Beyond respective regulations and strategies, there is a Code of Good Practice for use of biosolids in agriculture that sets the required parameters for analysis prior to use. Certificates of biosolids are issued accordingly and the producer is required to provide a full nutrient management plan taking into account soil testing results, crop type and any changes. The overview of Ireland's wastewater asset base reveal that there is a large number of small WWTPs, while 50% of wastewater sludge is generated at 11 WWTP with over 50 000 PE. It is claimed that centralized treatment required for efficient resource recovery in the future when quantities are expected to increase. The primary methods of wastewater sludge treatment are introduced with thermal drying delivering biosolids accounting for close to 40% and line stabilization having a share of 36.1%. Other types of treatment methods are used less extensively. Approximately 98% of wastewater sludge produced by Irish Water is currently goes to land. There is pressure on sludge agricultural outlets due to food industry quality assurance schemes and facility upgrades to increase energy recovery and reduce sludge quantities is a challenge in sludge management too. Groundwater vulnerability and soil metal levels restrict land spreading. The National Wastewater Sludge Management Plan urge stakeholders to establish cost effective and efficient treatment and sustainable reuse methods, to extract energy and other resources from sludge and to maximize the benefits of wastewater sludge as a soil conditioner. Challenges like negative perception, potential change in legislation were also addressed. In this context the role of sludge hubs and satellite dewatering centers of Irish Water were emphasized as they produce stable biosolid free of any harmful bacteria. Irish Water are investigating the option to develop a quality control assured biosolids scheme that integrates legislative requirements, transparency, sustainability, safety aspects.

Presentation 3: Nutrient recovery from sludge in Austria

Lukas Egle, City of Vienna

A summary of sewage sludge production was given which revealed that sewage sludge contains 40-50% of applied P as mineral fertilizers and currently 53% of sludge underwent to thermal treatment while 20% was directly applied in agriculture with the rest being treated in other ways. Currently, the nutrient flows in Vienna are linear although circular flows are desirable for circular economy. The sewage sludge strategy of Vienna to be implemented through 2030 requires enhanced P-recycling and improvement of the sewage sludge quality. To this end measures need to be introduced to prevent input of pollutants into urban wastewater. It is claimed that thermal treatment (incineration) has advantages including destruction of organic pollutants and microplastic producing sterile, transportable ash. Although there is great potential of P in municipal wastewater and technologies are available, actions at EU level are required to promote a clean circularity of phosphorous. The vision is to establish circular nutrient flows with a strong commitment of implementing P-recovery in Vienna.

Presentation 4: Life Newest

Dr. Jose F. Cabeza, SERVYECO, Spain

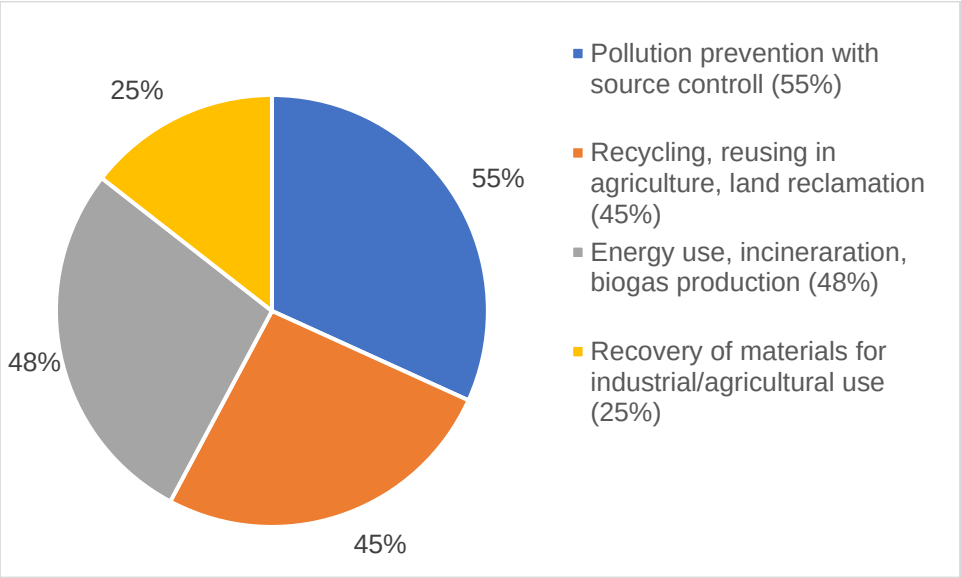
The company SERVYECO was introduced. With a staff of over 30 people in different fields of expertise they are committed to innovation, manufacture and distribute more than 5000 tons of chemical products for water treatment a year. The 2.2 million EUR project “Life Newest” was implemented with the co-ordination of SERVYECO between 2017-2021. A new, innovative and environmentally friendly technology for the removal of phosphorous from wastewater was developed for industrial demonstration. The technology is based on a new natural based organic polymer improving coagulation efficiency to withdraw phosphorous and to achieve total removal of toxic and corrosive products. The industrial validation of the efficiency of coagulants of natural origin both in urban and industrial wastewater treatment plants was carried out at several locations. Results were introduced in detail covering P, COD, VIS values, conductivity, concentration of SS, chlorides, etc. In addition, sludge evaluation procedure, sludge composting analysis were conducted, and it was concluded that the sludge generated with BEWAT could be considered a class A fertilizer product. In addition, it increases biogas production, and improves dry matter values. 30 tons of this polymer is going to be produced by SERVYECO to be used in four wastewater plants. Beside sales revenue growth, the real scale implementation of the technology in wastewater treatment facilities in three member states is envisaged.

Question and Answers

The session was moderated by the World Bank representative Mr. Stjepan Gabric. He pointed out that there were fundamental differences in sludge handling across countries. While in Ireland the overwhelming volume of sludge is applied to agricultural land by a few privately owned sludge contractors as a commercial operation which is centrally monitored to demonstrate compliance with regulations, in Austria investments are underway for P recovery in Vienna urban wastewater facility to substitute fertiliser export. It was agreed that introduction of advanced technologies in sludge management would increase costs for the taxpayers, however the social factor, the sensitivity of the population is often a more important factor when promoting sludge as a product, a source of nutrients or energy. Therefore, public information, public discussions, sharing data, technology knowledge, introduction of monitoring procedures are critical to make actual progress in seeing sludge as a resource.

Audience Poll question: Are there preferred options in your country / Danube Region or is there a need for a mix of solutions?

Pollution prevention with source control: 55%

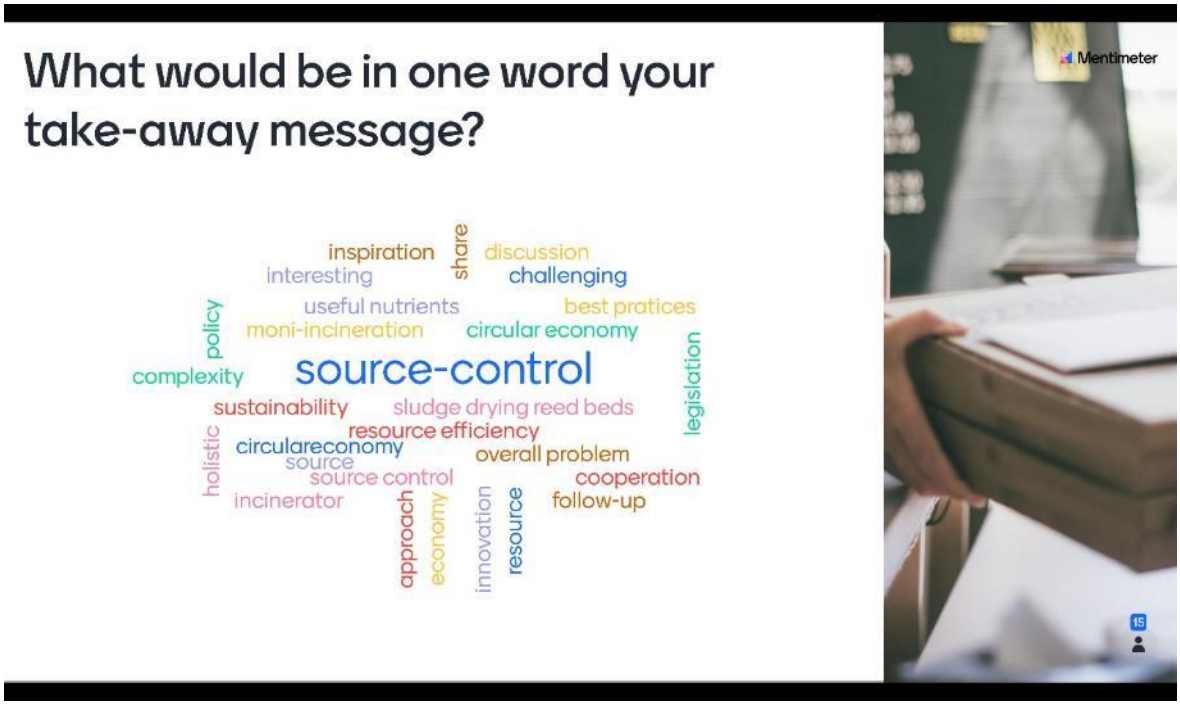


5. Figure: Preferred sludge management options

Session 5: Wrap-up & Recommendations

The wrap-up session was introduced with a simple poll question. Participants were invited to identify one word they think appropriate as the main message, a key aspect of the workshop. The key words identified (see figure below) on the basis of discussions during the workshop reflect the complexity of sludge management, the manyfold aspects related to the issue. No wonder though, that **source control is a priority according to many** – the concern about sewage contamination was often raised in the discussions and considered an obstacle of using sewage as a source.

Poll question: What would be in one word your take-away message?



As a wrap-up Mr. Balázs Horváth (EUSDR PA4), Mr. Ádám Kovács (ICPDR) and Mr Stjepan Gabric (World Bank) summarised the main conclusions of the workshop and by doing so, they identified those areas, challenges and aspects of sludge management that need to be addressed to better exploit the possibilities of sludge in order to promote the EU initiative of circular economy and zero emission.

Speakers drew conclusions pointing out the following key messages of the workshop:

- It is claimed that **there is a strong trend of increasing sludge volumes along with expanding wastewater treatment which is a challenge**.
- Not only the volumes are growing considerably but the **pollutant content of sludge is an issue to be addressed**; source control is encouraged for the circular economy and to avoid cross-media pollution.
- It is agreed that **data on sludge production, national or regional alike are often outdated, not reliable**, while data gaps are particularly soring with regard to pollutants, quantities and treatment methods.
- Sludge management **solutions applied drastically differ across countries** ranging from use in agriculture to incineration depending on technology advancement, general perception, legal framework, etc.
- It is acknowledged that **there is no tailor-made solution, but a mix of treatment solutions can be the most appropriate aligned with national, local particularities**.

- The acceptance of different treatment technologies by stakeholders and the public is a key which require a common understanding on how we consider sludge and technological improvement in addition to ongoing communication.
- Knowledge sharing, exchange of information, transboundary co-operations could change potentially negative perception and serve technology advancement too.
- **Better integration of regulations, policies on waste, water and sludge management in line with the green deal initiative could result in a more efficient legislation promoting achievement of common goals**.
- A common understanding of sludge as a waste/pollutant or product/resource should be adopted to better tackle the complex challenges of sludge management.
- A common approach would help better coordination, cooperation of responsible authorities and relevant stakeholders are prerequisites of efficient and responsible sludge management.
- Since technologies are getting more and more sophisticated and improvement is driven by costly innovation, investments, **the social aspects, affordability should also be considered** in order to promote sludge as a resource.

7. Workshop outcomes

The presentations and discussions shed light on the many different ways, practices, technologies and approaches adopted by the different countries in sewage sludge management including source control, treatment and application. While in some countries it is a neglected area, the society is less sensitive to environmental impact of disposal, there have been many efforts, ambitious projects that offer new technologies for sustainable treatment and use of sewage sludge. The socio-economic conditions, the current wastewater management practices in the countries are very different which are also reflected in the development of the legislative framework, the legal requirements on treatment, composition values, disposal or use.

As the relevant EU directives in relation to the Green Deal are being changed the various national policy frameworks need to be modified, possibly truly harmonised in the Danube countries to achieve the common goal of circular economy. Currently, there is strict legislation on application of sludge in many countries to prevent negative impact, pollution on soil, waters, however its use in farming as a source of nutrients or organic matter is widely acknowledged. Recovery of phosphorous content and reduction of hazardous substances should be unequivocally promoted in all countries. It is agreed that treatment solutions to reduce disposal and turn sludge into valuable materials or a source of energy have to be encouraged for a greener economy.

Participants mostly agreed that there was a strong need for strict and uniform regulation at EU level to ensure safe use of sludge and to minimize disposal which is currently either illegal or a waste of nutrient, energy resources. It has been emphasized that **a shift in the approach to sludge management is needed**; sludge should rather be considered as a product, a source of energy than waste, however appropriate and efficient technology solutions are to be developed to reduce environmental risks of its use. The complexity of wastewater treatment and sludge management including potential areas of use raised concerns whether having a single sewage sludge directive is the most efficient and reasonable approach in EU legislation or sludge management should be addressed in several relevant regulations when sludge is no longer considered a waste product.

Considerable investments in urban wastewater treatment technologies to cut nutrient emissions have been made in the Danube Region, however a large portion of sewage sludge in many countries is still a source of pollution and often disposed instead of being used with no appropriate technology in place. However, the future of sewage sludge use is promising, new technologies are emerging, development and innovative projects have shown that there are environmentally friendly ways of P-recovery, producing useful raw materials free of hazardous substances, pathogens. Responding to poll question, the participants identified three areas in sludge management options as practically equally important; recycling, (use in land reclamation), or energy source (incineration, biogas) and

recovery of materials for industrial/agricultural use. Pollution prevention, control at source is claimed to be a precondition of industrial or agricultural use.

It has been concluded that **further discussion with policy makers is imperative to exploit full potential of sludge management for the circular economy** by creating a favourable legal environment and getting to a common understanding by setting an approved direction in sludge management. **Pollution control at source has been considered an imperative issue** by most of the participants. Stringent regulations should be in place to prevent pollutants getting into sludge requiring producers to apply efficient technologies to comply with threshold values, composition requirements. Legislation should encourage application of sludge as source of energy or valuable products (nutrient recovery, P). To this end, sharing of best practices, exchange of experiences, innovation and introduction of novel projects can be an asset for national stakeholders to improve current practices, promote general acceptance of industrial, agricultural use. It is also a common understanding that technical guidance in due course can actually help adoption of new technologies.

Annexes

Annex 1: Concept Note

Workshop on Sludge management in the Danube Region for a greener EU

Outline

Recognizing the development of waste water treatment in the Danube Region and consequently the growing need for sewage sludge treatment and recovery, the EU Strategy for the Danube Region, Priority Area Water Quality (EUSDR PA4), supported by the Hungarian Ministry of Foreign Affairs and Trade initiated in 2020 the elaboration of a preparatory study on sewage sludge treatment and recovery in the Danube Region.
The study was carried out by TRENECON Consulting and Planning Ltd, finalized in March 2021 and its content was consulted with countries of the Danube Region within the framework of the Steering Group of EUSDR PA4. In the study, an overview is provided on the information available on the Danube countries' sludge management, the best practices and difficulties and the study provides recommendations for future steps to be taken.

The situation is varying across the Danube Region. In some countries advanced waste water treatment and sludge management practices exist while in others still the establishment of the waste water treatment facilities is the main challenge. Whereas some countries have specific sludge management and recovery strategies, others manage sludge in line with the criteria set out in their water and sewage management strategies. There are differences in the administrative backgrounds, the focus and the applied techniques however common points in management exist and common targets are derived from the EC legislation and strategies. Regardless of the embeddedness of countries actions into EU legislation, sludge can be considered an important resource and, at the same time, a risk for the environment in all EUSDR countries concerning soil and water quality as well as human health.
Considering the European Green Deal, the issue of sludge is specifically important as it has high energy content and contains several materials, notably phosphorus, that are important input materials for the chemical industry and agriculture.

In light of the conclusions from the above sludge management study, the EUSDR Priority Area Water Quality with cooperation of the International Commission of the Protection of the Danube River (ICPDR), the Danube Water Programme (DWP) and the International Sava River Basin Commission (ISRBC) call for a stakeholder workshop on Sludge management in the Danube Region for a greener EU on 10 June 2021.

Objectives
The main aim of the workshop is to discuss the situation of sewage sludge management in the Danube Region. It will set the scene on the situation and trends and raise awareness on this

important but so far relatively neglected topic. It will give a policy context in order to boost knowledge exchange especially in light of the ongoing review of the 86/278/EEC Sewage Sludge Directive. The workshop will also go into the technological context to give up-to-date information on the new trends in the related technologies by assisting to establish common understanding and knowledge development for long-term planning of sludge management in the Danube Region countries. The workshop is planning to kick-off the discussion on sewage sludge management in the Danube Region and pave the way towards more in-depth policy and technological dialogue on this issue.

Primary target group for the event is national sewage sludge experts and interested stakeholders in the Danube Region and in Europe, policy makers, water and sludge managers and thematic coordinators.

The workshop, planned to be held in a virtual format, would feature presentations and roundtable discussion about policy and technological contexts of sewage sludge management in the Danube Region and its countries; on EU legislation in light of the current revision process, operationalising Circular Economy for sewage sludge management (including recovery and reuse of resources/water/energy).

Invited speakers would include experts from EC DG ENV, JRC, ICPDR, ISRBC, DWP, EUSDR, EUSBR, GWP.
The event received approval to be a Green Week 2021 Partner event.

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Annex 2: Final Agenda

WORKSHOP ON SEWAGE SLUDGE MANAGEMENT IN THE DANUBE REGION FOR A GREENER EU

10 June 2021, online (**REGISTER HERE**)

EU GREEN WEEK 2021 PARTNER EVENT

10:00 SESSION I: WELCOME NOTES

Moderator: *Zsuzsanna Kocsis-Kupper* (EUSDR PA4)

Balázs Horváth, Priority Area Coordinator, EU Strategy for the Danube Region PA4 "Water Quality"
Stjepan Gabric, Senior Water Supply and Sanitation Specialist, World Bank
Ádám Kovács, Technical Expert-Pollution Control, International Commission for the Protection of the Danube River
Dragan Zeljko, Secretary, International Sava River Basin Commission

10:15 SESSION II: SETTING THE SCENE

Moderator: *Zsuzsanna Kocsis-Kupper* (EUSDR PA4)

Keynote speech: Revision of the Sewage Sludge Directive and the Urban Waste Water Treatment Directive – Sylvie Grajales and Nele-Frederike Rosenstock, *European Commission DG Environment*

Presentation block
Wastewater management in the Danube River Basin – *Ádám Kovács, ICPDR*
Preparatory study on sewage sludge management in the Danube Region – *Attila Fürstand, Trenecon Ltd.*

Q/A block based on chat messages

11:15 SESSION III: POLICY

Moderators: *Ádám Kovács (ICPDR) & Balázs Horváth (EUSDR PA4)*

Presentation block
Legislation and experience in Germany – *Andrea Roskosch, German Environment Agency*
Legislation and experience in Slovakia – *Veronika Gregusova, Water Research Institute*
Legislation and experience in Romania – *Gheorghe Constantin, Ministry of Environment, Waters & Forests*
Legislation and experience in Sweden – *Agneta Thor Leander, VA SYD Water & Wastewater Regional Association*

Roundtable discussion block
Slovenia – *Iztok Rozman, Chamber of Commerce and Industry of Slovenia – Chamber of Public Utilities*
Romania – *Gheorghe Constantin, Ministry of Environment, Waters & Forests*
European Union – *Sylvie Grajales, DG Environment*
World Bank – *Stjepan Gabric*

13:00 LUNCH BREAK

14:00 SESSION IV: TECHNOLOGY & BEST PRACTICES

Moderator: *Stjepan Gabric (WB) & Samo Groselj (ISRBC)*

Presentation block
Mitigation of hazardous substances in sewage sludge – *Hans Peter Arp, Sludgeffect project*
WALUE: Waste to Value for small/medium WWTPs – *András Deli, UTB Envirotech*
Wastewater sludge use in agriculture in Ireland– *Aoife Kyne, Irish Water*
Nutrient recovery from sludge in Austria – *Lukas Egle, City of Vienna*
Sludge biomethanization in Spain – *Jose F. Cabeza, LIFE NEWEST project*

Q/A block based on chat messages

15:45 SESSION V: WRAP-UP & RECOMMENDATIONS

Policy wrap-up: *Ádám Kovács (ICPDR) & Balázs Horváth (EUSDR PA4)*
Technology & best practices wrap-up: *Stjepan Gabric (DWP) & Samo Groselj (ISRBC)*

16:00 CLOSURE OF THE WORKSHOP

WORKSHOP ON SEWAGE SLUDGE MANAGEMENT IN THE DANUBE REGION FOR A GREENER EU

10 June 2021, online

EU GREEN WEEK 2021 PARTNER EVENT

10:00 SESSION I: WELCOME NOTES

Moderator: Zsuzsanna Kocsis-Kupper (EUSDR PA4)

Balázs Horváth, Priority Area Coordinator, EU Strategy for the Danube Region PA4 “Water Quality”

Stjepan Gabric, Senior Water Supply and Sanitation Specialist, World Bank

Ádám Kovács, Technical Expert-Pollution Control, International Commission for the Protection of the Danube River

Samo Groselj, Deputy Secretary, International Sava River Basin Commission

1st question ZOOM

10:15 SESSION II: SETTING THE SCENE

Moderator: Zsuzsanna Kocsis-Kupper (EUSDR PA4)

Keynote speech: Revision of the Sewage Sludge Directive and the Urban Waste Water Treatment Directive – Sylvie Grajales and Nele-Frederike Rosenstock, European Commission DG Environment

Presentation block

Wastewater management in the Danube River Basin – Ádám Kovács, ICPDR

Preparatory study on sewage sludge management in the Danube Region – Attila Fürstand, Trenecon Ltd.

Q/A block based on chat messages

11:15 SESSION III: POLICY

2nd question ZOOM

Moderators: Ádám Kovács (ICPDR) & Balázs Horváth (EUSDR PA4)

Presentation block

Legislation and experience in Germany – Andrea Roskosch, German Environment Agency

Legislation and experience in Slovakia – Katarína Kozáková- Veronika Gregusova, Water Research Institute

Legislation and experience in Romania – Gheorghe Constantin, Ministry of Environment, Waters & Forests

Legislation and experience in Sweden – Agneta Thor Leander, VA SYD Water & Wastewater Regional Association

Roundtable discussion block

Slovenia – Iztok Rozman, Chamber of Commerce and Industry of Slovenia – Chamber of Public Utilities

Romania – Gheorghe Constantin, Ministry of Environment, Waters & Forests

European Union – Sylvie Grajales, DG Environment

World Bank – Stjepan Gabric

3rd question ZOOM

13:00 LUNCH BREAK

14:00 SESSION IV: TECHNOLOGY & BEST PRACTICES

4th question ZOOM

Moderator: Stjepan Gabric (WB) & Samo Groselj (ISRBC)

Presentation block

Mitigation of hazardous substances in sewage sludge – Hans Peter Arp, Sludgeffect project

WALUE: Waste to Value for small/medium WWTPs – András Deli, UTB Envirotech

Wastewater sludge use in agriculture in Ireland– Aoife Kyne, Irish Water

Nutrient recovery from sludge in Austria – Lukas Egle, City of Vienna

Sludge biomethanization in Spain – Jose F. Cabeza, LIFE NEWEST project

Q/A block based on chat messages

15:45 SESSION V: WRAP-UP & RECOMMENDATIONS

MENTIMETER WORD

Policy wrap-up: Ádám Kovács (ICPDR) & Balázs Horváth (EUSDR PA4)

Technology & best practices wrap-up: Stjepan Gabric (DWP) & Samo Groselj (ISRBC)

16:00 Closure of the workshop