WATER IN THE CIRCULAR ECONOMY TASKFORCE GROUP

BACKGROUND PAPER

State of play in Bulgaria, Hungary, Romania and Slovenia

November 2021

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LIST OF ABBREVIATIONS

CEE	Central and Eastern Europe
EC	European Commission
EEA	European Environment Agency
EU	European Union
GDP	Gross domestic product
IWA	International Water Association
OECD	Organisation for Economic Co-operation and Development
WEI+	Water Exploitation Index+
WWTP	Wastewater Treatment Plant

INTRODUCTION

The EC adopted the new circular economy action plan in March 2020 (EC, 2020). It is one of the main building blocks of the European Green Deal. The expectations are that the EU's transition to a circular economy will reduce pressure on natural resources and will create sustainable growth and jobs in EU countries. It is already proven that half of total greenhouse gas emissions and more than 90% of biodiversity loss and water stress come from resource extraction and processing (EC, 2020).

The circular economy offers a new way of looking at the relationships between markets, customers and natural resources, promoting sustainable and resource-efficient policies and practices. A business model that enables the economy to grow, while minimising the amount of natural resources that are extracted. As many states and corporations are moving away from linear towards circular models of production and consumption, there is ample evidence that shows the need for policy and regulations to enable this, to help economies break away from a polluting economic trajectory and move to a 'clean' one. A transition to a circular economy will encourage a more efficient use of water, combined with robust incentives for innovation, can enhance an economy's ability to handle the demands of the growing imbalance between water supply and demand. Although water reuse faces numerous barriers, ranging from public perception to pricing and technological, safety and regulatory challenges, geographical and sector-wide strategies that underpin the circular economy are emerging, and have the potential to transform some of the main barriers to water reuse.

Water is at the core of sustainable development and is critical for socio-economic development, energy and food production, as well as healthy ecosystems and the benefits they deliver to people. Water and sanitation are vital for reducing the global burden of disease and improving the health, education and economic productivity.

The background paper has been elaborated by members of Task Force "Water in the Circular Economy" to the Global Water Partnership - CEE. The Task Force consists of researchers and practitioners from four countries – Bulgaria, Hungary, Romania and Slovenia. The aims of this Task Force is to establish a common understanding of circular economy principles in the water sector of CEE countries and to boost their implementation in the Danube region.

The paper deals with current situation of implementation of circular economy concept in the water sectors of the four countries. It aims not only to describe the state of play but the most important objective is to reveal what are the major gaps and how they can be filled by future research projects and programmes.

Water recycling and reuse as central to a circular economy approach is in a focus of this task force. Water reuse faces numerous barriers, ranging from public perception to pricing and regulatory challenges that would be addressed more effectively though a wider circular economy perspective.

The papers summarised results collected from four questionnaires filled by experts of investigated countries (Annex 1) as well information and data from other studies and datasets of OECD, Eurostat and national sources.

WATER IN THE CIRCULAR ECONOMY

The main idea of circular economy is to maintain as long as possible the value of products and materials. It is the opposite of a throwaway culture or society. Waste and resource use are minimised and when a product reaches the end of its life, it is reused to create further value. The concept of circular economy is based on three principles:

- Design out waste and pollution
- Keep products and materials in use
- Regenerate natural systems.

The concept of circular economy has emerged in response to drawbacks of the conventional 'take-make-consume and dispose' model of growth and the shift towards sustainable development. Yet so far, the water sector has not been systematically included in high-level circular economy strategy discussions. Circular economy principles offer an opportunity to recognize and capture the full value of water (as a service, an input to processes, a source of energy and a carrier of nutrients and other materials).

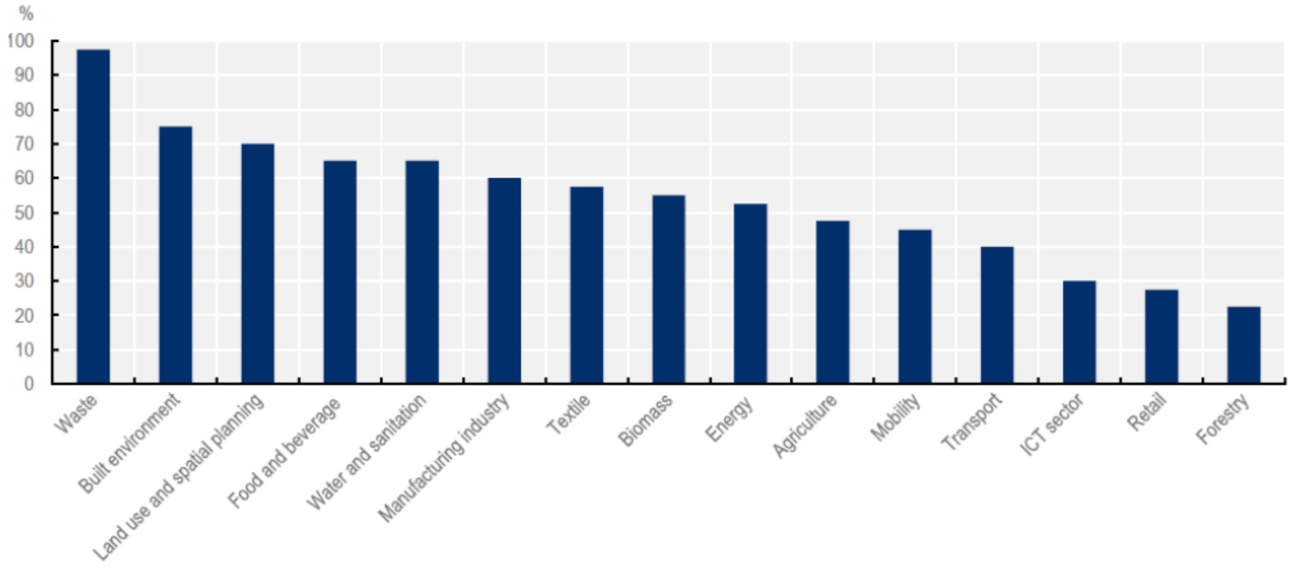
By its internal features, water management is fundamentally a circular business. Every drop is endlessly used and reused, and this circularity is already evident in the sector in initiatives such as recycling wastewater for reuse and capturing bio solids for agriculture.

The potential benefits of implementation of circular economy concept in the water sector tie with savings in water supply and needs of construction and maintaining an expensive infrastructure of water services, further utilisation of sludge in agriculture, solving problems in the area of water shortage and risk of floods. It also helps diminishing GHG emissions.

The most familiar circular economy processes are agroindustrial wastewater purification, renewable energy and compost production (Campos et al., 2016). According to the OECD (2020), cities and regions identify the waste sector as key in their progress towards a circular economy (98%), followed by the built environment (75%), land use and spatial planning (70%), food and beverages and water and sanitation (65%) (Figure 1).

Recycling and reuse are central to a circular economy approach and offer a strategy to improve water supply by managing wastewater better. Water reuse faces numerous barriers, ranging from public perception to pricing and regulatory challenges that could be addressed more effectively though a wider circular economy perspective. An integrated, interdisciplinary and holistic approach would facilitate the application of water reuse as part of an integrated water management strategy that could be significantly accelerated in the context of a circular economy. Such strategy should also ensure the safety of water reuse, and therefore apply water quality standards appropriate to the specific use, but also ensure adequate and reliable operation of water reuse systems and appropriate regulatory enforcement.

Figure 1. Share of cities including specific sectors in the circular economy initiatives



Note: Results based on a sample of 40 respondents that selected sectors responding to the question: "Which sectors are included in your city/region circular economy initiative?".

Source: OECD, 2020.

GENERAL COUNTRY FEATURES AND WATER RESOURCES

The population of four countries as of 1 January 2021 (Table 1) ranged from 2.1 million in Slovenia with area of 20,273 km^2, 6.9 million in Bulgaria, with area of 111,000 km^2, 9.7 million in Hungary and area of 93,030 km^2 and 19.3 million in Romania and area of 238,397 km^2.

Table 1. General country information

Country	Country size, sq. km	Inhabitants, millions	GDP per capita, USD
Bulgaria	111,000	6.9	7,351
Hungary	93,030	9.7	12,665
Romania	238,397	19.3	9,474
Slovenia	20,273	2.1	21,305

Source: Eurostat.

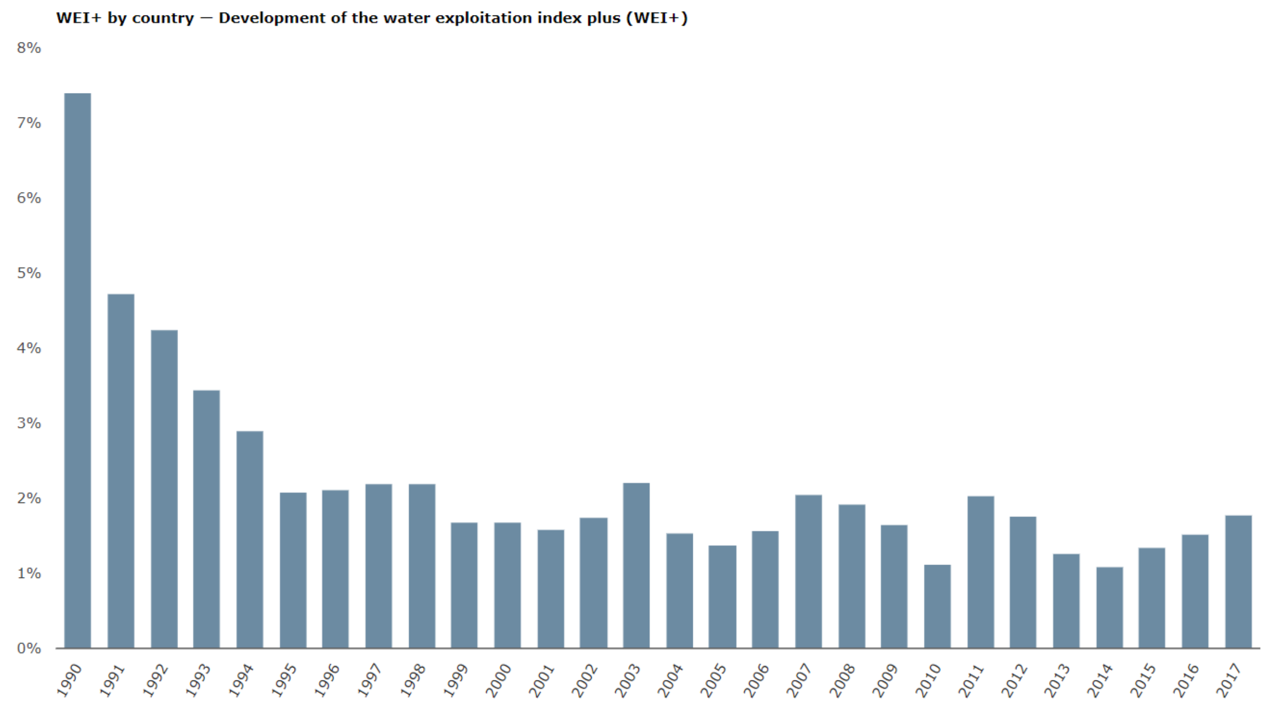
GDP per capita varies between USD 7,351 in Bulgarian to USD 21,305 in Slovenia (Table 1). In the middle are Romania with USD 9,474 and USD 12,665 in Hungary. This large difference in GDP per capita may influence water tariffs and affordability of water services in the studied countries.

WATER EXPLOITATION

Water Exploitation Index (WEI+) is defined as the ratio of all annual abstractions over inter-annual resources. It shows what part of available water resources are used in the given country. The European Environmental Agency (EEA) collects the data for calculation of this index. Data about WEI+ by studied countries from 1990 to 2017 are depicted in graphs Figures 1, 2, 3, and 4.

WEI+ in Bulgaria gradually has been decreasing in 1990-1994 due to dramatic changes and restructuring of the industrial and agricultural sector (Figure 2). From 1994 to 2017, WEI+ has been moving between 1.2-2.4%. One can expect that in the near future the fluctuation of WEI+ would be in the same limits. WEI+ in Bulgaria gradually has been decreasing in 1990-1994 due to dramatic changes and restructuring of the industrial and agricultural sector (Figure 2). From 1994 to 2017, WEI+ has been moving between 1.2-2.4%. One can expect that in the near future the fluctuation of WEI+ would be in the same limits.

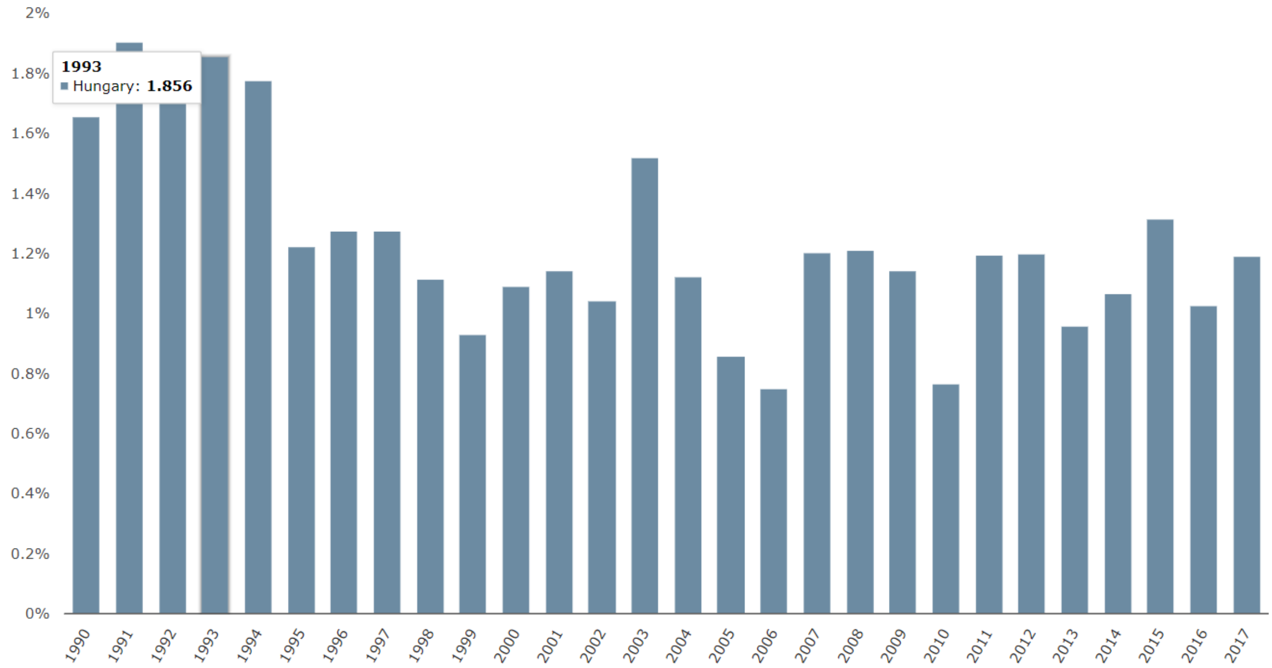
Figure 2. Water Exploitation Index+ in Bulgaria, 1990-2017



Source: EEA

In contrast to Bulgaria WEI+ in Hungary has smoother fluctuation (Figure 3). It also suffered from economic transition in 1990-1994 but no so dramatically. Later WEI+ in Hungary is moving between 0.8 to 1.5%.

Figure 3. Water Exploitation Index+ in Hungary, 1990-2017



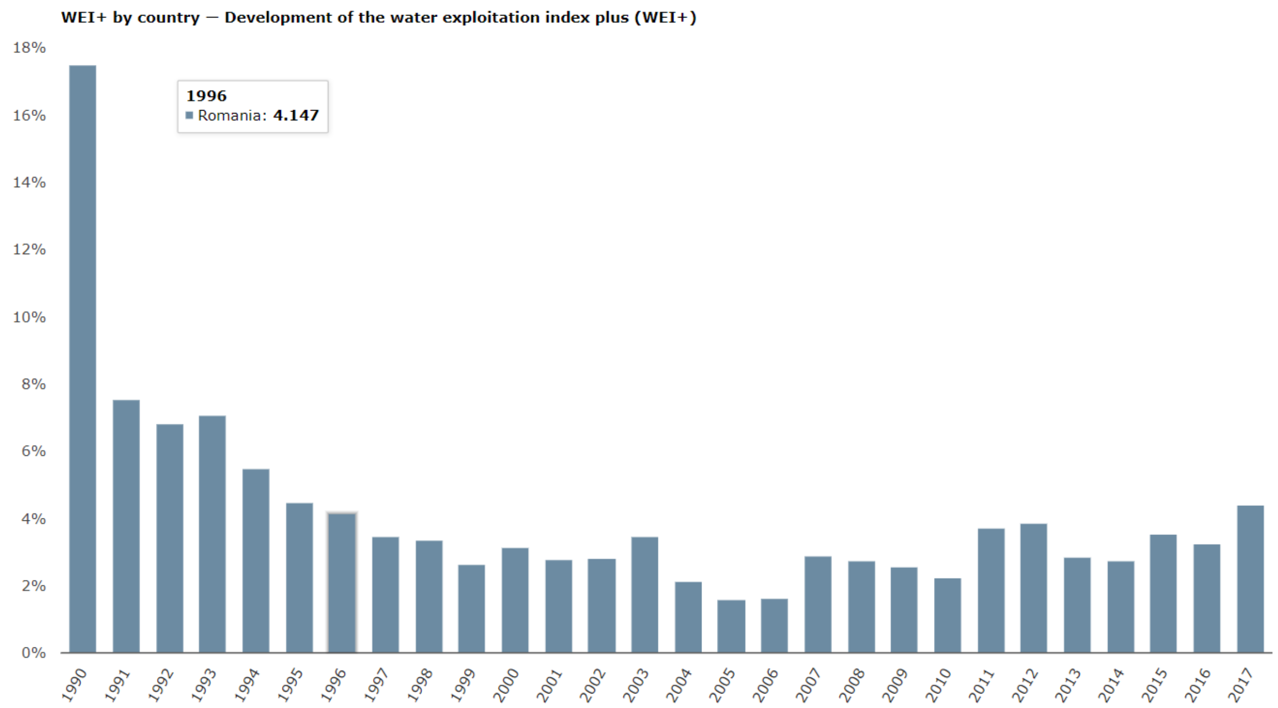
Source: EEA

The highest drop of WEI+ in Romania happened in 1990 when from almost 18% it reached less than 8% in 1991. In the next years until 1998 WEI+ gradually has been reducing to reached level between 2-4% (Figure 4). After 1994, WEI+ in Romania shows higher dynamics compared to Bulgaria and Hungary moving between 0.8-1.4%.

WEI+ dynamics in Slovenia has different development in 1990-2017 compared to other tree countries. It had negligible drop in 1991 and negative dynamics up to the year of 2000 (Figure 5). After that period, WEI+ passed to two four years periods of gradual increase and consecutive decrease. From 2008, the main trend is toward decreasing of WEI+ values. They are less than other tree countries, reaching 0.8% by 2017.

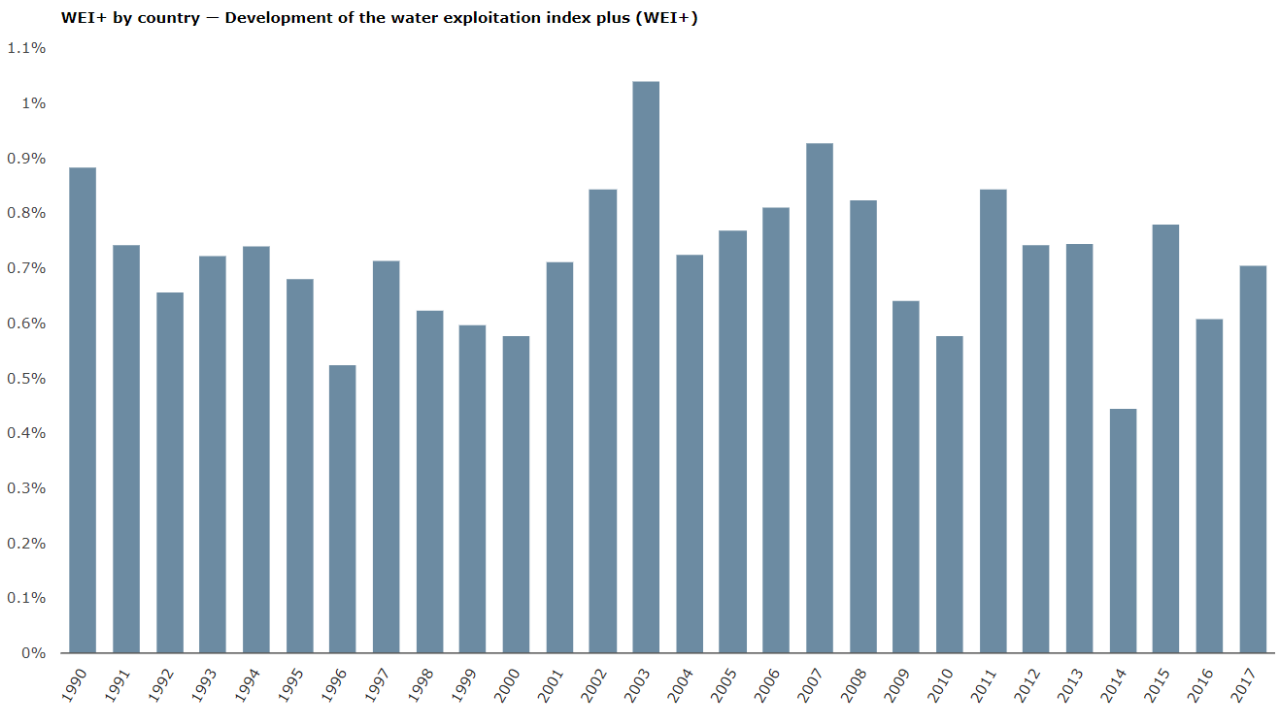
From short overview of dynamics of WEI+ in the studied countries one can conclude that WEI+ is at low level and do not present any risk regarding available water resources. In all countries, there are enough water resources to meet needs of population, industry and agriculture.

Figure 4. Water Exploitation Index in Romania, 1990-2017



Source: EEA

Figure 5. Water Exploitation Index in Slovenia, 1990-2017



Source: EEA.

WATER STRESS

Freshwater resources per inhabitant are considered an important indicator for measuring the sustainability of water resources. To this end, water stress index has been elaborated that presents total water available to a population of a country. This indicator has been developed by the United Nations and widely used by different institutions and purposes. Water scarcity clock provides information for not only water availability in the past but also deliver forecast for next decades (Table 2).

In Bulgaria there are no population leaving in water scarce areas in 2010, 2020 and 2030 (Table 2). Nevertheless, 1.6 million of population were exposed in water stress in 2010. Their number was reduced to 1.3 million in 2020 and expectations are that in 2030 they will be 28,000 less.

Romania has the highest number of population living in water scarce areas among the four countries (Table 2). In 2010, they presented 7% of population, in 2020 – 8% and in 2030. One can expect that 9% of population will live in these areas.

The most dramatic is satiation with population in absolute scarcity. Their number is almost 350,000 in 2010, 472,000 in 2020 and even little bit more in 2030. More than 1.5 million Romanian citizens lived in water stress and water scarcity in 2020. They will be 66,000 less in 2030.

Table 2. Water stress index

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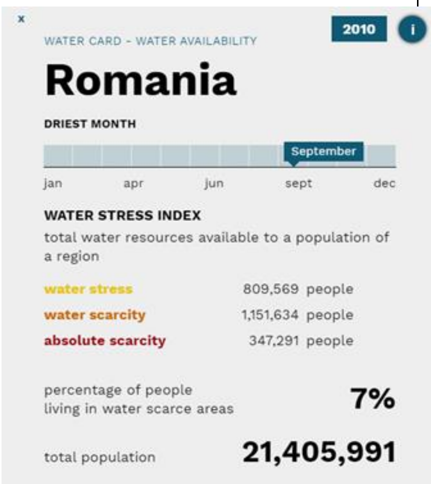
<td>
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Source: Water scarcity clock

Hungary also experience problems with population living under water stress. Their part of total population is 8% in 2010 and 7% in 2020 and 2030 (Table 2). There are no people living in absolute water scarcity areas, but 1.5 million in 2020 and 1.3 million in 2030 were and will be under water stress and water scarcity.

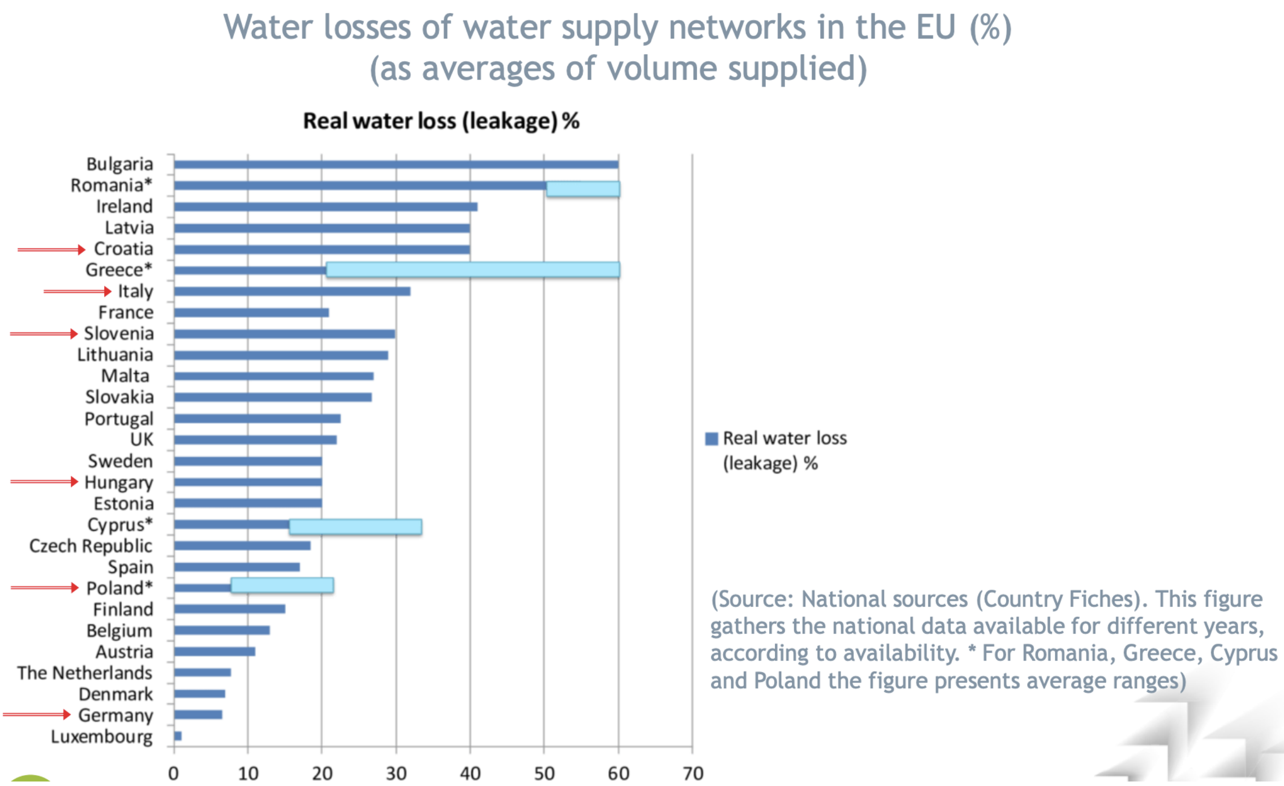
Slovenia is the best-positioned country among all others. This country has no problems with water stress and water scarcity (Table 2). No one citizen of Slovenian population lives under water stress and one cannot expect changes in this situation.

Data collected by TF about population with interruption of water supply in the four countries reveal that population with interruption of water supply in Bulgaria is 6.0% (out of them - below 180 days - 5,8% and more than 180 days - 0,2%) and Romania - 27.36% (72.64% of population is connected to public water supply).

NON-REVENUE WATER

Non-revenue water (NRW) is water that has been produced and is "lost" before it reaches the customer. NRW is an integral indicator for quality of water supply network and its management. There are different sources of information about NRW. They differ by the quality of data collected, periods and methods of calculation. It seems that Bulgaria and Romania recorded the highest level of NRW – about 60% (Figure 6). Hungary has the lowest level of water losses – 20%. For Slovenia, they are at level of 30%.

Figure 6. NRW in water supply network



Source: fbr, 2020.

Data about NRW provided by IWA reveal a little bit different picture (Liemberger and Wyatt, 2019). Bulgaria and Romania also report the same level of NRW, but 51%. Hungary and Slovenia replace their place. Hungary has 32% NRW while NRW of Slovenia is 25%.

Concerning annual losses in money from NRW they are USD 277.5 million in Romania, 105.7 million in Bulgaria, USD 60.9 million in Hungary and USD 11.7 million in Slovenia (Liemberger and Wyatt, 2019).

Regardless existing data differences it is obvious that NRW is at non-appropriate level in Bulgaria and Romania, while in Hungary and Slovenia it is closer to European benchmarks.

WATER POLLUTION

Regarding dynamics of water pollutant releases from 2010 to 2019 in the four countries, Bulgaria has reduced them by 52 to 78% (Table 3). Water pollutant releases in Hungary also dropped by 55-80% in the same period while the fall in Romania is between 15-72%. Only Slovenia increased water pollutant releases of a group consists of cadmium (Cd), mercury (Hg) nickel (Ni) and lead (Pb) by 61% from 2010 to 2019. Other groups of water pollutant have decreased in the period by 5.8-46.4%.

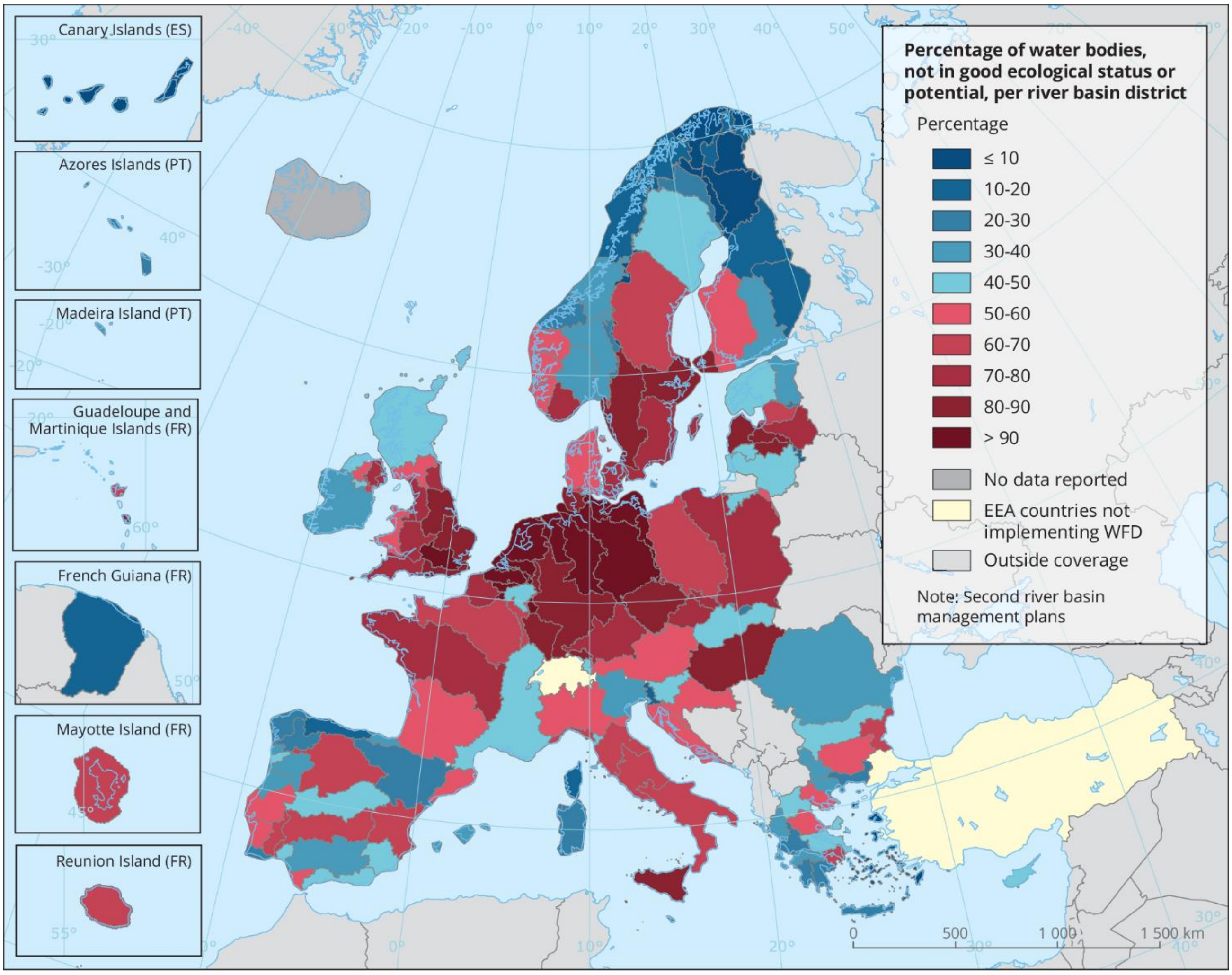
Water pollutant releases along with other factors shape the ecological status of river basins. The picture of current state of water bodies not in good ecological status or potential in river basin districts is presented in Figure 7. The worse situation is in Hungary where more than 90% of water bodies are not in good ecological status or potential (Figure 7). Bulgaria is divided into two parts. In North Bulgaria, 40-50% of water bodies are in good ecological status, while in South Bulgaria 50-70% of them are not in good ecological status. In Romania and Slovenia is more homogeneous. In both countries, 30-40% of water bodies are not in good ecological status.

Table 3. Water pollutant releases changes from 2010 to 2019 for the EU Member States

	Cd, Hg, Ni, Pb	TOC	Total N	Total P
Austria	-33.6%	-22.6%	0.7%	-21.9%
Belgium	-40.3%	-4.4%	-14.0%	20.7%
Bulgaria	-63.1%	-52.2%	-59.4%	-78.3%
Croatia	222.6%	0.2%	165.3%	235.0%
Cyprus	12294.7%	-20.4%	-3.7%	2677.2%
Czechia	-48.0%	-10.4%	-39.7%	-26.4%
Denmark	-20.1%	21.4%	35.5%	30.8%
Estonia	15.4%	55.3%	-34.9%	-60.5%
Finland	-59.3%	-63.0%	-7.8%	52.4%
France	-81.8%	-89.9%	-37.5%	-20.7%
Germany	-26.6%	-19.1%	-28.8%	-32.2%
Greece	236.7%	-55.4%	5.4%	-1.7%
Hungary	-80.4%	-55.5%	-70.4%	-76.0%
Ireland	-41.8%	40.5%	39.6%	18.2%
Italy	-24.8%	-23.1%	-24.8%	-40.9%
Latvia	35.1%	-47.1%	-48.2%	33.0%
Lithuania	-72.4%	-86.4%	-83.8%	20.2%
Luxembourg	-44.4%	-70.7%	-55.1%	-61.6%
Malta	-94.7%	0.7%	162.7%	105.3%
Netherlands	-53.4%	-45.0%	-42.5%	-48.2%
Poland	-53.0%	-13.1%	-43.1%	-32.2%
Portugal	-15.9%	-38.0%	28.3%	-11.2%
Romania	-72.5%	-15.1%	-25.1%	-33.7%
Slovakia	-37.5%	-36.3%	-42.8%	-52.0%
Slovenia	61.1%	-5.8%	-46.4%	-18.5%
Spain	2.6%	169.2%	49.9%	21.3%
Sweden	-20.2%	-5.8%	0.0%	-3.8%

Source: EEA.

Figure 7. Percentage of water bodies, not in good ecological status or potential, per river basic district



Reference data: ©ESRI | ©EuroGeographics

Source: EEA.

WATER TARIFFS

The water tariffs in Table 4 are calculated as an average of water tariffs for water supply plus wastewater treatment from different regions of the country. In some countries, specific calculations are used; e.g. in Bulgaria water prices are calculated from drinking water supply with/without pumping + household wastewater collection + household wastewater treatment. The water price in the four countries varies from 1.47 EUR/m^3 in Bulgaria up to 2.5 EUR/m^3 in Hungary. The highest annual spending for water services is in Bulgaria - 0.89% of GDP per capita and Hungary – 0.85% of GDP per capita, followed by Romania – 0.69%. The lowest spending for water services is in Slovenia – only 0.29%.

Table 4. Average Water Tariffs, EUR/m^3

	Water consumption l/cap/day	Water tariff (with VAT) EUR/m3	Annual spending for water services as % of GDP per capita
Bulgaria	98	1.47*	0.89%
Hungary	110	2.5	0.85%
Romania	128	1.72	0.69%
Slovenia	110	1.50	0.29%

Note: For Sofia.

Source: Answers of questionnaire.

INCIDENCES FROM WATER IN THE CIRCULAR ECONOMY

INCIDENCES IN BULGARIA

In Bulgaria one can find three applications of the circular economy principles in the water sector:

- Use of sludge
- Generation of electricity in WWTPs
- Use of surface water to increase groundwater.

These incidences are presented in the text below.

Box 1. Sludge use in forestry

In the framework of the pilot study, the species composition of phytopathogens in wastewater and dry sludge from WWTP Batanovtsi and the impact of dry sludge on the growth, development and health status of forest plant species have been studied. The main conclusions drawn are as follows:

- The presence of fungal and bacterium microorganisms in the sludge of WWTP Batanovtsi has been established and their exact type has been determined. Some of the identified microorganisms are known as pathogens in humans and animals, and another – as saprophytic microorganisms. A very small proportion of the microorganisms found in the samples examined are known as plant pathogens, mainly causing rotting plant production.
- The pathogenicity tests carried out on isolated microorganisms (having a connection with plants) to major tree species show a lack thereof. When incorporating sludge into soil mixtures for growing saplings in potted conditions, a positive influence was reported on the growth of saplings of white acacia and negative influence on that of winter oak, white pine and black pine.

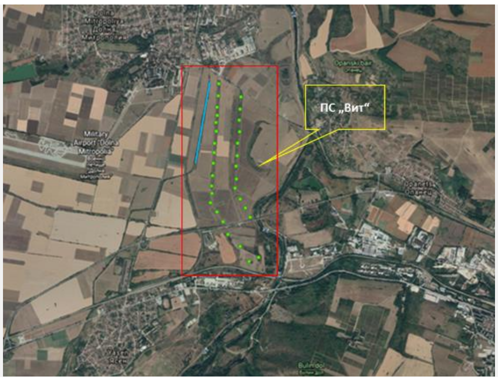
Box 2. Generated electricity from WWTPs

The biological wastewater treatment plant WWTP Kubratovo for Sofia city and the adjacent districts, towns of Bankya and Novi Iskar, and several villages: Svetovrachene, Chepintsi, Negovan, Kubratovo, Pancharevo, Bistritsa, Gorni Lozen, Dolni Lozen, German and Voluyak began work in 1984. Main characteristics of WWTPare as follows: quantity of incoming water – 5.7 m^3/s, maximum hydraulic load – 10.5 m^3/s, BOD5 of incoming wastewater - 100 t/day.

Later The the built co-generator installation in WWTP Kubratovo, where the recovery of biogas, which is released during the anaerobic stabilization of the sludge in the station, produces electricity sufficient to meet the needs of the station, while producing heat needed to stabilize the sludge in the methane tanks.

Box 2. Use of surface water to increase groundwater during drought

The relation between surface waters and groundwater is natural and repetitive in nature. There are cases, however, in which additional quantities of water for irrigation or water supply are sought, which can be obtained by artificial feeding from surface sources. An example is the water supply zone "Dolna Mitropolia", used for water supply of Pleven town, Bulgaria, with drinking water. It is a system of 31 wells, built in the terrace of the river Vit located in two parallel rows with a maximum depth of 13.80 m. During the summer-autumn drought, significant decreases of the water level in Quaternary aquifer with small depth are observed. For this reason, there is a decrease in the flow rates of shaft wells. Infiltration ditches (pools) have been built in the area of the water extraction wells for artificial recharge of the groundwater. An infiltration pool with a length of 1,280 m is used for the artificial recharge of the groundwater. The conditionally clean water delivered from Dolni Dabnik dam is used for its hydration, with a flow rate up to 250 l/s.



Location of the Dolna Mitropolia water intake group with infiltration Ditch 1

The infiltration trench 1 is a channel with a depth from 2.9 m to 4.6 m. The cross section of the channel is a trapezoid with a bottom width of 2.3 m on average. It is located parallel to the two rows of extraction wells. The constructed system for artificial recharge of groundwater envisages the water quantities to pass from infiltration Ditch 1 to the system of wells.

INCIDENCES IN HUNGARY

Use of reclaimed water in Hungary is allowed but not applied. There are:

- Good practices of rain water retention and use, use of treated wastewater for irrigation and use of sludge in agriculture and forestry
- Good practices of sustainable management of transboundary water abstraction together with water saving and water retention solutions in agriculture and industry, reducing also groundwater overexploitation
- Options to recover resources from water and wastewater
- Introduction of the circular economy principles in public works.
- Generation of electricity from WWTPs
- Cases of use of rainwater.

INCIDENCES IN ROMANIA

The incidences of water in the circular economy are well known in Romania. Here are some current facts:

- In 2012 an independent non-governmental association has been established as "The Institute for Research in the Circular Economy and Environment - Ernest Lupan" – IRCEM, through an initiative of the Technical University of Cluj-Napoca. In 2017, IRCEM/CIOS became the official partner in the Circular Economy Platform of Stakeholders (ECESP) from the European Economic and Social Committee of the European Commission. More information about this initiative can be found on IRCEM.RO or https://circulareconomy.europa.eu/platform/en/dialogue.
- IRCEM implemented the project "ROMANIA'S STRATEGY FOR THE TRANSITION TO A CIRCULAR ECONOMY (ROCES) 2020-2030", aiming to define the pillars which will support Romania's transition to a circular economy by involving all relevant stakeholders (i.e. civil society, public administration, industry, academics, social infrastructure), and by attracting the necessary financial support. The study aimed to collect opinions from relevant stakeholders regarding the level of penetration of the circular economy in terms of regional collaboration, in a way to ensure Romania to become a leader in implementation of circular economy principles in CEE.
- Aquademica Foundation - https://aquademica.ro/open-source-aqua-circular-2020/ uses an open source approach, in order to create, socialize and globally disseminate solutions for building local circular economies. Aqua Circular On-line Conference 2020 promoted the innovative solutions for all the interested stakeholders in Western Romania, but also from neighbouring regions with Hungary and Serbia. The main purpose of the conference was to organize the frame for matching demand and supply in the circular water sector, with the aim to improve the competitiveness of local stakeholders in the regional water market. The conference was an innovative mixture of circular water project presentations and debates, with the aim of creating business opportunities in regional markets and building strong partnerships among regional water operators, decision makers and technicians from regional utilities, local industry and agriculture, local start-ups, regional universities and R&D centres, technology providers, local and central administrations. In October 2021, a new conference, organized on-line, with the same topics regarding water and circular economy (https://aquademica.ro/conferinta-internationala-aqua-circular-2021-un-eveniment-stiintific-timisorean-de-anvergura/).
- Conditions for Circular Water Solutions - NextGen Water project, 2018 – 2022 – partners from 9 EU countries plus Romania – City of Timisoara – AQUATIM – (Horizon 2020) – for Timisoara – with technologies for Sludge management with production of byproducts and/or energy and Reuse of effluent for urban industrial and agricultural applications.
- NanoTermo – Patented technology for the circular economy. Increasing the efficiency and reducing the operating costs of existing and new, small and medium treatment plants, by KEMATRONIC SRL, Romania.
- Interesting article on "Industrial Symbiosis through the Use of Biosolids as Fertilizer in Romanian Agriculture", elaborated in 2021, and published in Recycling 2021, https://www.mdpi.com/journal/recycling, showing the application of Biosolids enhancing

soil fertility and crop yield in amended soils. Still, “the characteristics of the biosolids have to be controlled and monitored in order to minimize the potential impact on the environment and human health. At the same time, the characteristics of the land have to be monitored too, in order to receive the permit for biosolids’ use in agriculture. Additionally, Romanian legislation prohibits the use of sludge in vegetable and fruit crops growing in shrubs, vines, pastures and restricts the use of sludge in orchards. The use of sewage sludge is profitable also from the point of view of the savings it assumes. Thereby, at the country level, if all the sludge had been used in agriculture, the fertilizer replacement value would be worth the equivalent of about 3 million Euros for 2018 only and 2.9 million Euros for 2019. Moreover, exceptional savings can be achieved by water suppliers if they avoid discharge of sewage sludge at landfills. In this way, the water operators can maintain their operational costs at lower levels.”

- In the Operational Program for Sustainable Development under Priority Axis 2: Development of water and wastewater infrastructure and the transition to a circular economy, projects and investments would be implemented.
- In the National Recovery and Resilience Plan, under the Component 1 – Water Management, projects and investments would be implemented for water in connection with the circular economy.
- On the website of the Romanian Water Association, in the section dedicated to members, there is a section including monthly newsletter, in which there is a special topic on circular economy with news on research and findings regarding international best practices.

a. Good practices of rainwater retention and use, use of treated wastewater for irrigation use of sludge in agriculture and forestry

There is no available information about projects implemented in Romania at local or regional level. However, there are companies that sell and encourage small farms and individuals to use containers for rainwater storage and water reuse.

In Romania, for Mures county the project "Extinderea şi reabilitarea sistemelor de apă și apă uzată în judeţul Mureș" targeted the rehabilitation of wastewater treatment plants while improving the sludge treatment process for further applications in agriculture.

b. Good practices of sustainable management of transboundary water abstraction together with water-saving and water retention solutions in agriculture and industry, reducing also groundwater overexploitation

Transboundary waters refer to the aquifers, and lake and river basins shared by two or more countries. The UN-Water Transboundary Waters Thematic Priority Area, under the leadership of UNESCO and UNECE, has organized a compilation of good practices in transboundary water cooperation. As well created an online database that enables the continuous collection of good practices for sustainable management of water resources, which is one of the global challenges of the 21st century. The World Economic Forum placed water at the top of global risks. Water is an instrument of peace with a strong impact on security or crisis in the world.

Transboundary water resources management programmes and water infrastructure development require sustainable financing for the development and implementation of a legal framework; capacity-building; establishment and tailoring of institutional arrangements; management costs of transboundary institutional arrangements; cost of basin management: joint data collection, planning and monitoring; and long-term investment in water-related infrastructure for shared river management. Financing mechanisms for transboundary water cooperation include: (i) Inter-riparian financing by public means; this requires countries to fund activities beyond their territories; (ii) Public-private partnerships; (iii) Revolving funds to engage private investors in projects with positive transboundary externalities; (iv) Trust funds for programme implementation, administered by a transboundary or international institution or joint body.

Romania has signed intergovernmental agreements with neighbouring countries regulating issues related to cooperation for the protection and sustainable use of transboundary watercourses, operation and construction of hydrotechnical works, organizational, institutional and economic frameworks for economic and technical cooperation. Romania cooperates with neighboring countries: Hungary, Ukraine, Serbia, Bulgaria, and the Republic of Moldova, through bilateral agreements in the field of transboundary water. Recently, a new legal framework in the field of sustainable transboundary water management was finalized in collaboration with Serbia. The Agreement between the Government of Romania and the Government of the Republic of Serbia on cooperation in sustainable transboundary water management was signed in Bucharest in 2019, replacing the legal framework from 1955. With Ukraine, negotiations for the revision of cooperation regulations in the areas of water quality, flood protection, exchange of meteorological and hydrological data, their harmonization with European Directives and national legislation have been completed. All these forms of cooperation are based on the principles of the Convention on the Protection and Use of Transboundary Watercourses and International Lakeland the Convention on Cooperation for the Protection and Sustainable Use of the Danube River.

The Romanian 'GREENDANUBE' project (LIFE06 NAT/ RO/000177) also focused on integrating recreational needs into a nature conservation plan for eight selected islands along the transboundary part of the Lower Danube, between Romania and Bulgaria. These islands, which are located within the Danube Delta Biosphere reserve, one of Europe's most outstanding freshwater regions, contain rich floodplain ecosystems that are threatened by riverbank erosion from ship traffic and by the commercial pressure to convert floodplain forest into poplar plantations. 'GREEN DANUBE' proposed an alternative socio-economic use – eco-tourism. The project developed a strategy to promote the islands as eco-tourism destinations. This involved testing a certification model of the floodplain forest and actively involving the local community in the project's implementation, including providing training for foresters and other key stakeholders.

In Hungary, the 'Szigetkoz' project (LIFE04 ENV/HU/000382) helped addressing governance concerns at a transboundary level. The project team developed an innovative decision-support tool (DST) for sustainable water and land-use management planning in the Hungarian-Slovakian Transboundary Danube Wetland Area. Historically, there had been little cross-border cooperation between decision-makers in the Szigetköz area, with negative impacts on river basin management. The LIFE project broke new ground in terms of Slovakian-Hungarian scientific cooperation and stakeholder involvement, leading to the development, testing and implementation of an integrated action plan based around the use of the DST. The GIS-based decision-support tool enabled environmental, economic and social needs to be evaluated at the same time and by the same parameters. Thus, the DST, together with the other main result of the project, a flow-supplementation system, provided a means for Hungary and Slovakia to develop planning for sustainable development in line with the requirements of the WFD.

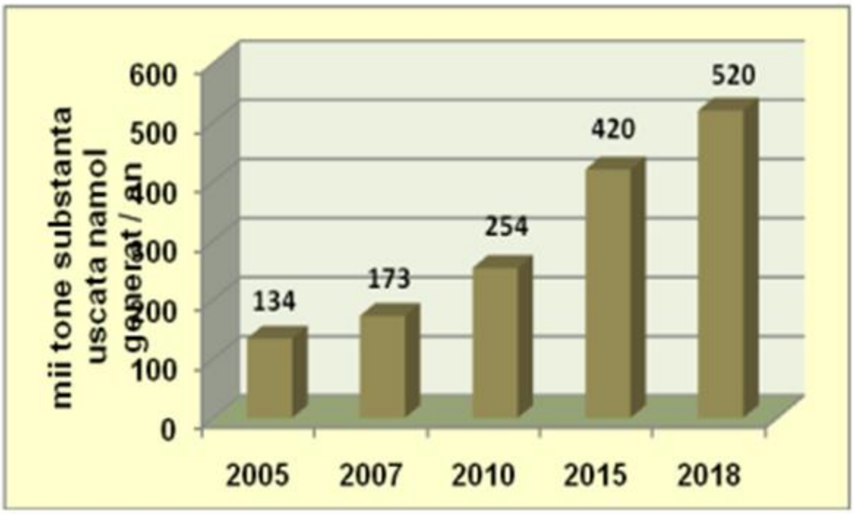
c. The most familiar circular bioeconomy processes

In Romania, the following measures were provided and industrial activities were carried out that affect the aquatic ecosystems:

- remediation of contaminated areas (historical pollution including sediments, water bodies, underground, soil) by keeping the tailings ponds safe for the environment and completion and reception of works for the closure-greening of contaminated areas;
- reduction of emissions, discharges and losses of priority hazardous substances, or reducing emissions, discharges and losses of priority substances;
- rehabilitation or modernization of industrial treatment plants (including farms) - purchase and installation of equipment for measuring industrial water flows and drinking, refurbishment of acid water recovery facilities, restoration of sections of damaged or clogged sewers, the realization of a dividing system for collecting a wastewater, updating water management permits in order to achieve environmental objectives of water bodies;
- research studies, improving the knowledge base that reduces uncertainty - other measures for diffuse and point mining pressures - closure measures and greening of landfills and ponds, rehabilitation and greening of landfills (land reclamation).

d. Generated electricity from WWTPs

The sludge from wastewater treatment plants comes from different stages of the treatment process and are considered waste falling under the impact of waste regulations. The treated sludge can be used or disposed of most commonly in three ways: use in agriculture, incineration or storage in landfills, depending on the properties' sludge as well as the option of the treatment plant operator. Other methods of using the sludge (although less often) are: in forestry, land improvement, wet oxidation, pyrolysis and gasification.



Sludge quantities generated by WWTP's in Romania

e. Measures in place of transition of water in the circular economy

Between 15.10.2021 and 30.11.2023, the Ministry of Environment, Waters and Forests in partnership with the Ministry of Health and the National Administration "Romanian Waters", carries out the project "Development of a national laboratory to improve monitoring of discharged substances and drinking water quality". The total value of the project is 191,094,390.22 lei and the project implementation period is 26 months.

The aim of the Project is to develop a national laboratory, which collects monitoring data from 99 laboratories for monitoring priority substances, other pollutants in discharged wastewater and surface water as well as monitoring drinking water quality indicators for reporting according to with the commitments in the Treaty of Accession of Romania to the EU, ratified by Law 157/2005, regarding the collection and treatment of wastewater and drinking water supply.

Romania's water resources are relatively poor and unevenly distributed in time and space with about 40 billion m^3 being available for use per year. Water demand in Romania in 2014 was 7.21 billion m^3/year. The balance between water availability and the expected trends for water demand shows no deficit at state level or in the 11 sub-basins; there are only a few river sections with deficits in the Prut - Bârlad basin that should be carefully considered in the future.

The total irrigated area in Romania is 29900 km^2 with 85% of the area being irrigated from the River Danube. In reality, irrigated land accounted for less than 3000 km^2 (less than 1% of the total arable land) in the last 5 years (2011-2015), consuming about 1 million m^3 per year. Although Romanian legislation does not restrict the use of treated wastewater in irrigation, there are no specific regulations and standards that govern water reuse.

The groundwater potential in Romania is estimated at 9.6 billion m^3/year. In general terms, groundwater is not overexploited in Romania. In fact, data for 2014 showed that surface water abstraction accounted for around 10 times the volume of water abstracted from groundwater resources. Furthermore, aquifer recharge using treated wastewater is currently a prohibited practice in Romania with the Waters Law explicitly prohibiting injections of wastewater into groundwater. The current potential for treated wastewater reuse in aquifer recharge, therefore, is effectively non-existent.

Exemple from Prahova county, Romania

Case study: an industrial project for a production unit with logistics and warehousing flows in Prahova county. The concept of the ACO Stormbrixx system starts from the basic elements, which are assembled on site, in the form of an interconnected system of blocks.

Two adjacent but separate Stormbrixx systems were installed. The first will function as an infiltration system, and the second as a retention basin. Above these systems will be built the parking lot that will serve the industrial platform. In addition to the system for infiltration or retention, the project will be served with a hydrocarbon separator, Oleopator G-H, NS with a nominal flow of 150 l / s, with the included mud hatch of 15,000 litters.

Slovenia

Slovenia is one of the few countries in the world that has incorporated the right to drinking water in its constitution. In Slovenia, the right to drinking water is ensured by supplying water to homes and also wherever people spend most of their time (e.g. educational institutions, shops, health care institutions). Drinking water is provided mainly through public water supply, with possibility of own drinking water supply or as self-sufficiency of certain facilities through intercepted rainwater. Only in exceptional cases water is supplied in other ways (e.g. water tank access) outside of the residences.

CONCLUSIONS

The TF studies the most important problems in the water sector in four CEE countries that could be tackle by the circular economy approach. Despite the new EC circular economy action plan adopted in March 2020 one can conclude that there are little incidences in the investigated countries relevant to implementation of circular economy principles.

The study reveals market niches in these countries where different initiatives are more suitable to be launched in near future:

- the implementation of energy efficiency and non-revenue water reduction programs that have recovered the investments in a short period of time while saving water and energy and increasing the amount of people with access to services.
- the recovery of resources from wastewater and the creation of new revenue streams by using for own needs or selling energy, water, and fertilizers to cover operating costs.
- the application of circular economy and resiliency principles in long-term strategies to become carbon neutral, recover resources from water and preserve the environment while providing water services.
- the assessment of the full potential of the existing infrastructure, resulting in huge savings in capital investments.

A circular economy is a systemic approach to economic development designed to benefit businesses, society, and the environment. In contrast to the 'take-make-waste' linear model, a circular economy is regenerative by design and aims to gradually decouple growth from the consumption of finite resources.

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ANNEX 1. QUESTIONNAIRES ON WATER USE AND REUSE IN CENTRAL AND EAST EUROPEAN COUNTRIES

1. Country features

- ✓ Current population in the country, ml inhabitants.
- ✓ Country size, sq km
- ✓ GDP dynamics, GDP per economic sectors – services, industry, agriculture

2. Water resources

- ✓ Water balance for 2019
- ✓ Water price (with and without VAT) in €/m3

	Household	Industry
tap water supply		
wastewater collection		
wastewater treatment		

- ✓ Water stress
- ✓ Population with interruption of water supply (%)
- ✓ Non revenue water statistics

3. Water in the circular Economy

- ✓ Is the incidence of water in the circular economy known in your country? How is it applied? Are there any best practices in local /regional resource management (water, nutrients, space, organic matter etc.)?

- ✓ Good practices of rain water retention and use, use of treated wastewater for irrigation use of sludge in agriculture and forestry
- ✓ Good practices of sustainable management of transboundary water abstraction together with water-saving and water retention solutions in agriculture and industry, reducing also groundwater overexploitation
- ✓ Options for recover resources from water and wastewater
- ✓ Introduction of circular economy criteria in public works.
- ✓ The most familiar CBE processes are: agroindustrial wastewater purification, renewable energy and compost production.
- ✓ Generated electricity from WWTPs
- ✓ Cases of use of rainwater and incentives for rainwater retention – Slovenia and Romania
- ✓ Measures in place of transition of water in CE
- ✓ Incentives for companies to save water and to reuse water
- ✓ Surface to ground water (underground water)

4. Personal information of respondent

- ✓ Name and surname
- ✓ Organisation
- ✓ Position/responsibilities within organisation
- ✓ E-mail