WATER IN THE CIRCULAR ECONOMY: STATE OF PLAY IN BULGARIA, HUNGARY, ROMANIA AND SLOVENIA

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Abstract. *Research background:* The EC adopted the new circular economy action plan in March 2020 as 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. 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 recycling and reuse as central to a circular economy approach is in a focus of this paper.

Purpose: 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.

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

Findings and novelty: The study reveals only a few cases in the countries studied, relevant to the concept of circular economy and as well as niche markets in the four countries. The implementation of energy efficiency and non-revenue water reduction programs that have recovered the investments in a short period 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 principles to become carbon neutral, recover resources from water and preserve the environment; the assessment of the full potential of the existing infrastructure, resulting in huge savings in capital investments.

Keywords: water recycling; water reuse; circular economy, East European countries

JEL: Q25; Q28; Q53; Q56

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 paper deals with the current state of play in implementing the circular economy concept in the water sectors of Bulgaria, Hungary, Romania and Slovenia. It aims at revealing the major gaps and how they can be filled by future research projects and initiatives.

Water recycling and reuse as central to a circular economy approach. 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 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).

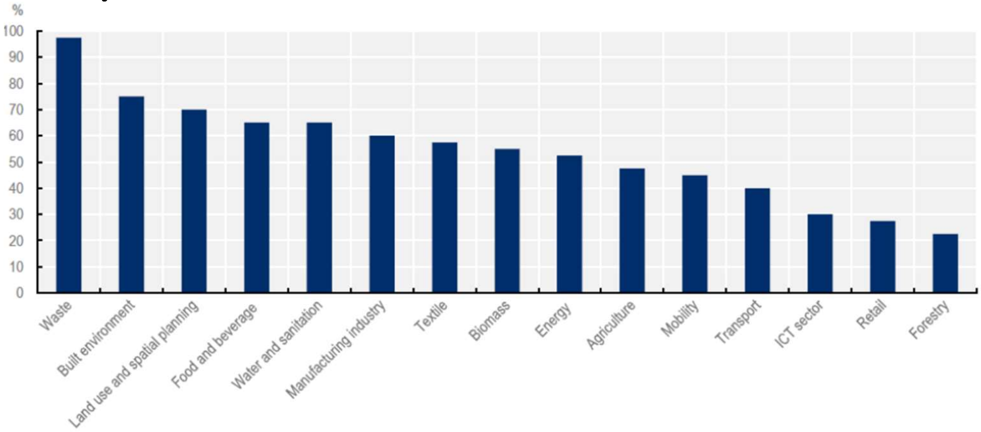
By its internal features, water management is fundamentally a circular business. Every drop is endlessly used and reused, and this circularity is already evident in the sector in initiatives such as recycling wastewater for reuse and capturing bio solids for agriculture.

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 agro-industrial 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 USE

The population of the 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.

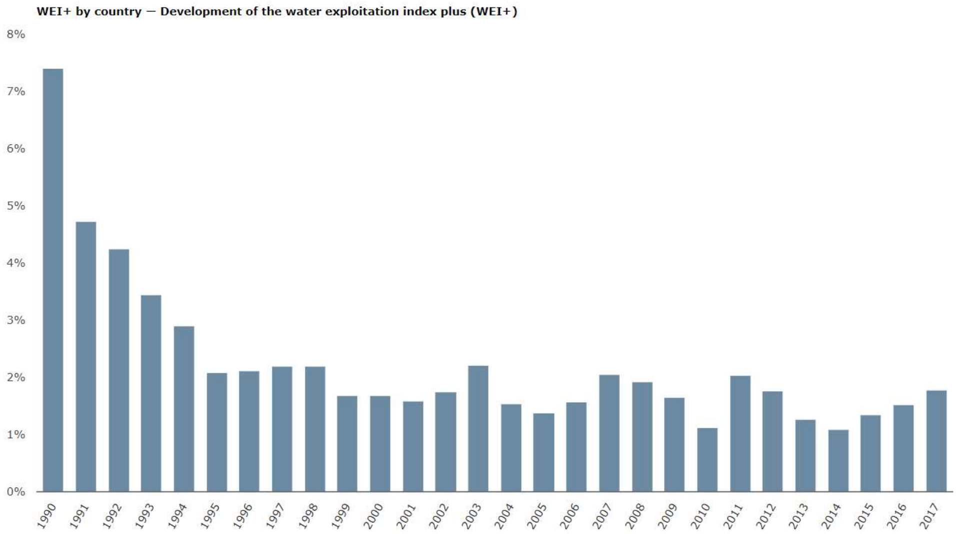
GDP per capita varies between USD 7,351 in Bulgarian to USD 21,305 in Slovenia (Table 1). In the middle are Romania with USD 9,474 and USD 12,665 in Hungary. This large difference in GDP per capita may influence water tariffs and affordability of water services in the studied countries.

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.

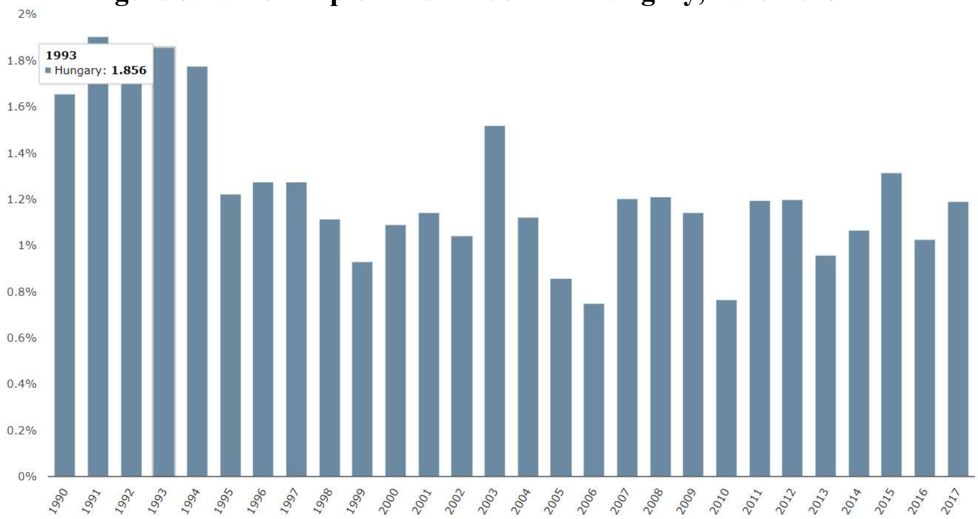
Figure 2. Water Exploitation Index+ in Bulgaria, 1990-2017



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



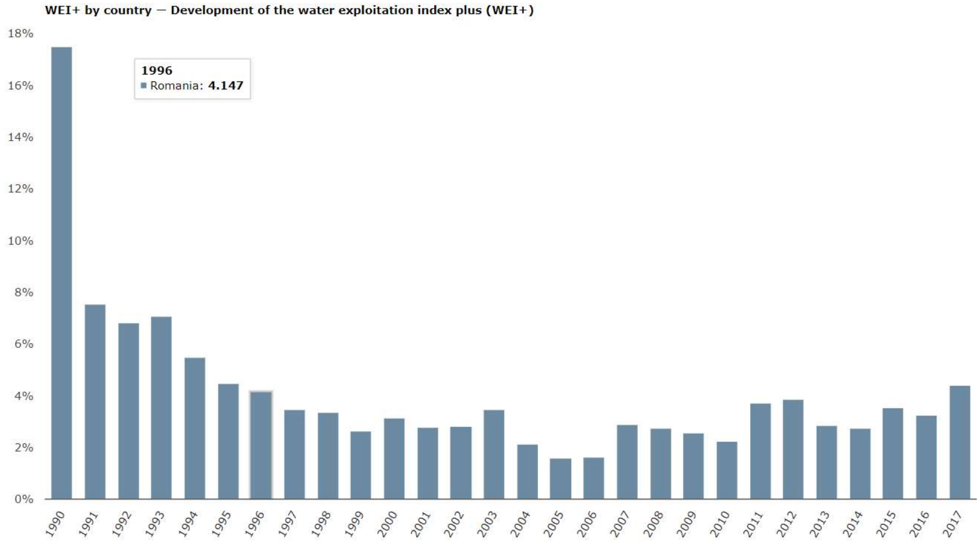
Source: EEA

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.

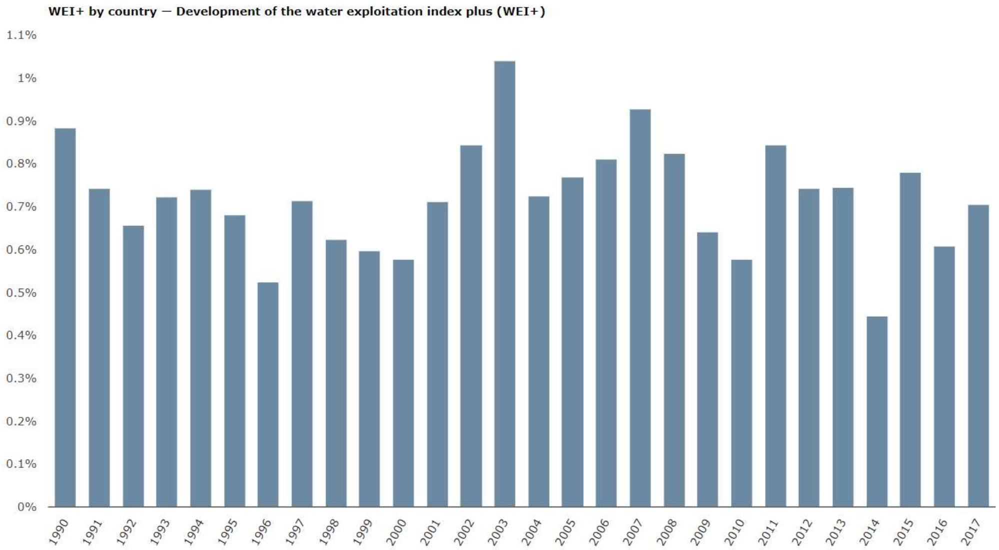
From short overview of dynamics of WEI+ in the studied countries one can conclude that WEI+ is at low level and do not present any risk regarding available water resources. In all countries, there are enough water resources to meet needs of population, industry and agriculture.

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.

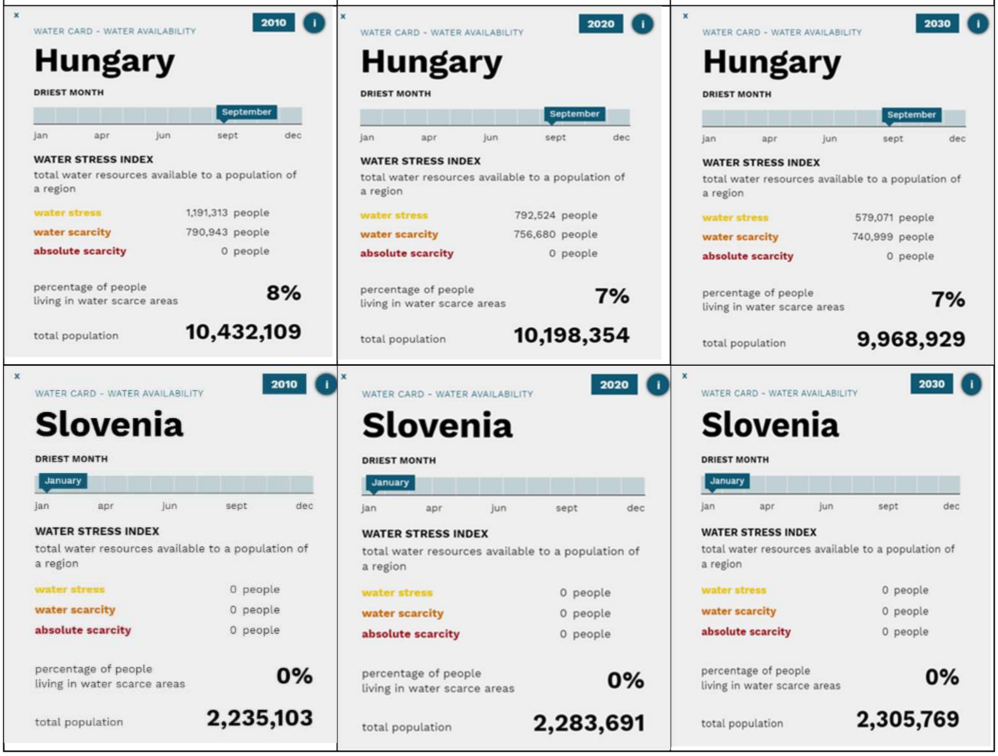
Romania has the highest number of population living in water scarce areas among the four countries (Table 2). In 2010, they presented 7% of population, in 2020 – 8% and in 2030. One can expect that 9% of population will live in these areas.

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

2010	2020	2030

2010	2020	2030



Source: Water scarcity clock

Hungary also experiences 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.

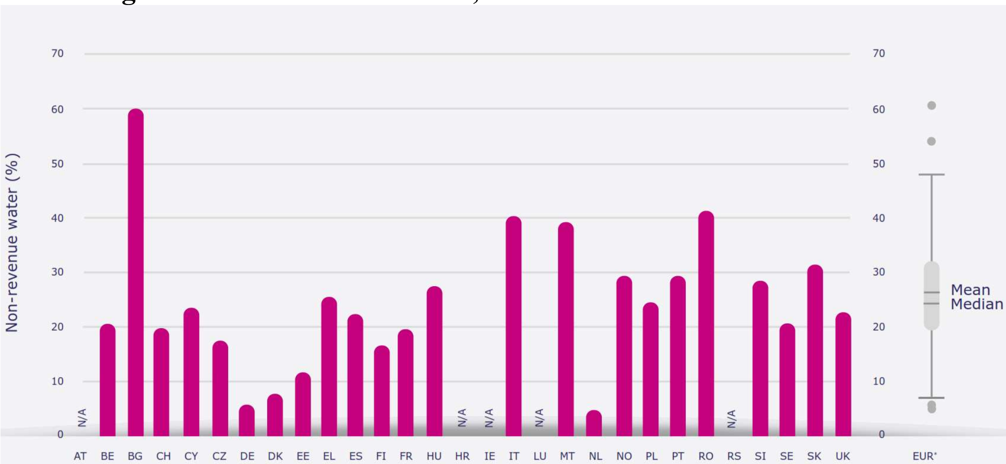
Slovenia is the best-positioned country among all others. This country has no problems with water stress and water scarcity (Table 2). No one citizen of Slovenian population lives under water stress and one cannot expect changes in this situation.

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. Bulgaria and Romania recorded the highest level of NRW – relatively 60% and 40% (Figure 6). Slovenia and Hungary have the level of water losses close to EU average - 25%.

Figure 6. Non-Revenue Water, in %



Source: EurEau, 2021.

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 average.

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%.

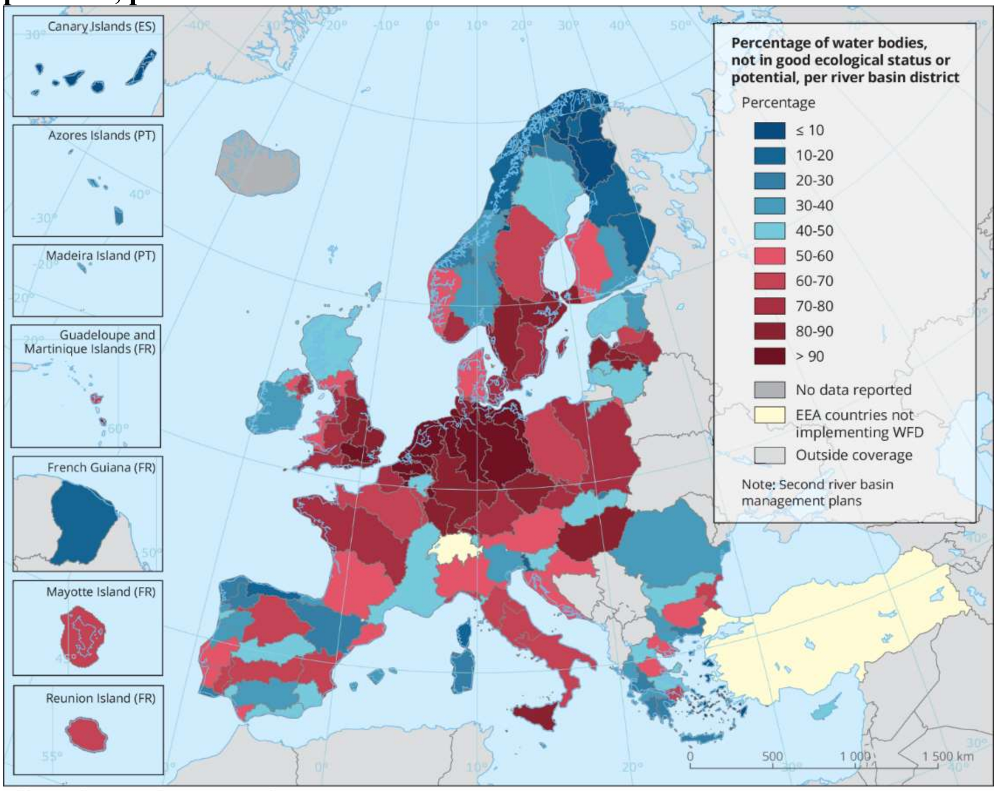
Water pollutant releases along with other factors shape the ecological status of river basins. The picture of current state of water bodies not in good ecological status or potential in river basin districts is presented in Figure 7. The worse situation is in Hungary where more than 90% of water bodies 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



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/m^3	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 OF 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 boxes 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.

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 3. 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

The use of reclaimed water in Hungary is allowed but not applied. In Hungary 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
- Cases 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 encompass not only `hard` but also `soft` measures and initiatives. In 2012 the Institute for Research in the Circular Economy and Environment - Ernest Lupan (IRCEM) to the Technical University of Cluj-Napoca has been established. 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).

Aquademica Foundation uses an open-source approach to create, socialise 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 Romanian Water Association regularly publishes in its monthly newsletter and web site information on circular economy`s research and findings and also on international best practices.

In brief, the following incidences are more common in Romania:

- Good practices of rainwater retention and use, use of treated wastewater for irrigation use of sludge in agriculture and forestry. There are companies that sell and encourage small farms and individuals to use containers for rainwater storage and water reuse.
- 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 UNICE, 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.
- 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).

▪ 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 is used or disposed in three ways: 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.

The innovative case of application of ACO StormBrixx system - a patented modular polypropylene system for infiltration or retention of stormwater in Pahova County is revealed in Box 4.

Box 4. Case study in Prahova County

The mounting of the ACO StormBrixx system in Prahova County 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 litres.

INCIDENCES IN 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.

KEY TAKEAWAYS

The paper 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 research projects and initiatives need 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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