Wetland collection basins built with vaporization discharge of treated wastewater - BAZIC

Water shortages and droughts are becoming more frequent and widespread. Further deterioration of water resources is expected if temperatures continue to rise as a result of climate change. Water scarcity is a seasonal, annual or multi-year condition of water stress. It occurs when water demand frequently exceeds the sustainable supply capacity of the natural watershed system.

Beyond water quantity, a water scarcity situation can also arise from acute water quality problems, when pollution (diffuse or point pollution) leads to a reduced availability of clean water. Deploying nature-based solutions on a larger scale would increase resilience to climate change and contribute to several Green Deal goals and must play a greater role in land use management and infrastructure planning to reduce costs, provide resilient services climate and to improve compliance with the requirements of the Water Framework Directive for good ecological status. Investments in nature-based solutions must be sustainable in the long term, as climate change amplifies stress on ecosystems.

Climate change also threatens water quality. Climate change will increase the risk of contamination and acute pollution of fresh water due to reduced river flows, increased water temperatures, floods. The challenges of adapting the existing wastewater systems in operation, under construction and in the design phase, to the future use of water and to the conditions of climate change are multiple. Large infrastructure systems are usually built and financed as long-term investments. Many existing wastewater treatment plants were built on the assumption of a growing population and historically higher per capita rates of water use. Reducing water use in the long term affects the volume of influent reaching wastewater treatment plants. Declining rates of water use can lead to many changed conditions that require adaptive actions, including more concentrated inflow and, for areas with stable or declining populations, lower inflow flows. Drought can exacerbate these effects by reducing infiltration and flow into catchment systems, which support baseflow and provide flushing. Climate change will bring many years of warmer and drier conditions, which will likely spur water reductions and additional regulations. Reducing the use of water directly affects the volume of influent that reaches the wastewater treatment plants. Wastewater infrastructure typically lasts decades, and most existing wastewater treatment systems were designed and built at a time when future population projections and water consumption rates were significantly different from current values, but they are built and designed currently on the same false forecasts. While influent flows are a significant factor in potential impacts, they are not the only factor. Other factors that influence influent flows include the installation of low-flow appliances and fixtures, indoor and outdoor graywater use, and water reuse.

For long-term adaptation planning, water conservation factors are not considered along with population changes, adoption of water-efficient appliances. Many collection systems are overdesigned for current flows. Increasing wastewater retention time in collection systems, particularly in upstream laterals, has resulted in changes in the composition of influent wastewater. These lead to accelerated corrosion for the treatment plant, which can reduce the life expectancy and integrity of pipes, valves and other components. It also increases the consumption of electricity and chemicals. Mismatches between influent flows and design flow parameters cause operational challenges in collection, treatment and reuse systems. Uncertainty in future conditions limits opportunities for adaptation. Wastewater systems are designed through detailed engineering studies that consider specific flow and concentration factors. It can be difficult to forecast future operating conditions, and designing plants to operate under a range of conditions can be very expensive.

The vast majority of individual systems in Eastern Europe are septic tanks that are declared drainable watertight basins, but discharge water into the ground without complying with the criteria provided in Standard EN 12566-2.

` Millions of septic tanks are sold, installed and used. They are produced and marketed under the SR EN 12566-1 standard and declared as watertight pools that can be emptied by the owner, in order to comply with the environmental notice.

systems recommended by the European Commission guidelines are mainly collection basins or other types of containers, which are impermeable, and the wastewater is collected by emptying and transported regularly to a sewage network and microstations purification. Only drainable watertight basins are accepted and not septic tanks that discharge water into the ground without complying with the criteria provided in Standard EN 12566-2.

For example, in Romania and according to the INSS report, the population connected to sewage systems in 2022 represented 59.2% of the resident population. The population connected to sewage systems equipped with treatment plants represented 58.1% of the population. If on January 1, 2022 the resident population was 19,038,098 people, it means that the population not connected to sewerage is 7,976,963,062. If for approximately 80% of them, respectively 6 million with 4.5 cubic meters of water used per month, emptying is necessary, transportation and disposal of waste water, monthly of 27 million cubic meters of waste water, that is to say, approximately 180 thousand drain runs daily, with draining and transport and disposal costs of at least 2 billion lei per month. Added to this is pollution, wear and tear on the roads, and the discomfort generated. In short, with 3 emptying trips per day, 90 thousand emptyings will circulate daily in Romania.

Taking into account the above mentioned, we propose a solution to solve the situation of households not connected to the sewage system in accordance with the legal requirements in Romania but also with the European regulations that do not require emptying and the consumption of energy and chemicals and that do not involve costs related to emptying , transport and disposal of drained waste water, BAZIC technology.

BAZIC technology, uses a wet area built in a sealed basin and the device for the discharge of treated wastewater from wet areas built into the atmosphere through evapotranspiration DAUZUC - ensures the discharge of treated wastewater only in the atmosphere and not in natural emissions, in the soil or on the ground

. Wastewater treatment in a constructed wetland is based on various complex physical, chemical and biological processes within the association of substrate, macrophytes and microorganisms. This depends mainly on: the hydraulic conductivity of the substrate, - the types and number of microorganisms; the supply of oxygen for microorganisms and the chemical conditions of the substrate.

In constructed wetlands, numerous mechanisms are applied to improve water quality: settling of suspended particles, filtration and chemical precipitation, chemical transformation, adsorption and ion exchange on plant, substrate and litter surfaces, decomposition and transformation and absorption of pollutants and nutrients by microorganisms and plants and predation and natural death of pathogens.

Wetland treatment systems are effective in organically treating nitrogen, phosphorus, and in addition reducing concentrations of heavy metals, organic chemicals, and pathogens.

Macrophytes growing in constructed wetlands have several properties relative to the treatment process. This makes plants an essential part of the design of constructed wetlands.

The most important effects of macrophytes in relation to the treatment process are physical effects. The roots provide the surface for attached microorganisms and root growth maintains the hydraulic properties of the substrate. The vegetation cover protects the surface from erosion and shading prevents the growth of algae. The litter provides insulation

layer on the surface of the wetland (especially for winter operation).

At BAZIC, in addition to the traditional constructed wetlands, the purified water is discharged, only through vaporization through the use and amplification of natural processes such as: capillarity, basket effect and evapotranspiration without: consumption of energy and chemicals.

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1. Evapotranspiration

For the design of a BAZIC constructed wetland equipped with a DAUZUC constructed wetland wastewater device to ensure the discharge into the atmosphere of the entire amount of wastewater without direct or indirect discharge into the natural outfall, the rate of evapotranspiration is essential. Evapotranspiration. is a complex process of turning water into vapor through a series of physical (evaporation in the case of the liquid phase and sublimation in the case of snow and ice) and biological (transpiration) processes. The transformation of water into vapor occurs at the land surface, in the soil (at shallow depths) and in the vegetation cover (natural or cultivated).

The rate of evapotranspiration is highly dependent on climatic factors such as rainfall, temperature and wind, as well as the growth and height of the plants in the system and their density.

Plants also play a key role in determining water loss in a constructed wetland.

Among the many studies on water management processes in wetlands, only a few contain a detailed analysis of the water balance of constructed wetlands with subsurface flow.

Such an analysis carried out in a region geographically close to Romania, in Hungary, was made by
David Somfai, Erno Dittrich, Eva Salamon-Albert, Anita Dolgos-Kovacsó in 2015

They measured the hourly, daily, and seasonal evapotranspiration of a constructed wetland with horizontal subsurface flow for four months. They found 16 days where there was no precipitation and no inflow or outflow affecting this constructed wetland, meaning the only effect on the water balance was evapotranspiration. On the investigated days, 71.7-93.1% of the total daily amount evaporated during the day regardless of the season.

These values were 229% and 150% in summer and autumn. As a result, the processes of are significant.

An analysis of evapotranspiration processes in a Romanian CW has not been carried out so far.

2. Capillarity

Capillarity is the ability of a porous body or tube to attract a liquid , which occurs in situations where the intermolecular adhesive forces between the liquid and the solid are stronger than the intermolecular cohesive forces within the liquid. Capillarity can induce an upward movement of water, unlike the downward movement induced by gravity. Capillarity is a set of phenomena due to the interactions between liquid and solid molecules on their separation surface. The forces that occur in this phenomenon are cohesive tension, adhesion and surface tension. For example, it appears on the surface of the liquid in contact with the solids, which is extremely high in the case of water because the adhesion forces between the water and the container that contains it are greater than the cohesion forces between the water molecules. The experimental values of the magnitude
the capillary rise heights, given in the specialized literature for detrital soils, have important variations determined by granulation, the degree of non-uniformity and porosity; if for gravel hc is of the order of centimeters, for fine sands it reaches values that exceed one meter, and in the field of clays values of several meters can be recorded.

3.. The chimney effect

The chimney effect causes a pressure above atmospheric at the high levels of an enclosed enclosure and a pressure below atmospheric at the lower levels. Just like in a chimney, the greater the temperature difference between inside and outside and the taller and wider the chimney, the greater the chimney effect.

4. Wastewater treatment device in the built wetland BAZIC with discharge only through evapotranspiration into the atmosphere - DAUZUC

DAUZUC is a treatment device in constructed wetlands that allows the discharge of treated wastewater only by vaporization without direct or indirect discharge into natural emissions. The temperature difference between the outside air and the inside air, the difference in surface and height between the air intake and exhaust tubes, creates a "natural current" of air. All mechanical and biological processes are achieved by using and amplifying natural processes such as capillarity, evapotranspiration and the basket effect. Wastewater loading followed by capillarity uptake into the soil layer pumps air and water into the soil state, increasing rates of capillary growth and evapotranspiration.

4.1 Description The device is composed of naturally ventilated tanks, with distribution filter tubes that communicate with the soil surface through absorption tubes and air exhaust tubes, through which the air is absorbed, thanks to the natural "chimney" effect. The distributor filter tube has rectangular slots in the lower part of the circumference, interrupted at the base by a drain. To clean the gravel layer of materials that can clog it, it is equipped with a washing device and a device for extracting water after washing. The plant was located in a constructed wetland with a gravel bed, covered with a geotextile membrane filter, placed under a layer of soil. All components are placed in a watertight pool made of flexible foil (geomembrane). **4.2 Operation** The process is continuous and consists of: 1. Mechanical treatment in the tank where, when the waste water falls into the tank, the liquid part enters the distributor filter tube through the slots, and flows down the drainage channel at its base, distributing evenly in the gravel layer, through the slots located outside the tank. Organic bodies larger than the width of the slits are kept 2. Biological treatment in the tank, through digestion, carried out by aerobic and anaerobic microorganisms existing in the wastewater but also migrated from the soil layer until total or partial liquefaction up to the size of the slits. In the tank, anaerobic digestion of biodegradable materials alternates with aerobic digestion, depending on the variation in wastewater flow and the loading of the constructed wetland. Aeration is achieved by air circulation between the absorption tube and the exhaust tube, but also due to the flow of water that enters the tank from the constructed wet area when it reaches the level of the distributor filter tube. This influx also enriches the content of aerobic microorganisms, with those of the constructed wetland. Faeces and paper are held in the tank until they are turned into liquid by aerobic biodigestion. Due to the turbulence generated by periodic level variations in a basic cylindrical space, biodigestion is enhanced, reducing the liquefaction time to a few days. In the tank, denitrification is carried out in the anaerobic phase for nitrogen gas removal, after nitrification in the constructed wetland and the anoxic phase for phosphorus removal. 3 Biological treatment in the gravel, geotextile and soil layers where the liquid seeping through the cracks in the gravel layer is purified by a biofilm-type biological filter, which forms in the gaps between the stones in the gravel layer and in the soil layer. on top. Here, the aerobic digestion of biodegradable materials takes place by the stationary bio-environments existing in the ground which, due to the variable flow of waste water and the level variations in the multilayer, is submerged and aerated alternately, every time the level of the distribution filter tube is exceeded, by the water inside the tank and its exit into the gravel layer and its withdrawal due to absorption by capillarity by the soil layer. Aeration within the gravel layer and in the soil is enhanced both by convection caused by the movement of water infiltration through the granular medium and by diffusion of air from the surface into the granular material layer by absorption into porous media. Ammonium nitrification (biological oxidation) also occurs due to chemoautotrophic bacteria, but also denitrification at its base, by aerobic microorganisms when dissolved oxygen consumes oxidized nitrogen instead of oxygen, and by anaerobic microorganisms. They turn nitrites and nitrates into gas, in the form of dinitrogen (N2). Due to the organic load from the soil and the permanent aeration, the elimination of phosphorus also takes place. Also in the substrates, two filtration processes take place, namely: the superficial filtration of the treated water, through which medium-sized solid suspensions are removed by retention in the pores of the gravel bed, until the portioned dissolution in the effluent. 4 Evacuation of treated water by capillarity and evapo-transpiration.

5. Design notes of the constructed wetland (ZUC), for the installation of DAUZUC There are several parameters selected for the design of the ZUC, which depend on the type of wastewater and climate, surface area, oxygen supply and oxygen consumption, retention time, water depth , substrate depth, tank filter capacity, hydraulic loading rate, organic loading rate and plants. The mechanisms of contaminant removal from ZUC are complex and include physical, chemical and biological processes between plants, substrates and microorganisms. Wastewater treatment in ZUC is carried out by many processes, the most important of which are settling or filtration of articles into, filtration and chemical precipitation by the substrate, chemical transformation, adsorption, ion exchange through the surfaces of the plant and substrate, decomposition and transformation of pollutants by to microorganisms and plants, the absorption and transformation of nutrients by microorganisms and plants and the natural disappearance of pathogens.

5.1 5.1. System Design The treatment performance results were identified as sufficiently comprehensive to provide valid data for the current evaluation at the inlet tube. Effluent sampling was carried out during the period of maximum flow. The hydraulic load rate for the inter-sample period was also measured using a magnetic dose counter (no. dose x dose volume = hydraulic load) mounted in the exhaust chamber at the domestic waste water inlet for 1 equivalent inhabitant (LE) which contains 150 I; 60 g CBO5 , 8 g NH4-N , 70 g SS data commonly used by designers of water treatment systems.. In the February 2019 experiment, a specific area of 3 m2 per equivalent inhabitant was used for reasons of commercial acceptability and operational robustness. The results of the treatment performance were examined in situ in locations distributed throughout Romania. **5.2 Tests carried out with natural systems with terrestrial purification in the constructed wetland with the wastewater discharge device purified by the constructed wetlands in the atmosphere DAUZUC** During the period 28.10.2019 - 25.10.2021, we carried out evapotranspiration (ET) experiments in Romania with 25 of natural systems with terrestrial purification in the constructed wetland with the device for the discharge of treated wastewater from the constructed wetlands in the DAUZUC atmosphere:

CITY	**Starting with the date**

Piscu	28/10/19
Pantelimon	09/11/19
Pantelimon	11/11/19
Pantelimon	27/01/20
Papa Leordeni	05/03/20
Tunari	11/07/20
Pascani	15/07/20
Mihai Bravu	20/07/20
Serdani	01/08/20
Domnesti	01/09/20

Jilava,	14/09/20
Provita de jos	07/09/20
Pantelimon	03/11/20
Cornetu	09/11/20
Domnesti	22/02/21

Piscu	06/03/21
Magurele	22/03/21
Bucureşti	22/04/21
Dascalu	05/11/21
Dascalu	12/07/21
Domnesti	20/07/21
Lipia	22/07/21
Pantelimon	08/08/21
Mihai Bravu	23/08/21
Afumati	14/09/21
Domnesti	25/10/21

5.3 Conclusions

Daily values of evapotranspiration they supported the maximum hydraulic loads, reporting no water level rises above the level of the gravel layer.