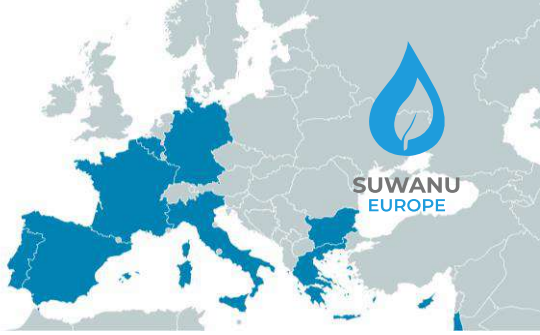
Sustainable **Water treatment** and
Agricultural reuse options in Europe

Info-package 4
Water Engineering Companies

Fact Sheet 4.4 – **Nature based options for water reclamation processes**



Filtration membranes and new filter materials | Sensors and other innovative tools for monitoring reclaimed water quality | Light-driven technologies for producing reclaimed water | **Nature based options for water reclamation processes** | Other technologies for water reclamation

SUWANU EUROPE is a H2020 project aiming to promote the effective exchange of knowledge, experience and skills among practitioners and relevant actors on the use of reclaimed water in agriculture. This factsheet is part of a total of 5 factsheets in Info-package 4 aimed at water engineering companies, that describe different reclamation technologies able to provide a treated effluent that complies with the standards for irrigation in agriculture.

1. Introduction:

As stated by the European Commission, nature-based solutions (NBS) are defined as *"solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits, and help build resilience"*[1]. While mitigating climate change effects or increasing biodiversity are some of their most common benefits, there exist certain NBS contributing to water management and security. In this sense, NBS are recognized for holding a great potential as water treatment and reuse systems[2]. The effectiveness of such solutions will depend on the technology selected, the quantity and quality of water to be treated, and the local conditions (e.g. climate, precipitation patterns, etc.). Examples of NBS for water reclamation include constructed wetlands, reed beds, green roofs or sustainable urban drainage systems (SUDS).

2. Constructed wetlands:

Constructed wetlands (CW) are probably the most common NBS for water treatment and reuse. They consist of a large gravel and sand-filled basin that is planted with wetland vegetation. As water flows through the basin, the filter material filters out particles and microorganisms degrade the organics. This solution can be used for rainwater treatment, combined sewer overflow treatment, greywater treatment, and polishing of outflow from existing wastewater treatment plants (i.e. advanced treatment after secondary or tertiary treatment). CW can remove up to 88% of TSS (total suspended solids), 92% of BOD (biological oxygen demand) and 83% COD (chemical oxygen demand) even after more than 20 years of operation. With regards to nutrients, it is estimated that 46-90% of TP (total phosphorus) and 16-84% of TN (total nitrogen) could be removed, depending on the system selected2. It is also reported that CW can remove organic and inorganic pollutants such as pesticides, heavy metals and CEC (contaminants of emerging concern). The effectiveness of CW to remove various pharmaceuticals has also been demonstrated in Ukraine, as well as by other studies at pilot scale[3]. The removal pathways are the uptake by plants, microbial degradation, adsorption and subsequent sedimentation, and also photodegradation. Some of the most common CW systems are: free-water surface CW, horizontal subsurface flow CW and vertical flow CW[4].

Provided the CW is well designed and maintained, the resulting treated water can be suitable for reuse applications. The Spanish Centre for New Water Technologies (CENTA) has wide experience in R+D and innovation applied to CW as solutions for water reclamation[5].

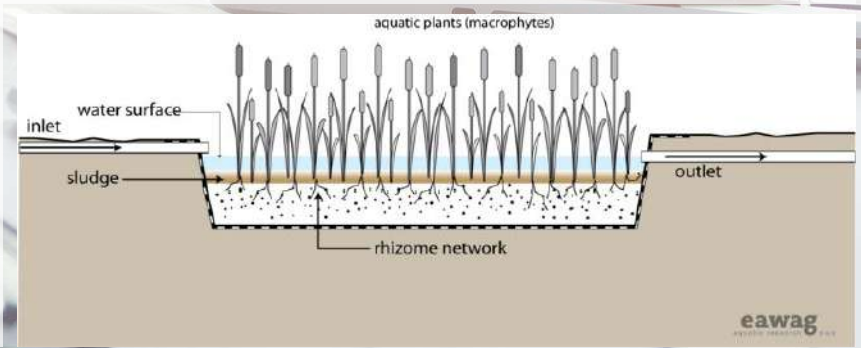


Figure 1: Free-water surface constructed wetland

Figure 2: Reed bed

3. Reed beds:

These aquatic plant-based systems allow bacteria, fungi and algae to digest organic matter present in wastewater. The effluent percolates through the layers of sand and gravel in an enclosed bed which operates aerobically to break down pollutants, including turning toxic ammonia into nitrates.

A horizontal flow bed would follow a vertical one and operate anaerobically – turning nitrates to nitrogen gas. Additional treatment stages, such as willow bed, could provide additional treatment and improve the quality at the final outlet[6]. Studies show that the removal efficiency of contaminants like TSS, TDS, BOD, COD, etc. varies with the type of aquatic plants used[7]. Reed beds are therefore considered as an effective and reliable secondary and tertiary treatment method where land area is not a major constraint, offering an interesting opportunity for water reuse.

4. Green roofs:

Green roofs can yield positive results in terms of water availability and quality[3]. This system enables rainfall infiltration and helps slow stormwater runoff reducing the rate at which water reaches the drainage system. Up to 75% of the stormwater they receive can be retained on average[8]. When combined with tanks for collection of rainwater harvested, the reuse of water for irrigation or toilet flushing is possible. Green roofs are also being explored as greywater treatment solutions to minimise the treatment footprint and usage of land[9]. These natural treatment technologies require reduced capital and operational costs, but further research should consider the feasibility for greywater treatment and recycling[10].

Figure 3: Green roof

5. Sustainable Urban Drainage Systems (SUDS):

Figure 4: SUDS

SUDS are drainage systems holding rainwater back while treating pollution and releasing the effluent slowly, without overwhelming the watercourse or sewer systems[11]. SUDS can effectively remove TSS, $NH4^{+}$-N and COD when combined with grassed swales, but the removal rate is related with the hydraulic retention time and adsorption capability of plant roots. An innovative and smart framework[12] was developed to combine permeable pavements, allowing water to infiltrate into the ground, with "smart" cisterns for rainwater harvesting, whereas an intelligent flood monitoring system using stream/river monitoring cameras provides real-time images of water revel. This innovative approach allows municipalities to reuse water in agricultural and landscape irrigation.

Reference/further readings

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