

# Sustainable small wastewater systems in Central and Eastern Europe: Case study Slovenia

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## Abstract

There is a big gap in establishment of small wastewater treatment plants in rural areas in Central and Eastern Europe. Numerous locations are going to be equipped with small wastewater treatment systems in the future. The selected treatment technology as well as the scale of wastewater collection (decentralized or centralized) are key factors affecting nutrient and water management. In Slovenia treatment wetlands have already been recognized as sustainable solution for small wastewater treatment systems. Moreover, compact systems for wastewater separation and reuse have been studied as well as zero-discharge evapotranspirative systems. The case study can contribute to change the water paradigm towards innovative and resource recovery oriented wastewater treatment systems.

## Keywords

Treatment wetlands, wastewater reuse, zero-discharge, wastewater management

## INTRODUCTION

In Central and Eastern Europe (CEE) numerous small settlements that currently lack proper sanitation are going to be equipped with wastewater collection systems and treatment plants in the future. In CEE (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, Slovenia, and Ukraine) almost 30% of the overall population (42 million people) lives in the settlements with less than 2000 inhabitants and only a handful of those is connected to wastewater treatment plants (Istenic et al., 2014). The current situation in the area of municipal wastewater treatment is a treatment of a mixture of all household waters in the same process usually at central wastewater treatment plant (WWTP) without perspective of closing material flows. After treatment the treated water is discharged into water bodies without any possibility of a re-use. The type of wastewater collection and selection of treatment technologies has a significant effect on water and nutrient management and thus on social, economic and environmental wellbeing of the society. This is of a special importance in rural areas where water and wastewater management can be integrated with water and nutrients needs in agriculture thus enabling sustainable solutions for both.

Due to scattered settlement small WWTP are common in Slovenia. Among treatment technologies, treatment wetlands (TW) are often used. The first TW in Slovenia was constructed 25 years ago. Since than horizontal (HF), vertical (VF), and hybrid systems were constructed. Today there are around 150 systems in operation, mostly HF. Research and development in the field of sustainable small WWTP is directed towards VF TW due to high performance (Brix and Arias, 2005; Langergraber et al., 2009). Moreover, technologies for wastewater separation and reuse as well as evapotranspirative systems with zero discharge are studied in the context of closing material flows.

## MATERIALS AND METHODS

A literature review was carried out on the status, presence and recognition of sustainable solutions for decentralised WWTP in CEE. Besides this, the efficiency of sustainable small WWTP in Slovenia was analysed from the view of pollutant removal as well as wastewater reuse.

## RESULTS

The review on the status of sustainable WWTP in CEE showed that different types of sustainable WWTP are used. There is a high level of knowledge regarding implementation and performance of TW at the scientific level; however, the transfer into practice is insufficient, and there is low awareness and recognition of TW at the institutional and administrative levels (Istencic et al., 2014).

### Case study Slovenia

Recently 32 novel single stage VF TW were installed with the capacity from 4 to 15 PE and footprint 1.5 m<sup>2</sup> / PE. Performance of VF systems was monitored by means of hydraulic loads, hydraulic retention time, and evaluation of physical and chemical parameters at inlet and outlet, targeted for the removal of BOD and COD only, to meet Slovenian legislation limits for WWTP < 50 PE, which are 30 mg/l and 150 mg/l, respectively. The wastewater separation unit and zero-discharge evapotranspirative systems are operating on a pilot scale.

**Table 1.** Performance of vertical flow treatment wetlands in Slovenia in mg/L (n=inflow; outflow).

	BOD <sub>5</sub> (n=2;15)	COD (n=14; 33)	TSS (n=1; 4)	TN (n=2; 5)	TP (n=2; 5)
IN (AVG±SD)	98.5±40.3	629±308	92.7	76.8±6.8	10.4±3.7
OUT (AVG±SD)	8.9±7.7	52.4±34.1	16.7±3.9	76.79±26.6	9.6±0.5

## DISCUSSION

In CEE there are different natural, social and economic conditions. An important characteristic of the region is the relatively high proportion of inhabitants living in the rural areas. Despite this, and the fact that nature-based WWTP are proved to be efficient and enable water reuse, they are used only marginally. In order to increase implementation of sustainable small WWTP, it is necessary to change the water paradigm by innovative wastewater management in rural areas. The performance results from Slovenia will be helpful in preparing national guidelines for TW with practical information about design, operational requirements, and efficiency to meet legislations demands.

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