A constructed treatment wetland as an opportunity to enhance biodiversity and ecosystem services

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A B S T R A C T

Today we have to face new challenges about decreasing water resources, wastewater treatment, limited spaces and ecological preservation. This problem must be solved in a sustainable way using innovative water management strategies that combine technology with landscape design by enhancing ecosystem services provision. An effective way of tackling this problem is to use Constructed Treatment Wetlands (CTW) as low-cost alternative to conventional secondary or tertiary wastewater treatment. The aim of this paper is to evaluate their multifunctional role in terms of biodiversity and ecosystem services’ enhancement by taking into account a case study in southern Italy. For this purpose an annual monitoring of fauna and vegetation has been carried out in order to identify species of national and international interest strongly related to the new habitats availability. Results have shown the ability of CTW in providing ancillary benefits, well beyond the primary aim of water purification, such as sustaining wildlife habitats and biodiversity at local and global scales, as well as its potential role in terms of recreational and educational opportunities.

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1. Introduction

Linkages between terrestrial and aquatic systems (Meyer et al., 1988; Likens and Bormann, 1995) lead to critical changes in freshwater systems that result from population growth and land use modifications. Today, 54% of the world’s population lives in urban areas, a proportion that is expected to increase to 66% by 2050 (United Nations, 2014). All populated areas, ranging from small rural communities to large urban settlements require adequate access to freshwater resources and, when cities grow in population, the total water needed for adequate municipal supply grows (Falkenmark and Widstrand, 1992; Postel et al., 1996; McDonald et al., 2011) as well as the need for a balance between wastewater disposal and water resource protection (Tarr et al., 1984; Burian et al., 2000). In this context, the European Community legislation sees the 91/271/CE Directive that aims at regulating the collection, treatment and discharge of urban wastewaters and those arising from certain industrial sectors, in order to protect water resources.

An adequate water resource protection is crucial since the ecosystem goods and services provided by freshwater systems are multiple, such as supporting numerous species, supplying water for drinking and irrigation, and assimilating wastes through abiotic/biotic cycling (MEA, 2005; Jackson et al., 2001). However, over the past fifty years, public attitude toward the environment has changed and also engineering has added sustainability to its general objectives to adapt itself to the demands of an evolving society (Davidson et al., 2007). This has produced a substantial change in how technology is designed and operates. In this sense, the application of sustainability criteria able to protect the provision of ecosystems goods and services is now the main focus (Wu, 2013), rather than environmental protection based on an end-of-pipe approach (Davidson et al., 2007).

The notion of ecosystem services has been introduced to identify the benefits people derive from the environment (Costanza et al., 1997; De Groot et al., 2002; Farber et al., 2002; CSE et al., 2003; Chee, 2004; MEA, 2005). Undoubtedly, the concept of ecosystem services is not just a semantic decision, but it is
integral to any process seeking to clearly illuminate trade-offs between natural resource management and policy (Petrosillo et al., 2010).

Since the concept of ecosystem services has been utilized in environmental planning and management (de Groot, 2006; Fisher et al., 2009), it can be also extended to ecological design and management of human dominated landscapes (Opdam et al., 2006; Nassauer and Opdam, 2008; Jones et al., 2013). The concepts of landscape design refers to all intensively used, managed, conserved, or restored landscapes where people have reshaped the spatial and functional heterogeneity of ecosystems for the benefit of themselves and sometimes nature (Musacchio, 2009).

One example of design and management of landscapes to improve the quality of wastewater before it is discharged to surface or groundwater and re-enters water supplies is the Constructed Treatment Wetlands (CTWs).

To improve water quality, wastewater plants should depend on natural treatment processes and low-carbon systems that rely on vegetative and microbial metabolism with little energy consumption (Cui and Jiang, 2011). The cleansing power of the natural treatments that mimic the humid ecosystems comes from a combination of physical, chemical and biological processes, such as microbial activity, the direct assumption by plants, sedimentation, filtration and adsorption (Brix, 1993). The continued development of this concept has allowed to apply successfully this approach to a wide range of polluted and wastewater sources including domestic sewage, industrial wastewater, landfill leachate, anaerobic digestate, mining waste, animal wastewater, urban storm water and

![Fig. 1. Location of the CTW under study.](image-url)
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