Chapter 12
Constructed Wetlands:
Description and Benefits of an Eco-Tech Water Treatment System

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ABSTRACT

Constructed Wetlands are an alternative, promising technology for water/wastewater treatment and pollution mitigation. They belong to the wider category of natural treatment systems. The main principle is to exploit natural materials (gravel, sand, plants) and naturally occurring processes under controlled conditions for treatment purposes. Constructed Wetlands have been characterized as an environmentally friendly, sustainable technology which provides multiple economic, ecological, technical and societal benefits. It is a rising technology which can be effectively used for domestic, municipal and industrial wastewater treatment, as also for sludge dewatering and drying. This chapter presents an overview of this eco-technology; its different types, main design considerations and various advantages over conventional treatment methods.

INTRODUCTION

The use of natural processes is not something new in waste/wastewater processes. Practically, most known technologies and techniques are based on these processes, such as sedimentation, filtration, biological activity etc, and are often constructed with complex and energy-consuming mechanical equipment. The difference that separates natural treatment systems from conventional ones is that only natural components are used for the treatment. Naturally occurring processes are utilized under a controlled environment, without the input of external energy source, unless perhaps for pump operation. Among the various natural treatment systems such as facultative and oxidation ponds, Constructed Wetlands (CWs) appear as one of the most promising eco-tech treatment methods, which have been attracting increasing worldwide interest. Their excellent treatment performance, coupled with an environmentally friendly character and reduced overall costs are gradually placing Constructed Wetlands in the forefront of the scientific and marketing interest. This chapter discusses the multiple environmental, economic

and technical advantages of these treatment systems and includes a brief description of their design and the wide range of their applications. These characteristics aim at presenting current research progress on sustainability issues in innovative wastewater treatment systems.

Background

Wetlands are considered today as natural systems with great ecological significance which provide habitat for numerous species and support their life. Natural Wetlands includes various benefits such as groundwater aquifer enrichment, control of flood incidents, absorption of carbon dioxide, heat storage and release, sediment trapping and other (Stefanakis, Akratos & Tsihrintzis, 2014). Their values can be translated in ecological, social, cultural and economic units (De Grot, Stuip, Finlayson, & Davidson, 2006). It was gradually realized that natural wetlands had always been capable of providing water purification and improving water quality, at least up until the point where industrial contamination had become so intensive. This observation initiated the investigation of re-assessing existing wetland purification potential. Natural wetlands have been utilized as disposal sites for secondary or tertiary wastewater effluents for many years, even some thousands years ago. Sewerage collection systems were constructed in the Zakros and Knossos Palaces during the Minoan era in the Greek Island of Crete, where nearby torrents and wetlands were used as disposal sites (Angelakis, Koutsoyiannis, & Tchobanoglous, 2005; Stefanakis et al., 2014). In modern times, the transition from Natural to Constructed Wetlands (CWs) was based on the potential exploitation of naturally occurring processes in a controlled environment for beneficial human and environmental usage and the healthy perpetuation of the natural environment. In this context, man-made Constructed Wetlands are designed to mimic and, thus, enhance the functions and operations of natural wetlands. While Constructed Wetlands generally offer the same functions and values as natural wetlands do, they also may appear as a more ecologically endowed system. Studies have shown that Constructed Wetlands possess a higher value in terms of flood and stormwater control, water quality improvement and biodiversity restoration (Ghermandi, Van den Bergh, Brander, De Groot, & Nunes, 2010). This may be because they are more easily integrated into the built infrastructure by urban planners, engineers, and landscape architects.

Today, the term "Constructed Wetlands" (also known as ""Treatment Wetlands" or "Reed Beds") refers to engineered systems which are designed to exploit under controlled conditions the processes that occur in nature (Stefanakis et al., 2014). Constructed Wetlands belong to the wider category of natural treatment systems which primarily rely on natural processes and/or natural components for wastewater treatment, where intensive use of external energy input can be avoided. Natural treatment systems are mainly classified into terrestrial, aquatic and wetland systems. Aquatic systems include stabilization or oxidation ponds and terrestrial systems slow rate systems and soil aquifer treatment (Stefanakis et al., 2014). Constructed Wetlands are in the middle of these two categories. The technology of Constructed Wetlands began with laboratory experiments in the Max Planck Institute in Germany in the 1950s. The first system in Europe was constructed in the 1960s and in the USA in the 1970s-1980s. Despite these early experiments and attempts, until the end of the 1980s Constructed Wetlands technology was not widely tested or utilized. Failure incidents of some of the first systems due to inadequate design, indicating lack of experience, and competition from conventional treatment methods in use for more than 80 years, were considered as the main initial obstacles for this limited expansion. However, over the last 20 years the interest for alternative treatment methods has increased and the Constructed Wetlands technology has experienced a tremendous increase in both research and applications, due to the simultaneous

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