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Ecological engineering technology enhances water quality, biodiversity, conservation success, ecological education and amenity values of Anteo Ecologial Park in Korea

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ABSTRACT

Anthropogenic wastewater discharges provide a major source of organic material (DOM and POM) that leads to oxygen depletion and eutrophication. Natural wetland reconstruction and ecologically engineered constructed wetland systems provide environmentally friendly ways to purify such waters in addition to other functions they have (e.g. water retention and safety, recovery, enhancement of biodiversity, environmental education). I present here the process of planning, design, construction and maintenance of a Sustainable Structured wetland Biotope (SSB) system in Korea, Anteo Reservoir ecological park. We particularly consider here ecological, environmental and natural features for an ecological restoration approach. The site-specific ecological and environmental analysis of Anteo revealed micro-climate topography hydrological process, water quality, and biodiversity. From here four major restoration goals were created: Hydrology and flood control/ Water purification/ Ecological restoration/ Ecological park. The created Anteo system treats polluted water by pumping it up from where it flows from a higher level down, meandering through the system on the wasteland. Water was sampled monthly at inlet and outlet from shortly after construction to subsequent years. Suspended solids, total phosphorus, total nitrogen, suspended solids and BOD5 were analyzed. After stabilization of the restored wetland the water purification showed an average efficiency of 60% or higher. Plants and animals (amphibians, reptiles) of the system were monitored during the whole period. The restoration of Anteo demonstrated that new laws are needed that meet the local condiditions within various procedures in the ecological restoration practice.

1. INTRODUCTION

In the course of recent excessive land development, biological habitats are rapidly lost due to urbanization, and industrial as well as by agricultural development (Byeon 2012; Kumarasamy et al. 2013, 2014). Particularly non-point source inflows cause

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pollution and a decrease of species diversity due to local extinctions or emigration (Byeon 2010a; Dahms et al. 2012, 2013; Heywood et al. 1995). This way several plant and animal species also become endangered. Ecological engineering technologies provide a way to improve environmental deteriorations (Harashina 2001). Free water surface systems (see US-EPA 1993, 1999a, b) are one of the promising engineering solutions for the improvement of water pollution (Byeon 2012). A milestone was provided by the development of a free water surface wetland “sustainable structured biotope” (SSB – sensu Byeon 2010a) with the main purpose of purifying non-point source polluted water. This became patented by the Korean government (Byeon 2010b). Besides water purification, such a free surface water SSB also provide other functions in enhancing habitat and biological diversity. It would also provide a better flood control and aesthethic values. These functions are the corner stones of integrated ecological restoration (Falk et al. 2006; Van Andel and Aronson 2006). Here, landscape architecture, civil engineering, art, design and environmental issues are combined multidisciplinarily (Byeon 2012). Such an attempt would also requires legal and institutional frameworks that need to be developed along with practical and theoretical guidelines for ecological and environmental restoration that fits site-specific characteristics (Byeon 2010c).

An Integrated Constructed Wetland, then called Anteo Ecological Park (AEP) at Anteo village in Gwang Myeong City, Korea, was created in 2005 as a novel way of treating a heavily polluted suburban and agricultural dumpsite. This project was jointly initiated by the Gwang Myeong City Council and Landscape Services Division, and National Parks and Wildlife Service of Korea. This restoration project followed a heavy conflict between developers who intended to built up the site and environmentalists who particularly wanted to protect a frog species of the 2nd level of endangered species in Korea – the Gold-spotted frog.

In this paper we will discuss necessary steps towards the establishment of theory and practice in ecological engineering and restoration making use of Anteo Ecological Park as an restoration example that now serves various functions.

2. APPROACH & REALIZATION

2.1. Strategies for ecological restoration

2-2. Inter-disciplinary convergence and integration

2-3. Directions of ecological and environmental site-specific restoration and urban development at Anteo -planning philosophy and strategy

2-4.Site-specific aspects

2-5. Designing AEP

2-6. Realization of AEP

3. After AEP construction – success control through water qualitymonitoring

3-1. Monitoring biodiversity

- Flora
- Central area of AEP
- The margin of AEP
- Mammals
- Birds
- Fish
- Amphibians
- Invertebrates
- Aquatic Invertebrates
- Semi-aquatic invertebrates
- Terrestrial invertebrates

4. CONCLUSIONS

The restoration effort of Anteo Ecological Park illustrates how engineering technologies allow to realize a set of ecological restoration objectives, such as enhanced water purification and biodiversity, protection of endangered species, environmental education, and recreation potential as an amenity value for the benefit of conservation and people. In the case of Anteo Ecological Park, a rather devastated rural dumpsite was transformed into a water purification unit where enhance biodiversity provides amenity values. It should be emphasized that enhanced biodiversity is not only a side benefit of the Anteo restoration efford. It is also a necessary prerequisite for the functioning of this constructed wetland. While only a small number of plant species were planted at the onset of the project our monitoring surveys revealed that several other aquatic plant and animal species have subsequently colonised the site. The constructed wetland has attracted species that can not otherwise be found in the area after this has become deteriorated due to anthropogenic effects. Colonizers indicate the success of the restoration effords in their variety. While, offering different ecological services they enhance the capacity to remove pollutants and further purify the existing water body. Wherever alien invasive species are threatening the restoration site they need to be regulated by appropriate eradication techniques. A potential threat are accumulating sediments that need to be dredged out of the system. If this is done cautiously and considering the time of year when this is done - outside the reproduction and nesting season, the impact on residing biota can be minimised. Excessive plant growth follows the eutrophying effects of enriched nutrient loads that can create an unsightly appearance. The removed material should then be recycled, through environmentally friendly composting.

The purification of water and underlying sediments was, offering habitats for a wide range of plants and animals in Anteo Ecological Park. This, has created a locally valuable site not only with enhanced biodiversity as such, but also a habitat for endangered species in a suburban setting of Korea. It also provides an excellent site for ecological and environmental education as well as for recreation. It is a model for successful ecological engineering practice with our hope that it will encourage similar projects elsewhere.

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