Revitalization of Topciderka river by biological systems for purification of polluted waters

Abstract

In larger settlements, such as the city of Belgrade, municipal wastewater is often mixed with industrial wastewater causing enormous damage to aquatic flora and fauna, preventing the use of surface water for recreational purposes, damaging the overall ambience of the river valley and more. Recognizing the aspirations of environmentally conscious society to perceived planning, management and protection of water as one of its main tasks, the Secretariat for Environmental Protection of the City of Belgrade granted at the tender Project "Revitalization of Topciderka river by biological systems for purification of polluted waters" to the Institute for Forestry from Belgrade in the year 2014. The main objective of the Project is to offer environmentally friendly, efficient and economically viable solution for the treatment and rehabilitation of polluted urban river flows. A pilot biological system for the treatment of polluted water was set up on the shore of the river Topciderka within the nursery of the State Enterprise for forest management "Srbijasume" Belgrade, FE "Belgrade" Belgrade in accordance with the fulfilment of the main objective. A biological system for the revitalization of Topciderka river has characteristics a temporary facility and it is set for the purpose of research in order to find suitable models of biological systems that would be used for water purification of other rivers, canals, ponds and lakes in the future. It is designed as a modified rhizofiltration system, which consists of a pump for the collecting of water from the river, an enclosed tank, four open rectangular cells in which floating islands with different vegetation are stored, an open rectangular cell with algae and recirculation pump. Decorative plant *Canna indica* L. (Indian shot) and decorative macrophytes - *Phragmites australis* (Cav.) Trin. ex Steud. (syn. *Phragmites communis* Trin., Common reed), *Iris pseudacorus* L. (Yellow iris), *Iris sibirica* 'Perry's Blue' (Siberian iris), *Alisma plantago - aquatica* L. (Common water-plantain), *Lythrum salicaria* L. (Purple loosestrife) and *Menyanthes trifoliata* L. (Bogbean) present the vegetation of floating islands. Upon start-up period experiments were carried out in order to determine the efficiency of the system itself. The sampling of water, substrate, plants and algae was done through all experiments.

The results obtained by determining efficiency of biological system with floating islands in treating polluted water showed that effluent into the biological system was classified as water with poor (Class V) and moderate (Class III) ecological status and that tested water at the outlet of biological system was characterised as water with excellent ecological status (Class I) based on the content of most of pollutants, which are the parameters for assessing the ecological status of waters. During the experimental period, it was concluded that the biological system was a good environment for the growth of selected plant species and algae. Plants and algae support the other physical, chemical and biological mechanisms for removal of pollutants from contaminated water in addition to accumulate the different metals in a biological system. The biological system with floating islands could have even greater performance with minor modifications.

The results obtained by determining phytoremediation potential of *C. indica* and selected decorative macrophytes in a biological system for the purification of polluted water showed that each species was able concentrate at least two or more different elements which are characterized as pollutants from contaminated water. It was concluded that there are differences in the efficiency of phytoremediation depending on the type of selected plants and that consequently vegetation of floating islands should comprise of mixed plantings of selected species. All studied species, except *M. trifoliata* grew quickly in a biological system

and thus created a considerable amount of below-ground and above-ground biomass. Species *C. indica* achieved the highest biomass production as compared to other species, while *L. salicaria* achieving the highest biomass production as compared to other decorative macrophytes. The results of this study showed that all tested species were resistant to different environmental conditions, pests and diseases, and that *C. indica* had a great regenerative ability. All tested species were also tolerant to a wide range of pollutants. Establishment of plants, their transplanting to a biological system and maintenance of floating islands vegetation were easy. Based on all these results it can be concluded that all selected species in a biological system, except *M. trifoliata*, are good candidates for biological treatment of polluted water. Even though *M. trifoliata* accumulated substantial amounts of targeted metals, this species is not characterized as a plant with a good phytoremediation potential in these studies, because it generated very small biomass during the vegetation period.

The results showed that the proposed System with floating islands is a technology that allows the achievement of ecological optimum with addition to the conservation and sustainability of natural resources. Since it does not require high investments, over a longer period of time proposed System with floating islands allows the quantitative and qualitative economic, social and other effects, so it is also economically acceptable. It was concluded that the implementation of this technology in practice can ensure treatment of polluted water based on natural processes without the use of various chemical substances and additional sources of energy. The proposed System with floating islands has greater flexibility for different cases in relation to other alternative systems for the treatment of polluted water. Unlike the conventional technology for water purification System with floating islands creates a reduced content of the waste at the end of treatment, which can serve as raw material for other technologies and thus facilitate the creation of additional profits. The implementation of the System with floating islands within the rivers, lakes and ponds may allow reclamation and reuse of water, nutrients and various biological resources, and restore the former biodiversity. During the research it was noted that the major obstacle to the implementation of the System with floating island, as well as other alternative biological system for the purification of polluted water is that they are not recognized by the laws and other relevant regulations of the Republic of Serbia.

The City Belgrade has a lot of potential areas for the establishment of System with floating islands that can help to restore and maintain the physical, chemical and biological integrity of the water. Locations that are important for the city and its inhabitants should be chosen as areas for presentation of the first projects. Through the demonstration of new good practices and involvement of the scientific community and the public at the beginning of the project it is possible to enable these stakeholders easy overview of all the advantages of the System and thus mitigate their potential resistance to the use of plants to clean polluted water.

Finally, it can be assumed that as the state budgets are being reduced, the price of water increased, federal or state norms became more stringent, simple, cost-effective and efficient systems for biological wastewater treatment and recycled in practice will have an increasing importance. Through the further development this technology could take a leading position in the process of wastewater treatment and revitalization of bodies of water in the future.