World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:14, No:11, 2020

The Role of Two Macrophyte Species in Mineral Nutrient Cycling in Human-Impacted Water Reservoirs

Authors : Ludmila Polechonska, Agnieszka Klink

Abstract : The biogeochemical studies of macrophytes shed light on elements bioavailability, transfer through the food webs and their possible effects on the biota, and provide a basis for their practical application in aquatic monitoring and remediation. Measuring the accumulation of elements in plants can provide time-integrated information about the presence of chemicals in aquatic ecosystems. The aim of the study was to determine and compare the contents of micro- and macroelements in two cosmopolitan macrophytes, submerged Ceratophyllum demersum (hornworth) and free-floating Hydrocharis morsus-ranae (European frog-bit), in order to assess their bioaccumulation potential, elements stock accumulated in each plant and their role in nutrients cycling in small water reservoirs. Sampling sites were designated in 25 oxbow lakes in urban areas in Lower Silesia (SW Poland). In each sampling site, fresh whole plants of C. demersum and H. morsus-ranae were collected from squares of 1x1 meters each where the species coexisted. European frog-bit was separated into leaves, stems and roots. For biomass measurement all plants growing on 1 square meter were collected, dried and weighed. At the same time, water samples were collected from each reservoir and their pH and EC were determined. Water samples were filtered and acidified and plant samples were digested in concentrated nitric acid. Next, the content of Ca, Cu, Fe, K, Mg, Mn, Ni and Zn was determined using atomic absorption method (AAS). Statistical analysis showed that C. demersum and organs of H. morsus-ranae differed significantly in respect of metals content (Kruskal-Wallis Anova, $p<0.05$). Contents of Cu, Mn, Ni and Zn were higher in hornwort, while European frog-bit contained more Ca, Fe, K, Mg. Bioaccumulation Factors (BCF=content in plant/concentration in water) showed similar pattern of metal bioaccumulation – microelements were more intensively accumulated by hornwort and macroelements by frog-bit. Based on BCF values both species may be positively evaluated as good accumulators of Cu, Fe, Mn, Ni and Zn. However, the distribution of metals in H. morsus-ranae was uneven – the majority of studied elements were retained in roots, which may indicate to existence of physiological barriers developed for dealing with toxicity. Some percent of Ca and K was actively transported to stems, but to leaves Mg only. Although the biomass of C. demersum was two times greater than biomass of H. morsus-ranae, the element off-take was greater only for Cu, Mn, Ni and Zn. Nevertheless, it can be stated that despite a relatively small biomass, compared to other macrophytes, both species may have an influence on the removal of trace elements from aquatic ecosystems and, as they serve as food for some animals, also on the incorporation of toxic elements into food chains. There was a significant positive correlation between content of Mn and Fe in water and roots of H. morus-ranae ($R=0.51$ and $R=0.60$, respectively) as well as between Cu concentration in water and in C. demersum ($R=0.41$) (Spearman rank correlation, $p<0.05$). High bioaccumulation rates and correlation between plants and water elements concentrations point to their possible use as passive biomonitors of aquatic pollution.

Keywords : aquatic plants, bioaccumulation, biomonitoring, macroelements, phytoremediation, trace metals
Conference Title : ICEB 2020 : International Conference on Ecosystems and Biodiversity
Conference Location : Singapore, Singapore
Conference Dates : November 19-20, 2020