




Article

Assessment of Potential Toxic Metals in a Ramsar Wetland, Central Mexico and its Self-Depuration through *Eichhornia crassipes*

J. Tabla-Hernandez ^{1,*} , P. F. Rodriguez-Espinosa ^{1,*} , J. A. Mendoza-Pérez ²,
E. Sánchez-Ortíz ³ , E. Martínez-Tavera ⁴ and A. G. Hernandez-Ramirez ¹

¹ Instituto Politécnico Nacional—Centro Interdisciplinario de Investigaciones y Estudios sobre Medio Ambiente y Desarrollo (IPN-CIEMAD), Calle 30 de junio de 1520, Barrio de la Laguna Ticomán, Alcaldía Gustavo A Madero C.P. 07340, CDMX, Mexico; gabo_heera@hotmail.com

² Instituto Politécnico Nacional—Escuela Nacional de Ciencias Biológicas (IPN-ENCB), Av. Wilfrido Massieu SN, San Bartolo Atepehuacan, U.P. Adolfo López Mateos, Gustavo A. Madero C.P. 07738, CDMX, Mexico; jorgemendozaperez@yahoo.com

³ Instituto Politécnico Nacional—Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional Unidad Durango (IPN-CIIDIR, Unidad Durango), Calle Sigma #119, Fracc. 20 de Noviembre II, Durango Dgo. C.P. 34220, Mexico; eduardo.sanchezortiz@gmail.com

⁴ Universidad Popular Autónoma del Estado de Puebla (UPAEP), 17 Sur No. 901 Barrio de Santiago, C.P. 72410 Puebla, Pue., Mexico; estefmtzt@hotmail.com

* Correspondence: jacobotabla@hotmail.com (J.T.-H.); pedrof44@hotmail.com (P.F.R.-E.); Tel.: +52-(55)-57296000 (ext. 52711) (J.T.-H.)

Received: 7 May 2019; Accepted: 12 June 2019; Published: 14 June 2019



Abstract: The Valsequillo reservoir is a Ramsar wetland due to its importance as a point of convergence of migratory waterfowl. It is located in Central Mexico and is currently endangered by the constant spill of municipal and industrial discharges from Puebla city. On this context, we evaluated thirteen potential toxic metals (PTMs) in water, Water hyacinth (*E. crassipes*) plants and sediments at this site. A combined number of 31 samples were collected from the study area. The degree/extent of metal contamination in sediments was assessed through different geochemical indexes, namely: Geoaccumulation index (I_{geo}), Enrichment Factor (EF) and Potential Ecological Risk Index (PERI). The ability of Water hyacinth plants residues as a phytodepurator in the Ramsar site was tested in terms of the bioaccumulation factor (BF) and the translocation factor (TF). The results concerning sediments showed that Pb, Cu and Hg pose a threat to the aquatic environment since I_{geo} and EF indicate sediments ranging from moderately contaminated to contaminated. Moreover, PERI pointed out Hg as the main contributor to the ecological risk in sediments, especially in the part of the reservoir covered by *E. crassipes*. Water hyacinth plants displayed good capacity to absorb PTMs from the water, since the content of Co, Zn, As, Ni, Cu, Pb, Ti, Cr, Ba, Mo and V in the total plant was (all values in mg/kg of dry weight) 21 ± 9 , 408 ± 300 , 12 ± 6 , 93 ± 21 , 93 ± 69 , 53 ± 29 , 1067 ± 643 , 78 ± 55 , 362 ± 39 , 14 ± 0.6 and 96 ± 35 , respectively. Metal content in sediments resembles to that of *E. crassipes*; especially in the roots, suggesting a constant deposition of plants at the bottom of the reservoir, which contributes to the eutrophication of the water. The present work encourages the need for a sustainable management of Water hyacinth plants in the Ramsar site, since they represent a plague and a natural phyto-depurator at the same time.

Keywords: ecological risk; enrichment factor; phytoremediation; potential toxic metals; translocation factor; bioaccumulation factor; Ramsar site; surface sediments