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Constructed Wetlands and Aquatic Phytoremediation: Nature-Based Solutions for Water Purification

Basim, S. A. Al Sulivany[1], Fehmi Boufahja[2], Gabriel Plavan[3], Dilara K. Sunakbaeva[4*], Abdol Ghaffar Ebadi[5]

[1]Department of Biology, Faculty of Science, University of Zakho, Zakho, Iraq
[2]Biology Department, College of Science, Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh, 11623, Saudi Arabia
[3]Department of Biology, Faculty of Biology, "Alexandru Ioan Cuza" University, Bvd. Carol I, No. 20A, 700505, Iasi, Romania
[4]Faculty of Sciences, Department of Ecology and Chemistry, Khoja Akhmet Yassawi International Kazakh-Turkish University, Turkestan, Kazakhstan
[5]Researcher and Faculty member, Jouybar branch, Islamic Azad University, Jouybar, Iran
*Presenter Author's Email: dilara.sunakbayeva@ayu.edu.kz

Abstract

Constructed wetlands (CWs) leverage the phytoremediation potential of aquatic vegetation to remove polluted water through natural biological processes. This current review offers a comprehensive overview of different CW types—free water surface, subsurface flow, and hybrid systems—and their efficiencies in removing nutrients, pathogens, heavy metals, and organic contaminants. Special emphasis is laid on the selection of appropriate macrophytes such as *Phragmites australis*, *Typha latifolia*, and *Eichhornia crassipes* with elevated uptake and tolerance capacity. The mechanisms of pollutant removal are through sedimentation, root zone filtration, microbial breakdown, and uptake by the plant. Urban landscape and agriculture landscape case studies highlight efficient CW usage in wastewater treatment, stormwater management, and industrial effluent regulation. The integration of CWs with green infrastructure and urban planning is a term used to explain a sustainable decentralized wastewater treatment system. The invasiveness of plants, seasonality, and long-term maintenance issues are also clarified. CWs present an environmentally friendly, low-energy, and cheap option in congruence with water security and sustainable development strategies.

Keywords: Constructed wetlands, Aquatic phytoremediation, Macrophytes, Wastewater treatment, Green infrastructure, Nature-based solutions