CONSTRUCTED WETLANDS FOR WASTEWATER REUSE AND RENEWABLE-ENERGY-DRIVEN IRRIGATION IN TRINIDAD AND TOBAGO, WEST INDIES

Michelle Shah*; Hazi Azamathulla; Kiran Tota-Maharaj*****

*Ph.D. Research Scholar,
Director,
Water, Energy and Environmental Engineering (WEEE) Research Cluster,
Royal Agricultural University, Cirencester, Gloucestershire GL7 6JS, United Kingdom.
Land and Water Development Division,
Ministry of Agriculture and Fisheries,
Centeno, Trinidad and Tobago, West Indies.
Email Id: Michelle.Shah@student.rau.ac.uk

**Professor of Civil & Environmental Engineering,
The University of the West Indies,
St. Augustine Campus, Trinidad and Tobago, West Indies.
Email Id: hazi.azamathulla@sta.uwi.edu

***Professor & Chair,
Water Resources Management & Infrastructure,
Royal Agricultural University,
Cirencester, Gloucestershire GL7 6JS, United Kingdom.
Email Id: Kiran.Tota-Maharaj@rau.ac.uk

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ABSTRACT

Constructed Wetlands are engineered systems designed to imitate natural wetlands for wastewater treatment. They utilise soil, plants and microbes to filter out pollutants and use macrophytes to absorb nutrients. This study adopts a mixed-methods research design to evaluate pollutant removal efficiencies and wastewater reuse potential using integrated nature-based solutions (NbS) and renewable energy solutions. Removal of key water quality parameters (BOD_5, COD, TSS, NH_4-N, PO_4^{3-} and E. coli*) was assessed by varying geotextile membrane types and biofilter media in experimental treatment rigs. Treatment performance was compared for reclaimed water (RW), conventional irrigation water (CW), and secondary effluent (SW) using a Wastewater Reuse (WWR) prototype. Horizontal flow constructed wetlands planted with* Phragmites australis *was designed with a cross-sectional area of 3.75 m^2, hydraulic loading rate of 0.8 $m^3 m^{-2} day^{-1}$, and flow rate of 3 $m^3 day^{-1}$, operating at retention times of 24–120 h. Field trials achieved average removal efficiencies of 75.99% (BOD), 76.16% (COD), 57.34% (TDS), 62.08% (nitrate), 58.03% (phosphate), and 57.83% (potassium). The study further evaluated a solar-powered automated drip irrigation system to quantify water savings, energy consumption, and crop yield outcomes. Knowledge, Attitudes, Practices, and Willingness to Pay were assessed to inform national wastewater reuse standards, supporting sustainable Water-Energy-Food-Ecosystems nexus.*

KEYWORDS: *Wastewater Reuse; Constructed Wetlands; Geotextiles; Solar-Powered Irrigation; Water Quality; WEFE Nexus.*

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