


Chapter 6

Enhancing Wastewater Stabilization Ponds for Treating Domestic Wastewater Using Machine Learning

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ABSTRACT

In the realm of wastewater treatment, Wastewater Stabilization Ponds (WSPs) are highly regarded for their efficiency, particularly when incorporating baffle walls (BW) into their design. These BWs play a crucial role in minimizing space requirements and improving contaminant removal, albeit at the expense of increased construction material usage. To find the best configuration, a thorough analysis was first carried out utilizing typical methodology (TM) design worksheets for WSPs. This phase validated the effectiveness of BWs by showing a considerable reduction

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in both WSPs area and hydraulic retention time (RT). Within the MM framework, additional reductions in WSPs area and RT were attained, coupled with a 5% drop in necessary concrete volume compared to TM, by employing the interior-point approach in MATLAB and the generalized reduced gradient (GRG) algorithm in MS Excel Solver. While these findings highlight the effectiveness of MM in optimizing WSPs, there is potential for exploring alternative algorithms to achieve more favorable results.

1. INTRODUCTION

In areas such as Turkey where water resources are scarce, managing wastewater sustainably is critical for maintaining sensitive ecosystems as well as public health (Dolgen, D. et al., 2023). With a significant portion of its water budget allocated to agriculture (73%), Turkey faces considerable pressure on its freshwater reserves (Ali, H. Q. et al., 2023). Consequently, the construction of effective and cost-efficient wastewater treatment technologies is necessary (Demirel, D. F. et al., 2022). Using treated wastewater for irrigation offers a twofold purpose: reducing water scarcity and increasing agricultural sustainability by providing a consistent and cost-effective water source (Ersoy Tonyaloğlu, E. et al., 2023). Turkey faces hurdles in modernizing its wastewater treatment system due to limited resources, demanding innovative solutions (Hafeez, A. et al., 2021). According to recent studies, only approximately half of Turkey's wastewater is treated, causing hazards to aquatic life and ecosystems as untreated wastewater is dumped into the environment (Ali, H. Q. et al., 2023). To overcome these difficulties, Turkey should improve its wastewater treatment systems, especially in rural and peri-urban areas (Kookana, R. S. et al., 2020). When choosing a wastewater treatment system, it's important to prioritise both good effluent quality and cost-effectiveness (Magwaza, S. T. et al., 2020). Encouraging the adoption of natural wastewater treatment methods by the Turkish government is advisable due to their environmental friendliness and economic viability. This study uses wastewater stabilisation ponds (WSPs) to meet Turkish class B irrigation criteria, resulting in a stable and cost-effective water source for agriculture.

In Turkey, the climate exerts a significant influence on various aspects of life (Canturk, U. et al., 2021). Northern Turkey experiences mild and rainy conditions, while the southern regions are characterized by hot and dry weather (Okur, B. et al., 2020). Turkey's climate, which has seven different climatic zones, is important for natural wastewater treatment systems (Tlhagale, M. et al., 2022). Wastewater Stabilization Ponds (WSPs) are widely acknowledged as the most cost-effective and ecologically sustainable approach for treating wastewater (Vagheei, R. 2021). Climates have an impact on the design area of WSP systems, which is inversely

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