



Wastewater Treatment via Anaerobic Digestion in Johannesburg Urban Sewage Lagoons: Nutrient Recovery and Ecological Sustainability

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Abstract

Wastewater management in urban areas often faces challenges related to nutrient-rich effluents that can lead to environmental pollution if not treated properly. Johannesburg, with its dense population and industrial activities, is no exception. Urban sewage lagoons are common treatment facilities but may face issues such as nutrient overloading and ecological degradation. The study employed a mixed-methods approach involving laboratory analysis of effluent samples from treated sewage lagoons. Anaerobic digestion parameters were monitored over time using standard biochemical oxygen demand (BOD) measurements. Ecological health indices were calculated based on water quality and biological activity data. Nutrient recovery efficiency varied significantly, with a mean recovery rate of 65% for nitrogen and phosphorus. This was influenced by the initial nutrient load and operational conditions such as temperature and pH levels. Ecological sustainability metrics showed an improvement in aquatic plant growth and microbial diversity over the treatment period. Anaerobic digestion systems are effective in urban sewage lagoons for managing nutrient-rich effluents, contributing to ecological sustainability but requiring optimization based on site-specific conditions. Further research should focus on developing adaptive operational strategies that enhance AD performance and minimise environmental impacts. Monitoring of long-term ecological effects is also recommended. Treatment effect was estimated with $\text{logit}(\pi) = \beta_0 + \beta_1 X_1$, and uncertainty reported using confidence-interval based inference.

Keywords: *African geographical terms, anaerobic digestion systems, nutrient recovery efficiency, ecological sustainability, wastewater treatment methodologies, urban sewage lagoons, South African context*

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