

Abstract

Kenya faces growing challenges in managing wastewater due to rapid urbanization, population growth, and limited investment in treatment infrastructure. Conventional wastewater treatment systems are often costly, centralized, and inadequately enforced, leaving many communities—particularly in rural and peri-urban areas—without safe and sustainable sanitation solutions. Biochar, a porous, carbon-rich byproduct of biomass pyrolysis, has gained attention globally for its capacity to enhance wastewater treatment through mechanisms such as heavy metal adsorption, nutrient capture, and organic pollutant removal. This paper critically reviews the role of biochar in sustainable wastewater management in Kenya, beginning with a discussion of biochar's physicochemical properties and production methods, particularly from locally available agricultural feedstocks like maize cobs and sugarcane bagasse. The paper outlines the current landscape of wastewater management in Kenya, highlighting gaps in regulatory enforcement, insufficient treatment capacity, and the pressing need for decentralized, low-cost alternatives. Existing research and pilot projects in Kenya demonstrate the potential of biochar when integrated into systems like constructed wetlands and biofiltration units, with promising treatment efficiencies. However, broader adoption is hindered by several challenges, including variability in biochar quality, limited local production infrastructure, high production costs, lack of supportive policies, and low public and institutional awareness. Looking forward, the paper identifies opportunities to scale up biochar-based treatment through increased research, community-based innovations, policy integration, and multi-stakeholder partnerships. It emphasizes the alignment of biochar solutions with circular economy principles and their contribution to climate resilience and Sustainable Development Goal 6: Clean Water and Sanitation. The review concludes that biochar represents a practical and scalable approach to enhancing wastewater treatment in Kenya. With targeted investment, supportive policy frameworks, and enhanced awareness, biochar can play a significant role in transforming the country's sanitation landscape.