Greenhouse Gas Inventorization of India's Waste Sector Using the IPCC Tier 2 Methodology: Integration of AI Models for Adaptation, Mitigation, and Policy Impact Analysis

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ABSTRACT

The waste sector, encompassing solid waste disposal, wastewater treatment, and waste incineration, is a significant contributor to India's greenhouse gas (GHG) emissions, primarily through methane (CH_4) and nitrous oxide (N_2O), which have high global warming potentials. The rapid increase in population and urbanization in India has significantly intensified the challenges associated with solid waste management and methane emissions. Despite its relatively smaller contribution, the waste sector presents viable opportunities for emission reductions. Implementing improved waste management practices not only reduce GHG emissions but also offer co-benefits like improved public health and resource conservation.

This study provides a comprehensive GHG inventorization of India's waste sector for the years 2021 and 2022, employing the IPCC tier-2 approach using IPCC inventory software and spreadsheet model for a detailed analysis of activity data and region-specific emission factors. The research covers municipal solid waste, wastewater, and other waste streams, delivering a granular emission profile. To address mitigation and adaptation challenges, Artificial Intelligence (AI) models are integrated into the analysis to evaluate waste management strategies, project future emissions, and assess the effectiveness of interventions such as methane capture, composting and policy instruments like carbon pricing and incentives.

The findings can contribute to India's national communication and climate commitments under the Paris Agreement, providing actionable insights for policymakers and stakeholders. This paper highlights the transformative potential of AI-driven solutions in GHG management and their alignment with sustainable national waste policies and global climate objectives.

Keywords: Methane emissions, IPCC Inventory Software, Sustainable waste policies, Carbon pricing, Climate commitments