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Application of Life Cycle Assessment to Evaluate Environmental Impacts of Municipal Solid Waste Management: A Case Study of Karadiyana, Sri Lanka

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Abstract

Municipal solid waste management in developing countries faces the dual challenge of minimizing environmental impacts while operating with limited resources. In Sri Lanka, large waste treatment facilities and open dumpsites are associated with growing environmental concerns, but detailed environmental assessments remain limited. The Karadiyana Waste Management Facility processes a substantial share of municipal waste from the Western Province and has significant impacts on nearby ecosystems. This study presents the first Life Cycle Assessment (LCA) of the Karadiyana facility, providing insights to support future improvements in waste management. The main objective of this study is to assess the environmental impacts of municipal solid waste treatment options using a gate-to-gate LCA framework using a functional unit of treatment of one tonne of municipal solid waste. The assessment focuses on waste treatment processes within the facility, from waste reception to treated outputs. Primary data on waste quantities, composition, and facility operations were collected from the waste management facility and the Waste Management Authority through operational records, site observations, and interviews with facility personnel. Secondary data and emission factors were obtained from IPCC guidelines and relevant literature. Environmental impacts were assessed using the ReCiPe 2016 Midpoint method in SimaPro across 18 impact categories, and the results were normalized to support comparative interpretation. Normalization results indicate clear differences among the evaluated midpoint impact categories. Global warming exhibits the highest normalized value. Freshwater eutrophication, freshwater ecotoxicity, and human carcinogenic toxicity show comparatively higher normalized values relative to other impact categories. The characterization results indicate that the global warming potential is primarily driven by untreated waste within the municipal solid waste management system boundary, due to Methane (CH_4) emissions generated during waste degradation. These findings highlight that current municipal solid waste management practices in Sri Lanka are linked to significant environmental impacts and underscore the need for targeted improvements to mitigate these effects.

Keywords: *Environmental life cycle assessment, Impact categories, Municipal solid waste, Waste management, Simapro, ReCiPe 2016*