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ASSESSING THE ENVIRONMENTAL IMPACT OF OPEN LANDFILL SITES BY QUANTIFYING PLASTIC EMISSIONS AND ESTIMATING THE PLASTIC RETENTION POTENTIAL OF SURROUNDING AREAS

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ABSTRACT

Although waste generation rates in developing countries can be relatively low, an upward trend has been observed in recent years. The positive development of increasing income levels and overall better living conditions goes hand in hand with an increasing fraction of plastic waste. Municipal services and the respective infrastructure systems often struggle to match population growths and increasing volumes of waste. As a result, a large percentage of mismanaged plastic waste poses a risk to the urban and natural environment. Improvements at final disposal sites, like the transformation of open dump sites into semi-engineered landfills or closing off dump sites and opening sanitary landfill sites can be an important step to curtail the uncontrolled discharge of plastic into the environment. When authorities want to address these gaps in their solid waste management infrastructure systems, they often face budgetary constraints and subsequently have to carefully plan these interventions, since they might require significant investment, as well as a steady provision of funds for operation, maintenance and monitoring. Therefore, it is important to have a clear understanding of the environmental impact of existing open dump sites, which might vary significantly from site to site. Although, there are plenty of investigations on greenhouse gas emissions and leachate, only few studies address plastic discharge from landfill sites. By quantifying plastic emissions from dumps and evaluating the further transport into the greater environment, authorities will have a solid baseline to make informed decisions on how to prioritize the implementation of measures, not only at the disposal sites themselves but within the greater context of their respective solid waste management system.

In recent years, a number of models have been developed to quantify plastic emissions from land-based activities. To develop a robust model specifically to quantify plastic leakage from open dump sites, this study provides a comprehensive overview over these existing model and approaches and summarizes the respective methodologies and data requirements. In addition, an on-site assessment of Rajbandh open dump site, the final disposal site for the city of Khulna (population approx.1.5 million people) is conducted to furhter review the previously identified models. Hereby, structural elements and formal operations as well as uncontrolled activities are identified. Based on these findings, a qualitative material flow analysis is developed. The three major pathways of plastic losses from dump sites to the environment are identified as flooding, water and wind erosion. Minor pathways might be leachate and

animal activity. Informal waste pickers create a return flow into the urban environment by removing a majority of the recyclable, and thus valuable plastic fraction. With accidental or purposely set fires the plastic mass within the waste body might be significantly reduced. Based on Yadav et al. (2020), each plastic waste flow along these identified pathways is characterized with regard to particle mass, shape, size and density. An appropriate dispersion and transport model is proposed for each pathway which also reflects the affected environmental compartment (air, water or terrestrial) and all mass flows are determined. Due to the varying quality of available datasets, the confidence in results differs significanly.

In a next step, the surrounding environment is taken into account. With the premise, that the negative impact of open dump sites can be mitigated if the surrounding environment offers sufficient retention capabilities, this study proposes a method to determine a retention potential for different geographical features, such as ponds, forest, open grass land or wetland. In the case study of the Rajbandh site in Bangladesh, the immediate surrounding area is classified into 16 ponds (see Figure below), two wetlands and one grassland feature. Each of these classes is characterized with regard to the five plastic retention mechanisms: adhesion, entanglement, sedimentation, deposition and entrapment.

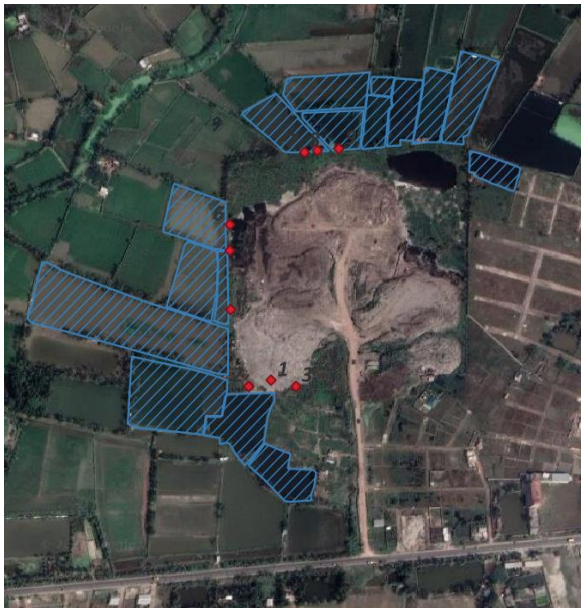

Figure: Dumpsite area with surrounding waterbodies (blue hatched areas) (image source: QGIS with Google Satellite, 2022)

Based on preliminary findings and literature references, the retention potential of the surrounding ponds significantly mitigates the plastic emissions of the Rajbandh site into the greater environment and ultimately into the riverine ecosystem of the Rupsa River.

Keywords: plastic waste, landfills, modelling, developing countries, Bangladesh

REFERENCE

Yadav, V., Sherly, M. A., Ranjan, P., Tinoco, R. O., Boldrin, A., Damgaard, A., & Laurent, A. (2020). Framework for quantifying environmental losses of plastics from landfills. Resources, Conservation and Recycling, 161, 104914.

