Forecasting plastic leakage from MSW disposal in Thailand

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INTRODUCTION

Thailand was ranked among the top ten countries polluting the world with mismanaged plastic waste (Jambeck, J.R., Geyer, R. et al., 2015). As approximately 22% of municipal solid waste (MSW) generation in 2019 was improperly disposed (PCD, 2020), the problem persists and could worsen during the Covid-19 pandemic. To tackle plastic pollutions, information such as sources and pathway of plastic waste could be useful for planning effective measures. This study aimed to quantify the amount of municipal plastic waste (MPW) in Thailand; estimate the leakage in the environments due to the improper disposals; forecast the leakage in 2020–2030; and present a mass flow of MPW under a business-as-usual scenario.

MATERIALS AND METHODS

Three linear regression models and four grey models were used in forecasting MSW generation. MSW data for 2008 – 2017 was used for model training and 2018 – 2019 for model validation. The independent comprised the population number and gross domestic products. Forecasts from the model with the lowest mean absolute percentage error were then used to estimate the MPW leakage as shown in the equation below.

$$MPWleakage_{yrX} = MSWgeneration_{forecast,yrX} \times \%ImproperlyDisposedMSW_{yr2019} \times \%Plastic_{proxy}$$

A proxy value for plastic content (wt %) in MSW was derived from (1) reviewing the literature, including city statistics, government reports and manuscripts published from 2008 to 2018, and (2) waste samplings at six landfills located in different regions of Thailand during 2018 – 2019. The possible MPW leakage to the Gulf of Thailand and the Andaman Sea was estimated as the summation of MPW leakages from provinces with partial or all areas located within 50 km of the coast. Finally, a mass flow diagram of MPW under a business-as-usual (BAU) scenario was produced using STAN (version 2.6.801). The assumptions for BAU scenario were that, in all years, (1) the proportion of MSW that was utilized, properly disposed, and improperly disposed was constant at 43.6%, 34.2% and 22.2%, respectively; and (2) the proportion of improperly disposed MSW that was sent to open dumpsites, controlled dumpsites (>50t/d), incinerations without air pollution control, and open burning was constant at 89.6%, 4.9%, 3.3% and 2.2%, respectively.

RESULTS AND DISCUSSION

The proxy range for plastic content in MSW was chosen to be 7– 25 wt%. The forecasting model with the lowest MAPE (=0.54) was GM(1,1). Under the BAU scenario, the total amount of MPW leakage was 0.451–

1.613 Mt/yr in 2020 and would increase to 0.534–1.907 Mt/yr by 2030 (Figure 1). The 2030 figures corresponded to approximately 3,672–13,114 GWh_{th} if the waste was used as fuel. Up to 1.803 Mt/yr of MPW would be improperly disposed on dumpsites (Figure 2). Meanwhile, about 0.104 Mt/yr of MPW would be burned, releasing more than 0.287 $MtCO_2$ and other pollutants from incomplete combustion to the atmosphere. There are 26 provinces with partial or all areas located within 50 km of the coast, contributing to 43.4% of the total MPW. Their MPW leakage were 0.213–0.761 Mt/yr in 2020 and would increase to 0.232–0.828 Mt/yr by 2030. The biggest contributors were Samut Prakan Province (20%), and Pathum Thani Province (5%).

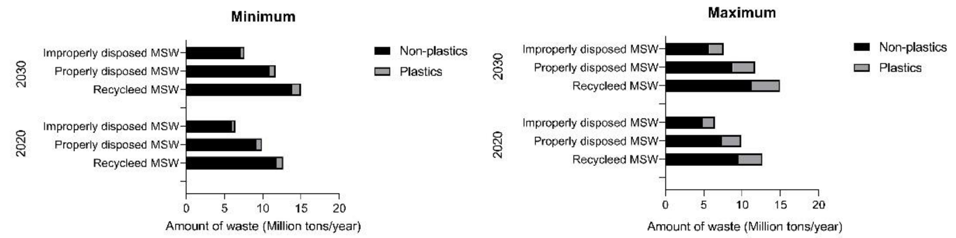

Figure 1 Forecasts of MPW in improperly disposed, properly disposed, and recycled portion.

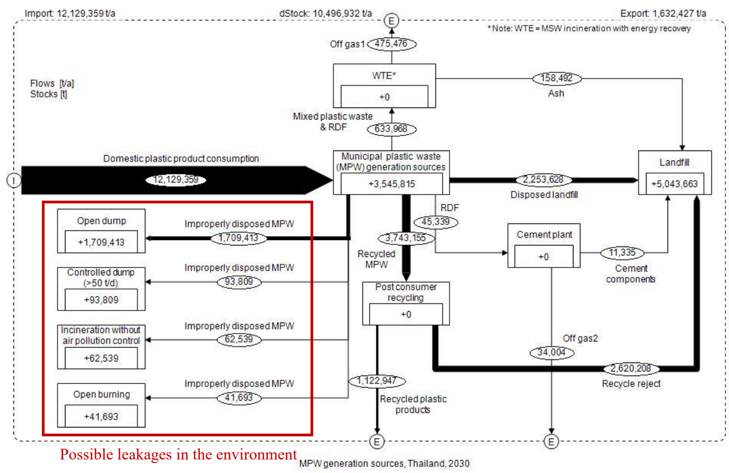

Figure 2 A mass flow diagram of MPW in 2030, under a business-as-usual scenario

CONCLUSION

Results from this study showed key pathways and hotspots for MPW leakage. With an increasing capacity of waste-to-energy plants and larger demands from cement industry, MPW leakage would be soon reduced. There could also be more MPW on recycle route if there is a higher degree of waste sorting at sources.

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