

# Modelling the Solid Waste Flow into Sungai Ikan Landfill Sites by Material Flow Analysis Method

Latifah A. Ghani<sup>a\*</sup>, Nora'aini Ali<sup>b</sup> and Nur Syafiqah A.Hassan<sup>c</sup>

<sup>a</sup>School of Social Development and Economic, Universiti Malaysia Terengganu, 21030 Kuala Nerus, Malaysia,

<sup>b,c</sup> School of Ocean Engineering, University Malaysia Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia

<sup>a\*</sup>latifah.ghani@umt.edu.my

**Abstract.** The purpose of this paper is to model the material flow of solid waste flows at Kuala Terengganu by using Material Flow Analysis (MFA) method, generated by STAN Software Analysis. Sungai Ikan Landfill has been operated for about 10 years. Average, Sungai Ikan Landfill receive an amount around 260 tons per day of solid waste. As for the variety source of the solid waste coming from, leachates that accumulated has been tested and measured. Highest reading of pH of the leachate is 8.29 which is still in the standard level before discharging the leachate to open water which pH in between 8.0-9.0. The percentages of the solid waste has been calculated and seven different types of solid waste has been segregated. That is, plastics, organic waste, paper, polystyrene, wood, fabric and can. The estimation of the solid waste that will be end as a residue are around 244 tons per day.

## 1. Introduction

The inclining of the population in Malaysia did not just increasing the level and the rate of solid waste produced per day of per capita. Other than incineration, composting, burning, solid waste typically will be sent to landfill. Based on CIA Factbook on Malaysia, as estimated in July 2016, the population of Malaysia are reaching 30,949,962 people across the country. A studies that were run by government on last year showed that the average Malaysian produced almost 1 kilogram of solid waste per capita per day [1]. Referring to the number of Malaysian's population on average solid waste produced per person, it is not impossible to predict that the amount of solid waste produced will rise up to 30, 000 tons per day by year 2020 [2]. Therefore, the main objective of this study focused on to analyzed amount and composition of solid waste at the Sungai Ikan Landfill that will end up as residues. Other than that, this study will also provide us with the percentage of solid waste portion and characterization of leachate composition currently.

## 2. Material and Method

### 2.1. Area of Study

Sungai Ikan Landfill (SIL) has been operated for almost 10 years and now categorized as level 4 landfill (Sanitary landfill with leachate treatment facilities). It has been upgraded and transformed by Hexagon Energy. At the early operation of SIL, crude dumping and burning became the cause of



concern among the residents because of the close parameter with Sungai Nerus, Terengganu, Malaysia. What makes the condition become worst is during the monsoon season, leachate that came from the landfill, contaminated the river. In the year 2014, in history of Malaysia, one of the worst flood has occurred, which has risen the concern of SIL where efforts were made to make an eco-friendly landfill by using geotextile to trap leachate and other contaminants. The new design that were managed by Hexagon Synergy, includes the constructions of leachate collection system, a recycling central and tidal gate [3].



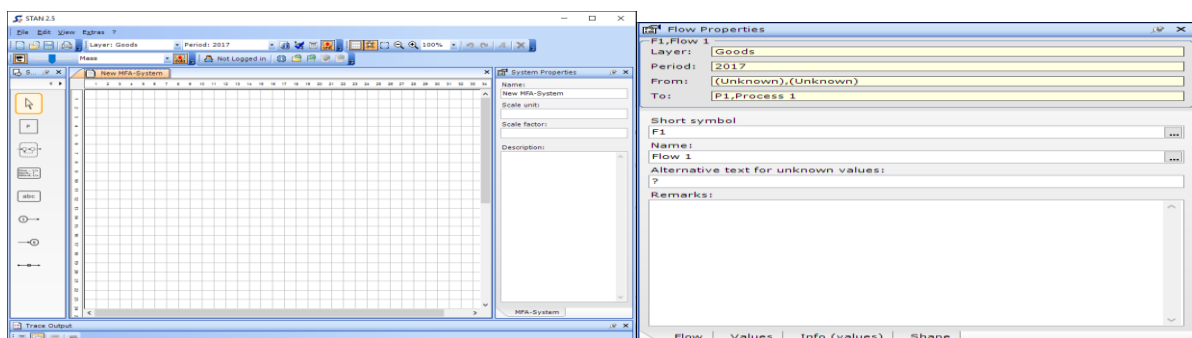
**Figure 1.** Sungai Ikan Landfill illustrated by Hexagon Energy with the Leachate Retention Ponds

## 2.2. MFA Methods

Material flow analysis comprises several elements as been listed out [4]: a system analysis comprising goods and processes, determination of the mass fluxes of all the goods per unit of time, determination of the concentration of the selected elements in this goods, calculation of the mass and fluxes from the mass fluxes of goods and element concentrations in these goods and finally, interpretation and presentation of the result.

## 2.3. STAN Software Analysis

After building a graphical model, with a predefined components in the software itself (process, flows, systems boundary, text field), users can enter or import known data or precise data (stocks, concentrations, mass flows, transfer coefficients) for different layer (substance, good, energy) and period to calculate an unknown quantities. All flows can be displayed in Sankey-style, in example, the width of the flow is proportional to its value. The graphical picture of the model can be printed or exported. For data export and import, Microsoft Excel is used as an interface. To build the model MFA-STAN, components consist of a system boundary, processes and flows [5].



**Figure 2.** STAN Software Workspace and Subsystem Involved.

## 2.4 Experimental Analysis of Leachate Water

Sample of leachate were collected and several analysis readings have been recorded. There are two type of analysis that could be used. First, 'in-situ' analysis, and second is 'ex-situ' analysis.

### 3. Result and Discussion

#### 3.1 Solid waste composition

Both result and discussion from the result were analyze. Segregation percentage, leachate characterization and MFA using STAN software were calculated and displayed. As for the solid waste that were sent to this landfill, a rough calculation has been made by using acquired data from the person in-charge at the Sungai Ikan Landfill. As the objective of this study is to determine Material Flow Analysis of the solid waste at Sungai Ikan Landfill, a segregation process is a must to determine the quantity and quality of waste composition that were deposited at the landfill sites (Table 1) [6].

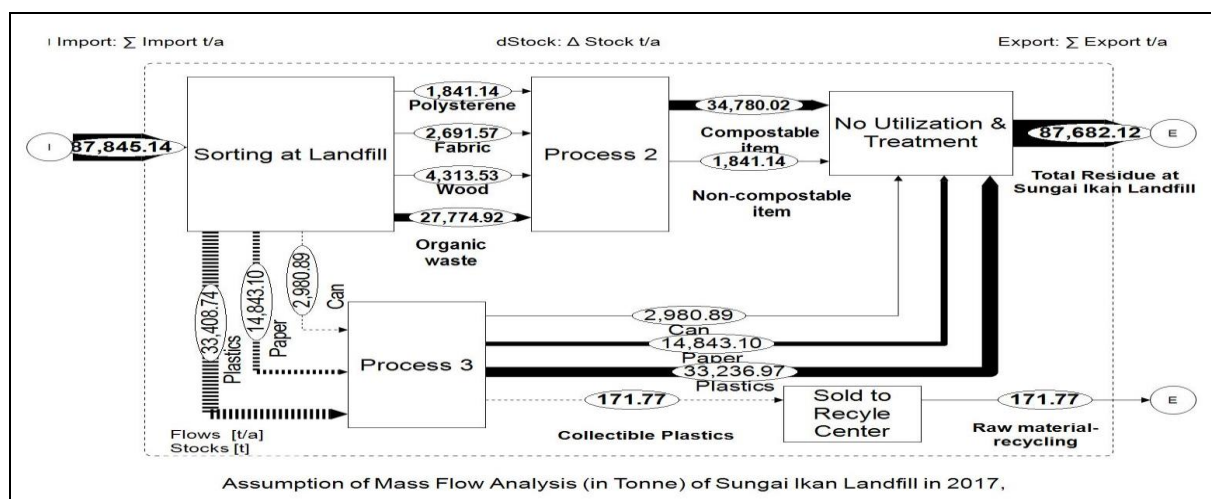
**Table 1.** Average Weight of Solid Waste in Sungai Ikan Landfill

Type of waste	Average weight (504.68 gram)
	Weight (gram)
Plastics	229.65
Organic waste	191.91
Paper	102.54
Polysterene	12.72
Wood	29.8
Fabric	18.59
Can	20.58

For the record, Majlis Bandaraya Kuala Terengganu (MBKT) recorded almost 300 tons of solid were brought to Sungai Ikan Landfill a day. Which makes, SIL receive almost 9000 tons of solid waste per month. As the majority of the solid waste were brought from residential area, shop lots and larger premises, it can be concluded that most fraction of the solid waste consists of plastics and organic waste. As been projected by one of the contractor from the landfill, with this attitude, the lifespan of the landfill could be reduced to just 3 years instead of 5 to 6 years.

#### 3.2 Material Flow Analysis

Many possible applications exist for material flow analysis (MFA) and of the function is to help with sustainable materials management (SMM) [7]. In towards sustainable solid waste management, the data from the sampling were analyzed and were inserted to the MFA calculating software called STAN, that often used by researcher. As we can observe from the Sankey diagram below, the total assumption of input that have been carried to Sungai Ikan Landfill can reach up to 88,000 tons a year. After the process of sorting at landfill, certain of recyclable item were separated and non-recyclable item such as organic waste, wood, polystyrene and fabric were left to be residue at the Sungai Ikan Landfill as depicted in MFA model in Figure 3.



**Figure 3.** Material Flow Analysis of solid waste at SIL generated by STAN Software

### 3.3 Leachate characterization

The table 2, below are the reading of the parameters, taken for 3 days.

**Table 2.** Leachate's Characterization at SIL (In-Situ Analysis)

Parameters	Day 1	Day 2	Day 3
Conductivity	1.92	2.02	1.98
DO (mg/L)	1.36	1.23	1.31
Temperature (°C)	29.0	30.9	29.4
TDS	1160.3	1174.0	1163.5
PH	8.29	8.08	8.19

## 4. Conclusion

From the result and discussion shown above, it can be concluded that Material Flow Analysis systems can be one of the effective method in conducting environmental assessment of the solid waste residues at the landfill. Considering the large amount of residues can be calculated using the projection using STAN Software analysis. People of Malaysian are still not aware of the consequences from not separating their waste. Other than that, the fraction and percentages of solid waste that were brought to SIL were able to be identified. Total residues at SIL can reach up to 88,000 tones per year. With this amount of solid waste, Malaysian people should be aware that one day, we will run out of space to be converted to landfill. The sustainable waste planning and management is very important for this consequences.

## References

- [1] Izni Izzati M, Mohd Zulkifli Mohd Y and Fatimah SA, *Malaysian Journal of Civil Engineering* 28 *Special Issue* 2016 **3** p. 180-191.
- [2] Rajkumar N, Subramani T, and Elango L, *Journal of Environmental Health Science & Engineering* 2012 **9**, 35.
- [3] Agamuthu and Fauziah. *Journal of Material Cycles and Waste Management* 2010 **3** 1-2.
- [4] Spyridon Achinas. *Journal of Sustainable Development Studies* 2014 **5**, 29-39.
- [5] Annisa B. *In Proceedings ACES :Annual Civil Engineering Seminar*. 2016 **1**, 235-242.
- [6] Agamuthu P, Venu Mahendra MS, and Mohd Afzanizam M. *Malaysian Journal of Science* 2011 **30** **1**, 16-27.
- [7] Oliver C, and Helmut R., 2008. *Material Flow Analysis with Software STAN*. Environmental Informatics and Industrial Ecology p. 21-80.