Solid Waste Management and Estimation of Methane Production by Land Gem Simulation Model, Case Study: Iran, Rasht

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Abstract*— Rapid population growth, rapid economic growth and rising living standards increasing municipal solid waste (MSW) production that causing its management to be a major worldwide challenge. There are different methods for disposal of wastes (waste disposal according to the current situation in various ways, such as the Landfill disposal, anaerobic purification methods, producing RDF (Refuse Derived Fuel), waste incineration and composting is done). Landfilling is the most common way of municipal solid waste (MSW) disposal in Iran. Because of the land available for burials and also the simplicity of this method of waste management, was expected for at least two decades later, is still one of the main methods of waste management in Iran. Methane production in landfill typically begin 6 to 12 month after the waste placement then raise to a maximum shortly after landfill closure and finally gradually decline over the period of 30-50 years. The aim of MBT, reduce the volume of waste to landfills and reduce the land needed to raise and lower the volume of leachate and leachate control is the fact that 70% of the waste is more, the volume of leachate as lack of proper control and also because of the high level of groundwater in the northern part of the country can bring great environmental hazard. We use LandGem for estimation of gas production in landfill nad our case study is Rasht in north of Iran. The amount of methane generation in first year is 9.514283 (Mg/year) and it is the peak of gas generation.

***Index Terms*—Solid waste Management, Landfill, LandGem, Rasht, Iran, Composting**

I. INTRODUCTION

Rapid population growth, rapid economic growth and rising living standards increasing municipal solid waste (MSW) production that causing its management to be a major worldwide challenge. Particularly in urban cities of Iran. Improper management of urban waste pollution of air, water, soil and can be a major factor in the risk to public health [2]. In recently year, developing countries carry out activities in order to improve municipal solid waste management. municipal solid waste management system in Iran, in addition to the above problems have problems such as low technical level and low level of investment in the municipal solid waste management sector. Financial resources in developing countries allocated in the municipal solid waste collection, transfer and disposal less attention is.

Improper management of solid waste has been reported by several researchers in different cities of developing countries [1], [5]-[6], [9].

Improper management of solid waste in most cities of the developing countries such as Iran affects on human and animal health and ultimately result in economic, environmental and biological losses [6].

There are different methods for disposal of wastes (waste disposal according to the current situation in various ways, such as the Landfill disposal, anaerobic purification methods, producing RDF (Refuse Derived Fuel), waste incineration and composting is done).

Landfilling is the most common way of municipal solid waste (MSW) disposal in Iran. Because of the land available for burials and also the simplicity of this method of waste management, was expected for at least two decades later, is still one of the main methods of waste management in Iran. MSW is made up of different organic and inorganic fraction. Typically, landfill gas consists of 50-60 vol. % of methane and 30-40 vol. % of carbon dioxide as well as trace amount of numerous chemical compounds such as aromatics, chlorinated organic compounds, and sulfur compounds [7].

Landfill gas is produced continuously by microbial action on biodegradable wastes under anaerobic conditions. Capturing the generated methane from MSW landfill has been targeted in many developing countries as feasible method to reduce the greenhouse gas emission (GHGs) and to recovery the energy instead [8].

Methane production in landfill typically begin 6 to 12 month after the waste placement then raise to a maximum shortly after landfill closure and finally gradually decline over the period of 30-50 years [4].

Estimating the amount of methane produced in landfill site can help assess the potential use of landfill methane as an alternative source of energy, hazard control, and contribution to global climate changes. If LFG uncontrolled contributes to smog and global warming, health and safety concerns may be caused.

In this paper, the municipal solid waste of Rasht (a city in Iran) according restrictions managed and amount of GFG estimated by LandGem software.

II. MATERIALS AND METHODS

A. Case Study

The city of Rasht (center of Gilan Province) is located in the northern part of Iran (Figure 1) with a population of about 500,000. The latitude and longitude of Rasht are 37°, 17′N and 49, 35′E, respectively. The population of Rasht city has increased in recently years [10].

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The price of lands of Rasht is higher than the other parts of Iran, so we try use at least land for solid waste management.

Figure 1: The location of Gilan province and Rasht city in Iran

Municipal solid waste of Rasht has specific waste component Table 1.

Table 1: Amount of waste component of municipal solid waste

Waste Components	%	Moisture %
Food Waste	60	70
Paper	6.22	6
Cardboard	5.37	5
Plastic	14.71	2
Textile	4.04	10
Wood	2.66	20
Glass	2.4	2
Ferrous metals	1.55	3
Non-ferrous metals	1.01	2
Dust, Ash and etc	2.04	8

In the table 1 is a considerable amount of each component is related to the total weight of the waste [3]. In accordance with the assumption that the per capita production of waste per person per day is 1 kg according to the average daily production of waste in the city's population is about 500 ton.

B. Seperation

At this stage, this issue is what percentage of waste to composting and MBT (Mechanical Biological Treatment) are a few of them. The aim of MBT, reduce the volume of waste to landfills and reduce the land needed to raise and lower the volume of leachate and leachate control is the fact that 70% of the waste is more, the volume of leachate as lack of proper control and also because of the high level of groundwater in the northern part of the country can bring great environmental hazard.

This step is the most important step in the waste management system, because many factors, including economic factors, environmental, equipment and technology, climate, social factors, lack of land depends on and is influenced by the results of this phase.

In Iran, almost all of the above factors are limiting factors that are difficult to design. In particular, in North America and fertile land all have high economic value as a result of a shortage of land is one of the major problems in these areas is a waste management system. The groundwater level is high in these areas and to avoid pollution of surface water and groundwater should be possible to prevent the removal of the waste stream to the ground. Due to the high humidity in the area and most of the organic waste to the volume of leachate produced in these areas is high. Proper management is essential before burying them in the ground to reduce the flows of leachate into ground. One of the best options is compost and trash burning to significantly reduce the amount of leachate indicates any of these methods are also associated with many problems. For example, the method used to produce compost with problems such as: the production of odors, noise and, most importantly, the lack of market for this product is one of the reasons for the low, low quality compost sales due to lack of proper equipment for the production of compost high quality. Incineration and energy recovery accompany with problems such as air pollution and expensive equipment and professional manpower is low for these methods. Due to these problems have to be the best option to achieve the maximum efficiency can be selected.

At this stage, the compost should be separated from the MBT. Because of the organic matter content, as well as the assumption of a market for the sale of 40% of the total of waste allocated to composting. Obviously wastes selected from the under screen. After the MBT, 182.4 ton of waste allocated to landfilling and therefore less space is needed for burial and it is easier to carry.

C. LandGem

In order to estimate the amount of methane produced from landfill can be used to bundle Land Gem. We assume that since the beginning of April to the landfills. The length of operation of landfills considers 20 years. Land Gem in several indicators needs to value them according to the type of waste and climatic conditions and geographic area is determined. Analytical equation used in this model is first order as follows [11]:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} k\left(\frac{M_i}{10}\right) L_0 e^{-kjt_i}$$

Where:

Q_{CH_4} = annual methane generation in the year of the calculation $m^3/year$

i= 1 year time increment

n= (year of the calculation) – (initial year of waste acceptance)

j= 0.1 year time increment

k= methane generation rate ($year^{-1}$)

L_0= potential methane generation capacity (m^3/Mg) (Table. 2)

M_i= mass of waste accepted in the i[th] year (Mg)

t_{ij}= age of the j[th] section of waste mass M_i accepted in i[th] year (decimal years, e.g.,3.2 year)

L_0 only function of the type and composition of the waste is buried. If the compounds of cellulose in the waste pile are high, the index value will be higher. Five L_0 default value for the index is shown in Table. In the amount of between 140 and 180m^3/Mg. Bioreactors have lowest L_0, after considering the geographical conditions of Iran, amount of L_0 considered 150 m^3/Mg.

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Table 2: Amount of potential methane generation capacity

Type of Default	Type landfills, according to the weather	Quantity of L_0 (m^3/ton)
CAA	Normal	170
CAA	Dry Weather	170
Inventory	Normal	100
Inventory	Dry	100
Inventory	Humid (Bioreactor)	96

In software, NMOC is concentration of non-methane organic compounds that release of the compounds used in the calculation of these compounds. There is data available, based on the recommendations Inventory Defaults option to use program guide that is equal to 600 ppmv.

In software, each of the following is briefly described:

- Properties of landfill
- Name of landfill
- Landfill open year (2014)
- Landfill closure year (2014)
- Have model calculate closure year? (we haven't any model)
- Waste design capacity

The user's inputs showed in (Figure 2)

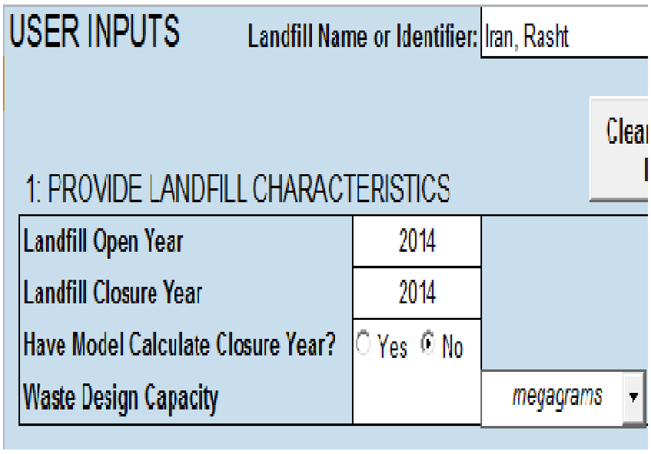

Figure 2: user's input in LandGem

The program has the ability to work with data field measurements, but in the absence of such data can be provided in the template default parameters (Inventory Defaults, CAA Defaults) used. In order to model the methane emission from the solid waste sector using LandGem, a set of inputs is required, these include:

- Enter waste acceptance rate (how much waste is generated and sent for land filling during the previously years, mass of waste acceptance)
- Default pollutant concentrations used by LandGem which should been corrected for air infiltration.
- Methane generation capacity rate and the potential of generation capacity (Table 2)
- Model parameter (user specified pollutant parameters for selected compounds)

Table 3: Amount of methane generation rate (K)

Type of Default	Type landfills, according to the weather	Quantity of k $(year^{-1})$
CAA	Normal	0.05
CAA	Dry Weather	0.02
Inventory	Normal	0.04
Inventory	Dry	0.02
Inventory	Humid (Bioreactor)	0.7

III. RESULTS OF LANDGEM

The result from quantity of disposal solid waste at Rasht during 1 year of landfill open year is shows in Table 4. The amount of disposal waste generated by municipal solid waste is 182 mega gerams.

Table 4: The amount of disposal waste generated by municipal solid waste

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	(short tons/year)	(Mg)	(short tons)
2014	182	201	0	0
2015	0	0	182	201
2016	0	0	182	201
2017	0	0	182	201
2018	0	0	182	201
2019	0	0	182	201
2020	0	0	182	201
2021	0	0	182	201
2022	0	0	182	201
2023	0	0	182	201
2024	0	0	182	201

A. Gas production

The Figure 3 shows a general decreasing trend in total gases emissions for each year.

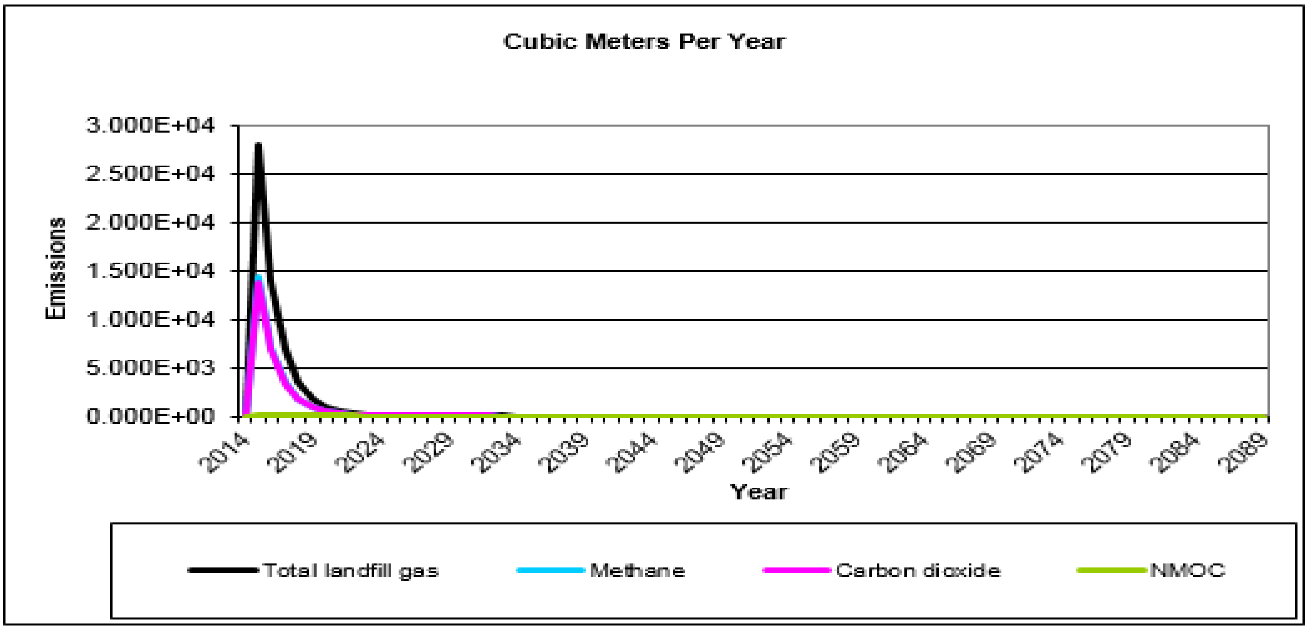

Figure 3: The amount of gas emission from Rasht landfill site in 2014 (Mg/year)

Table 5 shows the annually increasing the methane, Carbon dioxide production from disposed waste at Landfill.

Table 5: Annual increasing the methane and CO_2 production from disposal waste at landfill

Year	Total landfill gas		Methane		Carbon dioxide		NMOC	
	(Mg/year)	(m3/year)	(Mg/year)	(m3/year)	(Mg/year)	(m3/year)	(Mg/year)	(m3/year)
2014	0	0	0	0	0	0	0	0
2015	35.10738	27962.98	9.514283	14261.12	25.08124	13701.86	0.060139	16.77779
2016	17.43381	13886	4.724653	7081.862	12.45497	6804.142	0.029864	8.331603
2017	8.657374	6895.586	2.346193	3516.749	6.184957	3378.837	0.01483	4.137352
2018	4.299125	3424.247	1.165085	1746.366	3.071359	1677.881	0.007364	2.054548
2019	2.134882	1700.431	0.578564	867.2196	1.525192	833.211	0.003657	1.020258
2020	1.060151	844.4088	0.287306	430.6485	0.757388	413.7603	0.001816	0.506645
2021	0.526455	419.321	0.142672	213.8537	0.376108	205.4673	0.000902	0.251593
2022	0.26143	208.2287	0.070849	106.1966	0.18677	102.032	0.000448	0.124937
2023	0.129822	103.4033	0.035183	52.73568	0.092747	50.66761	0.000222	0.062042
2024	0.064468	51.34855	0.017471	26.18776	0.046057	25.16079	0.00011	0.030809
2025	0.032014	25.49894	0.008676	13.00446	0.022871	12.49448	5.48E-05	0.015299
2026	0.015898	12.6624	0.004308	6.457823	0.011357	6.204575	2.72E-05	0.007597
2027	0.007895	6.28796	0.002139	3.20686	0.00564	3.081101	1.35E-05	0.003773
2028	0.00392	3.122509	0.001062	1.592479	0.002801	1.530029	6.72E-06	0.001874
2029	0.001947	1.550592	0.000528	0.790802	0.001391	0.75979	3.33E-06	0.00093
2030	0.000967	0.770001	0.000262	0.392701	0.000691	0.377301	1.66E-06	0.000462
2031	0.00048	0.382371	0.00013	0.195009	0.000343	0.187362	8.22E-07	0.000229
2032	0.000238	0.18988	6.46E-05	0.096839	0.00017	0.093041	4.08E-07	0.000114

IV. CONCLUSION

In Rash, the level of ground water is near to surface of earth and the value of land is high. So we tried to use landfilling at least. The landfill of Rasht starts operation at 2014 with the purpose to receive the generated solid waste at surrounded area. The amount of methane generation in first year is 9.514283 (Mg/year) and it is the peak of gas generation. Generated methane can be used instead of source of energy.

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