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Research Paper

Landfill Site Selection of Savar Municipality, Bangladesh: A Multi Criteria Evaluation Approach

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ABSTRACT

Landfill has been recognized as the cheapest and more acceptable form for the final disposal of municipal solid waste and as such has been the most used method in the world. Selection of appropriate landfill site is a complex task as the selection process involves many criteria. This paper presents the landfill site selection process of Savar Municipality. Initially, area required for future landfill site has been estimated considering without waste composting and with different percentages of composting. The estimation shows that, 4.09 to 9.96 acres of land will be required annually by 2025 for landfill. Then Multi Criteria Evaluation (MCE) approach has been used to identify suitable sites for landfill. After having set-up of selected criteria, scaling of criteria and weighting of criteria; suitability scores for eight landfill sites have been calculated. Two landfill sites have been chosen on the basis of their higher suitability score.

1. Introduction

Management of municipal solid waste is a great challenge in developing countries, particularly in the larger urban centers (Scheinberg et al., 2010). It has been widely reported that the growth of municipal solid waste is associated with urbanization, industrialization, population growth along with improved living standards. The municipal corporations, with their limited capacities are often unable to handle the increasing volume of solid waste and uncollected waste being spread on roads and in other public areas leading to tremendous pollution and degradation of land as well as negative impact on human health (Babalola and Busu, 2010). Along with other waste disposal option such as, recycling, combustion (incineration) and composting, landfill is the most preferred option, because of its easy operation, low cost, less technological involvement and comfort of implementation (Hasan et al., 2009). Land filling is considered as one of the most environmental friendly and predominant treatment options of waste disposal which have served as ultimate waste receptors for municipal refuse, industrial or agricultural residue, wastewater sludge, incinerator ash, recycle discards and treated hazardous waste. For municipal solid waste disposal, land filling has proved to be the most cheapest and acceptable method (Khajuria et al., 2010). Despite reductions in waste generation, landfills will continue to be required for the safe disposal of municipal solid waste for the foreseeable future (Rowe, 2011).

Savar Municipality, situated 25 km away from the capital city of Bangladesh is comprising of 2,86,008 population. Here the population density is reasonably high (4,948 per sq. km) with a rapid urbanization rate of

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21.42 percent (BBS, 2011). Faster growth of this Municipality escalates the rate of waste generation as well. At present, Savar Municipality becomes unable to handle the increased volume of municipal solid waste adequately. Wastes haphazardly dumped on roads and in other illegal dumping sites are leading to enormous pollution, impair public health, drainage congestion and deteriorating aesthetic value. To prevent these negative consequences of indiscriminate illegal dumping; selection of apposite landfill site is essential (Kakon, 2011). Landfill site selection is a critical issue in the urban planning process due to enormous impacts on the economy, environment, public health and quality of life. Appropriate selection of landfill site is important in order to minimize environmental damage as well as to prevent negative impact on the public health, thereby improving the overall sustainability associated with the life cycle of the landfill (Mornya et al., 2010). In these circumstances this study estimates the land requirement for landfill site in Savar Municipality and then identifies most suitable landfill site among preferable sites by applying Multi Criteria Evaluation (MCE) technique.

2. Literature Review

Babalola and Busu (2011) stated landfill site selection as a complex task as the selection process involves a number of criteria. In this study, attempts have been made to determine sites that are appropriate for landfill in Damaturu town Nigeria, by combining geographic information system (GIS) and a multi-criteria decision making method. Mahamid and Thawaba (2010) attempted to identify a suitable landfill site with less impact on environment. In this research, a potential site for an appropriate landfill area for Ramallah Governorate was determined by using geographic information system (GIS) and Multi-criteria analysis. Paul (2012) investigated most suitable waste disposal sites for Nabadwip Municipality, West Bengal, India. Multi-criteria analysis was done for solid waste disposal site selection considering a number of ecological and land use oriented criteria in this study. Hai and Ali (2005) in their study have analyzed the characteristics of solid waste in Dhaka city, along with the associated environmental impacts and existing solid waste management practices. They determined land requirement for landfill of solid waste with special focus on the effect of composting on final waste disposal and also estimate transportation cost for anew dumping site. Hasan et al. (2009) in their study standardized selection criteria of landfill in the context of Dhaka city. They identified suitable landfill site using Multi Criteria Evaluation on the basis on three criteria such as road proximity, stream proximity and urban proximity. However, they did not clearly defined one criterion termed as urban proximity. Ahmed and Quader (2011) in their study on Narayanganj City identified that the poor disposal and handling of waste leads to environmental degradation, damage of the ecosystem and poses great risks to public health. Rahman et al. (2011) identified that rapid urbanization of Savar Municipality resulted in higher per capita waste generation. For effective waste management, this study suggested an integrated approach of waste segregation, door to door collection, involvement of community based organization, composting and sanitary landfill. Kakon (2011) in her study found that the overall scenario of solid waste management system is not satisfactory in Savar municipal area and she emphasize on waste collection, segregation and ultimate disposal at landfill site.

This brief review indicates that little has been done in waste management, particularly at municipal level in a developing country like Bangladesh. Since landfill is considered as the most popular and widely practice method of waste management, most of the studies have focused on waste segregation, collection and disposal in a landfill site. However, selection process of landfill site has not been addressed adequately. Therefore, research for landfill site selection at municipal level is warranted by incorporating appropriate selection criteria.

3. Data and Methods

3.1 Data

Data of waste type, quantity and waste generation rate have been collected and estimated from field survey. Total 450 sample households (50 from each Ward) were surveyed in this study. Estimation of land requirement for landfill site requires various data on population, Gross Domestic Product (GDP), waste collection efficiency, waste dumping height and compacted waste density which have been collected from reports of Bangladesh Bureau of Statistics (BBS), Bangladesh Economic Review, Municipal Infrastructure Development Plan (MIDP) and relevant literature on landfill site management.

3.2 Methods

This study estimates the future land requirement for landfill site and then identifies suitable sites for landfill by applying Multi Criteria Evaluation (MCE) technique. These procedures are briefly described in the following section.

3.2.1 Estimation of Future Land Requirement for Landfill Site

Two different methods are used for calculating demand of land for constructing land filling area.

- Method 01: Landfill area required without considering solid waste composting
- Method 02: Landfill area required with considering solid waste composting

Method 01: Landfill area required without considering solid waste composting

Following formulas have been used for calculating Landfill area required without considering solid waste composting.

According to Hai and Ali (2005),

$$\text{Landfill area required (m}^2\text{ per yr)} = \frac{\text{volume disposed at landfill (m}^3\text{ per yr)}}{\text{dumping height (m)}} \quad [1]$$

Here,

Dumping height = 6 m and

Volume disposed at landfill can be derived from the following formula:

$$\text{Volume disposed at landfill (m}^3\text{ per yr)} = \frac{\text{projected waste generation(ton per yr) x collection efficiency}}{\text{compacetd waste density (ton per m}^3\text{)}} \quad [2]$$

Here,

Compacted waste density =1.1 (ton per m^3)

Different collection efficiency such as 60%, 70% and 80% is considered.

Calculation of projected waste generation is done in the following ways.

Projected waste generation

Two formulas are used to estimate projected waste generation.

$$\text{projected waste generation} = \text{waste generation rate x projected population} \quad [3]$$

(Hai and Ali, 2005)

Here, Waste generation rate = 0.40 kg per day (estimated from field survey, 2014) and

Projected population can be estimated by Geometric progression method.

Waste generation is related with population and economic growth. So, it will be more accurate to make projection of waste generation considering discharge flexibility (ratio of annual growth rate of waste and GDP growth rate); which address the issue of economic growth.

$$\text{Projected waste generation} = \frac{\text{growth rate of waste}}{\text{growth rate of GDP}} \text{xprojected population}$$

(JICA, 1998) [4]

Here, Annual growth rate of Gross Domestic Product (GDP) (2011) =6.23 % (MoF, 2013),

Annual growth rate of waste is 7%

Projected population is calculated by Geometric progression method using the following equation.

$$p_f = p_p (1+r)^n \quad [5]$$

Here,

P_f= Projected population (2025);

P_p = present population (2011) = 286008;

r = rate of yearly population growth and

n = number of years to be considered = 14

The rate of population growth can also be estimated from population data of two years of n year's interval in the recent past using the expression:

$$r = \sqrt[n]{\frac{p_2}{p_1}} - 1 \quad [6]$$

Where, p_1 and p_2 are the population data of two dates of n number of years apart (Ahmed & Rahman, 2000).

Method 02: Landfill Area required with considering solid waste composting

Hai and Ali (2005) also calculate required landfill area considering waste composting.

$$\text{Landfill area required (m}^2\text{ per yr)} = \frac{\text{volume disposed at landfill (m}^3\text{ per yr)}}{\text{dumping height (m)}} \quad [7]$$

Here, dumping height = 6 m (Hai and Ali, 2005).

Volume disposed at landfill is calculated by the following formula.

$$\text{Volume disposed at landfill} = \frac{\text{projected waste generation} \times \eta \times [0.2 \times 0.75 + n \times 0.15 + (1-n)]}{\text{compacted waste density}} \quad [8]$$

Here,

Compacted waste density = 1.1 (ton per m^3) (Hai and Ali, 2005)

η = % of efficiency = 70% = 0.70 (MIDP, 2008).

3.2.2 Multi Criteria Evaluation (MCE)

Multi Criteria Evaluation (MCE) technique is used for suitability analysis of landfill sites selection. MCE technique generally has four steps:

a. Criterion establishment,
b. Criterion score or scaling of criteria
c. Establishment of criteria weight, and
d. Weighted linear combination with Criteria scores are combined by applying a weight to each followed by a summation of results to yield a suitability of site,

Equation 9 is used for analyzing more suitable site for landfill. Higher value of S for a particular site indicates more suitability of that site for landfill.

$$S = \sum w_i x_i \quad [9]$$

Where, S = suitability, w_i = weight of criteria i, x_i = score of criteria i (Hasan et al., 2009).

4. Study Area

Savar Municipality is located on the north-western part of Dhaka, Bangladesh. This Municipality is 25 km from the capital city and lies between 23º 44′ and 24º 02′ north latitude and 90º 11′ and 90º 22′ east longitude (Fig. 1).

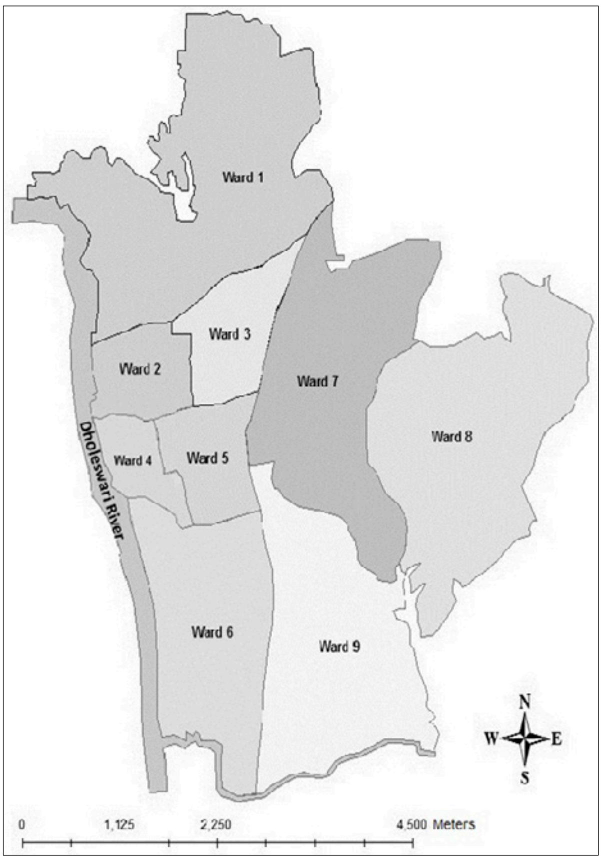

Fig. 1. Savar Municipality.

Municipal area is bounded with three rivers -Turag on the east and eastern west, Dhalesswari and Bonshi on the west and Buriganga on the South. The Municipality covers some area of 14.08 sq km and administrative divided into 9 wards. Residential land use (53.27 percent) seems dominant in Savar Municipality followed by mixed use (25.28 percent) and agricultural land (14.20 percent). According to Population Census 2011, total population of Savar Municipality is 286008 and the density of population is 4948 per sq. km. Ward no 7 of the municipality consists of highest number of population (50053) (MIDP, 2008).

5. Results and Discussions

5.1 Waste Generation Scenario

Both organic (vegetable, fish, fruit, animal dung) and inorganic wastes (polythene, plastic, metal, glass) are generated every day in Savar Municipality.

Table 1. Types and quantity of waste generation.

Organic waste	Quantity (Kg per Day)	Inorganic waste	Quantity (Kg per Day)
Vegetable Scarp	621.13	Polythene	27.38
Fruit Scarp	36.5	Plastics	13.6
Animal Dung	4.16	Metal	9.5
Fish Scale	32.5	Glass	5.4
Others	-	Others	19.5
Total	694.29	Total	75.38

Total 769.67 kg wastes of different types are generated every day. It is mentionable that the quantity of organic wastes (694.29 kg per day) is much higher than the inorganic wastes (Table 1). Waste generation rate in Savar Municipality is 0.40 kg per day per person.

5.2 Existing Dumping Locations

In Savar Municipality along with designated dumping site, a number of illegal dumping sites are also found (Fig. 2). Designated dumping sites refer to the disposal of waste into Municipality's own dumping sites or disposal of wastes into private property by seeking permission of owners of these sites which are presented in Table 2.

Table 2. Existing designated dumping sites.

Name of the dumping sites	Location (Ward no)	Area (Acre)	Ward Coverage
AraPara	2	1.20	1, 2
UttorNamaBazar	4	0.16	4
DoxinNamaBazar	6	0.24	6
Karna Para	6	0.64	6
Ulail	6	0.21	3, 5, 6, 9
Aich Noadda	7	0.32	7, 8

Out of six designated dumping sites, Savar Municipality is the owner of the Doxin Nama Bazar and Karna Para dumping sites. Ara Para, Uttor Nama Bazar, Ulail and Aich Noadda dumping sites are under the private ownerships. The dumping sites of Uttor Nama Bazar, Doxin Nama Bazar, Karna Para and Aich Noadda are situated in low lying area and during the rainy season these dumping sites become inundated (Savar Municipality, 2014).

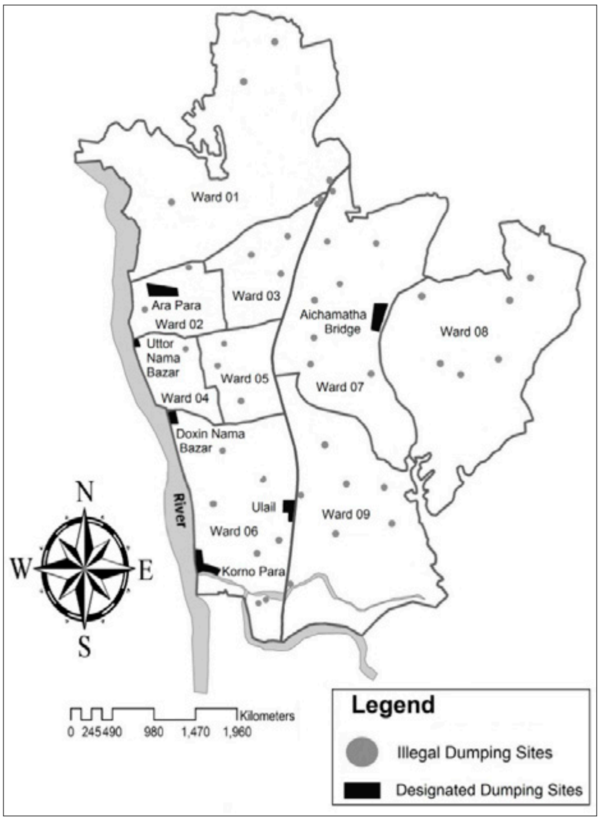

Fig. 2. Designated and Illegal Dumping Sites of Savar Municipality.

On the contrary, wastes that are dumped along the road sides, low land area and open drains that are considered as illegal dumping sites. The largest illegal dumping site is located at the Radio Colony; where wastes are dumped along the Dhaka Aricha highway. Other mentionable illegal dumping sites are located near Savar Thana bus stand and near the Bank Town area.

Table 3. Illegal dumping sites.

Location	Number of illegal dumping sites	Area (Acre)
Ward No 01	4	0.042
Ward No 02	2	0.019
Ward No 03	5	0.080
Ward No 04	1	0.007
Ward No 05	3	0.021
Ward No 06	7	0.053
Ward No 07	9	0.090
Ward No 08	6	0.048
Ward No 09	7	0.102

Total 44 illegal dumping sites are found in Savar Municipality among which most of them are located in Ward no 7 (Table 3). Lack of appropriate designated landfill site, municipal capacity and awareness are mainly responsible for illegal dumping in Savar Municipal area. These illegal dumping sites pollute the environment and impair human health.

5.3 Land Requirement for Future Landfill Site

Estimation of land requirement for future landfill site has made by addressing tow issues such as: without considering waste composting and incorporating waste composting in estimation.

5.3.1 Method 1: Land requirement without considering composting

Step 01: Projected population (2025)

At first, population growth rate (r) is determined by inserting values of P_1 (140300, BBS 2001), P_2 (286008, BBS 2011) and n (10 years) in Eq. [6]. Then, putting the values of r (0.07), P_p (286008) and n (14 years) in Eq. [5], population of 2025 has been determined. The population of Savar Municipality will be 737900 by 2025.

Step 02: Projection of Future Waste Generation

Using the values of 7% annual growth rate of waste, projected population of 2025 (737900), 6.23% annual growth rate of GDP (MoF, 2013) in Eq. [4]; future waste generation of 2025 is obtained. It has been observed that annually 3,32,516 tons of waste will be generated in Savar Municipality by the year 2025 if estimation is made on considering discharge flexibility; which address the relationship between economic growth and waste generation.

Step 03: Volume disposed at landfill (m^3 per year)

Putting the values of collection efficiency (60%, 70% & 80%), Compacted waste density (1.1 ton per m^3) (Hai & Ali, 2005) and Projected waste generation (332516.09 ton per year in 2025) into Eq. [2]; volume disposed at landfill (m^3 per year.) is obtained.

Step 04: Landfill area required (acre per year) without solid waste composting

Finally, required land for landfill site is determined (Table 4) by inserting the values of volume disposed at landfill (m^3 per year) for different collection efficiency (60%, 70% & 80%) and dumping height (6 m) (Hai & Ali, 2005) into Eq. [1].

5.3.2 Method 2: Landfill area required with considering solid waste composting

Step 01: Volume disposed at landfill

Volume disposed at landfill (m^3 per year) is obtained by putting the values of percentage of waste composting, n (60%, 70%, 80%); compacted waste density (1.1 ton per m^3) (Hai & Ali, 2005); percentage of waste collection efficiency, η (70%) (MIDP, 2008) and projected waste generation of 2025 (ton per year) into Eq. [8].

Step 02: Landfill area required with solid waste composting

Inserting the values of volume disposed at landfill for different values of n (percentage of waste composting) and dumping height (6 m) in Eq. [7]; landfill area requirement is calculated.

Table 4. Land requirement for landfill site.

Land requirement estimation by Method 1 (acre per year)		Land requirement estimation by Method 2 (acre per year)	
Waste collection efficiency	Land requirement without composting	Percentage of composting	Land requirement considering composting
60%	7.47	60%	5.58
70%	8.71	70%	4.88
80%	9.96	80%	4.09

Table 4 indicates that more land will be required if waste collection efficiency has increased. On the contrary, if more waste can be composted, the land requirement for landfill site will be dropped slightly from 5.58 to 4.09 acre per year.

5.4 Landfill Site Selection

The procedure of landfill site selection by using Multi Criteria Evaluation (MCE) technique is simple and performed in the following steps.

Step 1. Criterion establishment

Reviewing relevant literature and considering mixed land use pattern of Savar Municipality; 7 criteria have been selected for assessing suitable landfill site (Table 5). Disaster oriented issues are not taken into consideration here as the municipality located in area which is not vulnerable to disaster;

Table 5. Criteria for landfill site selection.

Sl. n.	Criteria for selection of landfill site	Mark
1	Distance from water body	DWb
2	Distance from build-up area	DB
3	Distance from high agricultural land	DA
4	Distance from recreational area	DR
5	Distance from flood flow area	DFf
6	Proximity to road	PR
7	Distance from well	DW

Step 2. Score or Scaling of criteria

The selected criteria for landfill sites selection have been given value 0, 1, 2, 3, 4, 5 to represent severe negative impacts, high negative impacts, moderate negative impacts, low negative impacts and very low negative impacts or no impacts respectively. The Criterion score of factor is determined on the basis of measured distance (Table 6).

Table 6. Score of landfill selection criteria.

Name of Criteria	Standard Distance from Landfill Site (m)	Measured Distance from Landfill Site (m)	Score of Criteria (x_i)
Distance from Build-up urban area	500	0 - 100	0
		101 - 200	1
		201- 300	2
		301-400	3
		401-500	4
		More than 500	5
Distance from water body	500	0 - 100	0
		101-200	1
		201-300	2
		301-400	3
		401-500	4
		More than 500	5
Distance from high agricultur al land	500	0 - 100	0
		101-200	1
		201-300	2
		301-400	3
		401-500	4
		More than 500	5
Proximity to road	100	0-20	0
		21-40	1
		41-60	2
		61-80	3
		81-100	4
		More than 100	5
Distance from flood flow zone	1000	0-200	0
		201-400	1
		401-600	2
		601-800	3
		801-1000	4
		More than 1000	5
Distance from recreatio nal area	1000	0-200	0
		201-400	1
		401-600	2
		601-800	3
		801-1000	4
		More than 1000	5
Distance from well	1000	0-200	0
		201-400	1
		401-600	2
		601-800	3
		801-1000	4
		More than 1000	5

Step 3. Established weight of criteria

Combining the opinions of experts, concerned municipal officials and local residents, it is found that criteria of distance from build-up urban area gained top most priority. Other criteria such as distance from water body, proximity to road, distance from flood flow area, distance from recreational area, distance from high agricultural land and distance from well gained priority in successive descending order. According to

Triantaphyllou et al. (1998), the weight of criteria is calculated in the following way.

Here,

Total criteria or parameter = 7

Cumulative rank value = 1 + 2 + 3 + 4 + 5 + 6 + 7 = 28

Weight of criteria get top most priority (distance from build-up area) =7/28 = 0.25

Weights of other criteria have been calculated in similar way (Table 7).

Table 7. Weight of landfill selection criteria.

Criteria for selection of landfill site	Mark	Weight of criteria (w_i)
Distance from water body	DWb	6/28=0.21
Distance from build-up area	DB	7/28=0.25
Distance from high agricultural land	DA	2/28=0.07
Distance from recreational area	DR	3/28=0.11
Distance from flood flow area	DFf	4/28=0.14
Proximity to road	PR	5/28=0.18
Distance from well	DW	1/28=0.04

Step 4. Estimation of landfill sites' suitability score

Initially, considering opinions of experts, concerned municipal officials and local residents 8 landfill sites have been short listed (Table 8). Seven landfill site selection criteria have been fixed. Scaling and weight of these criteria have been determined for 8 landfill sites. Finally suitability score for each landfill site has been estimated inserting the values of w_i (Table 7) and x_i (Table 6) in Eq. [9].

Table 8. Probable landfill sites.

Landfill site Name	Location	Area (Acre)	Mark
Bhat Para	Ward no.1	3.42	L1
Ara Para	Ward no. 2	1.20	L2
Doxin Nama Bazar	Ward no. 6	0.24	L3
Poschim Bank Town	Ward no. 6	6.0	L4
Aich Noadda	Ward no. 7	0.32	L5
Imamaddipur	Ward no. 7	2.30	L6
Moddho Rajasan	Ward no. 8	4.65	L7
Doxin Rajasan	Ward no. 8	5.70	L8

Table 9 shows that, Doxin Rajasan (L8) has obtained highest suitability score of 3.73 followed by Moddo Rajasan (L7). Poschim Bank Town (L4) attain the least suitability score (1.50). As suitability scores have been calculated considering 7 site selection criteria and weight of each criteria; this is more rational to choose site or sites that obtain higher suitability score. Therefore, suitability score indicates that Doxin Rajasan is the most suitable landfill site for Savar Municipality as this site fulfills the selection criteria in greater extent. The suitability of the landfill sites has been illustrated in Fig. 3.

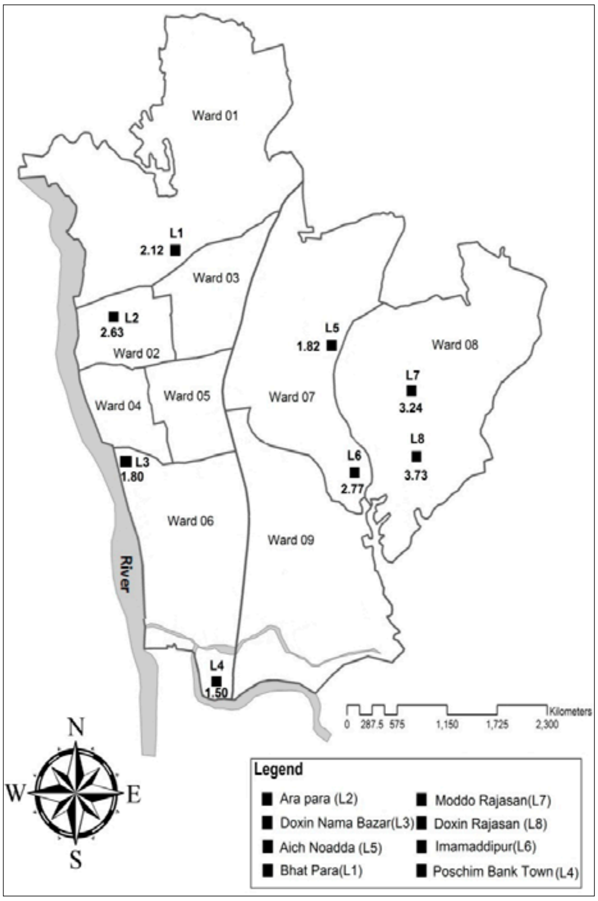

Fig. 3. Suitability of Landfill Sites (Based on suitability score).

Table 9. Suitability score of landfill sites.

Landfill site	DWb (w_i x_i)	DB (w_i x_i)	DA (w_i x_i)	DR (w_i x_i)	DFf (w_i x_i)	PR (w_i x_i)	DW (w_i x_i)	$S = \sum w_i x_i$
L1	0.21 x 5	0.25 x 1	0.07 x 4	0.11 x 0	0.14 x 0	0.18 x 3	0.04 x 0	2.12
L2	0.21 x 5	0.25 x 0	0.07 x 5	0.11 x 3	0.14 x 5	0.18 x 0	0.04 x 5	2.63
L3	0.21 x 0	0.25 x 0	0.07 x 5	0.11 x 5	0.14 x 5	0.18 x 0	0.04 x 5	1.80
L4	**0.21 x 0**	**0.25 x 0**	**0.07 x 0**	**0.11 x 4**	**0.14 x 5**	**0.18 x 2**	**0.04 x 0**	**1.50**
L5	0.21 x 5	0.25 x 0	0.07 x 5	0.11 x 2	0.14 x 0	0.18 x 0	0.04 x 5	1.82
L6	0.21 x 5	0.25 x 0	0.07 x 1	0.11 x 5	0.14 x 4	0.18 x 3	0.04 x 0	2.77
L7	**0.21 x 5**	**0.25 x 1**	**0.07 x 3**	**0.11 x 5**	**0.14 x 5**	**0.18 x 2**	**0.04 x 3**	**3.24**
L8	**0.21 x 5**	**0.25 x 3**	**0.07 x 3**	**0.11 x 2**	**0.14 x 5**	**0.18 x 4**	**0.04 x 2**	**3.73**

However, development of landfill site oblige to adopt some guidelines as waste disposed in landfills continues its process of material degradation results in potential harm to environment (Bronja and Bronja, 2014). People living in the surrounding area of the proposed landfill site also urge to maintain the standard guidelines and therefore following guidelines should be accomplished firmly.

- Waste at landfill site should be compacted properly. Waste Compaction helps to make the site less attractive to termite, rat, birds and other insect's generation and produce an even and stable surface (EPA Victoria, 2010).
- At the end of each working day or during the working day as well, the compacted waste should be covered with soil up to a thickness of 6 inches. (Ahmad and Rahman, 2000).This soil cover will prevent litter and odors, deterrence to birds and vermin, prevent air pollution and improve the site's visual appearance and prevent diseases (EPA Victoria, 2010).
- The final cover should be placed at the top of the landfill after waste has been dumped and compacted. The final cover of landfill should be 2 feet earth cover (Ahmed and Rahman, 2000). The design of the final cover must satisfy three functions for the sites e.g. ensure the long-term post closure integrity of the landfill with respect to any emissions to the environment, support the growth of vegetation or other site uses and increase the visual pleasant (EPA, 2000).
- A perforated piping system should be installed above the protective liner which collects and carries the leachate to a storage tank. Leachate must be removed from the storage tank periodically and should be treated and disposed of properly. Common leachate disposal methods include discharge to wastewater treatments plants and on sites treatment followed by discharge to surface water (Ahmed and Rahman, 2000). Effective leachate collection and removal system will help to prevent the hampering of land fertility, contamination of water, food production reduction, water borne disease and fresh water scarcity.
- Surface drainage system should be established to collects polluted surface run-off. It also requires ensuring that rainwater run-off does not drain into the waste from surrounding areas and that there is no water-logging on covers of landfills (Aljaradin and Persson, 2012).
- Landfill gas is flammable and poses a risk of explosion if not properly managed. A low cost design to handle landfill gas may consist of buried vertical perforated pipes to collect the gas, using its natural pressure and vent or flare it at the surface. This is called a passive collection system. More costly active collection system utilize a buried network of pipes and pumping to trap the gas, which is then processed and used for process heat or electricity generation (Ahmed and Rahman, 2000).Landfill gas management system will be helpful to prevent diseases, unpleasant odor and air pollution.
- In Savar Municipality total 769.67 kg waste generated per day of which 90% are organic in nature. Table 4 shows that more land will be required if wastes are not composted. Initially small scale composting can be introduced on pilot basis. Based on preliminary success medium to large scale composting can be considered for future. Simultaneously, a co-marketing policy for compost with chemical fertilizers would also make compost more competitive in the agricultural market. Engaging fertilizer companies to market the compost will be more effective, as these companies have an existing network of distribution channels up to the village level. Bangladesh Agricultural Development Corporation (BADC) should be engaged prominently to boost up compost market.

6. Conclusion

This study estimates that, annually 3,32,516 tons of waste will be generated in Savar Municipality by the year 2025 which in turn will require 4.09 to 9.96 acres of landfill area. Selection of appropriate landfill site is critical to avoid negative environmental, economical and social consequences of waste dumping. For this reason, Multi Criteria Evaluation (MCE) technique has been used to identify the suitable landfill sites. Selection of suitable landfill sites has been performed on the basis of 7 basic criteria including all relevant facts necessary for optimal landfill site selection. Weight and scaling of these criteria have been assigned following literature concerned to landfill siting. Initially 8 sites were selected as result of query for suitability. The suitability score of these sites indicates that, Doxin Rajasan is the most suitable landfill site for Savar Municipality followed by Moddo Rajasan. These two sites fulfill the maximal criteria and hence should be developed as formal landfill sites of Savar Municipality. Adopting appropriate design and regular maintenance of landfill site is crucial in this regard.

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