Evaluation of selected landfill sites using Landfill Site Rating Method (Diyala Governorate as a Case Study)

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Abstract. Solid waste, containing hazardous materials, are generated and dumped simply into drains or landfills where the rag pickers are exposed to contamination, and the prevalence of diseases has become alarming in cities near the landfills. Efficient waste management has become increasingly significant. Siting of sanitary landfills submit into two considerations, siting considerations and environmental construction requirements. One of the simplest methods of evaluating selected landfills is Site Rating Method, based on the experience to recognise the most appropriate conditions to be adopted in comparison between sites. The data for Canaan and Zanbour sanitary landfills, located in the city of Baquba, capital of Diyala governorate, are collected, analysed and comprised with each other according to Instructions of Environmental Determinants for Projects Establishing and Implementation Monitoring, No. (3), 2011, Iraq [1] and other international limitations. Canaan landfill, which satisfied 13 criteria, provides minimum environmental shortage, while Zanbour site is not applicable for the same reasons.

1. Introduction

Human activities can generate huge amount of waste that may have adverse effects on public health and environment. It is an essential step to reconsider waste management systems on the way to sustainable development. These systems generally emphasize the functional elements of waste minimization, reuse and recycling, and finally the residual material in the landfills [2], where the landfill is considered as an important element of any waste management system.

The sustainable solid waste management includes: (i) minimizing waste at origin; (ii) waste reusing before entering the waste stream; (iii) recovery of material and energy and (iv) disposing the remaining materials into landfills.

The process of landfill sites selection is very difficult because of many factors as environmental, political, economic, hydrological, hydrogeological and social factors. The main aim of the landfill site selection process is to select the best possible site with least adverse risk on public health and environment.

One of the simplest methods of evaluating selected landfills is Site Rating Method, based on the experience to recognize the most appropriate conditions to be adopted in comparison between sites. Canaan and Zanbour sanitary landfills lies at Baquba city, which is the capital of Diyala governorate between coordinates of 33.39° and 33.47°latitudes and 44.35° and 44.40° longitudes, occupies about 5119 km² in area, Figures1, 2 and 3. Daily solid waste generation rate of surveyed city is found to be (1.23) kg/day, which may be an increasing quantity with the decrease in indicators of regulations.
implementation and financial constraints. The data for mentioned sanitary landfills, are collected, analyzed and compared with each other according to Instructions of Environmental Determinants for Projects Establishing and Implementation Monitoring, No. (3), 2011, Iraq.

Figure 1. Diyala Governorate Administrative Map

Figure 2. Canaan Landfill Site
2. Environmental Management
Environmental management is the management that enables the organization to control the impact of its activities or products on the natural environment, helping the organization to set goals and targets to reduce these impacts and develop programs to achieve the objectives [3]. The importance of management is appeared at improving environment performance, reducing liability, competitive advantage, improving compliance, reducing costs and accidents, enhancement of customer trust, increasing suitable credit terms, and meeting customer requirements.

3. Surveyed Landfills
In this study, two active landfills in Diyala Governorate had been selected, namely: (Canaan and Zanbour sanitary landfills) lies at Baquba city. The surveying of the selected landfills is carried out over a period of 12 months (1 year).

The method that includes technical and social realities, has been used to collect information using two basic means namely: interview and field observation. Before the beginning of the survey, personnel of services unit attended an explanation meeting for better understanding of the precise procedures for collecting data. Information about the landfills locations have been taken from Baquba municipality directorate, while Baquba environment directorate provided the actual siting information. Actual construction requirements have been blogged by field observation. The data for mentioned sanitary landfills, are collected, analyzed and comprised with each other according to Instructions of Environmental Determinants for Projects Establishing and Implementation Monitoring, No. (3), 2011, Iraq as shown in table (1-a) and (1-b).
Table 1. Criteria of Landfill Site Selection for Siting Considerations and Construction Requirements

| Siting Considerations | Limitation of Criteria | Canaan Landfill Site | Zanbour Landfill Site |
|-----------------------|-------------------------|----------------------|-----------------------|
| Acquisition of Property | General Property         | General Property     | General Property       |
| Topography             | <10%                    | < 1%                 | < 1%                  |
| Urban Centres          | 3km                     | 8km                  | 20km                  |
| Roads and Highway      | 1km                     | 2km                  | 3km                   |
| Power Lines            | 0.03km                  | 1km                  | 0.2km                 |
| Airports               | 3km                     | 35km                 | 50km                  |
| Surface Water          | 0.5km                   | 6.5km                | 4km                   |
| Sensitive Areas        | 1.5km                   | Away                 | Away                  |

Table 2. Canaan Landfill Site in Comparison with Relative Importance

| Siting Considerations | Relative Importance (%) | Corresponding Ratio (%) | Gap Size (%) |
|-----------------------|-------------------------|-------------------------|--------------|
| Acquisition of Property | 15                      | 15                      | 0            |
| Topography             | 15                      | 15                      | 0            |
| Urban Centers          | 20                      | 20                      | 0            |
| Roads And Highway      | 10                      | 0                       | 10           |
| Power Lines            | 5                       | 5                       | 0            |
| Airports               | 5                       | 5                       | 0            |
| Surface Water          | 20                      | 20                      | 0            |
| Sensitive Areas        | 10                      | 10                      | 0            |
| **Total**              | **100**                 | **90**                  | **10**       |

4. Comparison of Canaan and Zanbour Landfills Siting
Siting considerations and Construction requirements of landfills is implemented according to relative importance of each criteria [4] and determined the corresponding ratio and gap size as shown in tables 2, 3, 4, and 5. Figures 4 and 5 show the wastes' requirements qualification of surveyed landfills for siting considerations and construction requirements, respectively.
Table 3. Zanbour Landfill Site in Comparison with Relative Importance

| No. | Siting Considerations          | Relative Importance (%) | Corresponding Ratio (%) | Gap Size (%) |
|-----|--------------------------------|--------------------------|-------------------------|--------------|
| 1   | Acquisition of Property        | 15                       | 7.5                     | 7.5          |
| 2   | Topography                     | 15                       | 15                      | 0            |
| 3   | Urban Centers                  | 20                       | 20                      | 0            |
| 4   | Roads And Highway              | 10                       | 0                       | 10           |
| 5   | Power Lines                    | 5                        | 5                       | 0            |
| 6   | Airports                       | 5                        | 5                       | 0            |
| 7   | Surface Water                  | 20                       | 20                      | 0            |
| 8   | Sensitive Areas                | 10                       | 10                      | 0            |
|     | **Total**                      | **100**                  | **82.5**                | **17.5**     |

Table 4. Canaan Landfill Site in Comparison with Relative Importance

| No. | Construction requirements     | Relative importance (%) | Corresponding ratio (%) | Gap size (%) |
|-----|--------------------------------|--------------------------|-------------------------|--------------|
| 1   | Cover soil                    | 10                       | 9.5                     | 0.5          |
| 2   | Supporting infrastructure     | 10                       | 9.5                     | 0.5          |
| 3   | utility, Equipment and machinery | 20                  | 19                      | 1            |
| 4   | Fencing the site              | 20                       | 0                       | 20           |
| 5   | leaving the site over 1 year after settlement waste deposing according to scientific methods | 10 | 0 | 10 |
| 6   | Waste deposing according to scientific methods | 30 | 5 | 25 |
|     | **Total**                      | **100**                  | **43**                  | **57**       |

Table 5. Zanbour Landfill Site in Comparison with Relative Importance

| No. | Construction requirements     | Relative importance (%) | Corresponding ratio (%) | Gap size (%) |
|-----|--------------------------------|--------------------------|-------------------------|--------------|
| 1   | Cover soil                    | 10                       | 9.5                     | 0.5          |
| 2   | Supporting infrastructure     | 10                       | 7.5                     | 2.5          |
| 3   | utility, Equipment and machinery | 20                  | 15                      | 5            |
| 4   | Fencing the site              | 20                       | 0                       | 20           |
| 5   | leaving the site over 1 year after settlement waste deposing according to scientific methods | 10 | 0 | 10 |
| 6   | Waste deposing according to scientific methods | 30 | 5 | 25 |
|     | **Total**                      | **100**                  | **37**                  | **63**       |
5. Results
Waste, discharged onto landfill sites, is one of the largest sources of pollution in Diyala Governorate due to the absence of observation and control of health and environment, the solid waste proportion contributes the total capacity of landfill. Many criteria have been studied and adopted with some acceptable buffer zone and limitations, which are put to ensure these criteria, like:

- Buffer zone of 1000 ft. (304.8 m) from water wells should be taken into consideration away from landfill sites [5].
- The best locations of landfill are flat rolling hills to avoid leachate and slope failure, topographical criteria should be noticed in site selection, where a land slope more than 10% should be avoided [6].
- Buffer zone of 5km away from urban centres, unless there are natural barriers, should be considered at siting process [7].
• Landfills should be placed farther than 500m from rivers or lakes and 250m from swamp areas [7].
• Distance greater than 1 km from roads and highways should be avoided because the expensive cost of constructing road networks [8].
• Landfills should be constructed on a distance farther than 1.5km from sensitive lands as cemeteries, historical sites and religious sites [9].
• Distance farther than 3km must be taken as a buffer zone from airport [10].

It can be noticed that was a gap in criteria of sanitary landfill sites, Canaan and Zanbour in Diyala Governorate, which ranged between very large to medium. The gap size was rather acceptable in the site considerations while very high in the construction requirements without real treatments. The siting considerations of sanitary landfills for 2 surveyed sites have a gap size ranging from 10 to 17.5%. Construction requirements get a gap rate of 57% at Canaan site, while it increased to 63% at Zanbour site. Therefore, this environmental activity, sanitary landfill, is very hazardous activity and it is necessary to start the process of recycling and recovery of solid waste in different industrial areas and disposal of the large quantities of waste.

Reference
[1] Instructions of Environmental Determinants for Projects Establishing and Implementation Monitoring, No. (3), 2011, Iraq
[2] Leao S Bishop I and Evans D 2004, Spatial-temporal model for demand and allocation of waste landfills in growing urban regions, (Computers, Environment and Urban System), p 353
[3] Amidi M 2016 The Effect of Reverse Logistic on Environmental Protection (Applied Study), M.Sc. Thesis, University of Babylon, Iraq
[4] Alshlah A 2015 Evaluating the Application of Some of Activities for Projects Construction Based on Environmental Management Requirements Using GIS: Babil Governorate as a Case Study, Higher Diploma of Strategic Planning Thesis, University of Babylon, Iraq
[5] Sener B 2004 Landfill Site Selection by Using Geographic Information Systems, M.Sc. Thesis, Department of Geological Engineering, Turkey
[6] Alshweikh Z 2017, Artificial Neural Network for Predicting Landfill Sites for Medical Solid Wastes: Case Study Babil Governorate, M.Sc. Thesis, University of Babylon, Iraq
[7] Al-Anbari R, Alnakeeb A and Abd M 2013 Landfill Site Selection for Kerbala Municipal Solid WastesUsing Geographical Information System Techniques, Engineering and Technical Journal, Vol. 32, Part A, No.13
[8] Allen A, Brito G, Caetano P, Costa C, Cummins V, Donnelly J, Fernandes C, Koukoulas S, O'Donnell V, Robalo C and Vendas D 2001 The Development of a GIS Model for the Location of Landfill Sites in Ireland and Portugal, British Geotechnical Association, 3rd Geoenvironmental Engineering Conference, University of Edinburgh
[9] Gisi S and Feo G 2010, Using an Innovative Criteria Weighting Tool for Stakeholders Involvement to Rank MSW Facility Sites with the AHP, Elsevier Ltd, Waste Management, Vol. 30, p 2370
[10] ElAlfy Z, Elhadary R and Elashry A 2010, Integrating GIS and MCDM to Deal with Landfill Site Selection, International Journal of Engineering and Technology Vol. 10, No. 6