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Landfill site selection literature review: For Bodrum District

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ABSTRACT

With the rapid increase of the world's population, waste production is also increasing rapidly and these wastes must be disposed of in landfill sites under control in national-international accordance with the decrees. Nowadays, some of the waste is still disposed of in wild irregular landfill sites. As a result of these wild irregular landfill sites, it is seen that there is a need for solid waste landfill sites due to environmental pollution and health risks. One of the areas where solid waste is disposed of in wild irregular landfill sites is the Bodrum district of Muğla province. For these solid waste landfill sites to be built in suitable areas, some criteria need to be considered. In this study, the location selection criteria for solid waste landfill sites for the Bodrum district of Muğla province were determined by examining the frequency of use in the literature. Nevertheless, national-international decrees that were evaluated in criterion restrictions have also been examined.

1. INTRODUCTION

With the increase in the world population, waste production is also increasing. Today, some of the waste produced is still disposed of wild irregular landfill sites that cause environmental pollution and health risks. Therefore, an effective solid waste management system is needed (Özkan 2018). The wastes must be collected, disposed of, and recycled in an order determined by national and international decrees (Chabuk et al. 2016).

These landfill sites must be able to serve for long terms as well as the population of the land it will serve, waste produced per person, the assumed number of waste to be produced in the following years as calculated by the earlier years of service should be determined. Then, it should be investigated whether there are sufficient alternative areas for the construction of the calculated storage area.

Solid waste landfill site selection is a complicated process because the suitability of alternative areas should be determined by paying attention to many environmental, economic, and social criteria (Özkan 2018).

For landfill site selections to be performed efficaciously, the criteria must be determined by paying attention to national-international decrees, expert opinions, and frequency of use in literature. Additionally, the criteria may vary according to the data availability and characteristics of the relevant region.

Geographic Information System (GIS) and Multi-Criteria Decision Analysis (MCDA) should be used in landfill siting because they are powerful, integrated tools used to solve the problem of landfill site selection (Chabuk et al. 2016). Among the MCDA methods, Analytical Hierarchy Process (AHP) is the most common and popular, used to identify criteria weights using a pairwise comparison matrix (Mohammed et al. 2019).

In Muğla, Bodrum where this study uses as an application area, wild irregular landfill sites that are close to residential zones, affects the environment and human health negatively due to methane gas explosions chained by the increase in heat during the summertime.

Also, Bodrum is one of the most touristic regions of Turkey and the summer population is much higher than the winter population. Therefore, the size of the landfill site should be taken into account according to the amount of waste in the summer population.

Consequently, a solid waste landfill site appears to be needed in Bodrum.

In this study, the frequency of use of the criteria in the literature and the national-international decrees that were considered in the criterion constraints were

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examined. At the same time, this study will guide the criteria to be determined for future research.

2. METHOD

GIS and AHP are often used for the alternative landfill site selections. AHP divides the decision problems into understandable parts; each of these parts is analyzed separately and integrated in a logical manner (Rahmat et al. 2016). AHP is a method used to determine the severity of effective measures in decision making with binary comparisons. The method helps to evaluate multi-criteria decision-making problems under uncertainty by including the decision maker's experience, knowledge, and intuition in the decision. In order to find the weights of the criteria, 1-9 grades of importance are used (Avşar 2018).

The reason for determining severity grades is to determine whether the decision- decider behaves consistently when comparing criteria. Weights can be used in comparison matrices as a result of the consistency rate being less than 10%.

In this study, the frequency of use of criteria has been examined in a total of 23 sources applied in 14 different countries since 2010. These countries are; Turkey, Iraq, Serbia, Pakistan, Morocco, Egypt, Malaysia, Bangladesh, Iran, Ethiopia, Ghana, India, Italy, and Cameroon.

Frequency of use of the criteria is shown in the Fig. 1 below. The least mentioned criteria in the literature were collected under the name of the other group.

The 28 criteria examined were weighted according to their frequency of use. The weighting table was shown in Table 1.Then, taking into account the characteristics of the region, the selected 11 criteria were reweighted. The reweight table was shown in Table 2.

3. RESULTS

In this study, the criteria to be considered in the selection of solid waste landfill site locations were examined. Since 2010, the criteria have been examined on a total of 23 sources in 14 different countries. As Fig.1 suggests, the most commonly used criteria are; distance to roads, distance to surface waters, slope, distance to settlements, and land use/land cover. Respectively weights; 0.10, 0.09, 0.08, 0.08, 0.08.

These criteria were seen to be the most important criteria for landfill site selections. Other criteria have been seen to change according to the characteristics of the region.

For Bodrum district, 11 criteria were selected from 28 criteria. Taking into account the data obtained from the open-source and the characteristics of the region, the criteria were determined. These criteria; distance to roads, distance to surface waters, slope, distance to settlements, land use/land cover, geology, distance to protected areas, distance to airports, aspect, distance to the coastline, and population density.

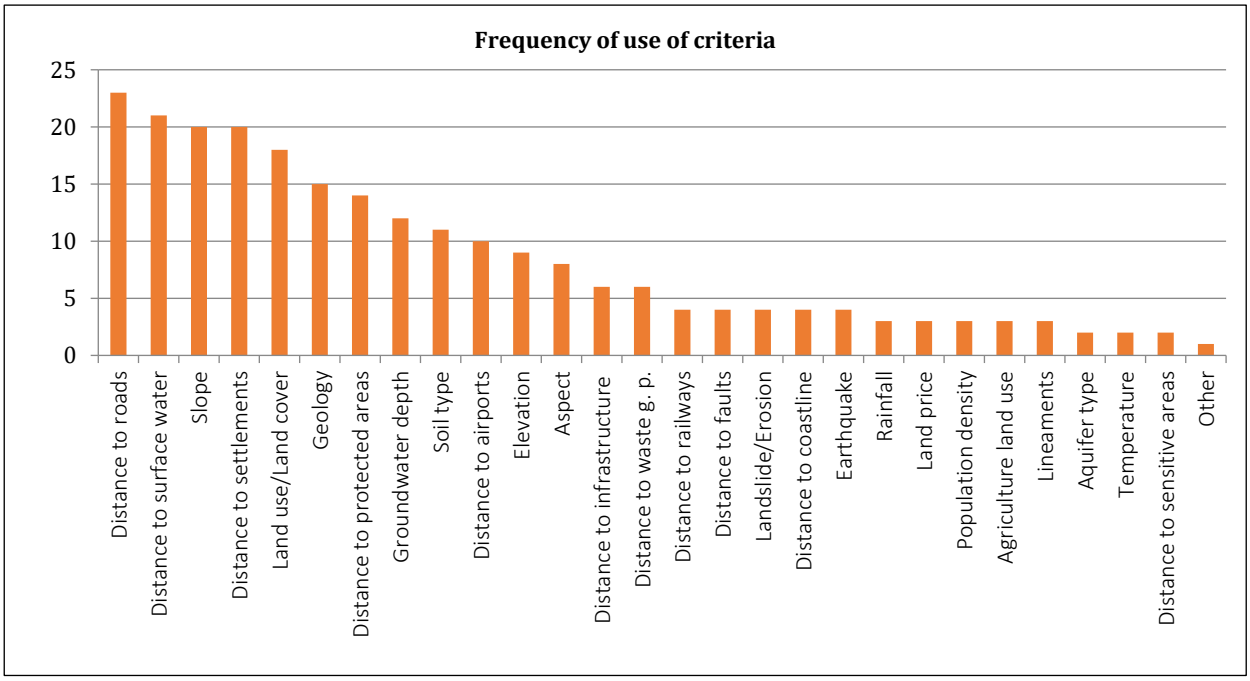

Figure 1. Frequency of use of criteria in literature

Other criteria are; state border, forests, snow/glacier, plantation, military areas, talwegs, landscape, borehole, flooding, nonferrous exploitation fields, and distance to industrial areas.

Table 1. Criteria in literature and their weight

Criteria	Weight	Criteria	Weight	Criteria	Weight	Criteria	Weight
D.t.roads	0.10	G.water depth	0.05	D.t.railw.	0.02	Popul. Den.	0.01
D.t. s.water	0.09	Soil type	0.05	D.t.faults	0.02	Agri. l. use	0.01
Slope	0.08	D.t.airports	0.04	L.S./Eros.	0.02	Lineaments	0.01
D.t.settl.	0.08	Elevation	0.04	D.t.coastl.	0.02	Aquifer ty.	0.01
L.U./L.C.	0.08	Aspect	0.03	Earthquake	0.02	Temperat.	0.01
Geology	0.06	D.t. infrast.	0.03	Rainfall	0.01	D.t.sens. a.	0.01
D.t. prot.ar.	0.06	D.t.waste g.	0.03	Land price	0.01	Other	0
						Summation	1.00

Then, the 11 criteria selected were reweighted. In the reweighting for the selected 11 criteria, distance to roads, distance to surface waters, slope, distance to settlement areas, and land use/land cover criteria were found to take high weights. Respectively weights are 0.15, 0.13, 0.13, 0.13, 0.11.

Table 2. Determined criteria and their weight

Criteria	Weight	Criteria	Weight	Criteria	Weight
D.t.roads	0.15	L.U./L.C	0.11	Aspect	0.05
D.t.s.w.	0.13	Geology	0.10	D.t.c.l.	0.03
Slope	0.13	D.t.p.a.	0.09	Pop.de.	0.02
D.t.settl.	0.13	D.t.air.	0.06	Sum.	1.00

While examining the criteria in the literature, it was also examined whether there are national-international decrees set by the countries.

When the studies carried out in Iran were examined; in 2016, Rahmat and others ignored national decrees, while in 2019 it was observed that Barzehkar and others took into account the decrees in his study. It has also been observed that Ghana and India take into account national decrees when determining criteria restrictions. Studies conducted in other countries have observed that expert opinions, questionnaires, and national-international decrees together were taken into account in determining criteria restrictions.

4. DISCUSSION

These findings suggest that the first five criteria were significant according to the weightings process. The first most commonly used criterion is the distance to roads criterion. Landfill sites need to be close to roads because moving waste over long distances will increase the cost. At the same time, landfill sites should not be too close to roads and should not create visual pollution.

Therefore, it has been seen that the distance to roads criterion is one of the criteria to be considered the most. The second crucial criterion is the distance to surface water. In this criterion, landfill sites must be built away from surface waters to avoid environmental pollution. The third most commonly used criterion was the slope criterion. Building landfill sites in areas with high slopes will cost a lot of money due to excavation-filling operations.

Therefore, landfill sites should be built where the slope is low. Landfill sites should be built in areas far from settlement areas. The environment and human health should not be compromised. The fifth most widely used criterion in the literature is the land use criterion. Land use/Land cover is the fifth most widely used criterion in the literature. Landfill sites should not be built in forest areas. It can be said that these criteria are the main criteria to be considered in future studies.

When criterion restrictions were examined, it was observed that 3 out of 14 countries were bound by decrees. In the studies examined, it was observed that the researchers applied different references when determining the criteria. As a result of the reviews, it is clear that the national decrees of the countries were inadequate.

5. CONCLUSION

In Bodrum, wild irregular landfill sites imperil the environment and human health. Therefore, a solid waste landfill site appears to be needed in Bodrum. In this study, the frequency of use of the criteria used in the selection of solid waste storage areas in the literature for Bodrum district was examined. The 28 criteria determined as a result of the literature review were weighted according to their frequency of use. The most commonly used criteria were observed as a result of weighting. 11 criteria were determined for the Bodrum district. The criteria were determined by taking into account the characteristics of the region and the data obtained. It was observed that the criteria vary according to regional characteristics in the sources examined. At the same time, it was examined whether national-international decrees were taken into account in the criterion restrictions. It has been observed in most sources that national-international decrees were not taken into account. It is clear that national-international decrees must be taken into account for an efficient outcome. This study will guide future studies.

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